School of Information Studies
SYRACUSE UNIVERSITY

Firm Information Systems Strategy

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Group 5 + 13

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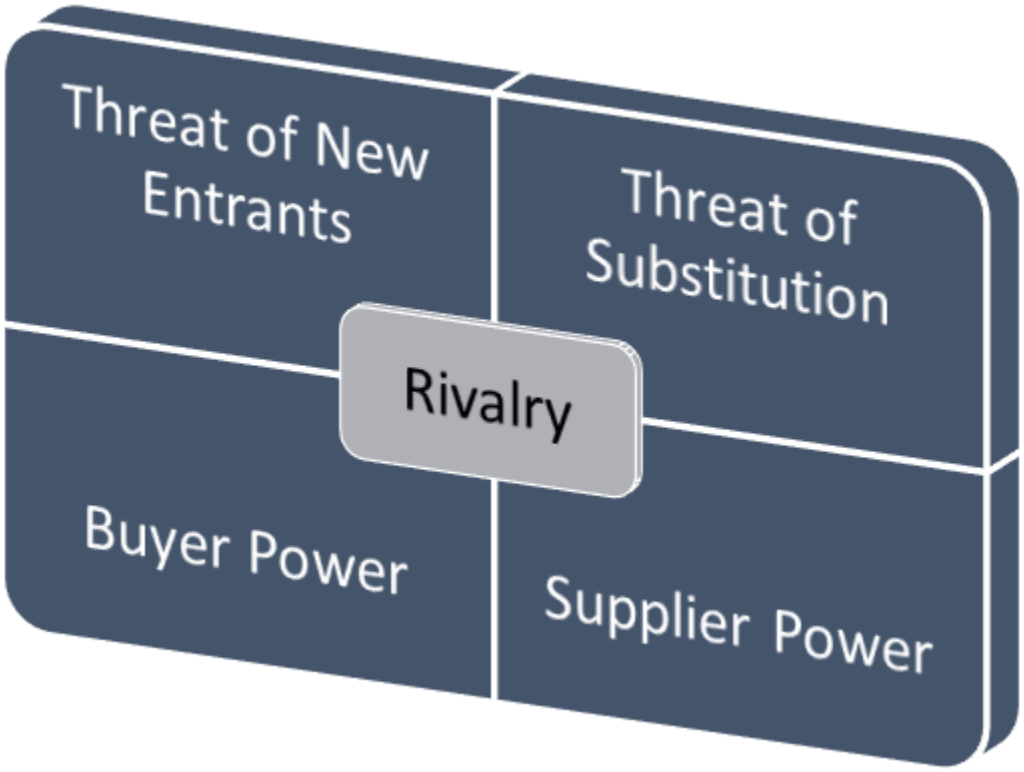
Introduction

Dell is an American multinational technology firm located in Round Rock, Texas. “Michael Dell founded [Dell] in 1984 in Austin, Texas with $1000 and a unique vision of how technology should be designed, manufactured and sold” (Dell, 2012). Dell’s business is aligned to address the various needs of multinational firms, small and medium sized business, governments, healthcare entities, educational institutions and personal users. Dell operates as a technology company which produces desktops, laptops, and tables. Additionally, Dell operates within the Infrastructure as a Service (IaaS), Software as a Service (SaaS), and Platform as a Service (PaaS). Today, Dell is a well-rounded organization that operates in all aspects of the client and user needs.

Porter’s Five Forces

The Porter’s Five Forces Model is a framework, which is commonly used to analyze the current state of profitability in an industry. It helps analysts determine the strengths, weaknesses and corporate strategies to implement, based on conditions of the industry. It consists of the following 5 forces:



I. Rivalry

This point deals with the competition in the industry. With a high degree of rivalry, companies can lure customers with aggressive pricing, and the customers can go elsewhere to find an equivalent product. On the other hand, if the level of rivalry is low, then the company itself can potentially have hefty profits.

The rivalry in the computer technology market is high. Yet the intensity of the rivalry is dependent on the following characteristics:

1. The number of firms impacts the intensity of the rivalry. The rivalry increases if the competitors are of equal size or market share, then the intensity of the rivalry will increase (Wilkinson, 2013). The rivalry decreases if there are small number of firms operating in the industry or if there is a clear market leader. Within the computer technology industry, Dell competes with Hewlett Packard for each other's market share in all aspects of the industry.
2. Industry growth impacts the intensity of the rivalry. The intensity of rivalry will be high while the industry growth is slow and the intensity of rivalry will be low when there is fast industry growth (Wilkinson, 2013). Hence, the rivalry is impacted the fluctuation of the market and by the pulls of the industry.
3. Fixed costs influence the intensity of the rivalry. If the fixed costs are high, then the competitive rivalry will be intense (Wilkinson, 2013). While, if the fixed costs are low, then the competitive rivalry will be decreased.
4. Storage costs influence the intensity of the rivalry. High storage costs force the producers to unload the products on the market, hence the competition for consumers increases (QuickMBA.com, 2010). Low storage costs the producers to maintain a certain quantity of products in stock, thereby lowers the competition for consumers
5. Switching costs impacts the intensity of the rivalry. The low switching costs increases rivalry and the high switching costs decreases rivalry. In recent years, personal devices have become diverse in usage and in different types. Despite so, in the computer industry there is high switching costs due to the higher price tags.
6. Product differentiation impacts the intensity of the rivalry in the market. Products that are undifferentiated or are considered to be commodities have intense rivalries. While the highly differentiated products decrease rivalries between firms.
7. High strategic stakes, increases the intensity of the rivalry in the market (QuickMBA.com, 2010).
8. Exit barriers impacts the intensity of the rivalry in the market. Losses incurred due to ceasing operations causes high intensity among the industry rivalry to increase (Wilkinson, 2013). While, if there are no losses incurred due to ceasing operations causes low intensity among industry rivals.
9. Diversity of rivals impacts the intensity of the rivalry in the market. If the competitors are strategically diverse, then industry rivalry will be intense (Wilkinson, 2013).

While if there is a lack of strategic diversity within competitors, then industry rivalry will decrease.

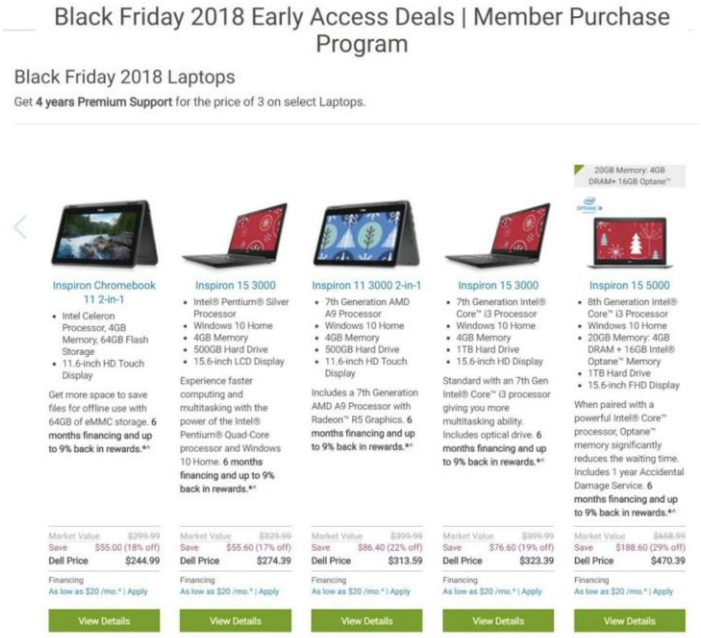
10. Industry shakeout
    When the when industry gets crowded with competitors, it gets too saturated and the growth rate slows. Thereby creates an environment, with intense competition, price wars, and company failures (QuickMBA.com, 2010). Hence an industry shakeout increases rivalry.

The rivalry in the computer technology market is high. Within the computer industry, Dell competes with Lenovo, HP Inc, Apple, Asus Group and others. In 3Q18, Dell ranked first in International Data Corporation's (IDC) "server shipment tracker for... shipping 556,000 units -- $4billion-worth", despite the growth in revenue, Dell's market share dropped to 17.5% in Q3 2018 from 18.1% in Q3 2017 (McLean, 2018).

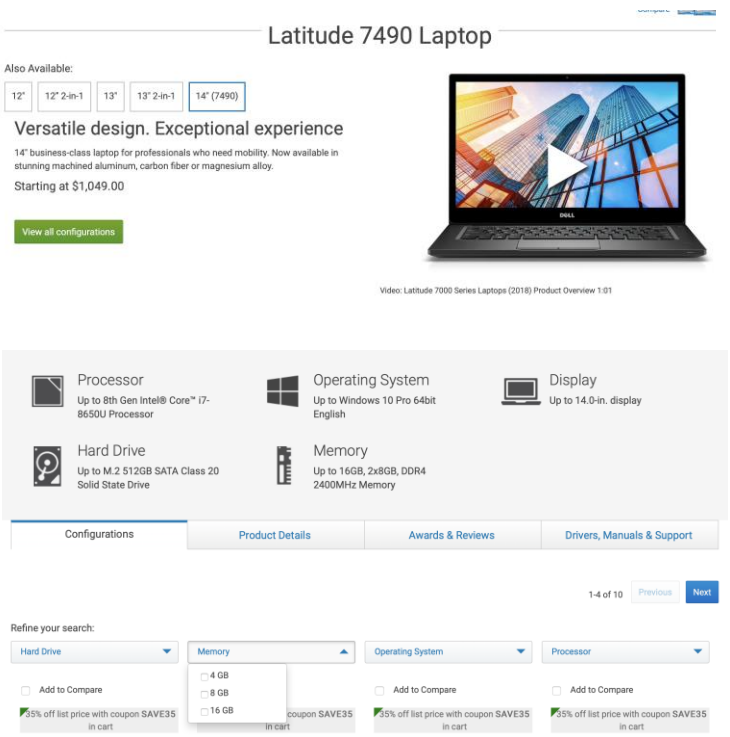
Top 5 Companies, Worldwide Server Unit Shipments, Market Share, and Growth, Third Quarter of 2018 *(Shipments are in thousands)*

Company	3Q18 Unit Shipments	3Q18 Market Share	3Q17 Unit Shipments	3Q17 Market Share	3Q18/3Q17 Unit Growth
1. Dell Inc.	556.0	17.6%	503.0	18.8%	10.5%
2. HPE/New H3C Group [a]	456.2	14.4%	501.4	18.8%	-9.0%
3. Inspur/Inspur Power Systems [b]	283.6	9.0%	149.1	5.6%	90.2%
4. Lenovo	193.5	6.1%	151.8	5.7%	27.5%
5. Huawei*	187.9	5.9%	133.3	5.0%	40.9%
5. Super Micro*	169.3	5.4%	136.7	5.1%	23.9%
ODM Direct	871.5	27.6%	668.0	25.0%	30.5%
Others	443.5	14.0%	428.0	16.0%	3.6%
Total	**3,161.5**	**100%**	**2,671.3**	**100%**	**18.3%**

Source: IDC Worldwide Quarterly Server Tracker, December 11, 2018.



In order to gain an advantage over its rivals, all firms in operation and all the firms in the computer technology market use the following competitive moves: changing prices, improving product differentiation and more tactics. Dell uses price discounts to gain a temporary advantage over its competitors. For instance, one specific day such as the Black Friday, “Black Friday 2018 Early Access Deals” (BlackFriday, 2019). This one of the many methods to gain advantages in the crowded market. Additionally, as Dell provides discounts to the consumers via the specific events to draw attention to it’s corporate identity and tries to humanize the firm by connecting with the consumers via participating on Black Friday, Cyber Monday, President’s Day, and others.



Additionally, Dell provides the users to customize their products prior to purchase. This is a way to differentiate Dell products from its competitors. For instance, on the same Latitude 7490, Laptop Dell offers multiple models of the same device. Starting from the hard drive and memory storage, different types of operating system and processors (Dell, 2019). This is a feature that Dell operates to differentiate its’ products from competitors, such customization is now standard to stand out in the crowded industry.

The computer technology market is involved by the following industry characteristics: a large number of firms, low level of product differentiation, and more. (QuickMBA, 2010). In the business and computer sectors, “Dell Inc. competes most closely with Hewlett-Packard Company and Lenovo… in the business hardware and software arenas” (Investopedia, 2018). With a close competitor, the rivalry intensifies as the firms struggle to acquire each other’s market share of customers and resources. Additionally, with enhancement in technology, it has been possible to create more complex but simplified devices such as laptops, tablets, desktops, and other services. For instance, if one would enter into a technology store, laptops are harder to differentiate from each competitor brands on the outside. Hence, from the consumer perspective laptops have a low level of product differentiation and the sole exception is the brand identity that differentiates one device over the another.

II. Buyer Power

This section deals with how easy it is for buyers to dictate and run the cost of a product down. Some other things that need to be considered, include the switching costs and the number of buyers. If there are only a few buyers, this would indicate that they have considerable power.

Buyers are vast and varied in nature - from corporations to consumers. Even among consumers, there is a wide spectrum, from college students/professionals with ultrabook offerings, to home desktop systems for families, to gamers with their premium Alienware line. With a net number of units sold in Q4 of 2018 as 10.92 million (Statista, 2019), the number of customers Dell has is also large. On the flip side, for each of these consumers, there are plenty of options other than Dell. For laptop/desktop computers, there are several competitors such as Lenovo, HP etc. There are also several independent system integrators like CyberPowerPC and Digital Storm (CRN, 2014) who source computer components from suppliers and assemble custom computers and laptops for consumers and businesses. There are some companies, such as Clevo, who make laptops which can be bought by system integrators and subsequently can be marketed as their own after rebranding. (Clevo Company Profile) Due to all these reasons, the market is neither a monopoly nor a monopsony. However, when it comes to the virtualization market, VMWare, which Dell owns, enjoys a huge majority at 75% (Smart Profile) market share in an enterprise setting, over competition from Microsoft and Citrix. Some markets that this is used in include the Government, Healthcare, Education, Wholesale/Retail, etc.

The buyers are not concentrated and are they are many numbers. Furthermore, no customer purchases any significant proportion of the output, for computers, or virtualization software. A lot of producers of computer components, like Corsair, are beginning to create computers for the mass market. This poses a credible threat to mainstream manufacturers from the perspective of gamers and professionals. (Linus Tech Tips, 2019) This points to the buyers not having much of an influence on products or the price - both from a consumer and enterprise standpoint, and hence their weakness.

On the other side, most computer components, accessories, and peripherals are standardized. Additionally, there is very little differentiation between most consumer computers apart from physical appearances. While during a lot of times Dell sources components from manufacturers, Dell themselves manufacture a lot of them too - from computer fans, to solid state drives. These facts point to the strength of buyers.

On the whole, we feel that buyer power is low to moderate, tending more to low.

III. Supplier Power

This section deals with the other end of the chain - i.e. how easy it is for suppliers to increase their price. Factors that affect this include how unique the product is and how expensive it is for the company to switch suppliers. Naturally, if there are many suppliers, the company would have many choices, and hence the supplier power will be reduced.

Suppliers in the computing market include primarily component manufacturers.

As mentioned, there is a credible threat from producers of computer components, like Corsair, to integrate forward and produce systems of their own. (Linus Tech Tips, 2019) Some companies like Samsung, which produce a lot of electronic components themselves, have already penetrated the market, but not to great success.

The recent decline in prices of electronic goods (Markoff, 2015) in alignment with Moore's Law, is due to the ease of which manufacturers are able to create chips with billions of transistors on them. This mandated an establishment of standards in their production - such as the 2280 form factor in M.2 solid state drives. Again, due to the immense amount of companies that are present in the electronic component manufacturing, especially for relatively cheap in Asia, there is hardly any difficulty in switching between suppliers. This is made even easier because standards exist for electronic components. There are still monopolies when it comes to these electronics manufacturers; for example, Intel with processors for laptops and desktop computers, at about 80% in Q1 of 2019 (Passmark, 2019). For enterprise customers, backward integration makes very little sense in terms of time, effort and money. Additionally, for virtualization, it is not feasible to do so. For individual buyers, the idea does not seem very bad. Obtaining individual components and assembling a computer is undeniably cheaper than buying directly from Dell, however, very few people would have the inclination or knowledge to do so themselves (Tom's Hardware, 2015)

From a buyers' perspective, since there are so many different types, we can comfortably claim that they aren't concentrated and are rather fragmented, and they consequently didn't purchase any significant proportion of output. As discussed before, the customers are also relatively weak in this industry. All these points to the suppliers having not much power.

Due to these points, we feel that the suppliers have rather low power.

IV. Threat of New Entrant and Entry Barriers

Having new companies enter into the fray is always challenging to handle. How easy it is to establish oneself in the industry, how expensive it is, how are the regulations in the industry - are just some of the factors that decided this section's score. If it doesn't take much money to set oneself up in the industry, it stands to reason that threat of new entrants is high.

The threat of new entrant and entry to barriers to the computer technology market is low. Theoretically, any firm is able to enter and exit the market. However, in reality the computer technology industry is one of the industries which has higher barriers to entry.

The barrier to entry starts from the need for a higher level of capital investment. Necessary for required for research and development (R&D) to stay innovative, ahead of competitors, retain the talent pool, and for the supply chain that needs to support a firm that will enter the computer technology market. These are a few of the barriers to entry.

Additionally, in order to compete with existing brands on the market, the new entrant will need to establish and new brand and brand equity. Building a brand from scratch is not some that can be built upon talent and capital investment, as it requires time and effort to build an organization and company character separate from the financial investment.

Apart from these, there needs to be a trustful relationship with the clients, customers, and suppliers alike. Trustful relationship requires time and effort from the new entrant with its partners and customers. Hence, for new entrants staying competitive and innovative in the market and staying afloat is considerably difficult, in comparison to established firms.

As a result, the threat of new entrants into the computer technology market is low as the entry barrier is high. In a theoretical environment, entry and exit from a market is simple, however in a realistic environment entry and exit is not so simple as it seems.

V. Threat of Substitutes

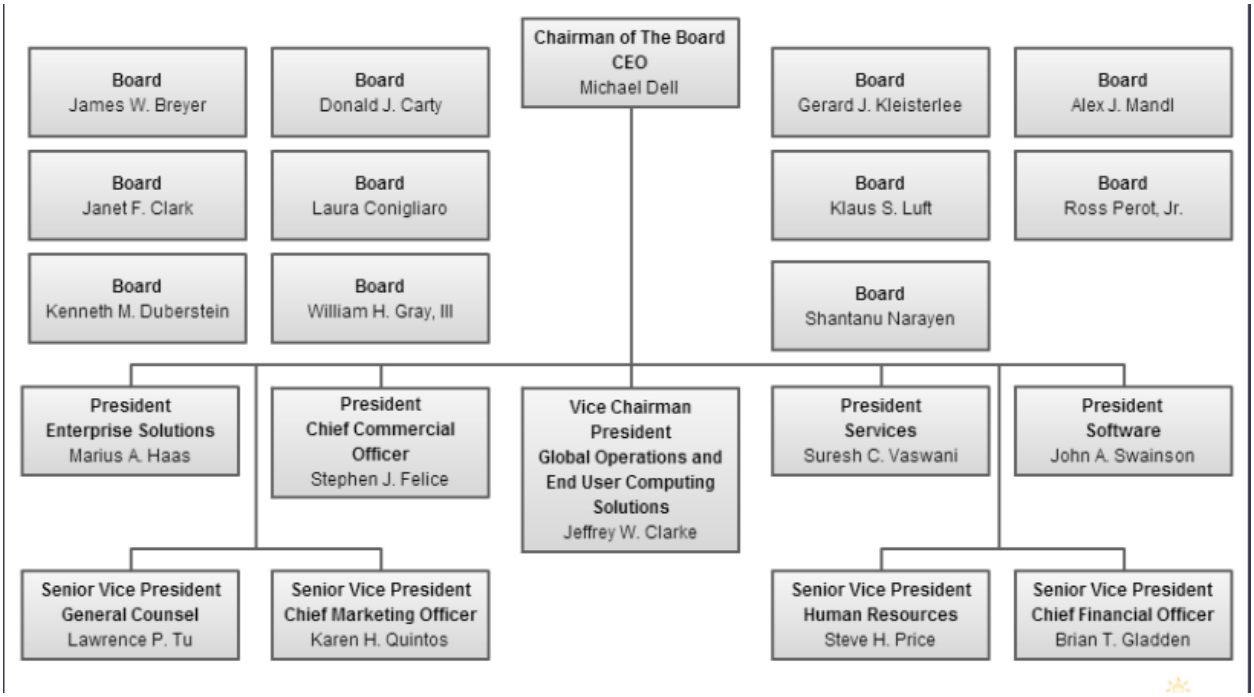
This final section deals with the probability of customers finding alternatives to your products - usually in other industries, as we shall see in the examples below. If the number of options afforded by the people is high, the threat of substitutes is also high.

In the gaming sphere, there are several console substitutes. Instead of gaming on a computer, an enthusiast could look into gaming through a PlayStation, X-Box, or handheld consoles like the Nintendo Switch. There are still more people currently using the PC for

gaming (McKane, 2016), but with the improvement in frame rates, prices and exclusive titles on consoles, the landscape might change in the future.

Buying a new computer for access to the internet, especially in developing countries, may not be a viable option for many families or individuals. There seem to be three major substitutes for this. The first option is internet cafes. WIth internet connectivity becoming so common, this has allowed people to access the internet easily with peripherals to take print outs, play games etc. This has been disappearing, as computers have become cheaper (Sarkhel, 2017). The second option is to use smartphones. With good phones becoming cheap and cheap phones becoming good, especially in developing countries with less purchasing power, smartphones have improved the people's access to the internet. (Chauhan, 2019). The third alternative is upgrading old and existing systems. If users have less purchasing power, they are less likely to upgrade to a new system every few years. So, an alternative is to simply upgrade some critical parts - like the processor, motherboard etc. piece by piece as and when possible financially. So, the overall threat of substitutes is rather high.

Organization Chart



Strategy Framework

I. Mergers & Acquisitions

With Dell's acquisition of EMC Corp in 2016 for $67 Billion (Miller, 2016), VMWare fell into their laps. Dell's common stockholders approved a reverse merger of VMWare with Dell on December 28, 2018, which is a way to go public, without any capital rise (Wistron, 2018). The plan with this strategy was to deliver "integrated solutions from the edge to the core to the cloud".

Dell acquired Alienware, a maker of premium gaming machines, in 2006 (Whiteside, 2016). While Dell had an exclusive deal with Intel for their processors, Alienware used the competition, AMD. This move was seen as one to get access to AMD expertise while putting pressure on Intel as well.

II. Product innovation

In the enterprise side of things, Dell Technologies has shown several examples of machine learning and artificial intelligence incorporated into IoT in supply chain, healthcare and even manufacturing (Wilder, 2017). Dell is also spearheading several projects such as "Project Nautilus", and "Project Fire", which are looking into areas from ingesting, querying data streams from IoT gateways in real time, to management and storage of IoT applications (Dignan, 2017). Dell is expected to spend over $1 billion on R&D over the next three years for this.

Dell has beaten most of its rivals in the gamer market as it is the first manufacturer to sell a 240Hz high refresh rate screen on a laptop, as part of their Alienware lineup. (Dent, 2019) This would help them target the professional e-sports market as they require quick refreshing screens, as opposed to high-quality graphics. Additionally, in the Consumer Electronics Show, 2019, Dell announced the world's first commercially available laptop with upgradeable graphics, which speaks to the premium segment of gamers (Smith, 2019).

III. Partnerships and Associations

Unlike other leaders in the industry such as HP and Compaq, Dell does not believe in taking over existing competitors to eliminate competition. Instead, the company has always prided itself in using partnerships and associations for integrated marketing.

For example, Xerox's addition to the company as a partner for providing printing products and services has served the purpose of integrating one more technology to its lists of comprehensive business services. As James Vanderslice, Vice Chairman of Dell says: "By adding Xerox to our roster of preferred printing partners, we are even better equipped to serve our customers with a full range of office printing technologies that provide end-to-end solutions. The Xerox brand is synonymous with quality, technology leadership and world-class services. We share these core values." ("Dell and Xerox Forge Strategic Marketing Tie").

IV. Operational excellence

Dell's dynamic organizational structure allows it to achieve diversified targets. By allowing the components to directly become integrated into the manufacturing process of Dell, it has been able to reduce middle channel costs (Mash, 2012). These components, such as OEMs, CMs, logistics, system integrators, repair, and support companies, component suppliers, third party HW, and SW suppliers and distributors have become each of the company's manufacturing processes so that ease of provision to the customers as possible. (Mash, 2012)

V. Differentiation

Alienware is instantly recognizable as a premium gaming brand - a credit to Dell's differentiation strategy. They have very uniquely identifiable design, special lighting effects and use premium materials like magnesium-aluminum alloys and carbon fiber for the lids, as opposed to plastic which is used in the vast majority of competition (PCM News, 2018). VMWare Sphere also establishes itself as a compact and purpose-built offering and differentiates itself from Microsoft Server 2012 as having only 153MB, as opposed to over 13GB (VMWare).

VI. Focus (market segmentation)

Dell targets tech-savvy people, Professionals & Executives. Moreover, it makes customer engagement channel strong in order to stand ahead of other companies. A strong connection with customers as well as serviceability are the winning factors in the hardware & software industry and that is what Dell is working on. Dell's strategy is global. It realizes that being geographically closer to the customer is essential in carrying out its marketing strategies as well as in enabling it to build a customer base (Bhasin, 2018).

Firm

Resource-based View

According to Barney (1991), we can see that in order to generate a competitive advantage, resources must be valuable, rare, and cost-effective and irreplaceable, which allows the company to obtain the full benefits of resources to achieve a competitive advantage. For more than two decades, Dell has revolutionized the industry, enabling customers worldwide, including businesses, organizations, and individual consumers, to base their computer products. The founder of the company, Michael Dell, said that their aim is to "keep direct sales, abandon inventory and form alliances with customers".

Dell Supply Chain Analysis

Supply chain management is a key factor in Dell's undefeated long-term competition. The first is inventory management. Inventory refers to the storage of raw materials, semi-finished products, and finished products in all aspects of the supply chain (Kapucinski et al. 2004). Traditional inventory management knowledge only controls the number of products, but in the supply chain management model, inventory management connects suppliers, manufacturers and retailers to share information, coordinate and monitor inventory, thereby reducing overstock or too little inventory. Dell's most distinctive supply chain model is to produce goods based on customer orders and needs. In theory, if there is no order, there will be no raw materials in the warehouse. In fact, every part of the product is purchased into the warehouse after it has a buyer, and once the entire machine is assembled, it can be delivered to the customer immediately. Dell uses this direct supply chain model to maintain zero inventory status savings.

The second key point is that Dell has a strict supplier network and the company has always maintained a close relationship with its suppliers. Dell has established a friendly alliance with suppliers, and Dell is able to provide suppliers with low inventory costs and high-profit margins, while suppliers also show high satisfaction (Vachon 2008). In addition, on the one hand, each supplier will also assign responsibility to bear Dell's inventory crisis. On the other hand, the supplier will also help Dell quickly enter the pre-production phase after receiving the order (Kanda & Deshmukh 2008). And suppliers can get more orders through Dell's brand advantage to make a profit. As a result, supply chain can help Dell and its suppliers achieve the win-win model.

The last point is the information strategy. An important feature of Dell's supply chain management is the widespread use of **electronic information tools**. Dell's electronic supply chain system provides a virtual platform for end-users and suppliers to network transactions on the same supply chain (Zhou & Benton, 2007). More than 90% of Dell's procurement processes are done over the Internet. Every day, Dell will publish personal computer sales data through an internal website to help suppliers understand market information and also let them know which parts have been purchased and which parts will be purchased based on customer purchases. In this way, suppliers can directly understand market demand and can **predict future product trends** based on these needs. Reliable information sharing helps Dell establish a good communication model with suppliers and customers.

The three key points mentioned above are the differences in supply chain management between Dell and its competitors. But for Dell's supply chain development, these differences are two-sided, both advantages and disadvantages. First, this direct marketing model (Bhasin, 2018) is a significant advantage for Dell, which helps Dell directly **understand customer needs** and receive feedback from customers in a timely manner to help Dell predict and update its products. Second, due to efficient information sharing and advanced inventory management, Dell's **production costs are declining**, (Colt,

2019) making it a high margin. In comparison, Dell's competitive advantage is obvious. However, the downside of Dell is that logistics costs can be high. If the distribution area of the product is large but the order is small, then a small number of orders will consume a high shipping cost. Therefore, it is necessary for Dell to establish **warehouse distribution** and distribution centers in some important sales areas. Although this may result in an increase in inventory costs, delivery time will be shortened. Another disadvantage is that the preparation period is too long, which refers to the time from receipt of the order to delivery to the customer. In Dell's sales model, customers can only imagine real things through pictures or commercials. Too long a preparation period will affect product satisfaction and trust, and customers will lose patience, which is Dell's potential service crisis.

VRIO resources

I. What is VRIO? Why VRIO is important?

The VRIO framework was originally developed by Jay B Barney to access the relative importance of resources to the company. VRIO is an acronym - the value of resources, the rarity of resources, the imitation of risks and organizational capabilities. Leaders of Dell's participants can leverage VRIO to build sustainable competitive advantage by better understanding the role of resources in the overall business model of Dell participants (Colt, 2019).

II. VRIO Analysis

As a major competitor to the computer industry, Dell is committed to increasing customer satisfaction and personalizing its products.

DELL	Valuable	Rare	Inimitable	Organized to Exploit	Competitive Advantage
Personalized and customized Products	Y	Y	N	Y	Temporary Competitive Advantage
Customer Relationship Management (CRM)	Y	Y	N	Y	Temporary Competitive Advantage
Specialized Distribution	Y	Y	N	Y	Temporary Competitive Advantage

Picture from: https://sites.google.com/site/dellvsapplesarreport/sar-ii-introduction/vrio-analysis

When customers look for new computers from Dell, they will ensure that customers get the computers they want. Dell does this by letting customers personalize the brand and model of one of the computers into a processor, battery size or software that the computer will be equipped with. This instant inventory approach has proven to be successful, so it has become one of Dell's temporary advantages (Dell Analysis,2018).

Dell is focused on its customers and is always committed to ensuring customer satisfaction. The company achieves this by using **customer relationship management** (CRM) methods in business strategy. This approach applies to their personalization strategy and allows Dell to capture and analyze the data of its customers. By doing so, Dell offers rewards, exclusive offers and outstanding protection to their loyal customers. Although this has proven to be a huge success, it is easy to imitate, therefore, it is also one of Dell's temporary advantages (Google site,2018).

Many competitors only distribute to the retailers they work with, however, Dell is different, because Dell provides products directly to their customers. By doing so, Dell satisfies the customers' buying experiences, users know exactly what products they are looking for, and still maintains a relationship with the retailer, who will also try and distribute their products. This way of **specialized distribution** is very profitable for the company and has become one of the company's temporary advantages (Google site,2018).

Dell has developed technologies such as computer learning and artificial intelligence, and if it can make some improvements and innovations in the company's computers, such as researching a computer with a high refresh rate screen, making this computer the only technology in the world (Dent, 2019). New computer products that are not easy to imitate, then Dell's products will not be easily imitated by other companies for a while, and this will be Dell's advantage (Google site,2018).

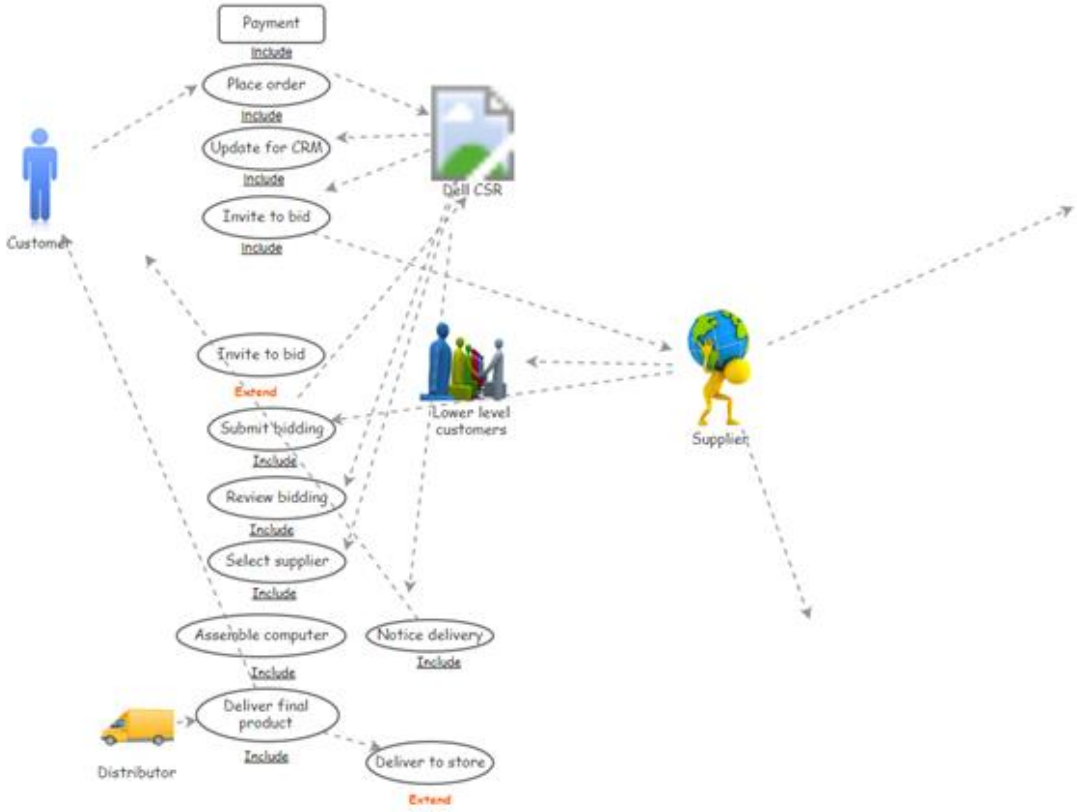
Core Competitiveness Analysis

Dell deals directly with customers and understands their needs and sells products directly to customers. Dell has been keeping in touch with potential customers and customers who have already purchased Dell products to understand their real needs and preferences, and where improvements are needed. This process does not exist independently, but it is through the entire process runs, design, manufacturing, and sales. Of course, it is still not a simple process, but through telephone calls, face-to-face interactions, and now through network communication and other channels, continuous understanding of customer feedback, timely knowledge of their products, services, and markets. Suggestions for other products. Other companies have completed the product before sending it to the order (Mba-tutorials, 2010).
In summary, we can clearly see that Dell's advantage is still very obvious. The competition between enterprises in the future is no longer the competition of products, but the competition of supply chains (Investopedia. 2018). Each enterprise should take advantage of the idea of supply chain management, based on its own reality, with channel management as its goal, and the outsourcing charter mode as the implementation method. It should be continuously optimized and implemented as an implementation method to establish an internationally competitive supply chain (Mba-tutorials, 2010).

Business Diamond

1. Business Process

Dell Business Process Diagram:



The customer selects their preferred configuration on the Dell website. After the payment is successful, the Dell system will receive the order and the customer's system information will be updated. This allows Dell to invite each supplier to bid after receiving the order, and then select a satisfactory supplier. Once the suppliers are determined, they should prepare the configuration and send them to Dell. Dell received all the configurations and assembled them. After the assembly was completed, they are ready to ship, and at the same time updated the customer system, and send notice to the customer that the computer was ready for delivery. The last is to deliver the finished product to the customer (Tan, 2015).

Dell assembles the product based on the customer's order and then sends the product directly to the customer. The essence of this model is to abandon the middlemen and retailers of the traditional commercial sales chain, saving costs and reducing product prices (Tan, 2015). This model has the following main features:

- Produced by order.
- Connect directly with customers.
- Efficient processes reduce costs.
- Product technology standardization:
- low cost + high efficiency + good service.

2. Value and Beliefs

Dell is diverse. Dell's philosophy is customer-centric. They need a team to collect and analyze customer needs and build great relationships with them. These relationships can promote Dell's business (Rubin & Myers, 2005). Dell is committed to being a friend who knows more about the customer than the customer, and the advertising of Dell is Dell Purely You (Mozza,2016). Therefore, Dell will give the customer the best shopping experience.

3. Management Control System

DELL integrates external resources through a supply chain management platform. DELL executives are responsible for DELL's success in its unique direct operating model and its modern and efficient supply chain. This supply chain management platform enables DELL to build a "**virtual integration**" between suppliers and customers (Feier, 2015). The platform ensures that the entire supply chain is seamlessly integrated. Dell hopes to achieve its goals by implementing ERP (Feier, 2015). After investing 200 million U.S. dollars in investment, and after two years of efforts, they found that ERP projects could not help DELL achieve external resource integration. Therefore, Dell's leaders decided to suspend the ERP project and invest heavily in establishing a supply chain management platform (Feier, 2015). Currently, more than 50% of customer orders are sent over the Internet, and within 50 seconds of the customer placing an order, the Supply Chain Management Platform Control Center will receive the information (Rubin & Myers, 2005). Through the supply chain management platform, Dell employees will quickly send the received order information to each component supplier, telling them the quantity, specifications, model, and configuration of the parts required by the company. The supplier quickly organized the delivery according to the relevant information. Through the supply chain management platform, DELL connects customers, parts manufacturers, suppliers, assembly lines and more (Feier, 2015).

The system uses the most advanced integrated management methods by professionals (Rubin & Myers, 2005). The service engineer directly classifies, integrates, manages and promptly and accurately answers the customer's questions, which makes the service more convenient, more efficient and faster.

4. Task and Structure

The organizational structure of a company is subject to strategy, so changes in the company's strategy may lead to changes in organizational structure.

Dell's strategy has three points. One is the direct sales model, which divides the internal and external sales teams according to the customer base and adjusts the sales department (UKESSAYS, 2016). Dell has built a customer-centric organizational structure. The company will establish different sales departments according to different characteristics of different target customers, preferences and procurement methods. There are currently three departments: LCA, PAD, Small Business, and Home User Department (Ruxiang, 2015). The main job of employees is to use and maintain Dell's **sales automation system** to flatten and soften the organizational structure. The second is to customize the **supply chain** structure of the organization as needed. Three directly serve customers.

Dell is constantly looking for the best fit of strategy and organizational structure, but it still has some problems. First, Dell ignored the integration of corporate culture and personnel in the matching process (UKESSAYS, 2016). Dell is a company that emphasizes execution, efficiency, and digital management. Therefore, its assessment system is very strict. The short-term seats of high-level people pursuing performance are passed to the lower-level personnel, which will cause the whole company to make a quick and profitable attitude from top to bottom (UKESSAYS, 2016). This corporate culture will result in a large flow of talent. Second, the adjustment of the organizational structure during the matching process is less flexible. A good corporate organizational structure must be flexible enough to allow employees to make progress together with the company, rather than just the development of the company itself (Ruxiang, 2015). Dell's specific organizational structure is easier to manage, but it tends to be sales and customer management, putting the enterprise center on the business opportunity, ignoring the development of employees (UKESSAYS, 2016). This inelastic organizational structure is not well integrated with strategy and may even be a drag on strategy implementation (Ruxiang, 2015). If Dell wants to implement its strategy well, it must make the appropriate adjustments to ensure the company's growth.

Dynamic Capabilities

The concept of ‘dynamic capabilities’ arose and became popular to explain how the company is adapting in the fast pacing environment to integrate the internal and external competences and orchestrate assets. The concept of ‘Dynamic Capabilities’ is defined differently by several researchers and Teece (1997) defined it as the firm’s ability to integrate, build, and reconfigure internal and external competencies in order to address rapidly changing environments (Asset orchestration process).

Dell has been survived in the computer hardware, software, and other technology industry for over 30 years. As the market goes more competitive with the technology advance, Dell has to expand its market and to keep innovative its products. One of the very products that Dell has built is its unique supply chain management integrating technologies and customers into its system. This system aligns with Dell's goal to invite more customers and to adapt to face pacing environment.

Sensing:

We have analyzed how the market is competitive within the computer industry such as hardware, software, and other related technologies. As the companies in the market are born to employ technologies, Dell has not only focused on innovating its products (Dent, 2019) but also made diverse ways to expand their market share within the market such as Black Friday or Christmas deals for temporal advantages or global marketing strategies.

Dell has accumulated a lot of data from its assets not only about goods but also sales, marketing and so on. The founder of the company, Michael Dell, said that their aim is to "keep direct sales, abandon inventory and form alliances with customers." The output of the aim and how Dell established to attract more customers and survive in a long-term competition was its innovative supply chain management. (Zhou & Benton, 2007) This supply chain management allows suppliers, manufacturers, and retailers to share information and communicate within the system. Also, this unique system connects customers as well by customizing their orders. The platform-like system enables to plan next steps of strategies for Dell.

Seizing:

For tech companies, it is hard to accompany new technologies into the organization. There are challenges to aligning new things for several reasons. One is that acquiring suitable talents that can deliver the new skills and fit into the company takes time and efforts to ensure a certain level of performance. (UKESSAYS, 2016) Also, since the success of the products or technologies is depending on timeliness as one of the vital factors of many, it is unclear to gain advantages in the market when the products cannot be delivered on time.

Dell has done mergers and acquisitions to adopt new skills and technologies to expand their market. Dell acquired EMC Corp in 2016 and VMWare fell into Dell's family. (Miller, 2016) It allows Dell to deliver integrated solutions for their products. The acquisition increases the chance of enhancing the quality of their products or services and gaining market advantages with a lower risk of human resources and timeliness.

Aligning Information System Strategies with Business Strategies

To succeed in an omnichannel environment, business must know how technology can help customers interact in ways that meet their needs. Technological innovation is one major step Dell has thrived on to maintain a competitive edge over its competitors. Dell has focused its company

on areas of growth like cloud computing, big data, security software, and mobile. Its future is in the services business. (Dell Technologies, N.D.)

Here are some of the technologies used by Dell to meet their business strategies.

Focus (Market Segmentation):

Dell has a huge presence in the healthcare segment. 62% of US hospitals use Dell computers and laptops (Healthcare and Life Services, N.D.) with even more using Dell storage. A large segment of corporations also uses Dell systems due to the large number of accessories and docking options.

When it comes to companies, in order to rake in the most customers, Dell would need to offer their products at a low price and a quick pace. This is where its relationship with its suppliers comes into play. The Supply chain management software, specifically the Electronic Distribution Tools (Zhou & Benton, 2007) help Dell not only keep track of each stage of an order, it can also help the suppliers and consumers have enough information to know at what stage the order is in currently. This leads us easily into the next Business Strategy.

Operational Excellence:

Very much in tune with the Supply chain system discussed in Market Segmentation, Dell uses Customer Relationship Management Tools (Google site, 2018) for managing all aspects of procurement, all the way until delivery. Due to this, the customer has access to all the information that they could possibly need, including what the status is of individual suppliers. By creating this virtual integration, it makes the process of purchase very seamless and efficient to the customer (Ruxiang, 2015)

Monitoring social media and using it as a marketing and troubleshooting platform is being implemented by almost all the tech giants. Dell has leveraged the social interactions as part of their data collection strategy and has used the same for service delivery. (Swallow, 2010) A lot can be learned through social media interactions. Putting the data collected through social media to use can help Dell deliver what its customers want, faster and better.

Aligning Organizational Strategy (Skillset) with Information Systems Strategy

As previously discussed, Dell's main Information Systems strategy revolves around its procurement and inventory management. The main information systems used include:

1. Electronic Distribution Information Tools (Zhou & Benton, 2007)

2. Customer Relationship Management Tools (Google site, 2018)
3. Sales Automation system

Within their departments of LCA, PAD, Small Business, and Home User Department (Ruxiang, 2015). They aim to achieve what is called a “virtual integration” between all aspects of the purchase from the supplier to the consumer so that all information is readily available to all relevant parties at all times. (Feier, 2015). All of these forms a part of Dell’s supply chain management system.

The structuring of the above-mentioned departments and the details mentioned in the Business Diamond details how the Organizational values of customer-centricity and their Tasks and Structures align with the above-mentioned Information Systems.

Since connected devices and IoT (Dell Technologies, N.D.) are the pinnacles of technology Dell has introduced in multiple devices that are connected and can be used to perform the same task, this technology might be very useful to target customers who work in complex environments (mostly tech-savvy professionals). These are the skill sets that we require to achieve technological innovation in the market.

Software Engineers and Project Managers – We're covering a couple of bases here because these jobs will be required in various forms from one end of the Industry ecosystem to the other. Manufacturers will need folks to write and modify programs for machines as well as develop new interfaces for their human counterparts to interact with them. We think that there will be a raft of data visualization and dashboarding jobs because many of these processes will require a "digital twin" so operators can oversee and interact with operations from a network operations center (NOC).

We think that they will be further challenged by having to link legacy systems and machines to new proprietary platforms from different manufacturers as well as supply chain applications. To do this, they will also have to become familiar with multi decade old serial communications protocols and architectures.

We mainly see alignment of professionals with these skill sets in the infrastructure side of things - Dell uses custom CRM and Supply chain information management tools (Zhou & Benton, 2007), and in order to maintain the information systems, at the most basic level, they would require analysts and programmers to take care of incremental changes, fix bugs etc.

Network Engineers and Architects– Connecting machines to each other and to the command and control systems that will oversee them will require the skills of a highly-skilled network engineer. They will have to be up to date on WANs, edge networking and fog computing as well as next-gen 5G networking technologies, WiFi, and the low-power LAN protocols that IoT devices often run on (Supalla, 2018).

“They will need to appreciate the challenges imposed by connecting systems and machines that were never designed with networking in mind. The cloud factors prominently in Industry ecosystems so moving data around efficiently with as little latency as possible will be a priority. Network function virtualization (NFV) and software-defined networking (SDN) will also be valuable skills to know as will open source technologies”, said Tabet who is the chief architect for IoT Solutions at EMC. (Bernard, 2017)

Similar to the previous listing, Network engineers and infrastructure architects in the vein of Supply chain, would be needed and would be critical to maintaining the infrastructure of the same, in addition to the Sales Automation System (Ruxiang, 2015), and all of Dell’s other internal systems.

Data Analysts and Scientists - Data is the lifeblood of an Industry so people who work with it, and glean intelligence from it will be highly prized. All of that data will need to be captured and analyzed so it can be used to improve machine performance, reduce resource consumption, assist in quality control, make supply chains more efficient and introduce new products and services. As mentioned in the Supply Chain analysis section previously, Dell prides itself on understanding its customer needs. Direct marketing model (Bhasin, 2018) is a significant advantage for Dell, which helps Dell directly understand customer needs and receive feedback from customers in a timely manner to help Dell predict and update its products. This feedback would generate a lot of data, which analysts could use to successfully forecast important information.

As it has been established, Dell’s production costs are declining (Colt, 2019), showing that this alignment of OS and IS seems to be working well. Now, certainly there are other professionals, like cybersecurity, quality assurance etc. that are needed for Dell to function, however, from the supply chain management perspective on which we are focusing, these are some major roles that would be reporting to the Chief Information Officer.

An application or Company partnership that can improve Dell’s strategy - Salesforce

Salesforce is the global leader in CRM, and Dell Technologies got into an extended strategic partnership with Salesforce. (Salesforce News, 2017) Extending the long-standing relationship between the two companies, Dell Technologies expanded the use of Salesforce's market-leading sales, service, and marketing applications and CRM platform, which have been made smarter by AI, to thousands of Dell Technologies employees worldwide, empowering them to deliver even greater customer success.

As mentioned in the Supply Chain Analysis section of our strategy analysis, Dell believes in a strong connection with customers and serviceability has always been a major factor for Dell. This would not have been possible without Salesforce’s CRM partnership with Dell. (Salesforce News, 2017)

Tech Adoption - Brain-Computer Interface

What is BCI?

Brain-Computer Interface (BCI) is a technology that allows communication between human or animal brains and external technologies. This means that BCI passes signals from the brain to the interface of external hardware, or the technology that sends signals to the brain (Techopedia, 2019).

BCI can be divided into three categories: non-invasive, semi-invasive, and invasive.

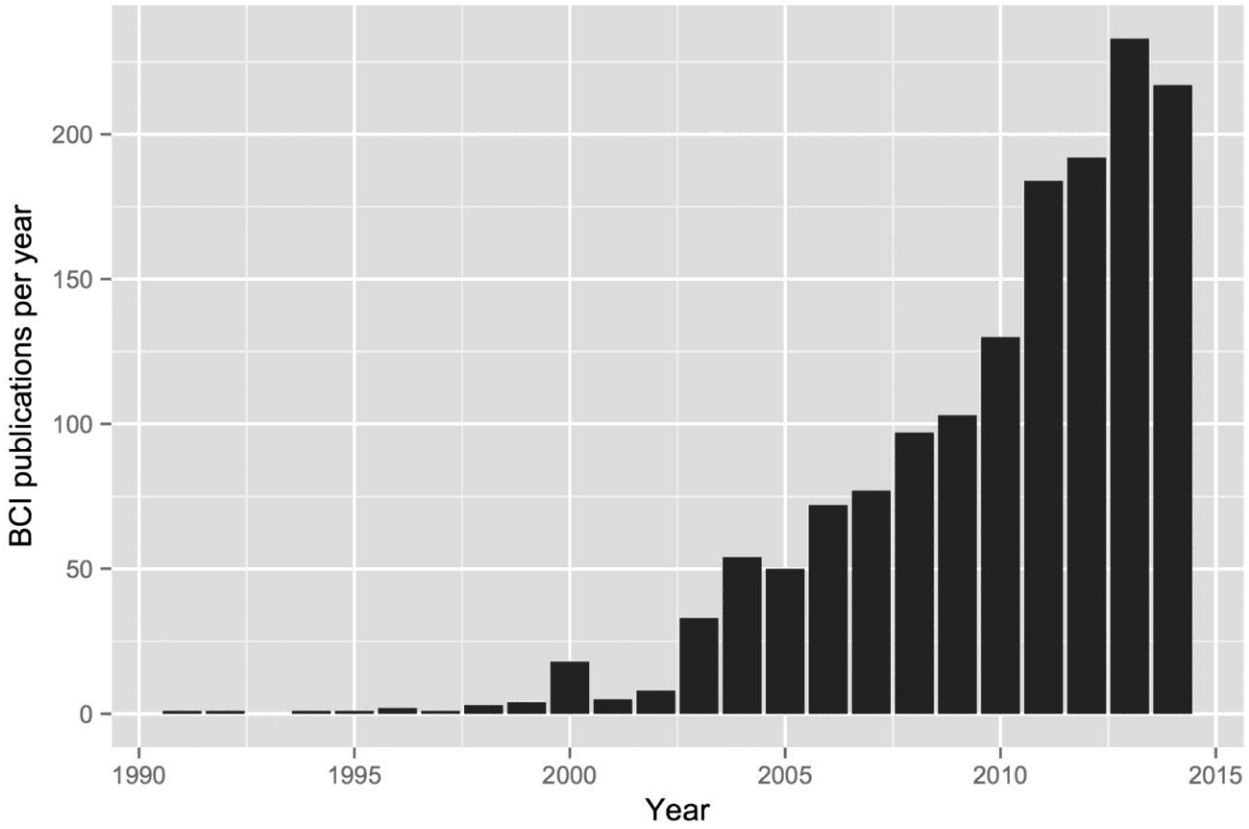
Invasive BCI
It requires placing a sensor on the scalp to measure the potential generated by the brain (EEG) or magnetic field (MEG).
This BCI signal is of the highest quality, but there is a risk of scar tissue formation in this process. The human body reacts to foreign matter and forms a scar around the electrodes, which causes the signal to deteriorate. Since neurosurgery can be a dangerous and expensive process, the goal of invasive BCI is primarily blind and paralyzed (Waldert, 2016).

Semi-invasive BCI
It requires placing the electrodes on the exposed surface of the brain (ECoG). The positive features of ECoG are high spatial resolution and confidence; fidelity; resistance to noise; lower clinical risk and robustness and amplitude over longer recording periods (Waldert, 2016).
This BCI still requires craniotomy to implant the electrodes. Therefore, it is only used when surgery is required for medical reasons, such as epilepsy.

Non-invasive BCI
It requires placing the microelectrodes directly into the cortex and measuring the activity of individual neurons. The vast majority of published BCI work involves non-invasive BCI based on EEG. EEG-based non-invasive technologies and interfaces have been used for a wider range of applications. Although EEG-based interfaces are easy to wear and do not require surgery, they have relatively poor spatial resolution and do not effectively use higher frequency signals because the skull suppresses signals, disperses and blurs electromagnetic waves generated by neurons (Waldert, 2016).

Growth of BCI as a Technology

Brain-Computer Interface (BCI) is a relatively young research field which has seen a growing interest with associated number of publications over the last two decades. Results indicate that BCI literature follows a power law growth, has an average author count of 3.9 and an average page count of 7.09. More than half (52.73%) of the BCI literature is never cited, and 14 papers have been cited more than 100 times. The 3 most productive authors are leading BCI research groups, in Austria, Germany and the USA. (Kim, Cho, Hwang, Lim, & Im, August 2011)



(Retrieved from: https://www.tandfonline.com/doi/full/10.1080/2326263X.2015.1008956?scroll=top&needAccess=true#)

There are many conferences and events that are taking place across the globe today. These are some of the related BCI upcoming conferences:

- IGS2019 – Your Brain on Art - Cancun, Mexico (Your Brain on Art Conference, 2019)
- Gordon Research Conference on Bioelectronics - Andover, NH, USA (GRC, 2019)
- Neuro Informatics 2019 - Warsaw, Poland (INCF, 2019)
- Bioelectric Medicines: Past, Present and Future - London, UK (SMR, 2019)
- IEEE SMC 9th Workshop on Brain-Machine Interface (BMI) Systems - Bari, Italy (Upcoming Events, 2019)

A measure of progress of BCI Technology is the attendance at international conferences.

- The six Graz BCI conferences in 2002, 2004, 2006, 2008, 2011, and 2014 were attended by 32, 52, 95, 116, 169, and 189 participants, respectively. (Brunner et al., 2015)
- The 2013 BCI Meeting was the 5th in the International BCI Meeting series with past meetings in 1999, 2002, 2005, and 2010. The meeting drew scientists from 29 countries,

> representing 165 research groups, with a total of 301 attendees, of whom 37% were students or postdoctoral fellows. (Brunner et al., 2015)

The brain-computer interface (BCI) field has been growing dramatically over the past few years, but there are still no coordinated efforts to ensure efficient communication and collaboration among key stakeholders. The European Commission (EC) has recently renewed their efforts to establish such a coordination effort by funding a coordination and support action for the BCI community called 'BNCI Horizon 2020' (BNCI 2020, 2019) after the 'Future BNCI' project. Major goals of this new project include developing a roadmap for the next decade and beyond, encouraging discussion and collaboration within the BCI community, fostering communication with the general public, and the foundation of an international BCI Society.

Press Coverage of BCI Technology

Press coverage trends tell an overall view of the topic about how much potential the topic has and/or how popular does the topic be. Media tends to write articles that can attract people's attention to make them read their articles. Thus, the press is highly likely to publish and deal with popular and promising topics. For example, the news search trends of Virtual Reality (VR) technology shows that it was the peak in October 2016 and currently it's in gradual decreasing phase (Google Trends, 2019). This shows that the technology was a rising star at the peak moment but now the sweet dream of the technology has fallen and only companies which can harness its capabilities and make profits from them adopt this technology.

One way we can dig this trend is available in Google trends. This trend service provides the relative interest of the topic over time the user selected. It also presents the trends of the topics shown by news search as well as web search.

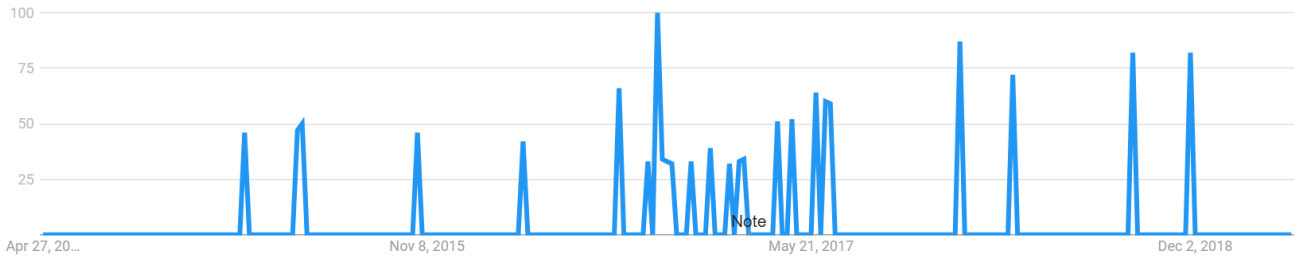


Image retrieved from:
https://trends.google.com/trends/explore?q=brain%20computer%20interface&geo=US

Surprisingly, the above figure from Google trends shows that the peak period when the term BCI has been mentioned is not recent, but from August 2016 to June 2017, which is over three years ago. Unlike other emerging technologies as we can find in the innovation trigger phase in the

Hype Cycle, BCI was already popular, but not as much as in these days. The rate of interests has not declined a lot, but the frequency was lower than the peak periods.

Image retrieved from:
https://trends.google.com/trends/explore?q=brain%20computer%20interface&geo=US

Among the recent 12 months above, media have covered BCI in the last 2 months more than other months. However, since Google trends only shows the relative interests among time, searching the number of news is critical to know how many articles were out there to understand the exact amount of press coverage.

The result from Google News shows that there are 101 news articles about BCI for a past year, which means about 25 articles are represented as the peak number of articles in the past 12 months. Accordingly, 33 articles were the peak number of news for the past five years. (Google Trends News, 2019)

Level of adoption of BCI among companies

According to the report, companies in a wide range are working and adopting BCI technology to expand their market shares such as in healthcare, gaming and entertainment, and communication and control domain. (Person, 2015) Since this technology is connecting the human brain and computer technology, it enables people to work without actions. Let me share the companies which opt the technology.

Neuralink - Elon Musk, the CEO of SpaceX and Tesla, launched a new business in neurotechnology startup in 2016. (Marsh, 2018) The teams in Neuralink research on BCI technology and, on April 24th (Marsh, 2018), announced that new information would be coming soon, which refers to a brain-machine interface that could one day hook human brains up to computers. Neuralink has initially concentrated on medical applications before focusing on developing a symbiotic relationship between artificial intelligence and humanity.

Facebook - The worldwide social networking service provider is also running the business in BCI area. (Tangermann, 2019) Facebook revealed it has a team of 60 engineers working on building a brain-computer interface that will let you type with just your mind without invasive implants. The team plans to use optical imaging to scan your brain a hundred times per second to detect you speaking silently in your head and translate it into text.

EMOTIV - Founded in 2011 by tech entrepreneurs Tan Le (CEO) and Dr. Geoff Mackellar (CTO) the company is a bioinformatics company advancing understanding of the human brain using electroencephalography (EEG). (EMOTIV, N.D.) EMOTIV makes it possible to control machines using your mind. Trigger events using thoughts with our Mental Commands detection. Tune applications in real time to respond to your cognitive state using our Performance Metrics. EmotivBCI, one of the products, lets users train multiple Mental Commands. (EMOTIV, N.D.) It can also enable users to view the Facial Expression and Motion Sensor data streams from the headset which can augment its BCI application.

We think that due to the high cost of R&D, the entry barrier to the technology is high, so many companies need to have sufficient expertise rather than rushing to introduce it and, thus, the adoption rate is not high. However, as technology advances, the barriers of the technology are likely to decrease and companies will adopt the technology.

Top Vendors of BCI

In the future, we can use the brain computer interface to control things with our brains, and even people can communicate directly with each other with our minds. Many technology companies believe that brain interface technology will become part of our lives in the coming years. Next, we introduce several companies that delve into brain computer interface technology.

MindMaze

MindMaze is a Swiss company founded by Tej Tadj in 2012. It builds a platform that combines VR, brain imaging, computer graphics and neuroscience (Linkedin, 2018). It creates a medical-grade neuro-virtual reality platform that combines virtual reality, augmented reality, electroencephalography (EEG) scanning and motion capture technologies (Aaron, 2016). To date, MindMaze's technology has been used primarily for the treatment of stroke victims in European hospitals (Aaron, 2016). That is to say, the company has developed a user interface which is integrated into a wearable head mounted display (HMD) and a 3D motion capture camera for the nervous system (nAnalyze, 2017). This user interface creates VR and AR environments for disease patients. It is designed to provide multi-sensory feedback to patients with brain damage to stimulate motor function during recovery (nAnalyze, 2017). It's a thought-driven VR/AR and motion capture game system, just like in simulations, people can use their minds to control the results. For hospitals, this technology package is expensive. It costs $80,000 or $2,500 per month (Aaron, 2016). MindMaze is expected to offer an affordable version for consumers (Aaron, 2016).

Kernel

Kernel is a neuroscience company founded in 2016 by Brian Johnson (Nick, 2017). It developed an interface that helps researchers and clinicians better understand neurological diseases and dysfunctions such as Alzheimer's disease, Parkinson's disease, depression and anxiety. Kernel aims to develop clinical solutions for neurological and neuropsychiatric disorders using knowledge gained from understanding basic brain functions (Nick, 2017). The company's goal is to “read and write the basic functions of the brain” (Nick, 2017). This goal is mainly for the hippocampus, which records people's long-term memory. Kernel uses AI to read the contents of the hippocampus write chip, and its accuracy is as high as 80% (nAnalyze, 2017).

NeuroPace

NeuroPace is a Silicon Valley-based medical technology company founded in 1997. NeuroPace is developing a medical device-RNS system. The system is used to treat refractory epilepsy, affecting at least 1 million people in the United States (NeuroPace, 2018). The RNS System is a type of BCI that identifies seizures by continuously monitoring brain waves, identifying each patient's unique “seizure onset fingerprint” (NeuroPace, 2018), which is emitted when it recognizes abnormal brain activity Pulses counteract or destroy abnormal signals that mark seizures to stop seizures (nAnalyze, 2017). Tens of millions of people around the world may have sudden seizures, and NeuroPace may help these people.

Rythm

Rythm is a neuroscience startup founded in 2014, that combines neuroscience and state-of-the-art technology to enhance human performance by exploring, monitoring and decoding the brain (Gust, 2018). Sleep clearly experienced a cycle of mild sleep, deep sleep and rapid eye movement (REM) sleep (nAnalyze, 2017). Dreem is their first product. It is a wearable headband that uses EEG to monitor brain activity and actively stimulate it to improve the quality of deep sleep (Gust, 2018). The company's products can solve the sleep problems of most people.

Platform and Network Effect

What is network effect?

Network effect is a phenomenon in which increasing the number of people or the number of participants can increase the value of goods or services (Banton, 2019).

Direct network effect:

The increase in usage leads to a direct increase in the value of other users. For example, telephone systems, fax machines, and social networks all mean direct contact between users (Banton, 2019).

Indirect network effects:

An increase in the use of a product or network increases the value of a complementary product or network, thereby increasing the value of the original product. This is also known as the cross-network effect. Most bilateral markets (or platform intermediary markets) are characterized by indirect network effects (Banton, 2019).

Platform and Network Effect of BCI

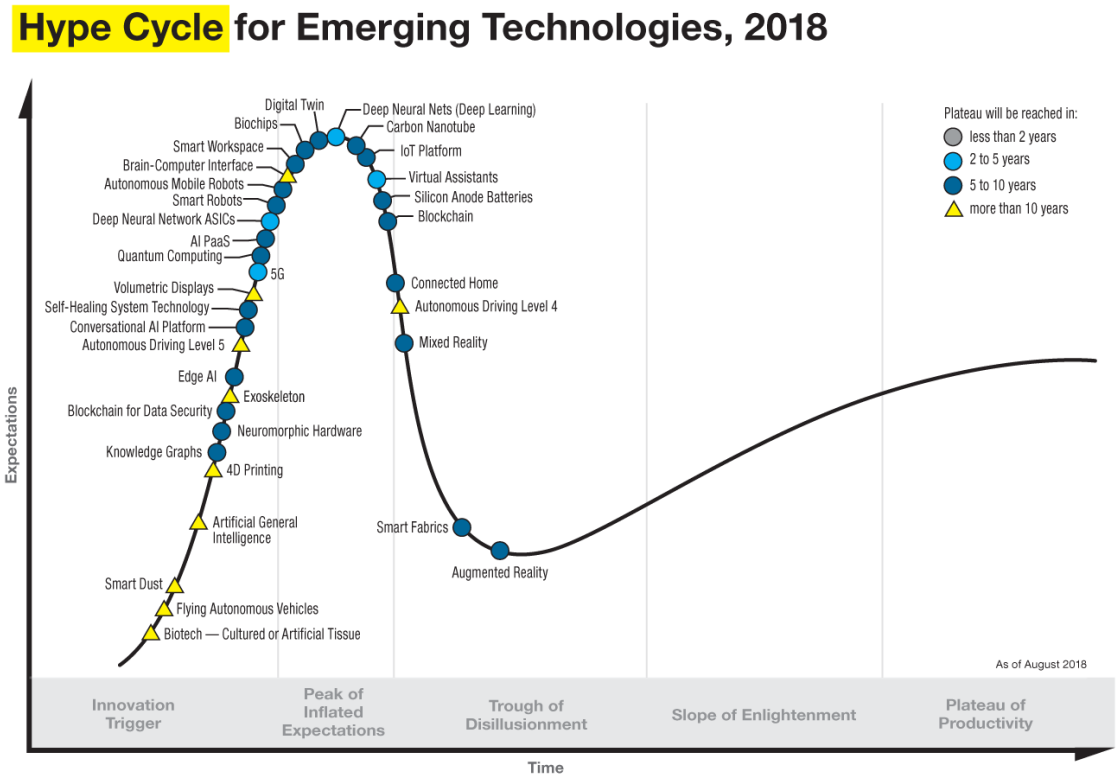
Brain-computer interface (BCI) is one of the interface technologies between people and machines. Brainwaves are very weak and there are many kinds of noise, so all companies that study BCI have to know which features are useful, how to extract these useful features, and how to suppress noise (Buch, el., 2018). Most of current applications of BCI are used in medical field, and people need to study deeply this technology to apply it to other fields, which can attract more users. That is to say, with the increase of BCI application and related products in various fields, its value will increase with the increase of users.

Fashion Bubble and Consultancies

Currently, the adaptation of the brain-computer interaction (BCI) is minimal and experimental at best. Despite having its beginnings from 1970s, BCI has yet to adopted to the market and to the larger IoT market. Rather BCI, has entered into the the healthcare sphere, “in order to improve quality of life for those suffering from stroke, spinal cord injury, or traumatic brain injury… [and] to restore the nervous system and reduce neurological deficits” (Krucoff et al., 2016). Despite the possibilities of improving quality of human life, still in 2019 the BCI resides within the areas of the R&D (research and development) and the larger research laboratories, even amongst the big players like Neuralink and Facebook, as mentioned previously. Therefore, there are no consultancies that provide implementation services for the BCI.

Hype Cycle

Based on several researches like Santhanam et. al, (2006), Schalk et. al. (2004), exploration into BCI started in the mid to late 2000s. Post this, is where the innovation trigger possibly started.



Retrieved from: https://www.gartner.com/en/newsroom/press-releases/2018-08-20-gartner-identifies-five-emerging-technology-trends-that-will-blur-the-lines-between-human-and-machine

Brain Computer Interface has just moved onto the Peak of Inflated Expectations. So, there are a lot of public successes as mentioned just prior, like Kernel and Neurable. There are many companies that are looking to pursue avenues in BCI, like Kernel, who are heavily promoted, while failures are less so.

We feel that once the trough of disillusionment passes, the failures are shaken off, and once it moves to the slope of enlightenment, Dell and its competitors would possibly move into BCI. However, we feel that companies like Dell should be innovating on this front. Dell's 4th quarter fiscal consolidated revenue were $21.9B. (Dell Technologies, 2018) So, rather than startups failing to get funding and good ideas never coming into fruition, Dell should try to explore some facets of BCI.

As is very obvious, from the hype cycle, BCI is far from reaching the plateau of productivity - over 10 years. This means that Dell has more time to try and fail, before they come up with a revolutionary solution to whatever BCI problem they're trying to solve.

Success Stories

Brain-Computer Interface, as a technology, is in a very nascent stage, as will be discussed in the hype cycle.

Kernel (company) has explored options to try to read/write information to/from the brain/the human body. It was founded in 2006 by Bryan Johnson, who had a goal of attempting to help

people suffering from severe neurological problems like Alzheimer's and Dementia. (Johnson, 2016) Johnson wants to develop a chip called a 'neuroprosthetic' to help said people deal with their disabilities. He's confident that even though it's a long play, it's going to be worth it - he's able to do all this as he sold his payments company, 'Braintree' to Paypal. The company has a total disclosed funding of $100M (CBInsights, 2019)

Neurable, a startup, raised $2M, uses electroencephalography (EEG) to help monitor brain activities. (nAnalyze, 2017) This is further mapped using AR to functions, with applications in gaming - such as in menus. It is attempting to sell its software to manufacturers like HTC, Microsoft and Oculus.

Gap in current implementation/Failures

The major gap among organizations that arises due to implementation of Brain Computer Interface are due to constraints that are arising from engineering, computational, ethical and neuroscientific factors.

The most immediate barrier to the wider implementation of BCIs is the difficulty in implanting them. (Mitrasinovic, 2018) There is no technology that exists which record an action potential without the need of a major surgery. The technology that exists can only record activity to the extent of a neuronal circuit and hence can only for low bandwidth interfaces. The Quality of recordings also degrade in time.

The next barrier is connection to a device. (Mitrasinovic, 2018) Let's assume that we are able record the action potential. This is just the first half of BCI. The signals must be communicated to a computer through a wired or wireless communication. Wireless communication creates a host of new problems in terms of bandwidth and the need for an implantable battery – which may last only a few months when powering a large BCI system. The system would usually require a communication protocol as fast as Thunderbolt 3 connection (Thunderbolt Technology, N.D.) which is offered only by Apple and Intel currently. Requirement of such complex devices increases the volume which is a critical flaw in any intracranial device.
The current multi electrode systems that are available can scan and record hundreds of neurons in an area whereas a general purpose BCI would require at least the sampling of tens of thousands of neurons from multiple cortical regions. (Mitrasinovic, 2018) This is a surgical challenge that is far beyond what is achievable using the technology that is available now.

Computational and data analysis challenges are also a huge barrier for organizations to implement this technology. After the signal is detected, it must be checked for spikes and the spikes must be sorted. (Mitrasinovic, 2018) Spike sorting is still an area of active research and has no clear optimal solution.

Physical scalability of the BCI systems are also something of a concern. The brain is a three-dimensional structure and manufacturing devices with a complex 3D Structure and including integrated electronics still pose a problem. Current designs of multi electrode arrays are typically not suited for scalability. (Mitrasinovic, 2018)

Real time processing of highly parallel recording systems still remains a key issue in this field. (Mitrasinovic, 2018) This would require a shift from the traditional central processing units to a more definitive application specific integrated circuits designed to perform a particular set of

functions, such as Google's tensor processing unit or the graphical chip found in computers.

As such, we can't say that there are many failures as such in the market, because the technology has just about crossed the innovation trigger in the hype cycle. As soon as it passes the Peak of Inflated Expectations, there will be more occurrences of failures (Stamford, 2018).

How BCI could help Dell's business

Gaming and Entertainment

Dell recognizes that gaming is a serious contender within the entertainment sector and that it is now perceived as a leading entity within the interactive market. Video games are now more widely accepted in everyday mainstream society and this can be seen through vehicles such as the media. (GamesIndustry International, 2004)

Gaming has gone far beyond the basement, and Dell is ready to support the industry's growth in many ways. From delivering the hardware needed to create the games to the PCs which are used to play them, to sponsorship of eSports leagues and professional gamers that bring the gameplay to even larger audiences. Dell has also refreshed their entire Alienware notebook lineup and continues to push the limits when it comes to performance. (Pevehouse, 2017)

At present gaming business revenue for Dell is approximately **$3 billion** (Ridley J.,2018) BCI is an upcoming disruptive technology for the gaming industry and as we saw from our previous analysis Dell has emerged as a superpower when it comes to the Gaming industry, so if Dell wants to maintain its supremacy it has to incorporate BCI. When it comes to brain-computer interfaces (BCI) and their use in video games, it can be hard to separate fiction from reality.

While it may seem far-fetched, however, here and now the technology is already proving its worth. While not yet really an option for consumer gaming, BCI games are already being used for a host of different health-related projects, creating a whole new way of thinking about how we treat a variety of conditions. But as time marches on, BCI could have a transformative impact on the world of video games. Thus, using BCI could help Dell in the long run.

Brain-computer interfaces (BCIs) have widely been used in medical applications, to facilitate making selections. (Hakvoort & Poel, (2011)) However, whether they are suitable for recreational applications is unclear as they have rarely been evaluated for user experience. As the scope of the BCI applications is expanding from medical to recreational use, the expectations of BCIs are also changing. Although the performance of BCIs is still important, finding suitable BCI modalities and investigating their influence on user experience demand more and more attention and hence Dell can make great use of it if they identified the opportunities through BCI and implemented them. (Hakvoort & Poel, (2011))

Laptops, PCs, Smartphones

Two minds may be better than one, but one mind connected to millions of others would be infinitely superior.

That's the thinking behind several companies that are currently racing to link mind and machine

by way of devices through the is brain-computer interfaces. Thus, putting this functionality in a laptop will help people to communicate seamlessly, instantly, and with whomever — or whatever — they want. Dell's primary products are laptops & PCs. Not only are laptops Dell's primary share in revenue but they also are what is Dell known by, hence Users can quickly learn how to activate a BCI interface and efficiently use it to operate a PC. Disabled users - like visually impaired could be able to use special computers, if they are being produced with BCI technology by Dell. (arXiv, 2017) (Li, Conti & Ding, 2015) (Brodwin E, 2018)

Rationale to adopt or not

To explain the rationale for Dell to adopt BCI, let us see how BCI aligns with Dell's Business strategy.

Innovation: Dell technologies have been continuously beating its competitors due to its Innovation in technology in the Laptop and Gaming Industry and BCI will be an extension to that.

Differentiation: Alienware is recognizable as a premium gaming brand - a credit to Dell's differentiation strategy, BCI will help Dell in maintaining this differentiation

Focus: Target customers for Dell are always tech-savvy people, Professionals & Executives. Moreover, it makes customer engagement channel strong in order to stand ahead of other companies. BCI will bring Dell closer to customers in Customer engagement

- Dell has a huge market if it implements BCI on Laptops and PCs as they are the main products that help Dell in gaining revenue, by adapting BCI Dell will be in par with its competitors.
- Dell has to fast adopt BCI not just to maintain but also to multiply its revenue in the gaming industry because BCI is the future of Gaming.

Furthermore, a staggering 65% of American hospitals use Del infrastructure. (Healthcare and Life services, N.D.) If we include corporations, the raw number increases hugely too. Dell has a very solid pre-existing base of corporate customers. Incorporating BCI to their hardware can help provide job opportunities to a huge number of physically handicapped individuals.

Acquisition: Now, for Dell to accomplish using BCI, it would need a significant amount of expertise in the market as well. Since these skills are difficult to come by, we feel that perhaps acquiring one of the many startups we mentioned in the success stories sections could be a good idea. This way, Dell will acquire all the necessary skills and competencies needed to deal with BCI hardware and can work on integrating it into its own hardware/computers to sell.

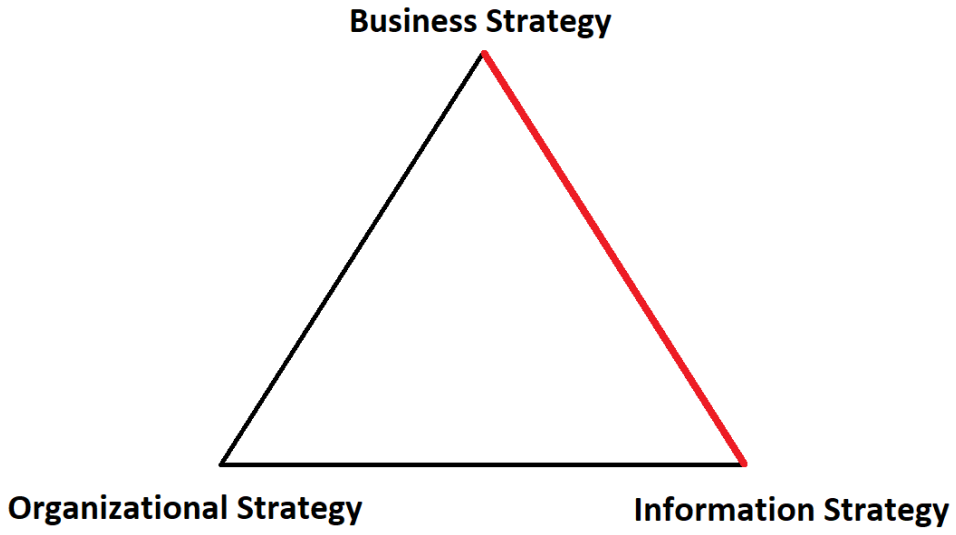
Thus, we can show that from a Business Strategy standpoint, BCI can help Dell a lot, especially in the corporate and healthcare segments of the market.

As for the Information Strategies to incorporate BCI, we feel that Dell would need to do the following:

1. Append their CRM solution to incorporate the sellers of BCI related hardware. The Electronic Distribution Information Tools (Zhou & Benton, 2007) that Dell typically uses to manage inventory and communicate information with clients and suppliers will need to be updated with BCI vendors.
2. The new people brought in to deal with BCI related tasks within Dell, through the acquisition proposed, will also have to be integrated into the Salesforce Customer Relationship Management Tools (Google site, 2018).

3. Dell's Sales Automation System will also have to be modified to incorporate the BCI offerings that Dell is planning to sell.

In short, the Information Systems Strategy will need to be remodeled in the realm of Supply chain to add more nodes in the process for BCI. Now, we see an alignment between Business and Information Systems Strategy.



Now, in order to align the Business Strategies and Information Systems to the Organizational Strategy, let us look at the skill sets that are needed to accomplish the integration.

Dell's main departments of LCA, PAD, Small Business, and Home User Department (Ruxiang, 2015) will need to add another branch for BCI tasks. This branch would host the new employees in BCI, the head of which would be Dell's Chief Information Officer, Mr. Bask Iyer (High, 2018), who coincidentally is VMWare's CIO as well (Miller, 2016).

In addition to the departmental change, Dell would also need to acquire laboratories for BCI testing purposes. They would also need necessary instrumentation to perform BCI tasks.

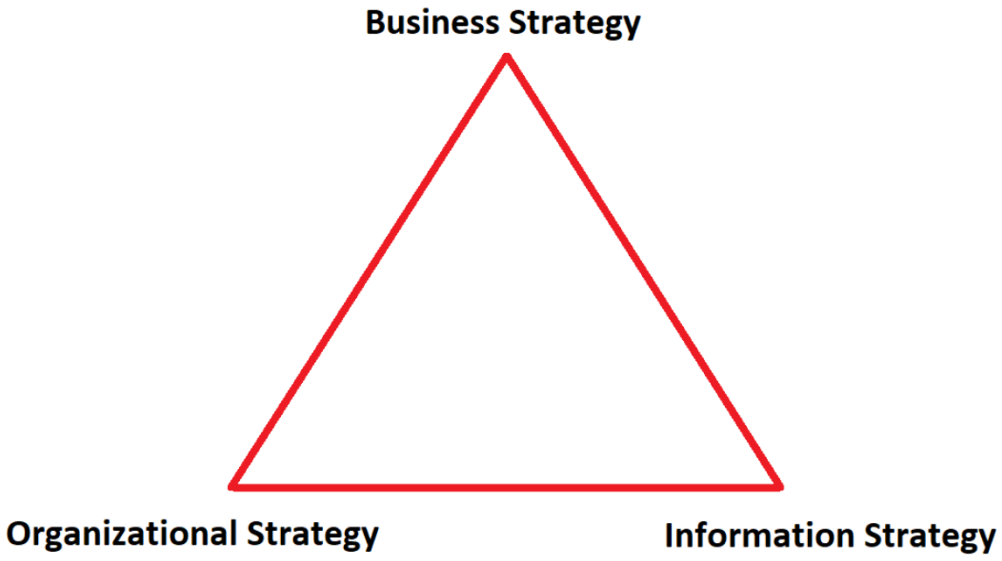
We feel that the following jobs would be necessary somewhere in the above-mentioned department:

Neuroscience experts - To understand the intricacies of the working of a brain, Dell would need to employ Neuroscience research technicians (Kernel, N.D.). They would ideally work in a lab, participate in instrument calibration and help read brain wave data. These people would likely have a research background, preferably in a medical field.

Engineers proficient in MATLAB - This individual would likely be interpreting the data that the neuroscience research experts drew from equipment. They would be well versed in MATLAB/CAD and other modelling tools (Kernel, 2018). They would ideally have a background in Robotics, Mechanical or Electrical Engineering.

Machine Learning Engineers/Scientists - The individual would have experience in C++ or Python (Kernel, 2018) and have a basic knowledge in NumPy/Tensorflow etc. and also know how to build models. They would have a Masters or PhD. in Physics, Mathematics, or any Information Studies with an emphasis on Machine Learning.

With the departmental restructuring, acquisition of labs, equipment and employees with new skill sets, we can comfortably say that doing so can help Dell align its Business Strategy and Information Systems Strategy to Organizational Strategy.



Conclusion

In conclusion, we feel that if Dell could implement BCI in a way we have eluded to here, it could still continue to be on the forefront of innovation and target the early adopters. We've shown an alignment to its existing Business Strategies, Information Systems and Organizational Strategies. Furthermore we've, recommended what Dell needs to do in these three realms in order to incorporate BCI into itself.

The BCI market is still nascent, which is why companies like Dell who are financially capable of experimenting should partner up or acquire BCI startups who have the ideas and skills to perform an implementation. The resulting marriage could propel Dell to greater heights than ever before.

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