INTELLECTUAL PROPERTY OFFICE

Patent thickets

An overview

Subject to peer review

This report was prepared by the Intellectual Property Office Patent Informatics Team, November 2011

E-mail: pit@ipo.gov.uk

Intellectual Property Office
Concept House
Cardiff Road
Newport
NP10 8QQ
www.ipo.gov.uk

Executive Summary

The Hargreaves Review of IP and Growth concluded that patent thickets can impact negatively on business and innovation. In response the Government committed to investigating the scale and prevalence of patent thickets, including whether they do in fact present a particular problem to small to medium enterprises (SMEs) seeking to enter technology sectors. This study is the first part of this work.

Thus the current study was initiated with three key aims in mind:

1. to begin to take the debate around patent thickets away from anecdotal and micro-study approach, toward a more generalised methodology by providing a general taxonomy for discussing patent thickets;

2. to generate an automated methodology for detecting patent thickets in published patent data; and

3. to assess whether or not patent thickets present a barrier to entry for companies, particularly SMEs, in the UK.

The phrase “patent thicket” is a descriptive term which highlights issues that new entrants to a market may face when attempting to innovate within, or enter into, a technology space having existing intellectual property rights. The most generally used definition of a thicket is that coined by Shapiro:

> “a dense web of overlapping intellectual property rights that a company must hack its way through in order to actually commercialize new technology”

Equal weighting is given to fragmented technological areas (areas where there are large numbers of small patent holdings), or areas where there are small numbers of large players with large patent holdings, each of which creates a thicket that any entrants into the area will have to negotiate in order to be able to operate.

There is no clear consensus on terms used to describe patent thickets and the entities involved with them. If these terms were applied consistently, further debate on any issues could be conducted on a level playing field. Any change in policy associated with patent thickets should be carefully considered for its potential impact across different technology landscapes.

The second aim is achieved by using the various micro studies of thicket existence which focus on patent pools, standards, blocking behaviour and products. Creating a set of algorithms and indicators will allow us to identify well-known thickets and identify where other patent clusters have similar characteristics.

Several indicators were calculated from the data, and the main patent density measures were the most useful in suggesting that thickets were present. However, it was interesting to note that some indicators potentially give more useful insight into the type of thicket present. Further work is required to expand on the indicators and their use in order to develop the toolkit for automatic detection, and perhaps categorising, of patent thickets in a generic area of technology.

Visual interrogation of patent landscapes offers an alternative method of assessing technology areas for patent thickets, as demonstrated by the analyses of the safety razor dataset. However, the complex terminology associated with some areas raises challenges in using this technique.

Following the creation of indicators, it was noted that patent applications themselves (as compared with granted patents) may also form a barrier to entry. This issue is compounded by the fact that in some jurisdictions (not the ones in the current study) the applicant can defer the examination of a patent for several years. In order to analyse whether this issue presents a problem, further work is needed to track cohorts of patents from application through to grant for certain technology areas and in certain jurisdictions.

It may be useful and perhaps more informative to analyse thickets by looking at the products which are associated with particular patents. Additional work would need to be carried out in order to start understanding how patents and products are linked, before datasets could be created.

To assess whether or not patent thickets present a barrier to entry for companies, particularly in the UK, a number of areas in distinct types of technology were selected to form the basis of the study. Some of the technology areas were chosen because they are known to contain thickets, and the areas also include traditionally relatively slow moving areas, such as safety razor blades, through to faster moving wireless networking systems. Much of the existing literature on patent thickets has its source in the United States and, as such, it is important to include US data together with European (EP) and UK data.

In order to explore some of the issues surrounding thickets in more detail, a case study based on safety razors was chosen. This is not one of the traditional high-tech areas presently associated with thickets, being more fundamentally mechanical in nature. However, there is a well known high patent density caused by the market dominance of the main players.

The data show that the companies involved are mainly large multinational companies, thus adding to the notion that there may be a barrier to entry. However, there are smaller companies present and as such there is no conclusive evidence either way, at this stage, to suggest that there are barriers to entry. The presence of an SME in a densely populated technology space is encouraging, but the key test is whether these companies can grow and develop within such spaces, and is an area which needs to be addressed in the next round of analysis.

This report has raised more questions than provided answers. Clarity and language associated with patents and claims, in particular, could be addressed. This was noticeable when attempting to visually map out some of the more complex high technology areas, such as wireless networking.

It was suggested in the Hargreaves Review of IP and Growth that one solution to patent thickets is to review the level of renewal fees charged. Work is needed to explore the issues surrounding the increasing of renewal fees, and particularly the impact any change would have on those parties who use the patent system in a non-thicket manner.

Additional research in considering the impact of the secondary market in patents should be contemplated. It seems that it would be interesting and relevant to study data relating to licensing and patent ownership for US, GB and EP data. However, this is not available at this time. A study in how this secondary market is evolving would be of value.

Contents

1 Introduction

This report was initiated as a part of the Government's Response[1] to the Hargreaves Review of IP and Growth[2] which committed to investigating the scale and prevalence of patent thickets. The Review expressed concerns that concentrated thickets of patents in some technologies may be anti-competitive and hence anti-innovation. Using the results of this study, the IPO will be conducting follow-on economic research and analysis to try to determine the impact that thickets are having on the ability of SMEs to gain market entry.

Thus the current study has three key aims in mind:

1. to begin to take the debate around patent thickets away from anecdotal and micro-study approach, toward a more generalised methodology by providing a general taxonomy for discussing patent thickets;

2. to generate an automated methodology for detecting patent thickets in published patent data; and

3. to assess whether or not patent thickets present a barrier to entry for companies, particularly for SMEs, in the UK.

In order to provide a useful overview, a review of the literature available in this area was conducted and an initial evidence base was needed to take forward this work into a consulting and analysis phase, with a number of points to feed into the discussion. This report provides an overview of the main terms used when describing patent thickets, thus providing a solid foundation to take forward any further discussion in a common language. It goes on to discuss the analysis of the patent data, reflecting on some of the indicators tested, and the results of a visual analysis. Following a case study, the report concludes with a set of questions raised to form the basis of discussion and further work.

A number of technology areas in distinct subject matter form the basis of the current study. Some of the technologies chosen have been the source of speculation as to the existence of patent thickets. Much of the existing literature on patent thickets has its source in the US system and, as such, it has been necessary to include US data together with European (EP) and UK data for the current study. There are a number of differences between the US and EP/UK patent systems, and where considered relevant, these have been highlighted.

One of the main drivers behind looking at patent thickets is to see if they were a barrier preventing SMEs from entering the market. By analysing the EP, UK and US data, this report looks at, for UK applicants, the company types involved in some areas of potential patent thickets.

[1] http://www.ipo.gov.uk/ipresponse-international.pdf
[2] http://www.ipo.gov.uk/ipreview-finalreport.pdf

2 Review and Definitions

2.1 Patents

Patents have become well-known tools in the management of commercial companies[3], and consideration of patent portfolio management has become an essential element of any company strategy[4]. Therefore the importance of understanding the scope of patent protection and thus the density of patenting activity in a particular field, has gained a new importance. Equally, the increasing availability of patent data globally has meant that both enforcers and granters of patent rights have been made increasingly aware of "ring-fencing" activities in technological areas[5]. The recent IP review "Digital Opportunity: A Review of Intellectual Property and Growth" identified the area of patent thickets as being an important hurdle to the development and innovation of new and existing technologies in the marketplace.

Patents contain a series of clear and precise statements setting out the scope of protection required by the applicant. These statements are known as the claims. An oft-quoted definition of the claims is that given by Lord Russell:

> "The function of the claims is to define clearly and with precision the monopoly claimed, so that others may know the exact boundary of the area within which they will be trespassers. Their primary object is to limit and not to extend the monopoly. What is not claimed is disclaimed."[6]

Much like a settler in a technology landscape, a patent applicant stakes their claims to an area of land via the wording of the claims. The claims set out in writing where the boundaries of their "land" lie in the technology landscape, so that others may know and be prevented from trespass. If another settler has already staked their right to the same area then the subsequent settler may not lay claim to the same "land". In exchange for this granting of an area of "land" or monopoly, the state requires that the applicants disclose how their technology works so that others in the same technology landscape may learn from and develop other related inventions.

However, in order to ensure that the claims are clear and precise, a specific terminology has been developed, which together with the technical language, can result in confusion as to the true scope of the protection provided by the patent to the casual reader. This element can also lead to difficulties in assessing the value of a patent or series of patents, and whether or not action is warranted if a competitor "trespasses" in a protected area. Thus an understanding of a technology landscape in terms of patents is a complex process. If the fact that a single patent database contains over 70 million records[7] is added into the mix, it is easy to see why this assessment of a technology landscape is further complicated for third parties, including new entrants into a marketplace.

Advances in management of information and the development of the internet have meant that information is more readily available than at any other time. This has raised further challenges to both applicants and Intellectual Property Offices, as the source of information

[3] Patent Thickets and Idiosyncrasy of Patent Strategy, LIU Lin-qing, ZHAO Hao-xing, 2007 Proceedings of International Conference on Enterprise and Management Innovation, p621-627, 93

[4] World Intellectual Property Report The Changing Face of Innovation, 2011, introduction and page 11 available from: http://www.wipo.int/export/sites/www/econ_stat/en/economics/wipr/pdf/wipr_2011.pdf

[5] Toyota Builds Thicket of Patents Around Hybrid To Block Competitors., John Murphy, The Wall Street Journal, Asia Business, July 1, 2009 available at: http://online.wsj.com/article/SB124640553503576637.html

[6] Lord Russell of Killowen at p. 39, in *Electric and Musical Industries, Ltd. et al v. Lissen, Ltd. et al* (1939), 56 R.P.C 23

[7] The doc DB database hosted by EPOQUE and the European Patent Office, not of all which will comprise patents that are in force.

concerning whether or not a part of the technology landscape can gain patent protection is not solely limited to the disclosures of patents, but can take the form of any prior datable disclosure.

However, this flow of information has the potential to increase the cross-fertilisation of ideas from one technology area to another, without the historical boundaries of traditional disciplines, consequently improving the potential for new and disruptive technologies to occur. Arguably, using the information disclosed in patents means that we are all "standing on the shoulders of Giants[8]". In more mature technologies, where there are a large number of patents, the distinction between what is a new invention and what is merely an enhancement of an acknowledged technology may become increasingly difficult to discern.

It seems that given the extensive profile, and increasing importance that patents are gaining within the global economy, an increasing volume of patents will be created. Does an increasing volume of patents equate to a patent thicket or difficulties in entering a technology space? This leads to the question: what is a patent thicket?

2.2 Patent thickets

The phrase patent thicket is a descriptive term which highlights issues that new entrants to a market may face when attempting to innovate, or enter into within a technology space with existing intellectual property rights. The most generally used definition of a thicket is that coined by Shapiro:

> "a dense web of overlapping intellectual property rights that a company must hack its way through in order to actually commercialize new technology."[9]

It is interesting to note that this definition does not restrict the thicket to be owned or created by a single or small number of players. Equal weighting is given to fragmented technological areas (areas where there are large numbers of small patent holdings), or areas where there are small numbers of big players; each of which creates a thicket that any new entrant will have to negotiate in order to be able to operate.

However, despite Shapiro's comments, on reviewing the general literature in this area, it seems that no concrete definition of a thicket has yet been agreed by researchers, as a number of different interpretations have been created. These definitions tend to fall into a number of forms.

Fragmented property rights:

- When multiple organisations each own individual patents that are collectively necessary for a particular technology their competing intellectual property rights form a patent thicket[10]
- Patent thickets are sets of overlapping property rights that occur in fragmented technology Markets[11]
- A patent thicket exists when too many patents covering individual elements of a commercial product are separately owned by different entities.[12]

[8]Sir Isaac Newton commented in a letter to Robert Hooke dated February 5, 1676 that:
"*If I have seen a little further it is by standing on the shoulders of Giants*."

[9] Carl Shapiro, Navigating the Patent Thicket: Cross Licenses, Patent Pools, and Standard-Setting, 2001, Innovation Policy and the Economy (Vol. I) (Jaffe, Adam B. et al., eds), pp. 119–150, MIT Press.

[10] European Intellectual Property Review 2009 Article Pools, Thickets And Open Source Nanotechnology Joel D'Silva. Gavin Clarkson and David DeKorte, "The Problem of Patent Thickets in Convergent Technologies" [2006] Ann. N.Y. Acad. Sci. 1093, 181.

[11] Patent Thickets, Spillovers, and Market Value: Evidence from a Panel of US Firms 1, Mahdiyeh Entezarkheir

Blocking patents:

- "The combination of complex technology and high volume patenting creates patent thickets which can be defined as dense webs of overlapping patent rights... The measure derives directly from information on blocking of one patent by another"[13]
- "A dense and overlapping set of complementary patent rights…of which at least one patent right is blocking the production of an innovation*."*[14]

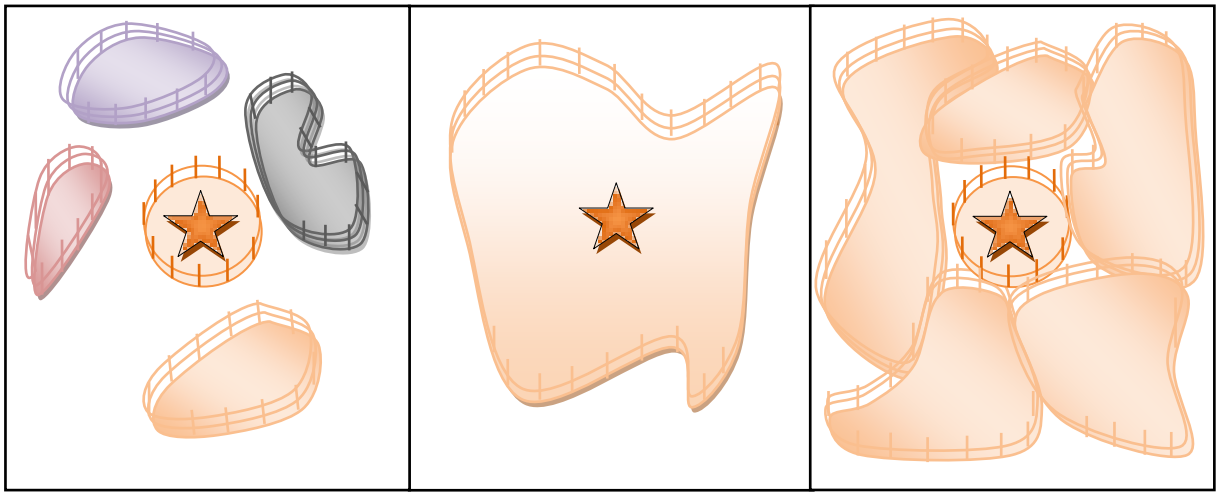
Alternative terms such as "patent floods"[15] and "patent clusters"[16,17] can also be used. For consistency the term patent thicket has been used throughout the current document. These differing definitions of what exactly a thicket may be, does not aid the reader in comprehending the scope of the issue. Indeed, the idea that patents should not be granted for the same invention, in theory, should not occur as was noted earlier in Section 2 where the scope of claims was discussed.

A number of technology areas have been highlighted in the academic literature as having patent thickets:

- Semiconductors[9,17]
- Biotechnology[18]
- Computer software[19] (in the US)
- E-commerce (in the US)
- Nanotechnology[20,21,22]
- Telecoms[23]
- Pharmaceuticals[24]

[12] The Rise and Fall of The First American Patent Thicket: The Sewing Machine War Of The 1850s, Adam Mossoff, Arizona Law Review, Vol 53:165 No measures are given as to precisely how many different entities are required to own individual elements of a commercial product before a thicket arises.
[9] How to measure patent thickets - A novel approach Georg von Graevenitz, Stefan Wagner and Dietmar Harhoff Discussion paper 2009-9July 2009
[14] A blocking patent right in the patent thicket is essentially held by a patent right holder who extracts strategic value from holding up complementary patent right holders, in addition to any intrinsic value that a patent right might generate. Empirically Detecting Patent Thickets Eric van Damme & Simone Keunen*(December 2009)
[15]"..multiplicity of patents, referred to as "patent thickets*" and "patent floods" ..."* in Mattias Ganslandt, Intellectual Property Rights and Competition Policy, IFN Working Paper No. 726, 2008, page 12
[16] "*One commonly applied strategy is filing numerous patents for the same medicine (forming so called "patent clusters" or "patent thickets")*" in European Commission, Pharmaceutical Sector Inquiry, Preliminary Report (DG Competition Staff Working Paper), 28 November 2008, page 9.
[17] Patent and literature statistics - The case of optoelectronics, World Patent Information, Sternitzke; Bartkowski C; Schwanbeck A; Schramm H; R, (2007) vol 29, 4, pp 327-338
[18] Negotiating the RNAi patent thicket, Charlie Schmidt, *Nature Biotechnology* **25**, 273 - 275 (2007)
[19] The Myth of the Software Patent Thicket: An Empirical Investigation of the Relationship Between Intellectual Property and Innovation in Software Firms, RJ Mann, 2004, U of Texas Law and Economics Research Paper No. 022, Available from: http://www.timeshighereducation.co.uk/story.asp?storyCode=187745&sectioncode=26
[20] Examining the Viability of Patent Pools to the Growing Nanotechnology Patent Thicket, Alexander Lee,
[21] Will the nanomedicine "patent land grab" thwart commercialization? Bawa, Nanomedicine: Nanotechnology, Biology and Medicine 1 (2005) 346-350
[22] Intellectual Property in the Nanotechnology Economy, Singh KA, available from: http://www.nanoforum.org/dateien/temp/Article%20on%20Intellectual%20Property%20-%2012%20JAN.pdf?23112011213516
[23] Betting on the 4G patent pool, Telecom Asia Staff, 2008, available from: http://www.telecomseurope.net/content/betting-4g-patent-pool

Following on from the analogy highlighted in section 2.1, Figure 1 provides an illustration of the concept of a thicket and shows some patenting strategies employed by applicants. The central “star” of the figure represents the key invention made by the applicant. In part (a) the initial key patent is protected by a certain wording of claims; the boundaries (or scope) of which is represented by the fence surrounding the star. There is other activity and patent protection present in the same technology area, which is represented by the other fenced areas. However, there is plenty of scope of competitors to protect potentially related developments in the “white space” of the technology areas present.



(a) (b) (c)

Figure 1 illustration of potential types of patenting strategy

In part (b) the applicant has drafted and been awarded a broad scope of claims which encompasses a large area of the technology space. However, this approach has its drawbacks, as it is more likely for a competitor to be able to challenge such a broad scope of protection in the courts, and potentially invalidate the patent, thus leaving the applicant without any protection for his key invention. There is evidence that US and EU based applicants tend to file applications with broad scope of claims and those from areas such as Japan tend to file large numbers of applications with narrower scope of claims[25].

In part (c) a patent thicket is represented, according to Shapiro, where a key patent has been surrounded by patents relating to the same technology and of potentially overlapping scope of claims, thus presenting any competitors from gaining a foothold in technology “white space”. If any of the patents are successfully challenged, the “ring fencing” of the initial key patent means that it is likely that the key initial patent will remain protected.

New or current players may therefore have potential difficulties in operating due to:

a) The voluminous nature of a group(s) of patents owned by a few large player(s) in a particular technology area;

b) The sweepingly broad scope of protection provided by a small number of patents to a low number of initial entrants into a technology field[26,27]

[24] Pharmaceutical Sector Inquiry Preliminary Report, DG Competition Staff Working Paper 2008, EUROPEAN COMMISSION competition DG
[25] Patent Strategy for Researchers and Research Managers, H Jackson Knight, 2005, Second Edn John Wiley and sons, pages 50-56.
[26] The Nanotech IP landscape: increasing patent thickets will drive cross licensing, Maebuis et al, available from: http://www.foley.com/files/tbl_s31Publications/FileUpload137/2955/Document1.pdf

c) The fragmented nature of a densely populated technology space.

High densities of patents create “no-go” areas in terms of research and development. These “no-go” areas can be created where it is necessary for later innovators to licence patented technology, which may come at too high a price to make it viable in R&D terms, or where it is prohibitively expensive or arduous to design around patents, or simply in the scenario where an assignee refuses to grant a licence. If the patent density is particularly great then these may potentially entirely prevent inventors from accessing technology areas[28] as seen in (c).

Further, the fact that an area of high patenting density may necessitate licensing discussions with a large number of individual patent assignees will hinder any technologies which require the licensing of the underlying technology to get a product of methodology into the marketplace. [29] In these cases royalty stacking[30,31] can become an issue. This occurs where an inventor must pay a large number of patent owners, royalties in order to be able to bring their invention to the market. Where there are a large number of different patent owners, these costs tend to increase and can be prohibitive.

It seems that given the extensive profile that patents are gaining within the global economy an increasing number of areas of high patent densities will be created. It is also interesting to note that the cross-fertilisation of ideas from one technology to another has the potential to create new thickets and fragmented technology areas.

In understanding the issue of a thicket it is important to fully comprehend exactly why a thicket forms and thus how they can be potentially detected and mitigated, if it is an issue for a technology/market space. Is there a difference between different technology areas or stages of development of technologies? Does this make a difference to considering whether or not a thicket exists? This then begs the question: can thickets themselves be subdivided into a number of alternate forms? Would this make a difference to the methodologies that can be employed to resolve this issue?

2.3 Historical review

Further to the issues raised above, it was decided to examine two contrasting areas of technology in terms of patenting strategies and technology landscapes, to compare how patents are used and how potential thickets may be formed. These two areas are pharmaceuticals and telecoms.

2.3.1 Pharmaceuticals

One of the areas that has historically been subject to litigation and intense patenting activity is that of pharmaceutical research. In a technology area where the rewards can be so great, and the costs so high, in the development of a single drug, worldwide patent protection is essential. Getting an effective system of patent rights in place is vital for any company entering into this marketplace, and indeed would seem essential for the major players already present. It is this pressure that leads to intensive patenting activity in the area of a

[27] The problem of Patent thickets in convergent technologies, Clarkson etc al, Ann. NY Acad. Sci, 1093:180-200 (2006)
[28] Patent Thickets, Licensing and Innovative Performance, Iain M. Cockburn, Megan J. MacGarvie and Elisabeth Müller, 2008, Discussion Paper No. 08-101, Centre for European Economic Research available from: ftp://ftp.zew.de/pub/zew-docs/dp/dp08101.pdf
[29] Patent Thickets, Spillovers, and Market Value: Evidence from a Panel of US Firms, Mahdiyeh Entezarkheir 2008,
[30] Patent Holdup and Royalty Stacking, Shapiro et al, available from: http://faculty.haas.berkeley.edu/shapiro/stacking.pdf
[31] Patent pools and diagnostic testing, Trends In Biotechnology, Verbeure B; van Zimmeren E; Matthijs G; Van Overwalle G, (2006) vol 24, 3, pp115-120

potential so called "blockbuster" drug[32]. The duration of a patent is 20 years, which can be extended with a Supplementary protection certificate (SPC) by up to five years[33] or a Patent term extension (PTE) in the US[34]. The time consumed by up front development costs in terms of drugs testing will devour much of the lifetime of a patent. The wolf in the form of generic manufacturers is also, metaphorically, never far from the door. This technology area should be thought of in a different sense to others, as this pressure is almost unique, as well as having the upfront costs of locating and synthesising a new active ingredient (or new chemical entity, NCE) they must also perform extensive drug testing to ensure that standards are met.

Reports from the EU commission[35,36] recently highlighted the fact that major pharmaceutical companies acknowledge they use their patent portfolios to extend the length of their patent protection for "blockbuster" drugs and delay or block the market entry of generic manufacturers. This conclusion is supported, in part, by data collected by the EU PatVal[37] survey[38]. The other point to make is that inventions estimated to be worth more than 10 million Euros are relatively frequent in chemical and pharmaceuticals (11.7%)[39]. This is what would be expected as the value of a patent for a pharmaceutical active ingredient can be worth millions of Euros. There may be a number of other patents which are less valuable, but the value of the "blockbuster" patent will skew the overall values of patents in this technology area. However, within this area there is also another factor which should be noted, and that is the regulatory framework for pharmaceuticals, which can vary depending on EU country; it is already believed to be having an effect on the number of filings for new drugs[40].

Patenting strategies are therefore an important consideration to any entrants or players in this particular area of technology. From the perspective of an existing operator they will have undertaken a large amount of research to arrive at a set of potential NCEs, usually from a group of compounds, and the race will be on to decide when would be best to submit the patent application to an Intellectual Property Office e.g. EPO, WIPO, US etc. The point at which this is done is important as it will dictate the length of time the patentee has for the protection of the invention but on the other hand, the longer they wait, the more likely other research groups are to make the same discovery. Equally, the longer the patentee delays, the more information they will have concerning which particular members of the compound family will be best in terms of activity and compatibility, thus enabling a better defined patent to be filed. There is always the balance to be struck between getting sufficient information into the patent application to ensure the patent will be allowed, and is relevant to the final product, which may not yet be fully known; and yet, ensuring that they are the ones who will

[32] medicines whose annual global turnover exceeds US$ 1 billion

[33] In the EU and UK. A supplementary protection certificate (SPC) is a form of intellectual property that extends the protection of a patented active ingredient or combination of active ingredients present in a pharmaceutical or plant protection product after the expiry of the patent. More information is available from: http://www.ipo.gov.uk/p-spc.htm

[34] Timing of patent filing and market exclusivity, Michael K. Dunn, Nature Reviews Drug Discovery 10, 487-488 (July 2011) Nature Reviews Drug Discovery 10, 487-488 (July 2011)

[35] Pharmaceutical Sector Inquiry, Preliminary Report (DG Competition Staff Working Paper), 28 November 2008 available from: http://ec.europa.eu/competition/sectors/pharmaceuticals/inquiry/index.html

[36] Final Report of Pharmaceutical Sector Enquiry, (DG Competition), 8 July 2009, available from: http://ec.europa.eu/competition/sectors/pharmaceuticals/inquiry/index.html

[37] Inventors and invention processes in Europe: Results from the PatVal-EU survey, Paola Giuri et al, Research Policy 36 (2007) 1107–1127

[38] Where patents in the area of chemistry and pharmaceuticals were dominated by large firms (81%) and a proportionally large amount of patents were described as "blocking competitors" and unused (28.2%). The next highest technology area using "blocking" patents was electrical engineering with 18.3%.

[39] Patents in chemicals and pharmaceuticals are generally estimated to be more valuable than those in mechanical and electronic technologies[37]

[40] DG COMP's Final Report on the Pharma Sector Inquiry: The Elephant Uncovered, Sept 2009, Killick and Dawes, Available from: http://www.whitecase.com/files/Publication/e34fe83a-bdbd-4dec-b28f-7cd40cbe2e13/Presentation/PublicationAttachment/69ef882a-66d3-4801-956b-80b95cd6949a/article_DG_COMPs_Final_Report_on_the_Pharma_Sector_Inquiry.pdf

gain patent protection for this drug in this area. Allegations that excessively broad and speculative patent applications have been filed by such manufacturers highlight the problematic nature of this balance. It is difficult to draft a patent application for a NCE for a specific condition where the research underlying the patent has not yet been completed; this includes the research associated with drug trials, as it is not always evident which compounds may cause unforeseen side effects. This potentially renders the patent worthless if it has been drafted too narrowly. Further patenting opportunities may arise, dependent on the discoveries made during the testing phase of the drug, as has been found in many cases e.g. Viagra® where the original drug was prescribed for cardiovascular problems rather than erectile dysfunction. These are often unforeseen. These further patenting opportunities give rise to what is known as "secondary" patents.

In pharmaceutical areas the originating patent or primary patent is often filed for the NCE with later filings defining various methodologies of production or subsequent useful side effects[41], as earlier noted. These secondary patents will fill the technology space surrounding the initial, primary patent, thus serving to further protect the key patent for the drug for the benefit of the manufacturer[42]. Surveys have noted that many major manufacturers use these extensive portfolios to maintain exclusivity of manufacture as long as possible, as would be expected of a company that has had to invest so extensively at the front end of the process. Indeed, it is important to realise that due to a number of factors, such as changes to the regulatory environment, costs of drug development[43] have vastly increased[44,45].

The prolonging of patent protection may take the form of secondary patents or divisional applications (that is, applications related to the primary or secondary patent but having a different scope of claims). The information that these divisional applications are based on *must* be disclosed in the parent application, but in the case of divisional applications the term of expiry of the patent is the same as that of the parent applicant. Continuation applications or continuations in part, may also be filed in the US. It has been noted that in the case of blockbuster drugs, there is a steady rise in patent applications through the life cycle of a product. Sometimes there is an even steeper increase at the end of the protection period conferred by the first patent.

2.3.2 Telecommunications

Another area which is also essential to consider when the issue of patent thicket arises is that of telecoms. Indeed, given the shift toward mobile computing, this has become a contentious area, in which vast sums of money are being expended to ensure that each company, with a stake in this marketplace, has a collection of patents or licenses which allows them to operate and settle any disputes without recourse to the courts, wherever possible[46]. The competition between two key players in the market that is Google and Apple

[41] Response to the invitation to submit comments to the preliminary findings in the European Commission Pharmaceutical Sector Inquiry, IP Institute, available from: http://ec.europa.eu/competition/consultations/2009_pharma/ipi.pdf

[42] The average number of patents and patent applications for best selling medicines is 140% higher (i.e. 237) than the average number of patents and patent applications for the overall sample (98.5)[36]

[43] The estimated average out-of-pocket cost per NCE is US$ 403 million (2000 dollars). When compared to the results of an earlier study with a similar methodology, total capitalized costs were shown to have increased at an annual rate of 7.4% above general price inflation[11].

[44] Rising research and development costs for new drugs in a cost containment environment, DiMasi JA, Pharmacoeconomics, 1992;1 (Suppl 1)13-20

[45] The price of innovation: new estimates of drug development costs, DiMasi JA, et al, Journal of Health Economics Vol 22, 2, 2003 151-185

[46] The arms race for intellectual property has only just begun", Tuesday 16th August 2011, 2:36am David Crow, available from: http://www.cityam.com/news-and-analysis/bottom-line/the-new-front-the-mobile-phone-wars

has recently made the headlines with the acquisition of Motorola by Google[47] after its failed bids for the patent portfolio of Nortel[48]. Since the Nortel auction of patents, there has been further patent battle[49] as exemplified by that between Apple and Samsung on the basis of their Smartphones and tablets, which started in the US in April of this year. The battle has now spread worldwide, with litigation actions initiated in nine countries: UK, US, Netherlands, Japan, Germany, South Korea, Australia, France and Italy and has not yet been resolved[50]. It has also caught the attention of the EU antitrust regulators[51].

According to the headlines, this is an area where the patent thicket is at its densest[52]. It is also an area where there has been a proliferation of patent pools which can be considered an indicator of thicket activity[53]. This is for a number of reasons, which are highlighted in the section on Standards and Patent pools below.

2.4 Other terms

Other important topics are discussed below. For telecoms, in particular, standards and patent pools are an essential consideration. Compulsory licensing and patent trolls also contribute to this debate and have been considered in the current report.

2.4.1 Patent pools

Patent pools have been in existence for a long time; the first American patent pool was set up in the technology area of sewing machines in the 1850's[54] where no single person managed to come with the complete sewing machine, so that in order to produce a machine, the use of a number of patents was essential. This led to a form of impasse as no-one manufacturer could produce and sell a machine. Consequently, the individuals who owned the patents eventually realised that the most effective way for them to gain from their intellectual property would be to work together[55] and they created the Sewing Machine Combination where the individuals pooled their patents[56] and established a fixed licence fee

[47] Google talks about Smartphones but really this is a patent arms race; Comment, Richard Fletcher, 15 August 2011, The Telegraph: available from http://www.telegraph.co.uk/finance/comment/8703369/Google-talks-about-smartphones-but-really-this-is-a-patent-arms-race.html

[48] Google Motorola bites back with patents, Apple not worried, August 17, 2001, available from: http://sanfrancisco.ibtimes.com/articles/199001/20110817/google_buys_motorola_patents_apple_android_iphone_ipad.htm

[49] "Smart-phones are not just another type of handset, but fully-fledged computers, which come loaded with software and double as digital cameras and portable entertainment centres. They combine technologies from different industries, most of them patented...The convergence of different industries has also led to a culture clash. When it comes to intellectual property, mobile-phone firms have mostly operated like a club. They jointly develop new technical standards..They then license or swap the patents "essential" to this standard under "fair and reasonable" conditions. Not being used to such a collectivist set-up, Apple refused to pay up, which triggered the first big legal skirmish over smart-phones." The great patent battle, Nasty legal spats between tech giants may be here to stay, Oct 21st 2010, The Economist, available from: http://www.economist.com/node/17309237

[50] The latest moves in the "patent battle" are highlighted in the Blog, Foss patents http://fosspatents.blogspot.com/2011/06/apple-amends-complaint-against-samsung.html by Florian Mueller June 17th 2011, with a visual representation here: http://www.scribd.com/doc/58081953/Apple-vs-Samsung-11-06-16

[51] EU regulator "concerned" over cellphone patents war, Foo Yun Chee, Thomson Reuters 22/11/11, available from: http://www.reuters.com/article/2011/11/22/us-apple-samsung-eu-idUSTRE7AL0ZQ20111122

[52] Google's Motorola Deal shows need for better patent system: view, Bloomberg, Editors, 19 August 2011, available from http://www.bloomberg.com/news/2011-08-19/google-s-motorola-deal-shwos-need-to-develop-better-patent -system-view.html

[53] Patent Informatics for Patent Thicket Detection: A Network Analytic Approach for Measuring the Density of Patent Space, Gavin Clarkson, presentation at the Academy of management, August 2005

[54] The Rise and Fall Of The First American Patent Thicket: The Sewing Machine War Of The 1850s, Adam Mossoff, Arizona Law Review, Vol 53:165

[55] Rather than sue each other in the so-called sewing machine wars. Sincere's History Of The Sewing Machine, William Ewers and H.W. Baylor, 39 (1970)

[56] This process took some time and was the basis for the "sewing machine wars" between a number of inventors: Howe, Wheeler, Wilson, Grover, Baker and Singer. The textile revolution, Sewing machine patent battle and Improvements, Mary Bellis, available from; http://inventors.about.com/od/indrevolution/a/sewing_machine_2.htm

for each patent in order to allow manufacture to proceed. This pool lasted until the final patent ran out in 1877. However, there are conflicting views as to whether or not patent pools actually encourage patenting and innovation[9, 57 ,54, 58 , 59 , 60] or ultimately discourage it[61]. Similarly in today's telecoms technology areas, it is increasingly the case that companies cannot manufacture and use the software associated with their smartphones without infringing a competitor's intellectual property[62]. This has, therefore, led to the creation of patent pools in specific areas, where, understanding that in order to profit from the intellectual property that a company has invested in, it is essential to co-operate with others, as following a litigious path can only lead to loss of revenue for all involved except the lawyers. Patent pools themselves have thus been defined as:

> "an agreement between two or more patent owners to licence one or more of their patents to one another or third parties"[63].

It can also be referred to as:

> "the aggregation of intellectual property rights which are subject to cross-licensing, whether they are transferred directly by patentee to licensee or through some medium, such as joint venture, set up to specifically administer the patent pool."[64]

There have been circumstances where governments have intervened to create patent pools where none existed; this was the case in aircraft in 1917[65,66]. However, through the creation

[57] "There is now widespread agreement among policymakers and economists that patent pools may benefit both intellectual property owners and consumers, provided that the pools include patents that are complementary or blocking" Efficient Patent Pools, Josh Lerner, Jean Tirole, September 3, 2003 available from: http://neeo.univ-tlse1.fr/202/1/patent_pools.pdf

[58] "Our research shows anecdotal evidence of how in such cases the adoption of standards (backed by ...patent pools) may indeed lead to accelerated technology development" Intellectual Property: Cross-licensing, Patent Pools and Cooperative Standards as a Channel for Climate Change Technology Cooperation, Iliev I and Neuhoff K, September 2009 http://www.eprg.group.cam.ac.uk/wp-content/uploads/2009/09/isda_intellectual-property_september-2009-report.pdf

[59] The Medicines Patent Pool, Stimulating Innovation, Improving Access, available from: http://www.medicinespatentpool.org/content/download/311/2031/version/1/file/FACTSHEET+FINAL+EB.pdf

[60] Facilitating access or monopoly: Patent Pools at the interface of patent and competition regimes, Barpujari Indrani, Journal of Intellectual property rights, Vol 15 September 2010, pp 345-356

[61] Contrary to theoretical predictions, the sewing machine pool appears to have discouraged patenting and innovation, in particular for the members of the pool." Patent Pools And The Direction Of Innovation - Evidence From The 19th Century Sewing Machine Industry, Ryan Lampe And Petra Moser, http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1468062

[62] Google Lawyer Says Patents Are 'Gumming Up' Innovation, Susan Decker, Jul 26,2011, Bloomberg, available from:http://www.bloomberg.com/news/2011-07-26/google-general-counsel-says-patents-are-gumming-up-innovation.html

[63] Patent Pools: a solution to the problem of access in biotechnology patents? Clark et al, USPTO, 5 December 2000, available from: http://uspto.gov./web/offices/pac/dapp/opla/patentpool.pdf

[64] An address to the American Intellectual property law association, on the subject of cross-licensing and antitrust law, Klein, Joel, 2 May 1997, available from: http://www.justice.gov/atr/public/speeches/1118.htm However, he also noted that the term patent pool was not a term of the art (United States v Line Material 333 US 287, 313 n24 1948)

[65] The patent pool known as the Manufacturer's Aircraft Association was created by the US Government at the outbreak of World War 1 and following extensive litigation between the Wright-Martin Aircraft Corp. and the Curtiss Aeroplane & Motor Corp. which prevented the building of aeroplanes. Heller, Michael. 2008. The gridlock economy: How too much ownership wrecks markets, stops innovation and costs lives. New York: Basic Books.

[66] The pool encompassed almost all of the airplane manufacturers in the US and bound all members to give each other non-exclusive licences and membership was open to three types of entities: 1) any responsible present or potential aeroplane manufacturer; 2) any manufacturer to which the federal government had awarded a contract for ten or more planes and 3) any owner of US aeroplane patents. All members would pay a flat $200 per aircraft royalty of which a proportion went to Wright and a proportion to Curtiss and the remainder to the pool for administrative costs. Further patents could be added to the pool and an arbitration panel was set up to decide on

of these patent pools there is the issue of generating an even greater monopoly, which followers would find harder to break or innovate from. Since the first pool, created in the US, was noted, there have been detractors from the approach claiming that it prevented others from entering the market place and limiting competition[67]. From this perspective, anti-trust or anti-competition laws have been invoked against the use of patent pools in some cases, and it remains a contentious issue for those entering into or excluded from patent pools.

It is important to realise that anti-trust law was not drafted to cover such circumstances as those created by patent pools[68], but that it has been seen to be the tool of best fit to address the potential for anti-competitiveness that such pools could represent. The US Supreme Court has adjudicated in the cases of two such pools in modern technology areas: MPEG-2[69] and Summit/VISX[70] pools. These have highlighted some of the shortcomings in adapting this legislation for such a use. However, given the current consideration of antitrust in intellectual property, guidance has been necessary for users of the intellectual property system to ensure that anti-competitiveness is not raised as an issue. Indeed a recent meeting[71] at the USPTO highlighted the similarities between the two sections of law, both of which deal with property whether tangible or intangible, and drive innovation[72] in different but complementary ways.

In the EU, the creation of patent pools is carefully watched and is subject to clearance by the relevant regulatory authorities; given that the impact of a pool is to ultimately create a further monopoly. A patent in itself is anti-competitive, in that a 20 year period of exclusivity granted to the inventor on the condition that the methodology and technology used to create the invention is made public. Dependent on the technology area, the patents may remain essential for the full term[73], or be rapidly outdated by new systems/technologies[74]. The law regarding this area is set out in Articles 101 and 102 TFEU[75] and specific concerns are related to the formation of horizontal and to some degree, vertical agreements. These types of agreements can be perceived as restricting competition with negative market effect on prices, output, innovation, and the variety and quality of products. This has to be balanced however, with potential positive effects associated with a patent pool, such as increasing knowledge transfer, investment and enhancing product quality and variety, and a potential overall increase in quality. Thus patent pools tend to be judged against a number of different

the royalties due on their actual use. Dykman, Harry, Patent licensing within the Manufacturer's Aircraft Association (MAA) Journal of the Patent Office Society 646 1964

[67] The popular press attacked the pool as a "*grinding pitiless monopoly*" and reacted with vehemence to the notion of seeking to further extend the lifetime or the number patents encompassed by the pool, as well as the concept of provision of a fund for fighting litigation from other sources regarding the validity or infringement of their IP. The Rise and Fall Of The First American Patent Thicket: The Sewing Machine War Of The 1850s, Adam Mossoff, Arizona Law Review, Vol 53:165

[68] Antitrust, patent pools, and the management of uncertainty, Joshua Newburg, 3 Atlantic L J 1 (2000)

[69] MPEG-2, Business Review Letter, 1997 DOJBRL Lexis 14 (Dep't of Justice Jun 26 1997)

[70] Summit Technology Inc FTC dkt No 9286 (21 Aug 1998) available at: http://www.ftc.gov/os/1998/d09286viagr.htm, http://www.ftc.gov/opa/1998/08/sumvisx.shtm

[71] Promoting Innovation through Patent and Antitrust Law and Policy, Varney Christine, remarks as prepared for the joint workshop of the USPTO, the Federal Trade Commission and the Department of Justice on the intersection of patent policy and competition policy: implications for promoting Innovation, 26 May 2010. Available from: http://justice.gov/atr/public/speeches/260101.htm

[72] White Paper, Standardisation as a business investment, BSI, available from: http://www.bsigroup.com/upload/Standards%20&%20Publications/Government/BSI_WhitePaper.pdf

[73] As in pharmaceutical areas, for example.

[74] As in telecoms areas, for example.

[75] Formerly Articles 81 and 82 of the EC treaty, these changes were made in order to decentralise application of the competition rules and remove some of the Commissions' administrative burden, to concentrate on the most serious infringements. They also ensure a role for national competition authorities in implementing EU competition law.

key factors[76] on a case by case basis. Similar considerations are necessary where the issue of standardisation is concerned.

The pool will allow the licensing of the relevant technology from the patent pool to the requesting company but the methodology which is used to calculate the redistribution of the fees associated with the license amongst members of the patent pool can itself be a cause of contention. The general method of redistribution is according to the share of the number of patents from the organisations which have been included in the pool. This can then encourage members of the pool, or competitors in a particular technology, to invest large numbers of patents, which may then gain them a greater share of fees associated with the pool. Whether or not all these patents are actually essential, or are simply part of a numbers strategy in gaining market revenue, can only be speculated upon[77]. In some circumstances it can be considered that the development of patent pool can itself actually encourage the formation of a patent thicket, rather than addressing the fundamental issue of high patent density[78]. This incentive also feeds into the development of standards.

2.4.2 Standards

Standards[79] are often developed in particular technology areas where a number of patents are essential in production or operation of a product. Many of the standards are developed from patent pools, where a decision is made to create an industry standard around those key patents; to ensure that all who require the key technology or processes can get their product to the marketplace without having recourse to all the individual rights holders in those areas.

Standardisation is an important aspect of technology, particularly in the electronics and information and communication technologies (ICTs) areas, as it is essential to both the end product and user that different pieces of hardware and software can communicate effectively to allow a user to employ the technology[80]. For example, when Sony and Philips cooperated to create and license the CD standard, this allowed CD technology to be adopted on a worldwide basis, rather than having competing interests and potential competing systems, which would confuse the general public. Other examples of commonly used standards are: the Intel x86 microprocessor architecture, Microsoft windows operating system, MPEG standard for compressing video data, Adobe Acrobat, ATM network standards and GSM standard for wireless telephone systems.

The standards setting process often takes place through a standards setting body. The standards setting body[81] can be one external to a patent pool, or group of owners of the patents. An example of a standards setting body is that of ITU (International Telegraph

[76] These factors are: 1) an assessment of the economic benefits of the agreement(s); 2) the restrictions must be a necessary and indispensible to achieve the gains; 3) the consumer must receive the benefit of the gains made by the restrictions and; 4) there must be no elimination of the competition relating to a substantial part of the product(s) in question. Article 101(3) TFEU).

[77] Patent pools and patent inflation - The effects of patent pool on the number of essential patent in standards, Baron J and Pohlmann T, Cerna Working Paper Series 2011 available from: http://ftp.zew.de/pub/zew-docs/veranstaltungen/innovationpatenting2011/papers/Baron.pdf

[78] According to Shapiro, patent pools are, in theory, the best way in which patent thickets can be addressed. However, when current practices of patenting strategy are considered in these contentious areas, it becomes clear that this is not a complete solution to the issue. "*In many respects, a patent pool..is the purest solution to the problem*.." Navigating the Patent Thicket, Shapiro C, Innovation Policy and the Economy 1, Ed. Jaffe et al. National Bureau of Economic Research, p134

[79] It is important to note that different types of standard exist; such as compatibility or interoperability standards.

[80] A pro-competitive policy, as noted in the Hargreaves Review and elsewhere: Heller, Michael. 2008. The gridlock economy: How too much ownership wrecks markets, stops innovation and costs lives. New York: Basic Books, and Supporting Document AA, at page 11; A review of Intellectual Property and Growth, an Independent report by Ian Hargreaves, May 2011, available from: http://www.ipo.gov.uk/ipreview-doc-aa.pdf

[81] SDO (Standard Developing Organisations) or (SSO) Standard-Setting Organisations, ie W3C (World Wide Web Consortium) who has the standards for the HTML (Hypertext Mark-up Language), CSS (Cascading Style Sheets) and XML (Extensible Mark-up Language).

Union), founded in Paris in 1865[82]. It is responsible for the standardisation and development of information and communication technologies (ICTs) on a worldwide basis. However, because of the sheer numbers of members, and the necessity for deciding what the lead on a particular standard should be on a national basis before going to the International Telegraph Union (ITU), this can be a lengthy process. Despite this, the process itself is seen as open and consensual process[83]. There are also national standard setting organisations (SSOs) such as BSI[84] and ANSI[85]. However, these national standard setting bodies are not the sole standard setters in the US or UK, in fact there are number of other consortia who create and then set standards which may be accredited by BSI or ANSI, if the rules set out by BSI or ANSI are adhered to in the formation process.

One set of principles, which are generally used in the standard setting process are set out in the FR(A)ND (Fair, Reasonable And Non Discriminatory) system, which may also be simple RAND. These terms are generally added to the contract that forms part of the standard setting process. Despite the addition of these terms, when the detail of such contracts is tested, it is often found that the precise scope of these terms is somewhat unclear[86] which can lead to private actions taking place in the courts to elucidate matters. As a part of the creation of the standard, the group involved often agrees to license the relevant IPRs in the standard, to those who require it, under the FRAND system[87]. This goes a way to mitigating anti-trust/anticompetitive concerns, and can enhance the inclusion of SMEs in the marketplace[88]. The involvement of a SSO does not necessitate the presence of a mediator to resolve disputes, and recourse to the courts is sometimes the only viable option[89].

Historically, a source of conflict has been the late disclosure of patents which are considered to be relevant to a standard that has already been developed, and may be already used in industry, or has been substantially negotiated. The discovery of further relevant patents is often known as a "patent ambush" [90,91] and at a late stage it is not possible or cost-effective to renegotiate the contract. Thus the owner of the patent derives royalties from the patents, which are not included in the standard, but are necessary to operate the technology defined in the standard[92].

This has happened in a number of cases such as Qualcomm[93] and Rambus. In the case of Rambus[94], the European Commission went as far as to insist that royalty rates for some

[82] ITU - Committed to connecting the world, March 2011, available from: http://www.itu.int/dms_pub/itu-s/opb/gen/S-GEN-HLPW-2011-PDF-E.pdf ITU is the UN specialised agency for information and communication technologies and can review or produce upwards of 150 standards in a typical year. Membership of ITU in the Standardisations/radio telecommunication sector stands at 31,800 sector members.
[83] Expanding the Boundaries of Intellectual Property, Innovation Policy for the Knowledge Society Eds R C Deyfuss, D L Zimmerman, H First, Setting Compatibility Standards: Cooperation or Collusion? Shapiro C, Oxford University Press, 2001.
[84] http://www.bsigroup.com/
[85] http://www.ansi.org/
[86] Defences to patent infringement in a standards context, Ari Lakkonen, Powell Gilbert UK, Presentation at the Fordham IP Conference, April 2011, http://fordhamipconference.com/wp-content/uploads/2011/04/Laakkonen.pdf
[87] As in the 3GPP/ETSI regime: "*the Declarant hereby irrevocably declares that it and its AFFILIATES are prepared to grant irrevocable licenses under its/their IPR(s) on terms and conditions which are in accordance with Clause 6.1 of the ETSI IPR Policy…* "
[88] Through the use of a common methodology, or technical standard or testing procedure(s); this may open up the market to companies that can produce components or products to, or through that particular measure, rather than having it restricted to larger players.
[89] As in the JPEG compression standard, Phillips and LG in the Netherlands Case No 261913, and GSM standard between Ericsson and Samsung electronics (UK, NL, DE and US actions).
[90] Rambus – the patent ambush, Patent World, April 2010, Charles Whiddington, Joseph Ward
[91] Deterring "Patent Ambush" in Standard Setting: Lessons from Rambus and Qualcomm, M Sean Royall, Amanda Tessar and Adam Di Vicenzo, Antitrust, Vol 23, No 3, 2009, pp34-37, available from; http://www.gibsondunn.com/publications/Documents/Royal-Tessar-DiVincenzo-DeterringPatantAmbush.pdf
[92] FRANDly fire: are industry standards doing more harm than good? Pat Treacy and Sophie Lawrence, Journal of Intellectual Property Law & Practice, 2008, Vol 3, No 1 pp 22-29
[93] Case COMP/39.247 - Texas Instruments / Qualcomm.

chips which were necessary to operate the standard were reduced on a worldwide basis for five years, and other chips were made available on a royalty free basis[95].

While it might be possible to create a standard which avoids the incorporation of any IPRs, it is now extremely unlikely that this could occur in certain sectors such as ICT. It is also probable that in many cases, where large patent portfolios are present, that unconscious patent ambushes may occur, as the company in question may not comprehend the scope of the IPRs that they currently own. This confusion can be increased when issues such as patent pendency[96] are considered. It is also interesting to note that the US anti-trust Dept of Justice[97] has commented that given the range of technology areas there are many different approaches taken by SSOs and that there is no "one size fits all" system appropriate for all areas of technology particularly one which involves patents.

Again, following on from the consideration of anti-competitiveness in the creation of a patent pool, surely the formation of a standard from a patent pool or even a standard in itself is the creation of a form of monopoly? The degree of creation and cooperation involved in putting together a standard is quite high, particularly given that the negotiations often occur between numerous different competitors in an area. Would the creation of the standard increase or reduce competition in that particular technology area?

In a recent US report on technical barriers to trade[98], concerns were raised about the consideration of compulsory licensing of patents that formed part of a standard, and about the inclusion of the Chinese government in the standard setting process. The Chinese government also refused to accept the testing of medical devices to international standards external to China so that these must all be tested in China before they can be used thus creating a barrier to trade between the US and China[99].

2.4.3 Compulsory Licensing

An important consideration in the area of thickets is that of compulsory licensing. If a patent owner is unwilling to licence their technology in certain circumstances can this be overcome through the issue of a compulsory license? This would thus prevent a key issue in thickets; that of "blocking" patents, which prevent progress whether it is technological or financial in the development of a product.

[94] COMMISSION DECISION of 9.12.2009 relating to a proceeding under Article 102 of the Treaty on the Functioning of the European Union and Article 54 of the EEA Agreement Case COMP/38.636 – RAMBUS, available from: http://ec.europa.eu/competition/antitrust/cases/dec_docs/38636/38636_1203_1.pdf

[95] Patent ambush in standard-setting: the Commission accepts commitments from Rambus to lower memory chip royalty rates, Ruben Schellingerhout and Piero Cavicchi, Antitrust, Number 1- 2010, pp 32-36, available from: http://ec.europa.eu/competition/publications/cpn/2010_1_11.pdf

[96] Where a number of patent applications are going through the examination process, the scope of protection gained from those final patents will be unclear, the longer the examination process takes, the longer the lack of clarity concerning the final scope of protection of the invention lasts.

[97] Promoting Innovation Through Patent and Antitrust Law and Policy, Christine A. Varney, Remarks as Prepared for the Joint Workshop of the U.S. Patent and Trademark Office, the Federal Trade Commission, and the Department of Justice on the Intersection of Patent Policy and Competition Policy: Implications for Promoting Innovation

[98] 2011 Report on Technical Barriers to Trade, Ambassador Ronald Kirk, Office of the United States Trade Representative, March 2011, pg 68 available from: http://www.ustr.gov/sites/default/files/TBT%20Report%20Mar%2025%20Master%20Draft%20Final%20pdf%20-%20Adobe%20Acrobat%20Pro.pdf

[99] They have also affected the standards associated with mobile phones through influencing the choice of encryption algorithm used. 2011 Report on Technical Barriers to Trade, Ambassador Ronald Kirk, Office of the United States Trade Representative, March 2011, available from: http://www.ustr.gov/sites/default/files/TBT%20Report%20Mar%2025%20Master%20Draft%20Final%20pdf%20-%20Adobe%20Acrobat%20Pro.pdf

The idea of compulsory licensing is not a new one, and is enshrined in the Paris Convention of 1883[100]. Article 31 of The Agreement on Trade-Related Aspects of Intellectual Property Rights[101] (TRIPs) provides further detail regarding the specific provisions necessary for a compulsory license to be issued.

These provisions include the following situations: if an unsuccessful attempt has been made to gain a voluntary license on reasonable terms and conditions within a reasonable length of time[102]; adequate remuneration should also be provided in the circumstances of each case, allowing for the economic value of the license and a requirement that decisions be subject to judicial or independent review by a distinct higher authority. Some of these conditions may be relaxed where licenses are used to remedy practices that have been established as anticompetitive by a legal process.

Further conditions under which a compulsory license may be issued are: the interest of public health, national emergencies, and in the overall national interest.

2.4.4 Patent Assertion Entities (PAEs) [103]or "Patent trolls"

The concerns surrounding the creation of "patent thickets", as has been noted earlier in Section 2.1, raises the further issue of "patent trolls"/PAEs, as these players can potentially block innovative activity and represent a further reason behind the patent "land grab" that is now seen as essential in some areas of technology. Indeed the existence of this secondary market in patents has many implications for companies' patent strategies[104].

The term "patent troll" is a controversial one, and a number of alternative terms also exist:

- Patent pirate has been used to describe both patent trolling and acts of patent infringement[105,106]
- Non-practicing entity (NPE)[107]

[100] Articles 5A (2)-(5) of the Paris Convention reads: "*Each country of the Union shall have the right to take legislative measures providing for the grant of compulsory licenses to prevent the abuses which might result from the exercise of the exclusive rights conferred by the patent, for example, failure to work*.
(*2) Each country of the Union shall have the right to take legislative measures providing for the grant of compulsory licenses to prevent the abuses which might result from the exercise of the exclusive rights conferred by the patent, for example, failure to work.*
(3) Forfeiture of the patent shall not be provided for except in cases where the grant of compulsory licenses would not have been sufficient to prevent the said abuses. No proceedings for the forfeiture or revocation of a patent may be instituted before the expiration of two years from the grant of the first compulsory license.
(4) A compulsory license may not be applied for on the ground of failure to work or insufficient working before the expiration of a period of four years from the date of filing of the patent application or three years from the date of the grant of the patent, whichever period expires last; it shall be refused if the patentee justifies his inaction by legitimate reasons. Such a compulsory license shall be non-exclusive and shall not be transferable, even in the form of the grant of a sub-license, except with that part of the enterprise or goodwill which exploits such license.
(5) The foregoing provisions shall be applicable, mutatis mutandis, to utility models" Further information about the Paris Convention is available from: http://www.wipo.int/treaties/en/ip/paris/trtdocs_wo020.html#P123_15283
[101] More information about TRIPs is available from: http://www.wto.org/english/tratop_e/trips_e/intel2_e.htm and Article 31: http://www.wto.org/english/docs_e/legal_e/27-trips_04c_e.htm
[102] a reasonable length of time might be perceived to be different depending on different technology areas (i.e. telecoms vs pharma) – how is this effected by patent pendency – when you may not actually know what the scope of your patent is until it is granted and thus no-one will know if it is blocking or not.
[103] This term is taken from: From Arms Race to Marketplace: The Complex Patent Ecosystem and Its Implications for the Patent System, Colleen V. Chien HASTINGS LAW JOURNAL Vol. 62:297, and defines PAEs as entities that "are focused on the enforcement, rather than the active development or commercialisation of their patents"
[104]
[105] http://www.wsgr.com/PDFSearch/09202004_patentpirates.pdf, http://www.axisoflogic.com/artman/publish/Article_24505.shtml, http://www.techdirt.com/articles/20090408/2119394438.shtml (see comments)
[106] http://www.technologyreview.com/InfoTech-Software/wtr_16280,300,p1.html

- Non-manufacturing patentee[108]
- Patent shark[109]
- Patent marketer[110]
- Patent licensing company[111] and
- Patent dealer[112],[113] which describes a patent owner who does not manufacture or use the patented invention.

Part of the issue surrounding the use of this term is that it was allegedly coined as a derogatory term[122,123,129] by Peter Detkin[114] an ex Vice President of Intel with a particular interest in patents, litigation, licensing and competition law. The origins of the term aside, it has been taken up and widely used by the media[115,116,117,118].

The phrase "patent troll" is often used in conjunction with a commentary on a piece about "patent wars" between large, multinational companies with a high media profile being sued by generally smaller outfits, sometimes with or without a manufacturing base, claiming infringement of a patents or series of patents[119]. Specifically, however, the term "troll" is used for companies that are not perceived as actually producing a tangible product or service but are merely trading in a secondary market of patents that others have filed for, but have not enforced for a number of reasons, such as: a lack of funds, or where the originating company has gone bankrupt and the patents have been sold as a part of the realisation of the assets of the company for its debtors[120]. This is where the somewhat less inflammatory term "non-practising entity" (NPE) is used instead of "patent troll". Sadly, this term is not a suitable alternative, as it encompasses a number of other business models within its scope such as: university technology transfer companies, divisions of companies, research institutions and individual inventors, who do not create a tangible product or service. The USPTO has

[107] http://itlaw.wikia.com/wiki/Non-practicing_entity, http://pitiptechblog.com/2011/08/02/federal-circuit-sanctions-non-practicing-entity-for-baseless-lawsuit-eon-net-lp-v-flagstar-bancorp/ , http://www.ipeg.eu/?p=926 , http://reguligence.biz/tag/non-practicing-entity/

[108] http://www.niroip.com/download.php?Id=113&Field=File, http://www.energy-news-reports.com/topic/20293-opti.html

[109] http://hbr.org/2008/06/patent-sharks/ar/1, http://www.researchoninnovation.org/WordPress/?p=70

[110] http://justice.syr.edu/sstlr/wp-content/uploads/preserving-the-patent-process-to-incentivize-innovation-in-t.pdf

[111] http://www.securinginnovation.com/2010/01/articles/patents/ipcom-patent-trolls-reputation-management/

[112] http://www.lawdit.co.uk/reading_room/room/view_article.asp?name=../articles/9097-Patent-Trolls.htm http://www.jltp.uiuc.edu/archives/Chung.pdf

[113] http://papers.ssrn.com/sol3/papers.cfm?abstract_id=959945

[114] Breda Sandburg, Inventor's Lawyer Makes a Pile from Patents, The Recorder, July 30, 2001

[115] The Reason Apple Is Becoming A Patent Troll: Calling Out Apple "Innovation" For What It Really Is, Andrew Greenfield, posted 31/7/11 on Talk Android blog, available from: http://www.talkandroid.com/49726-the-reason-apple-is-becoming-a-patent-troll/

[116] "Another Day, Another Patent Troll", Brad Feld, the Huffington Post, available from: http://www.huffingtonpost.com/brad-feld/another-day-another-paten_b_1079608.html

[117] Angry Birds Developer Sued by Patent Troll, Gene Quinn, IP Watchdog, posted on: 23/7/11 available from: http://ipwatchdog.com/2011/07/23/angry-birds-developer-sued-by-patent-troll/id=18312/

[118] Kootol (India-based troll with US and European patent applications) sends notices to many companies regarding Twitter/Facebook-style feeds, by Florian Mueller, posted on 15/7/11, Foss patents blog http://fosspatents.blogspot.com/2011/07/kootol-india-based-troll-with-us-and.html

[119] Examples of such actions include: NTP vs RIM Government Enters Fray Over BlackBerry Patents, http://www.washingtonpost.com/wp-dyn/content/article/2005/11/11/AR2005111101789.html, Eolas v. Microsoft, Plaintiffs-Appellees, v. MICROSOFT CORPORATION, Defendant-Appellant, No. 04-1234.-- March 02, 2005 available from: http://caselaw.findlaw.com/us-federal-circuit/1320506.html

[120] Patent Troll: "A Self-Serving Label that Should be Abandoned, Luerk et al, available from: http://www.rkmc.com/Patent_Troll_A_Self-Serving_Label_that_Should_be_Abandoned.htm

recognised this and refers to "patent trolls" as "patent assertion entities[121]". Given the uncomplimentary associations that surround the use of the term "troll", the current report is written using the term Patent Assertion Entity (PAE) rather than any of the other alternatives.

The key point about PAE-type business models is that they are funded in part or in total through enforcement of patents. The internet is alive with stories about how companies have been threatened in a direct or veiled manner by PAEs[122,123]. At the root of problem is that, in order to assess whether or not a patent or series of patents undermines an existing or new product or service, there generally has to be recourse to the courts, which is an expensive and potentially time-intensive process. Companies would normally wish to avoid this route, but if they are uncertain about the validity of the PAE's patents then it is normally a less expensive process to avoid the litigation entirely and come to a financial arrangement.

This situation, in terms of having patents which are relevant to another business' product or service, often arises, but given the interconnected nature of today's companies they are often settled though cross-licensing agreements. This process is not possible for PAEs as they do not produce any products or services which could potentially infringe anyone else's patents, and is consequently a source of vexation to businesses that are being sued by them.[124] Bessen[125] has recently calculated that NPE lawsuits can be associated with half a trillion dollars of lost wealth in the US.

However, despite all the controversy that surrounds PAEs, there are other factors at work. There are hints of a new business model emerging from the trading of IPRs: a secondary marketplace[126]. Much of the literature refers to how PAEs pick up their patents in "fire sales" when companies have gone under, but in reality, it is important that the value assigned to these patent rights is realised and that the patents themselves are utilised. Indeed, it has been pointed out that PAEs often assert patent rights that have been created by individual inventors and SMEs where they do not have the equity in place to do so themselves[127,128]. This is not in any way illegal[129] or beyond the scope of what was envisaged by the creation of the patent system or the Intellectual Property system, since IPRs can be traded like pieces of property such as a piece of land. It also has implications for the manner in which patents are applied for, in that large numbers of primarily defensive patents, which may remain unused in the hands of a company may be sold on[124] or fall into the hands of PAEs which means that

[121] The Evolving IP Marketplace, Aligning Patent notice and remedies with Competition, March 2011, FTC publication, available from: http://www.ftc.gov/os/2011/03/110307patentreport.pdf

[122] Bootstrapped Company Behind iDrive, iBackup Is Fed Up With Patent Trolls, Robin Wauters, Techcrunch blog 14/11/11, available from: http://techcrunch.com/2011/11/14/bootstrapped-company-behind-idrive-ibackup-is-fed-up-with-patent-trolls/

[123] "Like most fresh legal questions, the debate on patent trolls is long on passion and short on proof", "Gerard N. Magliocca, Blackberries and Barnyards: Patent Trolls and the Perils of Innovation, 82 NOTRE DAME L. REV. 1809, 1810 (2007)

[124] The Evolving IP Marketplace, Aligning Patent notice and Remedies with Competition, March 2011, FTC report at pages 61and 62, available at: www.ftc.gov/os/2011/03/110307patentreport.pdf

[125]"Using stock market event studies around patent lawsuit filings, we find that NPE lawsuits are associated with half a trillion dollars of lost wealth to defendants from 1990 through 2010, mostly from technology companies. Moreover, very little of this loss represents a transfer to small inventors. Instead, it implies reduced innovation incentives and a net loss of social welfare", The Private And Social Costs Of Patent Trolls, Boston University School of Law Working Paper No. 11-45 (September 19, 2011) James Bessen, Jennifer Ford and Michael J. Meurer, available from: http://www.bu.edu/law/faculty/scholarship/workingpapers/2011.html

[126] The Giants Among Us, Robin Feldman & Tom Ewing, Santa Clara Law, available from: http://law.scu.edu/hightech/file/The%20Giants%20Among%20Us%20(2011-10-07)1.pdf

[127] Inside Nathan Myhrvold's Mysterious New Idea Machine, Bloomberg Businessweek, Michael Oreay 2006, http://www.businessweek.com/magazine/content/06_27/b3991401.htm

[128] The big Idea: Funding Eureka! Harvard Business Review, Nathan Myhrvold March 2010 http://hbr.org/2010/03/the-big-idea-funding-eureka/ar/1

[129] http://spectrum.ieee.org/consumer-electronics/gaming/hooray-for-the-patent-troll

more litigation will result, perhaps reducing the prevalence of such patenting strategies overall[130] and thus limiting patent densities and potential thickets.

The PAE situation appears to be worse in the US than in Europe[131], but it may be the case that where the US starts, Europe follows. The differences between the US and European patent systems may serve to overall allow PAEs to operate in the US system[132] because of the following points:

- The presumption of validity of patents by US judges and juries[133]
- The allowance of business methods and "software patents"
- The potential for the existence of so called "submarine patents"[134], as not all patents are published at the 18 month stage
- The way in which costs are divided by the courts – both parties pay their own costs
- The high costs of litigation
- Where "wilful infringement" is decided, high level of damages can be afforded
- The payment system for lawyers can be considered to encourage lawsuits[131,135]
- The existence of patents of unclear scope.

The European/UK system can be contrasted on the following points:

- Relative to the US system the European system of litigation is less costly
- The manner in which the costs are divided, where the loser bears the costs
- The European courts generally aim to balance the right of the IPR holder with third parties
- Injunctions are not issued automatically, although this system has stopped in the US[136].

Key areas that can be used to overall reduce potential PAE activities in the UK and Europe are in the provision of low costs associated with litigation and the speedy resolution of validity proceedings together with a cautious approach to the use of injunctions.

The UK system also allows actions brought by SMEs, to proceed to enforce their patent rights via the County Court system, rather than through the High Court, with a cap of £50 000

[130] From Arms Race to Marketplace: The Complex Patent Ecosystem and Its Implications for the Patent System. Colleen V. Chien Hastings Law Journal Vol. 62:297
[131] Economic Cost-Benefit Analysis of a Unified and Integrated European Patent Litigation System
Prof. Dietmar Harhoff, Ph.D. Ludwig-Maximilians-Universität (LMU) München, Institute for Innovation Research, Technology Management and Entrepreneurship (INNO-tec) 26 February 2009 available from:
rhttp://ec.europa.eu/internal_market/indprop/docs/patent/studies/litigation_system_en.pdf
[132] Taming the patent troll, Undercover Economist, August 19, 2011, Tim Harford, Financial Times, available from: http://www.ft.com/cms/s/2/3246d5b4-c870-11e0-833c-00144feabdc0.html#axzz1eKV2IMWv
[133] 35 U.S.C. § 282 (2000)
[134] Patent trolls in the US, Japan, Taiwan and Europe (digest), tokugikon, 2007.1.30. no.244 73
[135] Innovation and its discontents: how our broken patent system is endangering innovation and progress, and what to do about it, Princeton University Press, 2004 – Law, Adam B. Jaffe, Joshua Lerner
[136] eBay Inc v. MercExchange, L.L.C., 547 U.S 388(2006)

on costs and £500 000[137] maximum damages. There is also a patent opinions service[138] which allows interested parties to review the validity of patent in the light of relevant documents or make decisions about whether or not to pursue an infringement action, and a mediation service[139].

Other issues which can reduce the potential for PAEs to operate are:

- Pendency of patent applications[140]; this contributes further to the lack of clarity about existing patent rights, as it is unclear until a patent application is granted as to what the precise scope of claims of that patent will be. This lack of transparency for third parties is an issue.

- Further improvements to the patent system in terms of ensuring that patent examination quality is maintained and improved, should ensure that the correct scope of claims and with the requisite clarity are granted[141,142].

2.5 Summary of key points

In understanding patent thickets it immediately becomes evident that it is important to understand the manner in which the patent systems operate in different locations and the motivation or strategies employed by companies in order to maximise the protection for their products or processes. As we have seen, the patenting strategy for a company working in the area of pharmaceuticals, with a relatively slow turnover of products, is vastly different to that of a company working in the field of communications technology, with a very fast turnover of products.

In both the areas reviewed there have been issues associated with patent thickets, but on consideration of the literature in these two contrasting technologies, it is evident that the different patenting densities in these areas have for different causes. Thus the evidence base for any analysis of patent thickets should include a wide range of technology areas. It also suggests that any change in policy associated with patent thickets should be carefully considered for its potential impact across different technology landscapes.

Following on from this initial conclusion there seems to be further scope for looking at potential types of thicket which may be related to technology type or stage of development.

[137] Small businesses given better access to justice to protect their rights, UK IPO press release, June 2011 http://www.ipo.gov.uk/about/press/press-release/press-release-2011/press-release-20110614.htm
[138] The UK IPO patent opinions service: http://www.ipo.gov.uk/types/patent/p-dispute/p-opinion.htm opinions can only be made on the grounds of novelty or inventive step on validity issues, and all decisions are non binding.
[139] The UK IPO mediation service: http://www.ipo.gov.uk/types/patent/p-dispute/p-mediation.htm
[140] Patent Backlogs and Mutual Recognition, An economic study by London Economics, UK IPO publication available from: http://www.ipo.gov.uk/p-backlog-report.pdf
[141] Note in particular recommendations 1 and 2, in response to the FTC report on The Evolving IP Marketplace: http://www.uspto.gov/ip/global/patents/Comments_on_the_FTC_Report_2011.pdf
[142] " Both competition agencies and patent offices lack the knowledge required to determine optimal patent breadth, but of the two, the patent offices seem to be in a better position to make trade-offs between incentives for primary as opposed to secondary innovation. At the same time, competition agencies enjoy a comparative advantage in discovering and appreciating the anticompetitive effects that overly broad patents might entail" OECD Policy Roundtables, Competition Policy and Intellectual Property Rights 1997, available from: http://www.oecd.org/dataoecd/34/57/1920398.pdf

3 Analysis discussion

3.1 Introduction

In the previous section the literature definitions of patent thickets tended to fall into two primary forms: fragmentary patents and blocking patents.

Fragmentary patents

As has been noted in the literature in this area, the identification of patents associated with a single product is challenging. The complexities of the manner in which a patent may be drafted mean that on the face of it a patent may not obviously be connected to a product but upon close inspection of the claims, it may actually be relevant. The interpretation of the claims of an application is a specialised determination and requires the input of a technology and patent law specialist, thus for the purposes of the current report this methodology was resisted, as a more macroscopic interpretation is required. This patent/product relationship may form the basis for further work in this area.

Blocking patents

The definition of when a patent becomes a "blocking patent"[143] is reasonably clear, but presents considerable challenges in gaining the requisite data for a sufficient evidence base. It should also be noted that the granting of a patent, itself a monopoly, is inherently "blocking". A blocking patent in the literature has been defined as:

> "Patents which have claims that overlap each other in a manner that the invention claimed in one patent cannot be practiced without infringing the claims of the other patent and vice versa"[144]

> "A blocking patent right in the patent thicket is essentially held by a patent right holder who extracts strategic value from holding up complementary patent right holders, in addition to any intrinsic value that a patent right might generate."[145]

These definitions highlight the fact that the location of such patents is in itself a complex business. Perceiving who is "blocking whom" is also dependent on perspective. When a patent is licensed, there is no requirement for this fact to be recorded in the UK, and a similar system works in the US and Europe (at the USPTO and EPO). Therefore, it is difficult to know what has or has not been licensed. It is also a challenge to understand how these patent rights are being used, unless it is highlighted by the companies concerned, as there is much that goes on behind closed doors when it comes to accessing technology areas and producing new product ranges. It seems that it would be interesting and relevant to study data relating to licensing and patent ownership for US, GB and EP data: this is not available at this time[146]. This matter has been noted by the USPTO.

In consequence this report has used publically available data as an evidence base for assessing the existence of patent thickets or high patent densities and looking at a variety of indicators in order to contribute to a picture of a range of technology areas, some of which may have thickets. The data has taken the form of datasets limited by 20 years for granted patents and the last five years for pending patent applications filed within each technology area.

[143] Carl Shapiro, Navigating the Patent Thicket: Cross Licenses, Patent Pools, and Standard-Setting, 2001, Innovation Policy and the Economy (Vol. I) (Jaffe, Adam B. et al., eds), pp. 119–150, MIT Press
[144] Patent Pools and the Antitrust Dilemma, Steven C. Carlson, 16 YALE J. ON REG. 359, 373 (1999)
[145] Empirically Detecting Patent Thickets Eric van Damme & Simone Keunen*(December 2009)
[146] The Changing Face of Innovation, World Intellectual Property Report, 2011, available from: http://www.wipo.int/export/sites/www/econ_stat/en/economics/wipr/pdf/wipr_2011.pdf

3.2 Summarised results

A summary of the results obtained by looking at the technology areas and the key indicators in conjunction with these areas is shown in the table below. A detailed overview is given the appendix and the main conclusions from this data are set out in the subsequent Sections 3.2.1-3.2.10.

		Nanobiotechnology	Telemedicine	Dendritic polymers	Microprogramming	Graphene	Photorefractive keratectomy	Wireless networking (resource management)	Wireless networking (handoff arrangements)	Safety razors	Fuel Cells
	Concentration index	0.005	0.015	0.017	0.02	0.015	0.032	0.043	0.041	0.122	0.015
IPC frequency	90th percentile	21	7	14	8	10	8	11	10	6	10
	Mode	2	1	3	2	1	2	3	3	2	3
	% in mode	8	25	11	19	17	20	13	16	26	15
	% EP oppositions	3.3%	0.8%	0.0%	0.9%	0.0%	3.2%	0.4%	0.5%	4.9%	1.1%
Citations	Mean patent citations per family	2.3	2.9	1.2	5.1	1.1	4.5	1.3	1.6	4.0	2.4
	Mean NPL citations per family	7.3	7.6	3.3	2.8	4.0	2.9	1.0	1.1	0.7	1.1
	% EP families having X,Y citations	35%	38%	31%	45%	25%	49%	24%	31%	36%	39%
Priorities	Mean no. priorities	4.0	3.8	3.0	2.7	2.8	2.8	2.7	2.6	2.3	2.4
	Median no. priorities	3	3	3	2	2	3	3	3	2	2
	Max no.priorities	592	76	12	73	37	22	31	58	11	37
Holdings	Top 1%	15	21	3	31	16	19	44	41	43	29
	Top 5%	34	42	16	56	36	45	74	74	61	50
	Top 10%	46	53	25	68	48	58	82	82	68	61
Family size	Mean no. families per applicant	3.7	2.8	1.3	5.7	2.8	3.6	12.7	11.6	3.7	19.3
	Mean	6.1	3.4	3.5	4.3	2.6	5.5	6.5	6.4	7.1	5.3
	Median	4	2	3	2	2	4	4	4	4	4
	Maximum	75	41	21	567	22	40	207	200	141	74

Table 1 Summary of indicator values (source IPO)

3.2.1 Wireless networking – handoff arrangements

Handoff arrangements in wireless networking relates to a networked device changing the network connectivity it uses. It refers the automatic selection and re-selection from one wireless data connection to another in order to maintain communication. This subject area was also chosen as a comparator to areas of perceived thickets especially in light of the recent high-profile Smartphone wars[147].

Using a total dataset size of 8408 patent families, an initial analysis of the indicators back up the theory those thickets might exist in this area. The monopoly index value is the third highest out of the areas and shows a concentrated share. The percentage share of the entire stock of patent families held by the top 10% of applicants is high, at over 80%, with over 40% of patent families being held by the top 1% of applicants. This suggests patent thicket behaviour and might therefore suggest that there could be barriers to entry.

However, in this area there were three UK based SMEs noted, with Ubiquisys Ltd holding a significant 14 patent families The company specialises in femtocell access points, a technology to extend mobile phone coverage to areas with typically poor signal, such as indoors. Whilst there is no clear evidence to suggest that barriers to entry are easy to overcome, this SME has demonstrated that it is possible to develop a speciality in a technology dominated by large organisations.

3.2.2 Wireless networking – resource arrangements

Wireless local resource management involves utilising the wireless bandwidth resources as efficiently as possible using strategies and algorithms to control parameters such as transmission power, channel allocation, data rates and error coding.

In the same way as wireless networking handoff arrangement above, this subject area was also chosen as a comparator to areas of perceived thickets especially in light of the recent high-profile Smartphone wars.

The dataset was large, having 10274 families, and the indicator results are similar to those of the handoff arrangements discussed above showing a concentrated monopoly index and also showing that the percentage share of patent families by the top 1-10% of applicants is also high. Again, this suggests that patent thicket behaviour and might therefore suggest that there could be barriers to entry.

However, there were three UK-based SMEs in this technology Cvon Innovations Ltd, Ubiquisys Ltd, and MMI Research Ltd, with both Cvon Innovation Ltd and Ubiquisys Ltd holding two patent families each.

3.2.3 Photorefractive keratectomy

Photorefractive keratectomy (PRK) is a type of laser eye surgery in which the outer surface of the eye is reshaped, using bursts of laser light, to correct vision. The dataset size was 5153 families. PRK was found to have a relatively large monopoly index (0.032), high rate of EP oppositions, and high citation rate compared to the other technologies. Almost 60% of families are held by the top 10% of applicants. This indicates some market dominance by large firms in this technology. PRK was not found to be a “complex” technology in terms of its IPC frequency distribution, however, the correlation of indicators shows greatest similarity with dendritic polymers, graphene, and fuel cells. No UK-based SMEs were found operating in this technology.

[147] http://patlit.blogspot.com/2011/11/patent-wars-new-infographic.html

3.2.4 Dendritic polymers

Dendritic polymers is an area concerned with the synthesis of highly-branched, tree-like macromolecules. The dataset comprised 133 families, and the indicators suggested a low level of domination by large companies, with a low monopoly index (0.017), moderate average family size, moderate number of priorities, and the lowest concentration of all technologies in the top applicants (with 25% of families held by the top 10% of applicants). This technology also showed a low rate of citations and no EP oppositions, indicating that the technology is not contentious. These indicators do not suggest thickets in this technology, even though it is a “complex” technology with a broad IPC frequency distribution. This technology correlates well with graphene, fuel cells, and dendritic polymers. One UK SME was found in this dataset, even though the UK presence in this technology appears to be low.

3.2.5 Telemedicine

Telemedicine is the combination of medical devices and telecommunications, opening up the possibilities of continuous, remote health monitoring, remote drug delivery, and the tracking of the source and spread of infectious diseases. The dataset comprised 8338 patent families. The indicators show no evidence of domination by large organisations and the technology is non-“complex” according to the IPC frequency distribution. There is no evidence of thickets in this technology. This technology showed correlation with graphene, photorefractive keratectomy, and fuel cells. Several UK SMEs were found in this technology, further indicating that there is no barrier to entry.

3.2.6 Safety Razors

Safety razors are well known to most people and the race to increase the number of blades that can fit on a single razor has gained momentum over the last 15 years. Although no earlier literature indicates razors as an area of patent thickets, this technology area was chosen because of its well known dominance by a handful of multi-national organisations who may be causing barriers to entry to others. The razors dataset consists of 709 DWPI families.

The indicators used show that the razors technology area has the highest monopoly index value, the highest rate of EP oppositions, and the highest mean DWPI family size. This suggests patent thicket behaviour because it shows a concentrated market share with an interconnected, dense technology space.

The correlation heat map also shows that razors exhibit similar indicator characteristics to two other technology areas which have been suggested as having thickets in the original literature review, namely wireless local resource management and wireless hand off arrangements. This suggests that razors may be a thicketed technology area.

King of Shaves, which was spun out from Knowledge & Merchandising Ltd, is a UK-based SME with seven patent families. The case study in section 3.3 expands on this.

3.2.7 Graphene

Graphene is a nanomaterial consisting of sheets of carbon atoms a single layer thick in a hexagonal arrangement. Graphene is an emerging technology area with significant R&D investment in recent years. The graphene datasets consists of 1282 DWPI families.

The eight indicators used for this analysis are all designed so that larger results are more likely to suggest increased barriers to entry, and hence patent thickets. Graphene is in the bottom half of all of the indicators and has the lowest median and mean DWPI family size,

the lowest mean patent citations per family representative and no EP oppositions. This suggests that there are very few barriers to entry and no patent thickets, which is not surprising given the emerging nature of this technology area with a large amount of academic research and very few commercial applications at present. The correlation of indicators suggests that graphene has similar indicator characteristics to dendritic polymers, photorefractive keratectomy, and telemedicine.

The small size of this dataset, with only a handful of UK-based companies present, suggests that at present there are very few barriers to entry for UK-based SMEs. There are only three UK-based SMEs with a single patent family each, again suggesting the immaturity of this technology area.

3.2.8 Fuel Cells

Fuel cells are electrochemical cells that convert the chemical energy contained within a fuel into electricity via reaction with an oxidising agent. Fuel cells were chosen as a comparator to perceived “thicketed” areas because it is a well-established technology area. This is reflected in the dataset containing 10274 DWPI families.

For a large dataset fuel cells have a low monopoly index value and moderate concentration of holdings by top applicants, indicating a low level of dominance by large companies. Fuel cells also have a low number of priority documents, suggesting fewer overlapping patents and less chance of patent thicket activity.

However, fuel cells have the highest mean number of families per applicant, which counteracts the previous points about barriers to entry because the number of families per applicant is a useful first indication of whether patenting in a technology space may provide a high barrier to entry. In addition, the correlation heat map suggests that fuel cells exhibit similar indicator characteristics to the technology areas which are perceived to be thicketed areas, namely wireless local resource management, wireless hand off arrangements and photorefractive keratectomy laser eye surgery. It is unclear if this suggests a patent thicket or is simply a general characteristic of a well-established technology with a large and diverse dataset.

UK-based SMEs are represented in this dataset by Intelligent Energy Ltd, ITM Power Research Ltd, AFC Energy PLC, Isis Innovation Ltd, and Adelan Ltd. Intelligent Energy Ltd and ITM Power Research Ltd held 26 and 25 patent families respectively in this technology, which are significant portfolios. These companies are both specialists in clean energy technologies. The relatively large patent portfolios for a SME suggests that it is possible for SMEs to operate with a technology space dominated by multi-national organisations, although the difficulties that these SMEs faced in establishing themselves within the marketplace is unknown.

3.2.9 Nanobiotechnology

Nanobiotechnology includes any biotechnology involving functional components below 100 nanometres in size. The dataset comprised 4644 families. This technology showed the lowest monopoly index and amongst the lowest concentration amongst the top 10% of applicants. However, EP oppositions were high, number of priorities were the highest (at 4.16), and the family sizes were high. In one instance the number of priorities was 592. This technology had the broadest IPC frequency distribution and is therefore “complex”. The indicators are therefore mixed in this case, so the evidence is not clear as to whether a thicket exists. Furthermore, this technology shows little correlation with most other technologies although some correlation with Telemedicine exists. SMEs were found to be operating in this technology, with the leading one (Isis Innovation) holding five patent families.

3.2.10 Microprogramming

This area was chosen because it is an established technology space in a competitive market. The programming aspects within this area tend to be focussed specifically on actions carried out within a processor, for example how data can be selected and operated on and thus issues of patentability tend not to arise. There is no direct evidence per se that thickets may exist in the more recent data but it should be borne in mind that micro-processing architecture in general has historically been dominated by the larger micro-processor companies. This dataset consists of 4218 DWPI families.

Computer micro-programming is near the bottom of several of the list of indicators, including the monopoly index value, IPC frequency distribution, EP oppositions and median DWPI family size, suggesting that it does not exhibit some the suggested properties of an area where a patent thicket may be present. However, a high percentage of X or Y citations and high mean number of citations per family suggests that computer micro-programming does exhibit some of the other suggested properties of a thicket. The correlation heat map suggests a strong relationship with wireless local resource management, wireless hand off arrangements and razors, which suggests that a patent thicket may be present in computer micro-programming.

UK-based SMEs in this technology were Clearspeed Technology Ltd and Displaylink UK Ltd, with one patent family each, suggesting that there may be barriers to entry for UK-based SMEs in this area of technology.

3.3 Case study: safety razor blades

In considering the data amassed as a part of the current research it was decided to examine the technology area for a representative small to medium enterprise (SME) seeking to enter an established technology area. On examining the razor blades dataset a UK based SME was noted. This was “King of Shaves”, which is based in Beaconsfield.

The technology area associated with razor blades is well established, with the first safety razor debuting in 1901. The current dataset is time limited to the last 20 years so that patents that are no longer in force are not included. However, as can be seen from appendix B, there are a number of large multinational companies that dominate this technology area in terms of patent portfolio ownership. This was still true when Mr King started his company in the 1990s and it thus seems apposite to investigate how he managed to enter into and succeed in such a densely packed technology area.

3.3.1 Company background

This SME was set up on 1993[148] with the advent of the “Original Shaving Oil” which was created by the CEO of the company, Will King. It has subsequently grown to become established in the UK marketplace for shaving and grooming products. The brand has also expanded to Australia, New Zealand, Japan and Brazil and has recently signed an agreement to extend into the US market with Remington.

The company has a total number of 50 employees with about 21 based in the UK, and a turnover of about 11 million pounds. It started selling shaving oil to men but has expanded into razor production with razors marketed for both men and women. The brand itself has

[148] http://www.shave.com/

been estimated to be valued at 45 million pounds[149] . The Azor system razor from the King of Shaves was the third best manual system razor handle in the 12 months to 4/9/10.[150]

King of Shaves owns, if the originating company (Knowledge and Merchandising Ltd) is included, 8 patents of which five are granted. There are 34 individual members of the DWPI "families" associated with these patents. It is evident from all this background information that this is a UK based SME which has broken into a well established, multinational technology area, which was considered to be challenging for new entrants[151], especially in terms of intellectual property, and in particular patents.

3.3.2 Technology landscape

The dataset considered earlier in Section 3.2.6 was used as the basis for the current investigation. This has been analysed through the use of Thomson Innovation landscape map, an example of the map is shown in Figure 2 below.

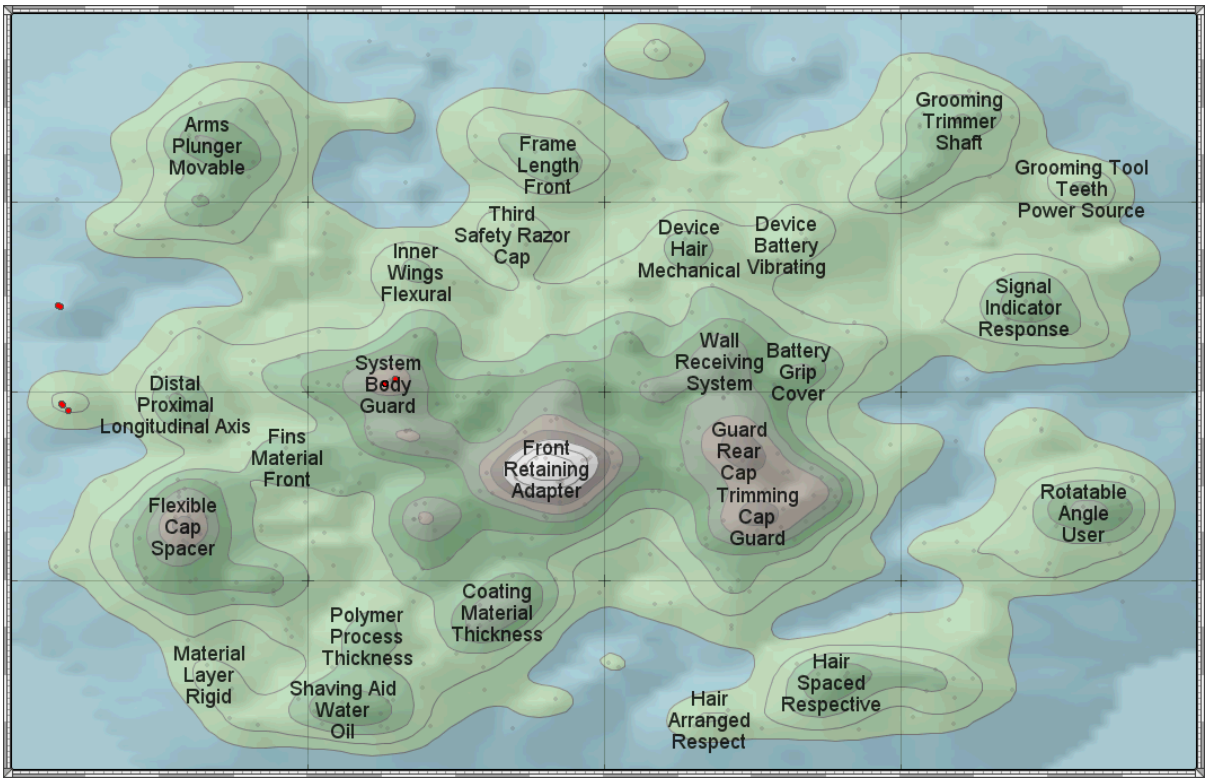


Figure 2 Patent Landscape map with King of Shaves and Knowledge and Merchandising Ltd highlighted © Thomson Reuters

The patents relating to King of Shaves are located in a single area of the map and highlight the innovation made, in designing a new handle.

Areas of intense activity, as illustrated by the "snowy peaks" on the map have been analysed and demonstrate the grouping of patents owned by major players in the dataset such as Gillette. This is illustrated in Table 11 in the appendix. However, despite the presence of

[149] http://www.marketingweek.co.uk/sectors/fmcg/king-of-shaves-up-for-sale/3029775.article
[150] http://www.thekingofshavescompany.com/corporate/pages/corporatehub/King_of_Shaves__Partner_Remington.htm
[151] http://www.telegraph.co.uk/finance/newsbysector/retailandconsumer/8260261/King-of-Shaves-chief-Will-King-aims-to-beat-Gillette-on-price-and-performance.html , http://www.telegraph.co.uk/finance/yourbusiness/8624755/Telegraph-Festival-of-Business-Will-King-says-business-needs-engineers.html

these major players, there are also a number of British inventors, which demonstrates that these independent inventors are also attempting to gain a foothold in this competitive marketplace and are not excluded from this “patent space.”

3.3.3 Case study summary

Patents are evidently not the sole reason behind the current companies’ success but when combined with business sense, and innovative marketing it is obvious that they can play a significant part in the success of an SME, despite entering an acknowledged[180] densely packed marketplace.

3.4 Analysis conclusions

The indicators tested provide an initial insight into whether or not patent thickets can be located within a technology area. In particular the density related measures such as the Herfindahl monopoly index and the percentage share of patents owned by the top applicants provide a useful indication of the thickets. Further work is needed to explore the use of these indicators further to address whether different types of thickets can be distinguished using different indicators.

The results generally show that technology areas which contain thickets do tend to be dominated by larger applicants though there are certain technologies, such as nano-biotechnology, which contain thickets caused by multiple applicants having smaller sized portfolios.

However it should be borne in mind that the range of technologies chosen varies in maturity and so some of these differences could be down to that. Further work is required to establish if this is the case.

It should also be noted that whilst patent thickets may be considered a barrier to entry, this is not conclusive either way from the evidence analysed so far. In the areas considered to contain thickets there are UK-based SMEs operating in their respective marketplaces and doing well; this is not to say that they had an easy time achieving their position but that it is possible to break through.

4 General Conclusions

This report has raised more questions than provided answers. It can be seen that there is no clear consensus on terms used to describe patent thickets and the entities involved with them. By applying these terms consistently it is hoped that further debate on any issues can be conducted on a level playing field.

The indicators appear to show that there is a possibility of different forms of thicket occurring where there are different types of technology linked to the degree of maturity of that technology space. These potential types can be subdivided into areas where there are large numbers of small patent holdings, or areas where there are small numbers of big players, each of which creates a thicket that any new entrant will have to negotiate in order to be able to operate. Additional research into more technology areas will serve to elucidate this possible link.

Is there are barrier to entry, in particular for SMEs? Again, the analysis work is not conclusive and further work is required, as discussed in the sections below. However, from reviewing the vast literature and taking into consideration observations made during the analysis it is also clear that there are several other issues which need to be considered.

5 Next Steps

5.1 Indicators and technologies

The indicators developed have started to show some promise in terms of being able to develop an automated thicket detection tool. Additional research is needed to develop these indicators further and also to extend the datasets used to test them. Current work being carried out by the IPO to link patent data with business data, which can then be used to help automate the company analysis, could provide further insight into the issue of thickets being a barrier to entry for SMEs. The economic significance test is whether SMEs can grow within such technology spaces and is an area which needs to be addressed in the next round of analysis.

The pharmaceutical industry has changed over time and so updating the datasets with some more recent examples from this industry may also provide a better understanding of patent thickets. This would also enable a degree of linking between the numbers of patents and the products which would be informative.

5.2 Are pending patent applications a barrier to entry?

Following the creation of indicators, it was noted that pending patent applications may also form a barrier to entry. For example, if a company flooded the market with lots of patent applications, anyone wishing to enter the market would be face with the uncertainty of where they could operate because it would not be clear which patents would ever be granted, nor what the scope of the granted claims would be.

This issue is further compounded by the fact that in some jurisdictions the applicant can request deferral of the examination of a patent for several years.

In order to analyse whether this issue presents a problem, further work is needed to track cohorts of patents from application through to grant for certain technology areas and in certain jurisdictions. This work hasn't been completed as part of this study as the largest dataset which might be used for comparison, the US, is incomplete because prior to 2001 patent applications were not published and only granted patent data are available.

Also, access to granted patent data and legal status data is important to users and potential users of the patent system. At present this information is available piecemeal directly from the relevant national patent office. Should this information become more readily available and analysable in bulk form, then applicants could be better informed.

5.3 Clarity

Clarity and language associated with patents and claims in particular could be addressed. This was particularly noticeable when attempting to visually map out some of the more complex high technology areas, such as wireless networking. It is usually possible to generate meaningful patent landscapes but in these areas the terminology used throughout the claims meant that meaningful maps were proving to be difficult to produce. This would also suggest that new entrants to this technology, or perhaps even established applicants, may find it difficult to understand the scope of the patents being sought[154,152,155].

[152] Patent Failure How Judges, Bureaucrats, and Lawyers Put Innovators at Risk, Bessen and Meurer, Princeton University Press, Chapter 3 – 1 "If you can't tell the boundaries, then it ain't property"

5.4 Inventiveness

Consideration of the interpretation of law surrounding the principle of inventive step[153] by patent examiners may be useful[154] and has been highlighted by authors[155,156,157]. This is important where there are a series of incremental innovations; proper consideration must be given to whether or not these increments actually constitute an invention or not. Therefore time and energy spent on understanding a technology area in terms of acknowledged activity, together with a consistent approach towards obviousness could potentially reduce numbers of patents being granted and decrease overall patent densities. This would also have the effect of increasing patent quality and thus potentially also reducing subsequent litigation.

5.5 Renewal fees

It was suggested in the Hargreaves Review that one solution to patent thickets is to consider the renewal fees charged. This report has not discussed this issue, and from the initial evidence gathered on thickets in general, it is not clear whether this would be appropriate within the UK at least. Further work is needed to explore the issues surrounding the increasing of renewal fees, and particularly the impact any change would have on those parties who use the patent system in less densely populated technology landscapes or to a lesser degree.

5.6 Secondary markets

Further work in considering the impact of the secondary market in patents should be considered. It seems that it would be interesting and relevant to study data relating to licensing and patent ownership for US, GB and EP data: however, this is not available at this time. A study in how this secondary market is evolving would be of value.

5.7 Links between products and patents

It may be useful, and perhaps more informative, to analyse thickets by looking at the products which are associated with particular patents. Further work would need to be carried out in order to start understanding how patents and products are linked before datasets could be created.

5.8 Other measures

If patent thickets are perceived to be an issue in some jurisdictions and not others, are there any mitigating solutions which may be in place to alleviate any potential problems? For example, the IPO in the UK offers an opinions service, there are new small court arrangements and also full mediation which could be used to offset the issue.

[153] whether or not an invention is obvious given what has been done before

[154] R M Ballardini, "The Software Patent Thicket: A Matter Of Disclosure", (2009) 6:2 SCRIPTed 207, http://www.law.ed.ac.uk/ahrc/script-ed/vol6-2/ballardini.asp

[155] "The difference between 'obviousness' in the US and 'inventive step' in Europe might lead to different determinations of the inventive step of a patent application", Inventive step and genomics, Soames and Kowalski, Nature Reviews Drug Discovery, 3, 729, (September 2004)

[156] How high is the inventive step? Some empirical evidence, Hazel V. J. Moir, 2009, 4th Annual Conference of the EPIP Association University of Bologna, Bologna, Italy. In reviewing Australian and US patents in business methods she notes: "The cases demonstrate that a range of procedural rules operate to allow grant of a patent monopoly to many 'inventions' that do not offer any advances in knowledge or know-how, and so provide no social benefits" and "Lengthy and complex drafting contributes to the few cases where existing knowledge did not lead to inventiveness objections."

[157] To Promote Innovation: The Proper Balance of Competition and Patent Law and Policy, A Report by the Federal Trade Commission, October 2003, Recommendation 3 http://www.ftc.gov/os/2003/10/innovationrpt.pdf

5.9 Stakeholder consultation

The Hargreaves Review of IP provided stakeholders with an opportunity to provide their views on patent thickets and further, more detailed consultation with stakeholders could be explored.

Appendices

Appendix A Methodology and analysis

A.1 Indicators

To enable a more thorough analysis of patent thickets to be undertaken, several indicators were used to see if those areas with patent thickets (or considered to contain patent thickets) could be identified. Note that these indicators were not developed solely for detecting thickets but were chosen to see if there was a suitable combination of indicators which would be helpful. Furthermore, potentially, the use of different indicators could also help to distinguish, and provide an evidence base for, the different types of patent thickets or disprove their existence.

The indicators used were as follows:

- Concentration index.
- IPC frequency distribution.
- Number and rate of EP oppositions.
- Mean number of families per applicant.
- Mean, median, and maximum patent family size (using the Derwent WPI family).
- Mean number of patent citations and non-patent citations per family representative (using the Derwent WPI family). Analysis of proportion of X,Y citations on patents with an EP family member.
- Mean, median, and maximum number of priorities.
- Percentage of patent families held by top 1%, 5%, and 10% of applicants, for all families and for families containing granted patents only
- Percentage of patent families by applicant portfolio size.

These are each detailed in the following sections. The sectors are ranked according to their value for each of the indicators.

A summary of the indicator values is presented in Table 2.

		Nanobiotechnology	Telemedicine	Dendritic polymers	Microprogramming	Graphene	Photorefractive keratectomy	Wireless networking (resource management)	Wireless networking (handoff arrangements)	Safety razors	Fuel Cells
	Concentration index	0.005	0.015	0.017	0.02	0.015	0.032	0.043	0.041	0.122	0.015
IPC frequency	90th percentile	21	7	14	8	10	8	11	10	6	10
	Mode	2	1	3	2	1	2	3	3	2	3
	% in mode	8	25	11	19	17	20	13	16	26	15
	% EP oppositions	3.3%	0.8%	0.0%	0.9%	0.0%	3.2%	0.4%	0.5%	4.9%	1.1%
Citations	Mean patent citations per family	2.3	2.9	1.2	5.1	1.1	4.5	1.3	1.6	4.0	2.4
	Mean NPL citations per family	7.3	7.6	3.3	2.8	4.0	2.9	1.0	1.1	0.7	1.1
	% EP families having X,Y citations	35%	38%	31%	45%	25%	49%	24%	31%	36%	39%
Priorities	Mean no. priorities	4.0	3.8	3.0	2.7	2.8	2.8	2.7	2.6	2.3	2.4
	Median no. priorities	3	3	3	2	2	3	3	3	2	2
	Max no.priorities	592	76	12	73	37	22	31	58	11	37
Holdings	Top 1%	15	21	3	31	16	19	44	41	43	29
	Top 5%	34	42	16	56	36	45	74	74	61	50
	Top 10%	46	53	25	68	48	58	82	82	68	61
Family size	Mean no. families per applicant	3.7	2.8	1.3	5.7	2.8	3.6	12.7	11.6	3.7	19.3
	Mean	6.1	3.4	3.5	4.3	2.6	5.5	6.5	6.4	7.1	5.3
	Median	4	2	3	2	2	4	4	4	4	4
	Maximum	75	41	21	567	22	40	207	200	141	74

Table 2 Summary of indicator values (source IPO)

A.1.1 Concentration

The concentration, or monopoly, measure is an adapted version of the Herfindahl Index [158]. The Herfindahl index is generally used to identify the concentration of market share amongst businesses within a particular market, but been adapted to measure for the concentration of patent applicants' portfolios in relation to the technology area. The Herfindahl index is used in this way by the Federal Trade Commission in the US as a screening tool to identify anti-competitive mergers. A Herfindahl index:

- below 0.01 indicates a competitive index
- 0.15 or below indicates a concentrated index
- between 0.15 and 0.25 indicates moderate concentration
- above 0.25 indicates a high concentration and an issue concerning the creation of a monopoly.[159].

The index is found by calculating the sum of the squares of the patent shares of each applicant in the technology area. It provides an indication of whether a technology area is dominated by large applicants with many patents, and so may be an indicator of potential for patent thickets. Thus, if the monopoly index is considered in a similar manner to the Herfindahl index, the higher the index is, then the increased likelihood there is that there is the potential presence of a monopoly.

Technology	Monopoly index value
Safety razors	0.122
Wireless networking (resource management)	0.043
Wireless networking (handoff arrangements)	0.041
Photorefractive keratectomy	0.032
Microprogramming	0.020
Dendritic polymers	0.017
Graphene	0.015
Telemedicine	0.015
Fuel cells	0.015
Nanobiotechnology	0.005

Table 3 Concentration index values for the technology areas under study (source IPO)

As seen in the above table, the safety razors dataset has the highest concentration index. Given the high relative value from this indicator it demonstrates that there are a few large players which dominate this established technology area. Relatively high values are also found for photorefractive keratectomy, wireless networking (handoff arrangements and resource management). This could also indicate that these areas are more dominated by larger players.

A.1.2 IPC frequency distribution

WIPO has found that so-called complex technologies have shown a faster growth than discrete technologies. Complex technologies are those comprising numerous, separately patentable inventions, whereas discrete technologies comprise few patentable inventions.

[158] http://www.justice.gov/atr/public/testimony/hhi.htm , http://stats.oecd.org/glossary/detail.asp?ID=6205
[159] Horizontal Merger Guidelines, US Department of Justice and th Federal Trade Commission, issued August 19,2010, available from: http://www.justice.gov./atr/public/guidelines/hmg-2010.html

Complex technologies may therefore cross different disciplines and include widespread patent ownership, and are also associated with strategic patenting behaviour. An example is the contemporary smartphone, where a number of separate technologies must be accessed to enable the final product. Thus, complex technologies lend themselves to the formation of patent thickets. The IPC frequency distribution can be an indicator of how complex a technology area is in terms of its constituent technologies. If a technology area has a tendency for each patent to be classified in a large number of IPC marks, manifested as a skew to towards the right for the frequency distribution, this may be an indicator of a complex technology, and hence a candidate for a patent thicket.

Technology	90% of records have this many or fewer IPC marks:	Modal value	% of records having modal value
Nanobiotechnology	21	2	8
Dendritic polymers	14	2, 4	11
Fuel cells	10	3	16
Wireless networking (resource management)	11	3	13
Graphene	10	1	17
Wireless networking (handoff arrangements)	10	3	16
Microprogramming	8	2	19
Photorefractive keratectomy	8	2	20
Telemedicine	7	1	25
Safety razors	6	2	26

Table 4 Cumulative frequency distribution of IPC marks for the technology areas under study (source IPO)

The Nanobiotechnology area stands out as having exceptionally broad IPC frequency distribution. It also has a large modal value, and smaller percentage within the modal value, indicating a complex technology, and hence the possibility of patent thickets. Telemedicine has an exceptionally sharp distribution which is also skewed more to the lower end, indicating a less complex technology.

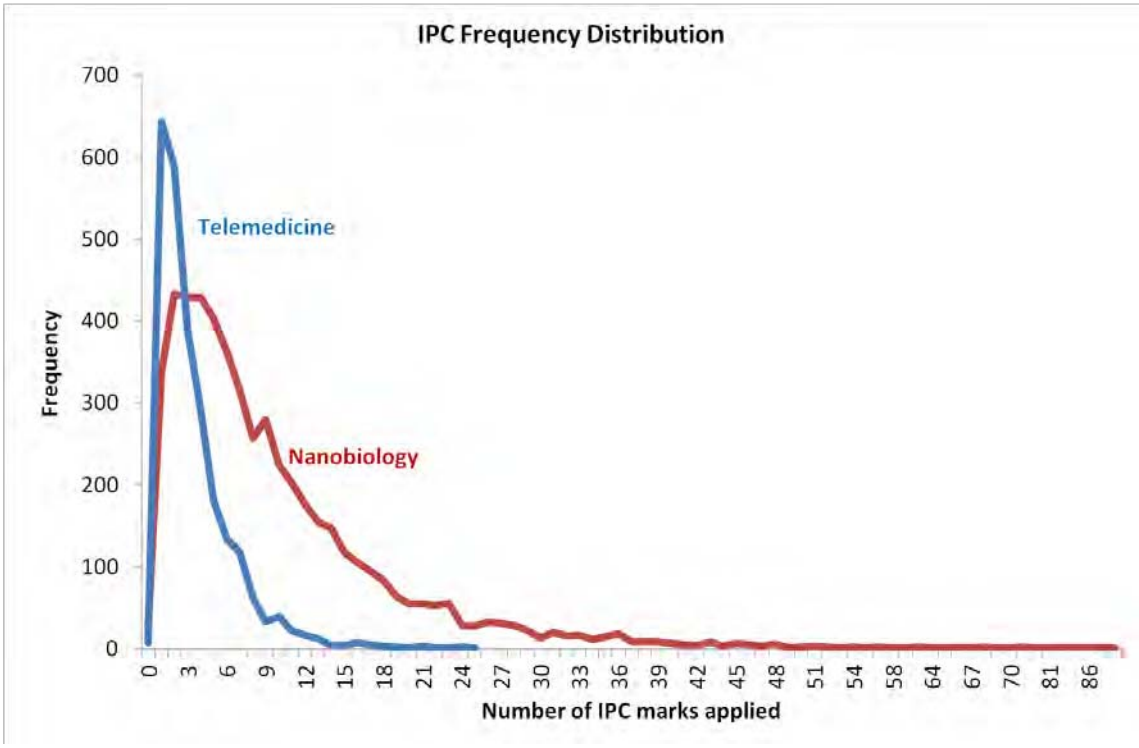


Figure 3 Comparison of frequency distribution for Nanobiotechnology and Telemedicine (source IPO)

This indicator provides no evidence for a thicket within Telemedicine of the type associated with complex technologies, although alternative manifestations of thickets are possible. Graphene, microprogramming, safety razors, and photorefractive keratectomy have similar characteristics to telemedicine. Dendritic polymers has similar characteristics to Nanobiotechnology.

A.1.3 EP oppositions

The opposition procedure allows third parties to centrally oppose a European patent at the European Patent Office within a limited period following the date of grant. Oppositions are therefore indicators of contentious patents. One reason for contention could be the perception that a patent thicket is forming and therefore oppositions may correlate with an interconnected, dense technology space, and consequently, a patent thicket.

However, it should be noted that the EP opposition statistics are based on at least one opposition occurring in DWPI families, which contain at least one EP publication. It does not make any adjustment for families containing multiple EP publications where, it could be argued, an opposition is more likely.

Technology	Rate of EP oppositions
Safety razors	3.10%
Nanobiotechnology	1.70%
Photorefractive keratectomy	1.42%
Fuel Cells	0.46%
Wireless networking (handoff arrangements)	0.29%
Telemedicine	0.21%
Wireless networking (resource management)	0.19%
Microprogramming	0.09%
Dendritic polymers	0.00%
Graphene	0.00%

Table 5 Rates of oppositions for EP patents in each sector (source IPO)

The safety razors area has a greater rate of EP oppositions than any other sector, and Nanobiotechnology and photorefractive keratectomy have still significant rates of EP oppositions. Therefore there is some evidence from this indicator of the potential for thickets in these sectors. Graphene and dendritic polymers have zero oppositions but given these are newer developing sectors the number of applications that have reached grant is likely to be limited.

A.1.4 Citations

Citations are documents that may be cited against a patent as it goes through the patent application process. They may take the form of earlier published patent applications or non patent literature (NPL) such as academic papers or conference proceedings. Citations are made against an application by an examiner assessing the scope of the claims. They may take a number of different forms and the main types are described below:

1) “A” or “prior art” citations: documents that are considered to be relevant to the application but do not prevent the grant of the patent;

2) “X” or “novelty” citations: documents that are considered to fall within the scope of the claims as they describe exactly the same product or process;

3) “Y” or “inventive step” citations: documents that are considered to be relevant to the scope of the claims in that it would be obvious to carry out or make the product or process, defined in the claims, for someone who works in this technology area.

Citations against a patent application therefore provide an indication that the invention was already known, or is similar to something that was already known. A large number of patent citations may indicate a large degree of overlap of the invention with prior patents and this may in turn hint at the existence of a patent thicket.

Technology	Mean patent citations per family representative
Microprogramming	4.05
Photorefractive keratectomy	2.65
Safety razors	2.61
Telemedicine	2.21
Fuel Cells	2.01
Nanobiotechnology	1.54
Wireless networking (handoff arrangements)	1.51
Wireless networking (resource management)	1.27
Dendritic polymers	1.20
Graphene	1.12

Table 6 Average number of patent citations per family representative for each sector (source IPO)

Microprogramming leads in Table 6, indicating that inventions in that sector may be more incremental and more likely to overlap with prior inventions, and so more susceptible to the formation of patent thickets. Graphene has a low number of average citations but this would be expected, given that this is only a recently developing technology and a body of prior art is yet to build up. Therefore, its low position in this table is not necessarily counter evidence of patent thickets in this sector.

However, as highlighted above, there are many forms of citation, and it was thought best if the patents that had X or Y citations were separated out from the main dataset as another potential signpost in the thicket assessment process. This process was completed for families where there was at least one European patent. The European families were chosen as the US patents often contain a large number of citations, which are actually documents mentioned by the applicant in the process of applying for a patent.

Dataset	Total dataset no. DWPI families	No. Of families with at least one X or Y citation	Percentage of dataset
Nanobiotechnology	4644	2681	58
Safety razors	709	403	57
Wireless networking (handoff arrangements)	8408	4559	54
Dendritic polymers	133	64	48
Graphene	1282	504	39
Microprogramming	4218	1042	25
Fuel cells	19555	4251	22
Wireless networking (resource arrangements)	10274	2121	21
Telemedicine	8338	965	12
Photorefractive keratectomy	5153	556	11

Table 7 Percentage of X,Y citations in the datasets (source IPO)

A.1.5 Priorities

A priority application is the earliest patent application within a family that contains a particular invention. A patent family containing numerous inventions may therefore also contain numerous priorities. Families having a large number of priorities may indicate several patents having a potential degree of overlap and therefore may indicate the existence of a patent thicket.

Technology	Mean number of priorities
Nanobiotechnology	4.16
Telemedicine	3.91
Dendritic polymers	3.02
Microprogramming	2.90
Graphene	2.84
Photorefractive keratectomy	2.83
Wireless networking (resource managements)	2.72
Wireless networking (handoff arrangements)	2.59
Safety razors	2.53
Fuel Cells	2.42

Table 8 Average number of priorities per family in each sector (source IPO)

Nanobiotechnology and Telemedicine have the most priorities.

A.1.6 Average Families per Applicant

The average number of families per applicant within each dataset provides a single figure indicator of the “density” of patent protection amongst applicants. Given that the most basic property, which is universal to all of the definitions of a patent thicket, is a high density of intellectual property rights, this indicator provides a useful initial indication of whether thickets are likely to exist in a technology area.

Making the simple assumption that a family of patent applications protects a single invention, figure 8 can be interpreted as showing that on average applicants will hold more than three times as many inventions if they are fuel cell technology businesses as opposed to the razor technology businesses.

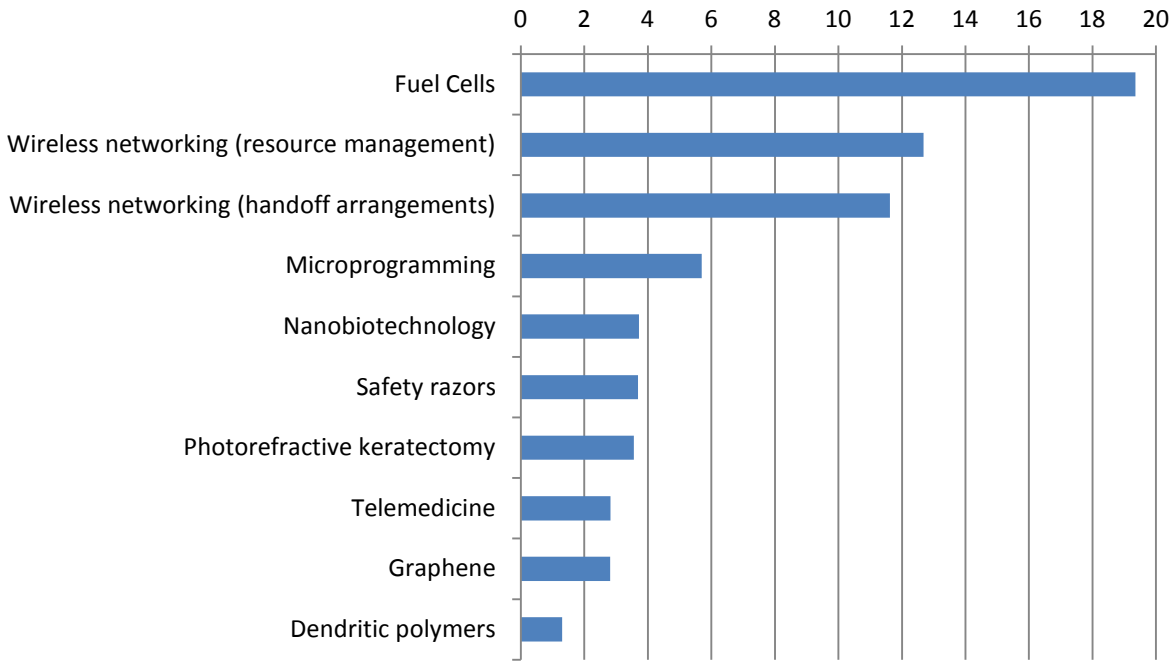


Figure 4: Average number of families held by an applicant in each sector (source IPO)

Thicketed technologies could be expected to have a higher number of families per applicant.

A.1.7 Patent Holdings of Top Applicants

The patent holdings by top applicants indicates the percentage of patent families held by the top 1%, 5%, and 10% of applicants, when applicants are ranked by the number of families they hold. For example, figure 7 illustrates that more than 70 percent of the families (i.e. inventions) belong to only 5% of the applicants in the telecommunication data sets of wireless networking (resource management and handoff arrangements).

Patent thickets may be implicated when percentage patent family holdings are larger for the top applicants.

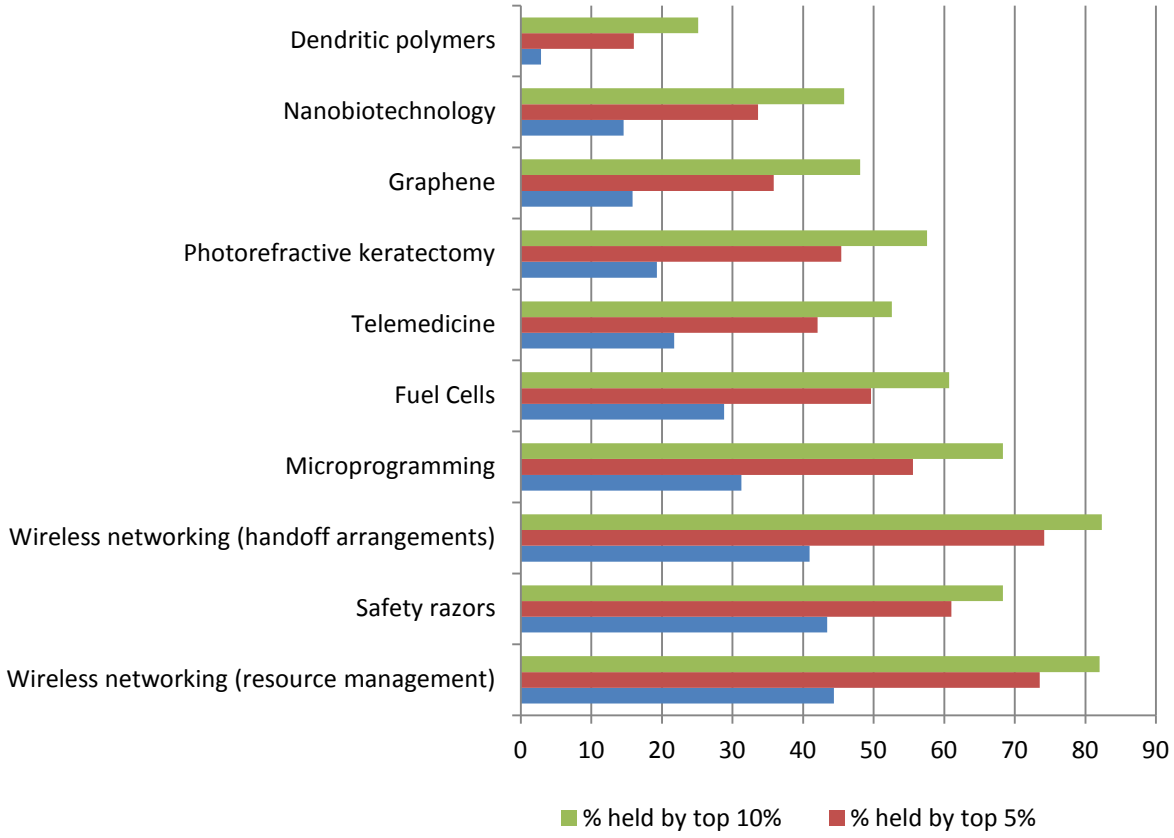


Figure 5: Patent holdings of top applicants in each sector (source IPO)

Generally, wireless networking (resource management and handoff arrangements) are most concentrated in the top applicants, with dendritic polymers the least concentrated. This indicates that larger portfolio sizes are found amongst wireless networking areas, signifying a strong dominance by the top applicants in terms of intellectual property. This could be interpreted as evidence of the existence of a significant barrier to entry into these technology areas.

A.1.8 Patent Family Size

Patent families are groups of related patent applications belonging to a single applicant. These may occur when an applicant requires protection for the same invention in many different countries, but can also occur when successive small developments of an invention are protected by separate patents which are based on the same initial patent application(s) (the “parent(s)”). The degree of overlap between family members of the second type may therefore be expected to be high, and may lead to the formation of a patent thicket. A tendency towards large family size within a technology sector may therefore indicate patent thickets within that sector.

Technology	Median DWPI family size
Safety razors	6
Photorefractive keratectomy	5
Nanobiotechnology	4
Fuel Cells	4
Wireless networking (handoff arrangements)	4
Wireless networking (resource management)	4
Dendritic polymers	3
Telemedicine	2
Microprogramming	2
Graphene	2

Table 9 Median family size in each sector according to DWPI family (source IPO)

From Table 9 it can be seen that the razors sector has the greatest tendency towards large families.

However, without further work to separate families which are large because protection is sought in multiple countries from families which are large because they seek to protect lots of very similar inventions in one “family”, this measure is not useful. For example, razors technology may have the highest median family size because in that area it is necessary to protect an invention in the most different countries. Razors are probably easier to counterfeit than a telemedicine device etc for example, and there may be an established market for razors in more countries than the markets for the other technologies. Conversely, using a large patent family to protect multiple inventions in one country, arguably creating a thicket as a barrier to entry, may be a strategy Gillette adopts. It is thus not possible to draw a conclusion from table 4.

A.2 Correlation of indicators

The previous sections have given detailed analysis and comparison of each of the indicators. Taken together, the indicators create a profile for each technology, and the degree of correlation, or similarity, between these profiles indicates the degree to which conclusions may be carried across the technologies. This is a first step in attempting to see whether any of these indicators could be used together in an automated toolkit.

	Nanobiotechnology	Telemedicine	Dendritic polymers	Microprogramming	Graphene	Photorefractive keratectomy	Wireless networking (resource management)	Wireless networking (handoff arrangements)	Safety razors	Fuel Cells
Nanobiotechnology										
Telemedicine										
Dendritic polymers										
Microprogramming										
Graphene										
Photorefractive keratectomy										
Wireless networking (resource management)										
Wireless networking (handoff arrangements)										
Safety razors										
Fuel Cells										

Table 10 Correlation heat map of technologies (source IPO)

Table 10 shows a heat map of the degree of correlation between each pairing of the technologies. Wireless networking (handoff arrangements) and wireless networking (resource management) correlate most highly, and therefore have the most similar values to each other across all the indicators. A thicket in either of these technologies suggests a high probability of a thicket in the other. On the other hand, safety razors and nanobiotechnology, for example, correlate poorly, so similar conclusions would not apply to this pair of technologies.

Further work is required to further investigate the indicators used and how they can be used together to allow for the development of a toolkit.

Appendix B Results

The results presented below show a summary of the indicators for each of the chosen technology areas. In brief, there are some indicators which can be used to help identify thickets but further work is required to refine the use of these indicators.

B.1 Basic data

An outline of each individual technology area is given below.

B.1.1 Photorefractive keratectomy (laser eye surgery)

Photorefractive Keratectomy is a type of laser eye surgery in which the outer surface of the eye is reshaped, using bursts of laser light, to correct vision. A US Federal Trade Commission Decision in 1999[160] found anticompetitive behaviour in the form of a patent pool agreement between manufacturers, but it has been suggested that this behaviour may, in fact, be a legitimate response to an existing patent thicket[161]. It is therefore possible that characteristics in this technology sector are indicators of a patent thicket.

A simple search using appropriate ECLA search terms was completed. The data gained from this was grouped into DWPI families with a total dataset size of 1042 families.

B.1.1.1 Small and medium-sized companies (SMEs)

No UK-based patent families were found for this technology and so no UK-based SMEs were found.

B.1.2 Fuel cells

The first fuel cell was created in the 1830s and has undergone a considerable degree of development since its inception. Fuel cells are simply electrochemical cells that convert the chemical energy contained within a fuel into electricity via reaction with an oxidising agent[162]. The most generally used arrangement of this type of cell is that where hydrogen is used as a fuel and oxygen is used as the oxidising agent[163].

Fuel cells can be used in a number of applications but are perhaps best known as a source of power for vehicles; there are buses that are used worldwide, but they have not yet made the transition into commercial production in cars. Other potential applications include smartphones, where they may be used on a micro-scale to feed energy intensive features. Given their potential as a “green” technology a considerable amount of research has been completed into this technology space in recent times.

This subject area was not chosen because there was a general perception of any difficulties in entering the technology space, but as a comparator to areas of perceived thickets. It is also an established area of technology.

A very simple search using appropriate ECLA search terms was completed. The data gained from this was grouped into DWPI families with a total dataset size of 21808 families.

[160] Federal Trade Commission Decisions 127 FTC, 1999, p208
[161] Gavin Clarkson, “Patent Informatics for Patent Thicket Detection: A Network Analytic Approach for Measuring the Density of Patent Space,” Global Business Institute Seminar on Cross Disciplinary Strategy, New York University, March 2007
[162] http://www.fuelcells.org/basics/how.html
[163] http://www.fuelcells.org/

B.1.2.1 Small and medium-sized companies (SMEs)

UK SMEs are represented in this dataset: Intelligent Energy Ltd, ITM Power Research Ltd, AFC Energy PLC, Isis Innovation Ltd, and Adelan Ltd are all SMEs. Intelligent Energy Ltd and ITM Power Research Ltd held 26 and 25 patent families respectively in this technology, which are significant portfolios. These companies are both specialists in clean energy technologies.

B.1.3 Graphene

Graphene is considered a nanomaterial consisting of sheets of carbon atoms a single layer thick in a hexagonal arrangement[164]. Industry interest in this material is high, in particular since applications in electronics, optoelectronics, and photonics devices have been discovered and are in development. The public profile of graphene was boosted when the Nobel Prize in Physics 2010 was awarded to Andre Geim and Konstantin Novoselov of Manchester University "for groundbreaking experiments regarding the two-dimensional material graphene"[165].

It is a new and developing technology area, with considerable amounts of investment in R&D and academic research[166] but as yet relatively few products in use. It also falls under the umbrella term of nanotechnology which has many references to having a thicket area[170,168]. Consequently it was included in the current report.

The data gained from this was grouped into DWPI families with a total dataset size of 1283 families.

B.1.3.1 Small and medium-sized companies (SMEs)

UK SMEs appearing in this dataset are as follows: Graphene Industries Ltd, Pera Innovation Ltd, and UWS Ventures Ltd. Each of these companies holds one single patent family in this technology, but this is a relatively small dataset, with just four patent families in this technology for the leading UK company (Hexcel Composites Ltd).

B.1.4 Dendritic nanotechnology

Dendritic nanotechnology is a specialised area of nanotechnology relating to dendritic polymers. A dendrimer (a building block of the dendritic polymer) is a highly branched macromolecule, resembling the branch of a tree without leaves sprouting from a central point, in a spherical configuration as shown in Figure 6. They are created via a number of iterative steps, which create the degree of branching on the molecule. These macromolecules were first synthesised in 1978, and a refined methodology put in place from about 1979.

[164] H.-P. Boehm, R. Setton and E. Stumpp, "Nomenclature and terminology of graphite intercalation compounds (IUPAC Recommendations 1994)", Pure Appl. Chem., 1994, Vol. 66, No. 9, pp. 1893-1901
[165] http://www.nature.com/news/2010/101007/full/news.2010.525.html and http://www.scientificamerican.com/article.cfm?id=geim-novoselov-physics-novel
[166] Huge UK investment in graphene will pay off, says Nobel prizewinner, Alok Jha, 7/10/11, the Guardian, available from: http://www.guardian.co.uk/science/2011/oct/07/huge-investment-graphene-nobel-prizewinner and http://www.itpro.co.uk/636484/government-announces-50m-graphene-research-hub

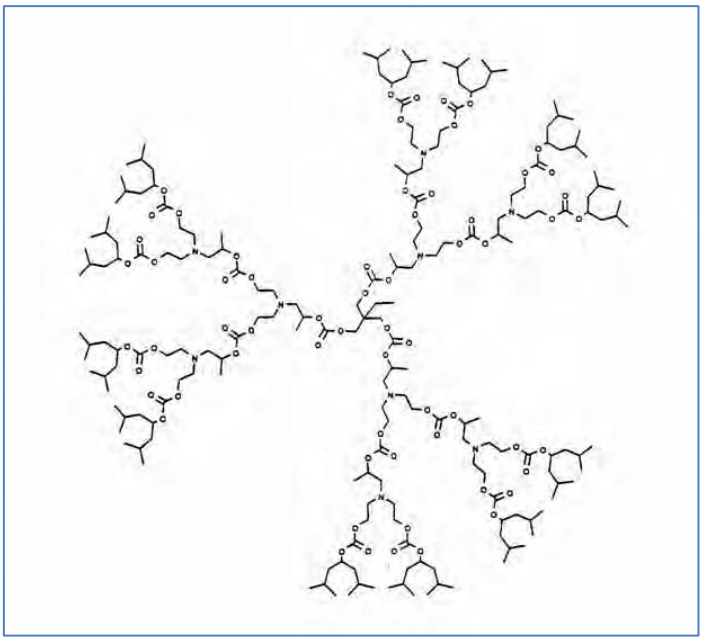


Figure 6 An example of a dendrimer taken from GB2308363 A (source IPO)

This has multitude of potential functions such as: drug delivery systems, membrane technology[167], sensors and gene delivery systems.

This subject area was chosen because this is a new and developing technology area[168] with the potential for the creation of a dense web of patent rights[169] and has been noted as such, with an assessment given of whether or not it would be a candidate for a patent pool.

A search using appropriate ECLA search terms in combination with a range of appropriate keywords was completed.[170] The data gained from this was grouped into DWPI families with a total dataset size of 133 families.

B.1.4.1 Small and medium-sized companies (SMEs)

One UK SME was found in this dataset: Semblant Global Ltd with one patent family in this technology. No company was found with more than one UK originating patent family.

B.1.5 Wireless networking - handoff arrangements

Handoff arrangements in wireless networking is a broad technology area but generally relates to a networked device changing the network connectivity it uses. It refers the automatic selection and re-selection from one wireless data connection to another in order to maintain communication. For example, a vertical hand off in a Smartphone may relate to the automatic 'fall over' from a high speed wireless LAN Internet connection to a slower cellular

[167] Current Patents of Dendrimers and Hyperbranched Polymers in Membranes, Jinrong Wang, Yiyun Cheng and Tongwen Xu, Recent Patents on Chemical Engineering 2008, 1, 41-51, available from: http://www.benthamscience.com/cheng/samples/cheng%201-1/Tongwen%20Xu.pdf

[168] The Nanotech Intellectual property ("IP") landscape, Serrato R et al, Nanotechnology Law & Business Journal, Vol 2, Issue 2, 2005, Article 3

[169] Dendrimers - an Overview of Intellectual Property and Patenting Issues, ETC Group report entitled 'Nanotech's "Second Nature" Patents: Implications for the Global South', April/May 2005, available from: http://www.azonano.com/article.aspx?ArticleID=1375

[170] Examining the Viability of patent pools to the growing nanotechnology patent thicket, Alexander lee, available from; http://www.nanotechproject.org/file_download/files/Nano-patent-pools.pdf

connection if a wireless LAN connection is unavailable.[171] An example of a horizontal hand off arrangement is when a laptop has the option of choosing one of several different in-range wireless LAN connections.

This subject area was also chosen as a comparator to areas of perceived thickets especially in light of the recent high-profile Smartphone wars.[172]

A simple search using appropriate ECLA search terms and appropriate keywords was completed. The data gained from this was grouped into DWPI families with a total dataset size of 8459 families.

B.1.5.1 Small and medium-sized companies (SMEs)

The following UK SMEs were found present in this dataset: Ubiquisys Ltd, Nomad Spectrum Ltd, and MMI Research Ltd. Ubiquisys Ltd holds 14 patent families in this technology, which is a significant portfolio. The company specialises in "femtocell access points", a technology to extend mobile phone coverage to areas with typically poor signal, such as indoors. This demonstrates that it is possibly for an SME to develop a speciality and find its own niche even in a technology dominated by large organisations.

B.1.6 Wireless networking - resource arrangements

Wireless local resource management involves utilising the wireless bandwidth resources as efficiently as possible using strategies and algorithms to control parameters such as transmission power, channel allocation, data rates and error coding. It includes wireless traffic scheduling and the selection or allocation of wireless resources.

In the same way as wireless networking hand off arrangement above, this subject area was also chosen as a comparator to areas of perceived thickets especially in light of the recent high-profile Smartphone wars.[173]

A simple search using appropriate ECLA search terms was completed. The data gained from this was grouped into DWPI families with a total dataset size of 11773 families.

B.1.6.1 Small and medium-sized companies (SMEs)

UK SMEs in this technology included: Cvon Innovations Ltd, Ubiquisys Ltd, and MMI Research Ltd. The largest portfolios of these were Cvon Innovation Ltd and Ubiquisys Ltd with two patent families each.

B.1.7 Computer micro-programming

This area was chosen because it is an established technology space in a competitive market. The programming aspects within this area tend to be focussed specifically on actions carried out within a processor, for example how data can be selected and operated on and thus issues of patentability tend not to arise. There is no direct evidence per se that thickets may exist in the more recent data but it should be borne in mind that micro-processing architecture in general has historically been dominated by the larger micro-processor companies.

[171] Vertical Handover in Beyond Third Generation (B3G) Wireless Networks, Navarro et al, International Journal of Future Generation and Networking, vol1 no 1, 51-58, available from: www.sersc.org/journals/IJFGCN/vol1_no1/papers/08.pdf
[172] http://patlit.blogspot.com/2011/11/patent-wars-new-infographic.html
[173] http://patlit.blogspot.com/2011/11/patent-wars-new-infographic.html

A simple search using appropriate ECLA and IPC search terms was completed. The data gained from this was grouped into DWPI families with a total dataset size of 6099 families.

B.1.7.1 Small and medium-sized companies (SMEs)

UK SMEs in this technology were Clearspeed Technology Ltd and Displaylink UK Ltd, with one patent family each.

B.1.8 Nano-biotechnology

Nanotechnology in itself is quite simply research into producing and manipulating matter on an atomic and molecular scale. The IPC and ECLA have a specific terms assigned as to whether or not patents can be termed as concerning nanotechnology: "entities with a controlled geometrical size of at least one functional component below 100 nanometres in one or more dimensions susceptible of making physical, chemical or biological effects[174]". This is a relatively new area of technology[175] and has been very fast moving with a huge number of applications, the evolution of technology has been so fast that consideration has been given as to whether or not specialised regulation of such technology is warranted as it appears that only recently work has been done looking at the toxicity and potential environmental impact of this work.

Nano biotechnology is therefore biotechnology carried out on a nanometre scale and encompasses numerous specific areas such as the development of biomaterials, and medical applications using nanoscale products such as nanotools. It also allows the development of nanodevices which mimic natural systems and processes. An example of an application would be the development of systems for imaging bimolecular systems, membranes and the use of cantilever array sensors.

This area has been chosen as there has been concern about the potential for the development of a patent thicket[176,177] in this emerging technology area. A simple ECLA based classification search was completed. The data gained from this was grouped into DWPI families with a total dataset size of 5253 families.

B.1.8.1 Small and medium-sized companies (SMEs)

UK SMEs in this technology included: Isis Innovation Ltd, Oxford Instruments Molecular Biotools Ltd, Prosonix Ltd, and Syntaxin Ltd. The leading SME, Isis Innovation Ltd, holds five patent families in this technology.

B.1.9 Razors

The subject area of razors should be one that is familiar to most people. In this case the dataset concerns multibladed safety razors, rather than including other razor types. The first safety razor was invented in 1901 and since then the technology area has undergone a

[174] http://documents.epo.org/projects/babylon/eponet.nsf/0/623ECBB1A0FC13E1C12575AD0035EFE6/$File/nanotech_brochure_en.pdf and http://www.epo.org/news-issues/issues/classification/nanotechnology.html
[175] Nanobiology – where Nanotechnology and biology come together, Charles Ostman, available from: http:\\www.biota.org\ostman\nanobio.htm
[176] http://www.foresight.org/nanodot/?p=2198
[177] The Nanotech IP Landscape: Increasing Patent Thickets Will Drive Cross-Licensing, Stephen B. Maebius & Leon Radomsky, available from:
http://www.foley.com/files/tbl_s31Publications/FileUpload137/2955/Document1.pdf

massive shift[178] as companies seek to stay ahead of the competition through evolution of the technology as highlighted by the number of razor blades battle[179].

It has been used in the current report as it represents mechanical subject matter and an established technology space. It is also known as an area of high patent density, and a competitive marketplace.[180].

A simple IPC based classification search was completed (for further detail see the Appendix D). The data gained from this was grouped into DWPI families with a total dataset size of 1033 families.

B.1.9.1 Small and medium-sized companies (SMEs)

UK SMEs operating in this technology were Knowledge & Merchandising Ltd, with seven patent families, King of Shaves Ltd, and Feonic PLC.

B.1.10 Telemedicine

Telemedicine is a technology sector that has emerged from the development and combination of medical devices and telecommunications. Telemedicine opens up the possibilities of continuous, remote health monitoring, remote drug delivery, and the collection of aggregate health data to allow the tracking of the source and spread of infectious diseases. Telemedicine was used as the focus of a study by Cambridge IP [181] which concluded that there is a strong possibility of an emerging patent thicket in this technology sector.

A simple search using appropriate ECLA search terms was completed. The data gained from this was grouped into DWPI families with a total dataset size of 2572 families.

B.1.10.1 Small and medium-sized companies (SMEs)

Several UK SMEs were found in this technology despite the small size of the dataset: T+ Medical Ltd, Danmedical Ltd, Iplato Ltd, Learning Clinic Ltd, OBS Medical Ltd, Safe Surgery Systems Ltd, Toumaz Technology Ltd, and Visual Healthcare Solutions Ltd.

B.2 Mapping Analysis

Mapping of the razor technology landscape has been completed to give an idea of the key areas where there are large amounts of activity.

It is difficult to associate peaks in the patent landscape maps for resource management and handoff with any particular aspect within these technology areas. This is perhaps because the terms appearing in the abstract are widely used in a number of different contexts and the algorithm used for producing the maps is unable to distinguish between these. For example, interference is generally an undesirable characteristic in the field of mobile telephony. However, it may appear in abstracts of simple methods of selecting a cell based on the

[178] World Business: The Blade Battle, 1965, available from: http://www.time.com/time/magazine/article/0,9171,839192,00.html

[179] Cutting edge- Just what is it about adding blades that makes a razor better? October 2008, Thomas Jones available from: http://www.guardian.co.uk/lifeandstyle/2008/oct/04/beauty.mens.razors

[180] Gillette, Schick go Blade-to-Blade, available from: http;\\www.marketplace.org/topics/world/gillette-schick-go-blade-blade.html

[181] Iliev I, Tang P, van der Merwe H and Tannock Q, 2011, “Emerging patent thickets and standards in the medical devises and Telehealth space: Innovation, market dynamics and policy options in cross-over technologies

quality of a received signal as well as applications relating to forcing handoff to improve performance of the network as a whole.

B.2.1 Basis of the Landscape Maps

Patent maps are a visual representation of a dataset and are generated by applying a complex algorithm with four stages:

1. Harvesting documents - When the software harvests the documents it reads the text from each document (ranging from titles through to the full text). Non-relevant words, known as stopwords, (e.g. “a”, “an”, “able”, “about” etc) are then discounted and words with common stems are then associated together (e.g. “measure”, “measures”, “measuring”, “measurement” etc).

2. Analysing documents - Words are then analysed to see how many times they appear in each document in comparison with the words’ frequency in the overall dataset. During analysis, very frequently and very infrequently used words (i.e. words above and below a threshold) are eliminated from consideration. A topic list of statistically significant words is then created.

3. Clustering documents - A Naive Bayes classifier is used to assign document vectors and Vector Space Modelling is applied to plot documents in n-dimensional space (i.e. documents with similar topics are clustered around a central coordinate). The application of different vectors (i.e. topics) enables the relative positions of documents in n-dimensional space to be varied.

4. Creating the patent map - The final n-dimensional model is then rendered into a two dimensional map using a self-organising mapping algorithm. Contours are created to simulate a depth dimension. The final map can sometimes be misleading because it is important to interpret the map as if it were formed on a three dimensional sphere.

Thus, in summary, patents are represented on the patent map by dots and the more intense the concentration of patents (i.e. the more closely related they are) the higher the topography as shown by contour lines. The patents are grouped according to the occurrence of keywords in the title and abstract and examples of the reoccurring keywords appear on the patent map.

B.2.2 Razors analysis

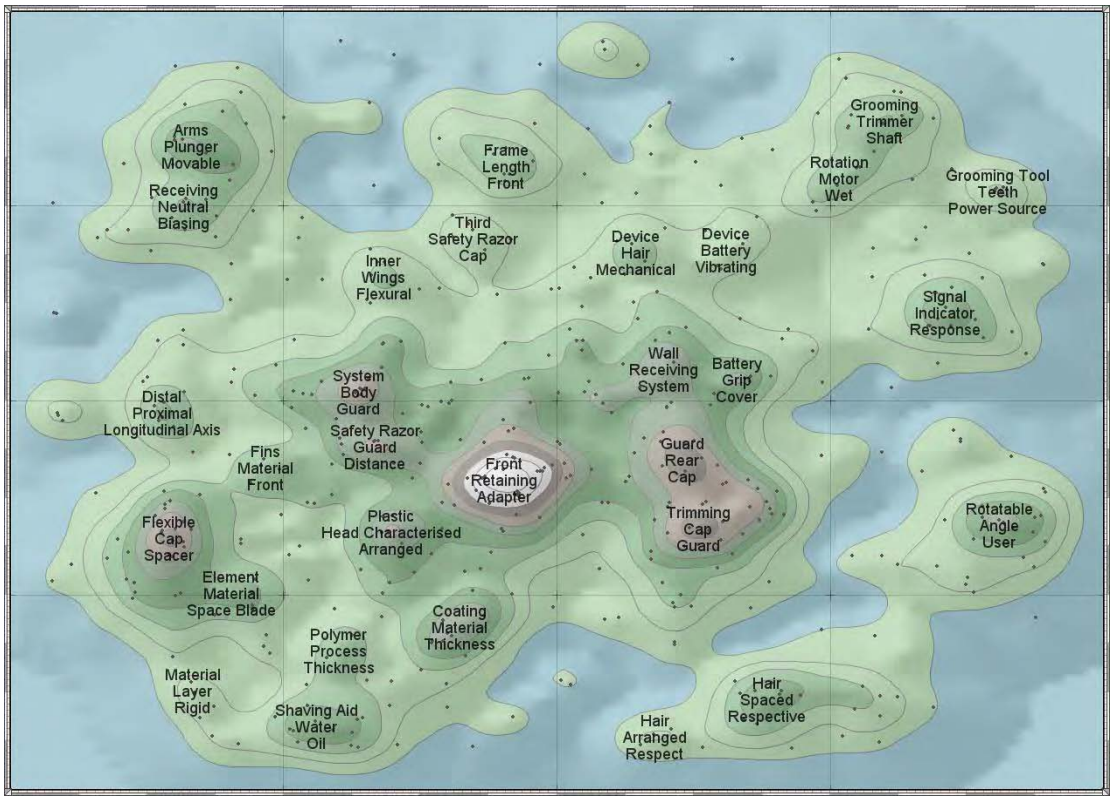


Figure 7 Patent Landscape map showing the razor technology landscape © Thomson Reuters

These maps can be interrogated in order to glean information about the sectorisation of a technology and where areas of patenting activity are occurring. This has been done for the map shown in Figure 7 and is illustrated by Figure 8. There are many aspects to the razor market and these are easily shown in such a patent landscape map.

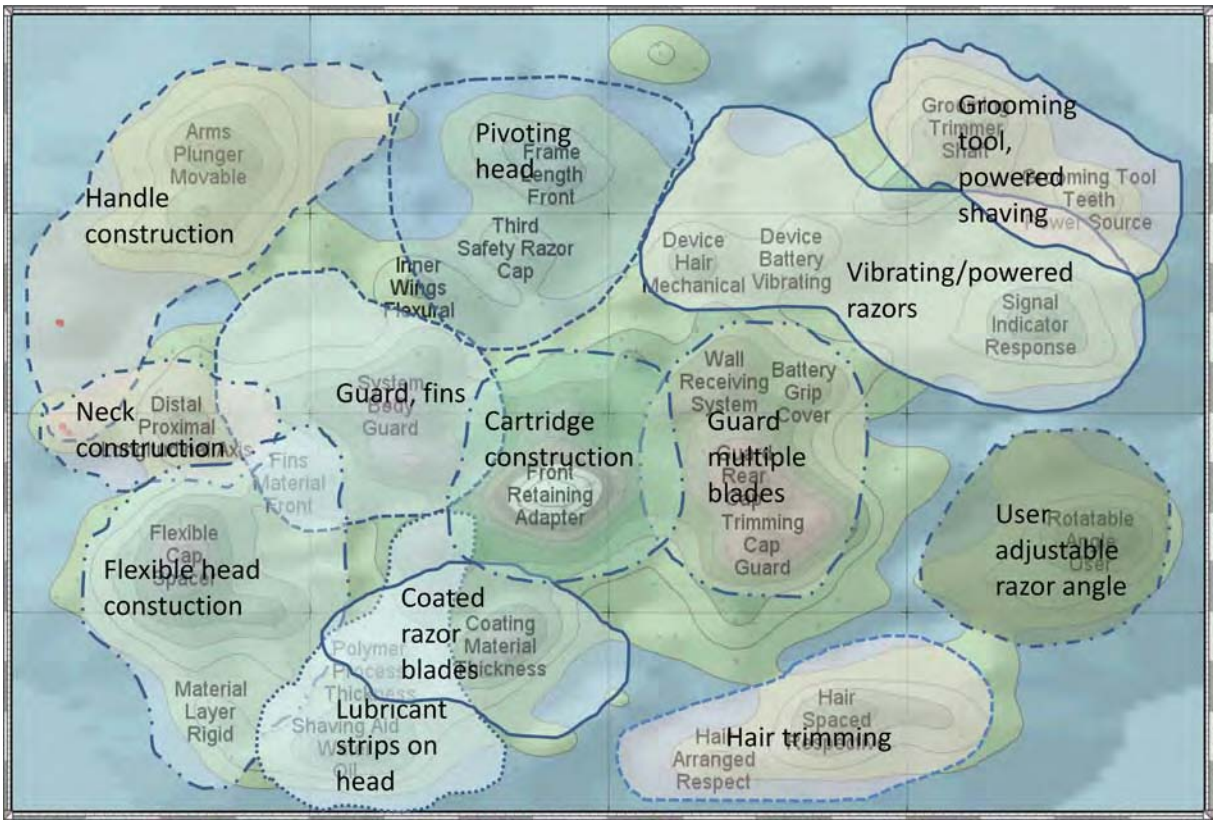


Figure 8 Patent Landscape map showing the sectorisation of the razor technology landscape © Thomson Reuters

The patents owned by King of Shaves and Knowledge and Merchandising Ltd are highlighted in the patent landscape map shown in Figure 9. The patents assigned to these companies are noted on the map. It is immediately evident that the patents assigned to King of Shaves fall outside the areas of peak activity on the map, with one located in the "sea" and two others located in a small "hill". These locations are consistent with the development of a new innovation that allows penetration into the "white space" or areas of low patenting activity, as Mr King himself has noted.

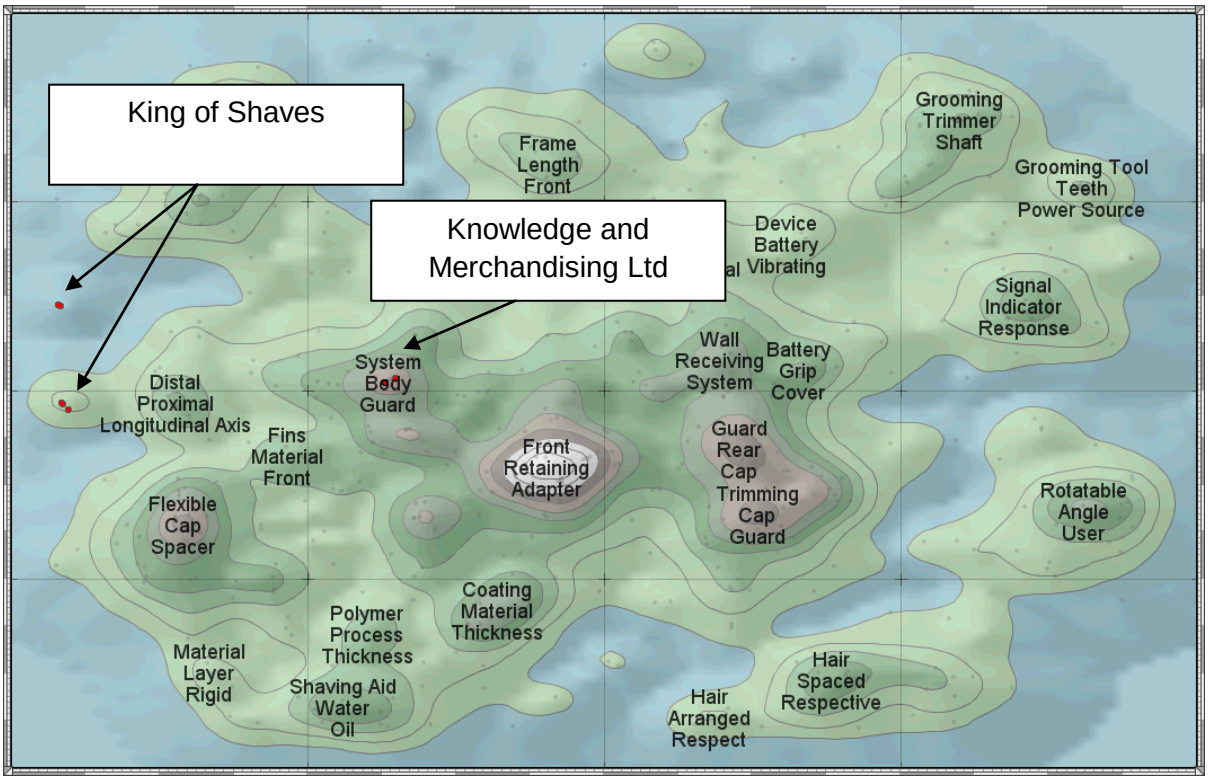


Figure 9 Patent Landscape map with King of Shaves and Knowledge and Merchandising Ltd highlighted
© Thomson Reuters

The map was analysed further in that the peaks of patenting activity in the map were highlighted and the individual patents which made up those peaks were listed and their assignees noted.

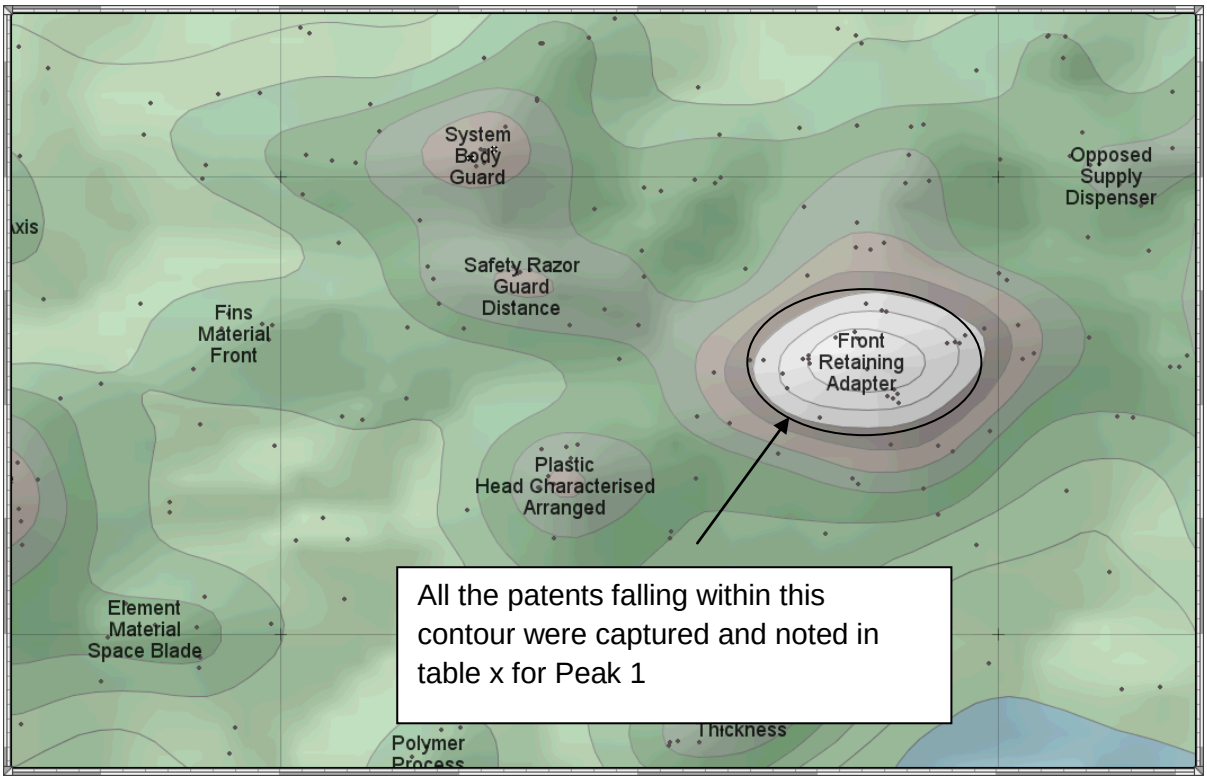


Figure 10 Snapshot demonstrating how top peak analysis was performed © Thomson Reuters

Peak Number	Peak reference	Number of patents (grouped by family)
1	Front retaining adapter	37 docs
3	System body guard	14 docs
2	Rear guard cap Trimming cap guard	32 docs
4	Flexible cap spacer	10 docs

Table 11 Peak analysis (source IPO)

The results of this peak analysis are shown in the tables below. The key applicants are American Safety Razor Company, Bio Violex, Ever Ready Battery Company Inc and Gillette. Knowledge and Merchandising Ltd appears in the analysis of peak 3. This is what would generally be expected in a patent landscape map with a high patent density for an established technology space. Interestingly, two British inventors appear (Kevin James Wain and Sean P Clark) in the peak analysis associated with peak 1 (front retaining adapter).

Publication Number	Publication Date	Assignee /Applicant
EP1697096B1	23/02/2011	The Gillette Company
EP1750911B1	02/03/2011	The Gillette Company
EP2231370A1	29/09/2010	The Gillette Company
EP2379289A1	26/10/2011	Close Cut Co Limited
GB2226973B	23/09/1992	Wilkinson Sword
GB2437887B	14/07/2010	American Safety Razor
GB2452411B	19/05/2010	Knowledge & Merchandising Inc
GB2452412B	30/06/2010	Knowledge & Merchandising Inc
US20070220753A1	27/09/2007	The Gillette Company
US20070227006A1	04/10/2007	The Gillette Company
WO2009062204A8	01/10/2009	Alfonso Goss-Melendez

Table 12 Patents in selected from the analysis of peak 3 of the safety razor map (System body guard) (source DWPI)

Publication Number	Publication Date	Assignee/Applicant
EP429174B1	24/05/1995	Warner Lambert Company
EP453138B1	05/07/1995	Warner Lambert Company
EP584215B1	28/05/1997	Warner Lambert Company
EP658134B1	19/11/1997	Warner Lambert Company
EP681518B1	18/03/1998	Warner-Lambert Company
EP686078B1	19/11/1997	Warner Lambert Company
EP696243B1	22/10/1997	Warner Lambert Company
EP594695B1	23/10/1996	Warner Lambert Company
CA2121427C	26/01/1999	American Safety Razor Company
EP802846B1	20/11/2002	American Safety Razor Company

Table 13 Patents selected from the analysis of peak 4 of the safety razor map (Flexible cap spacer) (source DWPI)

Publication Number	Publication Date	Assignee/Applicant
EP2207651A1	21/07/2010	American Safety Razor Company
EP2358506A1	24/08/2011	American Safety Razor Company
US6568084B2	27/05/2003	American Safety Razor Company
EP2056995B1	09/03/2011	Bic Violex S.A
EP2213428B1	29/06/2011	Bic Violex S.A
EP2017044A1	21/01/2009	Eveready Battery Company Inc
EP2176041A1	21/04/2010	Eveready Battery Company Inc
EP1252982B1	05/11/2008	Eveready Battery Company Inc
EP2371497A1	05/10/2011	Eveready Battery Company Inc
EP1729936B1	11/11/2009	Eveready Battery Company Inc
US20100229398A1	16/09/2010	Eveready Battery Company Inc
EP1987929B1	22/12/2010	Eveready Battery Company Inc
US20080022529A1	31/01/2008	The Gillette Company
EP2376262A1	19/10/2011	The Gillette Company
EP2276611A1	26/01/2011	The Gillette Company
EP2326470A1	01/06/2011	The Gillette Company
EP2349658A1	03/08/2011	The Gillette Company
EP2008780B1	18/11/2009	The Gillette Company
EP2040892A2	01/04/2009	The Gillette Company
EP2178681A2	28/04/2010	The Gillette Company
EP1722943B1	25/08/2010	The Gillette Company
EP1722941A1	22/11/2006	The Gillette Company
EP548278B1	20/05/1998	The Gillette Company
US7739797B2	22/06/2010	The Gillette Company
US7966731B2	28/06/2011	The Gillette Company
WO2011017239A1	10/02/2011	The Gillette Company
EP1046475B1	25/06/2003	Warner Lambert Company
EP1046474B1	11/06/2003	Warner Lambert Company
US20060277760A1	14/12/2006	Lee Sangyong
US20110094108A1	28/04/2011	Kevin James Wain
US20100299928A1	02/12/2010	Sean P Clark

Table 14 Patents selected from the analysis of peak 2 of the safety razor map (Rear guard cap, Trimming cap guard) (source DWPI)

Publication Number	Publication Date	Assignee/Applicant
EP2207651A1	21/07/2010	American Safety Razor Company
EP2358506A1	24/08/2011	American Safety Razor Company
US6568084B2	27/05/2003	American Safety Razor Company
EP2056995B1	09/03/2011	Bic Violex S.A
EP2213428B1	29/06/2011	Bic Violex S.A
EP2017044A1	21/01/2009	Eveready Battery Company Inc
EP2176041A1	21/04/2010	Eveready Battery Company Inc
EP1252982B1	05/11/2008	Eveready Battery Company Inc
EP2371497A1	05/10/2011	Eveready Battery Company Inc
EP1729936B1	11/11/2009	Eveready Battery Company Inc
US20100229398A1	16/09/2010	Eveready Battery Company Inc
EP1987929B1	22/12/2010	Eveready Battery Company Inc
US20080022529A1	31/01/2008	The Gillette Company
EP2376262A1	19/10/2011	The Gillette Company
EP2276611A1	26/01/2011	The Gillette Company
EP2326470A1	01/06/2011	The Gillette Company
EP2349658A1	03/08/2011	The Gillette Company
EP2008780B1	18/11/2009	The Gillette Company
EP2040892A2	01/04/2009	The Gillette Company
EP2178681A2	28/04/2010	The Gillette Company
EP1722943B1	25/08/2010	The Gillette Company
EP1722941A1	22/11/2006	The Gillette Company
EP548278B1	20/05/1998	The Gillette Company
US7739797B2	22/06/2010	The Gillette Company
US7966731B2	28/06/2011	The Gillette Company
WO2011017239A1	10/02/2011	The Gillette Company
EP1046475B1	25/06/2003	Warner Lambert Company
EP1046474B1	11/06/2003	Warner Lambert Company
US20060277760A1	14/12/2006	Lee Sangyong
US20110094108A1	28/04/2011	Kevin James Wain
US20100299928A1	02/12/2010	Sean P Clark

Table 15 Patents selected from the analysis of peak 1 of the safety razor map (Front retaining adapter) (source DWPI)

Appendix C General notes

For this project the Thomson Reuters World Patent Index (WPI) database was interrogated, which holds bibliographic and abstract data of published patents and patent applications derived from the majority of leading industrialised countries and patent organisations, for example the World Intellectual Property Organisation (WIPO), European Patent Office (EPO) and the African Regional Industry Property Organisation (ARIPO). It should be noted that patents are generally classified and published eighteen months after the priority date. This should be borne in mind when considering recent patent trends (within the last eighteen months).

The WPI database contains one record for each patent family, defined as all documents directly or indirectly linked via a priority document. This provides an indication of the number of inventions an assignee may hold, as opposed to how many individual patent applications they might have filed in different countries for the same invention.

C.1 Priority Date, Application Date and Publication Date

There are generally three dates which can be associated with a patent application as follows:

Application date: The date on which an application for a patent was made.

Priority date: The application date of an earlier, related patent application containing the same invention. A patent can claim a priority date from an earlier application which contains the same subject matter. The priority date is the earliest available indication of the date of invention.

A -Publication date: The date of first publication. This is normally 18 months after the priority date or the application date, whichever is the earlier.

B -Publication date: The date when the patent was published once it has been granted. If an application proceeds to grant it will usually occur within four years and six months of the application or priority date. Note that prior to 2001 US patents were only published upon grant and were designated as A publication.

C.2 WO and EP Patent Applications

European Patent Applications (EP) may be made through the European Patent Office (EPO) or through any European national patent office.

European Patent Applications are regional patent applications which may designate any signatory state to the European Patent Convention (EPC), and lead to granted patents having the same effect as a bundle of national patents for the designated states.

C.3 Patent Documents Analysed

The document dataset was identified through International Patent Classification (IPC) codes, European Classification (ECLA) codes, and word searching of abstracts in conjunction with patent examiner technology-specific expertise.

The applicant and inventor data are cleaned to remove duplicate entries arising from spelling errors, initialisation, international variation (Ltd, Pty, GmbH etc.), or equivalence (Ltd., Limited, etc.).

C.4 Small-medium sized enterprises (SMEs)

Small and medium-sized enterprises (SMEs) are defined by the European Commission[182] as companies having fewer than 250 persons employed and a turnover of up to €50m.

To find out which UK-based patent applicants belong to which class of enterprise, the Bureau van Dijk FAME database was used and, where possible, historical information was analysed to look at the company size when the patent application was made.

C.5 Glossary

Submarine patent: this term is generally used in the US patent system and refers to a patent whose existence is unknown to the general public and third parties as its publication and issuance has been delayed intentionally by the patent owner.

Evergreening: this is the term given to legal and business strategies where owners of patents which are about to expire, attempt to extend the scope of protection for the original patent subject matter. It can be a somewhat controversial term.

Divisional: a divisional patent is one that is divided out from a parent patent application, where more than one invention is defined. It will have the same priority/filing date as the parent application but will be of different scope. It may not claim subject matter that was not disclosed at the time of filing of the parent application.

Continuation: a continuation patent is similar to a divisional patent, but is known as a continuation in the US system. It can be filed when an Examiner rejects some of the claims in the parent application but the applicant feels that further protection is warranted for that subject matter, or where the applicant feels they have not managed to protect all of the potential embodiments of the invention.

Continuation in part: this type of patent is filed in the US and is similar to a continuation or divisional patent but where the inventor has added new subject matter pertinent to the parent application. The claims to this new subject matter are only entitled to the date of protection association with the filing of the continuation in part application, whilst any claims that relate to the subject matter contained within the parent application are allowed the date of filing of the parent application.

Patent family: a patent family is a number of patents that are all linked by a common source or priority, and usually consists of a number of patents filed in more than one country for a single invention.

DWPI family: a DWPI family is a family of patents which is linked via the Derwent World Patent Index.

ECLA: European Classification

IPC: International Patent Classification

WIPO: World Intellectual Property Organization

EPO: European Patent office

USPTO: US Patent and Trademark Office

[182] http://epp.eurostat.ec.europa.eu/portal/page/portal/european_business/special_sbs_topics/small_medium_sized_enterprises_SMEs

FTC: Federal Trade Commission

Appendix D Search strategies employed

The data source for this project was Thomson Reuters DWPI patent database, accessed using Thomson Innovation® and via the European Patent Office EpoqueNet. The results were generated in October 2011.

D.1.1 Search strategies

The search strategies for each technology area were kept as simple and as broad as possible to ensure maximum inclusion of relevant documents. The datasets were constructed using patents granted in the United States (US), Europe (EP) and the United Kingdom (UK) since 1990. To ensure that applications which may still be granted were also considered, patent applications published from 2005 onwards were also included.

For full details of what the classification terms mean please consult the appropriate web pages for the International Patent Classification (IPC)[183] or European Patent Classification (ECLA)[184].

Telemedicine

ECLA: G06F19/00M3F

Safety razors

IPC/ECLA: B26B21/22 (including lower terms), B26B21/14 (including lower terms)

Nanobiotechnology

IPC/ECLA: B82Y5/00

Microprogramming

IPC/ECLA: G06F9/22 (including lower terms)

Wireless networking (resource management)

IPC/ECLA: H04W72

Wireless networking (handoff arrangements)

IPC/ECLA: H04W36

Dendritic polymers

IPC/ECLA: B82Y plus keywords DENDRI+ OR STARBURST+ OR COMBBURST+ OR (DENSE W STAR+)

Graphene

ECLA: C01B31/04H+, H01L29/16G plus internal EPO indexing codes M01B204/00, M01B204/02, M01B204/04, M01B204/06, M01B204/06B, M01B204/20, M01B204/22, M01B204/24, M01B204/26, M01B204/28, M01B204/30, M01B204/32, T01L29/16G/ICO

Plus keyword GRAPHENE+

[183] http://www.wipo.int/ipcpub/#lang=en&refresh=page
[184] http://worldwide.espacenet.com/eclasrch?locale=en_EP&classification=ecla

Fuel cells

IPC/ECLA: H01M8

Photorefractive keractectomy

IPC/ECLA: A61F9/01(including lower terms)

D.1.2 General search notes

When ECLA terms have been searched, family member documents only classified with IPC terms are also retrieved.

The operators shown above are:

+ - any number of characters following (e.g. CLEAN+ would find CLEAN, CLEANS, CLEANING, CLEANER, CLEANERS and so on)

W – following word (e.g. Alpha W Bravo finds Alpha Bravo)

Where “lower terms” are indicated this means any terms below the one given in the hierarchical classification schemes.

D.1.3 Data cleaning

Once the data were extracted for each technology area, applicant names were cleaned using a combination of automatic fuzzy logic and manual methods to correct for typographical errors. Search Technology’s VantagePoint software was used for this.