How To Find, Assess And Value Open Innovation Opportunities By Leveraging IP Databases?

By Paul Germeraad and Wim Vanhaverbeke

An increasing number of companies are practicing open innovation by relying on external sources of technology.[1] However, inbound open innovation is not always leading to the expected improvements in innovation performance. A key factor for success is quickly and reliably determining which technology or solution a company should source externally. In this study, we explore reliable ways of finding relevant technology using intellectual property databases.

Intellectual property in general, and patents in particular, have long been an interesting source of technology. However, the use of patents as a means to understand new commercial opportunities was historically limited for two reasons. Firstly, publication of patents in paper form made access tedious. Secondly, geographic distribution of patents and publication in local languages made it expensive and time-consuming to understand what inventors had created.

These two limitations have recently been overcome. Patents were one of the first forms of technical publication to be categorised with metadata. They were also among the first publications used by linguistic scientists to convert textual material into keywords, key concepts, and scientific themes. Even more recently, high quality machine language translation has made patents published around the world in languages with various alphabetic character sets accessible to all.

With this vast amount of information now available, the questions become: (1) How to find the right technology and partners in this mountain of information? (2) How to use new patent databases and patent analysis software tools to improve the speed and quality of finding exactly the right technology and partners? and (3) How to negotiate access in an equitable and timely manner after finding desirable technology and partners?

To answer these questions firms first need to constantly improve their innovation productivity to stay competitive and grow. This requires a clear strategic, then tactical, view of which technology is needed and why. Upon gaining an understanding of the target technology, the next step is to find existing sources of such technology in patent databases. Finally, the technology found must be assessed and valued in ways that support win-win negotiations.

1. For a recent survey overview, see H. Chesbrough and S. Brunswicker "Managing open innovation in large firms," Fraunhofer Verlag, Stuttgart, Germany, (2013).

Open Innovation as Part of a Firm's Strategy and Patent Management Practices

When assessing whether technology needs can be met through open innovation it is important to first examine which types of innovation can create and sustain business growth. Corporations can conduct strategic planning based on a combination of three growth horizons: current generation growth; next generation growth; and new business growth. The first horizon is focused on slowly growing revenues coming from current generation market share growth and geographic expansion. Supporting current generation growth is typically based on incremental innovation. Most IP is commercially available to all industry participants. The company's price/performance position is well known and understood by others; and because the technology is mature, intellectual property protection is often obtained from trademark and copyright protection. External technology is often supplied by individual customers or inventors.

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To satisfy expectations of shareholders, growth from next generation offerings is also required. The technology for next generation products is not available today but will come from innovations—and the objective is to create a competitive advantage that others cannot readily follow. The goal is to block competitors using all forms of intellectual property, in particular patents. The innovations that support this type of growth often come from internal R&D initiatives or company-to-company open innovation initiatives.

Long-term growth requires new business growth. This often involves the development of new business models. Because this work is often developmental, intellectual property protection is based on nondisclosure agreements and trade secrets. Open innovation activities in this time frame are often joint development agreements between companies or collaborative research with universities or research labs.

Senior management teams thus need to look at technology needs that reflect the type of growth they want to stimulate. In doing so, they can also identify the type of external partners most likely to supply an appropriate technology.

The identification of technology needs is a first step. The analysis of patent landscapes is the second step. When looking for technology, a company will typically find one of the three following scenarios. In the first scenario, there is little prior art. Such a situation is called a *'patent desert'* and the only option for a company is to conduct internal research, or fund joint developments with another company or research organisation. In the second scenario, which we label as a 'patent forest' there are hundreds of patent families already describing potentially interesting technologies. In such an environment, the company has the option to make, buy, or license art from other companies. Options here include internal innovation or open innovation with another company. In last scenario it is possible to find tens of thousands of patent families—a —in a particular technology area. In this environment, it is imperative to buy or license the needed technology. Such technology often comes from research labs, universities, individuals or start-up organisations.

Upon combining the strategic posture with the patent landscape, we can develop a heat map for open innovation—see Table 1 (the darker blue area is the open innovation sweet spot). The idea behind this juxtaposition of strategic posture and IP position is that open innovation strategies for long-term, breakthrough innovations will be inappropriate in an IP-jungle, while open innovation for short-term incremental innovations can only be successful in an IP-jungle or IP-forest. If the open innovation strategy is not aligned with the patent landscape and strategy, the chance of successfully introducing new products and services is small.[2]

To comprehend the complexity of the choice between an external and internal technology sourcing it is important to understand that business needs and intellectual property needs have to fit into a hierarchy of business needs as we will explain below.

Table 1: Defining Open Innovation Strategies Based On IP Density And Strategic Posture

Strategic posture vs. IP position	IP jungle	IP forest	IP desert
Maverick - breakthrough	Kill project proposal	Screen for start-ups	Fund internal or academic technology
Offensive long range - next generation (new feature or big cost savings)	Fund to find and repurpose external technology	Fund external or internal technology	Fund internal technology or screen for start-ups
Offensive short-term maintenance - incremental (new but familiar feature or solid cost savings)	Use external already "baked" technology	Fund to find and repurpose external technology	Fund external or internal technology
Defensive short-term maintenance - next generation or incremental (familiar feature)	Screen for low cost external "baked" technology	Use external already "baked" technology	Fund to find and repurpose external technology

According to Maslow there are five business needs. They are unweighted and can be ordered much as the Maslow hierarchy of human needs[3] (see Figure1).

The most important objective for a management team is to guarantee that there are no surprises in the balance sheet. The second objective is that a company sustains or improves its market position. A company should continually improve its productivity and introduce new products to sustain its market position. Thirdly, a company should fully exploit all of its assets including its technology base. Technology cannot sit on a shelf unused and must be monetised via external paths to market.[4] Speeding up R&D and business product development activities is the fourth business need. As competition becomes global and best practices are shared among organisations, speed to market with new products is key to capturing the lion's share of emerging market segments. The last business need is to influence the industry's adoption of new technology and new standards that play to an individual company's core competencies.

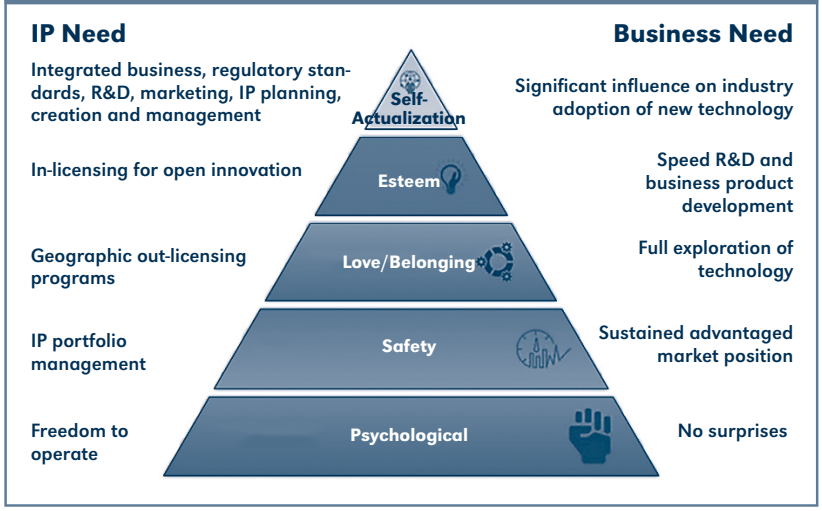
Figure 1 also shows the corresponding intellectual property needs. At the bottom of the pyramid it is important not to infringe the intellectual property of other organisations. The objective of a thorough search of external technology is to avoid 'freedom to operate' problems. Secondly, when R&D investments result in new products or services, intellectual property protection is essential to maintain a competitive advantage over an extended period of time. Thirdly, a

2. Similarly, we can combine patent intensity versus the IP-velocity: open innovation is tougher when the rate of investment in new technology is high (many patents issued per year) compared to technologies that evolve at a slower pace.

3. A. Patel and P. Germeraad, "The New IP Strategy Agenda," *les Nouvelles*. XLVIII (2), (2013), 86-93.

4. H.W. Chesbrough 2003, "Open Innovation: The new imperative for creating and profiting from technology," *Harvard: Harvard Business Press*, (2003).

Figure 1: Hierarchy of Business Needs and IP Needs



company can set up out-licensing programmes to fully exploit its technology. Fourthly, a company can develop outside-in open innovation initiatives to speed up innovation and strengthen its own technical capabilities. Open innovation is thus a relatively low priority compared to other critical business and intellectual property activities. Finally, a company should integrate its IP strategy into its innovation strategy and overall strategy. This is an IP objective for those organisations that have an advanced open innovation strategy.

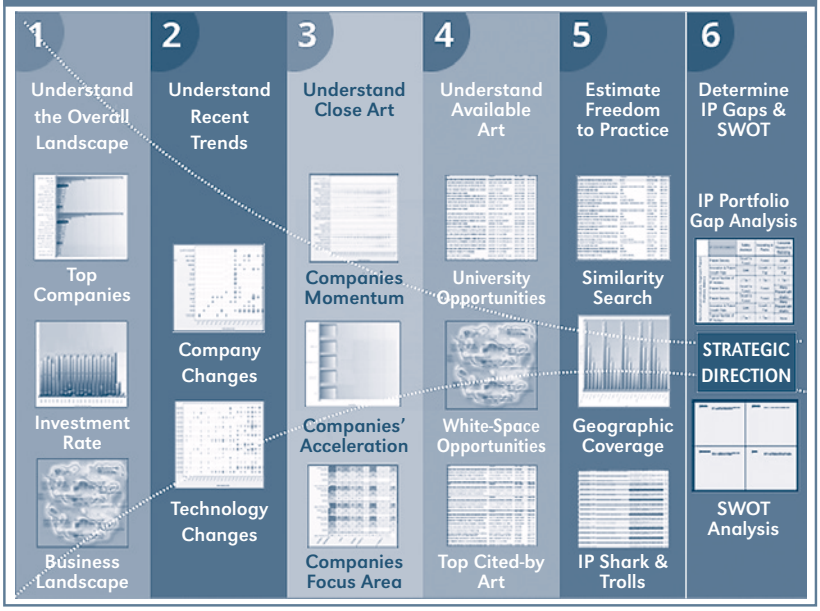
Climbing the IP needs hierarchy is difficult and, therefore, it is unsurprising that many companies have not yet put sufficient energy into open innovation best practices. However, the ambition to climb the IP needs hierarchy continues to persist and tools and training required for highly productive practices are now becoming available.[5] Using patent databases and new search engines to quickly locate open innovation opportunities is one example. The tools and associated benchmarking measures enable the potential opportunities to be quickly assessed. The opportunities that fit within a company's strategy can be visualised and shared with management teams in a way that creates fast and high-quality decisions. Furthermore, the value of patents can be visualised and used in productive open innovation negotiations. Finally, when a firm intends to acquire specific patents it can now visualise and assess the business risk associated with the freedom to operate, as well as the portfolio's ability to exclude competitors from acquiring the same business position.

Finding and Evaluating Open Innovation Opportunity Using Patent Databases

Once a company has determined which technology and applications are of interest, it can start the process of finding and evaluating open innovation opportunities. The process can be visualised as a successive funnel-type search process consisting of several consecutive steps—see Figure 2.

Within this search process any type of information can be used to find new technologies. However, the preferred form of information is patents and patent applications—because patents have proven to be the most reliable sources of technical and commercially relevant information. Most people think of patents as an intellectual property asset to be evaluated and understood by lawyers. However, for the purpose of detecting open innovation opportunities, patents are used as a research information source to be explored by

Figure 2: Overview Of The Process Used To Find And Evaluate Open Innovation Opportunities



5. H.W. Chesbrough, W. Vanhaverbeke, and J. West, eds.,"New Frontiers in Open Innovation," *Oxford: Oxford University Press*, (2014). and...

B. Leten, W. Vanhaverbeke and N. Roijakkers, "IP models to orchestrate innovation ecosystems: IMEC, a public research institute in Nano-electronic," *California Management Review*, 55(4) (2013): 51–64.

technologists and business development personnel alike. Patent documents can be considered as footprints left by companies or research entities. Patent analysis software can extract a wealth of information from those documents and finds relationships among them. The advantage of patent information over other sources of information is that leaving each of these footprints costs around a million dollars. Researchers, business development people, and management teams have all debated whether to start projects, and fund the research necessary to leave that footprint. The footprints are the result of thoughtful strategic planning. As a result, the patent landscape is a robust source of information about technical and commercial strategies and tactics.

We start with an initial understanding of the overall IP landscape to determine the available technology that IP owners should watch and leverage. We suggest dividing the process into six steps as illustrated in Figure 2 and Table 2.

These six steps are designed to ensure:

1. That the overall product or service will be launched in a favourable commercial environment;
2. That the change in technology being introduced, be it incremental or breakthrough, will be appropriate to the stage in the technical and commercial lifecycle;
3. That all sources of potentially relevant technology—individual, commercial and academic resources—have been explored for their ability to contribute to the quality and speed of introducing the new product or service;
4. That potential competitors lack the momentum to be a threat when the product or service launches;
5. That the degree of overlap between proposed technical solutions and existing solutions in the market is different enough to bring the risk of intellectual property infringement below an acceptable level; and that the potential risks of infringing IP of non-practicing entities (patent trolls) has been taken into account; and
6. That a unified vision is developed by the project and management teams involved on how to leverage and negotiate for desired external technology.

The logic behind this methodology is that information sources should first be analysed at the broadest level to ensure that investigators understand the overall IP landscape before focusing closely on individual patent families of interest. After obtaining a high level view, a team can subsequently focus on art closest to their needs.

Once potential technologies have been identified that match the company's strategic needs, the local patent environment surrounding these desired approaches has to be investigated. This step should produce a small number of potential options because there is usually more than 'one way to skin a cat'. For the final few candidates selected, the open innovation search methodology then estimates the IP risk of each option. Some IP-environments have inherently more aggressive participants than others and management may wish to avoid them. The last step in the process is to carefully summarise the strengths, weaknesses, opportunities, and threats so that the team negotiating access to the external technology will be well prepared to make a fair offer and negotiate a mutually beneficial agreement.

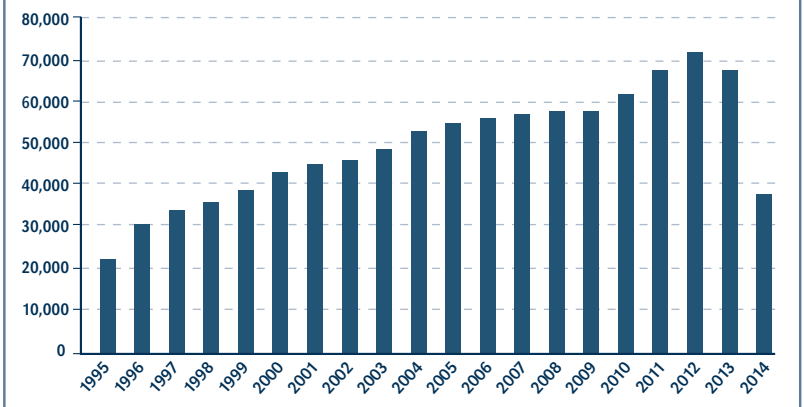
We apply this data analysis methodology to a case where companies try to find and evaluate relevant membrane technology.

Finding and evaluating opportunities in the membrane technology using patent databases.

Table 2: Overview Of The Process Used To Find And Evaluate Open Innovation Opportunities

1. Understand the overall landscape • Which entities have invested the most R&D money in this field? • Is the overall investment in this area increasing, decreasing, or staying flat? • What are the most frequent technical approaches and associated products?
2. Understand recent trends • Which entities are entering and leaving this field? • Which technologies are emerging and falling out of favour?
3. Focus on and understand the close art • What is the momentum of companies working near the desired product? • Which entities create components and who is focused on systems? • In which countries is R&D being conducted?
4. Expand your perspective to utilise all potential options • What academic entities are available to help? • What recent and unique technology exists? • What potential grandfather and next generation art exists?
5. Estimate the legal threats and opportunities • In which countries are patents being filed? • Will you have freedom to practice? • Will you have the ability to exclude others? • Are IP sharks and trolls present?
6. Determine who to watch and leverage • What gaps exist in your company's intellectual property portfolio? • What are the strengths and opportunities you should build upon? • What are the weaknesses and threats you should mitigate?

Figure 3. Rate of Investment In Membrane Technologies As Represented By Patent Families Filed Worldwide Each Year



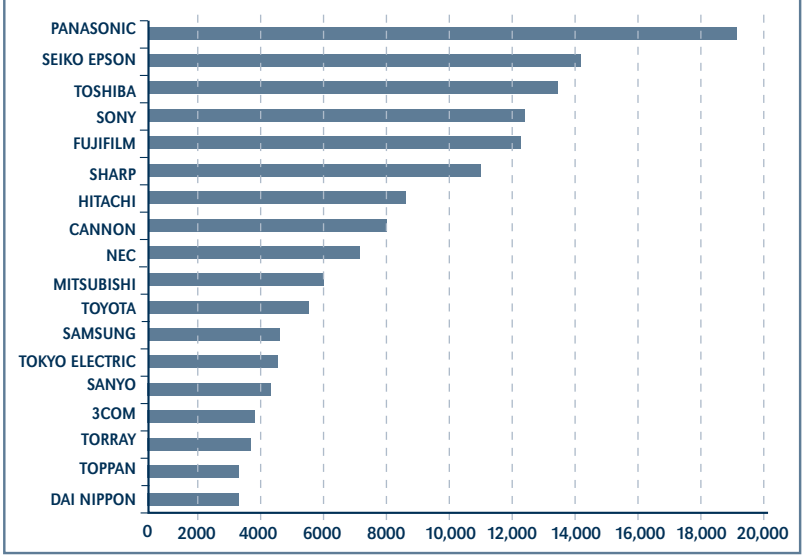
Assume a company with expertise in membrane technologies that wishes to expand its commercial offerings into environmental protection and clean-up markets. Its sales force and business competence is in business-to-business transactions. It wishes to remain in industrial markets but it also wants to enter the consumer marketplace where a new marketing and sales strategy would be required (in addition to acquiring new technology). However, there are no limits placed upon which market an acquired new-to-this-company technology is serving.

Using patent databases and the proposed analysis tools it is possible to get an overview of the membrane technology landscape. Making an assumption that the technology desired by this company would have been invented and published in the last 20 years, a patent search for membranes over that time frame can be conducted. In this case, over 1.5 million discrete patents were found. Although this is a very large dataset it is still possible with modern analysis tools to mine the dataset for critical business information.

The first question to answer related to membrane technology is whether the technology field is worthy of investing. Companies do not invest in new technology unless there is a good chance of a high return on investment. Technologies evolve through life cycles: within any overall technology there are also specific nuances of a technology that has its own life cycles within the overall trend. Figure 3 shows that membrane technology is a field in which many entities are investing at an increasing rate. Using an approximation of $1 million dollars invested by a company for each patent family published, the figure shows that this field is attracting billions of dollars in annual research.

The graph shows that the company intends investing in a growing area. It is a technological hotspot—an IP jungle—where many other companies have already been investing and so expresses a belief that this technology has business opportunities. The shareholders will be pleased with the management team for investing in a market that is growing. If the membrane technology were stagnant or decreasing the company might consider divesting its operations in this technology area. A large growing market implies that this technology is an intellectual property jungle and the appropriate strategy in such a rich technology environment is to look for external innovation opportunities.

Figure 4. Entities Investing In Membrane Technologies As Indicated By Patent Families Filed Worldwide



However, although the size and growth of the overall market is important, the distribution of investment among the industry's participants is also important. Again the 1.5 million patent families of the overall membrane field can be sorted by the largest participating entities. In this case, the largest organisations have over 1000 patents and this indicates that each organisation has probably invested over $1 billion in this field over the last 20 years. Figure 4 shows the distribution of major patent assignees in membrane technology.

Not shown in the table is a long list of companies that have hundreds,

tens, or even only a few patents in this field. These are also important entities. It is often the effort of a single inventor, a small start-up company, or university research group that uncovers a new technology. There are thousands of such entities participating in this marketplace that our company should investigate.

A heat map of the membrane technical field is suitable to narrow down the number of technologies to investigate, as well as to gain an understanding as to whether this company is going to be in the mainstream of the field or otherwise. Such a heat map (see Figure 5) shows how many 'membrane' patents are present in each of the 35 technical domains defined by the World Intellectual Property Organization (WIPO). Membrane technology is particularly important for semiconductors and pharmaceuticals. However, this is a generic technology that touches on most technical fields.

Such a diversity of applications underlines the generic nature of membrane technology and is good news for our company. It reinforces the understanding that this is a broadly applicable market. The firm's intention to enter the environmental technology space with membranes is not without precedent and perceived opportunity. There are 67,798 patents covering technologies in this field. Prior efforts in the field are good news and they can also serve to guide business development.

Figure 5. Heat Map Of The Technical Domains

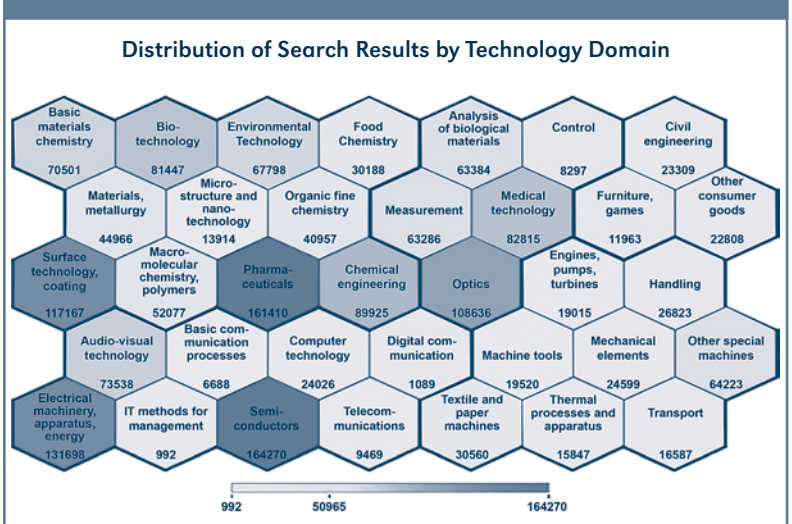
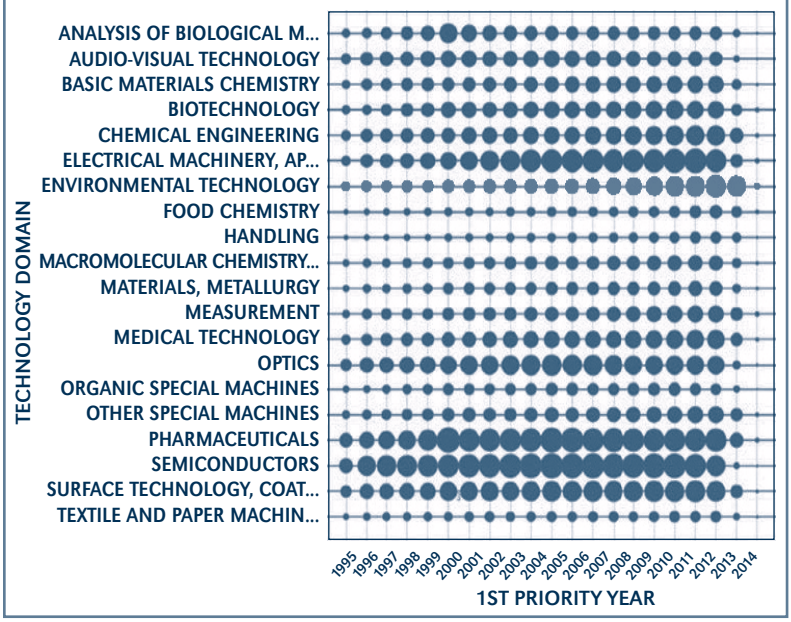


Figure 6. Growth And Decay Of Membrane Related Technologies

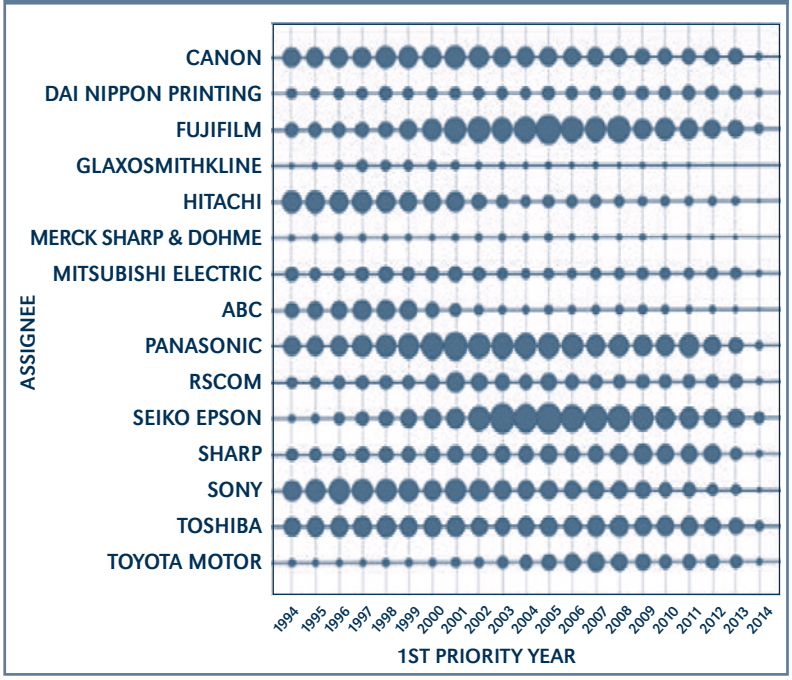


The next step is to juxtapose trends in the technology domains and entities participating in this technology area of 67,798 patent families. This is best done with trend maps showing how individual technologies or assignee efforts have changed over time. For the various technical domains in which membrane technology is used we can see some areas are growing and others are shrinking. Figure 6 shows the number of patent families in each technology domain that were filed annually. This chart represents the relative rates of investment per technology.

Shrinking fields represent subsets of membrane technology in which a technical alternate has been discovered in membrane use. Using membranes to analyse biological materials is an example of such an area. Fortunately, for our company the use of membranes in the environmental technology area is growing significantly. More good news is the fact that the use of membranes in this area is recent—indicating that membrane technology is going to be of value in the future and not a legacy from the past.

Likewise, the flux of companies entering and leaving the field is also important to understand. Figure 7 shows the growth and decay of investment in membrane technology as represented by annual patent filings worldwide. The flux of companies investing in membrane

Figure 7. Growth And Decay Of Corporate Interest In Membrane Related Technologies



technology is significant. Companies such as Toyota are entering the field with significant recent investments: such a pattern typically represents a situation where the company enters a new field to seize new market opportunities. Other companies have invested in membrane technology in commercial applications that are waning. These companies are leaving the field—and semiconductor companies such as Hitachi, NEC, Seiko Epson, and Sony represent this trend.

Both increasing and decreasing corporate investments is good news for our company. Increasing investments by corporations that are active in commercial spaces that are different to those of our company represent joint partnership opportunities if the specific membrane technology is interesting to both entities. Conversely, companies that are leaving the field have an excess of trained researchers who understand the nuances of particular technologies and either their individual expertise, or the intellectual property they have created, is an opportunity for our company to buy such assets at a depreciated price.

In conclusion, the investigation of the overall intellectual property landscape serves three important purposes. We know that: (1) the overall area is attractive for investment; (2) it is likely that there is useable technology available; and (3) we can identify from the 'footprints' how we can best negotiate mutually beneficial agreements with others.

With the first two steps in our overall process of finding and utilising external technology for open innovation completed, we now turn to the third step of finding valuable intellectual property. It is not the purpose of this paper to discuss in detail all the tools available to accomplish this task—however, we wish to focus on a few of these tools.

This set of documents is still too large for a manual screening. Therefore, the next step is to look for opportunities that are relatively recent, with the presumption that older technologies have either already been exploited or have performance versus cost ratios that are no longer commercially viable.

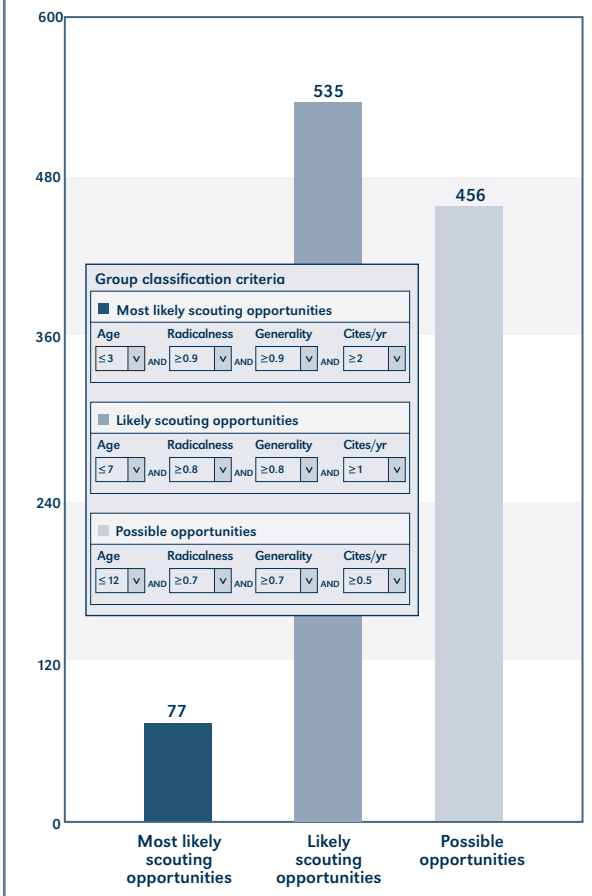
The next step in the narrowing process is to look at a company's core technologies. To determine these technologies, the company's patent portfolio was sorted for the WIPO technology domains. In so doing, we found that one of this company's core technologies was chemical engineering. By matching this company's core competency with the new interest in membranes related to environmental technology the set of documents in the group (67,798) was further reduced to those patents that mentioned chemical engineering technologies in their patent. This then reduced the art that would be most helpful to the company to 26,125 patents.

Looking at the overall investment rate in Figure 3 it can be seen that there is a burst in activity in this field around 2010. When 2010 is used as a cut-off date, the list of 26,125 patents is reduced to a set of 9,056 recent patents for further mining for sourcing external technologies.

The availability of technology domain metadata and the improving capabilities of semantic, thematic, and concept search engines makes it possible to try a variety of techniques to further narrow a dataset of patents to that which might be most useful for a specific application. Our dataset of 9,056 patents (which are most relevant for environmental clean-up or protection activities) is still excessively large. Fortunately there are a few new tools for finding the 'needles in a haystack.'[6] The methodology we show below is based on a software engine that tags patents and finds in

6. There are a few alternative methods to the one we present. Firstly, searching for universities and research institutes as a source of breakthrough innovation is always a productive exercise. The amount of art is typically small but can yield unexpected results. Secondly, one can use thematic maps that can handle datasets of the order of 50,000 records. Patent families located in the 'blue ocean' zone of these thematic maps can be isolated for further investigation.

Figure 8. Frequency Distribution Of Potential Open Innovation Opportunities



this way the most recent, original, and impactful technology developed within a period of time.[7] It is a three-level segmentation of the identified patents, from 'most likely scouting opportunities,' through 'likely scouting opportunities,' to 'possible opportunities' based on a combination of four segmentation criteria—age of the patents, radicalness, generality, and citation rate.

Figure 8 shows the frequency of the three segments for the dataset of 9,056 patents. These opportunities were found by segmenting the group of 9,056 patents into: age categories ranging from 3 to 12 years; radicalness scores (a score based on international patent classifications and the number of references that the patent family contained) from 70 percent to over 90 percent; generality scores (based on IPC codes and patents that cite the patent family under analysis) ranging from 70 percent to over 90 percent; and finally, a criteria based on backward citations.[8] These cited-by rates ranged from 0.5 citations per year to over two citations per year (the velocity is used as a metric to account for the fact that some patents are younger than others).

In the case of membrane technology, 77 patents of the 9,056 were identified as the most likely scouting opportunities. These 77 documents can now be reviewed by the subject matter experts of the company and they can determine which are the most interesting. One area that seems to be promising is 'biomass' and within this area the experts may look specifically for art from academic institutes and small companies. This is typically an interesting source of inbound open innovation. (The other source of inbound open innovation is typically R&D efforts orphaned by larger companies, but in this case there were none in the category to review). Table 3 shows the art of the biomass area wherein there is an interesting small entity: SuGanit Systems Corporation. This organisation had built on earlier research developed at the University of Toledo.

Table 3. Biomass Related Technologies And Uses Found Within The 77 Most Likely Top Potential Opportunities

Title	Applicant/Assignee	Publication Number
Aggregating microorganisms with electrical and acoustic energy	HELIAE	US2014017760
Process for producing high-carbon biogenic reagents	BIOGENIC REAGENT VENTURES	US2012285080
Ionic Liquid recovery and purification in biomass treatment processes	SUGANIT SYSTEMS; UNIVERSITY OF TOLEDO	US2013292331
Process for the recovery of oleaginous compounds from biomass	SAPPHIRE ENERGY	US2012022278
Methods of and system for insoluble oil recovery from aqueous slurries	DE WEB DEVELOPMENT DC; HELI MEET DEVELOPMENT	US2011195484
Non-dispersive process for insoluble oil recovery from aqueous slurries	ORGANIC FUELS ALGATE TECH; UNIVERSITY OF TEXAS	US2011174734
Biomass hydrothermal decomposition system and saccharide-solution production method using biomass material	MITSUBISHI HEAVY INDUSTRIES	US2012009642
Treatment of flue gas from an oxyfuel combustion process	AIR PRODUCTS & CHEMICALS	US2012009109

7. For more information about the software, see *https://questel.com/index.php/en/help/technology-scouting*, November 11, 2015.

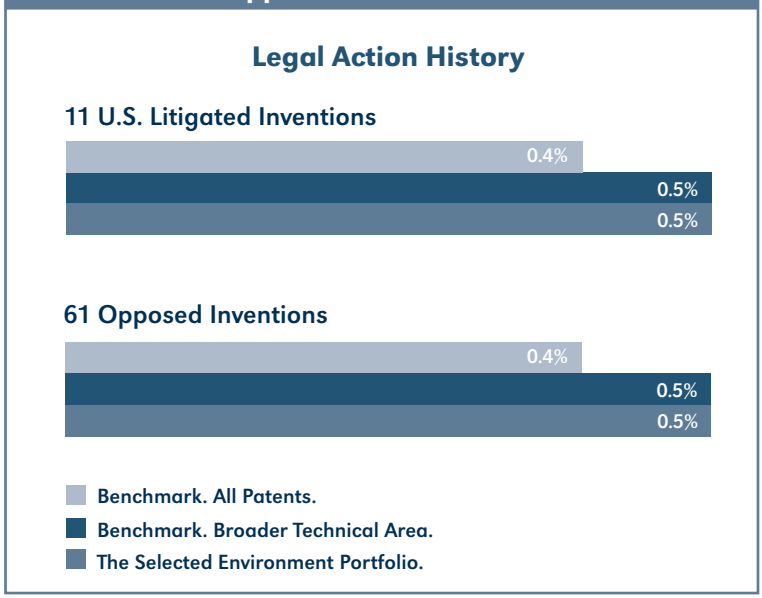
8. The values used to select art (age, radicalness, generality, and citations per year) are based on best practices. These rules of thumb vary up and down slightly according to the industry and technology under study.

Table 4. SuGanit's Portfolio Rated Within the Industrial Products IP Environment As Rated For Its Ability to Exclude Competition

Technical Prowess	Patent portfolio size should be larger than average
	Count of patents protected by fences should be at least within 20% of largest per assignee count
	Count of grandfather patents should be at least within 20% of largest per assignee count
	Count of acquired patents should be larger than average
	Average claim length should be within 20% of the smallest per assignee average in the study
	Average generality score should be within 20% of the highest in the industry
IP Prowess	Count of litigated patents should be within 20% of the highest per assignee count in the study
	Count of opposed patents should be within 20% of the highest per assignee count in the study
	Count of re-examined patents should be within 20% of the highest per assignee count in the study
Geographic breath	Average geographical coverage should be greater than or at least within 20% highest average geographical coverage in the study
Ability to Counter-Attack	Application velocity should be at least within 20 % of the fastest in the industry
	Patent portfolio should contain a U.S. prosecution time which is within 20% of the fastest time in the study
	Grant velocity should be at least within 20% of the fastest in the industry

Researching SuGanit's ionic liquid recovery and purification process (performed during the overall biomass treatment process) showed that a unique new technology had been uncovered. This technology involved pre-treatment of the biomass material in such a way that greatly increased the efficiency of the overall process. It also played to our company's chemical engineering strengths. Further research on the SuGanit technology showed that they had taken over the original work from the University of Toledo, and focused their own follow-on innovation efforts on building a patent portfolio of seven patents. Thus they had already started the good intellectual asset management task of building a patent fence to protect a commercial position once the technology was fully developed. The R&D efforts of SuGanit, as well as their solid intellectual asset management practices, made this entity a true nugget for the open innovation exploratory process.

Figure 9. SuGanit's Litigation And Opposition Environment

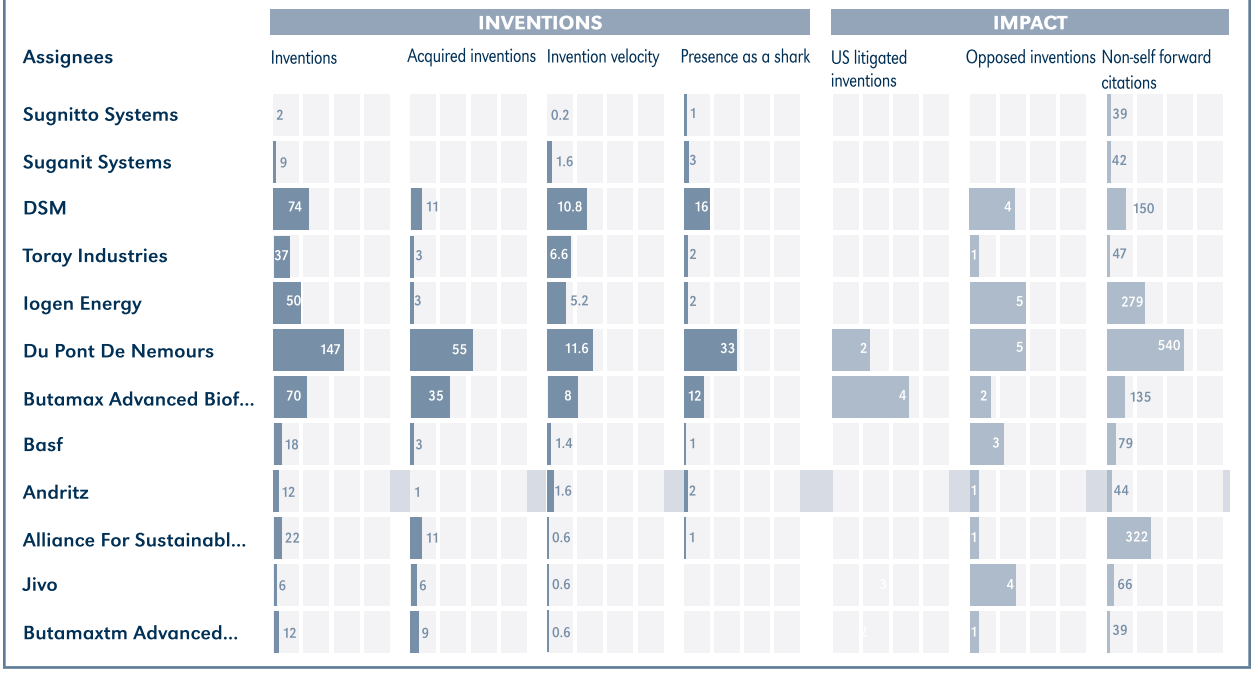


Our company, having uncovered a solid opportunity to explore, is now ready to prepare for acquiring the know-how from SuGanit. This brings us to the fifth step in the overall open innovation process, where we assess the IP risks associated with each option. Firstly, we should be aware that there are different intellectual property environments with their own best-practices for IP-management. In the case of the SuGanit patents, several factors need to be considered. These include the portfolio's ability to exclude others upon commercialisation of the technology, and the portfolio's ability to assess the freedom to operate.

Assessing SuGanit's ability to exclude competition, its portfolio of seven patents was compared against a collection of 3,384 patent families representing similar technologies applied to biomass processing. When the SuGanit portfolio was compared with the properties required in an intellectual property environment, the portfolio scored poorly with only two darker blue marked items (see Table 4).

9. Founding patents are those initial patents on which a new technology field is built. All posterior patents in that field refer to these founding patents.

Figure 10. Potential Competitors' Investments And Posture



However, this is not an atypical position given SuGanit's position early in the technology life cycle. When evaluating the SuGanit portfolio on the four general areas displayed in Table 4, only technical prowess showed two green labelled criteria for excluding competition in that technology field: (1) their patent portfolio was larger than average; and (2) the generality score was one of the highest in the industry. Areas where the SuGanit portfolio would need to be developed once acquired included: increasing the number of patents that are protected by patent fences; further developing the founding patents;[9] and ensuring that the claim length would be short (indicating good general coverage). Another area that should be addressed after acquisition is the geographic coverage of the portfolio. This would be possible since SuGanit has WIPO filings with many designated national states.

To obtain an overview of the litigation environment that our company would find itself in after entering this new field, we focus on the frequency of U.S. litigation—as well as the frequency of opposition in countries where opposition is allowed. Figure 9 shows the results.

This information is important because our company is entering a technology area in which it is not familiar. Senior management needs to understand that the litigation rate is likely to be above the U.S. average, although consistent with litigation in this technical field in general. Also, the rate of opposition in this field is much higher than the average for all WIPO technologies and even higher than the average for biomass technologies in general. This implies that our company must be committed to defending the technology in court and that its R&D and intellectual property teams will need to allocate time and budget to addressing opposition issues.

Figure 10 shows the entities that are likely to be both potential causes of legal actions, as well as those that our company must work to surpass. Other companies have made significant investments in this area, and have also invested in opposing, litigating, and building patent fences around what they consider to be threatening organisations. All of this must be taken into account by our company.

Our company should obtain this technology from SuGanit at a fair price and with a commitment to transfer the know-how so that it can compete against strong rivals. To ensure that the negotiations are conducted in a manner that yields the expected results, our company also has to study the individual patent-based metrics that will enable it to negotiate point by point with SuGanit.

This brings us to step six in the process. We evaluate SuGanit's portfolio using more than 40 patent metrics. This is done by comparing the SuGanit portfolio to portfolios of similar technologies for biomass conversion that are held by other entities. This comparison set is against the list of 3,384 patents we mentioned previously. The three areas that are evaluated are: the probable strength and validity of the SuGanit portfolio;

the strength and breadth of the technology and use coverage of the portfolio; and finally, the geographic coverage of the portfolio. The spider diagrams provide three outcomes per measure: 'outstanding' (white), 'above average' (yellow) and 'below average' (red). The performance of the SuGanit portfolio is represented by a red line.

During negotiations, portfolios that have outstanding metrics are of obvious interest. Portfolios that have no outstanding characteristics, but have—for any one of the three areas—five or more measures that are above average are rated as good (B+) portfolios and the price of licensing the technology should be set accordingly. By applying insight gained from these three areas, standard royalty rate databases can be used to negotiate the specific royalty rate terms.[10] The evaluation of a patent portfolio using these 40 measures sets the royalty range at the high-end or low-end of the royalty value range.

The SuGanit portfolio is represented by the red line in Figure 11 and is weak on validity and enforceability.

SuGanit's portfolio is at or below average in almost all of the validity and enforceability measures. This is not surprising for a young portfolio in a new technology area. However, the value of this portfolio is questionable at this point in time. Based on these measures the price our company would be willing to pay for such a portfolio is at the low end of the royalty range scale.

Figure 12 shows the SuGanit portfolio with respect to technology strength and use measures (B+ in this regard). It has over five individual measures that are well above average. Although none of these measures is worthy of a negotiating position in itself, the fact that multiple positions are above average indicates that this portfolio was well put together. Of particular interest is the good score on items such as the citation velocity, the average number of forward sites, the forward versus backward citation ratio, the patent classification disparity, the generality index, originality index, radicalness index, and average claim length.

As the portfolio is strong in terms of technology strength and use, our company needs to be prepared to pay SuGanit fair value for its technology. These metrics indicate that the price paid should be above av-

Figure 11. Validity And Enforceability Measures For Suganit's Portfolio

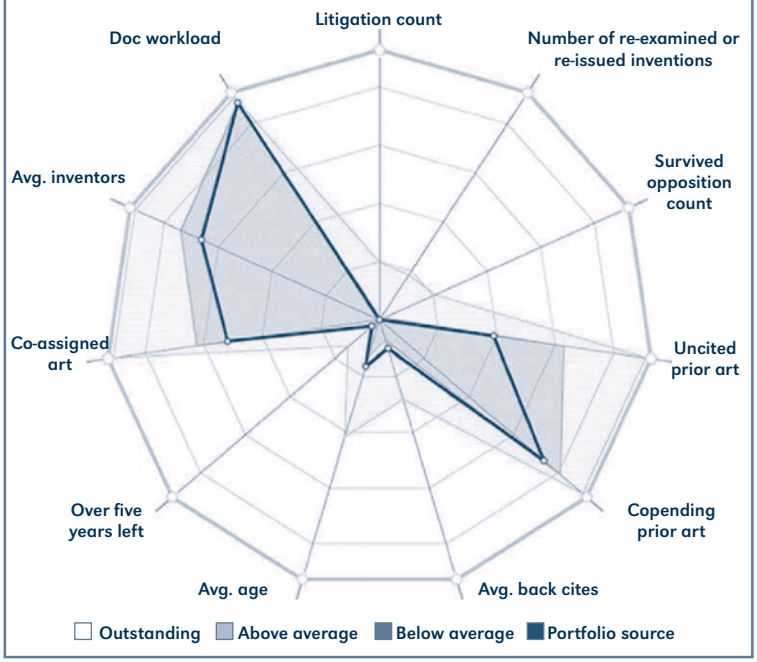
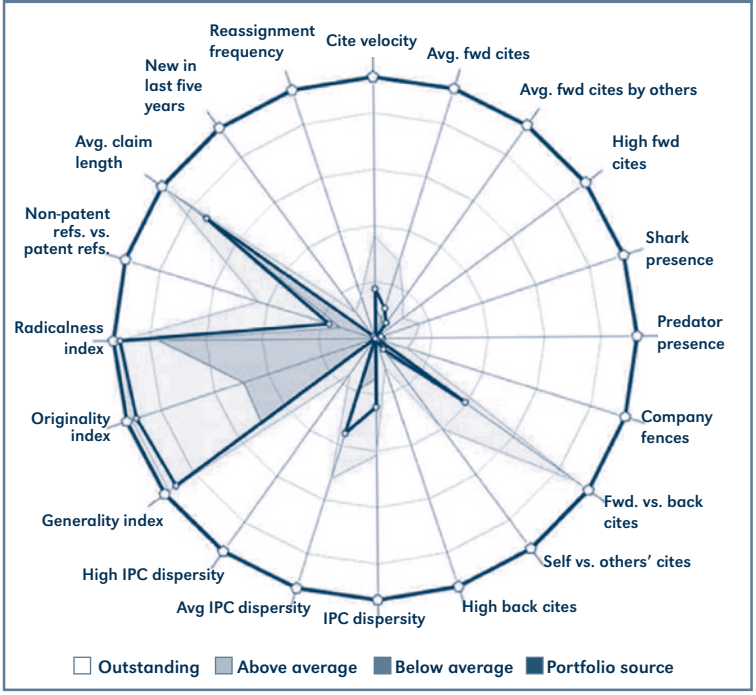


Figure 12. Technology Strength and Use Measures for SuGanit's Portfolio



10. Two common sources of royalty rate databases are the Royalty Source (*http://www.royaltysource.com/) and the Royalty Stat (https://www.royaltystat.com/*). November 11, 2015.

erage, but less than 80 percent of the maximal royalty rate that the royalty rate databases indicates.

Finally, looking at the geographic coverage of the portfolio we find in Figure 13 that it is small and does not yet have broad international coverage. All metrics are at or below average. However, this is not a major deficiency for a young portfolio.

It can be seen from the location of the circles on the red line that SuGanit has filings in the U.S., Japan, Germany, France, Britain, India, and Australia. China appears to be the only major country in which coverage is lacking. SuGanit's management team has thus been thinking about how to protect their technology on an international scale and our company must give SuGanit credit for this action. This implies that the price our company is willing to pay for the SuGanit portfolio should be about average of the royalty rate database range.

Taking all these three areas together, our company should be willing to pay an average royalty rate to acquire this portfolio. This is the sum of paying a below average amount for the validity and enforceability, above average for technology strength and use, and average for the geographic coverage. During the negotiations these graphics may help put the negotiations on a fact-based rather than an opinion-based foundation.

After assessing the intellectual property's strengths and weaknesses, the final activity in step six is to summarise the information uncovered in the analysis into a simple one-page SWOT assessment. Such one-page summaries show how an inbound open innovation opportunity will fit within the company's technology roadmap and current intellectual property. Table 4 shows the SWOT analysis for this project.

Once these six steps are completed a negotiation team can prepare for its initial contact with the desired partner. Work done by the Licensing Executives Society shows the wisdom in preparing carefully for such negotiations.[11] Upfront work is well rewarded with a fast and high-quality agreement that both par-

Figure 13. Geographic Measures For SuGanit's Portfolio

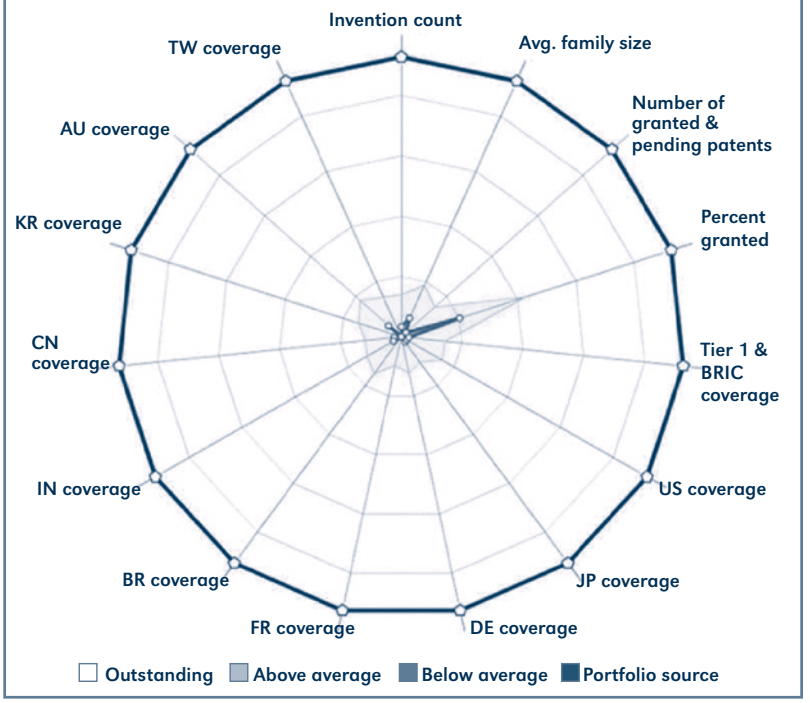


Table 5. SWOT Analysis Of Biomass Open Innovation Project

STRENGTHS	WEAKNESSES
• Strong investment ongoing in market • Novel technology approach • Aligns with our company's growth business strategy • Aligns with our company's core technical competencies	• University and venture company works needs lots of follow-up before commercialization
OPPORTUNITIES	**THREATS**
• Current R&D and IP positions indicate and "average" price Point of know-how and patent acquisition • Follow on work by venture company provides knowledgeable individuals to access / hire	• Other large corporations are interested in this area –They have invested enough that they will fight another participant –They may collapse our initial sale price upon commercialization • Full R&D and IP costs not known

11. See LES Education Course Overviews (*http://www.lesusa-canada.org/education*)(November 12, 2015) or R. Goldscheider ed. "Licensing best practices: The LESI Guide To Strategic Issues and Contemporary Realities," New York: Wiley, (2002).

ties feel is fair and mutually beneficial. As important as this external preparation are the preparatory actions necessary for the company's management to approve the project. The payback for such preparatory work is a quick and high-quality management decision that makes open innovation a viable option to pursue.

Instead of doing everything in-house, companies nowadays tap into external expertise to develop new offerings. The available technological knowledge is massive and searching for 'needles in a haystack' is a daunting task. However, the good news is that patent data is now readily accessible through text data mining tools (as well as new online tools) that enable competitive technological intelligence and prior-art searches. Enabled by these tools, managers can greatly improve the effectiveness of their open innovation activities. Firstly, starting from their strategic needs, companies should define which technology and partners they wish to find. Secondly, appropriate use of new patent databases and patent analysis software tools should improve the speed and quality of finding the right technology and partners. Finally, once desirable technology and partners are spotted, companies need to understand how to negotiate access to the technology in an equitable and timely manner. We have structured the last two parts via a six-step phased approach and have illustrated the approach with an example from membrane technology with environmental protection applications. Each firm has of course its own type of technology needs and will therefore have to adapt the suggested method to the specific context. However, the suggested methodology is comprehensive enough to be a good guideline for most organisations that face the challenge of finding and acquiring a specific type of technology from an external partner with reasonable conditions. Inbound open innovation has become so important that the search and acquisition of external technology cannot be left to the idiosyncrasies of trial and error. ■

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