

A Work Project, presented as part of the requirements for the Award of a Masters  
Degree in Management from the Nova School of Business and Economics

**Illumina:**  
**The sustainability of its competitive position**

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A project carried out on the Strategy course, under the supervision of

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## **Introduction**

This work project presents a case study about the sustainability of the competitive position of Illumina in the Sequencing Market. This is a very recent market, which is growing at unexpected rates and is contributing for many scientific discoveries. Illumina is currently the market leader in the sequencing devices manufacturing business and aims to become the leading company from manufacturing to end-users. Traditionally, Illumina manufactures instruments and pass them to the next intermediaries, which are service providers. However, more recently Illumina has not only been manufacturing devices but also developing and selling solutions directly to consumers. In such a dynamic and fast-growing market, predicting the future of the industry is particularly difficult. Furthermore, firms face important challenges when trying to sustain (and enhance) their competitive position. This is precisely the challenge that Illumina is facing. Since the objective was to conduct and in depth analyze the competitive situation of a company – Illumina –, the elaboration of a case study seemed to be the most appropriate approach.

The work project is composed by a case study and a case discussion. The case study starts with an overview of the Sequencing Market. We then describe Illumina's positioning in terms of market segments and products offered. After that, we present some facts about Illumina's performance. Finally, we leave some questions for discussion. The case discussion will focus on the value creation potential of Illumina and the sustainability of its competitive position. We describe the relevant frameworks to conduct these analyzes and apply them to the specific situation of Illumina. We conclude that Illumina is operating in an industry with significant barriers to entry. Furthermore, Illumina's reputation, knowledge, specialized workers and unique leadership are valuable and unique resources of the company. The firm also holds important size advantages, mainly because of its broad portfolio and control of the supply chain. All these factors contribute to the sustainability of Illumina's competitive position and to its strength.

## Case Study

*“A complete DNA read-out for every newborn will be technically feasible and affordable in less than five years, promising a revolution in healthcare and by 2019 it will have become routine to map infants' genes when they are born”*

(CEO of Illumina, Jay Flatley, 2009)

Illumina was considered the Smartest Company in the World in 2013 by the MIT Review.<sup>1</sup> Additionally, a McKinsey Study states that Next-Generation Sequencing Business is one of the twelve most disruptive businesses that will change our world in the next years, appearing on the 5<sup>th</sup> position in terms of economic impact.<sup>2</sup> Not less important, the British Government chose Illumina to be the company sequencing 100,000 genomes in the Biggest Sequencing Program in the World – the *100,000 Genome Project*.<sup>3</sup> Given all this, what is so unique about Illumina and what is driving its success?

### 1. Genome at a glance

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Every human being is made of millions of different cells. Each cell has a nucleus where the genetic code (DNA) can be found. The DNA is the molecule that contains all the genetic instructions that produce proteins used in the development and functioning of all known living organisms. DNA molecules are made of two twisting, paired strands and each strand is made of four chemical units, called the nucleotide bases (A, T, C and G). In total, each strand contains approximately 3 billion of these bases. It is now known that the DNA is made not only of genes (the bits that code proteins) but also regions between genes, which function is still largely unknown. In modern Biology and Genetics fields, the ‘genome’ is the new definition of DNA and includes both the genes and the intergenic regions (see Exhibit 1).

After years of intensive research conducted by thousands of scientists around the world, it was announced that a complete map of the DNA of a person had finally been finished, meaning

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<sup>1</sup> MIT Technology Review, 50 Smartest Companies, Eilene Zimmerman, February 2014

<sup>2</sup> Forbes, “Flatley’s Law: How one company became the force behind medicine’s genetic revolution”, consulted at <http://www.forbes.com/sites/matthewherper/2014/08/20/flatleys-law-how-one-company-became-the-force-behind-medicines-genetic-revolution/>

<sup>3</sup> Technology Review, “British Government picks Illumina to sequence 100000 genomes”, consulted at <http://www.technologyreview.com/news/528946/british-government-picks-illumina-to-sequence-100000-genomes/>

that the precise location and order of every gene along the molecule is known and the precise sequence of letters that codes for it. Now it is the time where many scientific discoveries may contribute to save lives, as many and many genomes are starting to be studied. Specifically, scientists are shedding light into the genetic causes of some diseases as they can now look at the genome of patients and determine, through a process called *Sequencing*, where a mutation (i.e., a wrong letter in a gene) occurred. Sequencing is the process of determining the string of letters contained in the DNA. In other words, it is the process of translating the information that is physically present in our genomes into the readable code of letters (A, C, G and T) that are then stored in an informatics file. For consistency, every genome is stored in the same exact format using the same type of file. This is very important for reproducibility of research and to allow comparisons between people's genomes. Sanger Sequencing was the first sequencing method, developed by Fred Sanger, who won two Nobel Prizes. Now many other companies are finding more effective and innovative ways to conduct that process using new technologies. These are called Next-Generation Sequencing methods. While it took ten years for the first genome to be sequenced through Sanger sequencing, next-generation sequencing made it possible to happen in about a week. However, Illumina Sequencing developments pushed the limit and made it now possible to sequence 96 genomes in a single day at much lower costs.<sup>4</sup>

Illumina is a leading Next-Generation Sequencing firm that develops, manufactures and markets various science tools and advanced systems for the analysis of genomics. Ultimately, Illumina helps scientists to better understand how genomes work and what relevant information they contain. Illumina's systems are applicable to a large range of scientific segments and they have greater throughputs, speed and scale than the Sanger ones did.

## **2. Value Chain of the Sequencing Industry**

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The value creation process in the Next-Generation Sequencing Market starts with **Suppliers of Raw Materials** (see Exhibit 2). There are many small specialized suppliers in this industry, which provide components to sequencing machine producers. They mainly supply electronic, mechanical, chemical and biochemical components (such as valves, cameras, flow cell stages,

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<sup>4</sup> Business Insider, "Illumina Genome", consulted at <http://www.businessinsider.com/illumina-genome-sequencing-growth-2013-10>

computers, etc). Hamamatsu (cameras), Vici (valves) and Dell (computers) are some of the suppliers in the market. Suppliers of flow cell stages strongly rely in this industry, because the product is strictly used in sequencing. As customers' orders represent very large portions of revenue for these suppliers, they are more willing to adapt and negotiate instead of losing it to their competitors. All those supplies will be used and transformed in the next stage by the **Manufacturers**. The main producers are Illumina, Life Technologies, Roche, PacBio, Affymetrix and Oxford Nanopore Technologies. They manufacture mainly three types of products: Sequencing Machines, Array Platforms and Consumables. The first are sequencing systems that are sold to those who want to investigate and sequence genomes on their own. The second are cheaper products that do not use the whole-genome as Sequencing Machines do: these arrays will just compare DNA of different people instead of comparing the whole-genome (only 2% of the whole-genome is DNA). Finally, consumables are necessary reagent kits and sample preparation kits to use on the machines. For producers, there are some switching costs while changing suppliers, because their machines depend on specific suppliers' components. Cameras, valves and reagents, among others, have specific sizes and features to fit on the machines they are building and selling, so changing suppliers is rarely an option. Besides manufacturing, those companies test and validate their instruments and consumables, and they must receive certifications to assure its quality before selling to customers. Afterwards, they normally sell it to two types of **customers**: (i) research centers, academic institutions and government laboratories; and (ii) hospitals, clinical practices, pharmaceutical and consumer genomics firms. The first group of clients is already the final user, which will use the products to make researches and discoveries of gene linkages with diseases, common mutations in people with same diseases, among other findings. The main players in this segment are institutes such as Macrogen, Broad Institute of MIT and Harvard, British Columbia Cancer Agency's Genome Sciences Center and the Sanger Institute. The second group – **Service Providers** – will continue the chain by selling services to consumers, either by a form of diagnostics, medical guidance, health check-up reports, ancestral and genealogic information, pre-natal tests, or by a form of delivering genotyping and sequencing services to institutes and researches that do not want to buy machines. That group includes companies like BGI (Beijing Genomics Institute), Luminex and 23andMe. Therefore, there

are thousands of different customers using sequencing instruments, array platforms and consumables. They have a relevant power when negotiating with manufacturers because many times they are very large research centers or institutions that will run hundreds of investigations over time. Additionally, sequencing machines are much differentiated between them and consumables can only be used by machines of the same brand. Thus, many customers prefer to stick to the usual machines instead of learning how to use new ones. Finally, customers are charged differently: there are some price-discriminating strategies based on their ability to pay, company/institute size and order size.

### **3. Manufacturing Business**

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Around 80% of rare diseases are genomic.<sup>5</sup> The increased interest in studying them will mandatorily pass by genetics and increase the market of sequence machine makers. Either by buying machines to sequence the DNA or by buying directly the DNA sequenced, genetics will be in the *menu* of institutes, hospitals and research centers.

#### **3.1. The Market**

The market of sequencing machines and consumables producers has been increasing over time. Macquarie Securities forecasts that the DNA-sequencing market could become ten times bigger, reaching \$23 billion by 2020.<sup>6</sup> Manufacturers are producing and selling in areas of science, such as Life Sciences, Agrigenomics, Reproductive and Genetic Health, Oncology and Informatics:

**Life Sciences** – Producers provide products and services for laboratories, universities, medical research centers and biotechnology companies. Those products are used in sequencing, disease and drug discovery and comparison among human genomes. There are more than 50,000 Molecular Biology Labs Globally, so there are plenty of opportunities for manufacturers, which are mainly Illumina, Affymetrix, Pacific Biosciences, Roche and Life Technologies (now belongs to Thermo Fisher).<sup>7</sup> The average rate of revenues growth segment has been 6% per year (from 2007 to 2013) for all companies except Illumina. Illumina's revenues in this sector have been growing at 25.1% annually.

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<sup>5</sup> *Understanding Genomics*, Genomics England, 2014

<sup>6</sup> See Note 2

<sup>7</sup> Illumina Inc, Investor Presentation, Spring 2012

**Reproductive and Genetic Health** – Reproductive health solutions are being developed and sold. The most common one is Non-Invasive prenatal testing (NIPT). The test can substitute invasive tests such as amniocentesis and can early identify and confirm abnormalities in the fetus. Sequencing players are currently seeing massive growth in this area as it eliminates the risk for the pregnant and fetus that common current tests have.<sup>8</sup>

**Oncology** – *In the battle against cancer, sequencing is a powerful weapon.*<sup>9</sup> Cancer is a disease of the genome. There are 330,000 new cases of cancer reported every year and thus they will need to be better understood.<sup>10</sup> Manufacturers are providing tools to identify genomic changes, mutations and to allow comparisons with healthy genomes. These advances will allow quicker diagnostics and a better selection of treatments for patients. In 2012, the market size of cancer investigation driven by sequencing was approximately \$1.5 billion and is expected to reach \$10 billion in the next five years.<sup>11</sup> The Molecular Diagnostics market revenues (which include Oncology, Reproductive and Genetic Health) have been growing at a 19.1% rate per year for the last six years (from 2007 to 2013).<sup>12</sup>

**Agrigenomics** – Manufacturers provide tools and solutions for the agricultural genomics industry. Those products will be used to identify traits that fit into specific climates and to drive sustainable productivity in crops. GeneSeek, Affymetrix and Illumina are the main players in this segment.

**Entering in new markets** – New areas are being explored, such as transplant compatibility. DNA analysis using sequencing instruments will conclude about the compatibility between the donor and patient before doing an intervention. Consumer genomics is also a segment in huge growth. People want to be aware of genetic diseases in order to change their behaviors towards a healthier life. They also aim to discover their ancestral origins, something that is possible due to genome analysis. In the near future, those opportunities will worth around \$800 Million.<sup>13</sup>

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<sup>8</sup> See Note 4

<sup>9</sup> Illumina Releases, consulted at [http://res.illumina.com/documents/icomunity/article\\_2011\\_06\\_sequencing\\_cancer\\_genomeanalyzer.pdf](http://res.illumina.com/documents/icomunity/article_2011_06_sequencing_cancer_genomeanalyzer.pdf)

<sup>10</sup> See Note 5

<sup>11</sup> Investor Day, Illumina Presentation, 2014

<sup>12</sup> Idem

<sup>13</sup> Information given by Matt Posard (General Manager of New and Emerging Markets Opportunities Department of Illumina) during a company presentation at Morgan Stanley Healthcare Conference



### 3.2. Competition

There are four main companies in the next-generation sequencing systems makers market: Illumina, Pacific Biosciences, Roche and Life Technologies, with market shares of roughly 71%, 3%, 10% and 16%, respectively, in 2013.<sup>14</sup> In 2012 the market share of Illumina was 66% and 24% for Life Technologies, which shows the increased dominance of the market leader. In the sequencing market, besides the instruments' producers that were mentioned before, Oxford Nanopore Technologies, Qiagen, Affymetrix, Agilent, Luminex and BGI are important players as well<sup>15</sup>. Those are direct competitors of Illumina in terms of Array systems and Consumables, such as sample preparation and sequencing kits and array-based genotyping consumables. The specific case of BGI, which stands for Beijing Genomics Center, is particularly special: it is the world's largest genome sequencing center and it is responsible for 25% of the world's genomic data.<sup>16</sup> All those companies produce and sell to the previously described segments. The number of sequencing systems makers is being stable over time. It is a high-investment industry in which know-how, experience and field understanding are essential. Thus, companies in the sequencing market have significant fixed costs, representing around 45% to 60% of total costs. It mainly includes R&D, SGA and Legal costs related with patents of their technologies. Additionally, there is some brand loyalty involved, which creates ties between current sellers and consumers and disincentives new entrants. For example, Sanger Institute in Cambridge, United Kingdom, receives Illumina's platforms from the beginning, as the staff and the procedures are already prepared for them. The market capitalization value of each company can also compare, in a certain way, its dimensions. Exhibit 3 comprises the market value of the main players in the market.

There are some examples of competition among firms. For instance, Illumina and Life Technologies created rival partnerships, each one with one leading medical institution to further develop and integrate their sequencing technologies in the clinical genomics field. Moreover, Life Technologies was acquired by Thermo Fisher Scientific in February 2014, the world leader scientific group present in many fields. Marc N. Casper, CEO of Thermo Fisher said:

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<sup>14</sup> Mizuho Securities and GenomeWeb Survey, 2013

<sup>15</sup> Genome Web, "Affymetrix, Agilent and Illumina affirm commitment to Array Market", consulted at <http://www.genomeweb.com/arrays/affy-agilent-illumina-affirm-commitment-array-market-light-roches-planned-exit>

<sup>16</sup> Genetic Literacy Project, "Disruptive genomics: Is China's BGI the epicenter of the world's biotech revolution?", January 2014

*“We are pleased to announce that this transaction is now complete, and excited about our opportunity to create unrivaled leadership in serving research, life sciences, specialty diagnostics and applied markets.”<sup>17</sup>*

#### **4. Illumina background**

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Based in California in April 1998, it currently has offices in several places, such as United Kingdom, Brazil, Singapore, China and many other countries and it employs more than 3,000 people (it started with only 25). The company is listed in NASDAQ and it has completed its initial public offering in July 2000. The firm is manufacturing some of its products in Singapore since 2009<sup>18</sup>. The factory started with a capacity to produce about 40,000 tools per quarter and now most of the products are manufactured there. Illumina has enough space to expand the facility in order to respond to increases in demand or new products development. The company uses their own technologies and offers an extensive line of products and services used in sequencing, genotyping and gene expression markets.<sup>19</sup> With those tools and services, many genetic tests can be performed in order to extract relevant medical information to do diagnostics, for example. By using Illumina’s tools, customers will be able to correlate genetic variation and biological function, which will contribute to drug discovery, early detection of some diseases, clinical research and a better choice of drugs for individual patients taking into account their own DNA.

#### **Illumina’s Main Markets**

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Illumina believes genomics will play an increasingly relevant role in science and society, and their tools will support research of many drugs, diseases, new treatments and diagnostics tests. Historically, Illumina’s core business has been in Sequencing for the Life Sciences segment. A human genome was costing \$100 Million back in 2001 (see Exhibit 4).<sup>20</sup> With Illumina entering the Sequencing market in 2007, the cost per genome has astonishingly dropped to

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<sup>17</sup> Thermo Fisher News, “Thermo Fisher completes acquisition of Life Technologies Corporation”, consulted at <http://news.thermofisher.com/press-release/corporate/thermo-fisher-scientific-completes-acquisition-life-technologies-corporation>

<sup>18</sup>, Asia Biotech Magazine 2009, “Singapore - Industry Watch”, consulted at [http://www.asiabitech.com/publication/apbn/13/english/preserved-docs/1304/0072\\_0072.pdf](http://www.asiabitech.com/publication/apbn/13/english/preserved-docs/1304/0072_0072.pdf)

<sup>19</sup> Genotyping is the process of determining the genetic constitution of a person by looking at its DNA sequence. Gene Expression is the process by which the genetic code of a gene is used to produce the structures of the cell.

<sup>20</sup> National Human Genome Research Institute Data, 2014

\$10,000 in 2014 and it is almost reaching the \$1,000 target.<sup>21</sup> Illumina also produces solutions to Agrigenomics. Lately, Illumina has been entering in the reproductive health segment by developing many genetic tests. It has also been developing many solutions for the oncology segment which has been growing enormously. Finally, the company provides informatics tools that allow customers (many research and clinical centers) to go from raw genomic data to meaningful knowledge and conclusions. Illumina is also exploring and leading the developments in new markets, such as transplants, forensic and consumer genomics.

## **Illumina's Products**

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Illumina sells Instruments (includes Sequencing Machines and Array Platforms), Consumables and Services (see Exhibit 5). Both instruments assume an extremely relevant role in Illumina's business, because the firm is the biggest supplier in the world, with a market share of approximately 70%.<sup>22</sup> Sales on those products represented 26% of total revenues of Illumina in 2013, 27% in 2012 and 35% in 2011.<sup>23</sup> In terms of prices, the latest sequence machine (HiSeq) has to be sold in quantities of 10 and each costs \$1 Million. All the other platforms are cheaper and can be sold individually. On the other hand, consumables are the reagents and flow cells that are necessary in all the machines for them to work, and thus they represent continuous sales throughout their useful life. Only Illumina's reagents and flow cells can be used in Illumina's sequencing machines. Consumables are also sample preparation and sequencing kits to simplify and accelerate analysis, avoiding huge losses of time from studying the sample to results. Illumina has, on average, 47% of the DNA sample-preparation technology market share.<sup>24</sup> Consumables sales represented 62% of total revenues in 2013, 64% in 2012 and 56% in 2011.<sup>25</sup> Finally, Illumina also provides some services, such as genotyping, whole genome sequencing services and individual genome sequencing. In the last one, individuals can ask, for example, for tests to diagnose inherited diseases or to analyze their predisposition for some future conditions. Service revenues represent 12% of total revenues in 2013. At a first glance, Illumina seems to have higher prices comparing with

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<sup>21</sup> Technology Review, "Does Illumina have the first 1000 genome", consulted at <http://www.technologyreview.com/news/523601/does-illumina-have-the-first-1000-genome/>

<sup>22</sup> Mizuho Securities USA and Sequencing Survey, 2013

<sup>23</sup> Illumina's Annual Report, 2013

<sup>24</sup> GenomeWeb WorldWide Survey, 2012

<sup>25</sup> See Note 23

customers' equivalent platforms. For example, MiSeq costs \$128,000, while Life Technologies equivalent costs \$80,490 and Roche costs \$108,000. However, the sequencing cost per GB of data is only \$502 for Illumina, \$1000 for Life Technologies and \$3,100 for Roche, and the observed error rate is also much smaller in the case of Illumina machines.<sup>26</sup>

## **Investments and Opportunities**

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**R&D Investment** – Research & Development Expense increased 20% from 2012 to 2013 to \$276.743 million. In 2013, the expenditure in R&D represented 19.5% of Total Revenues, value that reveals the consciousness of R&D importance for the current and future position of Illumina. The increase from 2012 to 2013 is explained mainly due to an increase in the number of employees in the department, the development of new products and the improvement of the existing ones.

**New and Emerging Markets Opportunities Department** – Illumina has been the first mover while entering into certain markets in the last years. The firm has acquired many other small businesses so that it could be the first landing on those opportunities, when compared with its direct competitors that are always one step behind. For this purpose, Illumina has a full-time staff in the New and Emerging Markets Opportunities Department which seeks to find good companies that they think Illumina should own.

## **Financial Performance**

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Illumina's performance has been outstanding. Revenues have been increasing over time in a six-year Compounded Annual Growth Rate (CAGR) of 25.1% (from 2007 to 2013), reaching \$1,421.18 million in 2013 (see Exhibit 6).<sup>27</sup> When compared to other companies, the average six-year revenue CAGR (from 2007 to 2013) for Illumina's competitors was 5.9% in the Life Sciences Segment, which is significantly lower.<sup>28</sup> Net income was \$125.308 in 2013, which is about 8.8% of Total Revenues. Recent releases indicate revenues of \$481 million in the third quarter of 2014, a 35% increase compared with the homologous period. In terms of end

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<sup>26</sup> Next Gen Seek, "Comparing Price and Technology of Illumina MiSeq, Ion Torrent PGM, 454 GS Junior and PacBio RS", consulted at <http://nextgenseek.com/2012/08/comparing-price-and-tech-specs-of-illumina-miseq-ion-torrent-pgm-454-gs-junior-and-pacbio-rs/>

<sup>27</sup> Financials, Illumina's Annual Report, 2013

<sup>28</sup> See Note 11

market, the biggest Illumina's clients are Academic and Government Institutions, NIH (National Institute of Health, USA) and firms in applied markets, such as reproductive health, diagnostics and individual genomics companies. Revenues in the Academic/Government Sector represented 47% of total revenues in 2011; 33% in the NIH, 17% in Applied Markets and 3% in Hospital and Diagnostics Market (see Exhibit 7). Illumina is currently selling inside and outside USA. Revenues outside USA represented 50% of total revenues in 2013, which accounts to \$706.5 million. In 2012 and 2011, respectively, revenues with these customers were \$580.1 and \$526.8 million (see Exhibit 8). Those customers are mainly from Europe and Asia (see Exhibit 9).

The exponential increase of the stock price over the years has been incredible. The current market capitalization of Illumina is \$22.76 billion (October 2014). In terms of total shareholders return, it was 273% for the period from 2008 to 2013.<sup>29</sup> But let's first get back to the beginning. When Illumina completed its initial public offering (IPO) in July 2000, the share price was \$19.59. In the following years, until 2005, the price per share decreased to values below \$5. By developing new products with greater quality and throughput and by acquiring Solexa, the share price increased rapidly in 2007 onwards (see Exhibit 10). Solexa gave Illumina the foundation of the technology and chemistry used in all its sequencing machines. On June 2012, the share price was \$40. Now, on October 2014, the stock price is \$180, which represents an increase of 350% from June 2012 until now. That increase was accompanied by many acquisitions that intensified Illumina's presence in the market and increased the investors' expectations. Cathie Wood, the Chief Investment Officer at ARK Investment Management, said:

*"It's rare that you find a company that has 80% to 90% share of anything and is driving the technology so fast that nobody can catch up. This is a stock in its infancy."*

## **Expanding Through Strategic Acquisitions**

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Illumina's high research and development spending combined with strategic and in-time acquisitions has helped achieving this great growth. Since 2005, Illumina has spent more than

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<sup>29</sup> See Note 11

\$1.2 billion on acquisitions.<sup>30</sup> Illumina was initially a company producing genotyping and gene expression platforms, but not their current and main product: sequencing platforms. The first acquisition of Illumina was Solexa, back in November 2006. Solexa was a company that developed a method to sequence genomes. In 2005, Solexa was able to sequence its first real genome, showing that “something other than Sanger sequencing could work”.<sup>31</sup> In November 2006, Illumina CEO Jay Flatley placed a \$650 million offer for Solexa, which would complement its offerings by expanding their portfolio to three main products. Back at the time, Flatley said:

*“This acquisition... may prove to be one of the most successful acquisitions and new technology introductions in the history of the life science industry.”*

Although the read length<sup>32</sup> was not as good as Life Sciences’ one (company that now belongs to Roche), throughput and cost per gigabase were better. In 2007, Illumina’s revenues doubled to \$360 million and then doubled again in 2008, as they were selling and installing more and more platforms. The Sanger’s Institute (one of the biggest Sequencing Centers in the World) output in 2008 was so massive that if the sequenced DNA information could be printed (using Courier 12) it could cover the earth 63 times.<sup>33</sup> Additionally, genome centers normally stick with the technology they got in the beginning, as the staff and pipelines are already optimized for it. Thus, as mentioned before, Sanger Institute elected Illumina as their supplier of platforms. By acquiring Epicenter Technologies (in January 2011), Moleculo (in January 2013) and NextBio (in October 2013), Illumina improved its current sequencing platforms to make them the best choice available in the market.

BlueGnome and Veritana Health acquisitions (late 2012 and 2013, respectively) were essential to expand into new applied markets, as they brought know-how, skills and understanding of the market where they were operating. BlueGnome has developed technologies to test for genetic abnormalities and it was already selling in more than 40 countries. Illumina’s CEO said:

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<sup>30</sup> MIT Technology Review, “50 Smartest Companies”, Eilene Zimmerman, February 2014

<sup>31</sup> Chief Science Officer, Tony Smith, 2002

<sup>32</sup> Read Length: is a measure of the resolution for an experiment, this is, the accuracy of the information sequenced. If the read length is 100, it means that on average, each base in the genome was covered by 100 sequencing runs. The higher the read length number, the higher the resolution, as it will sequence many times the same information to get it in deep detail.

<sup>33</sup> Bio IT World, “Solexa”, consulted at <http://www.bio-itworld.com/2010/issues/sept-oct/solexa.html>

*The BlueGnome acquisition supports Illumina's goal to be the leader in genomic-based diagnostics and enhances the company's ability to establish integrated solutions in reproductive health and cancer.*

On the other side, Veritana Health develops prenatal tests. Acquiring the firm gave Illumina a larger understanding about the segment and a wider portfolio of products to offer. By acquiring Veritana, Illumina entered in new markets that are out of their main core of manufacturing, by directly developing and selling prenatal tests, cancer diagnostics tests and other diagnostics. To many firms, the supplier is becoming a competitor in those markets.

Finally, and because Illumina is moving into the diagnostics and health tests market, the firm strategically acquired Myraqa in July 2014.<sup>34</sup> Myraqa is a regulatory and quality consulting firm specialized in In-Vitro Diagnostics and other diagnostics. It will mainly focus on regulatory strategy and application support now that Illumina is entering into this intensively regulated market.

## **Illumina in the Future**

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Illumina has been growing exponentially. The company is clearly the market leader. The future of the firm seems to be bright and promising. Illumina has already established collaborative partnerships for 2014 onwards with leading pharmaceutical companies to develop a universal next-generation sequencing-based oncology test market. A new era for oncology is coming and Illumina will be part of it. Investors look positive and the market value of the company was never as high as now. However, many wonder what will happen to the industry and firm. Is the industry attractive for new entrants to come? Does Illumina have to worry about competition? Will Illumina be able to sustain its position in the long-term, given the specific market conditions, competition and unique firm-specific resources?

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<sup>34</sup>Myraqa Releases of 2014, "Illumina Acquires Myraqa", consulted at [http://myraqa.com/blog/illumina\\_acquires\\_myraqa](http://myraqa.com/blog/illumina_acquires_myraqa)

## **Case Discussion**

The value creation potential of a company in a given industry depends not only on the attractiveness of the industry but also on the competitive advantage or disadvantage of the company (Besanko *et al.*, 2013: 362-279). The attractiveness of a market is determined by the size (and growth) of the market and by the intensity of competition (Porter, 1985: 255). These two factors determine the value creation potential of a typical or average competitor that operates in that industry. While the size (and growth) of the market determines the volume that companies that operate in that industry are able to attain, the intensity of competition, in particular the intensity of price competition, determines the price-cost margin at which companies are able to sell in that industry. Following Besanko *et al.* (2013), a firm has a competitive advantage in a specific industry when it outperforms its competitors. This advantage may result from a lower cost of production or from the ability to provide higher perceived benefits to clients (Porter, 1985: 12-14). A firm has a cost advantage when it is able to produce a good at a lower cost than its competitors, which may reflect in a lower price or a larger sales margin. A firm has a differentiation advantage when its products provide a higher perceived benefit to consumers (Porter, 1985: 14)

In the discussion of the competitive position of Illumina, we start by presenting each relevant framework and then we apply it to the specific situation of the company.

### **Market Attractiveness**

In this section, we analyze the attractiveness of the sequencing industry. We start by analyzing the size and growth of the market. After that, we focus on the intensity of competition.

#### **The Market**

The size and growth of the market determines, more than anything else, the volumes that companies operating in that market are able to achieve. A very useful tool to analyze the size and evolution of the market is the product life cycle. According to this theory, the sales of a new product follow, in general, an S-shaped curve over time and the product will pass through four stages: introduction, growth, maturity and decline (Kotler, 1967, 2011). The introduction phase is characterized by a low sales level related with the novelty of the product. The growth



phase is characterized by a large proliferation of products and an increase in sales. In the maturity phase the product is widely accepted and growth slows down. Finally, in the decline phase the product becomes redundant, unnecessary or obsolete (Kotler, 2011).

The DNA-sequencing market only started a few years ago, mainly with the development of large machines capable of sequencing large samples of DNA. Thus, products are only now passing from the introduction to the growth phase. In this new phase, companies, hospitals and research centers understand machines' advantages and added-value. Additionally, the DNA-sequencing market now is a \$2 billion business, but it is expected to reach \$23 billion by 2020. It also seems interesting to look at the different segments. These products are relevant for many segments, such as Life Sciences, Reproductive and Genetic Health, Oncology, Agrigenomics, Transplants, among many others. The existence of many segments shows the interest and demand of these products of many players. The main segment is Life Sciences, with a growing number of hospitals, research centers and pharmaceutical companies interested in understanding genes and acquiring sequencing platforms and arrays. The trend has been to move to the Molecular Diagnostics segment, mainly to Oncology, Reproductive and Genetic Diagnostics. Annual average revenues growth rate in this segment has been 19.1%, which shows the great interest customers of these areas have. Consumer genomics and transplant compatibility testing are also emerging opportunities that will be addressed by this market, resulting in a larger and growing industry.

### **Intensity of Competition**

The intensity of competition, in particular the intensity of price competition, determines the price-cost margin at which companies are able to sell in that industry (Porter, 2008). The intensity of competition is determined by industry structure and by the dynamics of competition. One should not only analyze the industry structure because there might exist two industries with a very similar structure but with completely different dynamics (for instance, one in which firms harshly compete and other in which firms are satisfied with their margins and thus opt to collude). Therefore, the intensity of competition depends on both factors.

## **1. Industry structure on competition**

Industry structure is the set of fundamental characteristics that determine the essence of what an industry is, both in terms of supply and demand (Porter, 1979: 2). To analyze the impact of industry structure on competition, we will use Porter's Five Forces Framework (Porter, 1979; 1980; 2008). According to Porter, the impact of industry structure on competition results from the inter-play of five forces: internal rivalry, bargaining power of buyers and suppliers, existence of substitutes and threat of potential entrants. Industry structure, manifested in the competitive forces, sets industry profitability in the medium and long run (Porter, 2008: 3).

### **Rivalry among existing firms**

The intensity of competition in an industry depends on the degree of rivalry among existing competitors. That competition takes a form of jockeying for position in the market (Porter, 1979: 8). First, the intensity of competition depends on the degree of concentration of the industry, *i.e.*, on the number and relative size of competitors. The higher the concentration, the higher the impact of the actions of a firm in the others; thus, intensity of competition is higher. The Herfindahl Index measures the size of firms in relation to the industry. The Concentration Ratio is the percentage of market share held by the largest *n* firms in the industry. In our case, the 4-firm concentration ratio in the sequencer makers industry is approximately 1, which means that the four main players capture all of the market. In the case of arrays producers industry, the 10-firm concentration ratio is roughly 1.

The differentiation and the switching costs are also important determinants of the rivalry intensity, as they lock in buyers and decrease the risk of competitors' attacks (Porter, 1979: 6). On the one hand, the differentiation is large, not only in terms of instruments but also in terms of the consumables used in the machines. Sequencing platforms sold by firms are differentiated according to their throughput, scale, easiness to use and purpose of use. A very large institute, for example, may not find a proper equivalent product, because products are differentiated and thus not all of them meet their needs. Additionally, many firms, such as Affymetrix and Illumina, require customers to buy their instruments platforms in order to process their arrays, and other firms' chips cannot be processed on their systems. These differences reduce the intensity of competition. On the other hand, switching costs are costs

that consumers incur when changing from one product to another. There are some switching costs involved, such as training employees to work with the new machines, rearranging the flow process and losing the beneficial experience curve effect that was acquired over time.

Furthermore, if firms have large fixed costs or if goods lose value rapidly, there will be more incentives to undercut prices (Porter, 1979: 8). In general, companies in the sequencing market have important fixed costs (rounding 45% to 60% of total costs), mainly related with R&D and legal services. However, price cuts are not common because of the relevant differentiation and switching costs explained before. Nonetheless, their products lose technological value rapidly and new instruments are constantly developed, which boosts some competition in terms of innovation and technology amongst firms. Furthermore, market growth also creates incentives not to capture current share but to gain new share on the new segments. In this industry, firms are more and more expanding their solutions to more applied markets. This dissipates rivalry in the core business (manufacturing) but extends it into the new segments. Finally, Porter also states that if rivals are highly committed to the business and strive for leadership, their rivalry will be more intense (2008: 9). Illumina is the market leader in manufacturing and is highly committed to gain dominance in the new segments, so it is expected that it will compete fiercely (technologically) against its current players in it.

### **Bargaining power of buyers**

The bargaining power of buyers is reflected on their capacity to capture more value, for example by forcing lower prices or demanding better quality (Porter, 2008: 7). The number of buyers in the industry determines their negotiating power. In this industry there are lots of independent customers, from small to large size, that in general do not have capacity to influence prices. However, large volume buyers have particularly strong power if the industry has high fixed costs, as firms will feel pressure to keep capacity occupied (Porter, 1979: 7). For example, BGI is the largest install of HiSeq's (one of Illumina's machines); its orders have a huge weight and thus it is a particularly strong customer capable of negotiating better deals. Other large research centers such as Sanger Institute and Broad Institute of MIT and Harvard also make large orders due to their enormous focus of investigation, which means they have relevant negotiating power. The level of differentiation of the product also affects

the negotiating power of buyers, depending on whether they can find equivalent goods or not. In this industry, consumers tend to have low price sensitivity because they do not have many equivalent options. Following the same reasoning, buyer's power also depends on the switching costs they face in changing vendors (Porter, 2008: 7). Changing sequencing machines and instruments would imply a huge cost; therefore, buyers are less willing to change and less sensitive to changes in prices.

### **Bargaining power of suppliers**

Suppliers can have a strong negotiating power by raising prices or reducing the quality of inputs. Among many factors, their power depends on the number of suppliers and on the degree of concentration of the supply market compared with the one in the industry they sell to (Porter, 2008: 6). The suppliers of the sequencing instruments producers do not hold much power, as there are many more suppliers of components than manufacturers. Moreover, suppliers provide stages, chips, cameras, valves, windows computers and many other things that can easily be supplied by others, as they do not hold much differentiation. Finally, the core components of the instruments are already owned by the manufacturers (this is, the software and technology used in the machines). Many manufacturers understood the advantages of up-stream vertical integration, *i.e.*, of owning their main and essential technology used in the platforms. One of the reasons of doing so is to avoid dependence on suppliers, which would strongly compromise the business. Thus, some suppliers were acquired by manufacturers.

### **Threat of substitutes**

When the threat of existing substitutes is high, industry profitability is affected. There are not other ways of sequencing human genome and getting genetic information, which means that there are not direct substitutes. However, there are some indirect substitutes. Traditional exams (such as biopsy, MRA, etc) and consequently their interpretations and comparisons represent alternatives to sequencing interpretation. Nonetheless, genomes contain much more information than those alternatives, which is reflected on the exponential growth of the demand on the sequencing market.

## **Threat of potential entrants**

The threat of potential entrants also determines the medium to long-term profitability of an industry. An entry barrier is anything that requires expenditure by a new entrant into an industry, but that imposes no equivalent cost upon an incumbent (Besanko, 2007: 302). High capital requirements limit the potential entrants, as they would need large financial resources in order to compete with incumbents (Porter, 1979: 3). In R&D intensive industries, such as sequencing, the barrier is even higher because those expenses represent unrecoverable costs. Additionally, product differentiation of existing brands leads to brand identification and customer loyalty, which becomes a strong difficulty for new entrants. Because of the high sequencing machines cost, scientists and institutes normally prefer to stick with brands that already have a well-known image and reputation. Moreover, incumbents face economies of scale, which imply that average costs decrease as quantity produced increase. This fact limits potential entrants to succeed and they must accept their cost disadvantage (Porter, 1979: 3). The existence of an experience curve in the industry may also represent an entry barrier. Experience curve is the concept that unit costs in many industries decline with experience – this is, with the company's cumulative production (Porter, 1979: 3). Thus, new competitors with no experience face higher costs than incumbent firms, especially when compared with the market leader. For instance, Illumina's constant investment in R&D and its technological advances allow the firm to offer units with smaller marginal costs. Finally, the level of vertical integration of the incumbent firms will also have impact on the entrant's willingness to enter the market. Large companies such as Roche, Thermo Fisher Scientific and Illumina currently manufacture and own some suppliers, which makes new firms reluctant of entering the market.

Thus, it is clear to see that current players in the Sequencing Market are protected from new entrants. There is a huge concentration of players, which means consumers buy from four main players. It is capital-intensive industry which demands high initial investments, so new firms would find it hard to enter the market. Additionally, the existence of large fixed costs decreases their willingness to enter. Moreover, rivalry in terms of technology and innovation is extremely large, thus new entrants would not be able to compete at the same level. Finally,

brand loyalty and reputation protect incumbents, as consumers prefer to stick to the traditional and trusted suppliers.

## **2. The dynamics of competition**

The dynamics of competition refers to the development of competition, over time, among a small number of firms (Besanko et al., 2013: 226). Companies use a variety of weapons to compete, such as price, innovation, product design and variety. Most of the times, *price is the weapon of choice* (Rao, Bergen & Davis, 2000). On those cases, the intensity of competition depends on how firms in the industry define their pricing strategies. However, competition in prices is not very relevant in this industry. All firms implement high prices and do not push them down. What sustains this equilibrium with such high prices is the concern about the likely retaliation. Price cuts would lead to a price war that would significantly damage the firms in the sector. Therefore, firms tacitly agree on keeping prices high and consequently their profit margins.

Instead of in prices, competition in this industry is related with technological developments. Firms compete by improving their current machines with higher processing capacities, speed, reduced error probability and cost per MB. Their new updates and developments are publicly announced and so it increases competitor's pressure to also release something new. For example, sequencing a whole genome with a \$1000 cost has been a target that biotechnology industry has been trying to reach for many years. Last year Illumina introduced HiSeq X Ten, a genome sequencer that finally enables it. This is an extremely efficient way of Illumina to compete with other firms based on its product technological advance, as it is the only product with that attribute. Technologic retaliation is extremely regular. When a firm increases its R&D expenditure, others will also do it. When a firm announces a partnership with a leading medical institution for further developments and discoveries, others will try to accompany it, just like it happened to Illumina with Life Technologies. Furthermore, the expectation while launching a new technology or entering into a new segment is that others will retaliate in a similar way.

## Illumina's Competitive Situation

As mentioned above, a firm has competitive advantage in a specific market when it outperforms its competitors. Illumina has a strong differentiation advantage, as its products provide a higher perceived benefit to consumers (Porter, 1985: 17). Illumina offers sequencing platforms with the largest power in the market, capable of sequencing larger samples of genome. The great accuracy of its technology makes its products the ones with lower errors in data. Additionally, it offers a great quality-price relationship: price seems to be high but costs of running the machine and sequencing data are much lower than the ones of its competitors. Additionally, there is a great reputation involved, which creates a positive differentiation and a preference for the firm products instead of others. In fact, Genomics England chose Illumina to be the sequencing provider behind the large *100,000 Genomes Project*, which will run in the UK. Moreover, its market leadership and its contributions to the cost reduction of sequencing have been a proof of its positive differentiation. However, can this competitive advantage be sustainable in the long-term?

In such a fast growing and rapidly changing industry, sustaining a competitive advantage may not be easy. There are, in general, two main sources of sustainable competitive advantage: *unique firm-specific resources* and *privileged market positions*. The *resource-based* view emphasizes firm specific resources as a source of sustainable competitive advantage (Rumelt, 1984; Wernerfelt, 1984; Barney, 1986; Dierickx and Cool, 1989). Firms' resources are the tangible and intangible assets hold or controlled by the firm and that contributes to a lower cost or to a higher perceived benefit of the products (Cool, Almeida Costa & Dierickx, 2002). In order to be a source of a sustainable competitive advantage, resources should (i) be acquired in imperfectly competitive factor market; (ii) be imperfectly mobile; (iii) not be imitable; and (iv) not be subject to substitutability (Cool, Almeida Costa & Dierickx, 2002). If all firms in a market have access or came develop the same stock of resources, no strategy is available to one firm that would not also be available to all the others (Cool, Almeida Costa & Dierickx, 2002).

The first factor states that resources should be bought in an imperfectly competitive market, *i.e.*, the costs of obtaining the resources should be acquired at a price below its net present

value (Cool, Almeida Costa & Dierickx, 2002). The second factor is the imperfect mobility and immobility of resources, which depends on whether they can be transferred from one firm to another. If all factors could be bought, competitors would simply acquire the required components and replicate the resources bundle. Additionally, the third factor is that resources should not be imitable. In fact, there are some isolating mechanisms that avoid immediate imitation of a firm's resource position, such as property rights and information asymmetries. Finally, resources should not be substitutable. Even when imitation is not possible, firms may try to create equivalent resources that will allow the same strategies.

Illumina has perfectly immobile resources which are non-tradable, such as reputation, brand loyalty, know-how, market intelligence and experience. Several authors emphasize the role of reputation and brand image as sources of sustainable competitive advantage (Dierickx and Cool, 89). Illumina is the company that has contributed the most to reduce the sequencing cost per genome, which makes it the most distinguished firm in the industry. Furthermore, Illumina has the capacity to forecast the growing segments and immediately focus on R&D to satisfy their future needs. This unique firm resource makes it possible for Illumina to implement its strategy before others (Lieberman & Montgomery, 1988). All those resources were built inside the firm and accumulated over the years, so they cannot be acquired by a company. Even if competitors wish to develop those assets, it would be a time-consuming process. More than being a time-consuming process, there is some causal ambiguity involved. Causal ambiguity is an important factor of inimitability, which occurs if the source of a firm's competitive advantage is unknown (Lippman and Rumelt, 1982: 420). Even if others wish to develop those assets, they probably do not know how to proceed or where to start.

Another fundamental aspect of Illumina strategy is the constant seek for acquiring other firms. Acquisitions have two main goals. On the one hand, firms acquire others in order to expand its business to those new segments with everything already operational. On the other hand, acquisitions may provide an opportunity to buy resources in bundles that otherwise would not be tradable (Wernerfelt, 1984). In fact, a firm may acquire another to acquire expertise and specialized workers that would not be able to acquire anywhere else. For example, the acquisition of Solexa gave Illumina a combination of technological capabilities that allowed



the beginning of their business in sequencing platforms. Epicenter, Moleculo and NextBio were also fundamental acquisitions in improving the platforms, as they added features, quality, accuracy and speed. Now that Illumina owns those resources, it must keep them as a source of competitive advantage and avoid imitation from others. Additionally, the fact that Illumina was the first great company to develop DNA Sequencing systems created a first-mover advantage. Illumina had the opportunity to establish long-term relationships with customers before other firms did, which is particularly important in such loyal-consumer market.

Additionally, Illumina also has a unique leadership advantage. Illumina has a visionary leader – the CEO and owner Jay Flatley – that has been leading the company since the beginning. A clear vision and insight of the industry, smart acquisitions and high R&D investments are driving the firm to succeed. However, other firms may develop a strategic planning process that will create the same market intelligence and act as a substitute. Lots of research on emerging opportunities and a clear planned strategy may lead to the same results. Therefore, there is a risk of firms creating strategically equivalent resources (Barner, 1991). Those equivalent resources are assets that enable the firm to implement the same strategies. In conclusion, Illumina has some firm-specific resources and privileged market positions that are sources of sustainable competitive advantages. Its reputation, expertise, specialized workers and acquisitions strategy, among others, are specific and valuable resources of Illumina.

As stated in the beginning of the discussion, a competitive advantage may be sustainable not because rival firms cannot replicate the resource position, but because they do not have the incentives to do so (Cool, Almeida Costa & Dierickx, 2002: 63). In this case, the firm has a *privileged market position* which arises from industry structure. Firstly, production capacity represents a source of privileged position for Illumina. The firm now manufactures some of its products in the factory in Hayward (USA) and others in Singapore, where it can take advantage of the cluster in human health. Illumina still has enough space to expand the facility in Singapore to respond to market growth. Therefore, the company has a clear commitment to compete aggressively if entry occurs or if a smaller competitor expands its own production (Cool, Almeida Costa & Dierickx, 2002). Secondly, Illumina's market

privileged position also results from the large variety of products it offers. Firms in dominant positions such as Illumina can crowd the industry with their products in order to gain market share at the expense of competitors (Schmalensee, 1978). Illumina sells the MiSeq, MiSeqDx, NextSeq 500, HiSeq 2500 and HiSeq X Ten machines, which are similar but vary according to the scale, power and specificities needed by the consumer. For instance, the needs of a small private practice are different from the ones of a large research center. By selling many machines with slight differences depending on the target needs, Illumina spreads its presence and reduces opportunities for others to satisfy those niches. Finally, Illumina's privileged position also results from the existing threat of forward vertical integration. Besides developing and manufacturing sequencers, Illumina is now selling many products and services that normally only its customers would offer. Diagnostics of current genetic diseases, guidance to change health behaviors according to genetics or prenatal tests are examples of these. Therefore, vertical integration may act as an entry barrier to the downstream market. New firms will hardly enter the market if they have to be supplied by one of its competitors. This would increase the influence of the firm in the supply chain and increase the negotiation power (Porter, 1985). Illumina could charge them high prices and still compete with them in the diagnostics market with lower prices. This would drive out of the market many firms. In sum, the market leadership, the excess of production capacity, the extensive portfolio and recent vertical integration contribute to a privileged market position of Illumina in the industry. All these factors are sources of a sustainable competitive advantage.

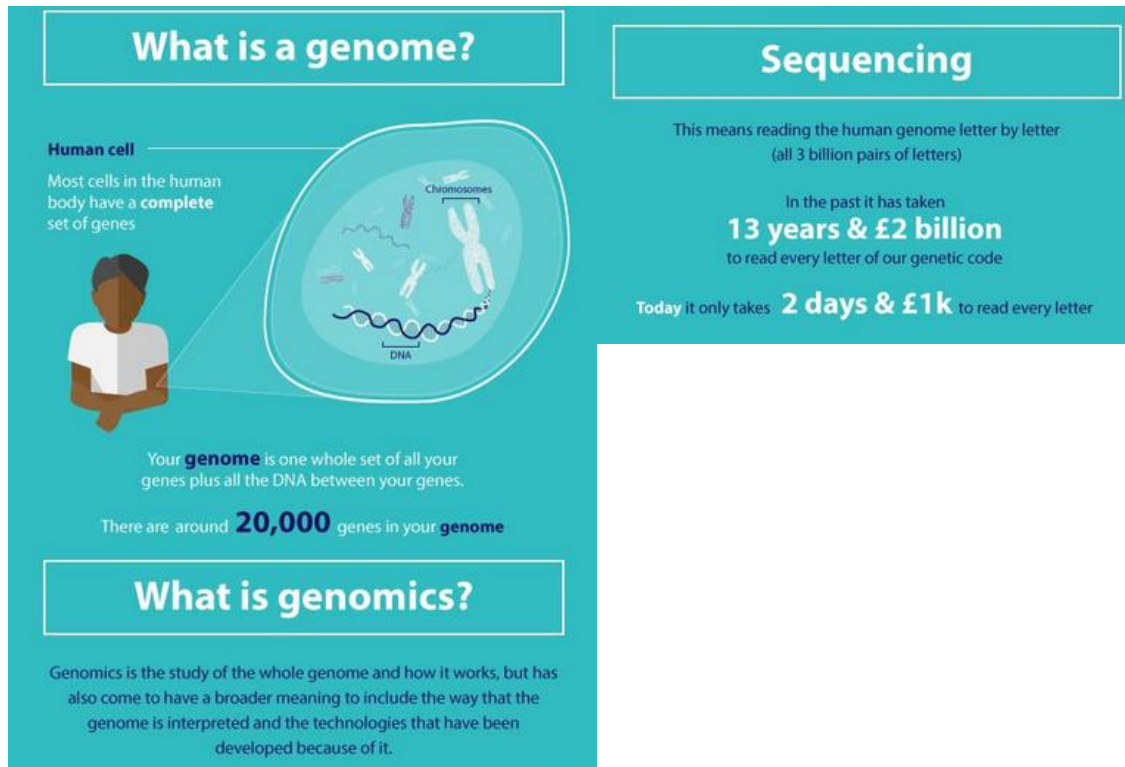
## **Conclusion**

After carefully analyzing the market attractiveness and the competitive positioning of the firm, it is clear to see that Illumina has all the conditions to sustain a competitive edge over competitors. On the one hand, the industry structure protects incumbent firms. The fact that the industry is highly intensive in capital and the large rivalry in terms of innovation and technology will make it hard for new firms to enter the market. On the other hand, Illumina has unique firm resources such as reputation, unique leadership and highly specialized workers. Its product capacity and large range of products also give Illumina a privileged market position. Those factors are all sources of sustainable competitive advantage. Thus, the

firm is in a favorable position to maintain its competitive edge over competition in the long-run.

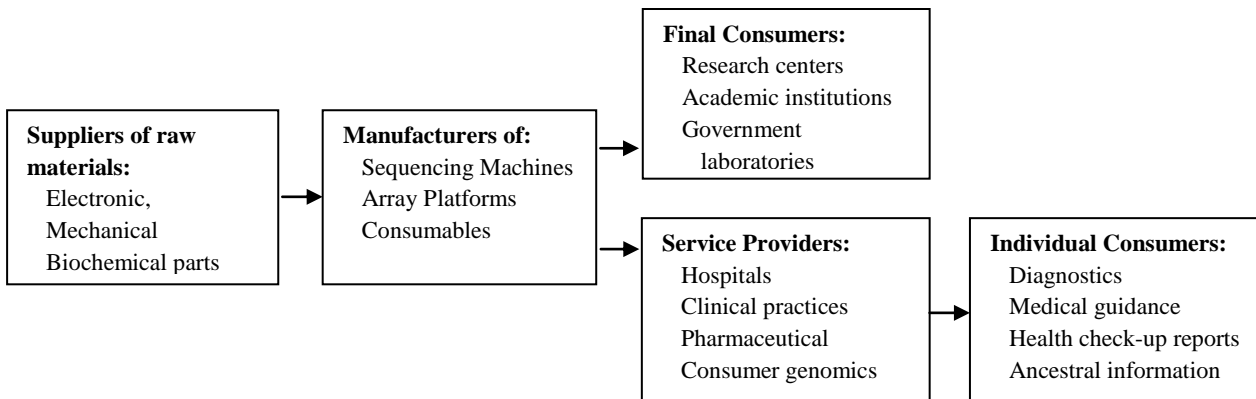
## Appendixes

### Exhibit 1 – Genome and Sequencing



Source: Understanding Genomics, Genomics England, 2014

### Exhibit 2 – Value Chain of the Sequencing Market

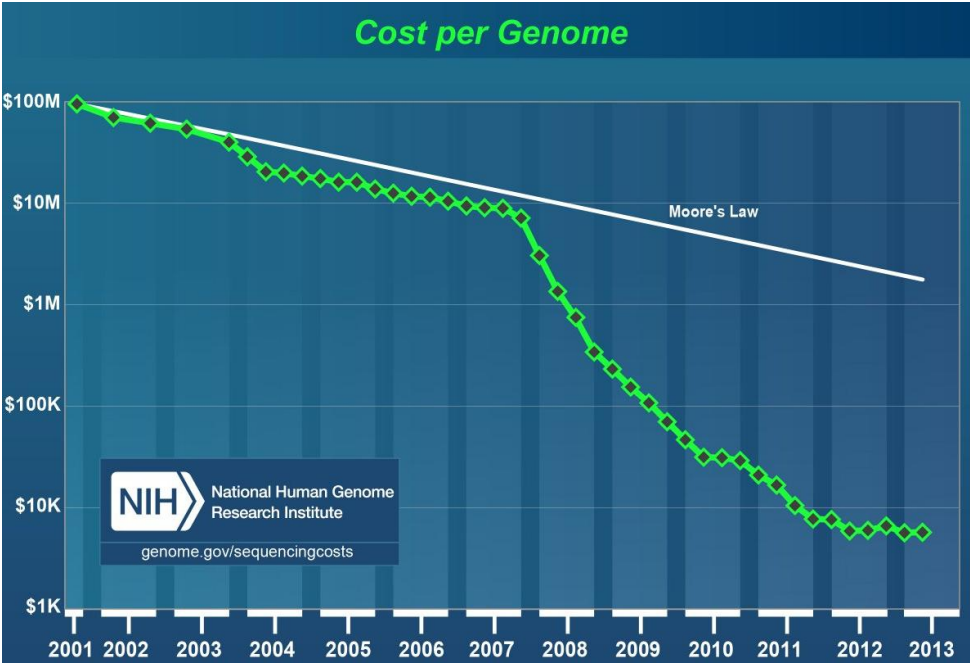


**Exhibit 3 – Market Capitalization, October 2014**

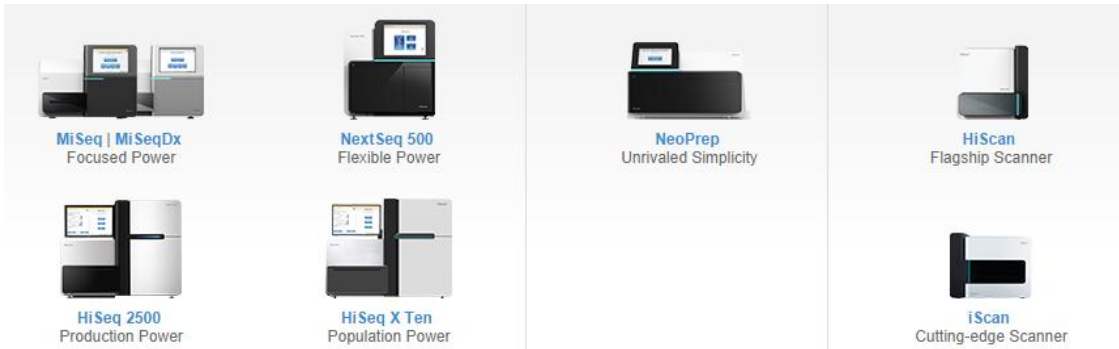
Company	Market Capitalization (\$b)
llumina	22.76
ThermoScientifics (after acquiring Life Tech in Feb 2014)	48.17
Life Technologies (prior to acquisition)	13.6
Affymetrix	0.55
Pacific Biosciences	0.35
Luminex	0.87
Roche	240.57

Source: Bloomberg, October 2014

**Exhibit 4 – Cost Per Genome Evolution, 2001-2013**

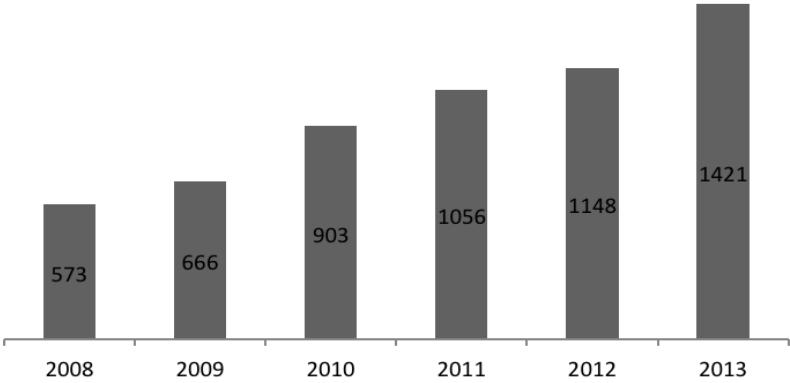


**Exhibit 5 – Portfolio of Instruments and Array Platforms, 2014**



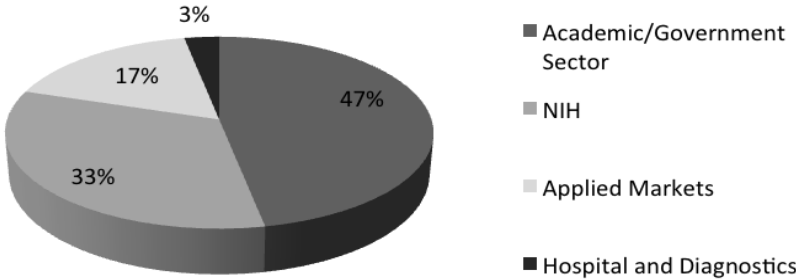
Source: Illumina Website, 2014

**Exhibit 6 – Revenues (in \$ Million), 2008-2013**



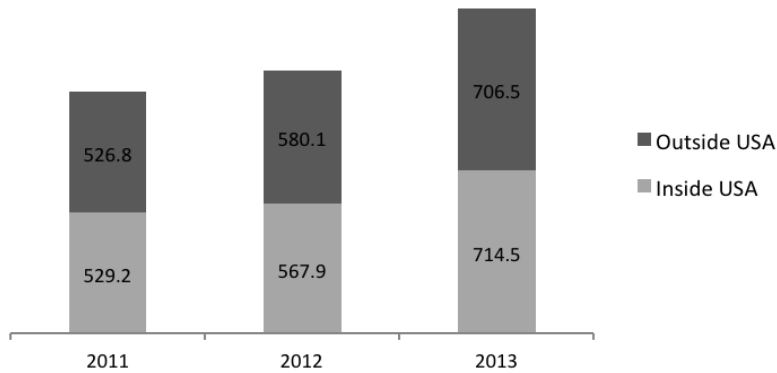
Source: Financials, Illumina Annual Report, 2013

**Exhibit 7 – Revenues of Illumina by type of customer, 2011**



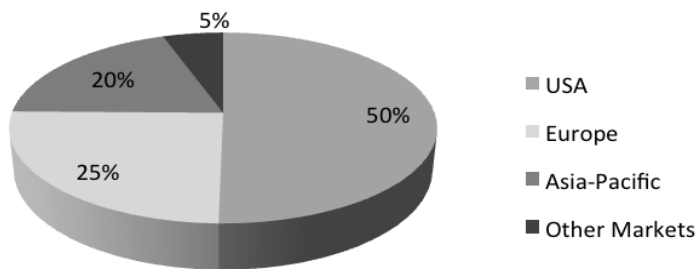
Source: Financials, Illumina Annual Report, 2013

### Exhibit 8 – Revenues Outside and Inside USA, 2011-2013



Source: Financials, Illumina Annual Report, 2013

### Exhibit 9 – Revenues by Geography, 2013



Source: Financials, Illumina Annual Report, 2013

### Exhibit 10 – Illumina Stock Price Evolution, 2005-2014



Source: Bloomberg, October 2014

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