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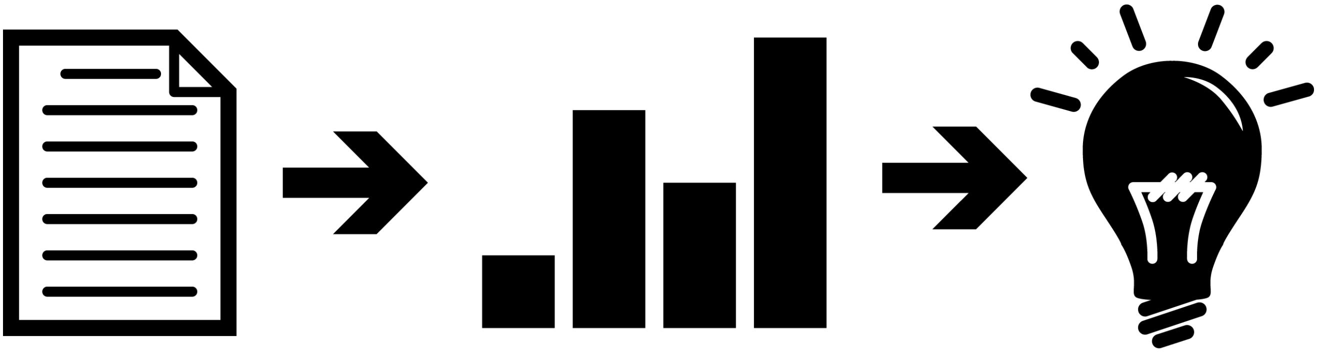

Suggesting a Patent Insight Process

A process of using patent data as a means for technological scanning

Master of Science Thesis
in the Management and Economics of Innovation Programme

Christian Ekberg
Felix Gärdelöv

Department of Technology Management and Economics
Division of Innovation Engineering and Management
CHALMERS UNIVERSITY OF TECHNOLOGY
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Christian Ekberg
Felix Gärdelöv

Tutor, Chalmers: Peter Altmann
Tutor, VCC: Erik Hjerpe

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Department of Technology Management and Economics
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Chalmers University of Technology
SE-412 96 Göteborg, Sweden
Telephone: +46 (0)31-772 1000

Cover:
The picture on the cover is a representation of the conversion of patent data into structured and comprehensible figures that lastly can be used to obtain an insight into the patent landscape of a technology. This process will be explained in chapter four, *Suggesting a Patent Insight Process.*

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Felix Gärdelöv

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Abstract

In an increasingly dynamic business environment characterised by progressively shorter product life cycles and rapid diffusions of disruptive innovations, it has become more important for companies to stay informed and have-up-to date information. This paper explores one such medium to gain information about technological developments, patent data. Drawing upon the theory of patent data analysis, the researchers explores scientifically acknowledged patent data utilities and devices an organizational process, coined Patent Insight, that will help companies achieve continuous up to date insight regarding the patenting landscape of a technology. By doing so, the paper will answer the research question of;

1. *What scientifically acknowledged utilities of patent data can be used to obtain an insight into the patent landscape of technologies'?*
2. *How can companies access these utilities through an organizational process?*

This has been done through the examination of 12 theoretical patent data utilities, conducting patent analysis on three technologies and by carrying out interviews at Volvo Car Corporation. This work have thus provided a starting point for organizations to complement their existing technological intelligence processes to gain an increased insight into the patent landscape of technologies, by outlining the Patent Insight process which is used to systematically obtain the theoretically proposed patent data utilities.

Keywords: patent analysis; patent insight; organizational process; patent landscape; technology scouting; patent search; patent data utilities; autonomous drive; 3D printing

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1. Introduction

"The productivity of knowledge and knowledge workers will not be the only competitive factor in the world economy. It is, however, likely to become the decisive factor, at least for most industries in the developed countries." - Peter F. Drucker (1997)

Stemming from the resource based view, knowledge based view proclaims that knowledge is one of the most important resources necessary to obtain a competitive advantage in an information driven society. Knowledge however, has a distinct character as it is continuously renewed, replaced and made obsolete by new innovations and continuous development, e.g. the substitution of mechanical by electrical calculators. This characteristic has escalated over the past decades as the business environment has become increasingly dynamic, with shorter technology lifecycles and rapid diffusion of new disruptive innovations, making knowledge obsolete at an even faster rate (Bayus, 1998; Nieto, Lopéz & Cruz, 1998). Thus it becomes crucial that modern firms have organizational processes to actively seek new and up-to-date information in order achieve an updated holistic view of a technology (Grant, 1996; Drucker, 1997).

A promising source of technological data is Patent data, characterised as being reliable, quantifiable, publicly available and well maintained (Mogee, 1997). What's more, by restructuring the data into information, and conducting an analysis, the focal firm may obtain useful and valid insights about a technology of interest. The insight provided by the patent data's unique characteristics and analytical potential, allows the focal firm to become more aware of its technological environment and the development there of. No wonder, there has been significant academic research in understanding the utility of using patent data as a means for knowledge creation (Porter et al., 2011; Mogee, 1997; Steven, 2012). However, despite these claimed utilities less research has been conducted to understand how companies through an organizational process may access these patent data utilities. By organizational process, the researchers refers to a structured process that would allow an organization to systematically obtain patent data and integrate its utilities into current operations, such as a technological evaluation processes within an R&D department where future technology investments are decided upon.

The proclaimed organizational process for converting patent data into information is here referred to as the Patent Insight process, a process of conducting a patent analysis. The output of this process is an overview of the patent landscape, here on referred to as Patent Insight (PI).

1.2 Purpose

The purpose of this paper is outline the most frequently mentioned theoretical patent data utilities and to develop a process for conducting a Patent Insight in an organizational setting, in order to obtain the perceived utilities. By doing so, the aim is to contribute with an initial understanding of how patent insight can be used by organizations to access useful information about a certain technology.

1.3 Research Question

In order to achieve this purpose the following research questions will be further explored in this paper:

1. *What scientifically acknowledged utilities of patent data can be used to obtain an insight into the patent landscape of technologies'?*
2. *How can companies access these utilities through an organizational process?*

To answer these research questions an exploratory empirical single case study has been conducted at the R&D Strategy department of Volvo Car Corporation (VCC), a Swedish car manufacturer within the premium car segment, renown for its innovations within vehicle safety. VCC has shown great interest in evaluating the potential of creating a PI process, to complement their current technology scouting capabilities. By the end of a summer internship that one of the researchers had conducted at the VCC R&D strategy department, Volvo decided that it would be in their interest to further investigate the topic of using patent data as a means for technological scanning. However, before making the decision to invest in such a process, they wanted to have both an insight into the utilities that patent data may provide and also a process on how to obtain and use these utilities within their current organization. As such, this master thesis aims to provide VCC with a foundation to further their patent intelligence capabilities.

In this paper, PI has been obtained for three different technologies seen in Table A. These technologies were chosen on the merits of being interesting for the case firm, having various subjectivity levels, and being in the introduction phase of technological diffusion with the potential of being disruptive. Differing levels of subjectivity can be seen as the level of individual interpretation of the definition of a technology, where a technology of high level is more susceptible to differing self-interpretation. As such 3D printing which has a low level of subjectivity, relative to Autonomous drive with a medium level of subjectivity, is less complex as it is a solid product that has clear delimitations between different engineering subjects, while AD continuously involves and interweaves subjects such as mechanics, electronics and IT into one whole offering. The reasoning behind using technologies of different subjectivity levels is to see how sensitive the proposed PI process is to the difficulty in defining the technology's boundaries and how this affects the quality of the outcome. Furthermore, technologies in the introduction phase were of primary interest as these were of concern to VCC and would allow the researchers to use the subjectivity levels as the primary dependant variable.

Table A, Technologies of interest and associated level of subjectivity.

Technology	Level of subjectivity
3D printing	Low
Autonomous Drive	Medium
Technology X	High

1.4 Delimitations

Due to time and resource constraints, the paper have focused on the utilities especially related to companies with a dedicated R&D department and the key stakeholders involved in the R&D-process of technology specialists and personnel at the R&D strategy department. Moreover, the time and resource constraint would have implication on how many interviews that would be conducted to understand the company's R&D processes and to delimitate the technologies. Additionally, for similar reasons high licence fees restricted the researchers to use the patent database of Patbase, a database provided by the case company. Furthermore, due to the time constraints the researchers were limited to three Patent Insights, all of which are in an early stage of development and had to consider the interests and needs of VCC. Lastly, the depth of the PI was limited to a holistic view and subcategories to cover the most essential and common themes of the technology.

1.5 Disposition of the report

The disposition of the paper is structured in the following way. Starting of by introducing the reader to current literature about patent data, characteristics of technological development, and the utilities of patent data. Followed by a description of the methodology used in order to develop a process for accessing PI. After which the results of the empirical study will elaborate upon the suggested PI process and its utilities of the PI outcome. Then an analysis and discussion will be conducted regarding the chosen method, the proposed PI process, and the obtained patent data utilities. Finally the researchers will round of by answering the research questions in conclusions and suggesting further research directions.

2. Theoretical review

The following chapter will outline current research about patents, technology S-curves and the utilities of patent data, used to develop the patent insight process. Moreover, the researcher will contribute to current research by outlining frequently mentioned patent data utilities by presenting it in a table.

In order to create a process to generate PI it is fundamental to understand how raw patent data can be converted into useful knowledge. To do so, one has to understand the sequential relationship between data, information and knowledge, which may be visualised through the knowledge pyramid model, see Figure 1. The levels are sequentially differentiated from degree of usefulness, data (low), information (medium), and knowledge (high). A relationship starting from a large set of unstructured data later structured into comprehensible information and finally converted into knowledge that may provide utility for the focal firm. (Rowley, 2007)

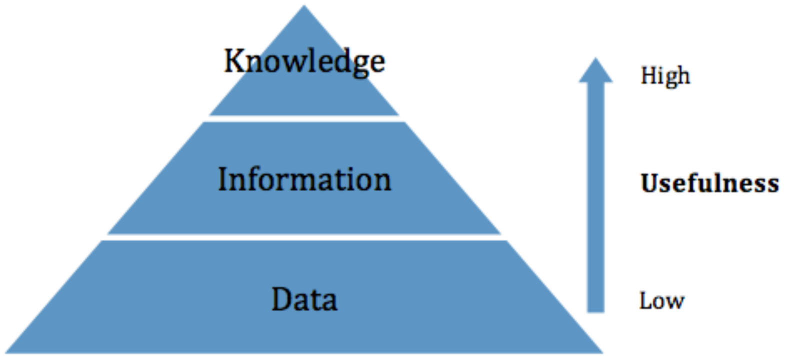

Figure 1, Knowledge pyramid model.

To understand how patent data can enable a holistic view of the patent landscape, it is important to first grasp the inherent characteristics of patent data, presented in the following sections.

2.1 Patents

As stated above, knowledge originates from a source of data, and an interesting source of technological data is patent data, known for being a publicly available, quantifiable, and well maintained source of technological information (Mogee, 1997). In order to understand how patent data can be used to achieve a PI (overview of the patent landscape), it is first important to grasp what patents are and what kind of data parameters they inherently possess, which provides the basis for the analysis, the utilities and ultimately the Patent Insight.

A patent is a form of intellectual property, which is used to incentivise innovators to invest in research and development by allowing monopolistic use of technologies within the filed countries during a time period of typically 20 years. This is done in exchange for publicly disclosing the patent after up to 18 months after filing, thus externalising the knowledge and making it publicly available. (Jell, 2012; USPTO, 2015a; WIPO, 2015a)

Patents are appropriate to use for technological analysis as they are considered as sign of economical and technological optimism, since companies would not patent a technology without a belief in its development. It is costly to file and maintain a patent, and the firm has to consider if there is valid reason to obtain the patent (Daim et. al., 2006; Lemley, 2001). Moreover, the firm also has to consider the size of the patent family, i.e. what countries it expects to see a market for the patent, as it will only be valid in these countries. The countries that will be included in the patent family has to be decided within a year of the original application and are filed and paid individually, thus putting pressure on the firm to evaluate the patent's potential in conjunction with the filing as it will be more expensive to include additional countries (Fleisher & Blenkhorn, 2000). The patent filing process for an international patent can be as costly as 140 000 $ not including the annual fee to keep the patent in forced (Mogee, 1997).

Furthermore, the firm's accumulated number of patents can be used as a measurement of its accumulated knowledge. As a firm invests resources in developing a technology, the firm will simultaneously develop an accumulated set of knowledge within that technological field. When the technological development unfolds the firm will tend to patent and protect its findings. As such, a firm with a large patent portfolio may be considered as possessing a good knowledge base within the technology area. (Cool, et al., 2005; Ahuja and Katila, 2001; Kim and Kogut, 1996 Hall, B.H., et al., 2005)

Patent is a unique and attractive source of information as it contains standardised and quantifiable information, which can be used in statistical analysis of technologies that results in a quantifiable outcome (USPTO, 2015a; Mogee, 1997). To create an effective PI process it is first important to understand what sort of information there is in patent data, thus getting an understanding of what parameters one can possibly analyze. The quantifiable patent data can be divided into four different categories;

- Description (title, abstract, full text, and claims),
- Ownership (assignee, inventor),
- Time and Place (application date, patent family, family number) and,
- Relation (citation, classification).

The *descriptive* part of the patent considers the title, abstract, full text, and claims. These parts are descriptions of the technology at hand, such as what the patent claims to protect, and are descriptive texts susceptible to bibliometric analysis. *Ownership* considers the data regarding the assignee, who is the person/firm who files the patent application, and the inventor who is the person/persons that were involved in inventing the technology which is patented. (USPTO, 2015a)

Patent data will also disclose information about the *Time and Place* of the patent. The time refers to the priority date, publication date, and application date, where priority date is the most commonly used in patent analysis, as it is the earliest time the first patent in the patent family is registered in the filing process (Jell, 2012; WIPO 2015c). Place, which is the geographical coverage of the patent, may be expressed through the use of patent family data. A patent family is a collection of similar patents covering one and the same technology grouped under a common family number (USPTO, 2015b; Mogee, 1997). The individual family members cover different geographical areas, which content may vary slightly to apply to local patent office regulations. Moreover, patent families are usually the prefered indicator for technological analysis, in contrast to individual patents, as these measure unique technologies (Mogee, 1997).

A patent's *relation* to precedent patents can be visualised as a tree branching out from basic patents to improvement patents. Patent citations are references to precedent patents that the technology builds upon (WIPO, 2013). As such, patents that are more basic, radical/fundamental, are usually cited more often than improvement patents, which are incremental improvements (Basberg, 1987). By backtracking citations one can thus locate fundamental technologies on which the focal technology has branched out from. Moreover, as an attempt to sort technologies into different categories, an advanced classification system is used. The classification system is built up in a hierarchical manner, stemming from eight main categories with up to 70 000 subordinate technology classes (WIPO, 2015b). Individual patents are classified according to multiple of these technology classes, making it easier to differentiate and locate patents in the haystack of the patent database.

In order to analyze the development of a technology over time it is important to have a historically well kept, standardised, and continuously updated data source. Considering the aforementioned aspects, patent data is an interesting source of information. A source with a unique continuity associated with it, as it is frequently used around the world and a patentable idea has to be considered as both novel and non-obvious, thus allowing for a database of continuously new and unique knowledge (USPTO, 2015a). Moreover, patents have a historical heritage that goes all the way back to the 17th century, and a well recorded data base from 1890 and forwards, which allows the analyst to go back in time to study the development of both new and old technologies (British Library, 2015).

With a better picture of what patents are, which data parameters patents consist of, as well as knowing what drives firms to file patents, a solid fundamental understanding has been acquired. An understanding that will be useful to determine what utilities there are and how these may be achieved through a PI process. As recently mentioned, patents have a historical heritage and the development regarding the patenting of a technology can thus be followed. It turns out that the patenting has a trend of actively following an S-shaped growth, similar to the technological S-curve (Daim et al., 2006; Wilson 1987a, Mogee 1997). As such, the applications and possibilities of understanding this trend will be further elaborated in the following chapter.

2.2 Characteristics of technological development

To understand how to interpret the development of a technology achieved from the patent data, one first has to know the characteristics of technologies development, what position the focal technology currently has in the development, and its expected diffusion.

Foster (1986a) states that the characteristics of technologies have an S-curved relationship between the performance of a technology (accumulated number of patent families) and the actual investment undertaken (time). By understanding the S-curve that can be received from patent data, see Figure 2, firms can better analyze the novelty of a technology and the potential it has for future growth. In the *introduction* of the technology development, there is a high uncertainty since little is known about the technology at hand and the efficiency of the R&D investments are low. As the accumulated effort increases, such as the number of filed patent families, the technology will become more understood until the industry settles on a dominant design, reducing the level of uncertainty. Consequently the number of patent families of the technology will increase exponentially, during this *growth phase,* until it reaches the point of inflection. When the number of patent families starts to saturate, since substituting technologies will start to displace the one at hand, the productivity of the investments diminish until *maturity* is reached. (Nieto, Lopéz and Cruz, 1998; Christensen, 1992; Porter et. al., 2011; Grant, 2010).

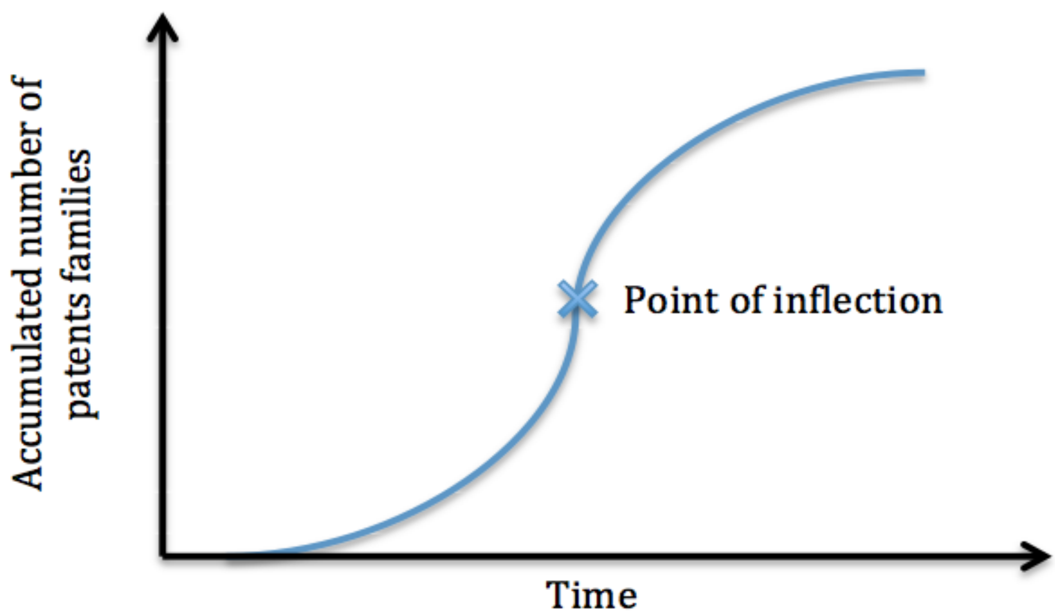

Figure 2, Technological S-curve.

Furthermore, the diffusion of new technologies can, according to Nieto et al (1998), be explained with a similar pattern as the performance of technologies. The speed of diffusion depends on the number of firms that have adopted the technology, but also on the number of firms that have yet to embrace it. e.g. how a disease is spread among a society. In the introduction phase, the number of active firms increases, while it would be a decreasing trend in the maturity phase (Robertson, 1967).

Due to the aforementioned properties, the S-curve can be used to make observations of the technology's current position, and its future potential growth (Nieto, Lopéz and Cruz, 1998). Accordingly, by understanding the S-curve and the current position of the technology, the firms have taken a first step of accessing a holistic view of the technology. To raise further insight into how S-curves can contribute to a holistic view of the patent landscape, the utilities of patent data will be further elaborated in the following chapter.

2.3 Utilities of Patent Data

With a good understanding of the basic characteristics of patents and the development of technologies, there are many ways in which patent data can be used to provide utility for a company. The following subchapter will review some of the most theoretically recognized utilities obtained from analyzing patent data, and the researchers will contribute with a table that summarises the most frequently mentioned scientifically acknowledged patent data utilities, see Table B.

Table B, Patent data utilities.

Type	Utility	Data	Source
Overview	Technological activity	Application date; Number of active assignees; Number of patent families	Mogee, 1997
	Position on S-curve	Accumulation of patent families; Number of active firms	Mogee, 1997
Activity of actors	Competitive landscape	Application date; Number of patent families	Campbell, 1983
	Buyer/supplier activity	Application date; Assignee; Number of patent families	Campbell, 1983; Ashton & Senn, 1988
	Focal firm activity	Number of patent families	Campbell, 1983; Fleisher & Blenkhorn, 2000; Wilson, 1987
	Competitor market belief	Size of patent family	Mogee, 1997
Technology	Subcategories	Keywords; Portfolio classifications	Mogee, 1997; Kim, Suh, & Park, 2008
	Key expertise	Keywords; Portfolio classifications	Mogee, 1997; Kim, Suh, & Park, 2008
	Evaluate partnership	Keywords; Portfolio classifications	Ashton& Sen 1988; Campbell, 1983
Outliers	Quality	Citations; Size of patent family	Basberg, 1987; Campbell, 1983; Ashton & Sen, 1988; Harhoff, 2003; Fleisher & Blenkhorn, 2000; Wilson, 1987
	Technology Cluster	Number of Patent Families	Mogee, 1997
	Recruitment	Inventors	Mogee, 1997

2.3.1 Overview

This section will outline the utilities of looking at the technology as a whole, which provides an understanding of where the technology is now, to better understand where it might be heading in the future.

For the analyst to gain an initial overview of the technology at hand, looking at the technological activity is a good way to get started. Technological activity can be measured in two different ways, through the use of patent counting and the number of assignees actively patenting the focal technology. Comparing the frequency of patent families filed during fixed time intervals, gives a good indication if the activity is increasing or decreasing. Additionally, by looking into the development of the number of assignees actively patenting the technology, an indication of the attractiveness and activity of the technology may be given. If an increasing number of assignees are patenting the technology it is an indication that there is a growing market or use for the focal technology deeming it attractive. (Mogee, 1997, Porter et al 2011)

To observe how much more a technology might develop before saturation, it would be valuable to know the *current position on the technology S-curve*, which can be indicated in two different ways, by looking at the accumulation of patent families per year or the number of active assignees. Using the number of active assignees, one might assume that the technology has reached the maturity phase if a large part of the actors have stopped filing patents. However, if the number of filing actors instead increases, it is an indicator of a technology in the introduction phase. By instead observing the accumulation of patent families, the priority date of the patent family reveals the traditional S-curve trend of the technology life cycle, where an increasing trend of patenting is a sign of being in the introduction phase. Here one has to keep in mind that there is a time lag of 18 months between issued and published patents, which makes the records of the two last years incomplete since all patents are not yet covered. (Mogee, 1997)

With good understanding of the most basic utilities of patent data, the next step is to become more familiar with active patent assignees.

2.3.2 Activity of actors

This section will cover utilities that help the analyst to gain a deeper insight to assess individual actors' activity, to get a better insight into the market dynamics, and the current competitive landscape.

According to Campbell (1983) and Ashton & Sen (1988), the patent data can be used to get a better insight into the competitive landscape of a technology. One of the measures recommended by Campbell (1983), is to analyze how the technology has developed in the last couple of years, by looking at the accumulation of patent families. This can be done by, observing the most frequently patenting actors and how the activity among them has changed over time. One can also set the growth of the number of the focal firm's patent families in a specific technological field, in relation to the development of the total activity within that field to examine the focal firm's patent portfolio. If the field has grown while the number of patents issued by the focal firm has fallen, it might be a cue to analyze if the focal firm is investing enough in the investigated technological field. (Campbell, 1983; Fleisher & Blenkhorn, 2000; Wilson, 1987)

Patent data can also be used as a source to determine the competitors' belief in foreign markets (Mogee, 1997). Patent family members outside the targeted firm's home country is considered as an indication of the competitors belief that there may be value in obtaining IP in that country in order to exploit the monopolistic benefits attained (Fleisher & Blenkhorn, 2000). The focal firm may thus use this insight to evaluate these markets for their own future technology investments.

So far, most of the arguments regarding why patent data is useful, has been to analyze and keep track of competitors. Though, it can also be used to create a more informed picture regarding the technologies of the focal firm's suppliers and customers (Campbell, 1983; Ashton & Senn, 1988). There are two possible indications of low patenting activity by the suppliers mentioned by Campbell (1983). First, low patent activity might indicate that the supplier has stopped investing and might stop producing the technology at hand, putting the focal firm at risk of being without supplier. Secondly, there is a possibility that the supplier is taking the focal firm for granted, if so, the level of improvements of the investigated technology might be low in the future. Furthermore, an analysis of the customers' patent portfolio is useful to at an early stage notice a shift in the buyers' strength (Campbell, 1983).

This shift could be a result from dissatisfied customers that are planning to integrate backwards up the value chain and bypass the focal firm. Campbell (1983) also mentions a risk that the customers that consider to backwards integrating may become a competitor of the focal firm, if it chooses to enter the market, which would imply that a current customer could be a future competitor.

As the actors and their activity is well understood, the subsequent part will be to outline useful aspects of patent data that can provide the analyst with a better understanding of the components of the technology.

2.3.3 Technology

To gain a deeper insight of the technological stance between actors, subcategories will prove to be a useful tool, as differentiating subcomponents of the technology will create an additional unit of comparison between actors.

Patent classifications and keywords can be used to determine subcategories of the technology and the key technological competences of the competitors. By subcategorizing a technology, various aspects of the technology is differentiated, to further obtain a deeper insight in the development of these sub categories and to gain a better understanding of the technology as a whole. For instance, the analyst may gain an insight into what subcategories that a targeted firm is investing more or less in, relative to other patenting actors, and thus see what categories the targeted firm believes is important to gain a competitive advantage (Mogee, 1997). The subcategorization can be done by looking at how frequently mentioned classifications and keywords in individual patent families are and from there extract and cluster words and classifications, building up the subcategories (Mogee, 1997).

Moreover, by looking into competitors’ patent portfolio and using the subcategories mentioned above the focal firm can evaluate potential candidates for both forming alliances or making acquisitions. A deep dive into a target firm would allow the focal company to gain a better insight into the technology of the targeted firm by looking at how its subcategorisation differ from the focal firm, thus finding complementary knowledge and patents what may strengthen the focal firm's patent position (Campbell, 1983; Ashton & Sen, 1988).

With a sense of the big picture as well as an understanding of how individual actors act and what technologies that they invest in, there is one last part to cover, the Outliers.

2.3.4 Outliers

Finally, the outliers concerns assignees that stand out from the masses as possessing high value patents and individuals highly involved in developing patents of the technology at hand.

To gain an insight of what actors that file high quality and impacting patents within the technology at hand, one may need to determine the value of the patent. There are two recognized ways of evaluating the quality of the patent, first the number of forward citations of a specific patent, second the use of patent family size (Harhoff, 2003, Mogee, 1997). If the patents of the targeted firm have more forward citations than the other patenting actors, the targeted firm has seminal impact on the technological development (Porter et al, 2011). Consequently, if the patent only has a few cites, it might be because the technology is not considered basic and important enough, which may be a signal that the focal firm is losing its competitive edge within the technological field (Basberg, 1987; Campbell, 1983; Ashton & Sen, 1988; Harhoff, 2003; Fleisher & Blenkhorn, 2000). Additionally, the patent family size can also be used as an indication of the focal firm's patent family value. Patents with large families are typically sign that the technology is perceived as valuable, considering the high expense the assignee has to carry (Mogee, 1997; Harhoff, 2003; Wilson, 1987).

According to Mogee (1997), patent data can also be used to locate technology clusters, where more patents of the focal technology might be filed in specific geographical locus. This may be considered as a cue for the focal firm to set up a foreign research unit in order to tap into the technological synergies created in these clusters.

Looking closer at the ownership aspect of the patent data, it is possible to see which inventors that were involved developing the technology that is patented. Analyzing a specific technology it is thus possible to differentiate lead inventors who may be considered as interesting subjects to either monitor or possibly recruit to keep up to speed with the development or obtain a valuable resource. (Mogee, 1997)

2.4 Theoretical summary

To conclude the theoretical findings, this chapter has given an overview of how patents and its inherent patent data comes together to create patent data utilities, which are used to obtain a PI. The chapter started of by introducing the reader to the basics of patents and patent data, followed by the theory of the characteristics of technological development. These findings were later used to express the patent utilities, which were divided into four main categories: Overview; Activity of actors; Technology; and Outliers. These utilities were outlined in Table B contributing to a better understanding of the most frequently mentioned scientifically acknowledged patent data utilities. Utilities that will later become the foundation in the PI, patent analysis and monitoring. The theoretical framework constructed in this chapter can be observed in Figure 3 below.

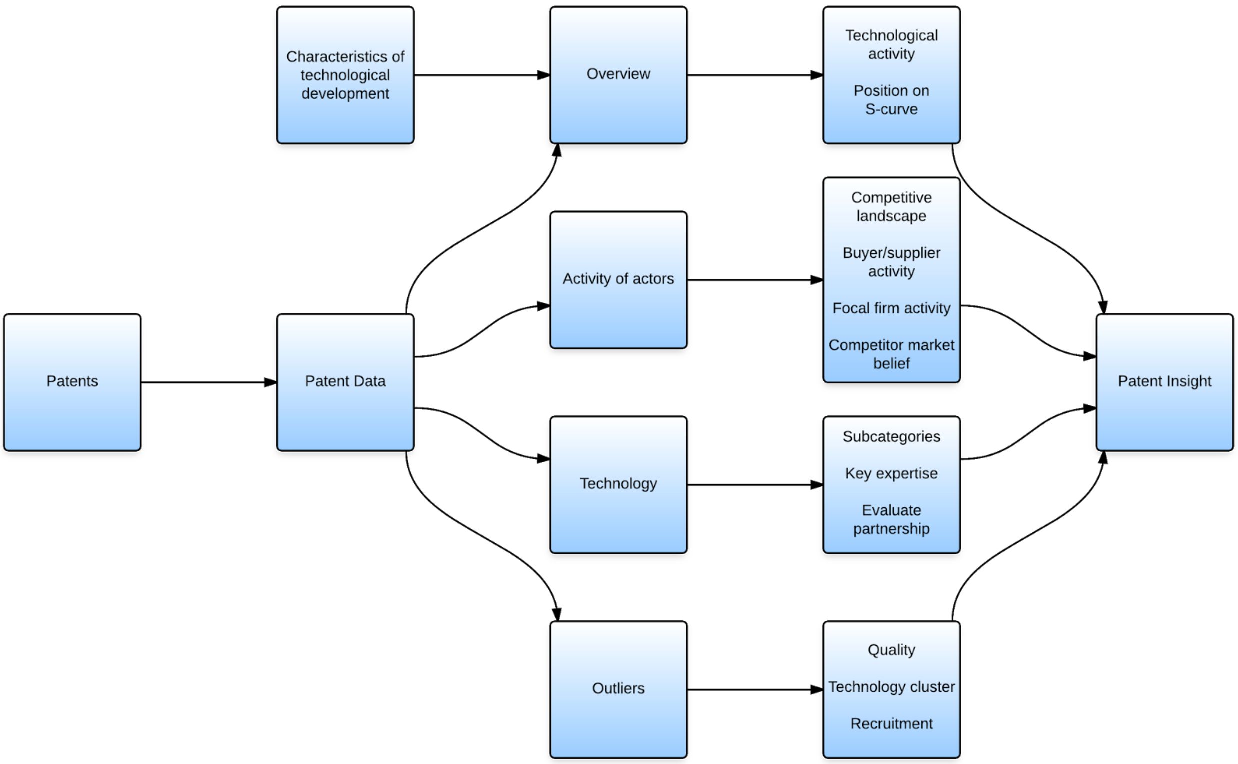

Figure 3, Theoretical framework overview of Patent Insight.

3. Methodology

This chapter presents and motivates the methodology used in this paper. It starts of by describing the research design used followed by the research methods, used to reach the answers of the research questions. The chapter is then rounded of with a discussion of the research design and methods chosen.

3.1 Research Design

The research design used in this report is that of a cross-sectional design involving multiple patent searches and a single case study of VCC.

As the intention of this project is to ultimately investigate how patent utilities can be accessed in an organizational setting, it is important to gain a deeper understanding of the focal firm in order to understand their current processes and how the PI process may complement and fit into these. A research design fitting these characteristics and the purpose of this research is a single empirical case study, i.e. an intensive study of a single case (Bryman & Bell, 2011). Moreover, Eisenhardt (1989) proclaims that a case study is a useful research design when the context is important and the purpose is to further explore an existing field, which is true in the case of patent data as there is a comprehensive literature outlining the utilities, but not as much research in a contextual manner of organizational processes, which is the goal of this paper.

Furthermore the single case study has allowed the researchers to acclimatize by spending a significant amount of time at the focal firm, thus enabling a deeper understanding of the focal firm's explicit and implicit R&D processes and the political environment amongst the stakeholders. Which would help the researchers to gain a more complete picture of the actual R&D processes rather than a refined official one.

In order to evaluate the proclaimed utilities stated in the theoretical review as well as putting the PI process to test, three technologies of differing subjectivity levels were investigated. By performing three separate patent searches within a time span of a month and then comparing the findings with the utilities observed in the theoretical review, the researchers aim to find patterns of association in order to determine the feasibility of obtaining the proposed theoretical utilities. Furthermore by conducting the patent insight process multiple times allowed the researchers to continuously improve upon the PI process as the research progressed. Moreover, by carrying out the PI process on technologies of differing subjectivity level, the researchers hoped to determine if the level of subjectivity affected the result of the PI process.

With a good understanding of how to answer the research questions, the next step is to outline the methods that were used to collect the data needed to answer the research questions.

3.2 Research Method

In order to answer the research questions it is important to use the right tools to collect the data. This report consists of both primary data, mainly interviews and patent searches but there has also been a review of secondary data, in the form of articles and reports.

3.2.1 Literature review

Arguably, to be able to create a PI process that will be used to access patent data utilities, the researchers would first have to know what utilities to look for. To determine what utilities that exist, an explorative literature study was conducted. The review was initially carried out with the aim to get as much information as possible of the subject at hand and as new information emerged the theoretical framework started to take shape (Bryman & Bell, 2011). The literature study was done using the *Chalmers Library Database,* where articles related to patent data analysis was the primary source of information. The utilities that were of interest for the researchers was foremost utilities that are obtained by analysing large sets of patents and not utilities on the basis of individual patents. The good understanding of the patent data utilities would later function as a starting point to determine both who the stakeholders of the patent insight process are by connecting individuals need with the means of the utilities, but also to determine if the PI processes that was developed would actually achieve the proclaimed utilities.

Bibliometrics were also used to gain an initial understanding and defining the boundaries of the technologies used in the PI process. The sources mainly used were general online articles about the PI technologies. This would later be used as an input for the preparation of the interviews as well as a way of complementing the obtained view of the technologies as the interviews were conducted.

With an insight into the patent data utilities, the natural next step would be to choose which technologies and try to find their respective patent utilities through a patent search method.

3.2.2 Technology Sampling

The sampling method used for the PI topics was a purposive sampling, which took the case company's needs and the subjectivity of the technology into consideration (Bryman & Bell). By purposively choosing which technologies to conduct a PI on, the research group would be able to satisfy the stakeholders need by providing a valuable insight into technologies that they find interesting, while still be able to choose technologies that would challenge the robustness of the PI process. Moreover, to focus on the impact of ambiguity, variables such as the phase of technological development the technology is in were held constant by using technologies that are considered as being in an early phase of technological development. The PI technologies used and their respective levels of subjectivity are all displayed in Table A.

With the PI technologies decided upon it is then possible to start the process of conducting the patent search. This process will be outlined in the following section.

3.2.3 Patent Search

The method used to conduct the patent search is mainly inspired by a seven step approach, see Figure 4, developed by Erik Hansson at Gothenburg University, which is an approach optimized for patent searches in early idea stages (Alänge & Lundqvist, 2013).
This *general search process* allows the user to consider aspects to help define the technology and its boundaries, which in turn will set the basis to generate a search string that involves relevant patent data that can later be displayed and analysed. The general search process was further complemented by the access to resources that a dedicated R&D department would possess i.e. Technology Specialists.

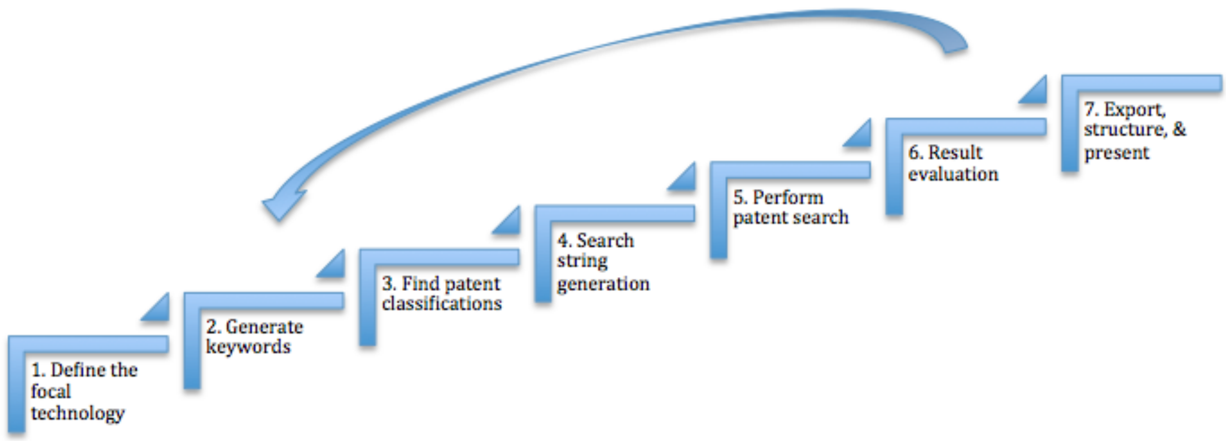

Figure 4, 7-step method of general search process.

The *first step* in obtaining a suitable search string is to define the focal technology. In order to do this effectively, interviews, which will be further discussed later, was conducted with technology specialists in each of the focus technologies together with bibliometric reviews (Kim, Suh, & Park, 2008). During these interviews the following three aspects were discussed and defined:

- The Utility,
- The Structure,
- The Function.

The utility is seen as the solution to the problem that the technology is mainly trying to solve. Followed by the structure, which concerns the properties/components that the technology is made up of. Lastly, the function of the technology is how the physical properties of the technology manage to deliver the utility. By looking at these different aspects the user will observe the technology from complementing points of views, thus obtaining a more complete picture of the technology at hand than if only one was used. Moreover, as stated before, a complement to the interviews were bibliometric reviews. These allowed the researchers to effectively gain a general understanding of the technology at hand and also an insight into the three technological aspects.

When the technology had been defined, the *next step* was to generate keywords for the patent search. Combining the definitions from the previous step and the expertise of the technology experts, the researchers generated keywords and synonyms to describe the focal technology.

Synonyms had to be considered as technologies may be described in multiple ways and may vary from country to country and also over time, e.g. car, automobile, and land based vehicle.

The *third step* was to find relevant patent classifications of the focal technology in order to further help to set the boundary of the patent search to include relevant patents. The definition in step one was still used as a starting point, and as the researchers found relevant patent families, the classifications of these were elaborated to explore if they could be included in the general search string. To find classifications was thus an ongoing process as more and more relevant patent families was found. In *step four*, the actual search string was then finally generated from the data obtained in step two and three.

Step five, the patent search was finally conducted using the search string generated in step four and patent data may be obtained. However, the result generated during the first search was usually not very accurate and may have included patents that were not related to the focal technology, thus an evaluation of the data obtained in stage five was done in *step six*.

Furthermore at this step an iterative process was initiated, going back and forth between step two to step six, marginally improving the search string until a sufficiently good patent search string is obtained, see Figure 4. When a sufficiently good search string was finally obtained, the patent data was finally in the *last step* exported, structured and presented in an attractive and comprehensible manner to allow for further analysis to be conducted in order to obtain the patent data utilities.

The patent searches, in this study, were conducted using the patent database of *Patbase*. This source was used since it is a well-known patent data provider, which has an organised and maintained patent database, with an immense coverage of over 47 million searchable patent families from over 100 different patent authorities worldwide, allowing a standard format of exportation and analysis of patent data. The tool was therefore considered as a good fit for conducting a PI. (Patbase, 2015)

With the method of conducting an effective patent search outlined, the following section presents the method of interviewing, which was used to define the technology in step one but also to get an understanding of the current R&D processes.

3.2.4 Interviews

To understand how a PI process could be outlined in order to conform to the current R&D processes at VCC, conducting semi-structured interviews proved to be a useful vehicle. By conducting interviews with stakeholders at the R&D department, an insight was gained into both the explicit and implicit R&D processes at VCC as well as gaining a glance of the political environment. Furthermore the interviews allowed the researchers to extract valuable information from technology experts regarding the PI technologies, which would prove to be useful for both defining the PI technologies as well as its subcategories. This method was preferable as the interviewers were interested in gaining an understanding of the interviewees' point of view on the subject at hand and it encouraged the interviewees to talk freely around the questions. This structure would also allow the interviewers to pursue emergent leads, changing the order of the interview questions in the interview guide, to conform to the development of the interview (Alvesson, 2011; Bryman & Bell, 2011).

The interviews were carried out in-person with two interviewers attending the interviews. This allowed for a good flow and fewer disturbances in the interaction with the interviewee as one of the interviewers took notes, while the other one primarily led the interview and could have a continuously going conversation. The person taking notes would also be able to add comments and follow-up question if necessary. Another perk of being two interviewers, was that after the interview, the notes taken, and the topics discussed could be revised to assure a common understanding of the outcome. Furthermore, by conducting the interviews in-person, the interviewers could pick up on the interviewee's body language, resulting in an additional understanding of when the interviewee found a discussion of the technology interesting, thus providing more insight of what to include in the patent search. Additionally, the body language would prove especially useful when discussing technologies of high ambiguity, as it made it easier for both the interviewers and the interviewees to express themselves when words ran out. (Bryman & Bell, 2011)

To capture the information that was generated during the interviews voice recordings was the primarily used medium. By recording the interviews, it would allow the researchers to retrace conversations and thus decreasing the risk of losing important details. Moreover, nuances in the voice pitch of the interviewees could be retraced when the researchers did not agree on what the interviewee found interesting and thus add further depth to the understanding of the interviewees. Additionally, when the first interviews were conducted the researchers had limited understanding of the processes within the focal firm, but as the research progressed, it was useful to re-listen to the interviews since the researchers were more knowledgable. On occasions when voice recordings were not an option, the main element of recording the interview was to use paper and pen to write down key statements to be able to retrace the conversations. After the interviews were conducted, discussions between the interviewers were made regarding the interview topics, to further cement the findings and ensure a common understanding of the main takeaways. (Bryman & Bell, 2011)

The sampling of the interviewees was initially done through convenience samples followed by snowballing sampling. This was mainly used because of time limitations and the interviewers had fairly good access to stakeholders within the case firm, such as technology specialists and key stakeholders in the R&D strategy department. (Bryman & Bell, 2011)

3.3 Discussion of the Methodology

Starting of this discussion the research design outlined, where the aim is to discuss if the structure of the research was suitable in order to answer the research questions. The subsequent section then discusses implications of the sampling and interviewing methods that were used to collect data.

3.3.1 Research Design

With the following discussion of the cross-sectional research design, one can better understand why the researchers consider this to allow for an answer of the research questions. The chosen design and its characteristics will also be compared to other alternative research designs.

The cross-sectional design had its start in a single empirical case study, which was a suitable design, as the researchers would develop a process that had to fit into an organization and complement its current processes. A single case study would allow the researchers to spend a significant amount of time at the focal company and thus become familiar with the current processes, and get an understanding of what departments that might have valuable input or could be interested in the outcome of the PI process. As such, the characteristics of the research design was appropriate for developing the Patent Insight Process, as it had to fit into VCC's organization and the purpose was to complement already existing information sources, which could not have been done without a deep understanding of their current processes.

An alternative to the single case study would have been to use a multiple case study design. In that case, the researchers would have studied more companies to get a broader understanding of available technology evaluation processes, thus getting better chance to develop a process that would fit into a wider span of organizations. One might thus realise that a risk of using the chosen single case study design is that the researchers develop a method with too much focus on VCC's processes, needs and requests. As such, if the processes at Volvo differ significantly from the rest of the industry, the PI process would not be organisationally applicable to a wider range of companies. Though, a single case study is still argued to be an appropriate research design, as more time at one single company would allow the researchers to understand how the processes actually look. With less time at the focal company, one might listen too much to how the company explains its processes, which has the risk of being refined and not give a true picture of the reality.

In order to iteratively develop and continuously improve the process, it was tested on three separate technologies within the time span of a month. The process could surely have been tested on more technologies to ensure a higher quality, but this was not an alternative due to the strict time limitation of the research. Additionally the time limitation did not allow the researchers to test the process over a longer time span, which would arguably had enabled the researchers to better evaluate the monitoring process.

To conclude, the researchers consider the chosen cross-sectional design to be the most applicable in order to answer the research questions and to test the process within an organization.

3.3.2 Research Method

This section discusses the tools that were used to collect the data. The purposively sampling method will be analysed and related to other alternative sampling methods. Additionally the interviews will be discussed to see if they had a good structure in order to understand the current processes and delimitate the technologies.

Sampling

Purposively sampling was the method chosen to evaluate and decide upon what technologies to use in the development of the PI process. As such the researchers could choose technologies that was considered as interesting to the focal firm, and also keep the technological development phase of the technologies constant by choosing technologies in an early phase. An alternative to purposively sampling would have been to use a randomly sampling method. If a randomly sampling method would have been used, it might have given technologies in different phases, where other possible utilities of patent data could have been analyzed. For example, one could have tested whether PI can give an insight when it is time to stop investing in a mature technology. On the other hand, if the parameter of the phase of development had not been constant, the researchers would not have been able to evaluate the effect of changing the level of subjectivity. Moreover by using a random sampling method the focal firm would not have been given the chance to affect the choice of technologies, resulting in the risk of evaluating technologies that it not considered as important for the focal firm. As the PI process aims to evaluate strategically important technologies, a case where the focal firm cannot see the strategic value in a technology, would put limitations on the evaluation of the PI process.

As a summary, purposively sampling was a suitable method to choose technologies that the focal firm considered as interesting, and the researchers was also able to evaluate how the level of subjectivity would affect the PI process. One of the aspects that were affected by the subjection level was the number of conducted interviews, which will be discussed in the following section.

Interviews

The interviews, with the purpose of getting an understanding of the current R&D processes and to delimitate the technologies, were conducted in a semi-structured manner. This proved to be a preferable method, as the researchers did not have a good initial insight into either the focal firm’s processes or the properties of the investigated technology. It would thus have been hard to prepare structured interviews, when the answer of the first questions had an impact on the follow-up questions. The semi-structured interviews would therefore help as guidelines to keep the interview on track, but still allow for emerging questions as the knowledge increased throughout the interviews.

Another possible way to prepare for the interviews could be to use unstructured interview guidelines, as the interviewers knew what subject the interviews would touch upon but not how the answers would change the content. On the other hand, the researchers considered this to be an inappropriate approach as the subjects of the interviews were very broad, thus risk discussing subjects that would not help to reach an answer of the research questions. Therefore, as mentioned before, the semi-structured interviews would be preferable to help the interviewers to ask relevant questions.

Moving on, using questionnaires or observations are arguably methods that could have substituted the interviews and helped to delimitate the technologies and understand the current R&D processes. Arguably sending questionnaires to the technology specialist could have been applicable to delimitate the technologies, as creating a list of keywords and their definition of the technology was the most questioned result. Though, the definition of a technology is not as clear as it might sound, and the interviews increased the probability that the researchers and technology specialists perceived the technology and its boundaries in a similar way. Furthermore observations of the daily work in the R&D department instead of interviews could arguably have resulted in a deeper insight of the R&D processes. This method was not used, as the researchers would have to make observations throughout a long time span, since some processes were conducted with months in between, which made it inapplicable due to the time limitations.

To recap the discussion of the interviews, it was a useful data collection method, since the researchers got the necessary information from the main stakeholders and it was possible to perform within the given time span. Moreover the guidelines of the interviews were semi-structured to allow for an open discussion but still keep the interview on track.

4. Suggesting a Patent Insight Process

The following chapter covers the development of the Patent Insight process, which resulted from interviews and the iterative process of conducting three patent searches. All components of the process will be elaborated and the results from the patent searches will be evaluated in chapter five.

The need for an organizational process for conducting a Patent Insight process originated in an expressed need by VCC to improve their Patent Intelligence capabilities. It all started as a summer internship at VCC's R&D strategy department where one of the researchers was asked to investigate the possibilities of using patent data as a means for gaining an insight into a certain technology area. By the end of the summer internship such insight was gained, however, little focus had been on how to actually create and integrate a process for conducting patent analysis in a on-going manner within the current organizational context. As such this paper aimed to explore the possibilities of creating an organizational process that would access theoretical utilities.

In order to develop a Patent Insight process the researchers first had to get a better understanding of the current technology evaluation processes at VCC. As such, the researchers conducted three semi-structured interviews with key stakeholders at the R&D strategy department, who were responsible of the current technology evaluation processes at Volvo, and six interviews with technological specialists who are knowledgeable about the PI technologies. This allowed the researchers to gain a deeper insight of what process and what kind of technology intelligence sources that already existed within the organization.

4.1 Current Technological Evaluation Process

Today, the Needs & Means process at VCC is the central process for evaluating technologies, analysing where the industry is heading, and considering in what technologies to invest in order to meet the future needs of its customers. The goal of the Needs & Means process is to find the best use of Volvo's resources, which are the means, but also question how the focal firm has to complement its current knowledge portfolio to stay competitive, referred to as the needs. This process is an important foundation of future technological investment decisions, where additional information sources that would increase the understanding of future technologies will prove to be valuable.

In order to strengthen the information going into the Needs & Means process, it is important to complement the existing information sources, e.g. VCC's Technology Insight. Technology Insight is a qualitative process and one of the main technology intelligence inputs into the Needs & Means process, where the focal firm partakes in industry fairs, publications and corporate events to get more information on where the industry is heading. The obtained information is presented in a clear and structured manner, where some technologies are analysed on a detailed level, while others are observed on a more abstract level. The Patent Insight can thus complement this information source, as it is a quantitative information source that presents a holistic view of the patent landscape regarding the technology at hand. Moreover, PI can easily be updated when the search string is generated, but Technology Insight requires the same amount of effort each time it is performed, as qualitative opinions cannot be automatically updated. Lastly the focal company qualitatively chooses what technologies and companies to include in the Technology Insight, thus it might risk missing out on new actors from other industries or unknown elements of the technology. Patent Insight on the other hand presents a more holistic view of the technology, as one does not decide in advance what actors or subcategories to include.

Technology specialists will prove to be a valuable resource that VCC processes. The technology specialists are individuals that work in the R&D department at VCC who are specialists within their technological field. These individuals possess great knowledge that can be accessed though interviews and effectively used in the technology delimitation process, as they know the technology better then the researchers. Moreover, these individuals proved to have an inherent interest of partaking in the PI as it would allow them to gain a better insight into their current technological area. As the technology expert in AD puts it: "Patent Insight can be used as a support when investing in AD." and "...as a basis to discuss the future development." As such conducting interviews with technology experts, a need was created, which is translated into a pull for the result of the PI process. Thus the customers were created on spot.

It was realized that in order for PI to work within in the current organizational context, it had to be self-sustaining, i.e. reduce interdependency between involved stakeholders, or as Interviewee C at the R&D strategy department explains "People already have their work cut out for them, and will not prioritise if someone hands them one time assignments to do extra. As such, if you hand over the baton to these individuals the whole process will become slow as you will have to wait for the these individuals to pass on the baton before the process can move on”.

Moreover, it was important that PI would complement current technology intelligence sources if it were to create any value for VCC. Like Interviewee A at the R&D strategy department said, “We don’t just need any information, but rather we need structured, objective and well presented data that we did not have before.” When asked if PI would provide to be complementary source of technological information the researchers received the following answers. The technology expert A from Technology X stated: “..I believe that Patent Insight can be used as a wake-up call” and technology expert B says “We don’t have this kind of information at the moment, only information from industry fairs, what the competitors choose to publish, and from suppliers. I believe that PI will be a good complement, a complement of more concrete information at an earlier stage”. Interviewee A from the R&D strategy department also believes that “Patent Insight can be used as a wake-up call to see when investments in a technology is taking off” and that “a quantifiable source of technology information such as patent data is useful and important.”

4.2 Proposed Patent Insight Process

With a better understanding of the current technology evaluation process at VCC it was now possible to developed a PI process that would efficiently work within the current organisational setting, which involves all key stakeholders. During the development of the PI process the three PI technologies of different levels of subjectivity, namely; 3D printing (low), AD (medium), and Technology X (high), was put through which made the proposed Patent Insight process seen in Figure 5 emerge. This sub-chapter will explain the different steps of the process from the beginning to the end.

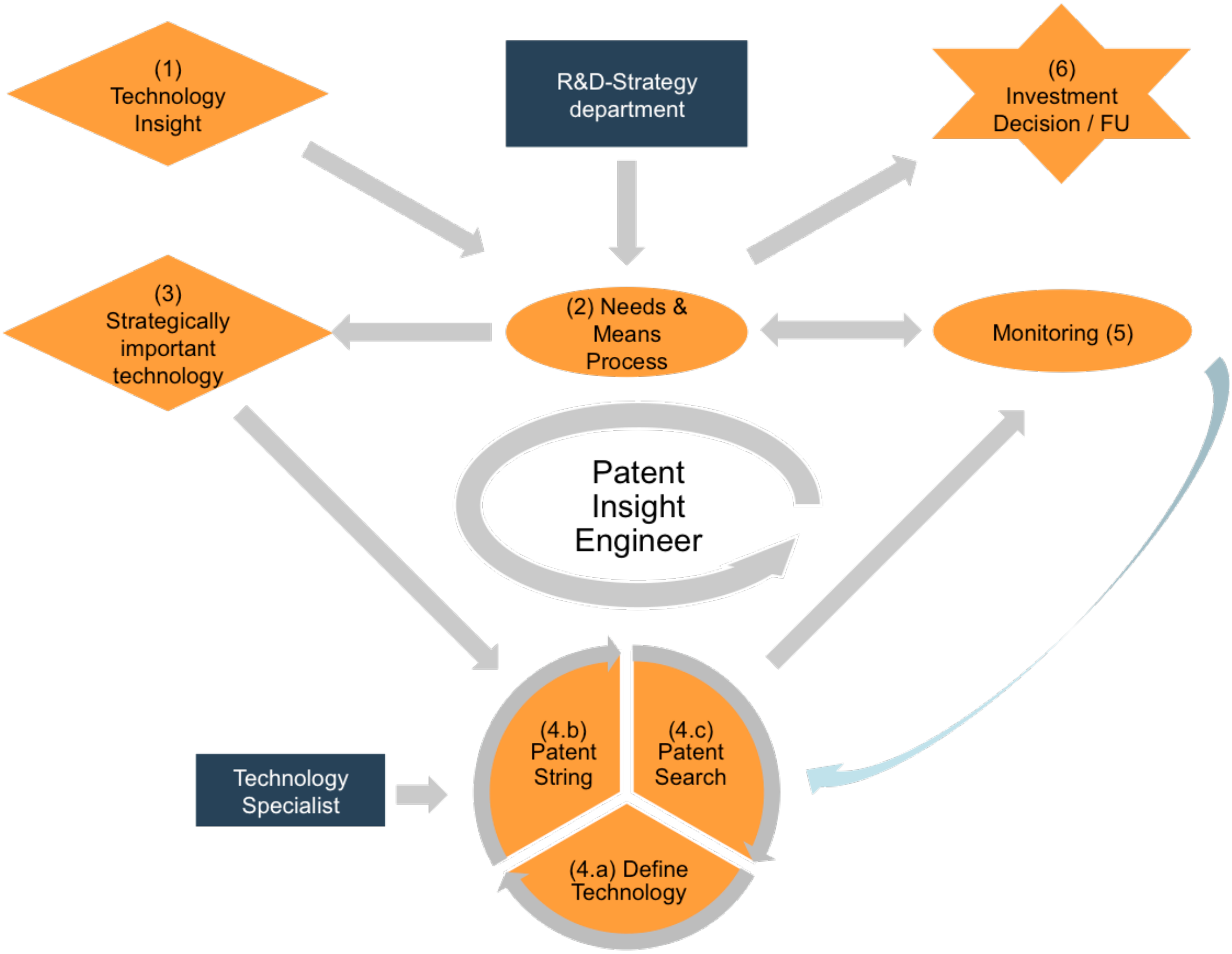

Figure 5, The Patent Insight Process

To efficiently conduct a PI process and evaluate all of the steps from choosing the technology to analysing the results, the Patent Insight Engineer (in this case the researchers), see Figure 5, acts as the catalyst throughout all the steps of the process. In order to minimize lead-time it was realized that the process becomes efficient if there is only one main responsible person that drives the whole process. This allows for less baton passing and a deeper understanding of the result and how it was produced, since the inputs are controlled and analysed by the same person.

Technology evaluation

The PI process starts of from the current technological intelligence source of (1) Technology Insight, where an interesting technology is identified and used as an input into the (2) Need & Means process. The R&D strategy department is a valuable resource to consult in the early stages of the PI process, as they know what sort of information that may complement VCC's current technology portfolio, and will also ultimately be the customer of the result from the

PI process. To involve the customers of the results already in an early phase was useful as it created a need for the results. As such, the key stakeholders at the R&D strategy department, then decides if they want to invest in the technology or not. However, some technologies that are considered as Strategically Important Technologies are of interest to gain a better understanding of the associated patent landscape, which in this case is AD, 3D printing and Technology X. Once the (3) Strategically Important Technology has been decided upon the iterative (4) patent search may begin.

Patent Search

The iterative patent search consists of three major steps following the 7-step patent search model previously mentioned see Figure 4. The three steps correspond to the following steps of the 7-stage model: (4.a) define the technology is step 1-3 (1. Define the focal technology; 2. Generate Keywords; 3. Find patent classifications); (4.b) create a search string is step 4 (4. Search string generation); and (4.c) conduct a patent search is step 5-6 (5. Perform patent search; 6. Result evaluation), see Figure 5.

For the sake of defining the technologies an initial bibliometric review was conducted for each of the technologies followed by six interviews with technology experts, one on AD and five on Technology X. When the researchers began defining the technologies, it became obvious that 3D printing did not need interviews to be defined but that bibliometric studies would suffice. This was much due to the extensive bibliometric findings, which deemed the need of using technology expert interviews redundant to define the technology. Another observation was that Technology X required more interviews than that of AD, which might be due to the higher level of subjectivity of Technology X, and that the case company did not have a standard definition of the Technology X. The definition of AD obtained from the interview with the AD technology specialist can be seen in Table C below:

Table C, Definition of AD obtained from interviews.

Definition	Description
Utility	Autonomous Driving (AD) provides a safer, more comfortable, and environmentally friendly mode of transportation that allows for time saving, as the driver can focus on other things than driving the car.
Structure	The technology is made up of sensors, positioning system, steering system, computing system, and a method to change between manually and autonomous driving.
Function	Through the use of sensors the car senses its surroundings and uses algorithms in order to autonomously guide the vehicle. Thus fulfilling the human transportation capabilities of traditional cars without constant human input.

Once enough intelligence had been gathered in order to delimit the PI technologies the delimitation was done in a hierarchical manner stemming from a "main search" branching out into different subcategories and types of subcategories. In the case of AD, the main search branched out into three types of subcategories; *Information*, *Travelling*, and *Application*, which have corresponding subcategories, as seen in Table D. Information refers to subcategories where information is obtained or presented to the driver and vehicle to allow for AD, whereas Travelling concerns subcategories of traffic situations that the AD vehicle needs to handle. Lastly, Application includes subcategories that are related to different application areas of using AD. These types of subcategories were the output of the interviews and subcategorization efforts and cover major parts of the AD technology.

Table D, List of subcategories in AD

Type of Subcategory	Subcategory
Information	Communication
	Dependability
	Environmental Scanning
	HMI
	Obstacle Identification
	Position
Traveling	Breaking
	Cruising
	Maneuver
	Navigating
	Speed Regulation
Application	Accident Prevention
	Deactivation
	Interior Design
	Parking
	Platooning

As the technology has been delimited, the next step is to create a search string (4.b). One example of a search string from AD is the search string for the subcategory of Environmental Scanning, which is a subset of the Information type subcategory for AD, seen in Table E. It should be stressed that the patent families within the subcategories are not necessarily heterogeneous but they may partially contain the same patent families.

Table E. AD Main category, Subcategories and associated patent search string.

Type of Subcategory	Subcategory	Patent search string
Information	Environmental Scanning	TA=((Environment* W3 Scanning) OR radar OR camera OR (optical NEAR (scanning OR detect* OR communicat*)) OR lidar OR "Pattern recogn*")

When the definition of the PI technologies had been done, and the patent search string generated, it was time to do the patent search (4.c). However, the fist time researchers conducted the patent search, the patent hits are not very accurate, but included many unrelated patents. As such, the iterative search process began, as the PI Engineer has to go back to redefining the technology and generate new search strings and search to improve the findings. Once satisfying hits were generated, it was time to export, structure, and presented the theoretically proclaimed patent data utilities and the ability to monitor these.

Technology Monitoring

Once the patent search string had been generated and the patent search performed, it will be possible to continuously update the patent search with up-to-date data and thus (5) *monitor* the development of the technology. Since once the technology has been delimited and the search strings for both the main search and the subcategories have been generated, the PI Engineer can just input these into the patent database once more to find the same result as before including the latest made public patent families. This is possible as technologies and their fundamental definitions do not change overnight. Moreover, if the search string is becoming out-of-date, one may just add new keywords or newly added classifications to the search string on a later stage, to include new subcategories and improve upon the main search. Thanks to these aforementioned aspects, PI can be used as a monitoring tool, to follow the development of technologies and present the theoretical patent data utilities.

Finally the results of the monitoring process and thus also the patent search data is to be presented in an informative way such as to show the theoretical utilities that the patent data provides, in a simple and easily interpreted manner, see the next chapter *Evaluating the*

Patent Insight Process. Back to where it all began, the material is to be presented to the R&D strategy department, during the (2) Needs & Means process meetings, and to other key stakeholders, such as the technology specialists that participated in the technology delimitation, in order to complement already existing intelligence sources. These stakeholders may then use the patent data utilities to discuss the (6) *investment decision* of whether or not to invest in the technology and consequently initiate preparatory research at VCC (Förberedande utveckling FU), which eventually may result in a product.

Simultaneous to the emergence of the Patent Insight process the researchers gained a better understanding of how to structure and present the findings so that the patent data utilities are to be found. To shine more light on the subject the results from the PI technology patent search will now be presented in the upcoming part.

5. Evaluating the Patent Insight Process

As the PI process is better understood, this chapter looks at the results from the patent search to evaluate what utilities it could provide. All the empirical findings are presented in connection to theoretical utilities to allow for an upcoming analysis of whether the theoretical utilities were actually accessed or not.

The utilities of using the PI process had similar results for each of the three investigated PI technologies, as such the researchers will only use one of the technologies to elaborate upon the findings. AD, with a medium level of subjectivity, will be used as the main case to present the utilities, and the result of 3D Printing can be found in Appendix 9.1. VCC considers the result of Technology X to be strategically important and the researchers are thus not allowed to visualise this in the paper. The PI result showed in the following chapter should also be considered as a part of the PI process, including the way to structure and display the data in the succeeding figures and tables. The utilities are presented in the same structure as in the theoretical review, starting off by observing the utilities to gain an overview of the technology, which is then followed by activity of actors and a subcategorization of the technology. Lastly the utilities of finding the outliers are outlined.

5.1 Overview

To gain a better insight of the whole picture and where the technology is heading, the researchers started out by evaluating the utilities of gaining an overview of the technology.

The first presented theoretical utility of using patent data was to gain an understanding of the *technological activity* and how it has developed over time. In order to observe this utility the researchers investigated the total number of patent families filed per year, see Figure 6. By doing so, one can observe that the number of issued patent families have increased significantly during the last ten years. Before this increased patenting pace, the trend can be described with a fluctuating development until the beginning of the 21st century when it first started to take off. The decreasing number of patent families in 2013 shall not to be confused with a decreasing activity from the year before, as it is a result of the 18 month time lag of issued patents, since the patent search was performed in March 2015 not all patents in 2013 had yet been filed.

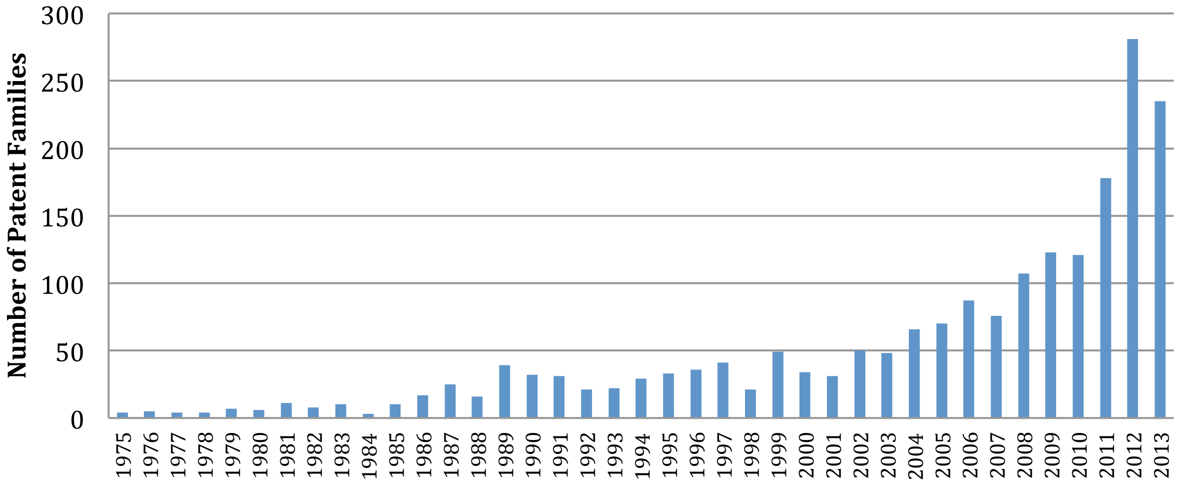

Figure 6: Total number of patent families per year

To find the *position on the technological S-curve* was the next theoretical utility of using patent data, where the empirical findings can be evaluated by observing the accumulated number of patent families, see Figure 7. It can be seen that the accumulated number of patent families has increased exponentially from the end of the 1970s up until now. Thus, the technology seems to be in an early phase of the technological S-curve, as the point of inflection has not yet been reached. The accumulated number of patent families could possibly also be used to evaluate the previously evaluated technological activity, but since it is not very sensitive to fluctuations, changing trends would be hard to discover with this data.

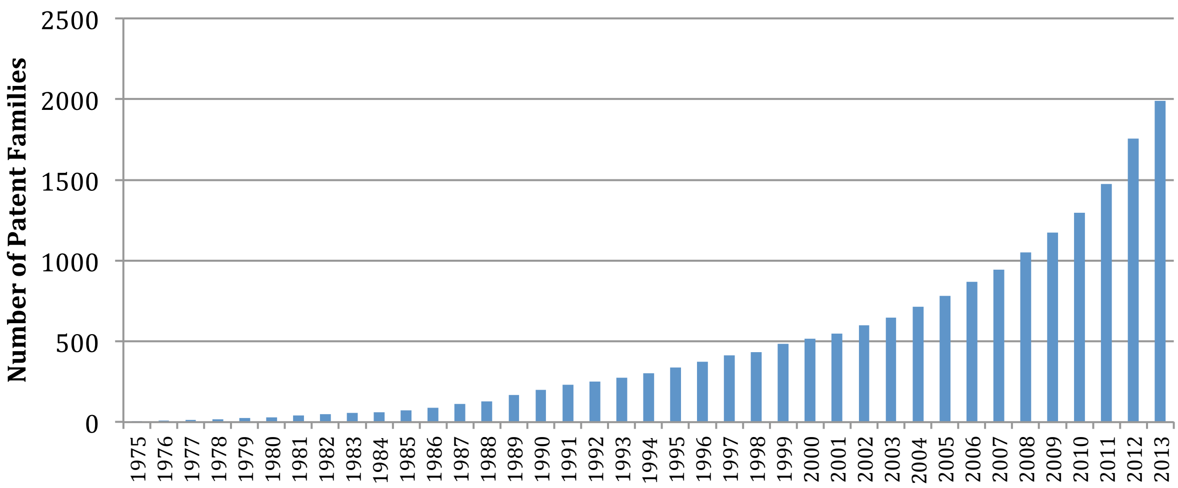

Figure 7, Total accumulated number of patent families

The number of actively patenting firms is an additional data source that might allow for an insight into both the technological activity and the PI technology's position on the S-curve. As can be seen in Table F, the number of firms actively patenting AD has a continuously increasing trend from 54 assignees in 2000 to 537 assignees in 2012. Such trend is one more characteristic of a technology in an early phase, as a dominant design has not been set and the uncertainty is still high.

Table F, Number of actively patenting firms

Year	2000	2003	2006	2009	2012
Number of assignees	54	146	255	313	537

With a general understanding of how the patenting of AD has developed over time, one can have a look at what actors are patenting the focal technology to get a deeper insight of the patent landscape, which is presented in the following section.

5.2 Activity of Actors

To get a better understanding of the focal firm's position on the AD market, it is time to relate the development of the patenting of AD to the most influential actors, thus getting a chance to assess the utilities of observing competitive and interesting actors such as suppliers, buyer and competitors.

First, the Patent Insight process' ability to find the utility of a more informed view regarding the *competitive landscape* within the focal technology can be evaluated by including actors in the observations of how the patent landscape has developed. As such, Figure 8 that displays the focal firm and the top ten actors possessing most patent families within the technology at hand will be a useful information source.

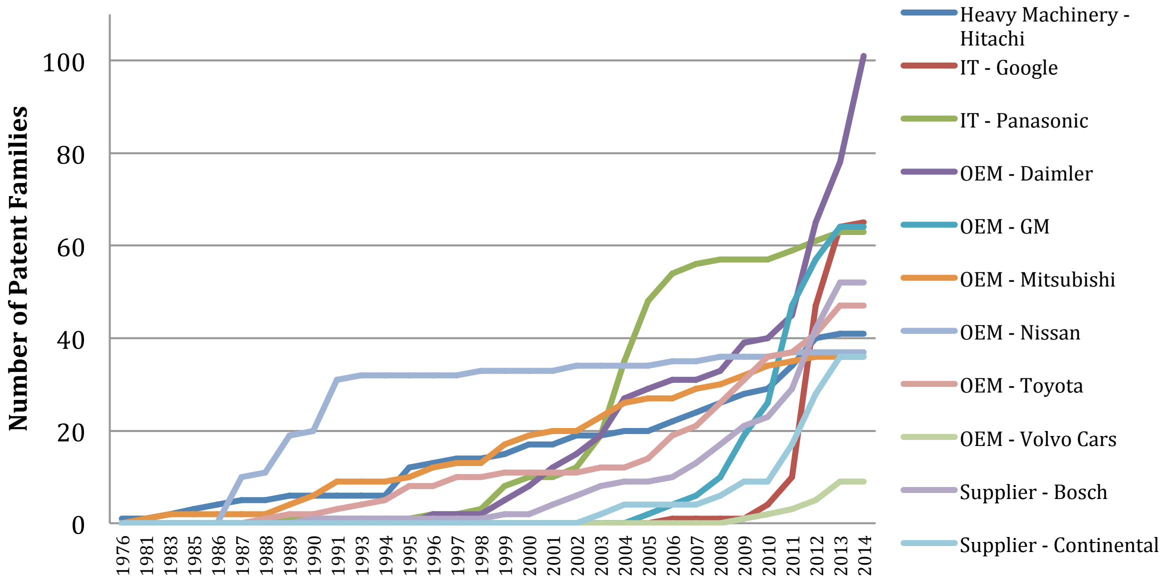

Figure 8, Top 10 actors: accumulated number of patent families

The first trend one might observe in Figure 8 is an on-going rapid increase of activity among the majority of these frequently patenting actors, as the curves of filed patent families in this case have a steep appearance. For example, in less than ten years, companies such as GM have gone from a few patents to having some of the largest patent portfolios within AD. An even higher patenting pace can be seen by observing the IT company Google, which gives an insight that the competitive landscape is getting even tougher when firms from other industries than the Automotive industry has such interest in AD. Google entered the market as late as 2009, but is now one of the assignees with the most patent families within AD. Moreover, it can be observed that Daimler had a head start, starting its patenting activities of AD technology as early as 1998, and is thus now by far the assignee with most patents.

Additionally, the data in Figure 8 can be used to reveal abnormalities among companies patenting behaviour of the focal technology. Some assignees e.g. Hitachi have shown a slow and continuous growth of its patent portfolio, whereas other firms such as GM and Google began their patenting of AD at a later stage and now have a more rapid increase of their patenting pace. Another patenting pattern that can be seen in Figure 8 is that some assignees have been initially aggressive regarding their patenting, and then later reached a plateau where they stop their patenting of AD, which is a phenomenon seen by looking at both Nissan and Panasonic. Furthermore, the overall patenting pace of AD has in the last years seen an increase among a group of actors, compared to the earlier years when there were only single firms that made temporary investments in the technology.

The next theoretical utility to evaluate if the Patent Insight process allowed the researchers to find is the *buyer/supplier activity*. By looking at the accumulated patent portfolios of suppliers in Figure 9, one can see that Bosch and Continental that were also some of the top ten patenting firms observed in Figure 8, stand out as the actors showing the most interest in patenting the focal technology. The rest of the suppliers, where Swedish Autoliv is one example, have significantly less patent families and also a lower patenting pace. The other part of the utility, which would be to observe the buyers' patenting activity, is not possible to find in this case, as Volvo is the last part of the value chain and thus the customers would be the end consumers.

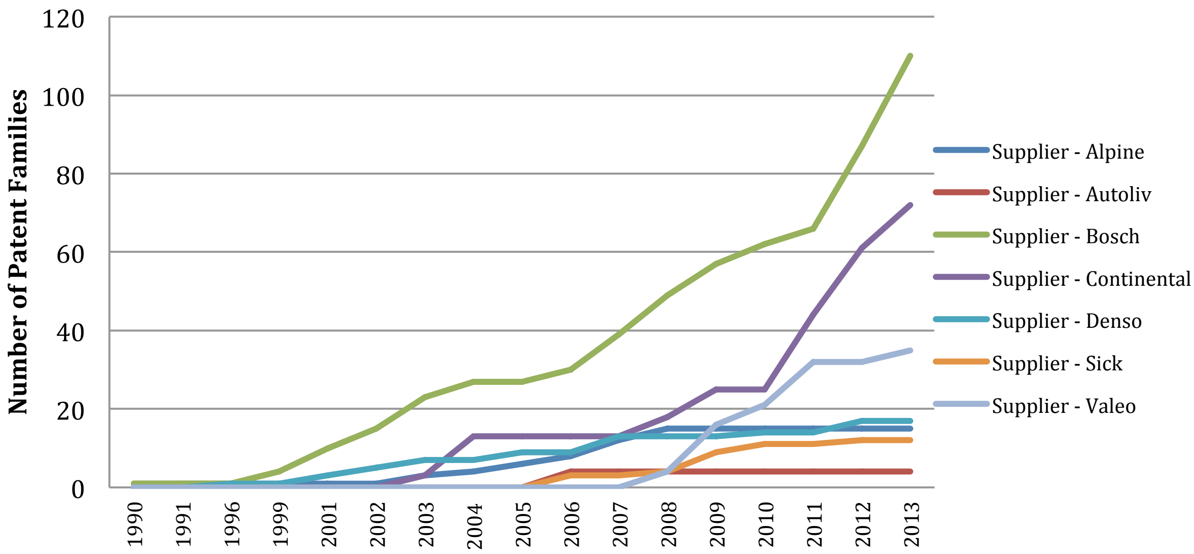

Figure 9, Accumulated number of patent families of suppliers

Furthermore getting an understanding of the *focal firm activity* is the next utility that was presented in the theoretical review. To find this utility, the focal firm can put the size of its patent portfolio in relation to the technology's main patenting assignees, seen in Figure 8. One can observe that compared to the top patenting firms, VCC has a relatively small patent portfolio and also entered the market of AD later than the top ten patenting firms, which might be one of the reasons of its comparatively low number of patent families. Though, Figure 8 can be used to observe that VCC in the last couple of years has invested more in its patent portfolio of AD, as the number of filed patents per year has increased.

Moving on from visualizing different actors' patenting activity over time, the utility of *competitors' market belief* will now be evaluated through an observation of where firms have filed their patents, see Figure 10. The assignees seen in Figure 10 are named *"the interesting six"* and will be a common theme for the majority of the following empirical findings. The reasons as to why the researchers chose these companies was to involve actors from various industries i.e. OEM, Suppliers and IT-companies, to get a first understanding if the patent trend seemed to differ between industries. Additionally these actors have many patent families and the case company considered them to be interesting.

A trend that stands out in Figure 10 is that all six companies have filed their patents in large automotive markets, such as USA, China, Japan and Germany. Furthermore WO is an international organisation that helps companies to file a patent in many countries simultaneously, instead of many separate patents, and EP is a similar European patent organisation. Thus, these two categories are also patents filed on a broad market. Moreover one last insight to add regarding Figure 10 is that all six countries have a significant amount of patents on their home markets, one can for example observe how Daimler has all their patents in Germany and Google has the same trend in the US.

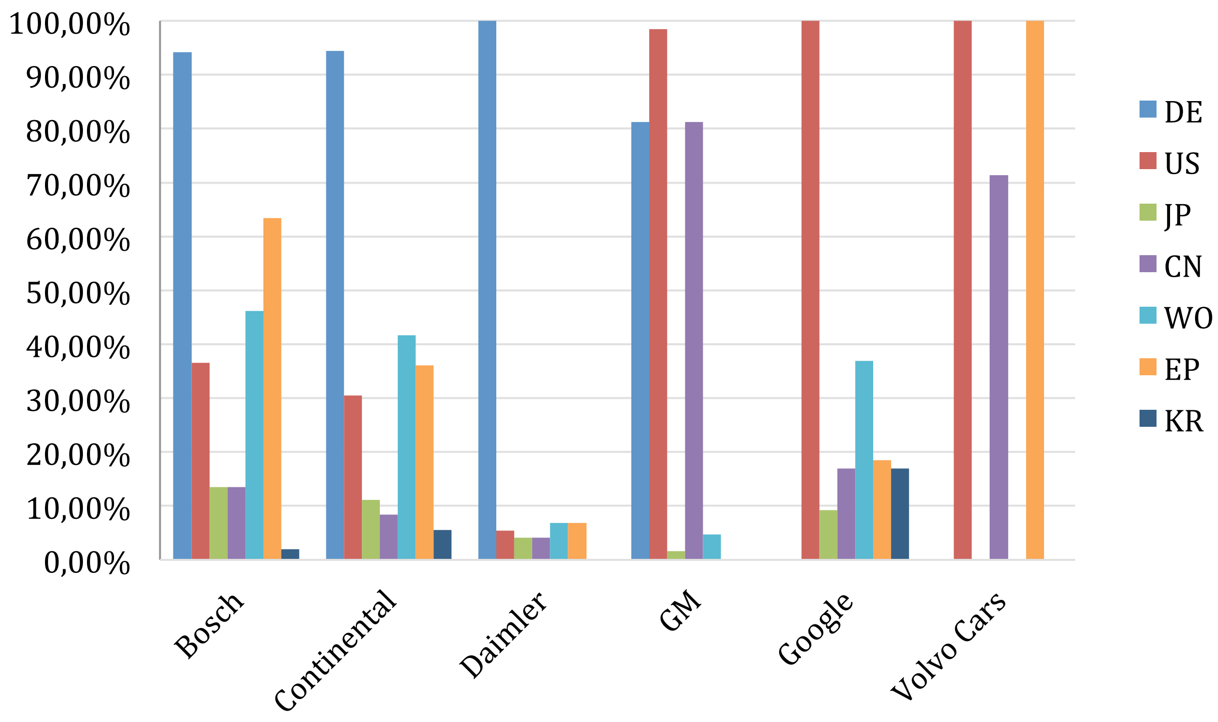

Figure 10, Interesting six: Patents on various markets

The presented data has so far only taken a general view of the technology, the activity of the main actors, and the main type of assignees, by looking at the total number of patent families as a whole. However, to get further insight into the technology a subcategorisation was made to depict the building blocks of AD.

5.3 Subcategories

The researchers will now test if a *subcategorisation* allows for further insight into the technology at hand, by associating individual patent families to certain aspects of the technology, through the use of keywords and classifications. Depicting the total patent family count for the subcategories of the primary case of AD, see Figure 11, it is possible to observe that the different subcategories have varying amount of patent families associated to them. Subcategories such as Positioning, and Obstacle Identification and Avoidance are frequently associated in the AD patent families. In contrast, subcategories such as platooning and simulations are at a low patent family count.

To allow for a better comparison between the subcategories, they were divided into three different types: Application, Information, and Travelling, see Figure 11. The Application type considers ways to apply the focal technology, whereas Information refers to the fundamentals that make the AD technology possible in terms of input and output. Moreover, Travelling concerns the actions carried out by the car while operating in the autonomous mode.

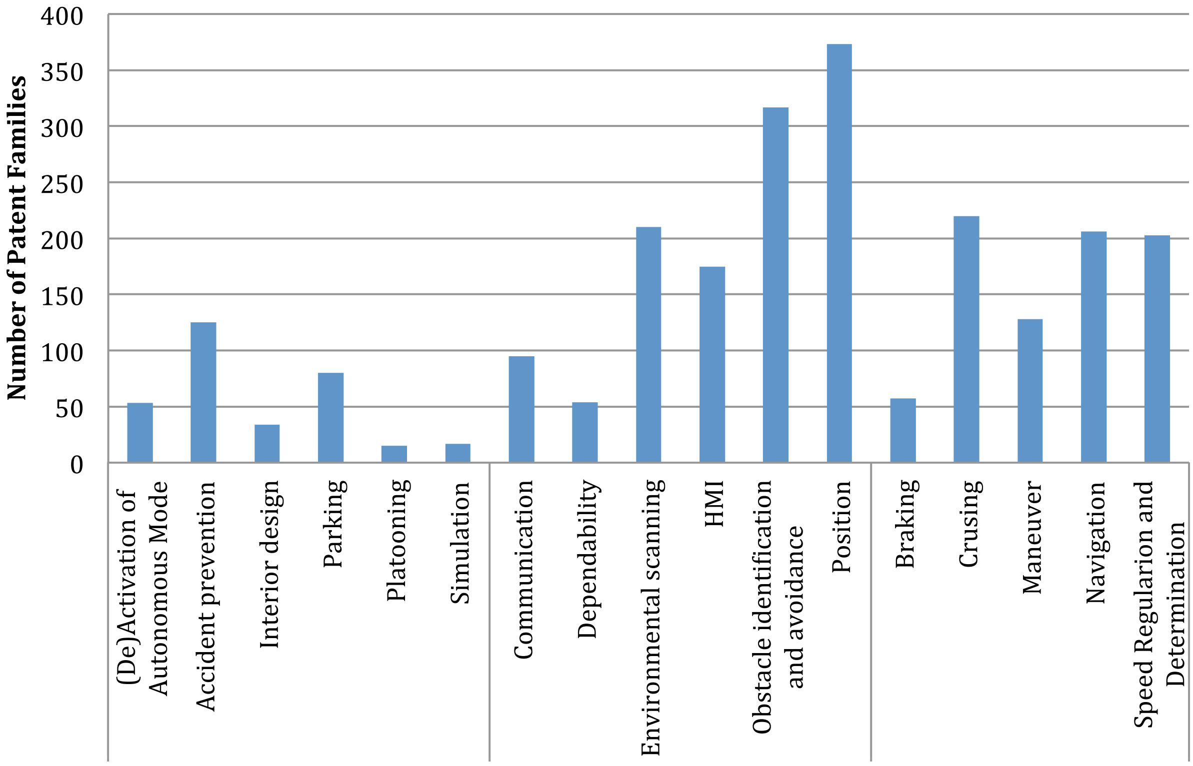

Figure 11, Accumulated number of patent families per subcategory

With the subcategories and its types at bay, it was now possible to add actors to the investigation and evaluate if the utility of *key expertise* could be found. Looking closer as to how "the interesting six" assignees choose to distribute their patent portfolio over the different subcategories, see Figure 12 for the information type category, an insight is gained of how these assignee types may relate to each other. At a closer inspection of Figure 12, some interesting insights can be gained. What may catch the eye is Google's investments in Obstacle Identification and Avoidance, which stands out for being high in Figure 12. Another interesting remark is GM's investments in HMI, which in Figure 12 seems to outperform all other assignees developments.

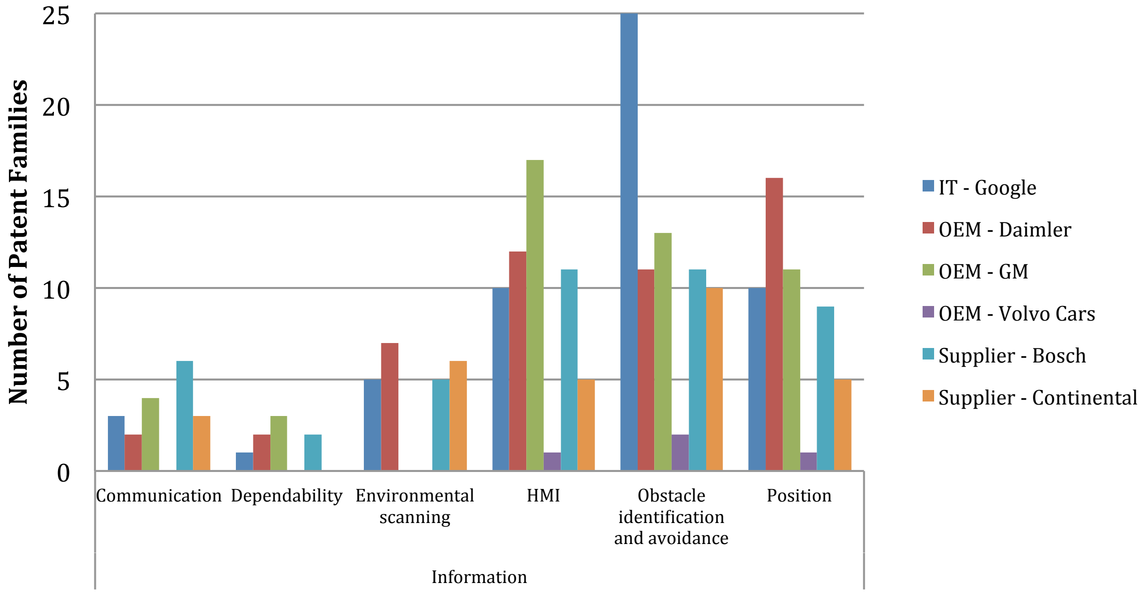

Figure 12, Interesting six: Total number of patent families per subcategory information

With an observation of companies' differing key expertise at hand, the natural next step is to assess the utility of *evaluating partnerships*. As GM and Google have different focus of their patent portfolios, thus also varying areas of knowledge, a partnership between the two might increase both companies total knowledge portfolio within the focal technology.

Another way of evaluating partnerships is to take one step back and observe how different industries focus their patent portfolios. When doing this it has been decided to look closer into and compare OEMs, Suppliers, and IT assignees, see Figure 13. These assignee types are arguably, interesting as OEM and Suppliers have a prominent role in the automotive industry value chain. Further, IT related assignees are of great interest as AD inherently involves a considerable amount of IT oriented technological expertise, e.g. digitized pattern recognition coupled with high tech sensor technology.

An abnormality that stands out in Figure 13 is that IT seems to follow a different pattern from that of OEM and Suppliers, focusing more on Obstacle identification, Positioning, and Navigation but lacking in Cruising, and Parking. OEMs and Suppliers on the other hand follow a more similar pattern of patenting the AD technology, with few exceptions of Maneuver and Interior design. As such it might be interesting for OEM's or supplier's to go into partnership with an IT company, as they seem to be knowledgeable within varying components of the technology.

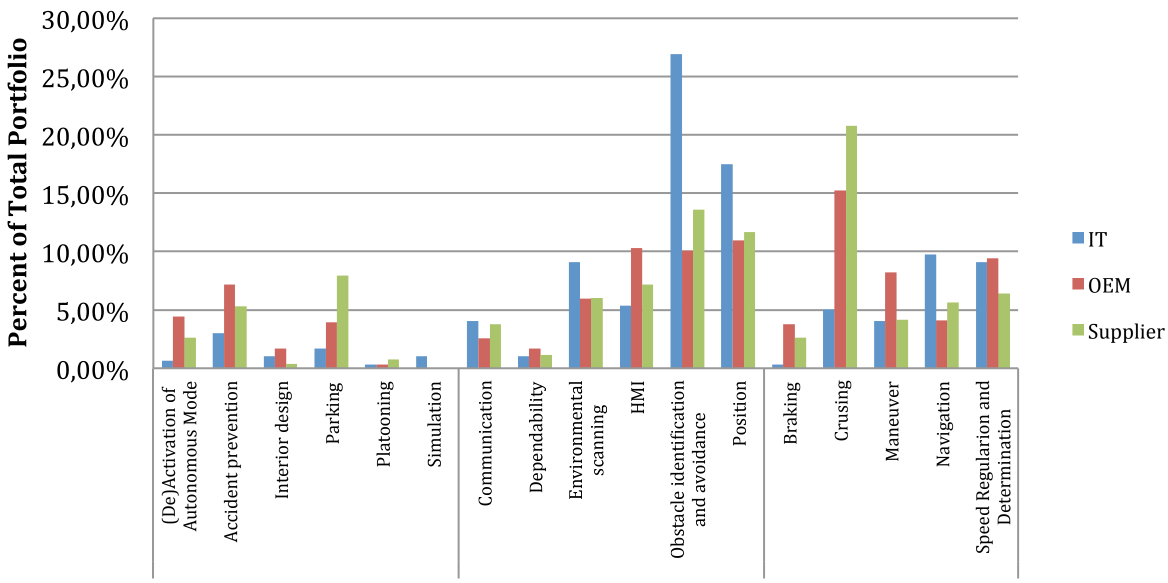

Figure 13, Total percentage of patent families per subcategories for IT, OEM and Suppliers

Taking one step back from the general patent data and the subcategorisation there of, additional point of views can be obtained through the use of data parameters such as patent family citations and information about the inventors to spot outliers.

5.4 Outliers

Outliers concerns patents of high quality, inventors with most filed patents, and countries with many associated patents. The following chapter tests if the researchers could find these utilities through the Patent Insight process and starts with an evaluation of the high quality patent families.

To find the utility of *high quality patents*, the researchers observed the patents with the most forward citations or large patent families. By sorting through the patent families the top five cited patent families were found and can be seen in Table G. Surprisingly the most cited patent family is one made by the company Caterpillar, a company within the Heavy Machinery industry. However, the patent family's topic of vehicle positioning is well in line with the observations found in Figure 11, where the subcategory of positioning had a prominent patent family count.

Furthermore, Looking at both companies and the type of assignee, there is a diversity to be seen. No one assignee holds two patents families among the top five and there are members from four different assignee types with Collaboration being the most commonly cited. There is also a fairly good spread between the earliest priority dates of the patent families ranging from 1989 to 2005.

Table G, Top five cited patent families.

TOP five Cited Patent Families AD					
Patent number	Title	Prioritet date	Forward citations	Assignee	Type of Assignee
30537954	Vehicle position determination system and method ;	19891211	1232	Caterpillar	Heavy Machinery
29748073	Vehicle information system ;	19970819	956	Continental Siemens	Collaboration
5012136	Navigational control system for an autonomous vehicle ;	19900519	291	US Navy	Defence
12569217	AUTONOMOUS VEHICLE ARRANGEMENT AND METHOD FOR CONTROLLING AN AUTONOMOUS VEHICLE ;	19971103	282	Volkswagen	OEM
34404535	SYSTEMS AND METHODS FOR OBSTACLE AVOIDANCE ;	20051021	218	IRobot John Deere	Collaboration

Furthermore, finding the patents that are filed in most countries is, as previously mentioned, another way of illustrating high quality patents. By looking at the data in Table H, one gained insight is that Caterpillar has the most influential patent families also according to this parameter, having the patent families on both spot one and two. Except Caterpillar there is a high diversity of the results among the top five patent families, with companies from different industries and the patents are filed in a long time interval from 1989 to 2010. One last aspect to comment regarding Table H is the small difference of number of countries the patents are filed in, with a difference of only two countries from the top patent to the one on spot five.

Table H. Top 5 Patent Families filed in the most countries

TOP 5 Patent Families filed in most countries					
Patent number	Title	Prioritet date	Number of countries	Assignee	Type of Assignee
11163899	System and method for managing access to a resource in an autonomous vehicle system ;	19941024	9	Caterpillar	Heavy Machinery
11173233	System and method for precisely determining an operating point for an autonomous vehicle ;	19941024	9	Caterpillar	Heavy Machinery
51756237	Method for the autonomous lacalization of a driverless, motorized vehicle ;	20101216	8	Siemens	IT
30537954	Vehicle position determination system and method ;	19891211	7	Caterpillar	Heavy Machinery
29748073	Vehicle information system ;	19970819	7	Continental Siemens	Collaboration

Moving on, to try and find the utility of *technology clusters*, the number of patents associated to each country is a parameter that can be counted and thus allow to find influential countries. From Figure 14, an understanding can be gained that China, Germany, Japan and the US are the countries with most associated patent families, where the US is the top country having 755 patent families. Moreover, similar to the findings in Figure 10, WO and EP are important categories also according to Figure 14, where they have 367 and 388 patent families.

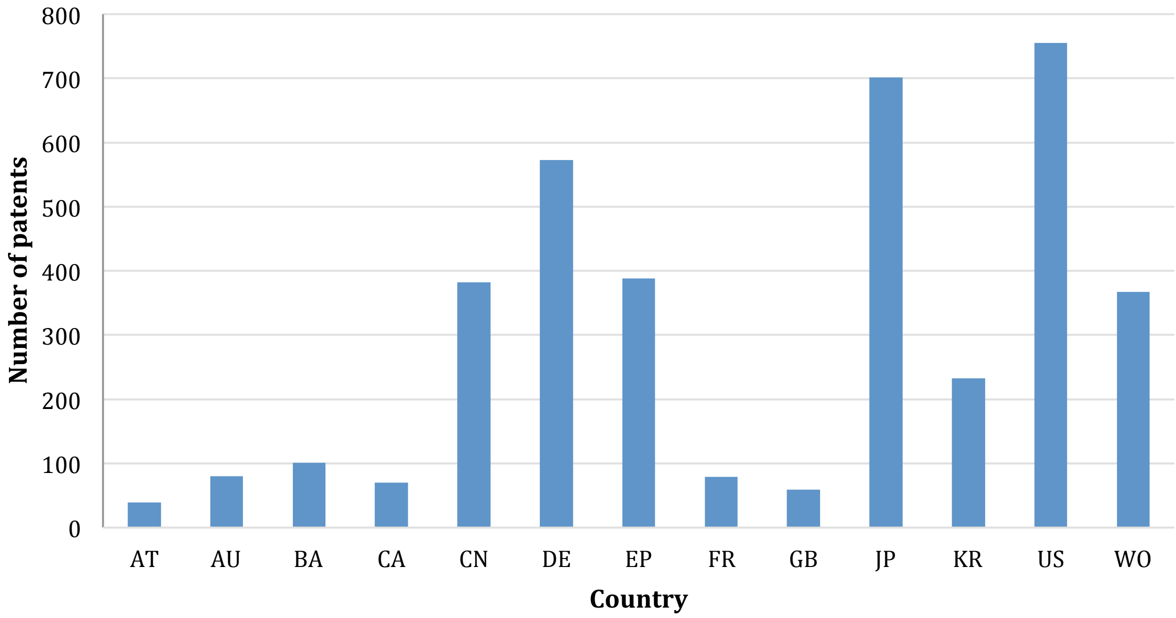

Figure 14, Total number of patent families filed per country

The last type of outlier to evaluate that was presented in the theoretical chapter are the inventors that haven been especially influential in the development of the focal technology. Inventors, the people who are the masterminds behind the innovative solutions that are patented, are mentioned as a post of data in each patent family. Sorting through this data an insight is gained of the most active minds in AD, see Table I below for top five inventors in AD. David Ferguson from Google is the person who has the most patents associated to him, second only by Hattori Akira from Nissan. It can be observed that the inventors come from different companies but out of the top five there is a common theme with three inventors from Google.

Table I, Top 5 Inventors

Top 5 Inventors AD		
Inventor	**Frequency**	**Assignee**
FERGUSON DAVID I	29	Google
HATTORI AKIRA	23	Nissan
EGUCHI OSAMU	18	Panasonic
ZHU JIAJUN	18	Google
DOLGOV DMITRI A	15	Toyota, Google

Now that the findings from the patent insight process have been evaluated, it is time to move on to the next chapter where the findings will be discussed and analysed more closely to see how well the patent data utilities presented in the theoretical review, have actually been accessed or not.

6. Analysis and Discussion

This chapter aims to analyze and discuss whether the empirical findings described in chapter four could provide the theoretical utilities of patent data described in chapter two. Furthermore the researchers will discuss the proposed Patent Insight Process to analyze if it was a suitable process to find the theoretical utilities.

6.1 The Proposed Patent Insight Process

The PI process which have been developed in order to allow Volvo Car Company to obtain the theoretically proposed utilities of patent data in a structured manner, will be discussed further below, where different aspects of the method will be in focus.

6.1.1 Accuracy

To truly understand how to analyse the patent data obtained through the PI process, one must first understand how accurate the Patent Insight process is and what inherent limitations that are associated to it.

As presented in Figure 4 and Figure 5 one of the steps in the iterative patent search process of creating a search string was to generate keywords and define relevant classifications. There is an obvious hurdle in this process, i.e. the PI Engineer has to make qualitatively based decisions about what keywords to include in the search string. This was a balancing act between finding relevant patent families and not include too many unrelated patent families. If the search was defined too narrowly, e.g. only patents with Autonomous Drive in the title and abstract, the hits would be extremely relevant, but a lot of patents that may be considered as relevant will be left out. On the other hand if one chooses a broad approach only using terms such as Automotive and Sensors, it would probably include a higher amount of AD related patent families but, at the same time these would be hard to identify as they would drown in the abundance of unrelated patent families, thus the total percentage of AD patent families would be low. Therefore, the researchers would always go through a randomly chosen part of the patents to ensure that the majority was relevant and contributed to a better insight of the technology. Though, when the number of patent families rose significantly it was more complicated to get an overview of the result and consequently also decide if a change to the main search string had improved the result or not. It can however be argued that what is left out from one assignee is left out from another. The relationships and its pattern would thus show a similar trend between assignees even if a minor part were left out.

6.1.2 Generalizability of the Patent Insight Process

The Patent Insight process may be considered as a general process fit for companies that have a dedicated R&D department. It can be argued that even though VCC was used as a reference for the development and evaluation of the patent insight process, many of the elements included in the process can be found at most technology oriented companies with a dedicated R&D department. As such the researchers suggest a general Patent Insight Process, see Figure 15, which will be further elaborated below.

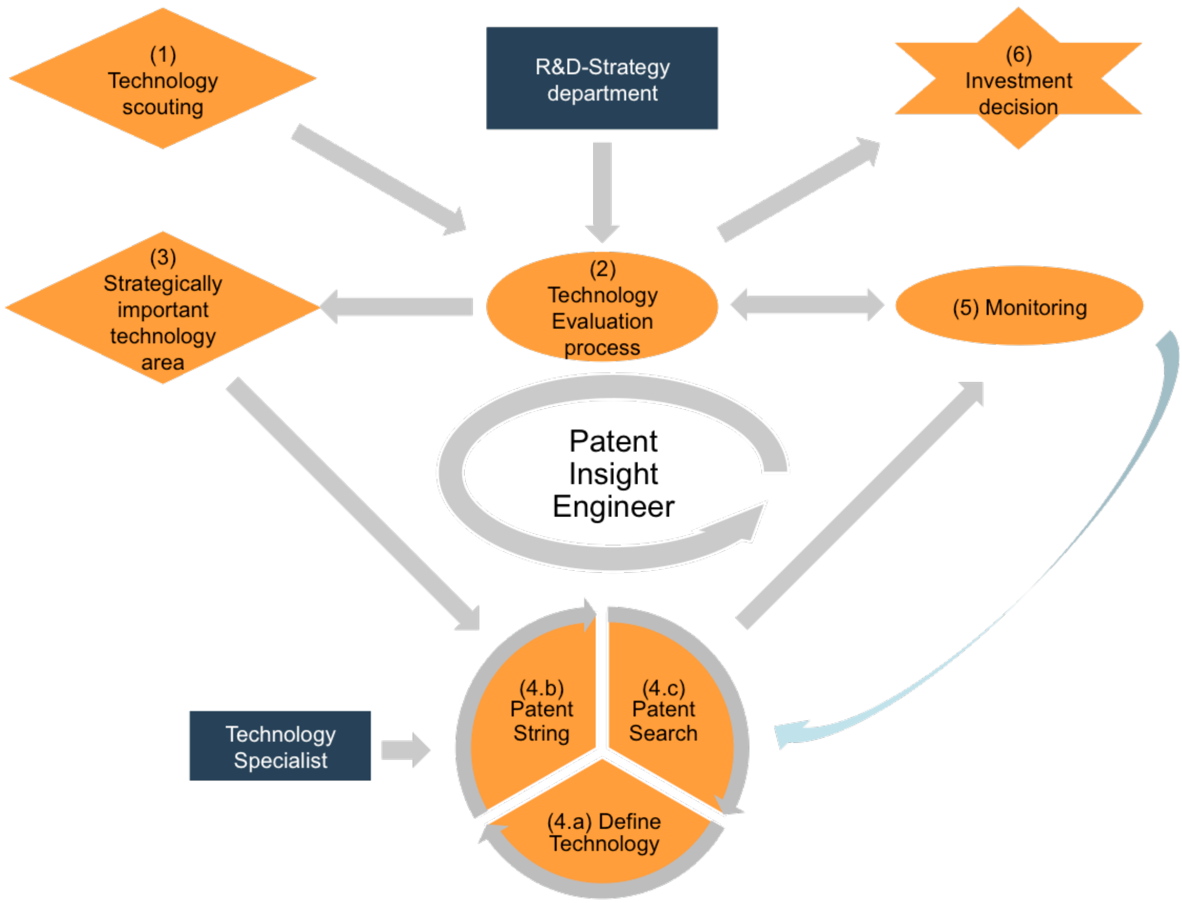

Figure 15, General Patent Insight Process.

Starting from the beginning of the process, the typical company has their needs and their means (resources) to solve these needs. However, a firm usually have more needs than resources and thus on a daily basis have to make qualified decisions on what needs to focus their resources on to achieve the highest return on investment. As such, the needs and means part of the PI process is generally applicable as firms have a (2) technology evaluation process where they do the needs and means trade off.

To obtain the needs, VCC used technology insight as one of the main inputs. However the typical firm usually gets an idea of their needs from a (1) Technology Scouting information source, be it from fairs, the internet or customer observations. No matter what, these can be conceptualized as a need, which may be of interest for the firm to solve. Hence it does not matter if it is technology insight or customer observation that is the input, the main idea is that there usually is some kind of information input that materializes into a need for technological development.

The subsequent (4) iterative patent search process of technology definition, search string generation and patent search is not company or technology specific and will thus work in more contexts than the focal case. However which will be discussed further below, the subjectivity level of the technology will prove to determine the emphasis of different parts of the process.

Lastly the (5) monitoring part of the Patent Insight process will help companies to continuously follow up on the development and activity of the technology. Once the Patent Insight has been done, it can easily be redone, supplemented, and updated to give fresh data on the technology at hand. Thus the company can go from a reactive to a proactive stage, allowing for decisions to be made on emerging data rather than in hindsight. This part as well should be independent of the type of company and technology, thus prove to be generally applicable.

To conclude the PI process is considered as being general and non-specific to the case company, and should therefore be applicable to a broader range of companies with dedicated R&D departments as seen in Figure 15.

6.1.3 Creating a self-sustaining process

When introducing a new process it is important to anchor it firmly into the organization for it to become sustainable, which can be done by creating a self-sustaining process and aligning stakeholder interests.

While developing the PI process the researchers aimed to create a process that would not disrupt current processes but instead be self-sustaining, reducing bottlenecks, and making the process efficient. This was done by only assigning one person, the PI engineer, as the primary catalyst for the PI process. Using one person will take up less time and resources from other individuals around the organization and would allow for a central drive less dependent on others to do their part. Further, by having a relatively self sustaining process the PI process complements the existing needs/means process without having to re-engineer any existing processes. By doing so the chances for successfully implementing the processes is believed to have increased than if this was not considered. As the R&D strategy department was involved in actively choosing the strategically important technology, this stakeholder was by default interested in the PI and felt the need to actively engage. Furthermore, considering technology specialists, the interviews would play an important role as it spurred a great interest of the result. Thus changing a seemingly push oriented process into a pull from the technology specialists that were interviewed.

To summarize, the PI process engages all the main stakeholders from the R&D strategy department's needs and means, to the technology specialists curious minds, creating a pull from stakeholders across the whole organization, while remaining self sufficient and non-disruptive to current processes. Such recipe is key to firmly anchor this process into the organization.

6.1.4 The Impact of Subjectivity

The level of subjectivity of the PI technology would prove to have an impact on the technology delimitation process. As could be seen in the empirical chapter, the three PI technologies required differing amounts of interviews to get a grasp of the technology at hand and its associated subcategories. Technologies at a higher level of subjectivity would require more interviews than that of low subjectivity level. This is mainly do to the fact that technologies of high level of subjectivity are more susceptible to individual interpretation of the technologies. Consequently to get the firm's interpretation of the technology, many interviews were required. Arguably, this would also have an impact on the categorisation of the technology, as it is made to fit the view of the company rather than the general public. As such, it is believed that the subcategorisation of technology X by another team of analysts may end up with differing subcategories. Nonetheless the main search would have a higher tendency to remain the same, as could be seen in the empirical data, the technology specialists would prove to be less useful when defining the general picture. Consequently, the main search will be less coloured by the lens of the focal firm.

Considering the utilities and the patent data per se, the researchers believed that the level of subjectivity did not have major impact on the outcome of the results, as trends and utilities could be analysed and attained in a persistent manner.

6.1.5 Knowledge accumulation and patent count

In the theory it was stated that a firm's total patent family count could be used as an indicator of its knowledge within that area. The researchers believe this to be possible if one assumes that all companies have the same tendency to patent its developed technologies. However, if we consider the automotive industry to be fairly slow at patenting in comparison to most IT firms, e.g. Google who is renowned for their active patenting culture, we may expect to see a somewhat skewed picture regarding of what company is most knowledgeable within the technology at hand. For the same amount of resources and effort put into developing AD technology, Google might for instance patent two times as frequent as Daimler, but if Google has a culture to more frequently patent new technologies it might not have more knowledge than companies that are more selective in its patenting. The same trend can also appear between companies within the same industry, where an additional reason for different patenting activity might be that companies focus on certain components of the technology, which might require varying amount of patenting. The researchers indeed believes that this has to be taken into consideration when analysing the data, as the companies with the largest patent portfolios do not necessarily have to be the most knowledgeable within the technological field.

It should also be considered that Patents first and foremost allows the assignee to protect its knowledge, and attain monopolistic use. Thus in the era of ferment, while ground breaking parts of the technology is being developed, it can be advantageous to obtain patents and protect the R&D investments. If the assignee considers itself as a lead developer, it would arguably benefit from protecting the knowledge that it has invested resources in developing, and thus allowing it to take part of the future possible revenues.

6.1.6 Potential of creating an automated process

It was early understood that a PI process would require significant initial time efforts, as creating the search string builds on manual and qualitative labour that cannot be easily copied between different technologies. The labour intensity was also experienced in the monitoring part of the PI process. However, the researchers believes that this part can be made considerably more automated and less labour intensive considering its quantitative characteristics. This quantitative characteristic is the key, since once the search string is created, there is nothing that hinders the user from creating a computer program that uses the raw quantifiable patent data and outputs standardized sets of figures and tables that can be automatically updated, thereby always keeping the results up-to-date. This program would use the formulated patent search strings to search, export, and process raw patent data, resulting into the more comprehensible format presented in the PI result in the empirical chapter. This would result in considerably less effort to structure the data in the monitoring part of the PI process and thus allow for a more effective continuous monitoring.

On the other hand, to keep the findings of the patent search relevant as more knowledge of the technology is gained, one might have to manually add new subcategories or change the main search. Though it would still not be a major issue as the time consumption of adding subcategories would be far less than creating the initial patent search string.

All in all, the computerization of the PI process monitoring part would result in a major increase in efficiency and would be highly recommended if the process is to be used on a large scale.

6.2 The Evaluation of the Patent Insight Process

As the PI process has been discussed and now is better understood, it is time to analyse the results from the patent search to see how well the Patent Insight process allowed to find the proposed theoretical utilities. As will be seen, all utilities could be found but did not always provide the desired value for the focal firm and thus, the researchers distinguish between utilities that were obtained and those that were vaguely obtained

6.2.1 Overview

To get a good introduction to the PI process results, the researchers starts with a discussion of whether the empirical findings was able to support the theoretical findings of how to get an overview of the technology.

As presented in the theory, patent counting can be used to get an insight of the *technological activity* to see whether it is increasing or decreasing. Figure 6 presents this sort of data as the number of issued patent families per year, where one could see a fluctuating development with small upturns and downturns until 2000, when a continuous increase of patenting activity started. To see the exponential increase of patenting from 2000 might be valuable for the focal firm as e.g. an additional information source to support investments in the technology at hand. For example, the data states that VCC started to patent the PI technology in 2011 and now has to increase its patenting activity in order to have a patent portfolio comparable with the top-patenting actors. Thus PI could have provided value to the focal firm as it might have had decided to enter the AD market at an earlier stage knowing the increasing trend from 2000 onwards. As such, allowing for an even better preparation for the investments in the technology that the company now seems to face.

Mogee (1997) explained in the theoretical review that patent data could be analysed to find out where a technology is located on *the technological S-curve*. Figure 7 would thus be useful as the exponential increase of issued patent families is a sign of being in the introduction phase of the S-curve. As such, there is still a relatively high uncertainty related to the AD technology and its investments, but as it has an increasing growth the uncertainty is becoming lower and lower by the year, thus reducing the risk of investments and increasing the efficiency of R&D investments. One might have been expected AD to follow this trend as it is in an early phase, but now visualised with quantitative data this assumption is confirmed.

On the other hand the accuracy of where on the S-curve the technology is before the point of inflection can be questioned. As before the point of inflection it is hard for analysts to accurately predict if the technology is in an introduction or growth phase just by observing the technological activity seen in Figure 7, since the technology will be increasing exponentially in both these phases with no indication on when it will reach the point of inflection. Thus not providing any information of how much longer the technology will grow before saturation. Arguably the value of looking at the S-curve would be higher when the point of inflection is passed, as one can then more easily estimate the position on the S-curve and thus predict how much more it will grow before reaching maturity and saturation.

The theory also mentions that the number of actively patenting actors is an additional indication of technological activity and a method to estimate the position on the S-curve. This utility could be observed in Table F, which presents an increasing trend of actively patenting firms, growing from 54 in 200 to 537 in 2012. Such trend might indicate that today, more companies believe in the development of the focal technology than ten years ago, thus patenting the technology to get a piece of future revenues. Moreover the theoretical findings regarding characteristics of theoretical development states that an increasing trend of actively patenting actors, is a sign that the technology is in an early phase of the technological S-curve, where the uncertainty is high. Thus, AD seems to be in an early phase where it is still attractive to enter the market.

To conclude one has now obtained a better insight of the technology and its activity than before by looking into the accumulated number of patent families, the number of patent families per year, and the number of actively patenting firms, thus providing the utility that was proposed. Moreover, the utility of using patent data to determine the technologies position on the S-curve would also prove to be accessed, but could only be vaguely obtained as the accuracy was not considered as high.

6.2.2 Activity of Actors

To further strengthen the insight gained from the overview of the technology and determine if the proposed utilities may have been obtained, the discussion will now continue with a focus on the findings related to the actors and their patenting of the focal technology.

The first theoretical utility to discuss when the actors are included is whether the patent data allows for a better understanding of the *competitive landscape*. The activity amongst the top-patenting actors has increased significantly over the last couple of years in relation to how it has been during the years before, which was seen in Figure 8, which indicates that the competitive landscape has become tougher. Google and GM are arguably the best examples of this increasing activity, as both have gone from having some of the smallest patent portfolios among the top ten patenting actors, to now being actors with some of the largest accumulated patent portfolios, see Figure 8. The focal firm can use this insight to e.g. decide if it believes that it is necessary to make more investments in the technology and have a patent portfolio that can be compared with frequently patenting actors such as Google and GM.

Abnormalities as how firms have changed their level of investment into the PI technology can also be seen in Figure 8. In the end of the 80s Nissan filed significantly more patents than the rest of the Top ten actors and the same phenomenon can be seen regarding Panasonic with a peak in 2004, see Figure 8. Such changes would give an insight of how the competitive landscape have developed over time, where one can also see that the increased patent activity have often been due to an increased activity of one assignee, while the peak in the last couple of years are due to a larger group of firms. Thus the chance that the technology will have a break through is arguably larger now than in the last decades, as it seems to be a more joint investment in its development than ever before.

One last aspect how Figure 8 enabled a better understanding of the competitive landscape was to see that new assignees started to patent the technology, possibly also coming from other industries, where the IT company Google is one example. It might thus be an even tougher competitive landscape if IT-related issues turn out to be crucial for the development of the focal technology, as companies from industries such as the IT-industry already have expertise within these technology areas.

With a better understanding of the competitive landscape, it is time to move on with an analysis of the utility to observe *buyers and suppliers' patenting activity*. First, an observation of the customers' patenting activity would according to the theory possibly give an early warning if they start patenting the focal technology, thus might be unsatisfied with the product the focal firm provides. In the case of VCC, the researches could not evaluate this utility fully, since the focal firm is positioned close to the end customer of the value chain. However, it was easier to evaluate suppliers and the theoretical utility to find out whether they have lost patenting pace, and the focal firm might risk to not having the most knowledgeable suppliers. This data is visualised in Figure 9 and one can see that Bosch and Continental clearly have the most patent families. If VCC collaborates with a supplier of low patenting activity, it can then contemplate whether Bosch or Continental may be a more valuable partner.

The *focal firm activity* can now be discussed in relation to the most frequently patenting firms, seen in Figure 8. From this data, one can see that VCC entered the market in 2011 and has then continuously increased its patenting pace. A larger patent portfolio might be advantageous if AD turns out to be a disrupting technology, as an increased patenting pace is arguably positive considering the argument that patenting builds and protects knowledge. The trend with a more joint investment in the focal technology also lowers the risk of entering the market and increases the possibility of the technology to reach a break through. The usefulness of monitoring the patent data can thus once again be noted, as monitoring the technology at an earlier stage, VCC can now more confidently invest in AD seeing that many other actors are undertaking investments in the AD technology.

Another way of looking at actors patenting trends is to see if the Patent Insight process allowed finding the utility of determining *competitors' belief in foreign markets*. The first insight that comes to mind when observing Figure 10 is that the interesting six have covered a majority of the largest automotive markets, which are USA, China, Germany, and Europe. Arguably the theoretical utility could thus be found. Though, it is hard to use this data to make predictions if any competitor has a special belief in one certain market, since once might expect the largest economies to be most attractive to patent in. Additionally, many patents are issued in larger areas through the EP and WO categories, which further dilutes the process of finding specific interesting countries. Furthermore, all six companies had many patents filed in their own countries of origin. This could possibly be an indication that they foremost focuses on their own market and do not believe that the patent will be of any use on a international market or they file the patents to block other actors from filing the patents instead.

To recap, the analyst has obtained the utility of both getting an insight into the competitive landscape as well as the utility of better understanding of the focal firms patenting activity and the activity of its competitors. Moreover it has also been possible to observe the utility of suppliers' activity to help the focal firm to better compare their patenting activity to each others'. Though the researchers could not evaluate the utility of buyers' belief in the technology, as Volvo is placed close to the end customers in the value chain. Lastly, the utility of competitors belief in foreign markets was also discussed where the utility data could be considered as vaguely obtained, as it was obtainable but would not provide its proposed value.

6.2.3 Technology

The theoretical utilities proclaimed that a better insight of the technology would be attained with a technology subcategorized and structured, which one will see also proved to be true in the empirical study.

To begin this evaluation the *subcategories* were obtained, see Figure 11 and Table D, and the researchers could start to mine, as stated in the theoretical review, information about how different assignees and type of assignees invested in what subcategories, and how these investments differed from one another. As can be seen in Figure 11, some subcategories have more patents associated to them than others, for instance Obstacle identification and Avoidance has more than Platooning. As such it might be considered as an indication that the subcategories with more patent families have caught the eye of many industry actors. Taking a closer look as to why the difference occurs, it can also be reasoned that the first mentioned subcategory is more fundamental and less case specific than the second. However, areas such as Platooning and Interior design which has a low total patent family count, see Figure 11, may have a higher risk associated to them, but could possibly be a seen as blue ocean subcategories that are relatively unexploited grounds of which the focal firm has a chance to make an impact at an early stage.

The subcategorization can now be used to evaluate if the utility of finding companies' *key expertise* was obtained. As could be seen in Figure 13, the IT industry actors are prone to patent in a different pattern than that of OEMs and Suppliers, which had a more similar patenting pattern. This is sensible as the suppliers work closely together with the OEMs, while the IT companies builds their knowledge base on another set of capabilities farther from that of the typical OEM. Taking a closer look at individual actors one may observe a similar pattern in Figure 12, where Google had an elevated investment in patent families related to obstacle identification and avoidance of 25 patent families. Considering the argument made above, this portfolio is what one would expect from an IT type assignee as this subcategory is especially related to software, and Google is a major actor within the IT industry specializing in the software sector. Google's patent portfolio within obstacle identification can for example be related to the focal firm's, which only has two patent families within that subcategory.

This leads us to the next utility, which is to evaluate *potential partnerships or acquisitions*. As can be seen in Figure 12 there is a level of heterogeneity between different actors patent portfolios. It could be of interest for a company to establish a partnership or to make an acquisition in order to obtain a complementing knowledge, thus synergy is obtained and both assignees become a greater whole. Going back to example of VCC and Google, where the size of the patent portfolio allows for an understanding that Google have made significant investments in this technology. Furthermore, the discussion of how building up a patent portfolio can be a sign of knowledge within the technological area thus allows for an insight that Google might have valuable knowledge within this technology. Though, one cannot for sure conclude that they have more knowledge than a company with a smaller patent portfolio, as they might focus on different components of the technology and have different patenting culture. It is thus possible that both VCC and Google might benefit from collaboration where an alliance would allow for an access to each other's knowledge.

To summarize, the subcategorisation of technologies has indeed allowed the researchers to obtain its expected theoretical utilities of a better understanding of different assignees' and type of assignees' patent portfolios, as well as providing a starting point for discussing partnerships, acquisitions and alliances, deeming this method useful. Moving on from subcategories, the next chapter will look into how outliers would prove to be useful, in order to assess different assignees, technology clusters and highlight high quality patents.

6.2.4 Outliers

Outliers are the last type of utility to discuss, where the Patent Insight process' ability to find high quality patents and particularly influential inventors and geographical areas are in focus.

Beginning with looking closer into the utility of *quality of patent families* through the lens of forward citations, see Table G, some interesting observations are made worth discussing. At the number one spot of the top five cited patent families lies Caterpillar, a company that earlier in the empirical study did not receive any major attention. However, despite this neglect and to the surprise of the researchers, they are now a prominent figure. On the other hand, it was highlighted in the empirical study that the newest of the top five forward cited patent families were filed in 2005, which is eight years from that of the latest fully visible patent data year, thus relatively old. This shows a drawback from using forward citations, which is that it takes some time before a patent would be able accumulate enough forwards citation for it to be considered as having a high impact. The analyst thus risks missing out on relatively newly filed patent families that may have a big impact and importance, but because of the time needed to build a substantial mass of forward citations, the patent family would be deemed to have a low impact. Nonetheless, keeping in mind the limitations, using forward citations to get an indication of high impacting firms have proved useful, as new insights has been obtained.

An additional tool to evaluate the most influential patent families, highlighted in the theory, was to look at the size of the patent families. Studying Table H allows for a continued observation of Caterpillar, as it is placed on spot one and two with the largest patent families, thus once again proves its impact on the development of the PI technology. Though, due to the already presented aspects of using EP and WO categories to patent in many countries simultaneously, the value of the results in Table H can be questioned. The patents within WO or EP could possibly be patented in more countries than the ones presented in Table H. As such, this data does not seem to be the most useful in order to find influential patent families.

Moreover, one must not forget that Table G and H still contains numerous of more patent families and assignees that are considered as having high impact on the development of the technology as they are forward cited numerous of times or have large patent families. As such the content of these patent families are just as interesting as the number one ranked patent family to have closer look at.

Moving on from Assignees, the next utility that the researchers tried to find with the Patent Insight process was influential *inventors* of the technology at hand, where the theoretically stated utility of finding and recruiting competent researchers was in focus. Recapping the empirical findings, Table I where the top five inventors of AD were ranked, shows some fairly interesting remarks. One of the main observations in the empirical chapter was the two top inventors, who were David Ferguson from Google being the lead inventor in the AD technology associated to 29 patent families, second only by Akira Hattori from Nissan who is linked to 23 patent families. Considering these observations it could be of interest for the focal firm to use this insight to improve its technological stance in the focal technology, by e.g. trying to headhunt these prominent researchers or establish a collaboration to make them work on the focal firm's projects. Another interesting aspect of the data is that it could also be used to distinguish teams of inventors that had been working on projects together. This understanding could also be seen as an input to decide on whom to recruit. If the most prominent inventor does not accept the job offer, then the company could still try to recruit colleges that have worked closely to this person and may be knowledgeable in the same area. Moreover, this intelligence can be used to give an indicator of what inventors to monitor as these inventors have been actively developing the technology and might file more interesting technologies.

The last form of outlier to discuss is *technology clusters*, which the theory describes as the countries with most patent families associated to them. This utility can be seen in Figure 14, where China, the US, Germany and Japan have the most associated patent families, thus the theoretical utility to find geographical clusters could arguably be found. On the other hand, the size of the countries should arguable also be taken into consideration before making any conclusions of this utility's value, and the top four countries from the result in Figure 14 are the world's four largest economies. As such the result of this parameter was relatively predictable. Additionally the WO and EP categories make it hard to find geographical clusters, as the patents are filed in many countries but it is to the researchers unknown what countries that are included. Thus one could observe what countries that had the most associated patents but it can be questioned how much value it actually provided.

To conclude the discussion of outliers, the researchers could observe that the utility of recruitment through the use of inventors was shown to be obtained and provide its stated value, which was also true when using number of forward citations as an indication of the quality of patents to find the patents of highest value. On the other hand, using family size as an indication of a patents value would prove to be vaguely obtainable and not very useful because of the data ambiguity. For the same reason finding the utility of technology clusters would prove to be vaguely obtainable.

6.2.5 Summary

To wrap up the discussion and analysis on the theoretical utilities and whether or not these were obtained through the use of the Patent Insight process, a summary is displayed in Table J below. As can be seen in Table J all the utilities were obtained as stated by theory. However, the actual utility proclaimed by theory would not always be as useful as stated. This was usually the case when the data that the observation was founded upon had an inherent ambiguity associated to it. Findings such as these were considered as vaguely obtained. Nonetheless, the utilities were all considered as obtained and thus the PI process has proven to work.

Table J. Empirically obtained utilities.

Type	Theoretical Utility	Empirical Findings
Overview	Technological activity	Obtained
	Position on S-curve	Vaguely obtained
Activity of actors	Competitive landscape	Obtained
	Buyer/supplier activity	Obtained
	Focal firm activity	Obtained
	Competitor market belief	Vaguely obtained
Technology	Subcategories	Obtained
	Key expertise	Obtained
	Evaluate partnership	Obtained
Outliers	Quality	Vaguely obtained
	Technology Cluster	Vaguely obtained
	Recruitment	Obtained

7. Conclusions

In a business environment that has become increasingly dynamic with shorter lead times it has become progressively important for companies to have up-to-date and relevant information regarding the technologies it invests in. To meet this need, the purpose of this paper was to develop a process for conducting a Patent Insight in an organizational setting and to identify its perceived utilities. By doing so, the researchers identified theoretical utilities that Patent Insight might provide, and created a self-sustaining organizational process to access these utilities by conducting the PI process on three technologies. As such, the researchers could answer the following research questions:

1. *What scientifically acknowledged utilities of patent data can be used to obtain an insight into the patent landscape of technologies'?*

The researchers found 12 theoretical utilities of using patent data to achieve a holistic view of the patent landscapes of a technology. These utilities were divided into four separate categories, which are presented in Table K.

Table K, Theoretical patent data utilities

Type	Theoretical Utility
Overview	Technological activity
	Position on S-curve
Activity of actors	Competitive landscape
	Buyer/supplier activity
	Focal firm activity
	Competitor market belief
Technology	Subcategories
	Key expertise
	Evaluate partnership
Outliers	Quality
	Technology Cluster
	Recruitment

In order to obtain an initial overview of the technology, the theoretical review stated that the technological activity and the position on the technology S-curve should be observed. Where the technological activity is both seen as the accumulation of patent families over time, patent families per year and also the number of patenting firms. Furthermore to gain the technological overview, S-curves together with the historical accumulations of patent families, were seen as a utility used to determine the position of the technology to better understand the technology's dynamics.

The next category of utilities was named the activity of actors, containing information of how the focal firm, competitors, suppliers and buyers have patented the investigated technology. First, one can find the most influential competitors in order to get an understanding of the competitive landscape, by looking at the number of patent families. Moreover, the competitors' market belief is an additional utility that can be seen by using patent family information, to see what countries they have a tendency to patent in. Furthermore including the activity of suppliers and buyers would according to the theory allow for a more complete view of the technology at hand. Finally, the patenting of the focal firm can be compared with these other actors and by doing so, see how well the focal firm's patent portfolio stands up to the competitive landscape.

Moving on, a subcategorization of the technology would according to the theory allow for a deeper insight of competitors' key expertise and an evaluation of partnerships. One can better understand the components of a technology by subcategorizing it with classifications and keywords, and then further analyze the development of these subcategories through a calculation of the number of patent families associated to each of them. Furthermore the actors, i.e. competitors and suppliers, can be related to these subcategories, to find out how they try to develop their portfolios. The theory states that such an observation can allow for an evaluation of partnerships to gain a competitive advantage.

Finally the theoretical review presented the utility to find outliers as the most influential patent families, lead inventors and technological clusters. An influential patent family can be used to find assignees with a seminal impact of the development of the technology, where the number of forward citations and the size of the patent family are parameters to find the utility. Moreover geographical clusters is an additional utility that can be found by using the size of the patent family, as more patents in a country would be an indication of a high activity in this area. Lastly the theory mentions how the inventors with the most filed patents can give an indication of persons that have been involved in developing the technology.

2. *How can companies access these utilities through an organizational process?*

The researchers have managed to develop an organizational process for conducting a Patent Insight within a dedicated R&D department, which is self-sustaining and obtains the aforementioned utilities. This process was mainly developed with the help of multiple interviews with key stakeholders and by conducting the Patent Insight processes on three different technologies; 3D printing, Autonomous Drive, and Technology X. The general PI process can be seen in Figure 15 above.

The Patent Insight process starts of from a central technology evaluation process where future technological developments of an R&D department have to be evaluated and decided upon. Future-needs has to be paired with resources, but as resources are scarce, not all future needs can be satisfied. This is where the Patent Insight Process comes in as it will help the firm to obtain a quantitative insight into the patent dynamics of the strategically important technology, to be an additional information source for what needs to invest what resources into. Once a strategically important technology has been decided upon it move on to an iterative process of defining the technology, creating search strings and conducting patent searches. The outputted patent data is then structured and presented for monitoring of the technology. From this stage in the process, the insight may allow for a decision to take the technology to the next step, or if it does not seem to be interesting enough at the moment, the technology will stay under monitoring until it is ready for a decision to be made.

This process involves three main stakeholders; Patent Insight Engineer, the R&D strategy department, and the Technology specialists. Patent insight engineer is the main person who acts as a catalyst driving the Patent Insight process forward, conducting the patent searches and is in charge of the monitoring and updating of the data. The R&D strategy department is mainly responsible for stating what technologies that needs further insight, and determine if a PI is suitable for the insight. Lastly the Technology specialists' role is to provide specialist input into the technology at hand in order to assist the Patent Insight Engineer in the technology delimitation process. As the process is mainly dependent on the Patent Insight Engineer, it is considered as a fairly self-sustaining process where time-consuming baton passing is kept at a minimum. To further enforce the process, the interests of the stakeholders are considered as aligned. This is because the R&D strategy department has an inherent need for the data, as they are the initial customers put in the order to do the Patent Insight.

Moreover, the interest of the technology specialist was also aligned, as they would gain a deeper understanding of their area of expertise.

The findings of this processes was consistent with the theoretically proclaimed utilities mentioned above. Some of these utilities clearly obtained while others were only vaguely obtained. This usually depends on the ambiguity of the data parameter that was used to indicate the utility.

The level of subjectivity of the technology of interest will have an impact on the technology defining process. Technologies with a high level of subjectivity are susceptible to individual interpretation of the technology, and as a consequence will require more interviews with technology specialists in order to define the technology, relative to a technology with low level of subjectivity.

In short, there are many utilities associated to patent data, which through a structured organizational process can help companies systematically gain insight into the patent landscape of technologies. One such organizational process is the Patent Insight process, which have proven to find theoretically proclaimed utilities in a sustainable manner.

8. Further research

In the pervious chapter it was concluded that a process for conducting a Patent Insight within VCC was achieved. Moreover, it was also believed that the different stages within the investigated process bears some general resemblance to firms with dedicated R&D departments, and as such it is understood that a wider range of companies could use the PI process. However, due to the time and resource limitations, the researchers could only conduct the PI within VCC, involving VCC personnel. As such in order to strengthen the claim that this process may be applicable to a greater variety of companies, it is recommended that future research is to be conducted in order to investigate if the PI process can be used within a multitude of different types of companies.

It would also be interesting to investigate how the patenting culture differs between companies and industries. This research was limited to consider patenting activity as building up a knowledge portfolio, but a better understanding of underlying factors to why some companies have a higher patent activity would increase the usefulness of the data presented in this paper. One such example would be to consider how many patents the investigated companies use compared to their total amount of filed patents.

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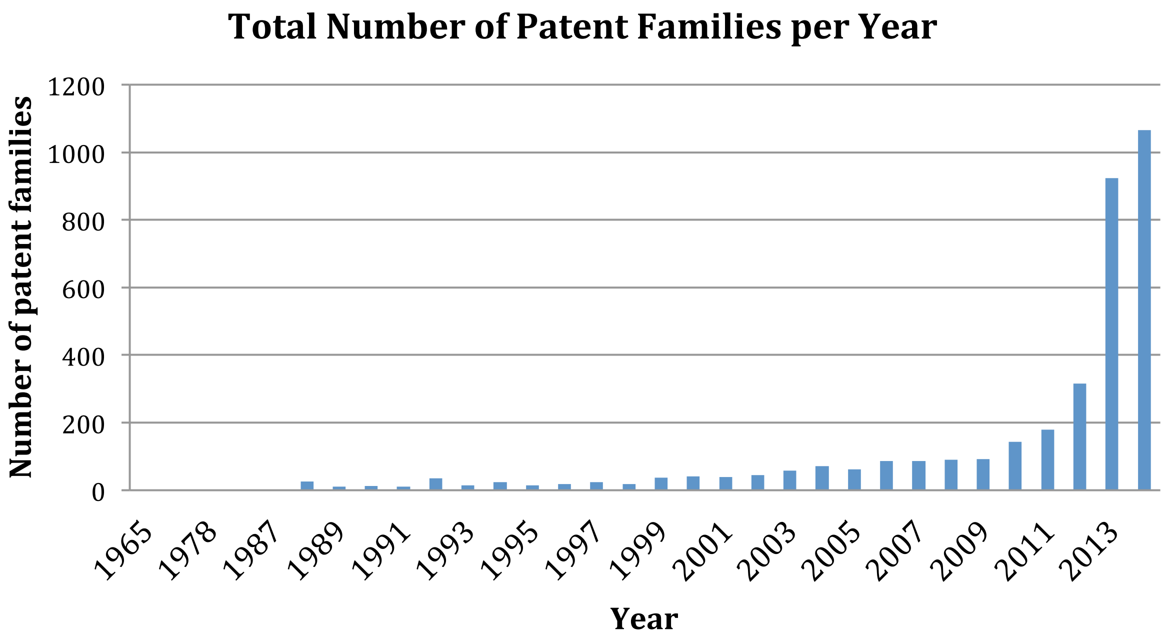
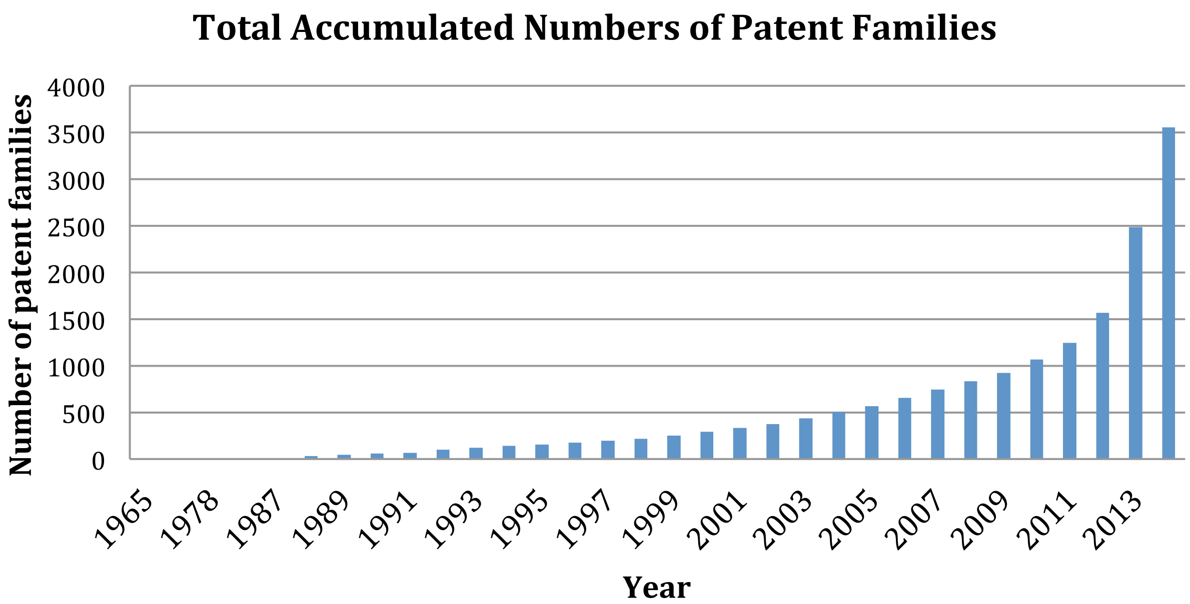
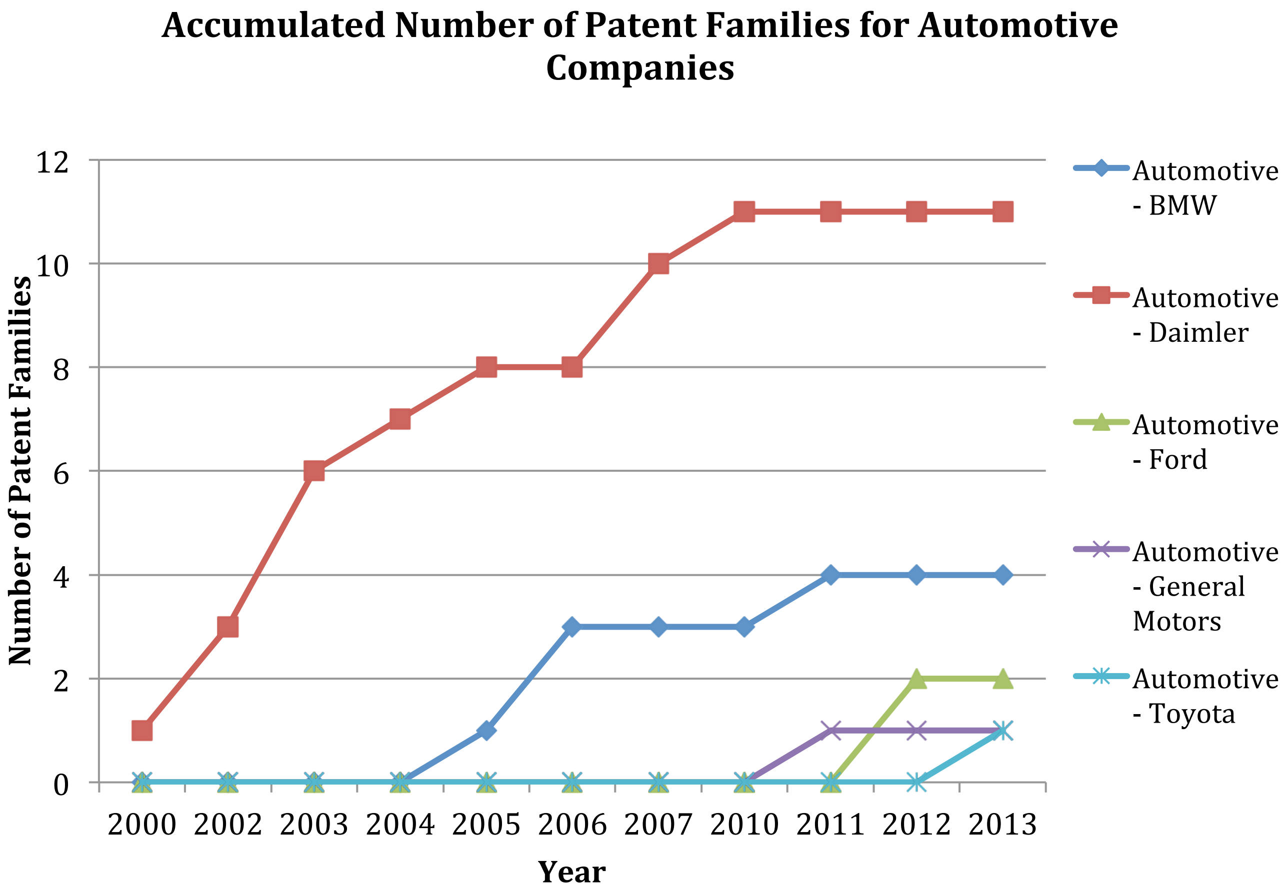
Appendix

Patent Insight Result - 3D printing







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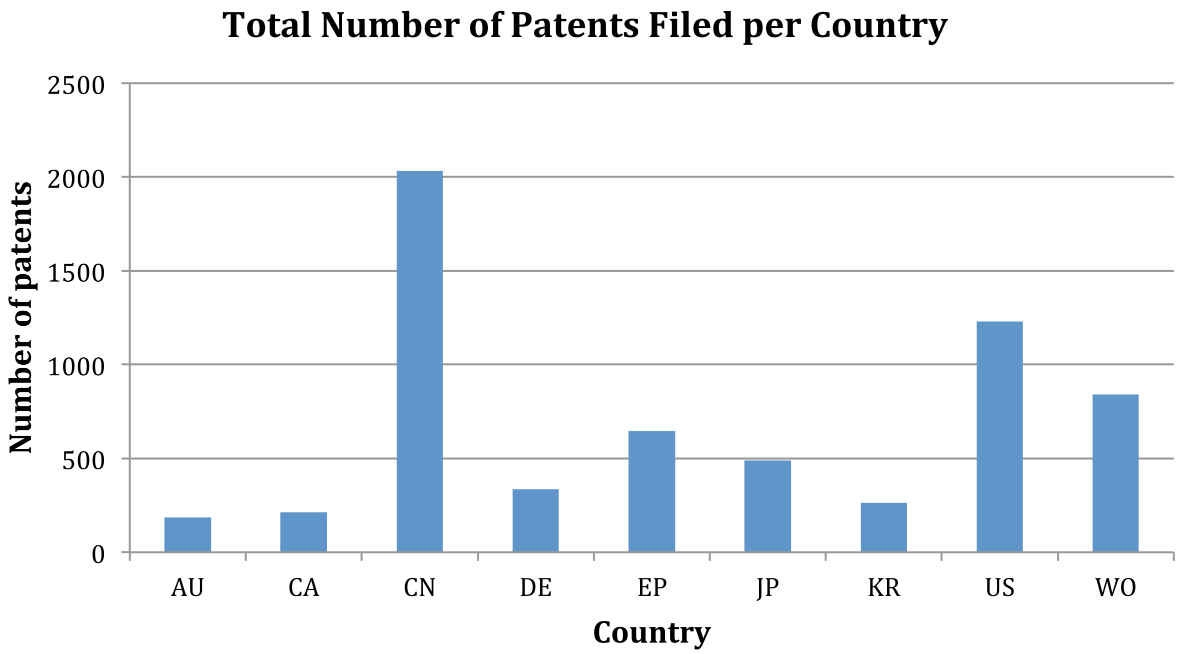
Number of assignees	202	346	499	569	1122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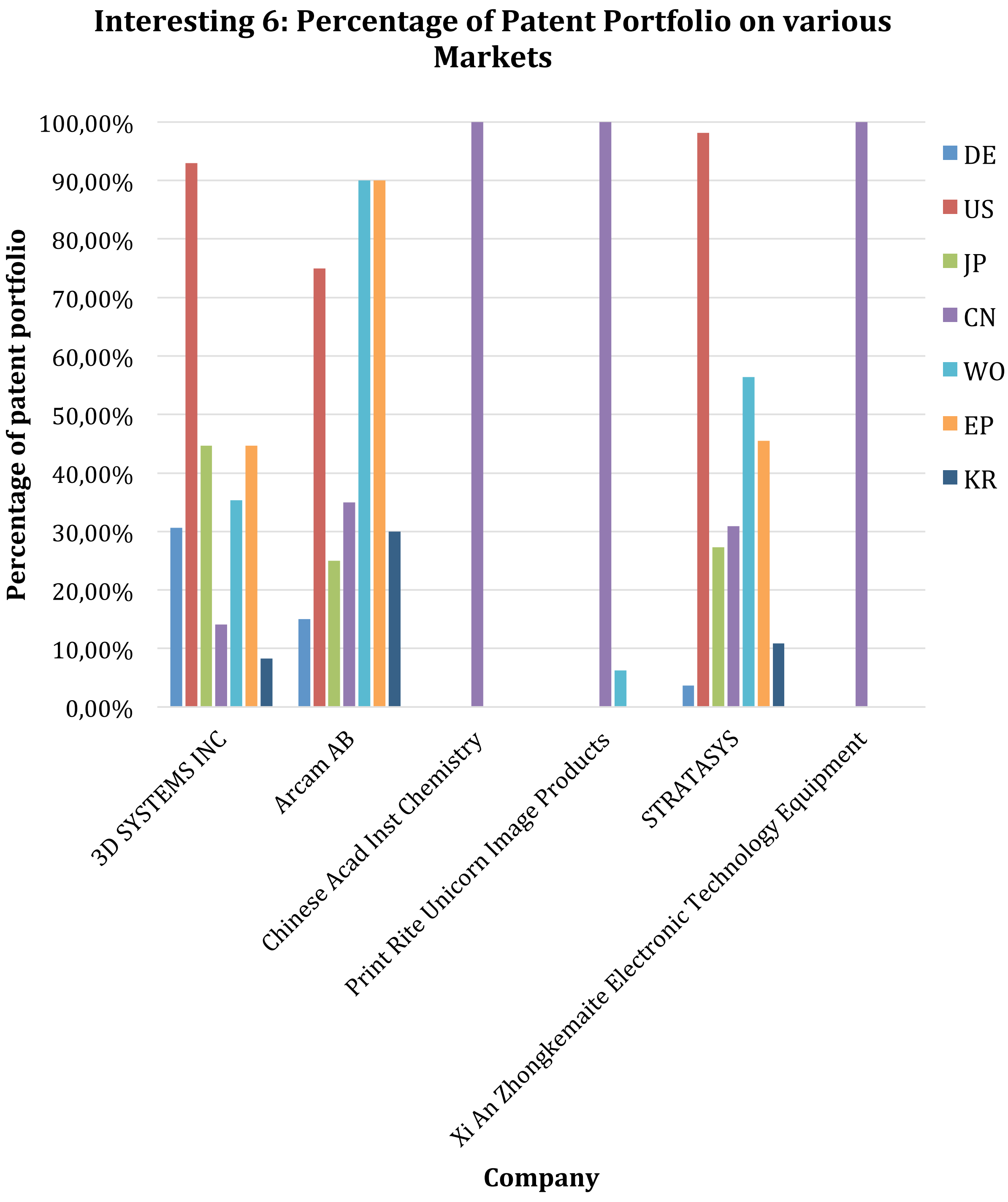
Interesting 6: Percentage of Patent Portfolio on various Markets
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70,00%
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US
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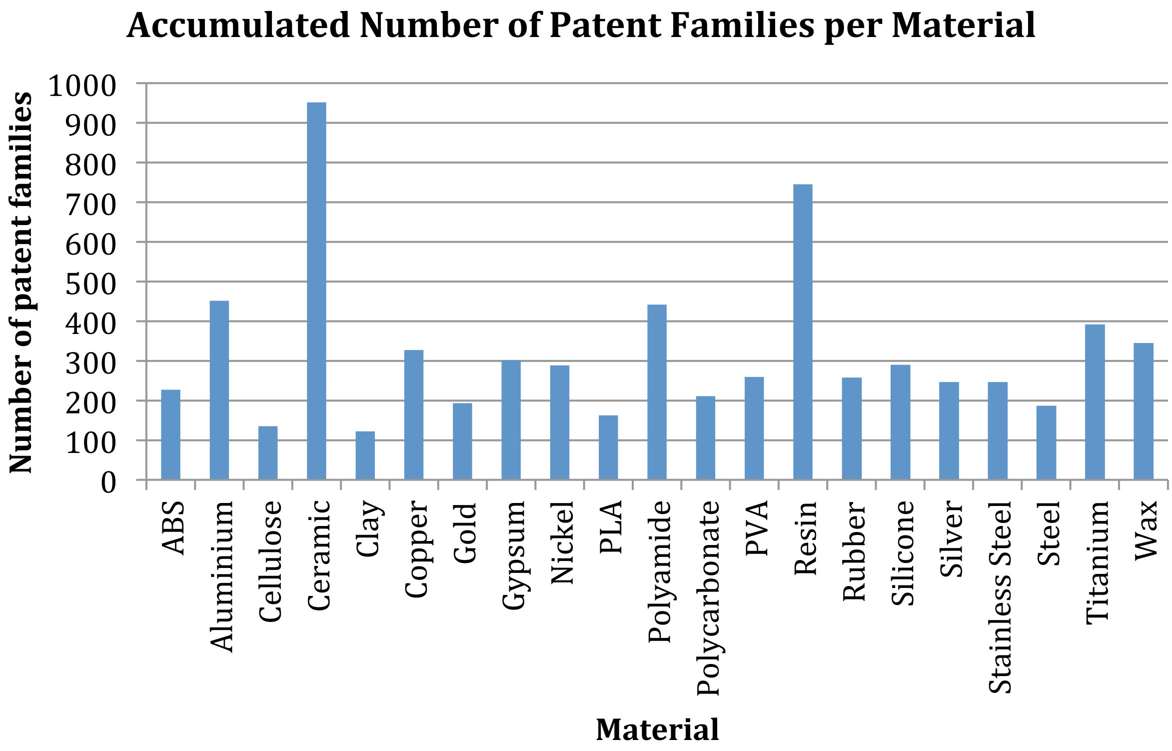
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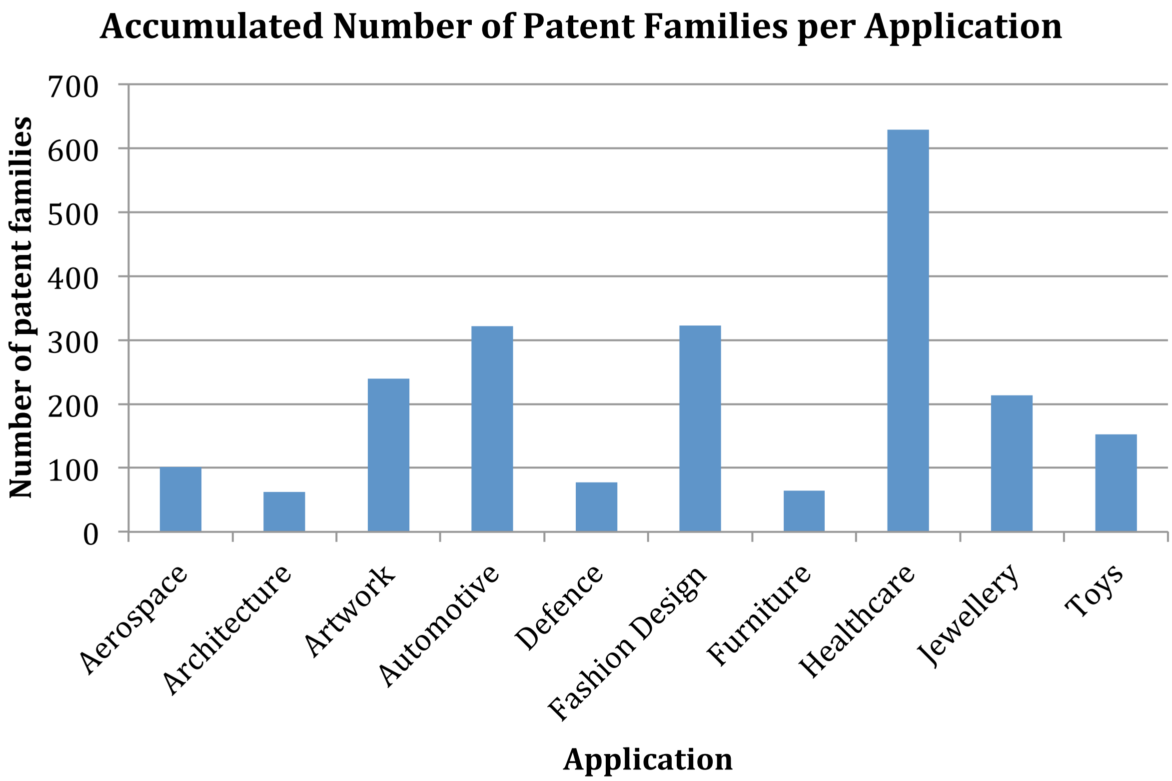
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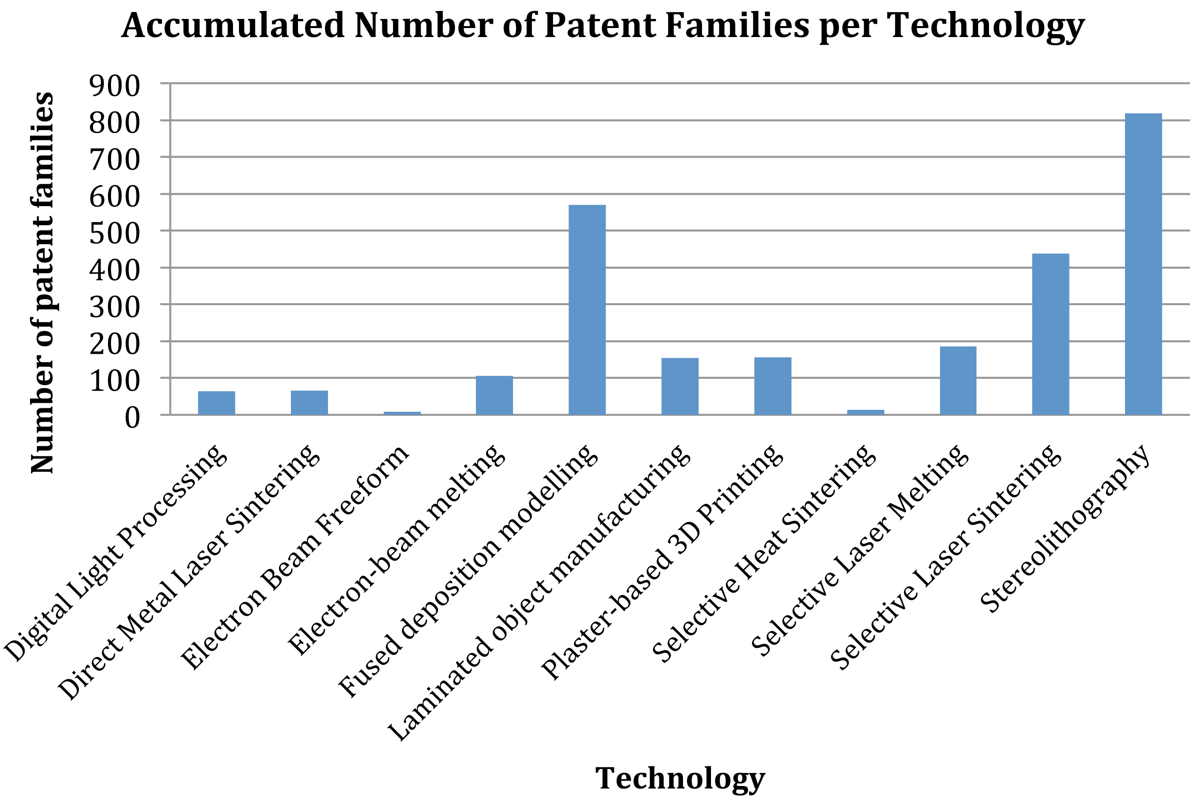
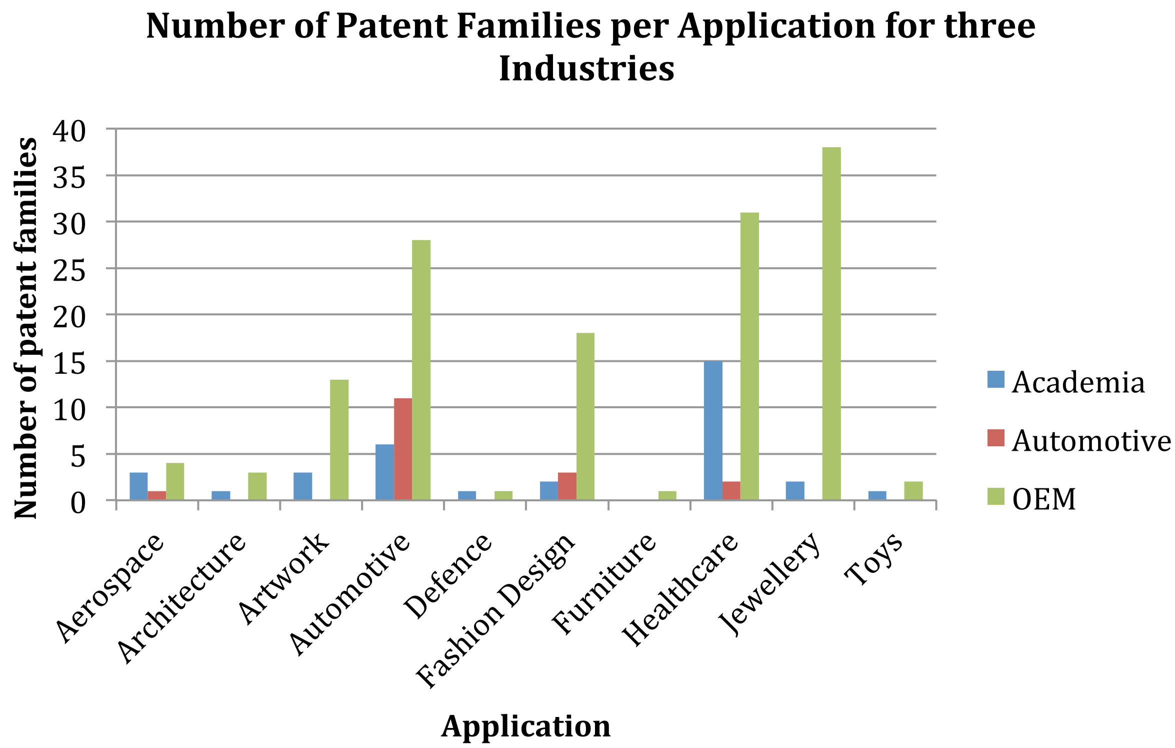
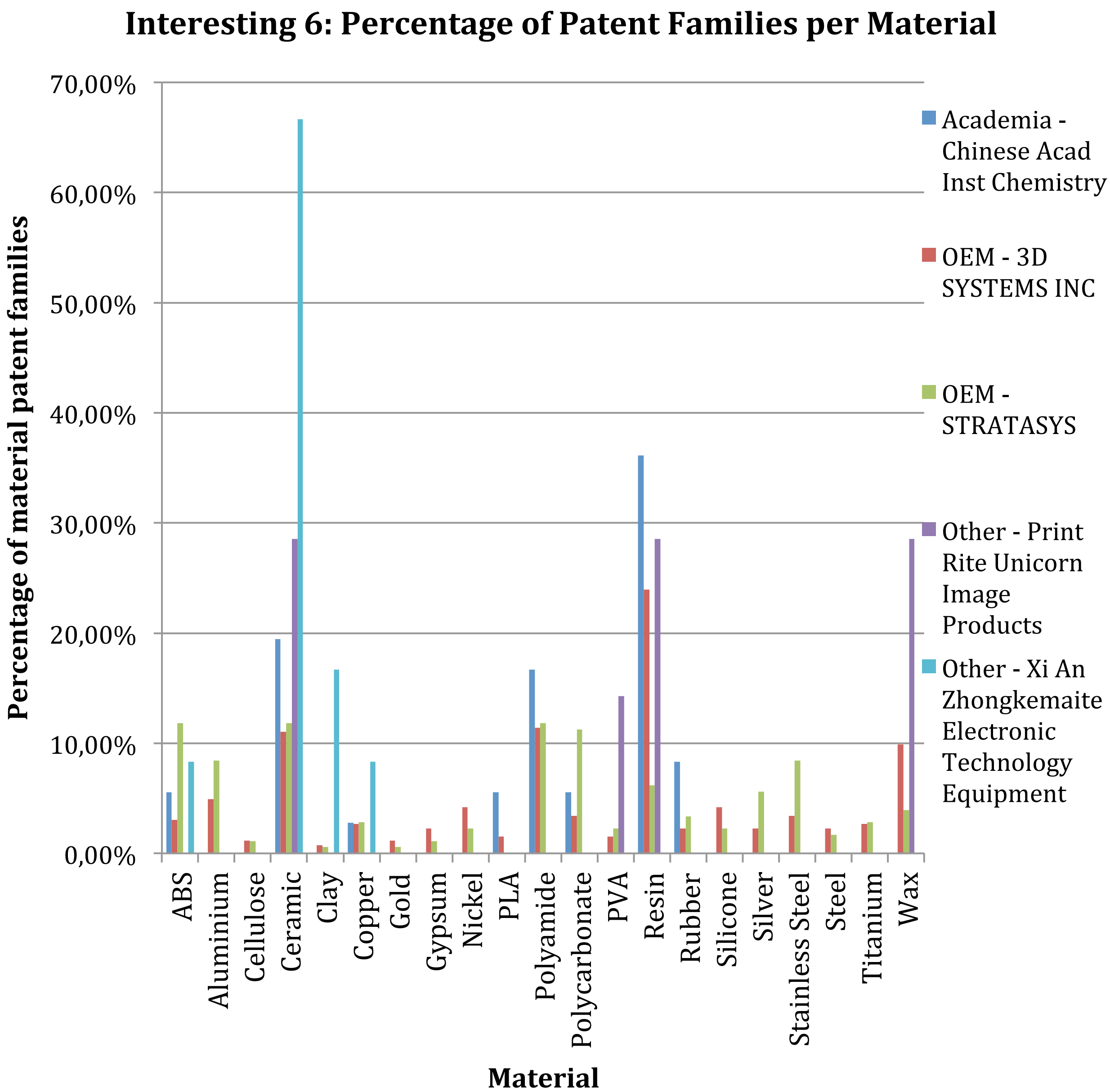
Aerospace
Architecture
Artwork
Automotive
Defence
Fashion Design
Furniture
Healthcare
Jewellery
Toys
Application


Accumulated Number of Patent Families per Technology
Number of patent families
900
800
700
600
500
400
300
200
100
0
Digital Light Processing
Direct Metal Laser Sintering
Electron Beam Freeform
Electron-beam melting
Fused deposition modelling
Laminated object manufacturing
Plaster-based 3D Printing
Selective Heat Sintering
Selective Laser Melting
Selective Laser Sintering
Stereolithography
Technology


Number of Patent Families per Application for three Industries
Number of patent families
40
35
30
25
20
15
10
5
0
Aerospace
Architecture
Artwork
Automotive
Defence
Fashion Design
Furniture
Healthcare
Jewellery
Toys
Application
Academia
Automotive
OEM



Interesting 6: Percentage of Patent Families per Material
Percentage of material patent families
70,00%
60,00%
50,00%
40,00%
30,00%
20,00%
10,00%
0,00%
ABS
Aluminium
Cellulose
Ceramic
Clay
Copper
Gold
Gypsum
Nickel
PLA
Polyamide
Polycarbonate
PVA
Resin
Rubber
Silicone
Silver
Stainless Steel
Steel
Titanium
Wax
Material
Academia - Chinese Acad Inst Chemistry
OEM - 3D SYSTEMS INC
OEM - STRATASYS
Other - Print Rite Unicorn Image Products
Other - Xi An Zhongkemaite Electronic Technology Equipment

TOP 5 Cited Patent Families					
Patent number	**Title**	**Prioritet date**	**Forward citations**	**Assignee**	**Typ Assi**
30541403	Apparatus for production of three-dimensional objects by stereolithography	19840808	992	3D SYSTEMS INC	OE
18788188	THREE-DIMENSIONAL PRINTING TECHNIQUES	19891208	827	MIT	Acad
33502740	Dosage forms exhibiting multi-phasic release kinetics and methods of manufacture thereof	19931018	626	THERICS INC/MIT	Collab r
29676630	SELECTIVE DEPOSITION MODELING METHOD AND APPARATUS FOR FORMING THREE-DIMENSIONAL OBJECTS AND SUPPORTS	19950927	418	3D SYSTEMS INC	OE
28195439	SYSTEM AND METHOD FOR RAPIDLY CUSTOMIZING A DESIGN AND REMOTELY MANUFACTURING BIOMEDICAL DEVICES USING A COMPUTER SYSTEM ;	20000405	362	THERICS INC	Ot

Top 5 Inventors		
Inventor	**Company**	**Number of Patent Families**
DONG JINYONG	Chinese Acad Inst Chemistry	53
LI CHUNCHENG	Chinese Acad Inst Chemistry	53
LIN XUECHUN	Chinese Acad Inst Chemistry	53
MA YONGMEI	Chinese Acad Inst Chemistry	53
SUN WENHUA	Chinese Acad Inst Chemistry	53

Top 5 Patents Filed in Most Countries

Patent Number	Title	Prioritet Date	Company	Type of Company	Number of filed countries
29676630	SELECTIVE DEPOSITION MODELING METHOD AND APPARATUS FOR FORMING THREE-DIMENSIONAL OBJECTS AND SUPPORTS ;	19950927	3D SYSTEMS INC	OEM	15
33007065	DIGITAL STEREO CAMERA/DIGITAL STEREO VIDEO CAMERA, 3-DIMENSIONAL DISPLAY, 3-DIMENSIONAL PROJECTOR, AND PRINTER AND STEREO VIEWER ;	20050310			22
33084307	USE OF POLYARYLENE ETHER KETONE POWDER IN A THREE-DIMENSIONAL POWDER-BASED MOLDLESS PRODUCTION PROCESS, AND MOLDINGS PRODUCED THEREFROM ;	20041221	EVONIK IND AG	Other	15
33253483	RAPID TOOLING SYSTEM AND METHODS FOR MANUFACTURING ABRASIVE ARTICLES ;	20050222			20
33253481	RAPID TOOLING SYSTEM AND METHODS FOR MANUFACTURING ABRASIVE ARTICLES ;	20050222			18