

Intellectual property strategy for small business

Semiconductor industry as case study

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Master's Thesis in European and International Trade Law

HARN63

Spring 2023



**SCHOOL OF
ECONOMICS AND
MANAGEMENT**

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Abstract

Intellectual properties are the valuable assets of each company, especially small to medium size enterprises are very dependent on intellectual properties to grow and compete. Usually, these companies have lots of Intellectual properties to protect, and it is important to protect them, and a well organised strategy is a great tool to manage this. This thesis studies IP strategy as a powerful tool for business development and reviews different sectors of Intellectual properties, including patent, Trademark, Copyright and Trade secret and explores different strategies that a company can make in order to reach its business goals. Semiconductor industry as a fast growing and high demand technology will be investigated and IP in its different sectors will be studied. As a case study, intellectual properties in AlixLabs AB, a Lund university spin-off start-up, active in research and development sector of semiconductor industry was studied. The finding of this thesis shows that a company with a well-developed intellectual property strategy will be most likely to survive the hard competition and succeed in its journey. Intellectual properties especially patent and trade secrets are very important for the companies active in the semiconductor industry, and it is very important for small companies active in this field to protect themselves against giant companies active in the field.

Acknowledgment

First, I would like to send my sincere gratitude to my Supervisor Peter Gottschalk for his supports during my work. In addition, I am very grateful to the management of AlixLabs AB specially Dr. Dmitry Suyatin and Dr. Amin Karimi for giving me the opportunity to investigate their IP strategy.

My classmates in law school, Wan, George, Dzhamilia, Raluca and Anna, thank you very much for making this study a joyful journey, I never forget your awesomeness. Shirin, Niloofar, Elena, Ken, Mohammad Reza, Sepideh, Omid, Ava and Maya, I was very lucky to get to know you. Being around you have always made me happy, thank you for great time you made for me. Also, I would like to take the opportunity and thank every one of my childhood friends especially Fatemeh M., Afsaneh and Fatemeh N. who always encouraged me to continue.

I would like to sincerely thank my lovely family, my dear parents, my sister, and my brother for supporting me in all aspects of my life. To Fatemeh, my lovely niece, this is for you, thank you for being the light of my life.

Finally, I would like to thank my lovely husband and dearest friend Reza. Thanks for always having faith in me and encouraging me to take initiatives. It was not possible to start and continue this journey without your unconditional support and love.

Abbreviations

IP	Intellectual properties
WIPO	World Intellectual Property Organization
EU	European Union
USPTO	United States Patent and Trademark Office
EPO	European Patent Office
EPC	European patent convention
PCT	Patent Cooperation Treaty
SMEs	Small to medium size enterprises
R&D	Research and Development
NDA	Non-Disclosure agreement
MTA	Material Transfer Agreement
Si	Silicon
Ge	Germanium
InP	Indium Phosphide
GaAs	Gallium Arsenide
IC	Integrated Circuits
EDA	Electronic Design Automation
IDMs	Integrated Device Manufacturers
Fabs	Fabrication labs
TSMC	Taiwan Semiconductor Manufacturing Company

UMC	United Microelectronic Corporation
SCPA	semiconductor chip protection act
IPIC	Intellectual Property in respect of Integrated Circuits
TRIPS	Trade-Related Aspects of Intellectual Property Rights
LNL	Lund Nano Lab
APS	Atomic Layer Pitch Splitting
CTO	Chief Technology Officer
CEO	Chief Executive Officer
IDF	Invention Disclosure Form
COO	Chief Operational Officer
USD	United States Dollar

1. Introduction

1.1 Background

For a lot of companies, intellectual property (IP) is an essential part of the business and the way they plan to form their IP portfolio is an important part of their business development. They need to set up an IP strategy regarding patent, copyright, trade secret and trademark so their business can start competing in the market. However, this IP strategy should be reviewed regularly to ensure that the strategy is aligned with market. The company might need to change the strategy to survive the business journey or even change the business direction. In addition, in this knowledge-based economy era, where technology is changing very fast, the classic system of monopoly is not effective, and companies are dealing with open innovation model in which they share IP with other companies which is also effective on companies' development.¹ But still IP has a significant importance in the development of companies, and it could not be neglected even in an open innovation model.

1.2 Purpose and research question

The purpose of this research is to study the IP strategy and its importance for businesses especially small to medium size enterprises (SMEs). For this semiconductor industry is chosen as a relevant section and a start-up active in this field was investigated as a case study. To satisfy the above-mentioned purpose, this thesis will answer the following questions:

1. What is IP strategy and who needs it?
2. What are important IP sectors for an SME involved in semiconductor industry?
3. How do a start-up company deal with IP?

¹ I. Tuomi I., "The Future of Semiconductor Intellectual Property Architectural Blocks in Europe", Joint Research Centre, (2009), DOI: 10.2791/13315. H. Chesbrough, Open Innovation: Where We've Been and Where We're Going, Research-Technology Management, (2012), 55:4, 20-27, DOI: 10.5437/08956308X5504085

1.3 Delimitations

Although IP management is a big segment by itself, the resources used in this thesis are more of online webpages. Semiconductor industry is a huge industry and since this thesis has a company involved in research & development (R&D) as case study, then the fabrication sector is chosen to be studied in more detail. During interviewing AlixLabs representatives, a checklist from world intellectual property organization (WIPO) was used.² However, the fact that the company was not willing to disclose all its IP strategy related information, limited the outcome of this research.

1.4 Materials and method

In academic topic case study is used as a method to increase in depth understanding of a program or a research field.³ A case study contains quantitative and qualitative information about the topics that being investigated. This is a very useful method to relate theory to the real world. This thesis is a qualitative case study in which the author investigated relevant resources to a specific industry and then interviewed a company active in the field. In this thesis, author conducted two interviews with managers of a start-up company active in field of semiconductor.

1.5 Structure

This thesis investigates the possible ways that IP strategy can affect the business development in a company active in semiconductor business. In second chapter it introduces IP strategy, the importance of IP strategy for business development and what is required for a successful IP strategy. In third chapter, the thesis continues by introducing semiconductor industry and strategies that companies in the field are following. Finally, as a case study, IP strategy of AlixLabs AB⁴ a start-up company, located in Lund, Sweden was investigated. The thesis explains how this SME deals with IP and how they use IP to protect the company's assets and develop the future as they grow to a bigger company.

² 'Intellectual Property Strategy' <<https://www.wipo.int/sme/en/checklist.html>> accessed 20 April 2023.

³ Sarah Crowe and others, 'The Case Study Approach' (2011) 11 BMC Medical Research Methodology 100.

⁴ 'AlixLabs' <<https://www.alixlabs.com/>> accessed 26 May 2023.

2. Intellectual property strategy

2.1 Introduction

This chapter will introduce the IP strategy and its importance for business development. It will review different IPs in different subsections and cover that how each IP sector could be dealt with during IP and business development. Different concepts like IP audit, landscaping and patent search will be introduced through this chapter and it will be investigated that how they can help company develop their strategy.

2.2 IP strategy and business development

Depending on which market they are in, businesses might have different core assets. An IP strategy will organize and prioritize the core assets of the company and manage the protection and infringement of the companies IP. Depending on what is the most important IP sectors in the company, a well-developed IP strategy helps the company to develop in accordance with their business plan. The IP strategy is not a one-time task, and it should be reviewed at different points, maybe annually or even several times during year. The IP strategy evolves as the company evolves and that means that it can change several times. The company might change its route, for example, change its focus from branding to innovation. This means that the most important asset of the company has changed from trademark to patent, and this needs a new strategy to protect and develop.

The intangible value of the companies has raised in recent years specially with the raise of knowledge-based and online businesses.⁵ The IP strategy is required to manage this intangible asset and it will be the best to start this from the very start of the company when the IP is not big so it will be easier to manage. It does not mean that this is not possible for huge and successful companies to start having IP strategy, it is just harder for them because they already have a big IP which is hard

⁵ Tamara Nanayakkara, 'An Introduction to the Intellectual Property System and to the Work of the World Intellectual Property Organization', pp 51.

to manage. The IP strategy is not only a useful tool to protect the companies' assets but also helps businesses to be stronger in a competitive market. In addition, investors are more likely to spend their money on a well-organized company so especially for start-ups and SMEs, a good IP strategy makes a company more favourable for investors.

In order to better secure their assets, it is very important that the company has an IP audit. An IP audit is when the company goes through its own IP and makes sure that the IP portfolio is complete and there is nothing around it that might put the company's IP at risk.⁶ While one might think it is a duty for the technical staff to do, IP audit is usually something done by team of IP experts that goes through IP and make sure that the IP is fully protected by law. This could be for example a company that wants to licence out its IP so they need to make sure that the core asset is fully secure so the licensee cannot put their IP at risk.

WIPO has a step-by-step IP strategy checklist for SMEs that a company can use during different stages of its growth, the checklist is divided into four different stages.⁷ The different stages are the Ideation process, product or service development, IP protection and IP commercialization. For each of these stages there are certain IP related question that an SME should answer in order to develop its strategy. The ideation stage is used to evaluate the market of the idea, knowing the competitors and evaluating the core IP and likelihood of IP protection. In the second stage a company is advised to conduct an IP audit and landscaping for product development. Third stage is where the SME is taking measures to protect its own IP, prioritise its IP based on its business plan and makes sure that competitors are not infringing its IP and they are not infringing a competitors IP. Last stage of the checklist is about the measures that the SME takes for commercializing its IP, the need to answer what the business plan is, for example if they have a product to sell or licence. If a licensing plan is in place, the SME need to check if the value of its IP for licencing is clear. This thesis uses the above-mentioned checklist to evaluate AlixLabs IP strategy. However, since companies might have different stages or

⁶ 'Intellectual Property Audits' <<https://www.wipo.int/sme/en/ip-audit.html>> accessed 26 May 2023.

⁷ 'Intellectual Property Strategy' (n 2).

might not want to answer a specific question for the public, then this thesis formulate answers explanatory texts to comply with their need.

2.3 Intellectual property

Intellectual properties are a company's intangible assets that needs to be protected so the owner can make profit out of them. The intangible assets could be a contract or agreement between two person or companies; however, the most well-known type of intangible assets are IPs. There are four different sectors in IP:⁸ Patent, Trademark, copyright and Trade secret which, this section briefly introduces these sectors and explained why they are important. Chapter continues with introducing IP strategy and its importance in business development.

2.3.1 Patent

Patent is the first concept that comes to mind as IP. Patent is the right that is given to a person or a company to protect their invention. This protection includes the right to use, sell or making of such invention. The patent is submitted through patent offices like the United States Patent and Trademark Office (USPTO) or European Patent Office (EPO) and if granted, they last for 20 years. According to article 52 of European patent convention (EPC),⁹ a patent should be granted to any invention that has an industrial application, is new and has an inventive step. There are exceptions to this provision including mathematical methods and laws of nature. One can refer to the guideline provided by EPO, USPTO or any other patent office in their territory of interest, to find out how these articles are applied to patent applications, the author leaves these here as they are behind the scope of this thesis.

Today's technology is very much about innovation and new technologies and these innovations need to be protected. Companies are relying on patents to protect their innovation. However, this is not as simple as it looks like that you come up with an innovative idea and you file it. There are several factors that one needs to consider before going for filing a patent. Companies need to make sure that all people

⁸ 'What Is Intellectual Property (IP)?' <<https://www.wipo.int/about-ip/en/index.html>> accessed 20 May 2023.

⁹ 'Article 52 – Patentable Inventions' <<https://new.epo.org/en/legal/epc/2020/a52.html>> accessed 20 May 2023.

involved in innovation, usually R&D team, are aware of steps and rules required for patent filing. In this section we review a few of them.

There are two types of patent strategy, offensive and defensive. In an offensive patent strategy company files patents to secure its technology and gain advantage against its competitor.¹⁰ This could be one patent or a small family of patents, but it builds up the core asset of the company. In a defensive strategy, the company forms a big patent portfolio to protect itself against any possibility of infringing a competitor's patent.¹¹ To form a big patent portfolio means a huge amount of money which is usually available to the big companies. Offensive strategy seems to be a suitable patent strategy for SMEs because first they do not have funding to form a big patent portfolio and form a defensive strategy. Second, they are small companies that need to come into the market, so they seek advantages over competitors which is the nature of offensive patent strategy.

If a business wants to expand domestic or globally then the company need to have a well-prepared IP strategy. For example, patent filing is not global, and one needs to file for each country or territory, so the company need to take care of filing in all regions that it needs protection in. In several regions, thanks to Patent Cooperation Treaty (PCT)¹² and with some exceptions, the patentee can file for more than one region or country at the time of filling. The cost for patent filing and translation to the language of extra region should be paid but the entire process will be easier, and the patent management will be more straight forward. The process of filling a patent could be very expensive (considering that one needs a patent attorney to facilitate the filing process) for small companies, patent filing is very much dependant on the available budget. Based on market size and importance of a country or territory (considering industry and competition) a company should pick up where to file the patent. These are all part of an IP strategy.

In order to file a patent, the idea should not be disclosed to the public before the filling date, this is what patent offices are referring as prior art. Companies usually

¹⁰ ipadmin, 'National Small Business Week: Protecting Your Intellectual Property' (*IP.com - Innovation and IP Solutions*, 6 May 2019) <<https://ip.com/blog/small-business-protect-intellectual-property/>> accessed 22 May 2023.

¹¹ Deepak Somaya, 'Patent Strategy and Management: An Integrative Review and Research Agenda' (2012) 38 *Journal of Management* p.1094.

¹² 'PCT FAQs' <<https://www.wipo.int/pct/en/faqs/faqs.html>> accessed 21 May 2023.

issue a press release to announce their new developments, but this could be a source of public disclosure. In addition, any work meeting or scientific conference that company might share part of its finding could be considered a public disclosure. As a result, if an idea has patent potential, it is very important for the business to have a strategy and make sure that the idea is protected. It could be that the idea is filed in patent office before the data is revealed to the public. It is also important to have confidential agreement with any party with whom a company shares data with so it can keep the patent filing possible under patent disclosure exceptions.

Patent landscaping is another part of IP strategy which is a very useful tool for business development. Patent landscape is a review on patents which investigate the business and technology development in a certain industry, for example semiconductor industry. A company that is aware of its competitor's development is usually in a better position to keep pace with technology development. During patent landscaping, patent related to other regional and international companies is investigated. First, this helps the company to understand what the current status of the technology is and what it can take from the stake. Second, this helps the company to make sure if the competitors are infringing their IP or they are infringing any competitors IP. This is very important that one prevent the damage rather than trying to fix it in the court.

In relation to the landscaping, there is a term called competing arts or patent market search, which are works that are not like yours but do the similar work. EPO suggests that parallel to their prior art search, companies perform a competing art search because:

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- Most inventions are a solution to a problem, and most problems have more than one possible solution. You need to examine other solutions, as some may offer more advantages than yours.
- If you try to exploit your idea commercially, alternative solutions may be strong competition. In order to argue successfully that your solution is better than alternatives, you need to know what the alternatives are!

By patent search one can figure out if the idea is novel and if it worth the effort to file. In a global patent search, company can figure out if there is anything close to its idea and plan to file its patent in a way that it differentiates from the other works.

It is very common that companies want to increase their patent portfolio to protect their business and compete with others. On the other hand, SMEs are usually limited in budget while patent filing is very expensive process so they might not want to patent all ideas. This is when a good IP strategy can pinpoint the important aspect of technology and help companies choose the idea that helps them to better reach their goal to be patented.

In addition, not all ideas are ready to go for patenting and usually a patent idea needs more research to make sure that it is ready for filing. In this case a provisional patent¹⁴ could be filed to protect it until the idea is well developed to be patented. A provisional patent is an inexpensive type of quick patent filing in which an idea is filed with minimum care so it could be protected against competitors. A provisional patent gives companies a one-year window until they make sure if they are ready for filing or if they want to withdraw the idea. In contrast to provisional patent is non-provisional patent in which the filing is final, and the patent office will either reject or grant it a patent. This is a very strong strategy to make sure that the idea is well prepared to pass the patent examination while it is protected from public disclosure. Furthermore, this is a great strategy for SMEs to manage the budget, if the idea does not worth patenting, then the company does not need to spend huge amount of money for non-provisional filing.

2.3.2 Trademark

Second concept that is protected by IP right is trademark. Trademark is a sign, logo, name, web address or other type of work that distinguish one brand or product from others.¹⁵ Trademark is the sign and reputation of one brand, and it protect the origin of a product. Examples of trademark could be logo, name and products of Coca

¹³ European Patent Office, 'What Is Prior Art?' <<https://www.epo.org/learning/materials/inventors-handbook/novelty/prior-art.html>> accessed 22 May 2023.

¹⁴ 'Provisional Application for Patent' <<https://www.uspto.gov/patents/basics/apply/provisional-application>> accessed 15 May 2023.

¹⁵ 'Trademarks' <<https://www.wipo.int/trademarks/en/index.html>> accessed 23 May 2023.

Cola, Apple and Nike. As can be seen a trademark guarantees the origin of a product and it could be a huge benefit for the company to protect their trademark and make sure there is no infringement of their trademark right by other companies. In that regards it is very important that companies have a strategy to help them achieve their goals through their business development.

To be protected, a trademark application should be registered in the trademark office. Trademark is territorial and the right is given for the country or region that the application is registered for. It is very likely that the product of the business is an international good, so the company needs to register them in all countries they see a market for their product. If companies want to protect their trademark in more than one country, then it is advised to be done through the WIPO international trademark system, the so-called Madrid protocol. By registering a trademark through the Madrid protocol, the trademark will be protected in up to 130 countries around the globe, representing eighty percent of the world trade.¹⁶ In contrast to PCT, there is no need to pay registration fee and translation cost for each country, registration through Madrid protocol is a one-time payment for all countries covered. This is a very effective system to keep track of trademarks registered in many countries. For sure if the business has potential in any country that is not covered with this service, then a separate application should be registered through the related trademark office.

Companies might have a trademark or slogan for each of their product and they might want to protect them all. This could be a very costly process for SMEs to file each of them so a good strategy would be to find out which product is important for business and file for that. It could also be that one can pick up registration based on country or region in which they think the product has more chance to success and consequently more chance of trademark infringement. In addition, a product could be trademark registered at any time so one can wait until the product market is evaluated and then register for the trademark, although, it could be a risky strategy.

The trademark strategy could be based on company's development and whether the business can see any other product or family of product to be presented in the future,

¹⁶ 'WIPO Lex' <<https://www.wipo.int/wipolex/en/text/283484>> accessed 24 May 2023; 'Members of the Madrid Union' <<https://www.wipo.int/madrid/en/members/index.html>> accessed 24 May 2023.

then it is very much worth it to register in advance. The trademark registration requires companies to identify the service that they target, and they cannot change it later; any change will require a new application and it is very much possible that someone else already registered an application for that service. In addition, it could be expensive for SMEs but a trademark search prior to launch a product is a very inexpensive considering that it can prevent rebranding and more importantly prevent any IP infringement which could be very damaging.

2.3.3 Copyright

Copyright is a type of IP that gives a right to owner for a specific time to sell or reproduce their work. Copyright starts exactly from the time that the work is created and get a tangible existence.¹⁷ For example, copyright applies to an e-book from the time it is disclosed to public. Some of the common copyrights works for example are, poem, story, novels, computer code, music, movies and designs. In recent years and by increase of computer-based companies, database copyright has got attention as new type of work. The copyright has a lifetime of as long as the creator of the work is alive and seventy years after that.¹⁸ Unlike other IPs, copyright does not necessarily require registration at any administrations but if a copyright is registered it can be easier to make a lawsuit for IP infringement.

The copyright holder has the right to use, translate, reproduce, adopt publish its work. It should be noted that the copyright holder is the author or creator of the product not the company. For example, in a company with software as product the one who writes the code have the copyright and if he or she leaves the company, then that IP leaves the company as well. Therefore, the first thing to consider is that the company should have an agreement with employee that assign all the copyrights to in employer and the employee waives all moral rights to the company.

2.3.4 Trade secret

Trade secrets or know-how is a company's confidential information that is valuable for the survival of company's technology, and it is not obvious to people. As the name indicates, it is a secret and a few people or at least one group inside the

¹⁷ 'What Is Copyright? | U.S. Copyright Office' <<https://www.copyright.gov/what-is-copyright/>> accessed 24 May 2023.

¹⁸ *ibid.*

company know about this. Companies usually keep it for themselves and never reveal it to the outsiders without taking protection measures. An example of a trade secret would be the knowledge on how to make a certain type of chemical. The ingredient of the chemical is what is usually easy for the competitors to figure out but how to mix the ingredient (recipe) to make the final product is the company's trade secret. That is the reason to file the chemistry of the product as a patent but not the knowledge on how to make it.

Having a proper action to protect their trade secret from breaching out is companies' responsibility. According to Trade secret directive (directive 2016/943/EU) the business owner should take steps to make sure that the trade secret is kept secret.¹⁹ Companies are advised to take measures like limiting access to the trade secrets and making sure that the related data is safe from digital access by any outsiders like hackers. The data could be breached by an employee who leaves the company or unconsciously talks to outsiders, or it could be shared during a meeting with someone who is not supposed to know this. Trade secret like all other IP rights should be protected from other people, but the way to protect it is different from other IP rights. As mentioned before the trade secret will never be submitted to any offices but the company can set up provision in their employees' contract to safeguard their product from breaching after an employee leaves the company. They need to occasionally bring up the importance of keeping the confidential information secret from outsiders. In addition, any employee who joins the company should be advised on not only keeping the trade secret of new business but also not to share anything from the previous employer as it might put the business at the risk of IP infringement.

A Non-Disclosure agreement (NDA)²⁰ is a type of contract that a company can sign with people outside their company to protect their confidential information like trade secrets. In an NDA, one or both parties agree that anything discussed during the meeting or shared is confidential and the other party has no right to disclose or

¹⁹ 'DIRECTIVE (EU) 2016/ 943 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL - of 8 June 2016 - on the Protection of Undisclosed Know-How and Business Information (Trade Secrets) against Their Unlawful Acquisition, Use and Disclosure'.

²⁰ '4 Things You Should Know about Non-Disclosure Agreements' (11 March 2022) <<https://legal.thomsonreuters.com/en/insights/articles/4-things-to-know-about-non-disclosure-agreements>> accessed 24 May 2023.

use it without the permission from the owner. An NDA is a legal document that can be used in lawsuits to make sure that the trade secret was protected. In case of idea disclosure, an NDA can be used as evidence to convince patent offices that the disclosure was a consequence of an abuse. This shows that how important it is to have an NDA available and make sure it is signed before any confidential information is shared.

Material Transfer Agreement (MTA)²¹ is another type of legal document that companies can use to protect their sensitive IP. Companies usually send samples out to third parties for extra measurement or treatments, as a contractual agreement, MTAs declare the ownership of those samples. The MTA also set up terms about who and how can use the results of that research. This way the company can claim the ownership of the samples, ownership of any IP from the results and make sure that the third party do not breach their data.

2.4 IP licensing

The IP licensing strategy is studied as a separate segment because it is a very common approach for companies to make direct incomes from their IP and it is applicable to several IP sectors. In addition, IP licencing is the business model for company that is the subject of case study in this thesis. IP licencing is an agreement or contract in which, the IP holder company (licensor) license the use of its IP to a user or another organization (licensee). The licensee will pay a fixed fee at the beginning or recurring fee at certain time spans. A very common type of payment is royalty in which the licensee pays a certain amount of its revenue (from the licensed IP) to the licensor for each time they use or sell the product.

IP strategy shows itself at very first steps of the licensing process. A key element for the licensing strategy is that the licensor should make sure that its IP is protected in the country or region of the licensee otherwise it cannot license its IP out and a well-planned IP strategy can make sure of it way before it happens. A well-managed IP can make sure that in case of dispute the licensor can benefit from its IP protection measures. Since the licensor might have several IP belongings to an IP family, then the agreement should indicate which IP is fine to be used, this is very

²¹ 'What Is a Material Transfer Agreement?' (13 May 2022) <<https://www.osp.pitt.edu/news/what-material-transfer-agreement>> accessed 24 May 2023.

important as it could become the source of extra income or infringement of license. A successful licencing strategy needs a team of legal experts with supervision of the top people in the company's managerial hierarchy. As it is clear this could be a very expensive procedure for the SMEs but in the end a well-established license agreement will pay off by reducing the risk of losing IP and by bringing revenue to the company.

2.5 Summary

This chapter reviewed the IP strategy for different IP sectors. There are several legal and technical consideration regarding the IP protection and infringement, and it could easily turn into a large pile of documents that is hard to control. This is very much an indication on importance of IP strategy to manage the company's intangible assets before it gets out of control.

3. Semiconductor industry

3.1 Introduction

Semiconductors are materials that can behave as both electricity conductor or insulator. Silicon (Si) and Germanium (Ge) or compound materials like Indium phosphide (InP) and Gallium Arsenide (GaAs) are examples of semiconductor materials.²² Semiconductor industry started to evolve from 1947 when the first Transistor was invented at the Bell Laboratory in the USA, the patent was granted by 1951.²³ This was the beginning of a new era in electronic devices and over time brought up different sectors which will be briefly reviewed in this section. Smart phones performance could not be improved if the size of electronic parts is not reduced, or the design of the chip is not improved. To have today's performance, in the absence of size reduction in semiconductor components, the size of a mobile phone would be very huge that it might not be a mobile device anymore. In addition, the energy consumption and heat generation from such a device makes it almost impossible to exist as its current form.

While the initial transistor was as large as a light bulb, its size has reduced over the years and right now billions of transistors can be fitted on a chip or integrated circuit (IC) as large as a fingertip.²⁴ There are limits to the size reduction so for the technology to improve and follow its roadmap the transistor design has changed over the years. This important development required another technology development called chip layout. The chip layout is a map of how billions of different semiconductor devices are placed on a chip so that it can function as desired. For a while, this was considered the important sector in the semiconductor

²² dcaadmin, 'What Is a Semiconductor?' (*Semiconductor Industry Association*, 22 January 2018) <<https://www.semiconductors.org/semiconductors-101/what-is-a-semiconductor/>> accessed 24 May 2023.

²³ 'Bell System Memorial- Bell Labs History of The (the "Crystal Triode")' <https://www.bellsystemmemorial.com/belllabs_transistor.html> accessed 24 May 2023.

²⁴ 'Apple Unveils M2 Pro and M2 Max: Next-Generation Chips for next-Level Workflows' (*Apple Newsroom*) <<https://www.apple.com/newsroom/2023/01/apple-unveils-m2-pro-and-m2-max-next-generation-chips-for-next-level-workflows/>> accessed 24 May 2023.

industry but over the years with developing the design of the transistors and other semiconductor devices the fabrication process became a big part of the industry.

The fabrication sector consists of different players including, equipment manufacturer, fabrication process development and fabrication foundries where they use the equipment and fabrication processes to fabricate chips in micro and nano scale. This sector is around development of lithography, the process of transferring a desired pattern into the semiconductor substrate. In today's technology this requires complicated equipment that is capable of patterning nanometre scale features. There are several companies that provide equipment that can do this, for example some provide complicated optical equipment to generate the pattern, and some provide advanced etching equipment that can remove material in such a regime with an atomic level control. However, without a well-developed fabrication process it is not possible to fabricate semiconductor devices, so a lot of companies are developing such a fabrication process flow and provide fabrication capabilities. In addition to these businesses there are companies that provide chemicals, like lithographical polymers, such as photoresists and electron-beam resists, acids and bases required for this technology.

The semiconductor industry has huge effects on sustainability, for example, semiconductor materials are very important in fabrication of solar cells as one of the renewable energies.²⁵ In addition, increasing carbon footprint is a concern of semiconductor industry and companies are putting effort on developing fabrication methods or device designs to reduce the carbon footprint.²⁶

3.2 Semiconductor ecosystem

Semiconductor industry is a big business with a revenue of several hundreds of billions of USD.²⁷ There are hundreds of companies active in different sectors of the industry. This is a very expensive business to run so not all companies have the resources to cover the entire industry, this is the reason that the businesses active in

²⁵ 'How Are Solar Panels Made Anyway?' (*The Climate Reality Project*, 9 October 2019) <<https://www.climateproject.org/blog/how-are-solar-panels-made-anyway?utm...>> accessed 24 May 2023.

²⁶ 'AlixLabs' (n 5); 'New Generation Memory Chips Promise to Cut Energy Use' <https://www.wipo.int/wipo_magazine/en/2022/02/article_0006.html> accessed 24 May 2023.

²⁷ 'Steve Blank The Semiconductor Ecosystem – Explained' (*Steve Blank*, 25 January 2022) <<https://steveblank.com/2022/01/25/the-semiconductor-ecosystem/>> accessed 24 May 2023.

different sectors are in close collaboration to make the required chips. Chips made by semiconductor companies are sold to government or private companies so they can make devices like phones and sell to the customers.²⁸

First one in the hierarchy of different sectors in the industry are Chip IP Core companies, these are active in chip layout design and out license their products. For example, companies like Apple license their chip from companies like ARM.²⁹ The Electronic Design Automation (EDA) tools are second sector where the companies are using simulation software and hardware to evaluate the chip design and find out any problem before the design goes for production.³⁰ Third sector in the industry are companies in material and chemical production sector which are responsible to provide wafers, gases and chemicals that are used during chip fabrication process.³¹ Equipment manufacturers like ASML, Applied material and Lam research are the forth sector, they are providing equipment such as lithography, etch and deposition. These equipment are crucial for manufacturing sophisticated structures for chip production.³² Fifth sector include Fabless companies like Apple, NVIDIA and Amazon, they are companies that were previously using available chips but now they do have their own design, and sending it to the Foundries for fabrication, they are sort of a mix of IP Core and EDA.³³ Integrated Device Manufacturers (IDMs) are companies that design their chip and in addition, have their own fabrication labs (Fabs) and manufacture their own chips.³⁴ The last type of company in the industry are Foundries, they have Fabs and are just involved with chip manufacturing. Taiwan Semiconductor Manufacturing Company (TSMC), Samsung and United Microelectronic Corporation (UMC) are the leaders.³⁵

²⁸ Ibid. P.2

²⁹ Ibid. p.3

³⁰ Ibid.P.3

³¹ Ibid p.4

³² Ibid p.5

³³ Ibid p.5

³⁴ Ibid p.6

³⁵ Ibid p.7

3.3 IP in semiconductor industry

3.3.1 History of semiconductor chip protection

The semiconductor chip protection act (SCPA) set out in 1984, was the first attempt that the governments made in order to protect the semiconductor industry.³⁶ The act was protecting the mask-work and had a reciprocity rule; any country wants its chip production protected in the US should apply the SCPA1984. This act raised the awareness in EU and in 1986 they set the directive on the legal protection of semiconductor products (87/54/EEC).³⁷ In contrary to the SCPA1984, this directive was protecting the topology or the layout of the chip. The advantage of this directive over the SCPA 1984 was that the topography has both mask and layout included.

First attempt for a universal protection was in 1989 by WIPO but the proposed directive, Intellectual property in respect of integrated circuits (IPIC) was rejected by the USA and Japan.³⁸ It took until 1994 that the chip protection was covered under article 35-38 of the agreement of trade-related aspects of intellectual property rights (TRIPS).³⁹

According to WIPO reports, number of published patents in semiconductor technology was 3.1 percent of total published patents indicating a 2.4 percent increase as compared to 2010.⁴⁰ The value of semiconductor IP market in 2032 is estimated to raise to 11 billion USD making it an attractive market.⁴¹

3.3.2 Semiconductor industry and IP strategy

There are several companies in the semiconductor industry but as mentioned before the industry has several sectors so not all these companies are competitors but sometime, they are complimenting each other. For examples those involved in

³⁶ Title III of Public Law 98-620 of November 8, 1984, now 17. USC Section 901 et seq.; Industrial Property Laws and Treaties, United States of America – Text 1- 001

³⁷ Council Directive 87/54/EEC of 16 December 1986 on the legal protection of topographies of semiconductor products, Accessed 6 May 2023.

³⁸ Washington Treaty on Intellectual Property in Respect of Integrated Circuits, <https://www.wipo.int/treaties/en/ip/washington/>, 5 May 2023.

³⁹ ‘WTO | Intellectual Property (TRIPS) - Agreement Text - Standards’ <https://www.wto.org/english/docs_e/legal_e/27-trips_04c_e.htm> accessed 6 May 2023.

⁴⁰ Daren Tang, ‘World Intellectual Property Indicators 2022’, p.34.

⁴¹ Market.US, ‘Semiconductor IP Market Predicted to Garner USD 11 Billion by 2032 | Market.US’ (*GlobeNewswire News Room*, 16 March 2023) <<https://www.globenewswire.com/news-release/2023/03/16/2629155/0/en/Semiconductor-IP-Market-Predicted-to-Garner-USD-11-Billion-by-2032-Market-US.html>> accessed 25 May 2023.

design are very much dependant on the manufacturing companies. The industry is very much moving towards an open innovation model.⁴² This means that IP is a very important part of the industry, and all sectors need to protect their asset from others. Patent and trade secrets are key IP for semiconductor industry. As the main part of manufacturing plants are placed in China then IP is very important so the design can stay secure when sending to the fabs. However, for the sake of national security, countries are not sure if they can trust the Chinese fabs and have plans to keep the manufacturing inside the trusted territories. In addition, in recent years there was a huge chip shortage which was due to limited resources and these all together led to what is called chip acts.

Although, a huge number of patents was submitted in the US, most of them were coming from outside country.⁴³ Since 1990, the contribution of the US in semiconductor market has dropped to 12% of the entire market.⁴⁴ In 2022, the US government put a 280 billion USD budget (over 10 years) on chip act that supposed to encourage the manufacturer to build labs around the US in order to supply the US demand in addition to prevent the IP to be shared with the Chinese manufacturing labs.⁴⁵ In the same type of action, the EU have put a 48 billion Euro budget to increase the fabrication capacity inside its borders and support the demand among EU countries. The EU chip act supports the collaboration among the companies and states active in the field.⁴⁶ Although these acts are highly supporting building infrastructures, the support that they provide to the IP is not significant while both these acts encourage the collaboration between different players in the field, from small to big companies which is a sign for huge IP protection.

⁴² Institute for Prospective Technological Studies (Joint Research Centre), Marc Bogdanowicz and Ikka Tuomi, *The Future of Semiconductor Intellectual Property Architectural Blocks in Europe* (Publications Office of the European Union 2009) <<https://data.europa.eu/doi/10.2791/13315>> accessed 23 May 2023.

⁴³ The CHIPS Act and Its Impact on Intellectual Property, <https://www.anaqua.com/resource/the-chips-act-and-its-impact-on-intellectual-property/>, accessed 23 May 2023.

⁴⁴ Pass the chip act of 2022, The semiconductor industry association, <https://www.semiconductors.org/wp-content/uploads/2022/07/Pass-the-CHIPS-Act-of-2022-Fact-Sheet.pdf>, accessed 23 May 2023

⁴⁵ ‘The CHIPS and Science Act: What Is It and What Is in It? | McKinsey’ <<https://www.mckinsey.com/industries/public-and-social-sector/our-insights/the-chips-and-science-act-heres-whats-in-it>> accessed 25 May 2023.

⁴⁶ ‘The European Chips Act’ <<https://www.european-chips-act.com/>> accessed 25 May 2023.

As mentioned, these types of acts are supporting the open innovation model which indicates that in order to benefit from this opportunity securing IP is very important. When negotiating to join, companies need to make sure that their patent and trade secret is secure. In addition, it is important that companies negotiate IP ownership, it should be clear that based on what IP they bring in, who will own the generated IP. For the EU countries the patent filing is going to face a shift from country based to EU filing strategy. Germany as the biggest industry in EU owns a big part of patent filing but with this EU act the companies are going to be forced to protect their asset in entire EU.⁴⁷ Furthermore, the EU act has a force major provision so in force major cases companies must reveal their IP to help important sectors like healthcare. Then companies should evaluate if they are willing to risk giving up their valuable IP to join the chip act or not.

3.4 AlixLabs AB; a case study

3.4.1 Introduction

AlixLabs AB is a R&D-based start-up company founded by Jonas Sundqvist, Stefan Svedberg, Dmitry Suyatin and Sabbir A. Khan in 2019 located in the city of Lund in Sweden. In 2016 and during a master thesis project at Lund University, the team observed a new phenomenon which later becomes the core technology for AlixLabs. They observed interesting phenomena for reducing dimensions of nanostructures without using expensive and complex equipment which has the potential to make a paradigm shift in the semiconductor industry. They filed a patent and after a few years and with the help of Lund Innovation, Ideon Science Park, and Ideon Incubator, a start-up was established. The company hired its first employee in 2020, and as of May 2023, they are six full-time employees who are working on the company's core technology. In addition, about ten part-time employees are taking care of financing, IT, and other administrative affairs. Furthermore, the company has a board of directors consisting of experienced individuals with extensive career backgrounds at leading companies in the semiconductor industry, IP and business development experts, as well as

⁴⁷ Igloo, 'Changes in the Semiconductor Industry: How Patent Strategies Need to Adapt, EIP | Patent Attorneys and Litigators' (EIP, 21 October 2022) <https://eip.com/uk/insights/article/changes_in_semiconductor_industry_how_patent_strategies_need_to_adapt/> accessed 26 May 2023.

representatives from the investors. In the beginning, AlixLabs used the Lund Nano Lab (LNL), a cleanroom owned by Lund University located at the Department of Physics for their R&D projects. Later on, they extended their activities to another cleanroom and now they are building up their own cleanroom at the Rise Pronano facility where their headquarter is located. AlixLabs is an early stage start-up with a disruptive technology for the fabrication of electronic chips in a cost-efficient and sustainable way. Their product is under transformation from a laboratory environment to an industrial-friendly environment for high-volume manufacturing and currently, the company covers its expenses via fundraising, grant applications, and some joint collaborations with other companies. The company's expenses can be divided into three main areas; I) Employees' salaries, II) Costs of R&D projects, and III) Safeguarding IP through filing patents and trademark and making sure that the trade secret is secure.

3.4.2 Alixlab's technology

AlixLabs is active in R&D sector of semiconductor technology. The company developed a technology called Atomic Layer Pitch Splitting (APS) that simplifies the fabrication of nanometre-scale features. To keep improving the performance of electronic devices manufacturers need to significantly shrink the size of electronic components such as transistors and memories. This not only requires huge financial investments but also requires a complicated fabrication process. The main tool which is used in the fabrication of electronic chips costs more than 150 M Euro and in the chain of nanofabrication, several such tools are required. Not so many companies in the world can afford to buy such expensive tools, and that is why chip production is limited to a few companies in the world, specifically US and Asia, with no single chip fabrication company in the entire Europe. On the other hand, the environmental footprint of chip nanofabrication is increasing substantially. TSMC, the world leading Foundry in the world, uses around 10% of electricity in Taiwan.⁴⁸ All these limitations have motivated companies and research institutes to look after novel and disruptive technologies which is cost efficient but also environmentally friendly. AlixLab's APS has the potential to be an alternative technology in the chain of nanofabrication. To achieve such size reduction, Alixlabs

⁴⁸ 'Does Taiwan Have Enough Power for TSMC? (2020-07-28), Commonwealth Magazine, <<https://english.cw.com.tw/article/article.action?id=2766>> accessed 26 May 2023.

APS technology removes several fabrication steps offering a faster and cheaper method to reduce the device dimensions. AlixLabs claims that compared to current fabrication methods, it reduces production cost by up to 40 percent and is a green technology that reduces carbon dioxide (CO₂) emissions by about 30 percent. This makes the company environmentally friendly and sustainable, moving in line with the WIPO 2030 sustainability program. AlixLabs technology does not need any investment or upgrade of lab equipment and infrastructures, helping Fabs and SMEs relax the need for huge funding.

3.4.3 IP at AlixLabs

3.4.3.1 Introduction

The semiconductor industry has a few big companies that have most of the control in the business. To compete with them, a business might need to put a lot of money and effort, which does not seem economically possible. For any company that wants to get into this market, IP is the greatest asset to develop. AlixLabs's current vision of business model is IP licencing, so IP is the important asset of the company. "IP is our main product, and we rely on it" says Dr. Dmitry Suyatin, AlixLabs' Chief Technology Officer (CTO). The company has a plan to license its nanofabrication process flow to customers. It should be mentioned that for SMEs like AlixLabs, it is very important to collaborate with other companies, especially big players in the field, so they can get recognised and find their way into the market. This will put the company at risk of disclosing sensitive information, so IP protection has a very high priority in order to protect the company's assets. Although the Trademark is also protected, patents and trade secrets are the core IP for AlixLabs.

3.4.3.2 Patent

The company's core technology is protected by a patent filed in 2016, years before the company established in 2019. Although budget is an effective factor to choose the regions, but the company do not hesitate to file patent in regions that they find important for the market. AlixLabs has a very clear patent strategy with regards to countries or region to file a patent. This main patent is granted in EU, USA and Taiwan covering 3 major regions active in the semiconductor technology. The patent protects the idea of fabricating semiconductor structures with a simpler and more cost-effective way than other competitors can do. This gives AlixLabs a great

opportunity to enter a business that is controlled by a few big companies. AlixLabs was granted two more patents in the USA and Taiwan to make sure that the technology is strongly protected. In addition, as company's number of R&D employees has increased, the level of generating innovation has increased and there are several patents pending that the company cannot yet reveal the country or region that they are filed.

As an early-stage start-up, AlixLabs takes the advantage that the leaders are all technical people with years of experience in the field of core technology which gives them the ability to actively comment on the company's technology and roadmap. However, the responsible person for taking care of IP is the company's CTO, someone who is well connected to the R&D team and company's Chief Executive Officer (CEO). Although, preparing patent ideas for filing is done by the company's CTO, AlixLabs uses an IP firm as an external source to file their patent applications. This firm is responsible for filing IP and although, they offer IP strategy services, but their help with the company's IP is limited because AlixLabs is capable and more skilled in doing the IP strategy development internally in this field. To keep the cost lower, AlixLabs decided to consult with legal advisers only when required. An IP expert in the company's Board of directors is giving advice for the IP strategy.

The process of filing IP starts with an idea coming up and if it has value for company's business, then it will be written down in a document called Invention disclosure form (IDF), the typical IDF can be found elsewhere.⁴⁹ The typical IDF includes explanation of the invention, and some extra information and images to plot a full picture of invention. The document typically gathers all information from the date that invention comes up and any possibility of the data being disclosed to the external sources. The document will be then typically submitted to the IP firm to evaluate patentability and draft the patent. In addition to easing the patent filing, the IDF could act as a legal document in case of any infringement or abuse to disclose the company's data.

Concepts of provisional and non-provisional patents are very important for AlixLabs. As discussed in chapter 2, IP filing is very expensive, so AlixLabs, as an

⁴⁹ Yumiko Hamano, 'Invention Disclosure: Form, Reporting Mechanism, Receipt and Processing', 2017.

SME with limited resources, evaluates which ideas are more important for the company's core technology and file them first. In addition, it happens that the R&D team has a finding, but they need more time to dig into it so a provisional patent will be submitted to protect company's IP. The rest of the ideas will be saved as a IDF for future filing or kept as a trade secret.

3.4.3.3 Trade secret

AlixLabs is a company active in the R&D sector of the semiconductor industry, and as mentioned before, the Trade secrets are key IP for this sector. AlixLabs takes several steps to make sure that the trade secret is well protected. Employees are always advised about what they are not allowed to share with external sources. If there is a need to share any data with an external party or contractual employee, an NDA will be signed beforehand. If not sure, employees are advised all the time to make sure an NDA is in place before sharing data. The company occasionally has external contractors which provide measurement services or any other processes that AlixLabs does not have on-site. In this case, and in addition to NDA, an MTA will be signed with the other party to make sure that any resulting IP of the company is secured. The exact same approach goes to all collaborations that AlixLabs has with other SMEs or large-scale companies.

3.4.3.4 Trademark

Like all the companies active in the field, R&D is very important, and as AlixLabs's Chief Operational Officer (COO) and R&D manager Amin Karimi explained, R&D is at the heart of the company. By increasing the internal knowledge, the innovation level has increased. This brings new aspects to the company, and the business model evolves. Trademark may potentially become an important IP for the business. The company has one trademark registered now.

3.4.3.5 Copyright

At this stage for AlixLabs, copyright does not seem to be important. However, the IP licensing model may imply that copyright may become a very important IP for the company in the future.

3.5 Summary

IP is the main product for the company, and it helps it to find its way into the market. Although a patent firm is hired to take care of patent filing, it comes to the attention that the IP strategy is mainly taken care of by the people inside the company. The main reason for this is that the team has the knowledge and skills for this and believes that this internal IP strategy development is more efficient because of the very dynamic nature of all start-ups like AlixLabs.

4. Summary and conclusions

The importance of IP strategy was studied, and it was discussed that as IP is a valuable asset for the companies then it worth spending time and money for its management. IP strategy is a systematic way to control and prioritise IP based on companies need.

Semiconductor industry is a key technology for day-to-day life of human beings which makes it a huge market, the industry consist of several sectors that are very much related to each other. The ecosystem of the industry is in a way that companies rely on collaborating with each other to survive and develop. Considering this, IP is very important part of the industry which helps companies protect their asset during this collaboration.

This thesis conducts a case study on a start-up company, AlixLabs AB, active in the field of semiconductor to elaborate the IP in a SME. Like many other SMEs, IP is the main product of the company, and the innovation relies on R&D. the main IP at this moment for the company are patent and trade secret. AlixLabs has relation with a local IP firm but there is no specific IP strategy service that they are using. The firm takes care of IP filing and upon request and on a case-by-case basis, AlixLabs is seeking advice from them. The team is very well informed and highly skilled, and the way the IP is dealt with at AlixLabs looks very strong. In addition, the company is successfully raising funding, which means that the IP due diligence looks convincing to the investors, this is another indication that the IP portfolio is well managed. However, when the number of IP increases, then its management will be harder. From authors point of view, it will be easier to manage their IP in the future if they already now start to expand their relationship with IP firms regarding their IP strategy. Although, AlixLabs does not use professional IP strategy services, the IP portfolio and management looks very well organized. The team is aware of fundamentals of IP, and they take all safety measures to protect sensitive information. The IP is very much aligned with companies current and future goals. The company is yet in early stage, and it is easy to manage the IP

strategy without help of an IP expert team but as the company grows the IP grows and it will be harder to keep track of everything. Author believes that additional services provided by IP firms, like IP audit and landscaping, are going to save time and money for the company and add to the company's value when they are done in a more systematic way.

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