STRATEGIC ANALYSIS FOR A NOVEL GEL ELECTROPHORESIS TECHNOLOGY

by

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ABSTRACT

A novel gel electrophoresis technology for separating protein and nucleic acid is under development by a research team at Simon Fraser University (SFU). Compared with the conventional gel electrophoresis technology, the new technology is easier to use, has higher throughput, and lower use cost.

The purpose of this project is to help the researchers to commercialize the new technology. This report begins with introduction of the project, followed by an industry analysis. Then it develops and discusses different strategic options and provides a recommendation, which suggests that the new technology position sodium dodecyl sulfate-polyacrylamide gel electrophoresis (SDS-PAGE) as first target product. It also provides an implementation plan for using a licensing business model.

Keywords: (Strategic, Gel Electrophoresis, Technology, Licensing).

Subject Terms: Business-Strategy

DEDICATION

I dedicate this work to my wife and son for their love, support and encouragement.

ACKNOWLEDGEMENTS

I would like to thank Mr. Elmer Sum for offering me the opportunity to work on this project. I would also thank my project supervisors Dr. Sudheer Gupta and Dr. Aidan Vining for their efforts and time to guild me complete this project. I would like to acknowledge the technology researchers Dr. Asim Siddiqui, Dr. Karim S. Karim and Ms. Ida Khodami for providing me with their knowledge, time and information.

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1: INTRODUCTION

Three researchers at SFU are developing a novel gel electrophoresis technology. This new technology envisions replacing the conventional gel electrophoresis method.

1.1 Gel Electrophoresis Technology[1]

In gel electrophoresis, the charged and suspended molecules in a matrix or gel support are separated by an electric field. Negatively charged molecules move toward the anode side of the gel, and positively charged molecules move toward the cathode side. The gel is a porous matrix, or meshwork, usually made of carbohydrate chains. In the gel, molecules are pulled through the open spaces and the moving speed depends on their properties, such as molecular weight, shapes and net charges.

There are many factors that determine the moving rate of these molecules through the meshwork: the electric field's strength, the gel support or matrix's composition, the composition of the liquid buffer solution, the molecules' size, shape and charge, and chemical composition of the molecules. The smaller molecules move faster than the larger molecules because they encounter less frictional drag in the gel. The frictional drag can be changed by increasing or decreasing the size of the pores in the gel, resulting faster separation, or finer resolution.

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1 Bloom, Mark V., Greg A. Freyer, and David A. Micklos. Laboratory DNA Science: An Introduction to Recombinant DNA Techniques and Methods of Genome Analysis. Menlo Park, CA: Addison-Wesley, 1996. http://www.bookrags.com/research/gel-electrophoresis-gen-02/

Gel electrophoresis technology is mainly used for separating nucleic acids and proteins though it can analyze and purify other molecules. The composition of the sample to be separated decides the use of this technique. For instance, whether it contains nucleic acids, or whether it is composed of proteins or carbohydrates. Another consideration is whether the purpose of the separation is qualitative or quantitative. Qualitative means the technology is used to evaluate the composition of the sample; quantitative refers to the collection of the separated materials for further analysis. In separation of proteins and nucleic acids, agarose or acrylamide gel is usually used as porous insoluble material.

1.2 The SFU's Technology

Gel electrophoresis technology has been used for more than seventy years since it was introduced in 1930s. It is widely used for separating proteins and nucleic acids and is one of the core techniques in biomedical research. This approach has three steps: the gel is run, stained and then photographed. As such, the separation process is of low throughput, high time consumption, and labour-intensive procedure.

The SFU's new gel electrophoresis technology creatively places an array of detectors under the gel box and measures the passage of the fragments across the array in the time domain rather than the spatial domain. As a result, it increases throughput by 10%, reduce cost by 30% than the conventional technique. It is also easier to use.

Figure1 demonstrates a flowchart of the process of the electrophoresis method with the new design.

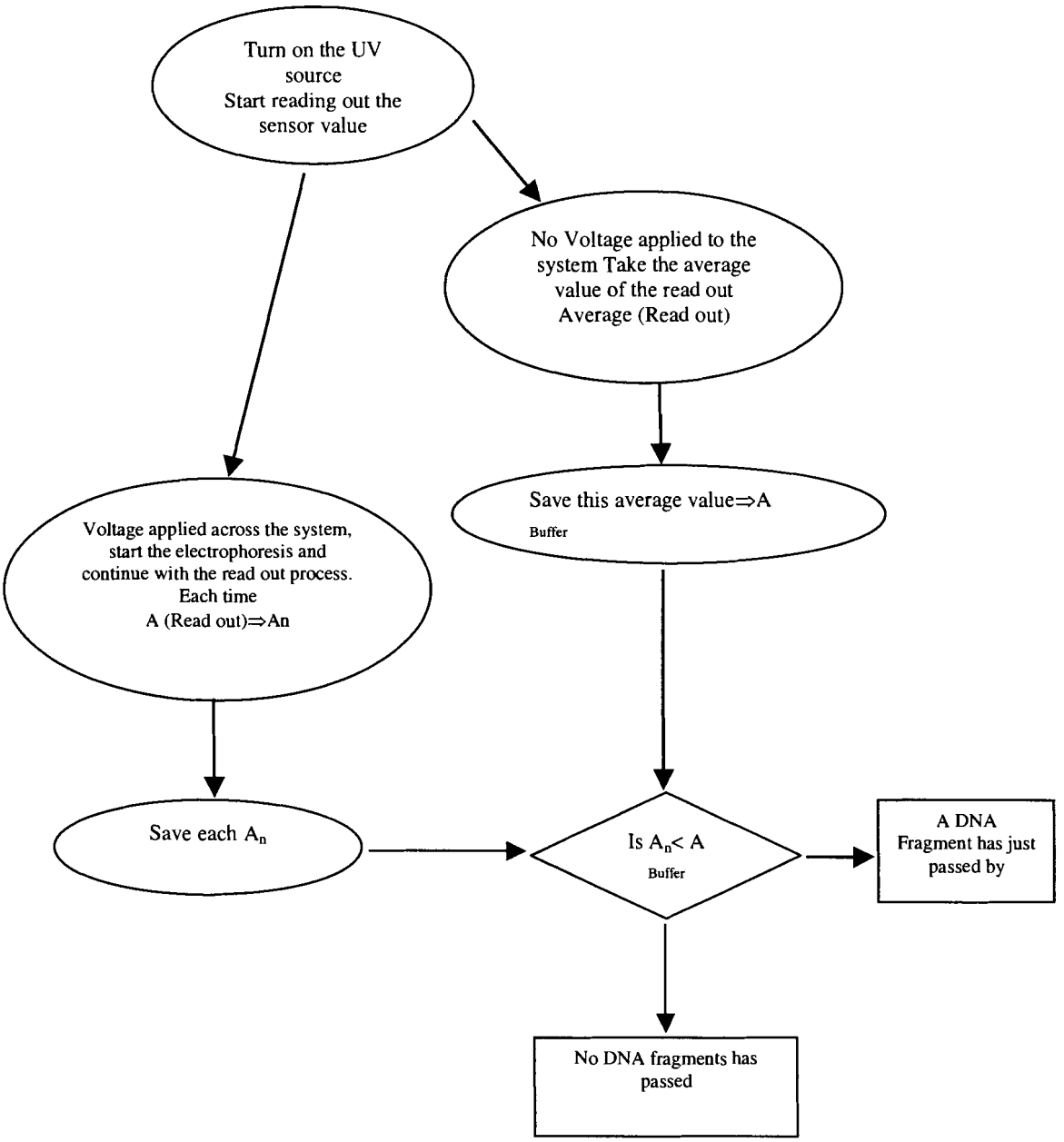


Figure 1: Flowchart of the Process and Picture of the Electrophoresis

1.3 The Research Team

Currently, three researchers are developing and own the new technology. They have access to the university and Canadian federal facilities for design, fabrication and test their first prototype. Their objective is to commercialize the technology after it goes through the prototype stage. The following is a brief introduction of the three researchers.

Dr. Asim Siddiqui is the Vice President at Research of Sirius Genomics. He has over 12 years industry experience in senior positions of research, software engineering and management. Dr. Siddiqui previously served at the Genome Sciences Centre (GSC) in Vancouver, where he contributed to the GSC great achievement for the sequencing the SARS virus, which was granted the BC Biotech Innovation and Achievement Award in 2004. Dr. Siddiqui obtained his Ph.D from Oxford University on protein structure and a B.S. degree from Cambridge University on Physics.

Dr. Karim S. Karim is appointed as an Assistant Professor at Faculty of Applied Sciences and School of Engineering Science, and the Director of Silicon Thin-film Applied Research. His education includes a B.A.Sc. degree in Computer Engineering from University of Waterloo, and a Ph.D. degree in Electrical Engineering from University of Waterloo. His research interests are microelectronic circuit, device and process development for large area electronics. Dr. Karim has received the CAGS/UMI award for the best doctoral thesis in science and medicine in Canada, the NSERC Doctoral Prize and the Douglas Colton medal for research excellence in microelectronics applied to medical imaging.

Ms. Ida Khodami has received her bachelor of applied science in Electrical Engineering from SFU in 2005. Currently she is pursuing her master degree. Her interests

are the design, implantation and feasibility study of amorphous silicon technology for Ultra Violate photo detectors and their application in biomedical devices, especially in sensors used for detecting the variations of Deoxyribonucleic acid (DNA). The different absorbance DNA under UV can potentially used for many genome-based projects, such as DNA fragment sizing, DNA sequencing, and amino acid analysis. Ms. Khodami currently holds a graduate student Scholarship from Natural Sciences and Engineering Research Council (NSERC) of Canada.

1.4 The Project Scope

The purpose of this project is to help the researchers commercialize their new technology. This report does not intend to develop a business plan or a marketing plan, since the technology has not been fully prototyped yet and cannot provide sufficient information to do so.

This report consists of six main chapters: the first chapter is a introduction to the technology and the researchers; the second chapter provides a comprehensive analysis of the industry; the third chapter is a fulcrum summarizing the industry analysis findings and the options; the fourth chapter develops a strategic options analysis by studying the potential target products; the fifth chapter generates a recommendation on the beachhead product; and the sixth chapter proposes a implementation strategy.

This report may help the founders to better understand the technology environment, the market and the competition. In addition, it may provoke a discussion among the founders to position their beachhead product in a niche market and commercialize the technology with a proper strategy.

2: INDUSTRY ANALYSIS

Gel electrophoresis technology is the core technique of the gel electrophoresis equipment, which is an analytic separation instrument used to separate macromolecules (nucleic acids or proteins), on the basis of size, electric charge, and other physical properties. The followings are analysis of the gel electrophoresis equipment industry.

2.1 Gel Electrophoresis Equipment [2]

Gel electrophoresis apparatus is the essential piece of gel electrophoresis equipment. It uses a positive and a negative charged pole to separate molecules. These apparatuses could be either in horizontal or vertical form. Horizontal gel electrophoresis unit are boxes with a middle platform divided the boxes into two compartments and are generally used for separating, visualizing samples, and analyzing restrictions. Vertical gel electrophoresis products consist of negative and positive electrode chambers, sample wells, gel plates, and cooling plates and typically used for DNA sequencing.

In gel electrophoresis equipment, an electrophoresis power supply is attached to a running tank and generates a regulated electric current to separate the charged molecules. Gel electrophoresis tanks comprise a flat bed, a column, and a slab. DNA sequencer is another important component to gel electrophoresis equipment that is made of a slab of gel and electrophoresis migration paths sandwiched between two glass panes. Different

2 About Gel Electrophoresis Equipment, http://laboratory-equipment.globalspec.com/LearnMore/Labware_Scientific_Instruments/Separation_Techniques/Gel_Electrophoresis_Equipment

DNA samples are put into each migration path and migrate with the influence of electrophoresis.

During the electrophoresis process, an acrylic tank is used to ensure that there is no leakage. Platinum electrodes embedded in acrylic tanks provide the process with a uniform, corrosion resistant electrical field. Nucleic acid electrophoresis equipment generally comprises of a removable UV-transparent gel-casting tray and end gaskets. It is used for analytical and preparative studies of nucleic acids.

Table 1 shows a comprehensive list of electrophoresis equipments.

Table 1: Electrophoresis Equipment [3]

2-D Gel Electrophoresis (2DGE)	**Electrophoresis Systems**
2-D Conversion Kits	2-D Gel Electrophoresis (2DGE)
2D Electrophoresis Accessories	Capillary Electrophoresis
2-D Electrophoresis Cells	Electrophoretic Genotyping Systems
2-D Electrophoresis Control	Horizontal Electrophoresis Systems
2-D Electrophoresis Overlay Agarose	Microfluidic Chip Technology
2-D Gel Analysis Software	Nucleic Acid Purification Fractionator
2-D Gel Electrophoresis System	Pulse Field Electrophoresis Systems
2-D Protein MW Markers	Vertical Electrophoresis Systems
2-D Sample Preparation	**Gel Drying Equipment**
Carrier Ampholytes	Gel Dryer Accessories
IPG Buffers	Gel Dryers
IPG Strip Equilibration Buffers	Gel Drying Frames
Isoelectric Focusing Cells	**Nucleic Acid Electrophoresis - Gel Documentation / Gel Imaging**
Isoelectric Focusing Gels	Gel Documentation Systems
Isoelectric Focusing Systems	Gel Imaging Filters

3 Electrophoresis Equipment http://www.biocompare.com/jump/39/Electrophoresis-Equipment.html

Preparative 2-D Electrophoresis Systems	Imaging System Accessories
Electroelution	Laser-Based Fluorescence Imaging
Electroelution Systems	Multi-Use CCD Imaging Systems
Elution System Accessories	Polaroid Camera Hoods & UV Shields
Electrophoresis Accessories	Polaroid Film
Handcast Gel Accessories	**Transilluminators**
Horizontal Electrophoresis Accessories	Dual Wavelength Transilluminators
Miscellaneous Electrophoresis Accessories	Handheld Transilluminators
Preparative Electrophoresis System Accessories	Single Wavelength Transilluminators
Vertical Electrophoresis Accessories	White Light Transilluminators
	Gradient Makers, Power Supplies, Electrophoresis Cleaning Solutions

2.2 Applications of the SFU's Technology[4]

The SFU's Technology can be used in both protein and nucleic acid separation equipment, such as Vertical PAGE, SDS-PAGE, 2DGE, PFGE and Agarose Gels.

2.2.1 Polyacrylamide Gel Electrophoresis (PAGE)

In a Vertical PAGE, proteins with a greater negative charge will run faster toward the anode. The charge density will move smaller molecules more quickly through the gel's pores than bigger ones. According to the size range of the proteins, the size of a gel's pores can be changed by raising or lowering the concentration of acrylamide and bisacrylamide in the gel. Increasing the concentration reduces the pore size; decreasing the concentration expends the pore size.

4 Bloom, Mark V., Greg A. Freyer, and David A. Micklos. Laboratory DNA Science: An Introduction to Recombinant DNA Techniques and Methods of Genome Analysis. Menlo Park, CA: Addison-Wesley, 1996. http://www.bookrags.com/research/gel-electrophoresis-gen-02/

2.2.2 Sodium Dodecyl Sulfate (SDS-PAGE)

Researchers can determine the weight of a purified protein's molecular by measuring the speed of the protein moving through a gel. The protein is purified and then is treated with an anionic detergent. When moving through a gel, the smaller protein runs faster. The even negative charges ensure that the moving speed of the protein is only related to its molecular weight.

If the test proteins run on a gel along with a ladder of proteins that their weight is known, the molecular weight of the test proteins can be determined by comparing their moving speed with that of the ladder of proteins whose molecular weights are known. This technique is called sodium dodecyl sulfate-polyacrylamide gel electrophoresis (SDS-PAGE).

2.2.3 Isoelectric Focusing

Gels can be used to determine the "isoelectric point" of a protein or the pH at which the net charge is zero. The net charge on a protein is pH-dependent because the pH changes the ionization state of amino acid groups. This charge is changed gradually by running proteins in a gel with a pH gradient from one end to the other. At a particular pH, the net charge of each protein will become zero, and the protein will stop. This procedure is called "isoelectric focusing".

2.2.4 Two-Dimensional Electrophoresis.

In "two-dimensional electrophoresis," after separating a mixture of proteins in a bioelectric focusing tube gel, the tube is placed one side on an SDS-PAGE. Two-

Dimensional Electrophoresis can separate more proteins than one parameter technique within the same time.

Two-dimensional electrophoresis is an important tool for separating large quantity of proteins. The proteins are isolated all at once after being expressed in response to a drug, hormone or other stimulus. The tow-dimensional electrophoresis can be used together with nucleic acid microarrays to determine both what genes are expressed and what proteins are produced.

2.2.5 Agarose Gels

Agarose gel, a natural seaweed product, is used to separate larger nucleic acids from 200 to 500,000 base pairs long. Other gel techniques can only separate small nucleic acid fragment between 5 to 500 base pairs. However, these small pores of the polyacrylamide gels are not suitable for larger nucleic acid fragments or intact nucleic acid molecules.

2.2.6 Pulse-Field Gel Electrophoresis

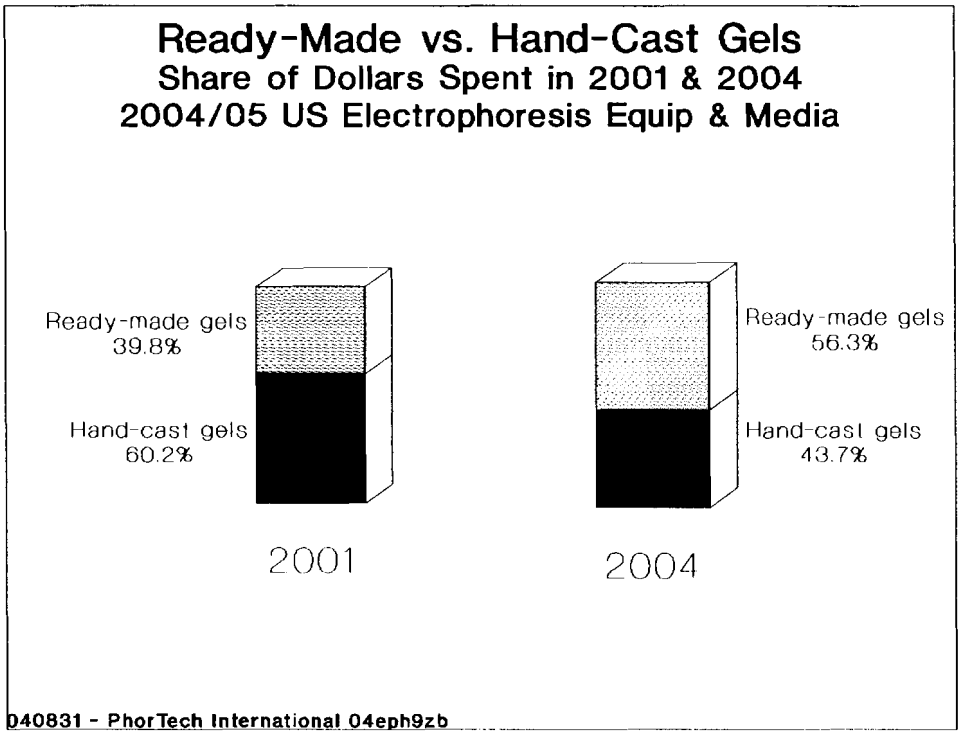
The agarose gel electrophoresis can only be used for separating nucleic acid fragments less than 50,000 base pairs (50 kilobase pairs). Pulse-field gel electrophoresis can separates big pieces of nucleic acid between 200 and 3,000 kilobase pairs long. During the separation, the electric field is not constant; instead, its direction and strength are constantly changing. Every time the current changes the molecules reorient themselves, the molecules slither through the gel matrix, the smaller fragments move faster than larger ones. After the large nucleic acid pieces are separated, then they can be

isolated for further experiments. For example, they can be sequenced, cloned into a bacterium, or amplified by polymerase chain reaction.

2.3 Market Overview [5]

In U.S, two thirds of life science researchers (over 93,000 individuals) use electrophoresis with more than $100 million expense annually. Most of the budget goes to reagents with ready-made gels. Figure 2 indicates that the sales from ready-made gels have surpassed hand-cast media since 2004.

Figure 2: Ready-Made vs. Hand-Cast Gels Share of Dollars Spent in 2001 & 2004



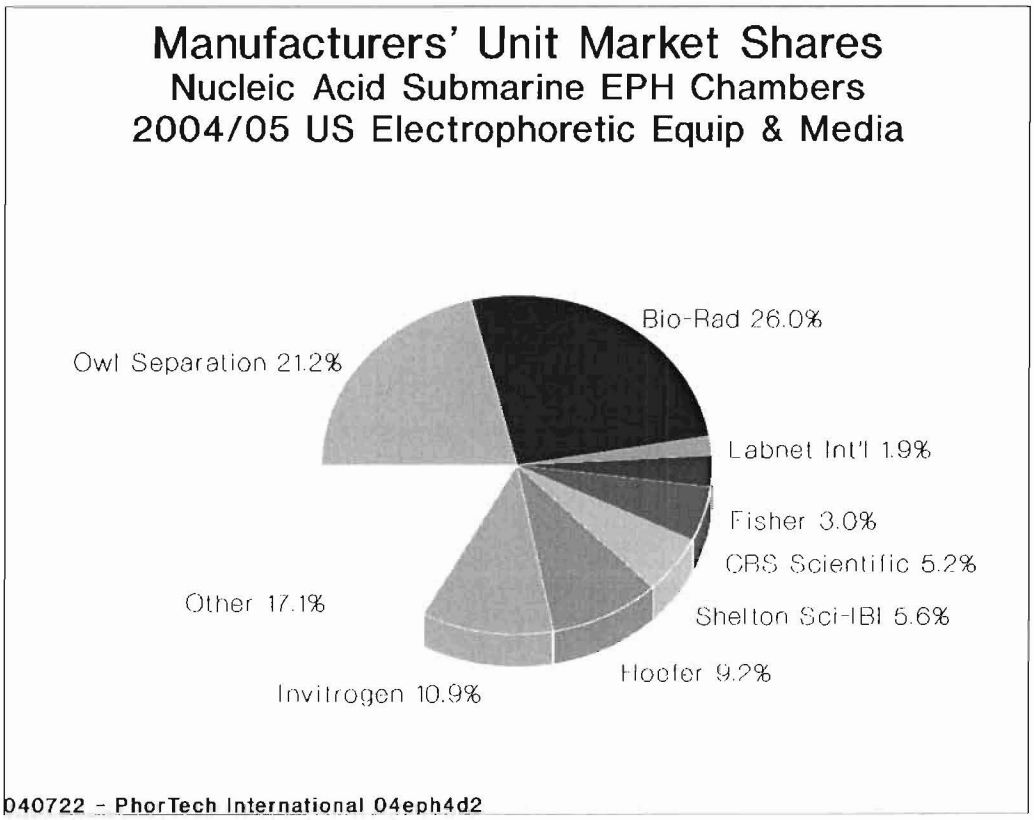
Source: www.phortech.com

5 2004/2005 U.S. MSPPSA report on Electrophoresis Equipment & Media Market, Increasing Profits in Electrophoresis as Researchers Show Willingness to Trade Capital for Labor, August 27, 2004 http://www.phortech.com/04ephpr1.htm

The growth for ready-made gels is forecasted to be even faster in the coming years because of the increasing number of life scientists who switch to ready-made gels for labour saving consumables. In addition, more than 20% of current users have planned to buy other electrophoresis instrumentation in the coming years.

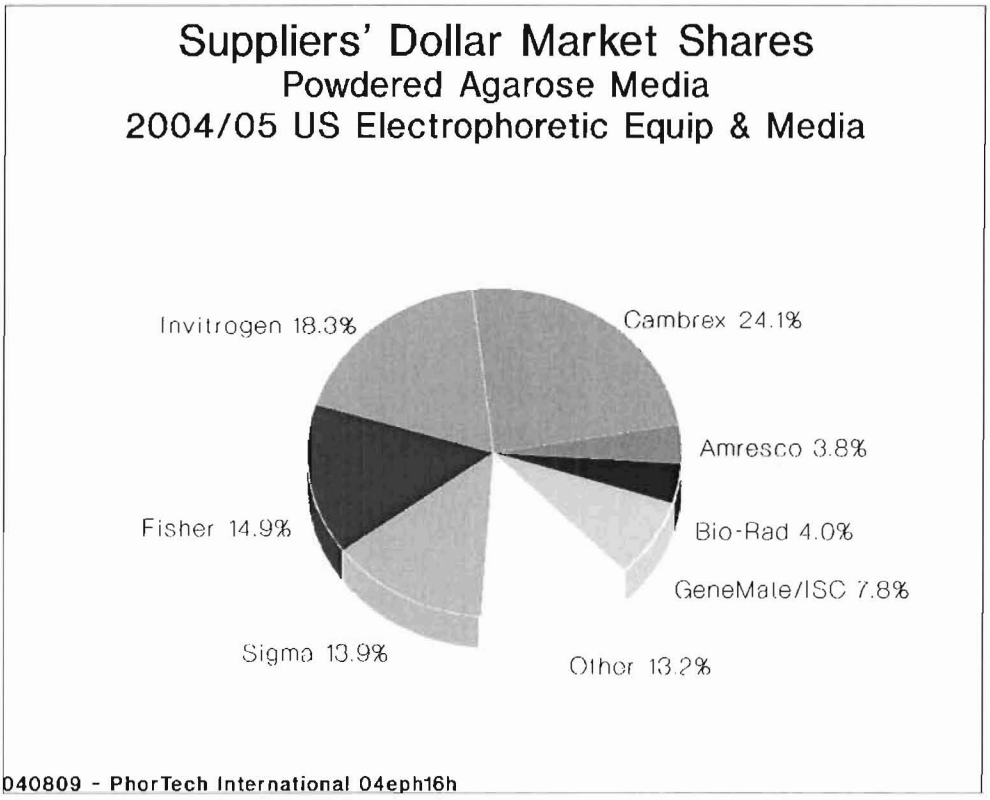
There are many companies involving in the electrophoresis equipment business (See Appendix: 1); a few of them have dominated the market. Figure 3 is a pie chart of the market share of major players. Figure 4 is the suppliers' dollar market shares powdered agarose media.

Figure 3: Manufacturers' Unit Market Shares Nucleic Acid Submarine EPH Chambers



Source: www.phortech.com

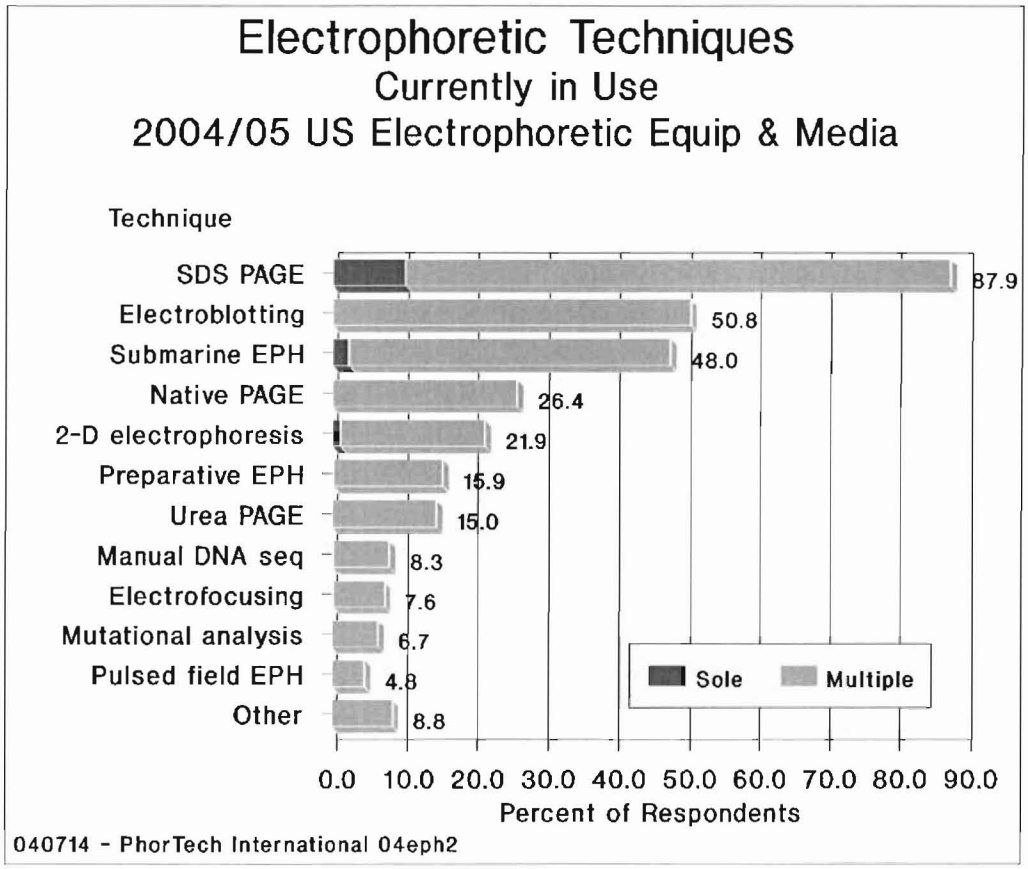
Figure 4: Suppliers' Dollar Market Shares Powdered Agarose Media



Source: www.phortech.com

Electrophoresis equipment is widely used and can be found in high concentrations among researchers within all biomedical organizations. Most users apply many different techniques available for separating both protein and nucleic acid samples. The most popular technique is SDS-PAGE, which is used by 87.9% of all researchers, followed by 50.8% using electroblotting, and 48.0% using submarine methods for nucleic acid separations (See Figure 5).

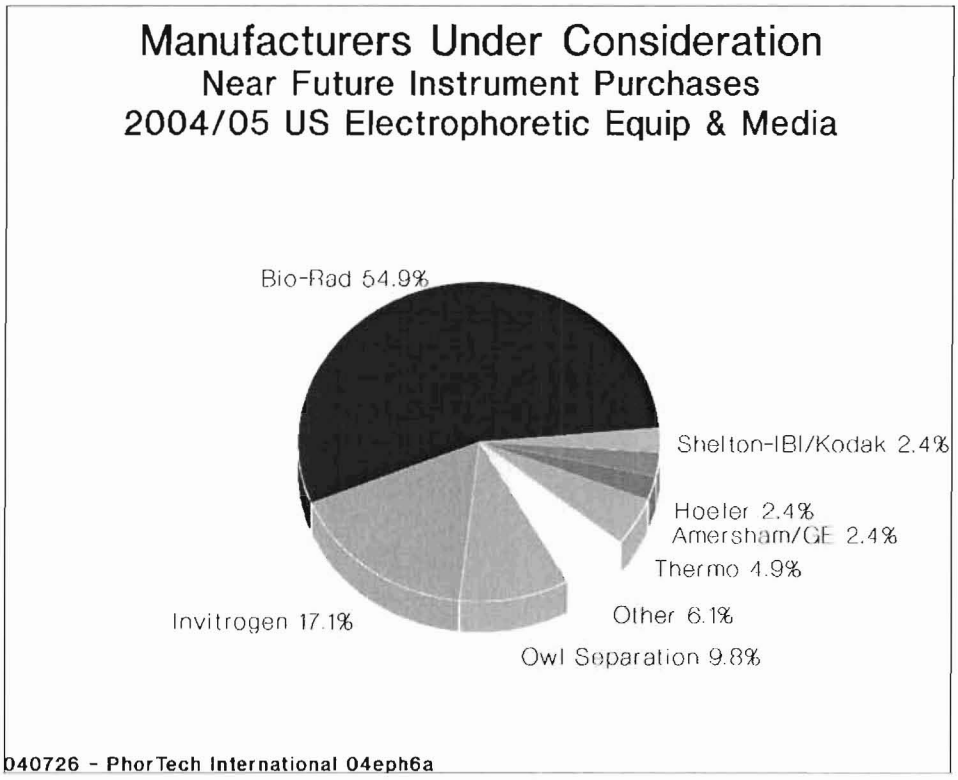
Figure 5: Electrophoretic Techniques Currently in Use



Source: www.phortech.com

In the electrophoresis equipment market, several major players have great influence on buyers' decision. The Figure 6 illustrates the manufacturers under consideration when users plan to buy electrophoresis equipment.

Figure 6: Manufacturers under Consideration Near Future Instrument Purchases



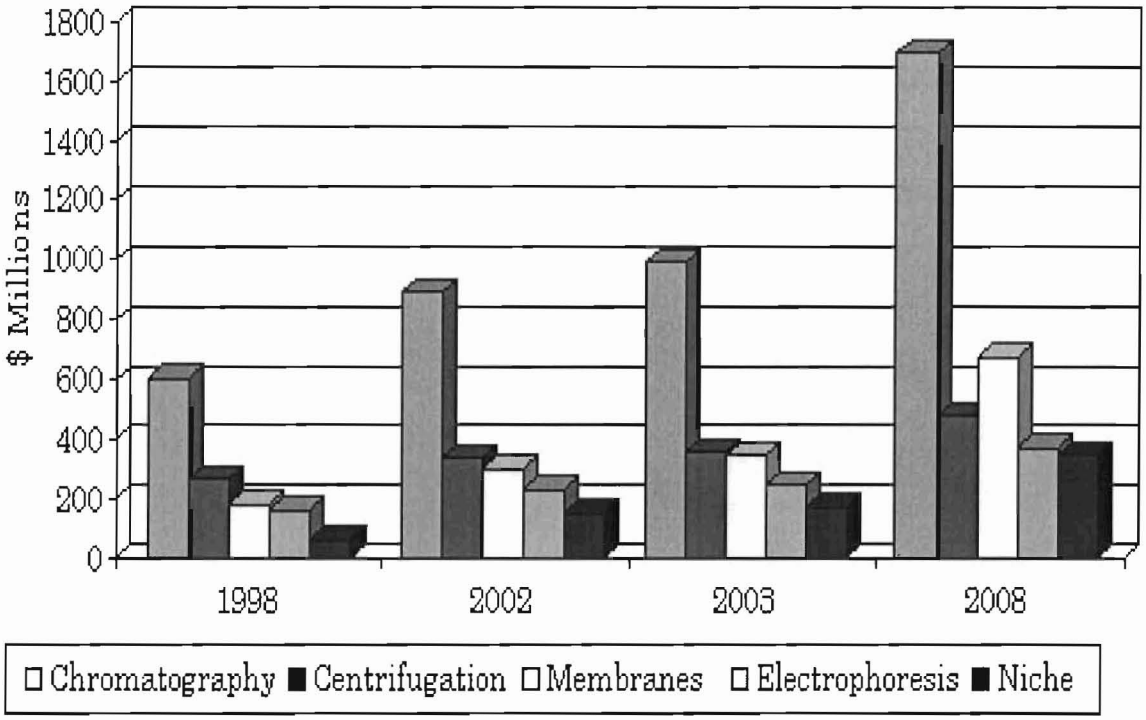
Source: www.phortech.com

Electrophoresis equipment industry has experienced fast growth since it was introduced in 1930. The Human Genome Project, a $3 billion, federally sponsored effort that mapped out the 3 billion chemical base pairs that make up human DNA is a big drive of the industry growth. [6]

Figure 7 shows the market trend of separation equipment in US.

6 Ross Kerber, Globe Staff, Competition in gene analysis heats up, 3 local companies push faster methods, challenge top firm, August 16, 2005
http://www.boston.com/business/globe/articles/2005/08/16/competition_in_gene_analysis_heats_up/?page=1

Figure 7: TRENDS U.S. Separations for Biotechnology Market Value, 1998-2008 ($ Millions) [7]



Source: www.phortech.com

The sale of the separation market segment is $2.1 billion in the U.S. in 2003 and is projected to rise to $3.6 billion in 2008, with an average annual rate (AAGR) of 11.0%.

Fast run, high throughput and reproducibility are major factors in liquid chromatography's dominance. Rising at an AAGR of 11.3%, this segment will increase to $1.69 billion in 2008.

Competition from membrane technologies should continue to limit growth of centrifugation to an AAGR of 6.0% through 2008.

7 Norma Corbitt, Separations Systems for Commercial Biotechnology, November 2003 http://www.bccresearch.com/RepTemplate.cfm?reportID=58&RepDet=HLT&cat=bio&target=repdetail.cfm

Readily met sanitary design regulations, easily enclosed systems and greater recovery rates contribute to an AAGR of 14.1% for membrane filtration. Sales should reach $673 million in 2008.

Electrophoresis systems, led by capillary designs, will rise at an AAGR of 8.3% from $249 million in 2003 to $371 million in 2008.

Electrophoresis, particularly the 2DGE, is one of several technologies to take advantage on the rapidly expanding field of proteomics while capillary electrophoresis continues to make inroads into the market. [8]

2.4 Major Players

There are many players (See Appendices 1) in the electrophoresis equipment market. Most of them are American companies (See Appendices 2). The following is a brief introduction of the seven leading companies, which dominated more than 90% of the electrophoresis market.

2.4.1 Bio-Rad [9]

Bio-Rad has more than 50 years manufacturing and distributing life science research and clinical diagnostics products. It is renowned worldwide in hospitals, universities, research institutions as well as biotechnology and pharmaceutical companies. Bio-Rad operates globally and serves more than 85,000 research and industry customers worldwide. The company has more than 5,000 employees globally with $1.3 billion revenue in 2006.

8 Analytical Separations: Trends and Markets 2005 http://www.bccresearch.com/ias/IAS009A.asp

9 Bio-rad http://www.bio-rad.com

Bio-Rad's Life Science Research Group is well known for their pioneering electrophoresis products. Other products are DNA amplification, chromatography, imaging, gene transfer, microarray technology, nucleic acid and protein quantization, protein expression, blotting, multiplexing assays, software, and the Biotechnology Explorer Program.

2.4.2 Invitrogen[10]

Founded in 1987, Invitrogen Corporation is a global company with operation in over 70 countries. It has more than 4,300 employees and $1.15 billion revenue. The company provides over 25,000 products and services for disease research, drug discovery and commercial bio-production.

Invitrogen's product line includes genomics, proteomics, bioinformatics, cell culture, and cell biology. Its products are widely used in almost every major laboratory in the world and have helped to develop many greatest medical discoveries, including AIDS virus, advancements in cancer treatment, and stem cell research tools. Invitrogen's quest is "to better the human condition through innovations in science and technology".

2.4.3 Owl Separation[11]

Owl has a wide range of product line from complete horizontal and vertical electrophoresis systems, blotters, unique protein stains to reagents essential for specialized protein separation applications. Its customers include academic research, biotech and major pharmaceutical laboratories.

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10 Who We Are, http://www.invitrogen.com/content.cfm?pageid=10051&CID=TN-Corporate- Who We Are

11 Owl Separation Systems-Innovative & Efficient Solutions for Gel Electrophoresis, http://www.owlsci.com/

2.4.4 Thermo Fisher[12]

Thermo Fisher Scientific is a leading company in serving science with annual sales over $9 billion. The company has 30,000 employees and serves more than 350,000 customers globally, including pharmaceutical and biotech companies, hospitals and clinical diagnostic labs, universities, research institutions and government agencies, as well as environmental, industrial quality and process control settings.

The company provides analytical instruments, equipment, reagents and consumables, software and services for research, analysis, discovery and diagnostics. It has a broad selection of analytical instruments, equipment, consumables and laboratory supplies, including technologies for mass spectrometry, elemental analysis, molecular spectroscopy, sample preparation, informatics, fine and high-purity chemistry production, cell culture, RNA interference analysis and immunodiagnostic testing.

2.4.5 Hoefer[13]

Founded in San Francisco in 1967, Hoefer is the premier supplier of gel electrophoresis, blotting and imaging equipment. Its distinctive electrophoresis products have been used in laboratories all around the world.

The Company offers products that are intelligently designed, easy-to-use, high quality, and yield consistent and reproducible protein and nucleic acid electrophoretic separations. It has a broad product line of instruments, accessories, and consumables, including vertical units, horizontal units, and blotting instruments. Hoefer also provides a

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12 Corporate Profile, http://phx.corporate-ir.net/phoenix.zhtml?c=89145&p=irol-homeProfile

13 About Hoefer, http://www.hoeferinc.com/Static_Pages.asp?Static_Page=51

line of imaging systems under the trademark of ULTima. It also offers a full line of complementary products, such as power supplies, fluorometers, chillers, filtration units, visualization units, and caliber reagents.

Hoefer now is a wholly owned subsidiary of Harvard Bioscience and has an OEM agreement with GE Healthcare for selling its products under the GE brand. It also sells products under the Hoefer brand. Hoefer is also the sole distributor for Biochrom's Amino Acid Analyzers in the United States.

2.4.6 Amersham/GE[14]

Amersham is a leading company in medical diagnostics and in life sciences with over 10,000 employees worldwide and had sales of $2.54 billion in 2002. The company focused on enabling molecular medicine, working through three main business areas in diagnostic imaging, protein separations and discovery systems. Amersham is UK based company and its shares are traded on the London, New York and Oslo stock exchanges. Amersham is part of the FTSE index of Britain's 100 largest public companies.

Amersham's strategy is to build itself as "a leading provider of products and technologies enabling disease to be better understood, diagnosed sooner and treated more effectively, based upon a growing understanding of disease at the molecular level".

2.4.7 Shelton Scientific-IBI[15]

Founded in 1989, Shelton Scientific-IBI was located in CT US. In 1998, Shelton bought the electrophoresis apparatus production line from Jordan. In 2000, it bought

14 Over View http://www.amersham.com/about/index.html

15 http://www.industry.iastate.edu/biotechmixer/mixer9companies.pdf

Kodak's IBI brand of electrophoresis equipment and reagents. In 2004, several Iowa investors purchased the company and relocated it to Peosta, IA.

Shelton Scientific-IBI produces a full line electrophoresis equipment, including Electrophoresis reagents, Beta Protection acrylic products, and TUNAIR Cell Growth Systems. The company sells products both domestically and internationally through an authorized distributor network.

2.5 Competition Analysis

To better understand the industry, the following analyzes five factors that determine the long-term viability of an industry: competitor rivalry, barriers to entry, substitute products availability, power of suppliers, and consumer bargaining power.

Factor 1: Rivalry among Existing Firms: Medium

The competition in the electrophoresis equipment industry can be categorized as medium, since only a few of them among many players dominated the market. The electrophoresis equipment market is growing at a high rate and attracts more companies entering the market.

Technology plays a key role in the competition. Many organizations are developing different approaches to increase throughput, reduce cost and automat operation procedure.

(-) Numerous competitors

There are numerous companies in the electrophoresis equipment business, however, only few of them dominate the market such as Bio-Rad, Invitrogen, Owl

Separation, Thermo Fisher, Amersham/GE, and Shelton Scientific-IBI. These players have been in the market for years and the small players are hard to catch up. These big companies also have high recognition, economic scale, and well-established sales channels.

(+) Fragmented Industry

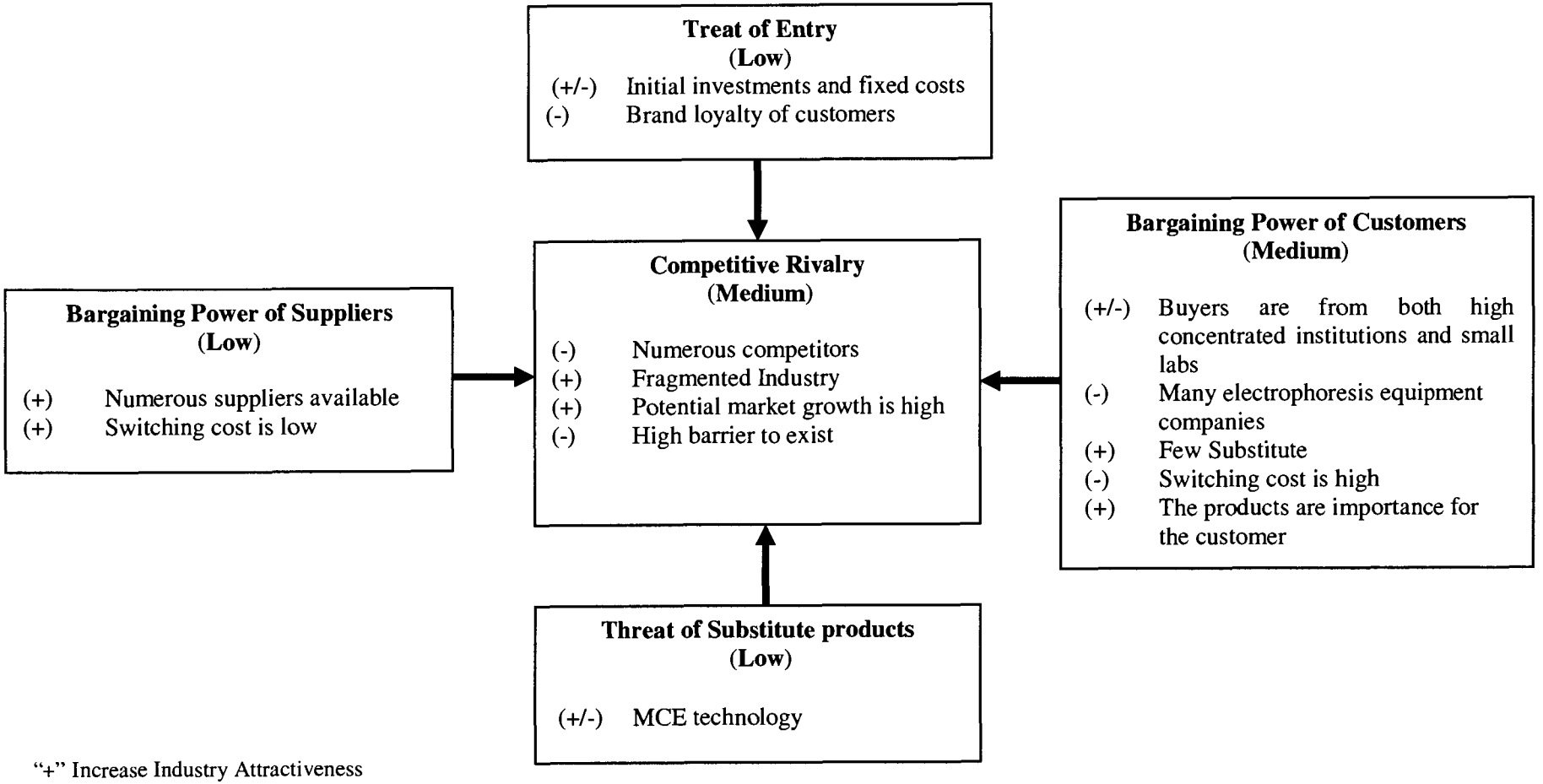
The industry consists of many different products and customers. As such, the players can differentiate their products by employing different strategy. The incentive to compete on price is medium.

(+) Potential market growth is high

The annual growth rate of electrophoresis industry is 8.3%. This enables all players to enjoy market expansion without sacrificing others' market share, thus the competition is medium.

(-) High barrier to exit

The electrophoresis equipment is high-specialized instrument. If an established company wants to leave the business, the production facilities will have less value for other use. The barrier to exit is high.



"+" Increase Industry Attractiveness
"-" Decrease Industry Attractiveness

Figure 8: Industry Competition Analysis

Factor 2: Suppliers' Bargaining Power: Low

(+) Numerous suppliers

The components of electrophoresis equipment are charge-coupled devices, lasers, pumps, electric power units, plastics, and polymeric materials. Most of the input components are off-the-shelf commodities and numerous suppliers in the market.

(+) Switching cost is low

It's easy to switch from one supplier to another, since the supplying products are not specially customized and many options for the buyers. Therefore, the switching cost is low.

Factor 3: Buyer Power: Medium

(+/-) Buyers are from both high concentrated institutions and small labs

Electrophoresis equipment customers are from both large public and private research institutions and small labs. As new technologies increase the performance and decrease the price of the products, more and more researchers will buy electrophoresis instruments for their labs.

(-) Many players in the electrophoresis equipment industry

There are many suppliers in the electrophoresis equipment business. As a result, the buyers have many options, giving them more bargain power.

(+) Few substitutes

Electrophoresis equipment is highly specialized instrument for separation of proteins and nucleic acids. MicroChip electrophoresis (MCE) technology is the only

alternative. However, it is still in a very small niche segment due to its high price and use cost.

(-) Switching cost is high

If customers want to switch to another products, they have to make the old ones obsolete. The only way to recover some cost is to sell them on the second-hand market.

(+) The product is important for the customer

The electrophoresis equipment is specially designed for separation of proteins and nucleic acids, which is the most fundamental and essential utility in biotech research and healthcare organizations.

Factor 4: Threat of New Entrants: Low

The incentive to enter the industry is low. It's hard for new entrants to compete with the big incumbents due to their dominated market position.

(+/-) Initial investments and fixed costs

The initial investments and fixed costs depend on the business scope and scale. It could be low, if a few products are produced; or high, if many different products are produced.

(-) Brand loyalty of customers

Brand is an important consideration for buyers. A well-known brand name means high quality and good service. It is difficult for new entrants to challenge the few leading brands.

Factor 5: Threat of Substitute Products or Services: Medium

(+/-) Substitute product

Currently MCE is the only substitute to the conventional electrophoresis product. However, its high use cost makes it only being found application in small niche segment.

2.6 Technologies Analysis

Currently, there are two major technologies for separation of protein and nucleic acids: conventional electrophoresis technology and MCE. Gel electrophoresis is still the dominated technology in the market.

2.6.1 Gel Electrophoresis Technology

Several electrophoresis equipment companies are pursuing innovative approaches to improve the performance of the gel electrophoresis technology. The followings are two companies who have introduced improved products to the market.

2.6.1.1 Invitrogen E-Gel Technology[16]

Invitrogen's E-Gel® 96 system turns routine agarose gel electrophoresis into an automated, high-throughput operation. Pre-cast E-Gel® 96 gels are used for analyzing multiple polymerase chain reaction (PCR) products, plasmid preparations, and restriction digests. It's a fully automated, robot-compatible, and ready to put into action system.

Each E-Gel® 96 consists of 96 sample lanes and 8 marker lanes to provide a 1.6 cm run length with a resolution between 100 bp and 10 kb. The staggered-well format is compatible with robotic loading systems. With fluorescent-labeled lane numbers that

16 E-Gel® Nucleic Acid Analysis - Snap, load, run! http://www.invitrogen.com/content.cfm?pageid=3372#7

transfer instantly during photo documentation, band identification and tracking become effortless. E-Gel® 96 gels run only 12 minutes in the E-Base TM devices.

2.6.1.2 Febe Gel Electrophoresis Equipment of Biokeystone Company[17]

Febe gel electrophoresis equipment is novel electrophoresis equipment provided by Biokeystone. Febe stands for Faster Easier Better Electrophoresis equipment, which only needs 15ml running buffer and 6-minute for high-speed electrophoresis. It also enables researchers to make gels themselves to save cost from purchasing commercial gels. The 20 self-made gels can be made at once and store for a month without any wrapping. The straight banding technology can prevent gel-smiling problem.

2.6.2 MCE Technology

The most competitive technology to the gels electrophoresis is MCE, which was first introduced by Manz et al. in 1992 as an alternative to conventional gel electrophoresis. MCE has several advantages: high-speed analysis in seconds, small amount of sample, high separation efficiency, and high-throughput analysis.[18]

At present, MCE has been applied to separation of DNA fragments, analysis of PCR products, DNA sequencing, and mutation detection. For example, Agilent 2100 Bioanalyzer, Shimadzu MCE 2010, and Hitachi SV 1100 and SV 1210 are now serving researchers in many institutions around the world. As an alternative technology to conventional gel electrophoresis, MCE is gradually gaining market share. This is mostly

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17 About Biokeystone Co, http://www.6mgel.com/about-biokey.htm

18 Fumihiko Kitagawa, High-speed Enantioseparation by Microchip Electrophoresis, February 2, 2007. http://wwwsoc.nii.ac.jp/scs/Journal/pdf/28-1_19.pdf

driven by the growing biotechnology market and strong demand for fast analytical applications, such as high-throughput screening and gene expression analysis.[19]

Agilent Technologies has launched its gel electrophoresis-replacing analyzer, Agilent 5100 Automated, which was claimed "the industry's first fully automated, high-throughput 'lab-on-a-chip system' for basic life science research and drug discovery". The Agilent 5100 Automated can generate thousands of DNA and protein samples per day and aimed at replacing the tedious, time-consuming gel electrophoresis and facilitating large-scale genomic and proteomic applications.

Agilent 5100 has two most obvious advantages over gel electrophoresis - full automation and reproducible, digital data. The system automates the electrophoresis workflow of sample handling and analysis, lowering per-sample analysis and allowing 3,840 samples per run. It also minimizes the use of sample and reagent, reducing hazardous waste and per-sample cost.

The Agilent 5100 can also produce more subjective data by using internal reference standards. The digital data is managed by oracle database, which enables researchers to access and analyze thousands of samples and millions of data points. [20]

2.7 Opportunity Analysis

The SFU's technology has obvious advantages over the conventional electrophoresis method. It integrates gel electrophoresis apparatus and imaging device as

19 Lin Chen and Jicun Ren, High-Throughput DNA Analysis by Microchip Electrophoresis, 2004 http://www.bentham.org/cchts/samples/cchts7-1/0005A.pdf

20 Gel electrophoresis-replacing analyser from Agilent, http://www.labtechnologist.com/news/ng.asp?id=55846-gel-electrophoresis-replacing

a single instrument, making the separation and imaging processes in a simultaneous and consistent manner. Hence, it saves manufacturing cost by 30%, reduces use cost by 30%, and increases throughput by 10%. In addition, it is easier to use and the size of the equipment is also fairly small, enabling the equipment more transportable. These attributes are strong incentives to attract the gel electrophoresis equipment users to switch to the SFU's technology when they consider buying new equipment.

Other new approaches are still in their early stages and have not created strong threats to the conventional gel electrophoresis technology, i.e. MCE can only be found in a very small niche market due to its high use cost which substantially barriers its application. Alternatively, the SFU's approach is a gel based technology but in an innovative way. As a result it is easier to be accepted by users than other approaches departing from gel electrophoresis based technology.

These two attributes coupled with the fast growing market and medium competition in the industry provides the SFU's technology a good opportunity to enter the gel electrophoresis equipment market.

3: FINDINGS AND OPTIONS

The electrophoresis equipment industry is a fast growing and fragmented industry with different products and applications. Although there are many players in the arena, seven of them have dominated more than 90% of the market share. In electrophoresis equipment industry, technologies play a significant role in the completion. New approaches are being pursued in both incumbents and outside industry. Currently, however, none technology has successfully penetrated the position of conventional electrophoresis technology. Moreover, the barrier to entry and the suppliers bargain power are both low. Such situation creates an excellent entrepreneurial opportunity for the researchers at SFU to join the game.

However, before planning to commercialize their technology, the researchers need to make challenging alternative decisions. First, which product they should focus on in their further research; second, how they complete with the incumbents, especially the major players. Finally, how they differentiate the SFU's technology from other technologies.

The rest of this report will discuss these issues and provide recommendations.

4: STRATEGIC OPTIONS

Currently, the SFU's technology is still in its early stage and some assumptions need to be confirmed when the complete prototype is ready. However, several issues require investigation to guide the research and help the commercialization in the future. The most important issue is to decide what product the researchers should focus on in the next step.

4.1 Potential Products Analysis

The electrophoresis equipment industry is fragmented. The core competence is the electrophoresis technology, which can be applied to different electrophoresis equipment. The SFU's technology can be used for the following product categories:

4.1.1 2DGE Systems[21]

2DGE is widely used for analyzing complex protein mixtures. Two steps for separating proteins: the first-dimension is bioelectric focusing, which separates proteins according to their bioelectric points; the second-dimension is SDS-PAGE, which separates proteins according to their molecular weights. As such, complex proteins mixtures can be resolved and each protein's relative amount can be determined.

2DGE is used for identifying differential protein expressions. The mini gel format commonly used in 2DGE has yielded high-resolution, large format gels that are

21 Two-dimensional gel electrophoresis, http://www.tau.ac.il/lifesci/units/proteomics/2dimgel.html

incorporated into high output proteomics analysis. The tremendous volume of samples under analysis ensures that proteomics will serve as the most significant driver for the 2DGE product.

A report from Frost & Sullivan estimates that the revenue of 2DGE markets is $313 million in 2003 and will reach $717 million by 2010. 2DGE is able to gather large amounts of information by image analysis and data-mining solutions. Generally, large companies are inclined to adopt new solutions, while smaller firms are more circumspect. An obvious disadvantage of 2DGE is its time-consuming procedures and hard to use. [22]

4.1.2 SDS-PAGE Systems[23]

The SDS-PAGE system could be made either vertical or horizontal and used for denaturing proteins and exterminating molecular weight.

SDS can denature proteins by "wrapping around" the polypeptide backbone - and SDS binds to proteins fairly. As such, SDS confers a negative charge to the polypeptide in proportion to its length. In denaturing SDS-PAGE separations, migration is determined not by molecular weight but intrinsic electrical charge of the polypeptide.

SDS-PAGE is also used to determinate molecular weight of proteins of known molecular along with the protein or nucleic acid to be characterised.

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22 2D gel electrophoresis market heading for boom, 2004, http://www.drugresearcher.com/news/ng.asp?id=54209-d-gel-electrophoresis

23 Ed Rybicki and Maud Purves, SDS POLYACRYLAMIDE GEL ELECTROPHORESIS (SDS-PAGE) http://www.mcb.uct.ac.za/sdspage.html

4.1.3 Continuous and Discontinuous Buffer Systems

Continuous and discontinuous are two types of buffer systems in electrophoresis. A continuous system has only a single separating gel and uses the same buffer in the tanks. In a discontinuous system, a non-restrictive large pore gel, called a stacking gel, is layered on top of a separating gel. Each gel is made with a different buffer, and the tank buffers are different from the gel buffers. The resolution obtained in a discontinuous system is much greater than that obtained from a continuous system.

4.1.4 Electrophoretic Genotyping Systems

Genotyping is the process of determining the genotype of an individual. Current methods of genotyping are PCR, DNA sequencing, and hybridization to DNA microarrays or beads. The intrinsic of the technology is for test on father/motherhood and for the investigation of disease-associated genes in clinical research.

Due to current technological limitations, only a small fraction of an individual's genotype is determined. New innovations, such as the Human-1 BeadChip developed by Illumina claimed to provide whole-genome genotyping in the future.[24]

Four different products under this product category: Constant Denaturing Gel Electrophoresis Systems (CDGE), Denaturing Gradient Gel Electrophoresis Systems (DGGE), Single Stranded Conformational Polymorphism Analysis Systems (SSCP), Temporal Temperature Gel Electrophoresis Systems (TTGE).[25]

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24 Genotyping http://en.wikipedia.org/wiki/Genotyping

25 Electrophoretic Genotyping Systems

http://www.biocompare.com/jump/2960/Electrophoretic-Genotyping-Systems.html

4.1.5 PFGE Systems[26]

PFGE systems are used for characterizing various strains at the DNA level. It can separate larger DNA than conventional electrophoresis, allowing direct study of intact chromosomes. At present, no single technique is sufficient for preparing a map of an intact human chromosome and the new generations of devices are expected to separate even larger fragments and entire human genomes eventually.

PFGE will play an important role in mapping the human genome. Future applications for PFGE techniques may include nucleic acid sequencing, protein separations and DNA topology study. As physical mapping methods are displacing genetic methods for chromosome assignment, PFGE is essential to let researchers to understand the behaviour of circular DNA species.

4.2 The SFU's Technology Strategy Position

Compared with other technologies, the SFU's technology has some advantages and disadvantages.

4.2.1 Cost

Compared with the conventional method, the SFU's gel electrophoresis technology can decrease the manufacturing cost by 30%. This is a substantial reduction and makes the equipment more affordable. The reduced instrument cost also enables more researchers to consider purchasing electrophoresis equipments for their own labs.

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26 Esin (HACIOÚLU) BASIM, H.seyin BASIM, Pulsed-Field Gel Electrophoresis (PFGE) Technique and its use in Molecular Biology, 2004, http://journals.tubitak.gov.tr/biology/issues/biy-01-25-4/biy-25-4-6-0006-5.pdf

The new equipment also reduces use cost by 30% than the conventional technology, because it's higher throughput and requires less labour. The SFU's technology has the lowest cost for both manufacturing and use, and the MCE technology has the highest cost.

4.2.2 Throughput

The new technology increases the separation throughput by 10%. This is mainly due to the methodology employed in the technology. However, this speed is still much slower than MCE technology. As a result, the throughput of the SFU's technology is higher than conventional method but lower than the MCE technology.

4.2.3 Easy to Use

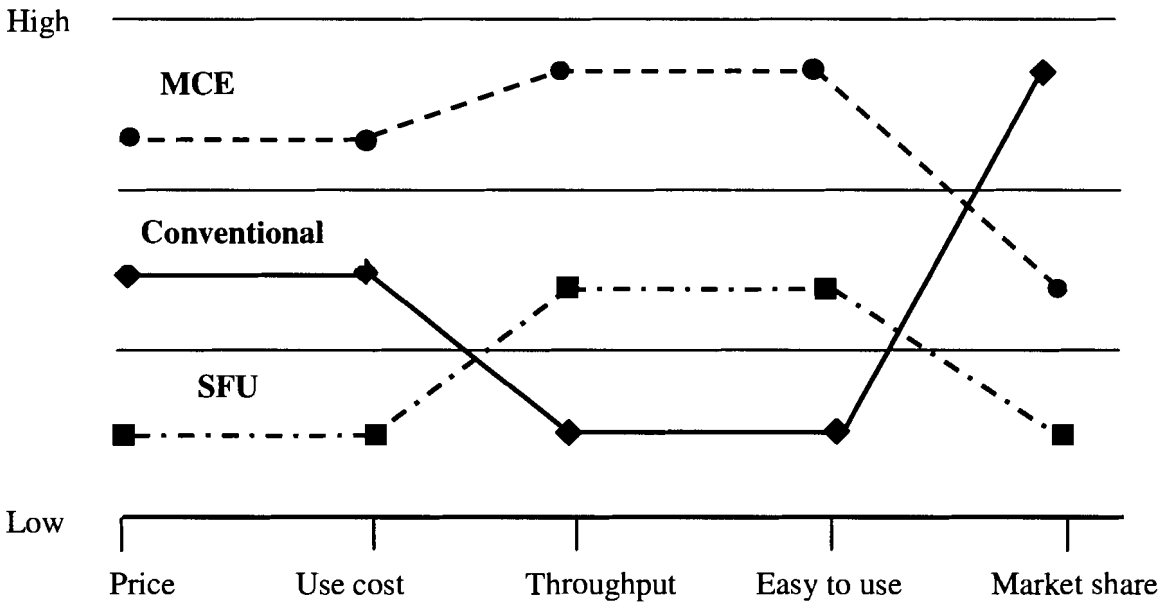
In the conventional method, the users have to involve many steps in order to finish the separation. First, they need to load the gel and run the separation, and then they photograph the result and do analysis. With the SFU's technology, the users only need to load the gel and the equipment will do the last two steps of running and scanning the gel electrophoresis simultaneously.

4.2.4 Maturation

Compared with conventional gel electrophoresis technology and MCE technology, the SFU's technology is the newest. The conventional gel electrophoresis technology has been used for seventy years and is mature. MCE technology has been in the market from 1990s and used by early adopters in many organizations. Although MCE has not reach the main street market, it has gradually grabbed market share from conventional electrophoresis equipment market.

Figure 9 is a strategy canvas of the three different technologies.

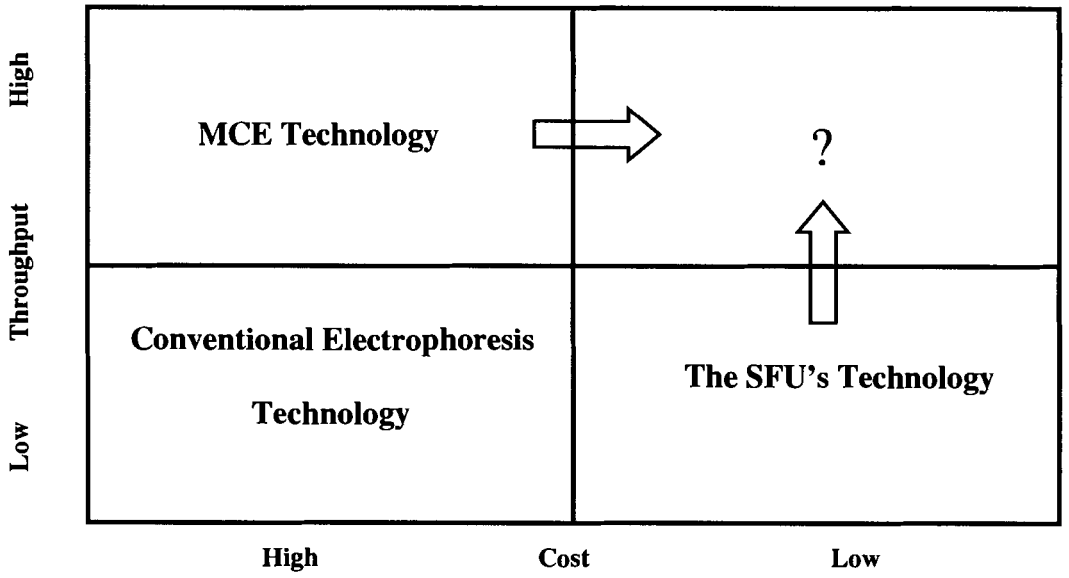
Figure 9: The Strategy Canvas of Three Separation Technologies



4.2.5 Technologies Position Maps

Among these attributes, throughput and cost are two critical attributes to determine the technologies' future. Figure 10 is the technologies position maps. Whether the SFU's technology can become disruptive to the conventional electrophoresis technology mostly depends on its throughput, which needs the researchers at SFU to pay particular attention.

Figure 10 Technologies Position Maps



5: RECOMMENDATION

The immediate concern of the SFU researchers is which product they should concentrate on.

As discussed in the strategic options analysis, the technology could be used as a central technology for separation of both proteins and nucleic acids. Accordingly, it can be applied to several different products, such as Vertical PAGE, SDS-PAGE, 2DGE, Agarose Gels, and PFGE. Based on the former analysis, it is recommended that the researchers consider SDS-PAGE as the beachhead product. The supportive evidences are as following:

First, the SDS-PAGE is the most widely used technique among all electrophoresis users. Among all the potential products categories, SDS-PAGE is the single most popular technique. 87.9% of the electrophoresis users use SDS-PAGE, following by 50.8% of electroblotting usage, and 48.0% of submarine methods. [27] Therefore, taking SDS-PAGE as beachhead product will expose more users to the new technology than other products. Once getting used to the new products, these users will be a good source to spread the words to attract others switching to the new technology.

27 2004/2005 U.S. MSPPSA report on Electrophoresis Equipment & Media Market, Increasing Profits in Electrophoresis as Researchers Show Willingness to Trade Capital for Labor, August 27, 2004 http://www.phortech.com/04ephpr1.htm

Second, the US market of protein separation systems is about $3.0 billion in 2006 and will grow at an AAGR of 11.1%. It will surpass $5.0 billion by the year 2011.[28] This growth rate is faster than 8.3% AAGE of total protein and nucleic acid separation market.[29] As a consequence, the protein separation electrophoresis market is more attractive than nucleic acid separation market.

Finally, as a new entrant to the market, the SFU's technology faces great challenges from the well-established companies, which have influential brand names, huge customer bases, and strong financial and R&D capabilities. Therefore, focusing on one product is easier than launching many different products at the same time.

28 Business Communications Company, Separation Systems for Commercial Biotechnology, 2007, http://www.piribo.com/publications/biotechnology/separation_systems_commercial_biotechnology.html

29 Norma Corbitt, Separations Systems for Commercial Biotechnology, November 2003 http://www.bccresearch.com/RepTemplate.cfm?reportID=58&RepDet=HLT&cat=bio&target=repdetail.cfm

6: IMPLEMENTATION

At present, there are three options under consideration for commercializing the new technology: setting up a new company and running it themselves, partnering with others, and licensing out the technology.

6.1 The Options Analysis

Each of these options has its pros and cons. The following will discuss these options and decide the most attractive option.

6.1.1 Setting up a New Company

In this option, the researchers will be responsible for every thing from getting trademark registration to getting packaging developed. They also need to decide whether to set up the facilities to manufacture the products or contract out the production to other manufacturers who can produce finished, packaged products ready for sale. There are also many other details to take care within the company.

The pros:

- The researchers can fully control the technology and avoid the possible leakage to other competitors.
- The researchers completely own the company and have the highest incentive to run the business.

- They will involve all the operation activities and can make decisions upon their own judgments.
- The researchers will share all the profit generated from the business.

The cons:

- Among all the options, this option has the highest risk. Once the company fails, the researchers will have to take all the liability.
- The new company needs to do marketing from the very beginning and it is difficulty to enter the already competitive market.
- The researchers have a very strong technology background, while setting up a new business needs more management skills.

6.1.2 Setting up a Joint Venture with Other Companies

"A joint venture is a strategic business partnering and legal agreement between two or more businesses to mutually accomplish a business objective. The parties agree to create a new entity together by both contributing equity, and they usually share assets, costs, risks, profits, other rewards, and the control of the enterprise. The venture can be for one specific project only, or it can be a long-term continuing business relationship"[30]

The researchers can invest their technology to the joint venture and decide the technology value by negotiating with the other investors. As such, the researchers will have partial ownership of the company.

The pros:

30 DEFINITION JOINT VENTURE, http://www.12manage.com/description_joint_venture.html

- The risk is higher than licensing but lower than setting up a company themselves.
- The researchers participate the critical decision through shareholders' meeting or board meeting.
- Financial interests will ensure that all parties have high incentive and commit to the company's growth.

The cons:

- The decision-making is slow because it needs get approval by the majority of the participants.
- The corporate cultures and different interests of the investors could lead to disastrous consequences.

6.1.3 Licensing the Technology to Another Electrophoresis Company

In this option, the researchers license their technology to another manufacturer, which will pay the researchers royalty percentage from sales of the products through a Licensing Agreement. In this situation, the researchers are the technology "Licensor" and the manufacturer is the "Licensee" who is granted the rights to use the technology.

The pros:

- The researchers will not involve in any details to commercialize the products, which would be at the Licensee's expense.
- The researchers will take no risk no matter the products success or not.

The cons:

- The researchers will get less return than the first two options if the product is successful.
- The risk of the technology leaking to other competitors is high, because the researchers cannot fully control the use of the technology.

By comparing the pros and cons of the three options, it's recommend that the researchers give the licensing option the priority based on the following reasons:

First, licensing the technology to a big company can increase the chance to succeed. The company has all the resources to commercialize the product, including its well-known brand name, established sales cannel, and financial support.

Second, the researchers do not have enough experiences for running a gel electrophoresis equipment business. It will be too risky for a start up business to compete with big companies.

6.2 The Potential Licensing Partners

When choosing licensing partners, the researchers should use the percentages of the "Manufacturers Under Consideration Near Future Instrument Purchases" as the most important criteria. The percentages are an excellent index of the future of the electrophoresis equipment manufacturers. Therefore, the priority should be given to the companies with highest percentages. Table 2 is the potential partners priority ranks according to their "Manufacturers Under Consideration Near Future Instrument Purchases".

Table 2: Potential Licensing Companies Priority Ranks

Priority Ranks	Companies	Percentages
1	Bio-Rad	54.9%
2	Invitrogen	17.1%
3	Owl Separation	9.8%
4	Thermo Fisher	4.9%
5	Hoefer	2.4%
6	Amersham/GE	2.4%
7	Shelton-IBI	2.4%
8	Others	6.1%

The other consideration to support this proposal is that these companies are pursuing new approaches to update their conventional gel electrophoresis equipment, but still none has come up with a solution that can disruptive the current technology. The SFU's technology could help them stand out among other competitors. The new technology is a promising alternative for these companies.

6.3 Potential Licensing Terms

The License Agreement is the most important document in the licensing strategy. Table 3 is a list of important terms in the Licence Agreement.

Table 3: Important Terms in the License Agreement[31]

Terms	Description
Confidential Information	Means all information (whether in print, oral, magnetic, optical or electronic form), which is expressly marked as confidential.
Documentation	Means the operating manuals, guides and other support materials provided by the Licensor to the Licensee in either print, magnetic, optical or electronic form, including any materials which are designed to assist or supplement the understanding or application of the Technology.
End-User	Means an end-user of the Licensed Product that has, before securing access to the Licensed Product, entered into an end-user license agreement with the Licensee.
Field of Use	Means the field of the technology being used.
Improvements	Means any and all changes, modifications, additions, alterations, enhancements, upgrades and development to the Technology, but shall not include any part of the Technology or Documentation, which remains proprietary to the Licensor.
Intellectual Property Rights	Means any and all the vested, contingent or future inventions, innovations, discoveries, design rights, model rights, patents, patent applications, trade secrets, copyrights, codes, technical information and know-how, including but not limited to any methods, techniques, processes, discoveries, inventions, innovations, unpatentable processes, technical information, specifications, recipes, formulae, designs, plans documentation, drawings, data and other technical information, relating to the Technology, Documentation and the Licensed Product, registrations of and applications to register any of the aforesaid rights, rights in the nature of any of the aforesaid rights in any country, rights in the nature of unfair competition rights and rights to sue for passing off relating to the Technology and Documentation and any other proprietary information belonging to the Licensor, whether solely, jointly or otherwise.
License	Means the licence granted to the Licensee.
License Fee	Means the fees payable by the Licensee to the Licensor.
Licensed Product	Means any product fabricated using any part of the technology.
Parties	Means the Licensor and the Licensee collectively and "Party" means either the Licensee or the Licensor, as the context dictates.
Revenue	Means any and all revenues received and receivable by the Licensee, including but not limited to transaction fees, subscription fees, and all other revenue sources attributable to the use of the Technology under the License Agreement.
Royalty	Means the percentage of annual Revenue payable by the Licensee to the Licensor as calculated in Schedule.
Sale Price	Means the price quoted and charged by the Licensee in direct sales to any party of any part of the Licensed Product.
Term	Means the license duration.

31 Technology License Agreement Template, http://www.exploit-tech.com/inventors/Technology%20Licence%20Agreement%20Template%205-9.pdf

When negotiating with the potential partners, the researchers need to particularly pay attention to the following terms.

Intellectual Property Rights:

As described in table 3, the Intellectual Property Rights are the most important term in the Licence Agreement. It defines in great details about what intellectual property rights are licensed to the licensee. The License Agreement includes any technologies, techniques, ideas, methods, and patents, which will make the SFU's technology different from other technologies. A well-defined Intellectual Property Rights can benefit the researchers and avoid potential disputations between the two parties.

Field of Use:

The SFU's technology can be applied to several electrophoresis equipment, such as vertical PAGE, SDS-PAGE, 2DGE, and PFGE. How to define the field of use will be critical to control the technology.

Royalty:

Royalty is the percentage of annual revenue payable by the licensee to the researchers as calculated in schedule. Under this term, it should define clearly in which territories the revenue is generated; how the royalty is paid; and who is responsible for auditing the financial data.

6.4 Issues and Challenges[32]

Licensing option is a very challenging task for the researchers. The followings address the important issues and challenges.

6.4.1 Protection of Intellectual Property

Intellectual property is the core competence of the researchers. To better protect the technology, the researchers should be very cautious.

Prior to taking with any potential companies regarding a possible license agreement, the researchers need to provide confidential information to the counter part. It is important to sign a confidential information agreement before offering the technology information to the other party. Under the terms and conditions in the confidential information agreement, the two parties then decide whether to develop a licensing agreement after reviewing the technology. Once the two parties have decided to reach a license agreement, it is also important to require the other party to pay for securing the technology protection in the agreement.

6.4.2 Interim Agreement

If the two parties intent to establish a license agreement, it will be helpful to tentatively have a memorandum as an interim agreement allowing the parties to work together for the purpose of completing the final agreement to be reached at a later time. The memorandum will state the key points such as the licensed technology, territory,

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32 A. JOSE CORTINA, License Agreement Is More Complex Than Just Completing a Form, Jul. 11, 2007 http://www.wral.com/business/local_tech_wire/opinion/story/1578814/

exclusivity and compensation. It is also important to indicate that these are for further negotiation purposes only and subject to change in the final agreement.

6.4.3 Preparation and Approval of the License Agreement

It involves many tough works in the preparation and approval of the license agreement. Many details regarding the final agreement need to be negotiated with lot of back and forth between the parties. It not only includes technique issues, but also many business and legal issues. Without former experience in such area, it will be at the researchers interest to hire a professional licensing agent and attorney to participate the whole process.

6.4.4 After the License Agreement

Signing the license agreement is not the last step, it is important for both parties to ensure that their activities are accordance with the provisions and the terms in the license agreement. To ensure the required royalty payments, the researchers have the right under the license agreement to audit the licensee's books and records. It is also possible that the parties require changes for the agreement after the license has been performed for a while. These changes can be enforced either by an amendment, by a side letter, or by a supplemental agreement.

6.4.5 Other Considerations

In addition to the above considerations, it is also important to keep in mind that a final license agreement may not be reached due to inconsonance disagreements between the two parties. It is possible that a reached license agreement may be terminated within a short period due to it fails to address each party's needs. If the researchers feel that the

efforts to reach an agreement is impossible, it is better to walk away instead of wasting too much time and resources.

In summary, to complete a licensing agreement is not a simple task but a complicated and a time consuming process. It would be helpful for the researchers to keep in mind the above considerations in advance.

7: CONCLUSION

This project aims to help the researchers at SFU to commercialize their novel gel electrophoresis technology. To meet this goal, this report develops a comprehensive strategic analysis, including technology analysis, industry analysis, and strategic options analysis. Finally, it offers a recommendation for the beachhead product and proposes an implementation plan for the licensing strategy.

The industry analysis identifies that the SFU's technology falls into the electrophoresis equipment industry. The new technology can be used to produce varied products, such as vertical PAGE, SDS-PAGE, 2DGE, PFGE, and Agarose Gels. Then the report develops a market segmentation and market trends analysis. The major players in the electrophoresis industry are Bio-Rad, Invitrogen, Owl Separation, Thermo Fisher, Hoefer, Amersham/GE, and Shelton-IBI, which dominated more than 90% market share. By doing a competition analysis, it discovers that the electrophoresis equipment industry is high attractive to the researchers.

In the strategic options analysis section, the report discusses the potential products and illustrates a Strategy Canvas of Separation Technologies by comparing the advantages and disadvantages of the SFU's technology, conventional gel electrophoresis technology and MCE technology. In addition, it generates a position these technologies. The position map demonstrates that the SFU's technology is the lowest cost technology and MCE is the highest cost technology; the throughput of SFU's technology is higher than conventional technology and lower than MCE technology. At present, it is not obvious

which technology will become the disruptive technology with both high throughput and low cost.

This report recommends that the researchers should target SDS-GAGE as beachhead product, because SDS-PAGE is the most widely used technique among all electrophoresis users and grow at a highest AAGR of 11.1%. Focusing on one product also is easier than launching many different products at the beginning.

To implement strategic option, this report analyzes three possible options of setting up a new company, setting up a joint venture and licensing the technology to other electrophoresis companies. The report prefers the licensing approach than other options through balancing each option's pros and cons. Meanwhile, the licensing priority should be given to the companies with higher percentage of under consideration near future instrument purchases. In a priority sequence, these companies are Bio-Rad, Invitrogen, Owl Separation, Thermo Fisher, Hoefer, Amersham/GE, Shelton-IBI, and Others.

This strategic analysis also lists the terms in the license agreement and recognizes the most important terms for the researchers in particular, which are Intellectual Property Rights, Field of Use and Royalty.

Licensing technology to other companies is a very challenging task for the researchers. To help them better carry on the license process, the report discusses some important issues such as the protection of intellectual property, interim agreement, preparation and approval of the license, after the license agreement and other considerations.

ABBREVIATIONS

2DGE	Two-Dimensional Electrophoresis
AAGR	Average annual rate
CDGE	Constant Denaturing Gel Electrophoresis Systems
DGGE	Denaturing Gradient Gel Electrophoresis Systems
DNA	Deoxyribonucleic acid
MCE	MicroChip electrophoresis
PAGE	Polyacrylamide gel electrophoresis
PCR	Polymerase chain reaction
PFGE	Pulse-Field Gel Electrophoresis Equipment
SDS-PAGE	Sodium dodecyl sulfate-polyacrylamide gel electrophoresis
SFU	Simon Fraser University
SSCP	Single Stranded Conformational Polymorphism Analysis Systems
TTGE	Temporal Temperature Gel Electrophoresis Systems

APPENDICES

Appendices 1:

55 Companies Make Gel Electrophoresis Equipment[33]

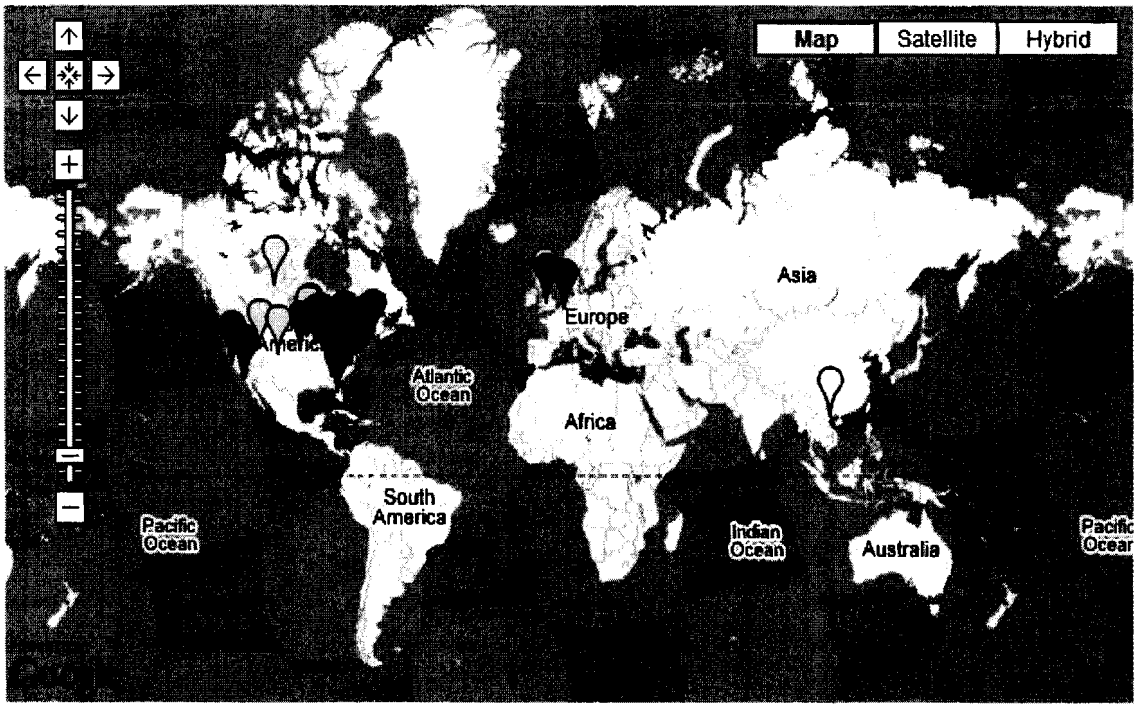
Company	Headquarters	Manufacture	Distribution	Services
Labconco Corporation	Kansas City, MO	✔		
Sigma-Aldrich	Milwaukee, WI	✔	✔	
ANSYS Technologies, Inc.	Lake Forest, CA	✔		
6mgel.com	Beaverton, OR	✔		
ABgene Inc., USA	Rochester, NY	✔		✔
Alpha Innotech Corporation	San Leandro, CA	✔		
ArmaLab, Inc.	Bethesda, MD	✔		
Biochrom Ltd.	United Kingdom	✔		
BioMachines Inc.	Carrboro, NC	✔		
Bionexus, Inc.	Oakland, CA	✔		✔
Bio-Rad Laboratories, Inc.	Hercules, CA	✔		✔
BioSupplyNet, Inc.	Plainview, NY	✔		✔
Biotech Holdings Inc.	Akron, OH	✔		✔
C.B.S. Scientific Company, Inc.	Del Mar, CA	✔		
Cole-Parmer	Vernon Hills, IL		✔	
Cole-Parmer Instrument Co. Ltd.	United Kingdom		✔	
CONSORT nv	Belgium	✔		
Continental Lab Products	San Diego, CA	✔	✔	
Cynmar Corporation	Carlinville, IL		✔	
Dan-Kar Corporation	Wilmington, MA	✔		
Diamed Lab Supplies, Inc.	Mississauga, Canada		✔	
Ellard Instrumentation Ltd.	Monroe, WA	✔		
EmbiTec	San Diego, CA	✔		
EMCO High Voltage Corporation	Sutter Creek, CA	✔		

33 Gel Electrophoresis Equipment,55 companies make Gel Electrophoresis Equipment. http://laboratory-equipment.globalspec.com/SpecSearch/Suppliers/Labware_Scientific_Instruments/Separation_Techniques/Gel_Electrophoresis_Equipment?SrchItem=1&frmqry=55%20companies%20make%20Gel%20Electrophoresis%20Equipment

Company	Headquarters	Manuf.	Distrib.	Svcs
Gel Company (The)	San Francisco, CA	✔		
Geno Technology, Inc.	St. Louis, MO	✔		
Genomic Solutions, Inc.	Ann Arbor, MI	✔		✔
Harvard Bioscience, Inc.	Holliston, MA	✔		
Helena Laboratories Corporation	Beaumont, TX	✔		
Hoefer Inc.	San Francisco, CA	✔		
Invitrogen Corporation	Carlsbad, CA	✔		
J2 Scientific, LLC	Columbia, MO	✔		
K-D Medical, Inc.	Columbia, MD	✔		
KOH Development Inc.	Ann Arbor, MI	✔		
Labnet International, Inc.	Woodbridge, NJ	✔		
Life Technologies	Rockville, MD	✔		✔
National Diagnostics U.S.A.	Atlanta, GA	✔		
Owl Separation Systems	Portsmouth, NH	✔		
Phenomenex, Inc.	Torrance, CA	✔		
R. Shadel, Inc.	San Francisco, CA	✔		
Rose Scientific Ltd.	Edmonton, Canada		✔	
Shelton Scientific Manufacturing, Inc.	Peosta, IA	✔		
Sooner Scientific, Inc.	Garvin, OK	✔		
Spectrum Chemicals & Laboratory Products	Gardena, CA		✔	✔
Stovall Life Science, Inc.	Greensboro, NC	✔		
Stratagene	La Jolla, CA	✔		
Synoptics	United Kingdom	✔		
Tecan US, Inc.	Durham, NC	✔		✔
Techne, Inc.	Burlington, NJ	✔		
Teknova, Inc.	Hollister, CA	✔		✔
Thermo Fisher Scientific Inc.	Waltham, MA	✔	✔	✔
Ultra-Lum, Inc.	Claremont, CA	✔		
USA Scientific, Inc.	Ocala, FL	✔		
VWR Scientific Products	West Chester, PA	✔	✔	
Wealtec Corp.	Sparks, NV	✔		

Appendices 2:

Geographical Location of Electrophoresis Equipment Companies



Source: http://www.caliperls.com/