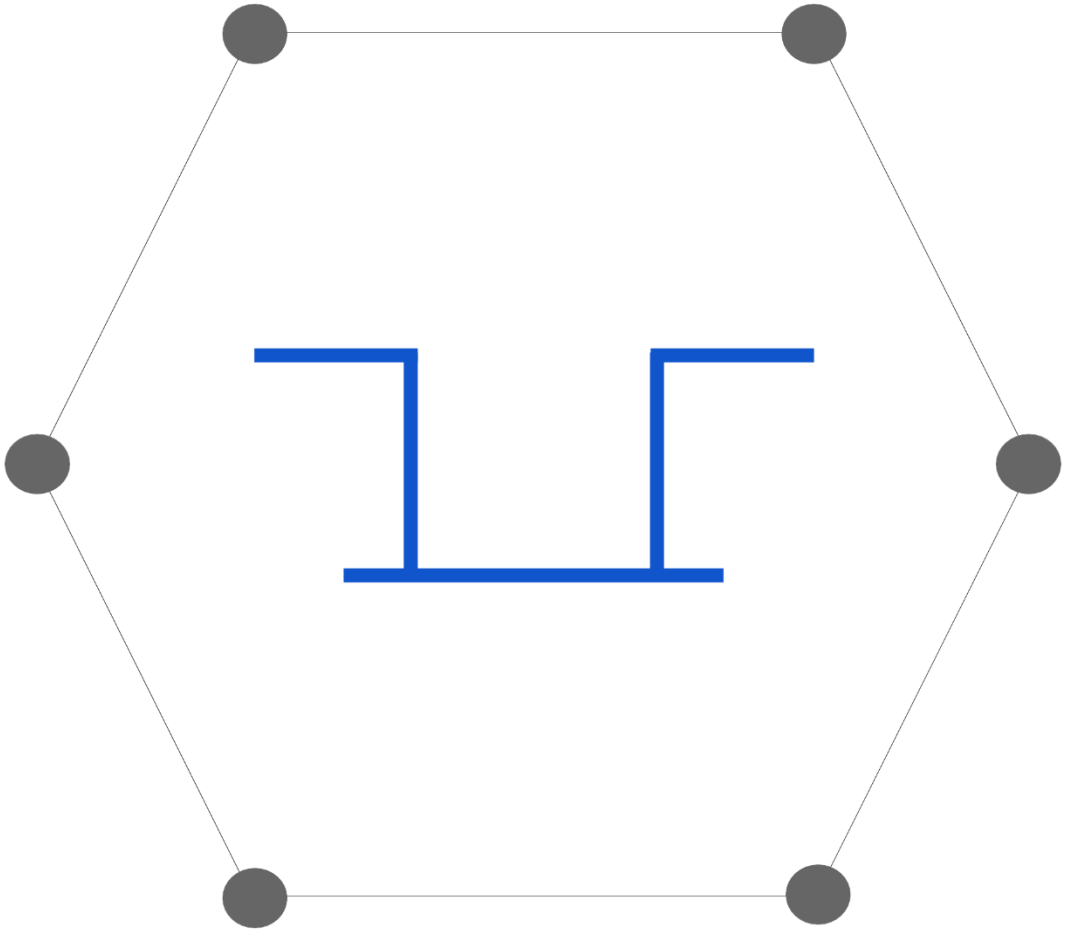
International Business Plan

DECA 2019-2020

GRAPHENE TRANSISTORS CO.



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EXECUTIVE SUMMARY

Despite the need for processing power everywhere, large semiconductor companies have failed to deliver. Currently, Google processes about 75,000 search queries per second, while keeping 200 factors that are considered while searching, sponsored links, and analytics. Google also must search through hundreds of billions of webpages and 15 exabytes of data (As much as 60 million personal computers) every time someone attempts to search using Google. This is done 75,000 times per second. Modern silicon can barely keep up and Google is constantly replacing servers with more effective CPUs.

Enter Graphene Transistors Co.. Graphene Transistors Co. uses a layer of graphene between the source and drain of a transistor to create an extremely powerful CPU, sporting many benefits over silicon-based CPUs.

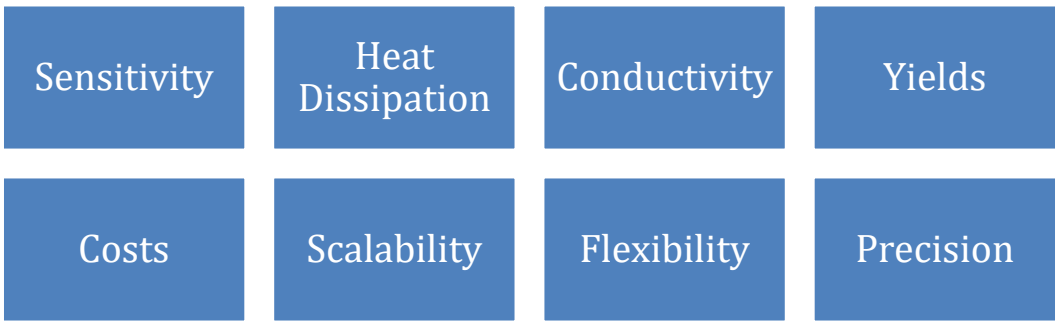
The potential of graphene-based transistors is extremely high. While silicon CPUs can only clock up to 5GHz, graphene CPUs can clock to well beyond 200 GHz. In a world where 20% improvements in processing power year over year are considered impressive, graphene has the potential to shake up the entire computer processor industry.

We will combine 2 efficient technologies in making CPUs to deliver the best possible performance at a low price to consumers: Chiplets and graphene.

Chiplets is a new modular method of designing CPUs, which greatly lowers costs and increases yields and scalability.

Graphene is a revolutionary nanomaterial that is composed of a single sheet of carbon atoms arranged in a hexagonal lattice. It boasts tremendous conductive properties due to the arrangement of the atoms (research in appendix)

While typical channels are made of silicon, graphene is a much better solution. Graphene Transistor Co.'s proposed graphene chiplet CPUs improves on traditional silicon CPUs in multiple dimensions, as listed below:



In addition to selling CPUs, Graphene Transistors Co. also plans on selling research papers on graphene CPUs. These papers will inform our consumers about the benefits of using graphene in CPUs and will also serve as a source of revenue. However, of course, not everything will be in the research papers so competitors will not be able to replicate our technology.

Financials

The company will be started in either Kitchener or the Greater Toronto Area due to the already high number of successful startups in that area. Internationally, although there are tensions within countries such as China and the USA, it is difficult to hinder the trade of a computer processor because they are so important for everything.

Most of the costs associated with the company will be research and development, cost of goods sold, and distribution.

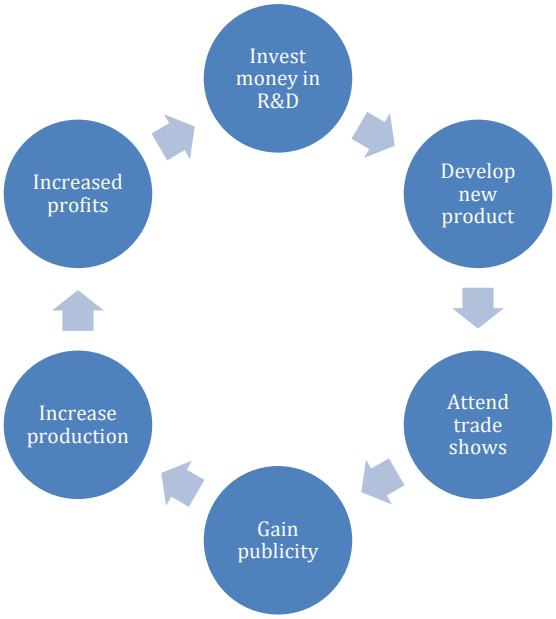
With the steady growth of the PC and semiconductor market, Graphene Transistors Co. will see a similar growth. The market is expected to continue to grow because of the never-ending need for processing power.

The business will be valued at around $5 million to start, but then grow larger. A bank loan of $1-2 million will be obtained, the rest of the capital will be raised by angel investors. Debts will be paid off as soon as possible, once the business starts moving forward in sales.

The CPU market will be closely monitored along with various other metrics such as expenses and sales to optimize profit. The largest challenge in starting up the business is gaining publicity though attention can be gained through guerilla marketing tactics such as unsponsored YouTube reviews or social media.

CPUs will be fabricated using other foundries such as TSMC and GlobalFoundries as it is extremely expensive to build a foundry. However, there are plans of building a graphene transistor foundry once enough capital has been raised.

Here is the general plan for growth of the company:



ANALYSIS OF THE INTERNATIONAL BUSINESS SITUATION

Economic, political and legal analysis of the trading country

Canada's economy is growing at a slow pace, an estimated 2% in 2019. It does not seem to be affected by the US-China trade war. However, Canada's net debt is $768 billion with a debt per GDP of a mere 30.9%. This is exceptionally low compared to other countries in the G7, such as Japan with 237.5%, USA with 106.7%, and France with 99.2%. Debt per Canadian is just over $18000, which debt per American is just under $69000. In short, Canada's economy shows promise.

Canada's strong economy will make it much easier for businesses to start up as citizens will not have to worry about economic crashes. This will cause them to be less afraid of spending more and the overall velocity of money will be high. This is especially beneficial for startup businesses as there will be a lot of money going in and out of the company, so startups can recover financially much quicker than usual. Therefore, starting a company in Canada at this current time is a good idea.

Justin Trudeau, who leads the Liberal Party, was re-elected as the Canadian prime minister in the 2019 Canadian federal election. Trudeau has been hit with numerous scandals, such as the blackface scandal and the SNC-Lavalin scandal. However, unlike certain East Asian islands, Canada is extremely stable with very few riots or protests. The largest protest that happened was when the Minister of Ontario's decision to cut the education budget which caused an uproar in students and teachers alike.

The Liberal party supports businesses in multiple ways, but they aim to create jobs and have good global relations. Some Liberal policies include providing as much as $50000 to 2000 entrepreneurs every year to start their business and cutting tax rates for small businesses to 9%, which is the lowest rate in the G7. As long as large corporations create a good amount of jobs and develop relations with other countries, Liberals will not look upon these companies unfavorably.

The Greater Toronto Area and also the Kitchener-Waterloo area in Canada show promise in terms of startups. Many famous businesses, such as Wattpad, Drop (Formerly Massdrop), and North (Formerly Thalmic Labs) are all new 21st-century startups based in these areas. Due to these locations' support for innovation, it would be a wise choice to begin a graphene transistor company based in those areas.

In conclusion, starting Graphene Transistors Co. in the Greater Toronto Area at this current time would yield the best results.

Trade Area and cultural analysis

Though wants are different for everyone, there is something that the majority of people will require to get through their daily lives. Such products include typical household items like toothbrushes, showers, and now in the 21st century, computing devices. Without such computing devices, hundreds of millions would be thrown into unemployment, and humanity would have to find another way to gather, store, process, and access data.

However, the demand for computing power is increasing exponentially. The school Chromebooks lag even when scrolling through a Word document, and the Chromebook is powered by a CPU millions of times more powerful than the CPU that NASA used on the Apollo Guidance Computer to send rockets into space. However, clock speeds for today's CPUs have hit a ceiling and there is no longer a 2x speed increase year-over-year unlike 2 decades ago.

With the introduction of graphene field-effect transistors, this ceiling won't just be broken through, it will be *obliterated*. While transistors are commonly thought to only be used in CPUs, there are many other applications for transistors. They merely act as a switch or an amplifier for an electric signal. Other than CPUs, transistors are used in solid-state drives, electronic displays, and more. It is evident that the market for transistors is colossal, to say the least, and the potential implications of a graphene-based transistor will spur a new era of technology.

As graphene field-effect transistor technology is extremely new, it will take years for it to become available to the mass market. As it took decades for computers to be accessible to the public, it will take years for graphene field-effect transistors to reach that status.

Trade War

The trade war has a massive effect on the world's economy because it affects 2 of the most productive countries in the world. China currently has a major advantage over the USA, making $539 billion from the USA while the USA only made $120 billion from China in 2018. Also, China is becoming increasingly independent from the USA technology-wise through the development of HarmonyOS (Which will be a Chinese Operating System made by Huawei) and China's plans to launch their own country-wide cryptocurrency before the USA.

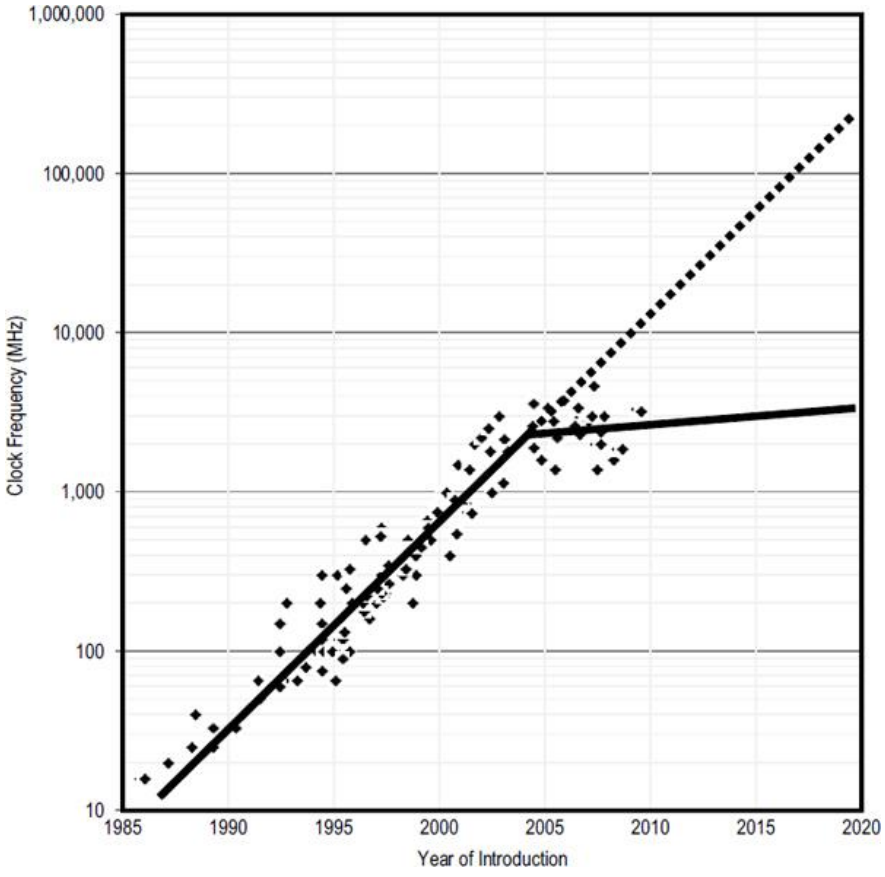
Of course, the graphene field-effect transistor will be marketed worldwide. An analysis of the United States of America shows an extremely high demand for computational power as they have recently announced the construction of a massive Exascale computer, Frontier, powered by AMD EPYC CPUs. It will be likely that the United States will accept this new technology as they need every advantage they can get over China (at the time of writing), especially in the wake of trade tensions and a technological kind of arms race.

PROBLEM

There are multiple problems associated with current transistors: Heat output, conductivity, and physical flexibility.

Silicon transistor-based CPUs tend to run extremely hot. Unless a decent cooling solution is used, these CPUs can easily thermal throttle, which is detrimental to both the performance and longevity of the CPU. This will also cause the CPU's cooling solution to run at a higher speed, which produces uncomfortable levels of noise and degrades the cooling solution at a quicker rate. This all leads to higher power consumption because more cooling power is required. As such, it is necessary to find a solution to this problem.

From 1985-2000, clock speeds of CPUs were increasing at an exponential rate. However, that trend completely disappeared in the early 2000s when CPUs lost the ability to push clock speeds higher. Clock speeds remained constant at around the 4GHz mark for a decade.



To combat this, companies had to add multiple CPUs on a printed circuit board to keep up with the extremely high demand for computing power. That worked for some time, but researchers are currently finding trouble with shrinking the transistor. As the size of the transistor (currently at 7nm) nears the size of the silicon atom (0.2nm), it gets exponentially more difficult and more expensive to produce that transistor.

Computational power is still in extremely high demand although the ability to produce that power is dwindling. Quantum computing is not plausible at this moment because quantum bits, which power quantum computers, would need to be stored near absolute zero to prevent decoherence (which is essentially the quantum bit falling out of its quantum state, thus rendering it useless). With 2019 technology, finding a cooler with near-absolute zero capabilities is impossible. Therefore, quantum computing is ruled out.

The mobile phone industry is putting a great deal of emphasis on foldable technology. Samsung already sold 1 million Galaxy Folds already and there are multiple foldable devices on the market from numerous different companies, such as Huawei, Samsung, and Motorola. Unfortunately for foldable phones, they are pulled down by an extremely high price - several times higher than the typical smartphone.

The high price of foldable technology is attributed to yield, durability, and quality of flexible displays and also the internals of the device. Manufacturers will have to cherrypick the least defective components, which adds to the cost of making the phone itself. In addition, people are reluctant to purchase foldable phones because of fear of durability issues. This all slows down the growth of foldable phones, which discourages innovation from phone manufacturers and the industry as a whole.

CUSTOMER SEGMENTS

The customer segments are split into 2 sections. As graphene technology is nearing an inflection point, markets will change wildly once that inflection point comes. The first section is before that inflection point is reached and the second section is after the inflection point is reached.

Before graphene reaches the inflection point, graphene is still a niche, small-scale, high-end material that very few people would have heard about. It is difficult to incorporate graphene into CPUs at this stage because of the lack of research in this area and high costs with only small-scale production.

Here, because the graphene CPU is a small-scale product, it will be sold at a high price to only the most affluent and power-hungry users. Also, it will not be sold to those looking to start a server because servers require lots of CPUs or the typical everyday computer user. The product will be marketed towards individuals who want risky and bleeding-edge technology. Typically, this means the younger generation.

In the second section, graphene has hit an inflection point and the price and availability would have greatly decreased and increased respectively. Graphene CPUs will also be mass-produced and low-cost. In fact, they will be as expensive as current silicon CPUs. However, given the benefits of using graphene in the above section, and that graphene CPUs are now on the same playing field as silicon CPUs, graphene CPUs will be practically objectively better than their silicon parts.

Graphene CPUs will now take the position of the typical silicon CPUs. In other words, the target market for graphene CPUs will replace that of silicon CPUs. It spans everything, from a small calculator to servers the size of warehouses, to the typical desktop computer. It will be sold to everyone with a computing device and beyond, regardless of income.

UNIQUE VALUE PROPOSITION

Graphene CPU - The processor that’ll never slow you down

SOLUTIONS

There are multiple solutions associated with graphene transistors that directly address the problems associated with silicon transistors: Heat output, conductivity, and physical flexibility.

A higher heat output directly correlates to reduced performance as it causes the CPU to thermally throttle and underperform to not overheat. However, with graphene transistors, this wouldn't happen again. Graphene has an extremely high thermal conductivity of 3000-5000 w/mk. In comparison, copper, which is highly regarded as a strong conductor, has a thermal conductivity of only 100-500 w/mk. This would greatly improve heat transfer and heat generated by graphene transistors would be dispersed at a much quicker rate compared to traditional silicon transistors.

The extreme conductivity of graphene allows CPUs using graphene to clock much faster. Where silicon CPUs max out at around 5 GHz, CPUs made with graphene transistors can clock well over 200 GHz and even into the terahertz range.

Graphene enhances transistors to be thin and flexible which opens up the possibility for technology such as foldable displays (currently on the market) and e-paper (like the Harry Potter e-newspapers). At the time of writing, the prices of foldable phones are at least $2000 USD (no, the Escobar Fold 1 does not count). Using graphene transistors, the yield, durability, and quality of flexible and bendable displays will be greatly improved.

DISTRIBUTION CHANNELS

Graphene Transistors Co. will employ a dual distribution strategy, using both zero-level and one-level distribution methods. Because there are so little middle agents, less money will be lost through them. Graphene Transistors Co. will most likely use the zero-level distribution method in the first few years but switch to one-level distribution as production increases.

Graphene Transistors Co. will sell CPUs directly on their own website, and there will also be a section to learn about graphene and purchase research papers if the viewer wishes to go into greater depth.

In addition, CPUs can be sold online on the websites of other stores such as Best Buy, Amazon, and Staples. They will also be sold physically in retail stores although Graphene Transistors Co. will not have their own physical retail store.

REVENUE STREAMS

Revenue from goods sales

As mentioned in the distribution channels section, most of the revenue will come from selling the products, which are the graphene CPUs.

Revenue from intellectual property

Of course, not all the research performed will be available for the public. However, research papers will be consistently released on a monthly update circulating around graphene transistors and graphene CPUs. This is a similar approach to The Human Genome Project, which is an international effort during the 1990-2003 to sequence the human genome.

Unlike the Human Genome Project, research on graphene transistors will not be freely distributed or redistributed. Therefore, these research papers will serve as a good source of revenue and provide a source of information for those who are passionate about graphene technologies.

COST STRUCTURE

Customer acquisition costs

Instead of spending money on advertisements, the product will most likely gain attention through media. In the early 21st century, there are far cheaper ways to spread word of graphene transistors than using simple advertisements. For example, YouTube has a massive user base of over 1 billion people. Leveraging the power of famous technology YouTubers such as Linus Tech Tips, the product will gain plenty of exposure. Videos from Linus Tech Tips usually receive millions of views alone, not to mention tons of other sources of exposure from other media such as news or even other YouTubers. All this will contribute to free advertising for the product.

According to Drop CTO Jasper Chan, the cost of sponsoring Linus to review a product is around $120,000. However, with millions of views focused on one product, the exposure and customer acquisition that can come from that single video is extremely high even if 1/1000 of the viewers become interested and decide to purchase the product themselves. Assuming Linus creates a sponsored video of graphene CPUs for $120,000, customer acquisition costs are around $120 per customer which is a large number assuming those customers spend around $200 on a CPU each (which is the estimated cost of a graphene transistor based CPU) This means there is a total return of $480,000 from a single video.

Distribution Costs

As this is an internationally sold product, distribution costs are expected to be high. Here are the calculations for shipping to Beijing, China from Toronto, Canada. With a weight of 50 grams (reference: Ryzen 7 2700X), dimensions of 6x6x2cm using an OEM/Tray, it is possible to stack a 6x6x18 box of graphene CPUs with the dimensions of 36x36x36cm with a weight of 72.43 pounds and a total value of $12960 with the value of the processor being $20. Using the UPS website, the cost of shipping that is $1524.92. Shipping to domestic areas like Vancouver using the same package will cost $539.94. Shipping the same package to Silicon Valley will cost $183.08. Each shipment will ship 648 processors.

Human Resources Costs

As this is a small company (about $5 million in market cap), there will be few employees and executives. They will consist of a CEO, CTO, and CFO. This company will leverage the resources of existing semiconductor foundries such as TSMC or GlobalFoundries and thus will not require many employees. The CEO will own 40% of the company, and the CTO and CFO will own 30% of the company each.

Cost Of Goods Sold

Here is a graph outlining the cost per wafer bought from TSMC. Opting for a 7nm process (the most advanced lithography process today) will cost $9965 for a 300mm wafer according to Wccftech. Using a 4-chiplet design with a size of 9.5mm*10.5mm to maximize yields would net a total of 622 chiplets per wafer (modeled by the equation $Dies = \frac{\pi(R-\sqrt{A})^2}{A} = \frac{\pi(150mm-\sqrt{99mm^2})^2}{99mm^2} = 622$ with R being the radius of the wafer and A being the area of the CPU), with each chiplet containing 2 cores. Factoring in a yield of 70%, which is the yield of AMD's CPUs that use a 7nm process, there will be about 436 working chiplets or 109 total CPUs. An average selling price of $500 per CPU would pull in a revenue of $54500 per wafer, and a profit of $405 per CPU.

DETAILED FINANCIALS

Projected income and expenses

Graphene Transistors Co.

Income Statement

For the month ending December 22nd, 2019

Revenue (Thousands)															
Fees Received						$	3	0	0	-					
Total Revenue											$	3	0	0	-
Expenses (Thousands)															
Utilities								5	0	-					
Salaries							1	0	0	-					
Supplies							1	0	0	-					
Total Expenses												2	5	0	-
Net Income (Thousands)													5	0	-

Graphene Transistors Co.

Income Statement

For the month ending January 22nd, 2020

Revenue (Thousands)															
Fees Received						$	4	0	0	-					
Investment Revenue							5	0	0	-					
Total Revenue											$	9	0	0	-
Expenses (Thousands)															
Utilities							1	0	0	-					
Salaries							1	5	0	-					
Supplies							1	0	0	-					
Total Expenses												3	5	0	-
Net Income (Thousands)												5	5	0	-

Graphene Transistors Co.

Income Statement

For the month ending February 22nd, 2020

Revenue (Thousands)															
Fees Received						$	10	0	0	-					
Investment Revenue							3	0	0	-					
Total Revenue											$	13	0	0	-
Expenses (Thousands)															
Utilities							2	0	0	-					
Salaries							2	5	0	-					
Supplies							1	5	0	-					
Total Expenses												6	0	0	-
Net Income (Thousands)												7	0	0	-

Projected Cash Flow

Money in thousands

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Opening Balance	20	30	50	80	90	150	130	140	200	130	130	105
Cash in												
Sales	20	30	60	50	100	60	80	120	70	90	55	110
Total	20	30	60	50	100	60	80	120	70	90	55	110
Cash Out												
Marketing	0	0	10	10	20	60	40	30	50	70	60	50
Cost of goods sold	10	10	20	30	20	20	30	30	70	20	20	40
Total	10	10	30	40	40	80	70	60	140	90	80	90
Cash Flow	10	20	30	10	60	-20	10	60	-70	0	-25	20
Closing Balance	30	50	80	90	150	130	140	200	130	130	105	125

Balance Sheet

Graphene Transistors Co.

Balance Sheet

For 6 months ending December 22nd, 2020

Assets (Thousands)						Liabilities (Thousands)					
Current Assets						Accounts Payable	$3	0	0	0	-
Cash	$	1	2	5	-	Taxes Payable		2	0	0	-
Temporary Investment	1	0	0	0	-	Mortgage Payable	2	0	0	0	-
Accounts Receivable (Net)	2	0	0	0	-	Interest Payable		1	0	0	-
Supplies		1	0	0	-	Bank Loan	2	0	0	0	-
Inventory		8	0	0	-						
Total Current Assets	4	0	2	5	-	Total Liabilities	7	3	0	0	-
Property											
Land	1	0	0	0	-						
Buildings	4	0	0	0	-						
Equipment		5	0	0	-						
Total Property	5	5	0	0	-						
						Owner’s Equity	2	2	2	5	-
Total Assets	$9	5	2	5	-	Total Liabilities and Equity	$9	5	2	5	-

Projected 3-year plan

Timeline:

Activity	**Details**	**Time**
Find Investors (Part 1)	Capital will be raised through angel investing	January 2020 – February 2020
Obtain a bank loan	Request $1-2 million from the bank to start up the company	February 2020
Begin R&D on graphene	Once funding is acquired, research and development on graphene and graphene-related technologies will begin as soon as possible.	March 2020
Begin selling goods	TSMC will start manufacturing CPUs at around this point, but at a small scale (10 wafers per month).	May 2020
Contact YouTubers	Youtubers such as Linus Tech Tips will be more than happy to make videos on interesting new technology. After the Youtubers are contacted, they will provide a source of publicity for graphene CPUs.	May 2020
Start selling research papers	Research papers will be sold near the beginning of June 2020 on graphene transistors.	June 2020
Re-invest into R&D	Most of the money earned from selling graphene CPUs will be reinvested into research and development on graphene	July 2020
Apply for CES 2021	CES (Consumer Electronics Show) is one of the largest technology conferences in the world. It focuses on consumer electronics and will be a great opportunity to gain more publicity.	July 2020 – December 2020
CES Keynote	In the keynote at CES, the second generation of graphene CPUs will be teased and introduced.	January 2021
Increase production of CPUs	Production of graphene CPUs will be increased to about 25-30 wafers per month because of increased demand from CES.	January 2021

Apply for Computex 2021	Computex is a large technology conference in Taiwan in June and will continue to serve as a source of publicity.	January 2021 – May 2021
Find Investors (Part 2)	Go on Dragon's Den and Shark Tank to potentially receive investments from successful businesspeople and gain attention on TV.	January 2020 – February 2020
Launch second generation of CPUs	The second generation of graphene CPUs, using a refined process technology and a new microarchitecture, will be launched.	March 2021
Computex Keynote	Outline the advantages of graphene technology and gain attention from media.	June 2021
Apply for CES 2022	Graphene Transistors Co. will go to CES a second time in order to gain more publicity and educate others about the benefits of graphene.	July 2021 – December 2021
Pay off bank loan	At around this time, enough money would be going in the company to start paying off debts. A monthly payment of $100,000 to the bank will start at around this stage	November 2021
CES 2022 Keynote	Graphene Transistors Co. will continue to show innovation on CPUs in CES 2022.	January 2022
Continue to increase CPU production	Production of graphene CPUs will be increased to about 80-100 wafers per month from increased demand due to many trade shows and media coverage. About 10,000 CPUs will be sold per month at this point.	February 2022
Begin developing instruction set	In order to take advantage of graphene's miraculous properties, a new instruction set will be developed for future graphene CPUs to be based on.	March 2022
Computex 2022	The third generation of graphene CPUs will be announced and launched at Computex 2022, using a brand new 5nm process node and a new method of graphene creation.	June 2022
Pay bank loan	At this stage, the bank loan will be fully paid off.	August 2022

Increase R&D spending	Increased money will go into R&D in order to further development of graphene CPUs.	September 2022
Increase CPU production	Wafers of graphene CPUs will be produced at a rate of 400-500 a month to keep up with high demand due to the new process technology.	October 2022
Apply for IPO	Graphene Transistors Co. will apply for an Initial Public Offering to become publicly traded.	November 2022
IPO	Graphene Transistors Co. will aim to IPO with a market cap of $100 million.	January 2023

Proposed Plan to meet capital needs

It will require about $7 million of capital investment into the company to start it up. A lot of money will be put into investments to raise capital. Capital will also be raised through angel investors and bank loans. Later, Graphene Transistors Co. will go to Dragon's Den or Shark Tank to gain publicity.

Graphene Transistors Co. will see tremendous growth from the technology-oriented community and will increase production several times throughout the 3 years. Debts will be paid off through revenue from sales.

Due to the extremely high demand for computing power, Graphene Transistors Co. is expecting to encounter demand issues. In that case, production will increase. The numbers in the timeline are not exact and will vary greatly based on reception of the product and external factors such as trade as well.

KEY METRICS

Research and development

Although it is difficult to measure research and development, it can be estimated through results. Progress of research on a new graphene depositing process on a substrate can be easily tested, and work on new lithography nodes can be tracked.

Sales

Sales can be tracked through orders from distributors or customers online. It is essential in determining demand for the product and whether any price adjustments are necessary.

Expenses

Fabricating CPUs are difficult with a high margin of error. Expenses can easily accumulate to difficult levels and it is important to keep those expenses under control.

Industry trends

In order to understand what consumers want, conducting market research or simply browsing through social media and seeing what consumers are happy with is important in continuing to innovate on a product that will attract consumers. In addition, research on the technological capabilities of similar semiconductor companies such as Intel will be important in determining the competitive stance of this Graphene Transistors Co.

COMPETITIVE ADVANTAGE

Easily the greatest competitive advantage of Graphene Transistors Co. is in the name: The use of graphene in transistors.

Graphene transistors have multiple advantages to silicon processors as stated earlier, and although Graphene Transistors Co. will create research papers, they will not disclose everything. This means that Graphene Transistors Co. can have a source of income from research papers while enjoying a lead over their competitors.

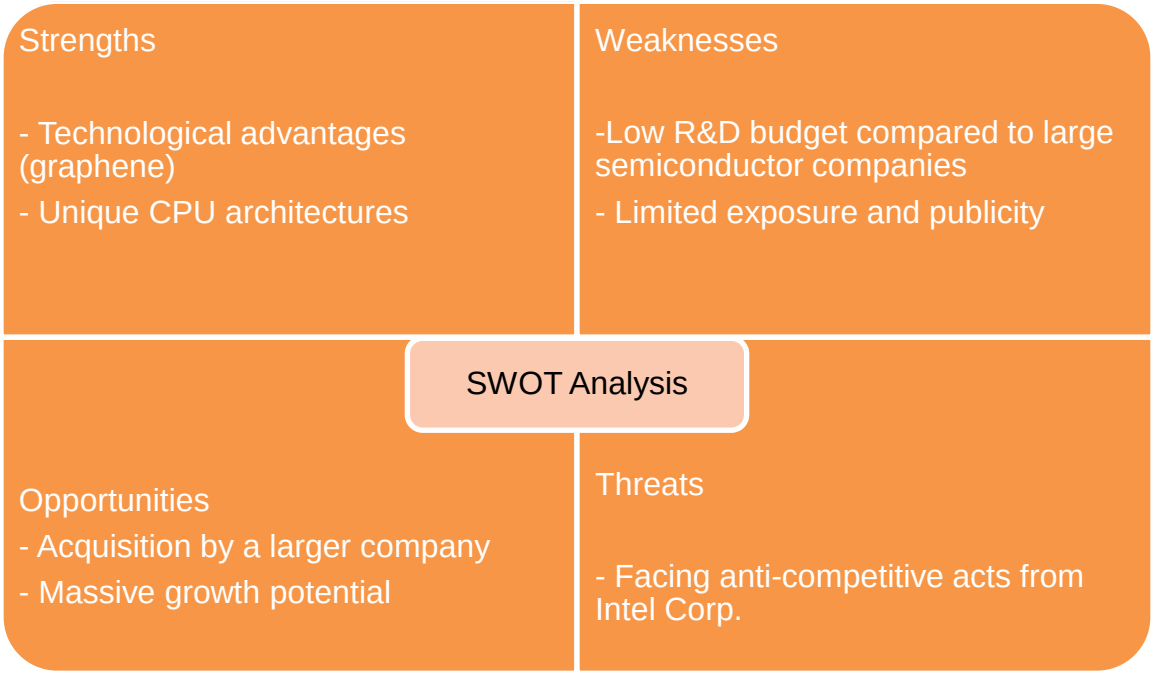
Startups like these have radical views on the technology industry as a whole and offer products or services to complement these views. Larger corporations such as Intel, Nvidia, and Advanced Micro Devices would not be willing to risk spending so much time and money on a technology that’s so new there are very few research papers on it.

Although graphene can easily be researched, the technology itself is difficult to replicate. Graphene Transistors Co. will use a unique method of CVD to deposit the graphene on the transistors. That part will not be in the research papers so competitors will not be able to replicate that.

Like Intel with the x86 instruction set, Graphene Transistors Co. will attempt to obtain licenses to graphene-specific instruction sets that take advantage of graphene's superior properties. This is to ensure that no competitor can match Graphene Transistors Co.

CONCLUSION

SWOT Analysis



PESTLE Analysis

Factor	Effect
Political	There are many political tensions in the world right now. Iran currently has tensions with many countries due to unfortunate incidents such as assassinations and plane crashes. Many fear this will lead to a third World War. A world war will raise the demand for bleeding-edge technology such as graphene CPUs to empower countries in the war. This will be beneficial to Graphene Transistors Co.
Economic	Canada has a strong economy that is steadily pacing forwards with a safe inflation rate of around 2% per year. However, trade tariffs between USA and Canada are existent, as shown with steel and aluminum tariffs from 2018-2019. Therefore, there is a possibility for more tariffs between USA and Canada which could impact sales of graphene CPUs internationally.
Social	The user base of emerging technologies typically consists of young, passionate individuals. Conferences such as CES gain large amounts of hype and there is typically a high demand for technology during or right after these trade shows. Graphene Transistors Co. can take advantage of this and gain both sales and publicity by attending more technology conferences.
Technological	The technological outlook for Graphene Transistors Co. is extremely favorable. Due to the development of graphene-based technology, Graphene Transistors Co. holds a massive technological advantage over other companies.
Legal	Legally, Graphene Transistors Co. cannot sell computer processors based on the x86 instruction set due to only Intel and AMD having the license to do so. Other companies such as Qualcomm and Apple manufacture processors based on the x64 instruction set. Apple has shown to manufacture processors with similar performance to Intel's processors despite the difference in instruction set. Graphene Transistors Co. will start by selling processors based on the x64 instruction set. Once enough research has been done on graphene transistors, Graphene Transistors Co. will develop a brand-new instruction set to take advantage of graphene's electronic properties.
Environmental	The media currently puts a large amount of emphasis on the environment, such as the Team Trees campaign in late 2019 (which was to raise $20 million to plant 20 million trees). Thus, it will be crucial for Graphene Transistors Co. to operate will as few carbon emissions as possible in order to have a strong public image. Although environmental factors will not have much of an impact on Graphene Transistors Co., economic factors will have a larger impact.

Massive product technological advantage

It only costs $109 to manufacture an 8-core CPU yet it can easily be sold for $500. Companies today sell 8-core CPUs for the same price, and using superior graphene technology, our CPUs will clock hundreds of times faster.

Using chiplet technology, the scalability of processors is greatly increased due to a modular design. Hence, economy of scale will play a major factor in crafting the CPUs and can help to further improve performance while lowering costs.

Extremely high growth potential

The PC market and the server market combined is about $45 billion. Even capturing 0.1% of market share (which is extremely achievable due to massive technological advantages) will mean significant growth for Graphene Transistors Co.

In addition, technology enthusiasts are generally very quick to try new technology. On the technology adoption life cycle, they are generally early adopters or even innovators. This means that Graphene Transistors Co. can attract a large amount of customers even right after a product launch.

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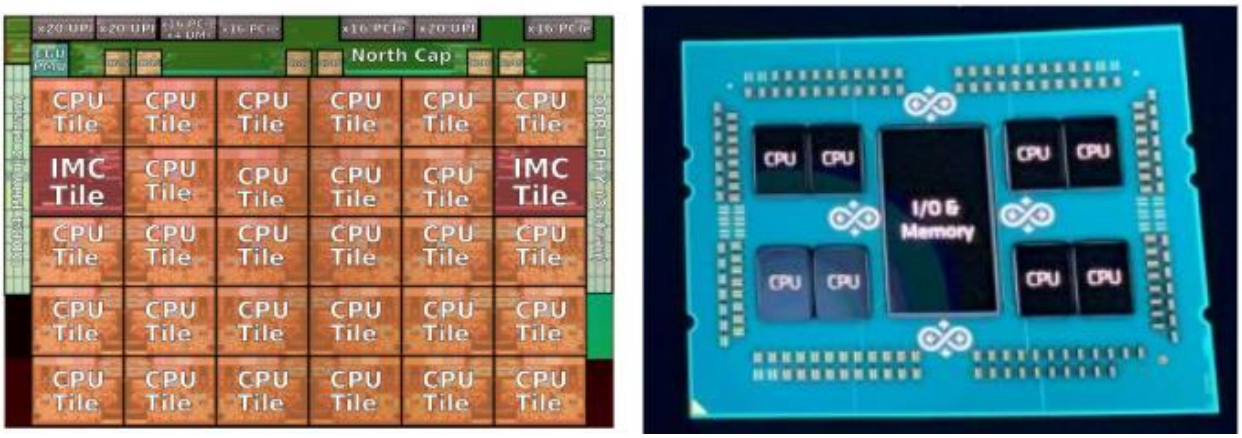
APPENDIX

Research on Chiplets

While some companies prefer to keep their entire processor on the same die, there are more efficient methods of creating CPUs. AMD, for example, combines 2 Core Complexes (CCX's), each housing 4 cores for a total of 8 cores. This process improves scalability and yields of a CPU while reducing cost and power consumption.



Intel Xeon CPU (left). AMD Epyc CPU (right).

Examples were taken from Intel and AMD, 2 large semiconductor companies.

Intel uses a monolithic die — unlike AMD. AMD is using a method of construction CPUs called chiplets. The chiplets design involves manufacturing everything separately and then fitting them all together on the same PCB. While Intel's approach involves stuffing all the cores together, AMD splits everything up in 8 8-core chunks for a total of 64, with the I/O die in the center.

There are numerous advantages to using chiplets to construct microprocessors. However, the two largest are cost and scalability. With a 64-core EPYC CPU costing $7000 and a 28-core Xeon CPU costing $13000, the cost advantage of EPYC was clearly shown in the numbers. However, scalability is also a major issue. While Intel's offering only goes up to 28 cores, AMD can go up to 64 cores, with literally half the power consumption per core. As

electricity prices are a major concern for servers, 50% less power consumption makes a massive difference.

Therefore, using a chiplet design in Graphene Transistors Co.'s CPUs will be a wise choice and will offer greater performance at a lower price to consumers, as well as many other benefits such as economy of scale and a reduced number of defects.

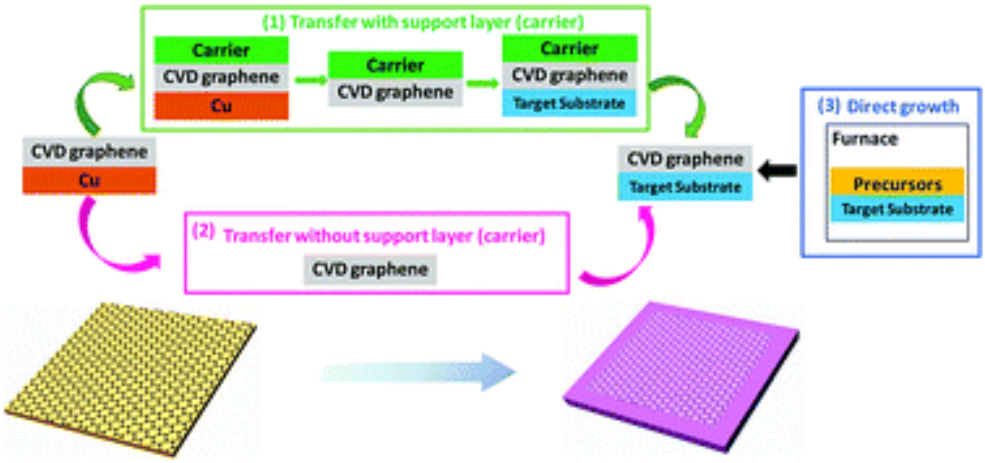
Research on Graphene

Carbon, having 4 valence electrons each and each carbon atom in the graphene structure being connected to 3 other carbon atoms, has an extra free electron. That electron is called the pi electron and can move through the entire graphene structure with virtually no resistance, which contributes to a conductivity over 10x greater than copper. This is especially useful in field-effect transistors.

Field-effect transistors are based on the concept than a charge on a nearby object can attract charges in a semiconductor channel. It is basically a type of electric field effect, hence the name. There are 3 parts to a transistor - the gate, the source, and the drain. The source and the drain are located at either end and the gate is located in the middle. The gate controls the flow of electrons between the source and the drain using its electric charge.

Production

Graphene, despite being made of an extremely common element, is notoriously difficult to produce. There is an extremely high chance of defects and the yields of any method of graphene production are typically extremely low, being about a gram per hour at most. Graphene transistors today are typically manufactured using a process called Chemical Vapor Deposition, or CVD for short.



CVD is a chemical method of graphene production and the primary method of how graphene is implemented in transistors. CVD starts by decomposing carbon at a high temperature which is put on a deposition substrate. Graphene will start to form on that substrate in as little as 5 minutes.

Then, metal catalysts are used to lower the temperatures required in the process from 2500° C to 1000° C. Extra care must be taken to reduce the risk of the catalyst creating impurities in the graphene. After that, the graphene layer of the deposition substrate is then put on the target substrate. Metal electrodes are placed on the graphene, then graphene channels are shaped into desired shapes and sizes.

CVD can produce high volumes of graphene with relatively high quality. However, the process is expensive and complicated involving many complex steps. Today, this is still the most well-rounded method of graphene production.