A STRATEGIC ANALYSIS OF THE VOLUMETRIC THREE-DIMENSIONAL DISPLAY DEVICE INDUSTRY

by

Vijay I. Parasram
B.Sc., University of the West Indies, 1997
&
Samuel Weiqing Bi
B.Sc., Qing Dao Institute of Chemical Engineering, 1995

PROJECT SUBMITTED IN PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR THE DEGREE OF

Master of Business Administration
MBA-MOT Program

in the Faculty

of

Business Administration

SIMON FRASER UNIVERSITY
November 2003

APPROVAL

Name:	Vijay I. Parasram, Samuel Weiqing Bi
Degree:	Master of Business Administration
Title of Project:	A Strategic Analysis of the Volumetric Three-Dimensional Display Device Industry

Supervisory Committee:

Dr. Aidan Vining
Senior Supervisor
Faculty of Business Administration

Dr. Ian McCarthy
Supervisor
Faculty of Business Administration

Date Approved: 20/11/03.

Partial Copyright License

Title of Thesis/Project/Extended Essay

A Strategic Analysis of the Volumetric Three-Dimensional Display Device Industry

Author: _____

Samuel Weiqing Bi

Nov 20, 2003

Date

Partial Copyright License

Title of Thesis/Project/Extended Essay

A Strategic Analysis of the Volumetric Three-Dimensional Display Device Industry

Author: _____

Vijay Parasram

20th Nov 2003

Date

ABSTRACT

This document presents a proposed marketing strategy for International Digital Planet Technologies Incorporated. The volumetric three-dimensional (3D) display industry and the product market segments in which Digital Planet operates are examined to construct the marketing strategy. It analyses the company, its customers and competitors, and considers the vertical and horizontal forces acting on the products of International Digital Planet Technologies Incorporated.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1 INTRODUCTION TO DIGITAL PLANET

1.1 Purpose of this Strategic Analysis

A strategic analysis of the three-dimensional[1] (3D) display industry is presented to International Digital Planet Technologies Incorporated (Digital Planet). Digital Planet is a start-up research and development organization operating in the 3D display industry. This paper examines the 3D display industry and the product market segments in which Digital Planet operates. It analyses the company's customers and competitors and considers the vertical and horizontal forces acting on Digital Planet's products (Porter 1980).

The analysis of the competitive situation in which the company currently operates helps to identify competitive advantages and disadvantages. The current situation and future trends are examined to determine if a strategic change is necessary. An analysis of the firm's ability to create value (its "value chain") is proposed for the company based on its technology needs, resources and people. Additionally a marketing strategy is proposed with which to enter into the volumetric 3D industry.

1.2 Background of Digital Planet

Digital Planet is a privately-held research and product development (R&D) company operating in the 3D display industry. It was founded in Canada in 1997 and incorporated in British Columbia (BC). In May 2003, the company was reincorporated as a Canadian, federally incorporated company. Donna Peach is the founder and president of the company. The founder holds the majority of the company shares with a 10% share

[1] A glossary of terms is included at the end of this paper.

belonging to the out-sourced device hardware manufacturer. Additionally, there are a small percentage of share options held by advisory board members and several small investors. An employee share program is being developed and will be implemented in the near future.

Digital Planet's management and advisory board bring diverse business expertise to the company. The company's management is experienced in business, marketing, technical feasibility studies, project management and product design. The company carries out R&D internally and through a series of strategic alliances. Digital Planet currently has alliances with research teams from three universities.

Digital Planet develops state of the art, volumetric 3D imaging vision products and systems. These intelligent display platforms allow 3D, 360-degree visualization and user interaction with 3D images. The images can be viewed without stereoscopic glasses. The products incorporate 3D display technology, wireless and/or internet communications, intelligent software and micro and/or nano-fabrication technologies.

Digital Planet is targeting the biotechnology (biotech) group as its main customer segment. The specific market segment applications are genomics, proteomics, pharmaceuticals and nano-biology. The company is working closely with researchers and scientists within these areas to understand better and to meet the requirements of these market segments.

The company's ultimate goal is to be a leader in the 3D display industry and it is striving to develop products that provide an end-to-end solution for customers. The aim is to develop "frontier" technology that is designed to improve predictive, preventive and personalized healthcare in the next five years. The product solution will encompass both

hardware and software development. Additional company goals are to miniaturize the hardware, reduce the cost of the technology and make the devices portable and easily available.

1.3 Digital Planet's Products and Customers

1.3.1 Strategic Alliances

Digital Planet has strategic alliances with three universities. These help to align the company's products with the target customers' needs.

Digital Planet is working with a team from the Alberta Ingenuity Centre for Machine Learning Group (AICML) of the University of Alberta. This collaboration will allow Digital Planet to design and implement intelligent technology platforms. The partnership aims to ensure the ability of the platforms to function in flexible and changing environments and to be able to adapt to future advances in medicine.

Another team has been established with members from the Faculty of Pharmacy and Pharmaceutical Sciences of the University of Alberta. This group has research interests in proteomics, protein-based drug targeting, medical diagnostics, nuclear magnetic resonance (NMR) technology development and pharmaceutical bio-informatics. This collaboration aims to provide on-going alignment with the needs and requirements of the research and medical community. The goal is to ensure the intelligent volumetric 3D technology platforms have sufficient designed functionality and flexibility to meet current and future requirements of the target market.

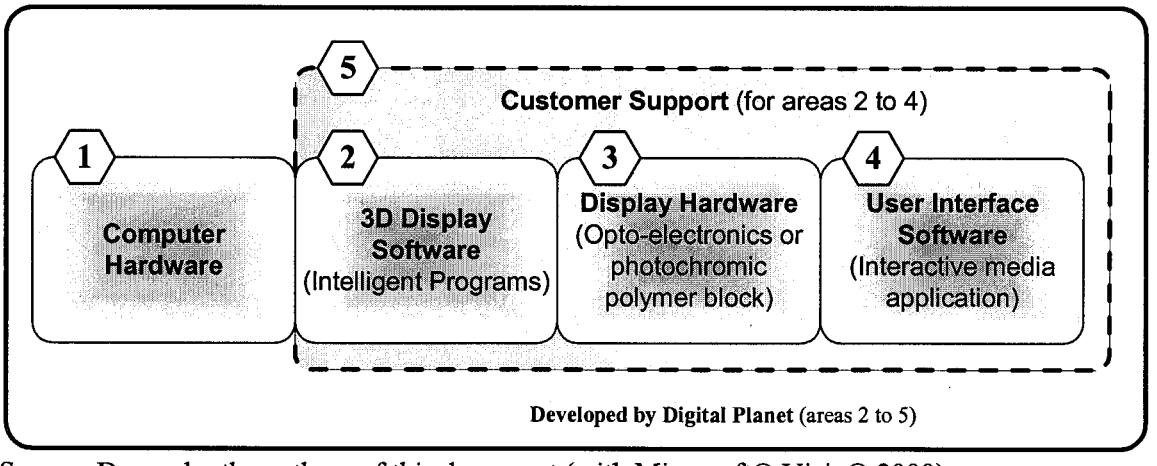
The third team is from the British Columbia Institute of Technology (BCIT) Group for Advanced Information Technology (GAIT). Digital Planet and the GAIT team

are engaged jointly in the development of an initial supercomputer host application. The goal is to develop a host interface/initial application utilizing the Bio-informatics (Sun Sunfire) supercomputer of the GAIT team. The host application will be dedicated to performing complex calculations and requested changes or views of macromolecules. The interface will allow a supercomputer to interact with Digital Planet's 3D display devices on a real-time basis.

1.3.2 Products

Digital Planet is at the pre-production stage of their volumetric 3D display systems. The company is developing both hardware and software applications. This is necessary to produce an end-to-end customer solution for the targeted market segments. Figure 1 depicts the components of an end-to-end customer solution.

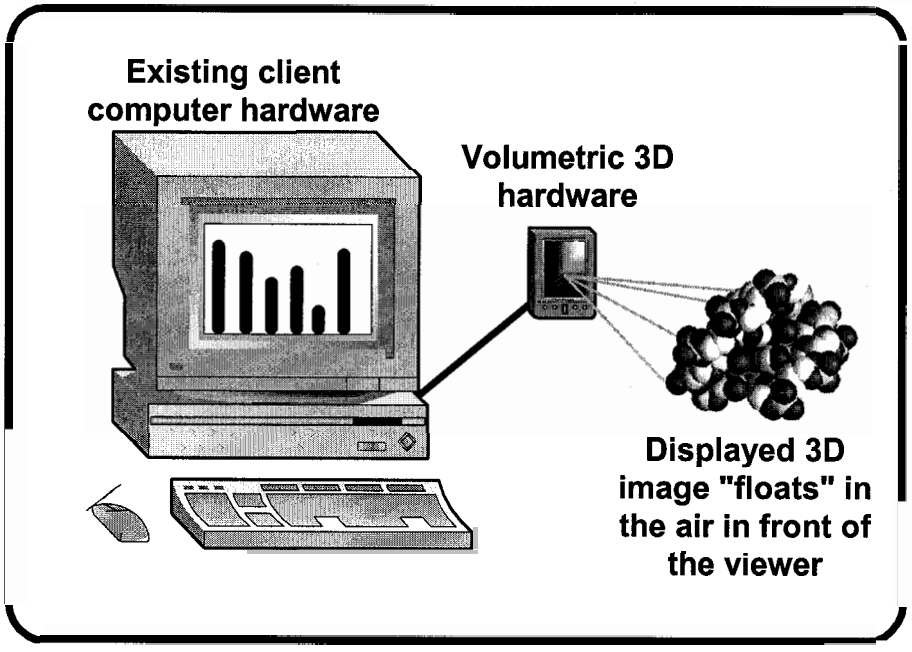
Figure 1: Components of an End-to-End Customer Solution



Source: Drawn by the authors of this document (with Microsoft® Visio® 2000).

Digital Planet's technology will run off of existing customer computer hardware. The company will develop applications and volumetric 3D hardware in the other three areas (areas 2, 3 and 4 as shown in figure 1) and provide customer support (area 5 as shown in figure 1) to supply the full customer solution. The actual system will involve attaching the volumetric 3D display component to a customer's existing computer hardware. A conceptual view of one product is shown in figure 2.

Figure 2: A Conceptual View of Digital Planet's Volumetric 3D Display Platform



Source: Drawn by the authors of this document (with Microsoft® Visio® 2000).

The 3D image is projected from the volumetric 3D hardware. This hardware, in tandem with the 3D display software, will allow images to be displayed. The user interface will provide further functionality, for example, by allowing ease of manipulation of the 3D image. The image displayed "floats" in air and can be viewed from any angle,

providing full motion parallax (image look-around) and true depth perception. The second system developed by Digital Planet will involve the 3D image being suspended in a translucent block rather than "floating" in air.

1.3.2.1 Hardware Products

Digital Planet is currently developing two distinct display platforms. There are two basic categories of volumetric 3D displays: swept volume[2] and static volume 3D displays. Both of Digital Planet's display platforms belong to the static volume display category. Static volume displays are systems that are able to create a display volume without the need to employ mechanical motion. Static volume systems can project the image in transparent materials, gases, electronic fields and others. (Langhans, Bahr, Bezecny, Homann, Otlmann, Guill, Rieper, Ardey 2002).

The first product involves development of a small-scale (small-footprint) 3D, 360-degree visualization device. The device integrates advanced opto-electronics with interactive and tele-collaborative technologies (that is technology to collaborate interactively with remote groups). The images produced can be manipulated and viewed in a natural way. The product can project 3D images into a defined space that "floats" in the air in front of the viewer. No special devices or goggles are required to view the image. Users will be able to view and interact with these images from any angle. Digital Planet has a provisionary patent for this device that has been designed for mass manufacturability to capitalize on the potential for economies of scale.

---

[2] Swept volume displays utilize spinning screens onto which an image is projected. The image appears to viewers as a true 3D form.

The second R&D hardware product involves the development of a device similar to the first. The first and second devices use different display technologies. The second device will utilize a translucent block of photochromic material within which the 3D image will be displayed. The photochromic material is a "new material" that undergoes a color change upon excitation with light of a specific wavelength. The "new material" is made via chemical synthesis. The material is then dispersed in a polymer matrix to produce the translucent block. This 3D display device will provide a platform with 3D, 360-degree visualization with no goggles, user interactivity and tele-collaboration technology. This product is still in the early development stage.

1.3.2.2 Software Applications

Digital Planet is developing two software applications. The company recognizes that the software required to operate 3D display platforms will have increasing strategic value. Digital Planet aims to develop software applications that allow interaction between a displayed 3D image, 3D data storage formats and the user.

The first software product will be designed to provide intelligent interfaces for Digital Planet display devices. The interface will allow users to interact with data and images quickly and easily. The objective of the interface is to allow researchers to visualize molecules individually or in combination and to easily interact with the images for different applications. This software package is being developed to meet the needs and requirements of the biotech industry.

The second software package involves the development of an end-to-end software system. The system will enable connections to various host computers with real time or

near real time response capabilities. Digital Planet is collaborating with the BCIT Group for Advanced Information Technology (GAIT) to develop this system. The system will assist life science researchers in exploring 3D multiple macromolecular structures. It will also be capable of simulated interaction mechanics that is superior to other products in this industry. The initial system will consist of a host application and an interface to allow researchers and collaborators to develop and test concepts and functionality in a volumetric 3D display environment.

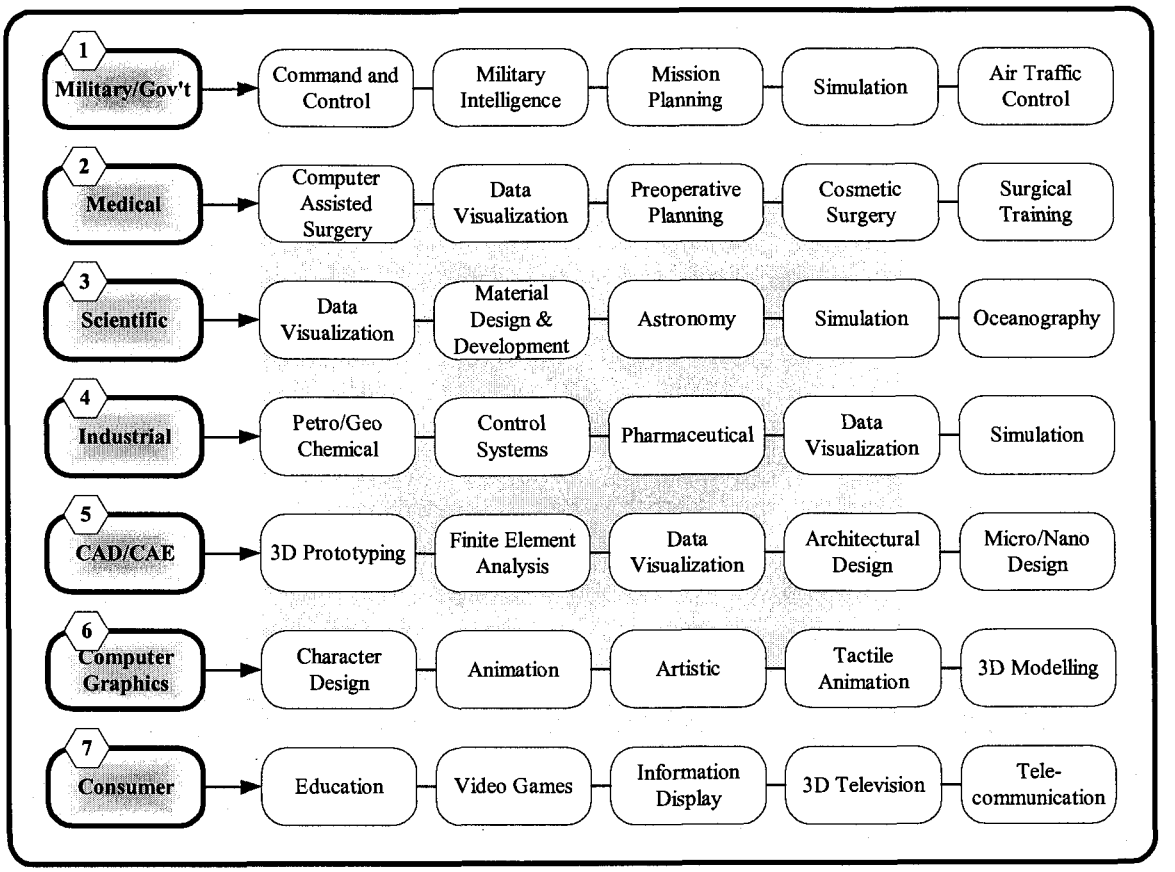
1.3.2.3 Customer Support

Customer support will provide service for both the hardware and software products of Digital Planet. Maintenance contracts and warranty extensions can be bundled or sold as separate customer support products. The customer support function will also be responsible for developing an efficient help desk, and recognizing and issuing bug fixes. These latter two functions can be bundled with other product offerings.

1.3.3 Customer Groups

Potential customers of 3D display systems may be divided into seven groups: military/government, medical, scientific, industrial, computer-aided design/computer-aided engineering, computer graphics, and consumer (LightSpace Technologies 2003). These groups were formed based on the requirements of different customer clusters and each represents a relatively homogenous market segment. Figure 3 depicts examples of applications that fall into each category.

Figure 3: The Volumetric 3D Display Market Categories and Application Examples.



Source: Adapted from LightSpace Technologies, Inc. (2003) DepthCube™ Technology White Paper.

The market segments targeted by Digital Planet are the medical, scientific and industrials groups. The main group is the medical market, but this group utilizes multi-disciplinary skills from the scientific and industrial markets. The scientific and industrial groups combined under the medical group form the biotech market segment. The specific biotech companies targeted by Digital Planet are those involved in genomics, proteomics, pharmaceuticals and nano-biology. These research areas were chosen based on their future potential growth and their need for 3D, 360-degree visualization. The entry biotech market clusters being considered for the volumetric 3D platforms are located in the United States of America (USA) and Canada.

The 3D technology adoption within the biotech segment is driven by the fact that shape is extremely important. The shape of structures is a major determining factor in the functionality of the molecule being designed or manipulated. This acts as a major driver for the adoption of volumetric 3D display systems. To synthetically engineer nano-scale devices, delivery vessels, targeted repair molecules and mechanisms, it is imperative that the 3D, 360-degree structures be visible to designers. Designers need to be able to interact with 3D structures not only from the outside, but also from the inside. An in-depth understanding of molecular physiology and pharmacology can be achieved more easily with intelligent volumetric 3D display platforms. From this understanding, the predictive behavior and diagnosis of diseases can be seen long before the stages at which they are currently revealed. The critical need for real-time 3D displays within the developing molecular-scale biotech fields and the ability of these companies to afford the product make them a suitable market.

Digital Planet's small-scale intelligent 3D platforms are being designed to address the current display problems of the biotech market segments. The 3D platforms will be able to improve productivity in such applications as molecular-scale synthetic engineering, reconstructed or assembled biomedical repair systems, and molecular delivery vessel design. In addition, volumetric 3D systems complement and work in tandem with existing computer hardware and 3D software applications. This allows ease of integration with the current technology. Digital Planet has collected customer information from researchers that indicate that the planned functionality of the 3D platforms could reduce project time by as much as 25% to 50% depending on the

application. In the biotech segment where the time between product introductions is long, it is a huge advantage to assist in the minimization of project costs.

1.3.4 Analysis of the Products and the Customers

A useful framework for analyzing which products will sell to each customer segment is a product-customer matrix. The product-customer matrix assists in determining the key strategic issues of "which product-customer segment to compete in and how to compete in each specific product-customer segment" (Boardman and Vining 1996).

The seven market categories are used to generate a prospective product-customer matrix. Table 1 depicts the prospective product-customer matrix for Digital Planet. Though the company does not currently have commercial products, the product list was generated from the pre-commercialized product holdings that the company possesses. The "3D Display System – Type 1" and the "3D Display – Type 1" as seen in table 1 refer to a volumetric 3D display in which the image "floats" in air. The "3D Display System – Type 2" and the "3D Display – Type 2" as seen in table 1 refer to a volumetric 3D display in which the image is displayed in a translucent photochromic block. Both of these products were described in section 1.3.2.1. An "X" in a cell of the product-customer matrix indicates a high probability of a sale to that group. A blank cell indicates a potential opportunity to sell the product to another customer group (although this is dependent on the business requirements of the group).

Table 1: Prospective Customer-Product Matrix

PRODUCTS	CUSTOMERS									
	Military/ Gov't	Medical		Scientific		Industrial		CAD/ CAE	Computer Graphics	Consumer
		N	M	N	M	N	M			
End-To-End Customer Solution										
3D Display System – Type 1	X	X	X		X		X	X		
3D Display System – Type 2	X	X	X		X		X	X		
(Includes hardware, software										
and customer support)										
Hardware										
3D Display – Type 1			X		X					
3D Display – Type 2			X		X					
(Includes customer support)										
Software										
User Interface (site license)			X		X					
Intelligent Program (site license)			X		X					
Customer Support										
Maintenance Contracts	X	X	X		X		X	X		
Extended Warranty	X	X	X		X		X	X		
(Help desk access and, bug										
fixes are not aspects of										
customer support that are										
sold)										

N – represents applications with normal-scale dimensions.
M- represents applications requiring molecular-scale dimensions.

Digital Planet intends to bundle their products to form an end-to-end customer solution. However, the company recognizes that allowing customers the option to purchase products separately will improve cash flow and enhance the company's reputation. This also gives the customer more product flexibility to allow for better customer satisfaction. There are four product categories and each has two product offerings as shown in table 1. Customer support will only offer maintenance contracts and

extended warranties as separate product offerings. Access to the help desk and bug fixes will not be sold separately; these are bundled with the other product offerings.

The product-customer matrix shows that Digital Planet's products will be mainly used where molecular-scale dimensions are involved. The customer groups of interest are the medical, scientific and the industrial market segments. Companies utilizing skills from these three groups form the biotech market segment. The biotech market segment is unique in that understanding the spatial structure of molecular-scale structures is of critical importance to research and development efforts.

The product-customer matrix shows potential customers in the military/government and the CAD/CAE segments, but no interest from the computer graphics and consumer segments. The military/government market could be a potential customer, however they have a preference for purchasing from American companies. The CAD/CAE market mainly shows interest for virtual prototyping where they can justify the cost of the volumetric 3D system by increased productivity. The computer graphics and consumer groups are highly sensitive to price and until the product conforms to their price point they will be unwilling to purchase the product. Consumer group penetration is also dependent on the development of complementary products unlike the other segments.

Digital Planet has invested in developing closer ties with several biotech R&D groups to meet the biotech market's requirements. Specific customers are those companies involved in genomics, proteomics, pharmaceuticals and nano-biology research and development or similar molecular-scale type engineering. This ensures that the commercial product is in line with the target markets' wants and needs.

The product-customer matrix shows neither the specific business requirements of each group nor their price sensitivity. Competitor presence and price are further examined under the section 'Analysis of the Competition'. In addition, the product-customer matrix does not illustrate potential competition between Digital Planet's various product offerings. The "Type 2" (the volumetric 3D display utilizing the transparent photochromic polymer block) display will not become available until approximately three years after the "Type 1" has been released.

1.3.5 Technological Attributes of the Products

Volumetric images require a display volume within which the image may be drawn. The two basic categories -- swept volume displays and static volume displays -- have unique advantages and disadvantages. Digital Planet is developing two products that fall into the second category.

Static volume displays are much more robust than swept volume displays. Swept volume displays have moving parts, are prone to mechanical failure and can be noisy when in operation. Digital Planet's products incorporate solid-state opto-electronic components or a translucent photochromic polymer block, which are used to display the image. Both products have no moving parts, do not vibrate, and require less maintenance than swept volume displays. The displayed images can be fully rendered or constructed to be translucent to show internal features, which is an advantage for the biotech market segment. The company's volumetric 3D platforms resolve stereopsis (a slightly different perspective image in each eye) and parallax issues. Depth perception is achieved and the human mind is better able to comprehend the spatial arrangement of the image.

Digital Planet recognizes that software development is lagging behind that of the hardware. Software is becoming of increasing strategic value. The company is developing two software applications that will be fully integrated with their platforms. Both applications will feature intuitive graphical user interface technology (GUI). In addition, these applications are being developed specifically for the biotech segment to better meet that market's needs.

1.3.6 Key Product Attributes

Digital Planet's products need to possess several key product attributes for the company to survive and prosper. These product attributes are required to produce an end-to-end customer solution. The product attributes must address two issues, what the customer requires in the products and services and how the company compares against the competition (Grant 1995). The first of these two issues will be addressed here and the other will be addressed later in this analysis.

Digital Planet's customers want volumetric 3D display platforms that meet the unique needs of the biotech market segment. This segment is very sensitive to governmental regulations. Thus quality is a very important attribute of the products and services. An end-to-end customer solution must encompass adaptable, flexible software and robust, high performance hardware. A strong vendor and product reputation with readily available customer support services must back the product. Design and development of such a system requires an intimate understanding of the customer needs and specialized knowledge to meet those needs. The key product attributes are summarized in Table 2.

Table 2: Key Product Attributes of Digital Planet's 3D Display Platforms

- Flexible specialized software
- Specialized knowledge
- End-to-end product - hardware and software integrated seamlessly
- Quality software application
- Intimate understanding of customer needs and the ability to address them
- Provision of customization services by industry-knowledgeable experts
- Customer support
- Vendor and product reputation

1.4 Summary

Digital Planet is a start-up company involved in research and product development in the 3D display technology industry. The company is developing 3D display platforms specifically for the biotech market and has strategic alliances with three universities to help develop an end-to-end solution for their target market. The company intends to enter the 3D display market with a static volume 3D display that features a fully integrated end-to-end customer solution.

2 THE VOLUMETRIC 3D DISPLAY INDUSTRY

This section reviews the structure of, and competition in the volumetric 3D display industry in which Digital Planet competes. The section includes an overview of the industry and the forecasted revenue and profitability within the industry for North America. This is followed by an analysis of Digital Planet's competitors and an analysis of the volumetric 3D display industry.

A useful framework for analyzing the industry is Michael Porter's "Five Forces of Competition" model that assesses the impact of five competitive pressures on a company (Porter 1980). These five forces consist of the competition from existing rivals, the threat of entry, the threat of substitutes, the bargaining power of buyers (customers) and the bargaining power of suppliers. These factors affect the competitive environment experienced by Digital Planet. The analysis will give an overall assessment of each of Porter's five forces.

The boundaries of the industry within which Digital Planet competes must be established to conduct this analysis. Only companies that produce "true" 3D displays are considered as competitors in this analysis. A "true" 3D display is one that produces a 3D image that does not require any special aids with which to view the image. The image allows the viewer a slightly different perspective image in each eye (stereopsis), depth perception and resolves motion parallax (image look around) issues.

2.1 Overview of the Volumetric 3D Display Industry

The exponential increase in computational performance of modern computers, as well as the wide range of new 3D applications that run on them, has brought an increase

in the level of effort to produce volumetric 3D displays. Companies that have long been quietly researching volumetric 3D display technology are now planning to release commercial products. By some estimates, over US$45 billion will be spent in 2003 alone on 3D computer hardware, software, systems and services (LightSpace Technologies 2003).

The biotech market segment is relevant to the volumetric 3D display industry because of its unique display requirements. In 2002, the market size of the life science[3] technology tools was approximately US$1.6 billion and is projected to more than double to US$3.5 billion by 2007, growing at a compound annual growth rate (CAGR) of 17.7% (Global Information Incorporated 2003). It is also estimated that in 2003 the research and development budget growth of the top 20 biotech companies will be 16%. The estimated biotech spending CAGR is 21% from 2000 to 2005 for North America. This impacts the volumetric 3D market segments of Digital Planet, as they are specifically targeting the North American biotech clusters.

2.2 Forecasted Industry Revenue and Profitability

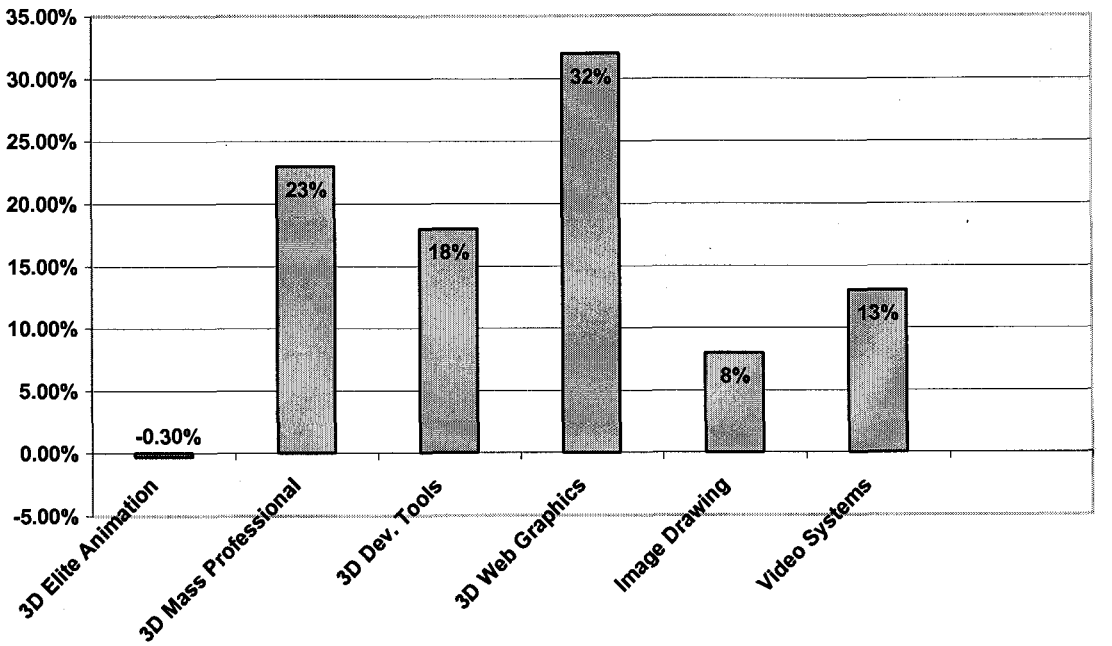
The demand for increased medical services and government funding continues to grow in North America. This is caused by the increasing size of the senior population (50 years and over). Canada and the United States of America (USA) both aim to increase their medical funding by 7.3% within the next seven years. The increased spending will be put into areas such as medical facilities improvement, pharmaceutical research and

[3] Life science - is defined as any of the branches of natural science dealing with the structure and behaviour of living organisms.

development, and medical training. The biotech market segment pertaining to the research and development of better and new medical products will benefit from the increased spending. This, in turn, affects spending within the volumetric 3D industry as the biotech group represents a major market segment.

The 3D hardware industry is growing more slowly than the 3D software industry (Meloni 2002). The graphics industry has transitioned past the growth stage of its life cycle and is now in the mature life cycle stage (Meloni 2002).

Figure 4: Compound Annual Growth Rates in the 3D Imaging Industry



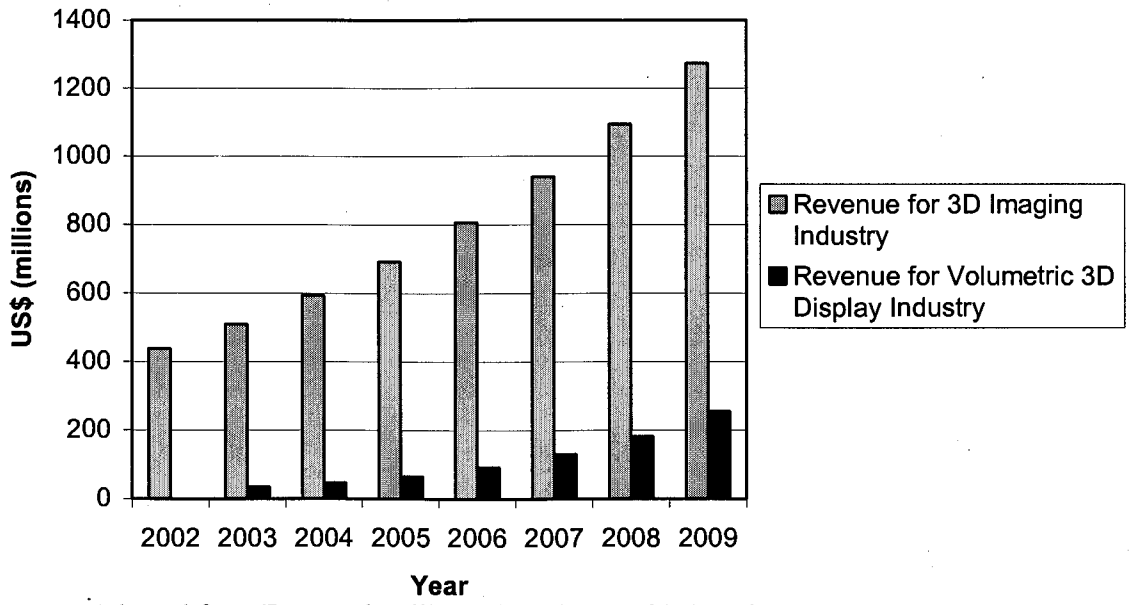
Source: Adapted from Wanda Meloni. (2002). The Decline and Resurrection of the 3D Industry.

Conversely, all of the 3D software market is not necessarily entering this mature stage. There are certain segments of the 3D market that show the potential for high growth over the next five years, particularly segments such as 3D Web Graphics and Mass Professional 3D (3D tools used for professional design-centric purposes). Figure 4 shows

the compound annual growth rate (CAGR) of the 3D imaging segments that are relevant to the volumetric 3D display industry. The 3D software applications are important because they help to form an effective, high-performance volumetric 3D display. The 3D software industry acts as a mature complementary product market to the volumetric 3D hardware display industry.

The 3D imaging market generated revenues worth US$397.6 million in 2002 and is likely to reach US$1.15 billion in 2009 (Frost and Sullivan 2003). This implies that the overall growth rate is approximately 16.5% per year. Let us assume that the 3D imaging market in Canada will follow the same pattern and that the market size for Canada is about 1/10 of that in the United States. Then the overall market projection for 2009 is about US$1.27 billion. As there is no historical data for the volumetric 3D display industry available, a reasonable projection is that by 2009, out of the overall revenue for 3D imaging industry, 20% will come from the volumetric 3D display industry. Assuming that the growth rate for a new technology for the first five years will be 40% and that the profitability is 50% of the overall revenue, we can forecast the revenue and profitability for the next 10 years for the volumetric 3D industry in North America. The revenue forecasts for the volumetric 3D display industry versus the 3D imaging industry are shown in figure 5. Table 3 displays industry revenue and profitability data. According to the forecast the volumetric 3D industry is an attractive industry in terms of annual growth rate, revenue and profitability.

Figure 5: Revenue Forecast for the Volumetric 3D Display Industry



Source: Adapted from Frost and Sullivan. (2003). U.S. 3D Imaging Markets.

Table 3: Revenue and Profitability Forecast for the Volumetric 3D Display Industry

(In US$ millions)	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	
Revenue for 3D Imaging Industry	398	463	540	629	732	853	994	1150	16.5% annual growth
Revenue for Volumetric 3D Display Industry	-	31	43	60	84	117	164	230	40% annual growth rate
Profitability	-	15	21	30	42	59	82	115	50% of total revenue

Source: Adapted from Frost and Sullivan. (2003). U.S. 3D Imaging Markets.

2.3 Analysis of the Competitors

This section reviews the main competitors of Digital Planet in the volumetric 3D display industry. In addition, it evaluates them based on price and product scope and places them in strategic groups within the volumetric 3D industry.

2.3.1 Actuality Systems Inc.

Actuality Systems Incorporated (Actuality), one of the pioneers in the volumetric 3D industry is based in Massachusetts, USA. The company was incorporated in 1997 and holds several patents for its volumetric 3D display technology. Actuality has partnerships with various investors, and research and development entities. The company serves the following industries: the life sciences, manufacturing, government, and oil and gas.

In 2001 Actuality's volumetric 3D display became available for purchase. Today the system is known as the Perspecta™ Spatial 3D System. This is a swept volume system that has large components that spin at high speeds. Actuality's 3D devices are priced between US$40,000 to US$45,000 depending on the volume of products purchased by the customer.

The 3D display platform is able to generate real 3D imagery floating inside a glass spherical display dome. The device is able to render 360-degree viewing with a resolution of approximately 100 million voxels[4]. The 3D display area can accommodate an approximately 10" diameter spherical image by using swept-screen multi-planar volumetric display technology. The core technology of Actuality's system utilizes a Texas Instruments high-performance embedded processor and six giga-bytes (6GB) of double data rate synchronous dynamic random access memory (DDR SDRAM). Actuality's advanced spatial 3D workstation – Perspecta™ Spatial 3D System is in full color and compatible with many existing OpenGL based 3D software applications.

---

[4] The term voxel is used to characterize a volume pixel element (it has an x,y,z spatial position); it is a generalization of the notion of pixel that stands for a picture element.

The company faces demand for its products from various markets that it is currently unable to fill. This is due to the complexity of the manufacturing process that limits the quantity of devices that can be produced per year. The Perspecta™ Spatial 3D System was not designed for mass manufacturability. Table 4 shows the detailed price listings of Actuality.

Table 4: Price Listing for the Perspectra™ Spatial 3D Display by Actuality Systems, Inc.

- Volumetric 3D Display (hardware): US$45,000
- Actuality Visualization Operating System (software): US$3,000
- Developer's Program and Software Development Kit: US$2,000/month
- Installation: US$2,100
- Hardware Support Programs: Basic (US$3,000/yr) and Premium (US$7,000/yr)
- Software Support Programs: Basic (US$3,000/yr) and Premium (US$7,000/yr)

Source: Adapted from Actuality Systems, Inc. Retrieved November 3, 2003, from http://www.techspot.com/vb/showthread/t-1297.html

2.3.2 Ethereal Technologies

Ethereal Technologies (Ethereal) is based in New Jersey, USA and has branches in Michigan and research teams in Europe. The company was founded in 1998 and is a privately held venture and currently has five employees.

Ethereal has engaged in strategic alliances with various partners and is utilizing its partnerships to gain greater exposure to Homeland Security, military and defense-related initiatives in the USA. The company has worked extensively in military defense and surveillance applications with the United States (US) Army Tank Command and also

with the US Navy in 3D surveillance and visualization applications. The partners and affiliations of Ethereal are listed in the table 5.

Table 5: Partners and Affiliations of Ethereal Technologies

- ACIN Center for Technology: a venture with the US Army Command and Control Directorate, Communications and Electronics Command (CECOM)
- Realisma Optical Ltd,Scotland
- Realview Innovations Ltd, Ireland
- University of Strathclyde, Glasgow, Scotland
- University of Michigan, Ann Arbor, MI
- National Center for Manufacturing Sciences, NCMS, Ann Arbor, MI
- Port of Technologies, University Science Centers, Philadelphia, PA
- U.S. Army Tank and Armaments Command, Warren, MI

Source: Adapted from Ethereal Partners and Affiliations. Retrieved November 3, 2003, from http://www.etherealtech.com/about.htm

Ethereal has acquired funding from both the US government and the private sector to develop its first 3D platform. Ethereal's propriety system, the VIS4D, is a unique combination of advanced optics, prisms and software. The core of this patented optics-based system, a 1.2m concave vacuum-controlled mirror, has the unique ability to vary focal length over a wide range, yielding superior quality stereo images. Projecting stereoscopic right-eye and left-eye video images onto the single concave mirror sitting several feet away from a person creates the 3D image. The concave mirror reflects those images directly at the viewer's eyes. The person looking toward the mirror sees a single, 3D picture that seems to be suspended in the air between their eyes and the mirror.

Ethereal is currently working on a new, lighter, portable version of their 3D platform. They estimate the device will initially cost US$2,000 to US$3,000.

The first volumetric 3D display device is known as the VIS4D ™ Workstation and costs US$50,000. Current cutomers include medical and scientific researchers, the US Army and Navy, and the DaimlerChrysler Corporation. The initial 3D device is large and heavy because of its 1000-pound concave mirror. The device runs off existing personal computers and is able to interface with many common 3D software-rendering formats to produce an image.

2.3.3 Genex Technologies Inc.

Genex Technologies Incorporated (Genex) was founded by Dr. Jason Greg and is based in Kensington, Maryland, just outside of Washington, DC. Genex is an electro-optical company focused on developing cutting-edge 3D imaging technologies. Genex's mission is to develop state-of-the-art technologies that can bring commercially viable 3D imaging and display products into various markets. The company has several strategic alliances and a strong advisory board that possesses over 200 years of business experience in various levels and stages.

In 2001 Genex was ranked 291st on the Deloitte & Touche Technology Fast 500. This is a survey of the 500 fastest growing technology companies in North America. The company also made the top ten on the Maryland Technology Fast 500, a ranking of the 50 fastest growing technology firms in Maryland. In addition Genex was awarded the 2001 Tibbetts Award. The Tibbetts Award is presented by the Small Business Administration

(SBA) to honor outstanding achievement on a Small Business Innovative Research (SBIR) project.

Genex has 24 employees, most of whom possess PhD degrees in optical engineering, software engineering, or electronic engineering. The company has more than 30 patents and other proprietary rights to its innovative optical inventions.

In 1999, Genex worked with NASA's Stennis Space Center to create a real-time volumetric 3D display. The technology developed was capable of depicting true, 3D images, enabling multiple users to simultaneously view and analyze 3D data from various 360-degree perspectives. Utilizing the developed technology, Genex was able to advance three different imaging and display technologies that are now commercially available. The three systems developed include one volumetric 3D platform and two complementary products that can capture 3D video data. The VolumeViewer® is a volumetric 3D platform capable of displaying 34 million voxels of 3D data in spatial volume. This is a swept volume device priced at US$75,000.

2.3.4 LightSpace Technologies Inc.

In September 2003 LightSpace Technologies Incorporated (LightSpace) acquired the DepthCube™ 3D display technology, along with key personnel, from Vizta^{3D}, Inc. Vizta^{3D} Incorporated (Vizta^{3D}) formerly known as Dimensional Media Associates Incorporated was founded in 1994 and developed leading-edge 3D visualization solutions. In 2001, Vizta^{3D} introduced its patented Z20|20 product based on the DepthCube™ technology.

The DepthCube™ 3D display was developed over a period of seven years by researchers at Vizta[3D]. The DepthCube™ is a solid-state volumetric 3D display system that offers high resolution, full color 3D images. The DepthCube™ 3D display is a rear projection volumetric 3D computer monitor in which a conventional projection surface is replaced by a three-dimensional projection volume. The projection volume is composed of a stack of electronically controlled optical elements that enable the creation of space-filling 3D volumetric images. The DepthCube™ can capture 3D images in real-time from most 3D software applications, including video games. The product is the world's first, solid-state 3D computer monitor. The DepthCube™ is a physically deep 3D system that features full motion parallax (image look-around).

One of Vizta[3D]'s key component suppliers, LC-Tec Holding AB (Borlänge, Sweden), recognized the extraordinary value of the DepthCube™ technology. LC-Tec formed LightSpace Technologies AB and its wholly owned US subsidiary, LightSpace Technologies Incorporated, to acquire the DepthCube™ technology and immediately bring the DepthCube™ Z1024 product to market. Dr. Alan Sullivan, former chief technical officer (CTO) of Vizta[3D] and inventor of the DepthCube™ technology, was hired as the president of LightSpace. The DepthCube™ Z1024 went into commercial production in the third quarter of 2003. Currently prices for the DepthCube™ Z1024 display are not available. However the pilot product cost US$95,000 per unit so it is estimated that the commercial product will be similarly priced.

2.3.5 Neos Technology Inc.

Neos Technologies Incorporated (Neos) was founded in 1982 and is based in Florida, USA. The company specializes in state-of-the-art laser modulation and deflection systems for research and original equipment manufacturer (OEM) applications. Neos is currently involved with the development of a volumetric 3D display. The commercialization of the 3D display is a collaboration of three parties: Neos Technologies, RGB Technologies and Naval Command, Control and Ocean Surveillance Center RDT&E Division (NRaD).

The volumetric 3D display system in development allows true 3D visualization of images. It is a swept volume system consisting of three major parts: a laser optics system, a computer controller, and a helical display system. It is being designed for air traffic control purposes and no official cost estimate has been listed. The product is not yet commercially available.

2.3.6 Felix 3D

The Felix 3D display is a project team that evolved from a scientific working group of students and teachers at the Vincent Lubeck High School in Stade, Germany. It is a non-commercial group with minor funding resources. The main objectives are to give interested young students the possibility of an up-to-date, practice-oriented education. The team have been involved in R&D with both swept volume and static volume display technologies.

The university team has a working 3D platform known as the Felix 3D. The Felix 3D and its predecessors have been displayed at many renowned international conventions.

It is a swept volume 3D platform that produces a 3D image by projecting images onto a rotating helical screen. The screen is enclosed in a glass dome. The Felix 3D team regularly releases their findings in technical publications. Thus far, the Felix 3D has not been made commercially available to the market. It is estimated that should it be sold, it would cost approximately US$50,000.

2.3.7 Other Potential Competitors

The volumetric 3D industry has many other potential competitors who are currently investing in research and development of volumetric 3D display systems. These companies include the US Navy, Deep Video Imaging Limited, Dimension Technologies Incorporated, Dresden 3D GmbH, X3D Technologies Corporation (formerly 4D-Vision GmbH), Philips, Sanyo, Sharp, Holografika and StereoGraphics. Several of these companies currently have products that mimic 3D displays, but which cannot be classed as true 3D imaging. Such companies are not included in the segmentation analysis and strategic groups encountered in the next section.

2.3.8 Segmentation Analysis and Strategic Groups

The nature and the intensity of the competition vary within the volumetric 3D industry. It is useful to split the industry on the basis of a number of key strategic variables. These variables help to determine which of the companies follow similar strategies on the same strategic dimension and belong to the same strategic groups (Grant 1995). The volumetric 3D device customers can be segmented into seven market

segments (section 1.3.3). Table 6 shows the competitor presence in each market segment. An "X" in a cell denotes competitor presence in that market.

Table 6: Competitor Presence By Market Segment

	Military / Govern-ment	Medical	Scientific	Industrial	CAD / CAE*	Computer Graphics	Consumer
Digital Planet		X	X	X	X		
Actuality	X	X	X	X	X		
Ethereal	X	X	X	X			
Genex	X		X	X			
LightSpace				X		X	X
Neos	X						
Felix 3D	X	X	X	X			

Note: Company names that are outlined in grey currently have not released commercial products.
* Computer-Aided Design (CAD), Computer-Aided Engineering (CAE).

Table 6 includes Neos Technology Incorporated (Neos) and Felix 3D volumetric 3D display systems although these two entities do not have commercially available products. However, similar to Digital Planet, commercial products can enter the market from these entities in the near future (approximately two years). It can be seen from table 6 that Digital Planet currently has three main close competitors (Actuality, Ethereal and Felix 3D) with products or potential product offerings within their target markets. Actuality has actively begun to try to extend into other market segments, thus they have greater market presence than other companies.

Although the focus of the industry is turning to business solutions for customers, technology is still a highly relevant competitive variable. Product technology has two aspects: the hardware display technology and the software application. The type of display technology used greatly impacts the total cost of ownership of the product to the customer. Swept volume displays have moving parts, thus they require more maintenance than do static volume displays. Static volume displays consist of solid-state electronics and offer a more attractive long-term cost package to customers. In addition swept volume technology has size limitations and portability issues. The underlying technology of the volumetric 3D display products of the various competitors is shown in the table 7. An "X" in a cell denotes competitor presence in the relevant technology section.

Table 7: Competitor Technology Type and Product Price

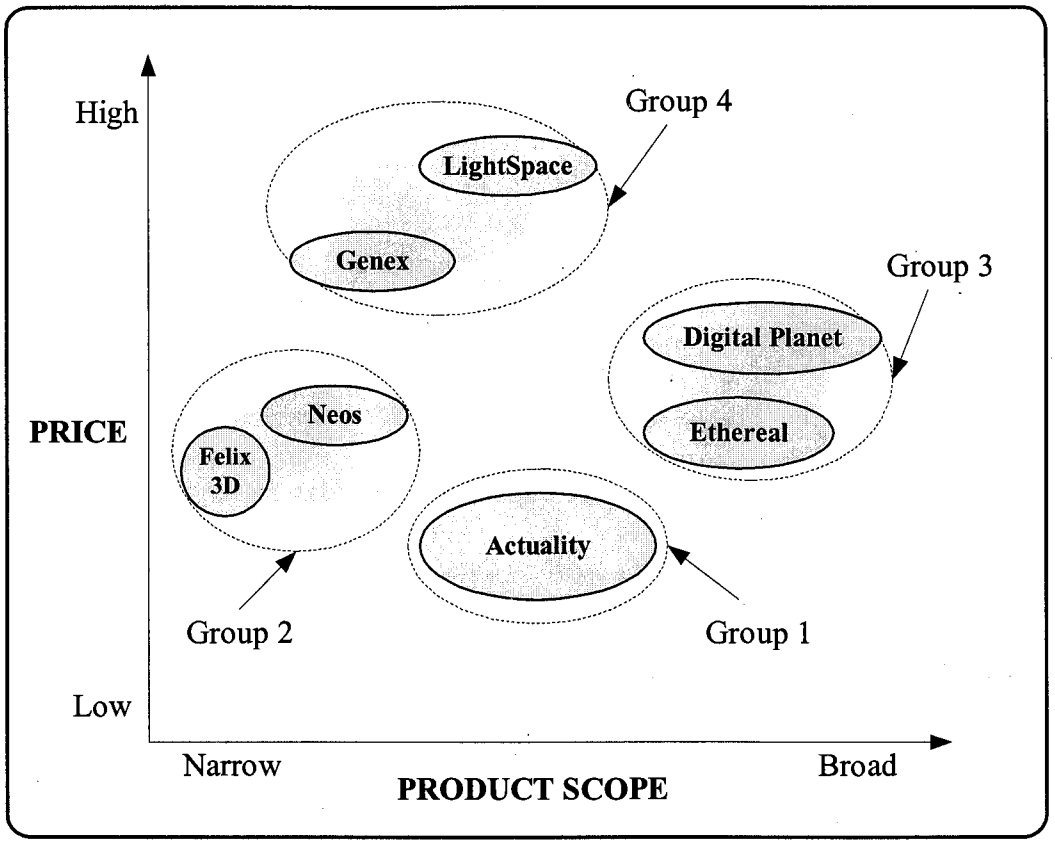
	Display Technology Type		**Price**
	Swept Volume	**Static Volume**	**$ (US dollars)**
Digital Planet		X	50,000 to 60,000*
Actuality	X		45,000
Ethereal		X	50,000
Genex	X		75,000
LightSpace		X	95,000**
Neos	X		55,000***
Felix 3D	X		50,000

*Digital Planet: - accurate cost estimates are currently unavailable but the product cost is estimated to initially fall into the range listed above.
**LightSpace: - the DepthCube™ first generation models (in 2001) cost $95,000 per unit; the newer production models should cost less.
***Neos – an estimated price based on the price of competitors with similar technology.

A further important technological variable is the user interface, graphical user interface (GUI) and/or Windows interface. The majority of the companies are building their products to interact with standard 3D data formats. Companies are quick to follow in this area and incorporate new 3D protocols. This reduces the importance of this variable as a differentiator between the competitors. Currently both Digital Planet and Actuality are working on 3D display software. This software will reside between the host computer and the volumetric 3D display. This software application will increase the functionality of the overall volumetric 3D display platform.

In addition to the breadth or scope of the product line, price is the other most significant variable in the volumetric 3D industry. The price is shown in Table 7. The price of the product is a function of several variables such as cost, maintenance, quality and service. Figure 6 shows the strategic groups in the volumetric 3D industry. The strategic groups are formed based on product price and product scope.

Figure 6: Strategic Groups in the Volumetric 3D Display Industry



Source: Drawn by the authors of this document (with Microsoft® Visio® 2000).

The analysis suggests that there are four strategic groups in the volumetric 3D display industry. Group 1 consists of low price/moderate product scope (Actuality). Group 2 consists of medium price/narrow product scope (Felix 3D and Neos). Group 3 consists of medium price/broad product scope (Ethereal and Digital Planet). Group 4 consists of high price/moderate product scope (Genex and LightSpace). It is expected that companies within each strategic group are more likely to follow similar strategies along the product scope and price variables. Although companies may be in the same strategic group, they may not be in direct competition because of differentiation based on other variables. However, the opposite is also true. Actuality though in a different strategic

group to Ethereal and Digital Planet is a direct competitor, because of the specific market segments that it targets. The success of a company when it attempts to compete within a market segment whose business requirements do not conform to its product offerings is usually quite limited.

The segmentation analysis and strategic grouping show that competition is increasing in the industry. This is due to companies attempting to compete in multiple market segments by extending their product scope and target markets while lowering their prices. Competitors' greater ability to move between segments can increase competition. Generally, movement between segments is difficult due to "barriers to mobility" caused by high product differentiation. However, some companies possess capabilities that afford them some movement across segments. The easiest route to compete in another segment is via software applications development. This requires that the company have competencies in software research and development and sufficient funds to pursue this path. Actuality is attempting to widen its product scope by investigating custom software applications.

The principal competitive strategies are product differentiation, horizontal product expansion and geographic expansion into more market segments. These strategies are aimed at expanding a company's respective market. Market expansion could allow capable companies to capture economies of scope and increase their profitability. Current strategies are focused on establishing company and brand reputation and exploiting the opportunities in the market. Competition is not focused on taking existing market share from competitors.

2.4 Competition – "Low"

The intensity of rivalry among competitors, while low, is increasing. In the volumetric 3D display industry there exists product differentiation, but limited price competition. The industry is still in the infancy stage of its life cycle (M2 Research 2002). The stage of the life cycle impacts the competition experienced by industry competitors (Moore 2002).

The volumetric 3D display industry has evolved from many different approaches which all had the same goal: to produce a volumetric 3D display. The current product offerings reflect this difference and are highly differentiated in terms of software and hardware. Each competitor is seeking a niche market from which to refine its product offerings and capture additional customers. The main components that can affect competition in the volumetric 3D display industry are discussed below.

Industry Growth

The high compound annual growth rate (CAGR) of the volumetric 3D display industry increases the market size and reduces competition among the existing competitors.

Industry Concentration

Industry concentration does not presently affect competition in the volumetric 3D industry. There are currently only a few companies in the industry. The market size is large and this mutes competition among the rival companies. There are no dominant

players in the industry and all competitors are seeking to gain sufficient market penetration to establish an installed base and gain economies of scale.

Cost Structure

The cost structure of companies in the industry does not affect the competition between competitors. Companies with commercial products are unable to contract out their production requirements because of the small volumes currently being sold. This small-scale manufacturing generates high variable costs which ramp up the product cost that is then passed onto the customer.

Product Differentiation

The high product differentiation in the volumetric 3D industry results in reduced competition. The products available in the market are all differentiated and each product solution is driven by its company's technical background. The highly differentiated nature of the products in terms of hardware requirements and application software results in customers being unwilling to switch between competitive offerings because of small price differences. This leads to muted price competition.

Brand Identity

Presently, brand recognition is not a major differentiating factor among competitors in this industry. This is mainly because of a lack of any industry leaders and the infancy of the technology. As such, competing companies are presently attempting to build company and brand recognition for the future.

Diversity of Competitors

Different companies are focusing on different end applications. This minimizes the direct competition among rivals. For instance, Genex is focusing on air traffic control applications, while Digital Planet is focusing on biotech applications.

Exit Barriers

Low exit barriers allow unsuccessful companies to easily leave the industry, resulting in muted competition. Currently companies outsource their hardware needs but assemble the components in-house. This does not create any significant barrier to exit, as there is no large capital investment tied up in manufacturing facilities.

2.5 Threat of Substitutes – "High"

The threat of substitutes for volumetric 3D display platforms in the 3D display industry is high. The main segments of competition are from existing 2D displays coupled with 3D rendering software applications (allowing 2.5D viewing)[5] and others (holographic, stereovision and virtual reality systems).

The first can be called the 2.5D segment[6]. The 2.5D display technology is a mature industry with numerous coalitions and complementary products and has had extensive testing and usage. Systems offering 2.5D viewing are currently the dominant

---

[5] Two-dimensional (2D) displays coupled with 3D application software allow the viewer two-and-a-half-dimensions (2.5D) capability. 2.5D occurs when all the faces and relationships of a 3D structure cannot be seen at the same time, but only the selected view on the screen is visible.

[6] The 2.5D segment is considered to be any 2D display coupled with a 3D rendering application software package.

products in the market. The 2.5D segment is only a close substitute for 3D displays when spatial shape and depth perception are not critical.

The second segment of substitutes consists of different technologies such as holographic, stereovision and virtual reality systems. These technologies are older than volumetric 3D display platform technology. In addition, these technologies are expensive, bulky and thus far require non-standard computer configurations to function. The stereovision and virtual reality systems can usually only be used by one viewer at a time and offer no tele-collaborative functionality.

The factors that can affect the threat of substitutes in the volumetric 3D display industry are discussed below.

Switching Costs

Switching costs are low for customers in the biotech market segment when switching from the incumbent 2.5D technology to a volumetric 3D system. This cost represents only a small fraction of the overall cost of a project and the volumetric 3D system can be used for multiple projects.

Switching costs are high for customers changing their display systems from a 3D substitute system to a volumetric 3D display system. Conversion requires a high initial expenditure accompanied by the uncertainty of switching to a new technology. For some applications requiring less precision or visualization capabilities, converting to volumetric 3D display platforms neither enhances the core capabilities of the company nor boosts their productivity.

Low switching costs allow the customer to change to a substitute product easily. High switching costs lower the threat of substitution as the customer becomes locked-in due to cost. Currently, the majority of the industry has 2.5D display systems so switching costs overall are considered to be low, hence the threat of substitution is high.

Customers' Inclination to Substitute

Customers in the biotech segment or any similar market segment where spatial shape is crucial will have a high inclination to substitute to a volumetric 3D display. Such segments are currently restricted by the limitations of current 2D and 2.5D systems. Holographic, stereovision and virtual reality systems are viable substitutes but the number of producers, users and the lack of any tele-collaborative technology limit them. Buyers (customers) that are focused on performance and functionality have a high inclination to switch to a volumetric 3D display platform.

Price-Performance Trade-off

The price-performance trade-off plays a significant role in the adoption of volumetric 3D display platforms over current 2D and 2.5D systems. Volumetric 3D display systems are new technologies that have higher prices accompanied with enhanced performance when compared to the dominant 2D and 2.5D technologies. However, the higher price will serve as a deterrent to substitution. This can be counteracted by achieving economies of scale and maximizing performance levels. Digital Planet is attempting to achieve this by designing their products for mass manufacturability and

providing integrated application software. For market segments that are insensitive to price because performance is critical, substitution is high.

2.6 Threat of Entry – "Moderate"

The threat of entry is currently moderate. The volumetric 3D display platforms have yet to cross the chasm and enter the mainstream (Moore 2002). Companies competing in this space have yet to achieve the large-scale production required to obtain economies of scale and brand recognition. As such, there is no dominant company in the industry and system design architectural standards are still to be set. The factors that can affect the barriers to entry and the threat of entry into the industry are discussed below.

Company Experience – Industry Learning Curve

The industry has a learning curve associated with the design and implementation of volumetric 3D display technologies. This learning process acts as a moderate barrier for new entrants. It would take a significant amount of time and money for new entrants to research, design and develop the underlying technology and skills necessary to enter into the industry.

Proprietary and Patented Technology

Intellectual property protection acts as a moderate barrier to entry into the volumetric 3D display industry. The companies within the industry all have proprietary designs and patents to protect their intellectual property. These patents have a life span of 20 years.

Access to Industry Inputs

The inputs for volumetric 3D display devices include hardware devices, software applications and personnel. The first two do not serve as a barrier to entry as once designed the actual inputs (such as memory chips, integrated circuits, etc) are easily accessible.

Trained personnel with the necessary skills are inputs that create a barrier to entry. The underlying technology is "new" and few people are familiar and competent within this new area. An entrant would be forced to compete for trained personnel, which can be considered to be a scarce resource.

Access to Distribution Channels

Ready access to distribution channels creates a low barrier to entry. Entrants will be required to have enough volume to attract the interest of the installed distribution base. Presently no one company has an advantage in this area.

Government Policies/Regulatory Policies

Governmental regulations and policies do not affect the barriers to entry in the volumetric 3D display industry. The devices are only required to comply with general health and safety standards that apply to all device designers.

Capital Requirements

Capital requirements do not pose a significant barrier to entry. While a certain level of capital expenditure is required this only becomes significant if a company intends

to pursue an entirely new field of technology. Entrants can more easily work around patents and so reduce the investment costs.

Switching Costs

Switching costs do not, at this time, create a barrier to entry. There is no dominant volumetric 3D display company and customers are not locked into any one 3D display technology. An entrant will not have to overcome an entrenched incumbent with a large, installed base.

2.7 Bargaining Power of Buyers (Customers) – "Moderate"

The bargaining power of buyers is moderate in the volumetric 3D display industry. There are only a limited number of companies that can provide volumetric 3D display solutions and this effectively reduces the ability of a buyer to use the threat of switching to gain bargaining power. In addition, such factors as product differentiation and information asymmetry also serve to limit the bargaining power of buyers. The factors that can affect the bargaining power of buyers are discussed below in more detail.

Price Sensitivity

The biotech industry is relatively insensitive to price. The three attributes of the volumetric 3D display system that reduce the price sensitivity are the highly differentiated nature of the product, the importance of performance and quality of the product, and the small percentage of the costs of the product with respect to the total costs of buyers. The price sensitivity is offset when the cost of the product is a small percentage of the

customer's total costs (Grant 1995). In this instance the cost of a volumetric 3D display system would represent a very small percentage (less than 1%) in the total costs of the biotech company.

Bargaining Leverage

The relative bargaining power between the suppliers and buyers is determined by their credibility and the relative costs of either party not undertaking the transaction. There are a limited number of companies that can presently provide volumetric 3D display solutions and these companies offer widely differentiated products. An unsuccessful supplier can easily switch its sales effort from one potential buyer to another with minimal cost. The buyer, however, is most often affected by information asymmetry. These factors reduce the bargaining power of the buyers.

Buying Volume

Buying volume increases the power of the buyer. Buyers who buy in large volumes (must be of a size that is significant to the supplier company) have more power than those with small orders.

Threat of Backward Integration of Buyers (Customers)

Threat of backward integration involves buyers of volumetric 3D display systems integrating backwards into volumetric 3D display industry. This scenario of backward integration by volumetric 3D display buyers is low. Most companies that use these products have no competencies in the design and development of the products and would

gain no advantage by such vertical integration. These companies use the volumetric 3D display technology for a small portion of their operational needs. The American army may be one exception to this rule, as they appear to have an interest in any and all volumetric 3D display technologies. They are a unique case as they develop and use their own 3D display systems in addition to purchasing those of competitors and actively analyzing the underlying technology.

Product Differentiation

The complex and highly differentiated nature of the products in the volumetric 3D display industry makes switching between competitive offerings difficult, expensive and time-consuming to execute. The importance of the operations in which the 3D display will be used within the biotech industry makes quality and performance very important. The buyers are willing to pay a premium for a high-performance, error-free product. This reduces the bargaining power of the buyers.

Availability of Substitutes

Available substitutes increase the bargaining power of the buyers. In this instance the buyer can threaten to use another technologies such as 2.5D, holographic, stereovision or virtual reality systems to try to achieve the desired goal. This strategy can only work effectively in areas where depth perception and accurate spatial structure display are not critical.

2.8 Bargaining Power of Suppliers – "Moderate to High"

The bargaining power of suppliers in the volumetric 3D industry is moderate to high. The suppliers for volumetric 3D display platforms provide hardware, software and if required, assembly of the final product. The existing volumetric 3D companies do not have any in-house capabilities to mass-produce their products. The present demand for 3D display platforms is of insufficient volume to warrant the volumetric 3D companies investing in and constructing manufacturing facilities. Original equipment manufacturers (OEM), therefore, have a high degree of bargaining power. Suppliers who provide generic hardware and software components have a moderate degree of bargaining power. Again, the small volumes acts against the volumetric 3D display companies and they gain no volume discounts and are considered to be small customers.

The bargaining power of labour for software production in this industry is high. The requirement for qualified personnel who can produce quality software means that companies are less sensitive to the cost of this type of labour. Also, the relative bargaining power of employees is high because of the high demand for qualified employees and the lack of knowledgeable personnel in this field. A final factor affecting the bargaining power of labour is that employees are able to switch employers easily. The cost of training an employee is high for the company. The labour supplier switching costs are low, and the producer switching costs are high.

The aspects that can affect the bargaining power of suppliers are discussed below in more detail.

Importance of Volume to Suppliers

Major suppliers require sufficient volume to achieve economies of scale. The current demand for volumetric 3D display platforms is not sufficient to attract the interest of a large original equipment manufacturer (OEM). The small volumes produced are of little significance to the suppliers and their bargaining power is subsequently high.

Supplier Concentration

There are only a few suppliers for several of the required components that go into the manufacture of volumetric 3D displays. In such instances the bargaining power of the supplier is high. Conversely, there are numerous suppliers for the generic computer components that are required for a volumetric 3D display. In this instance the supplier bargaining power is reduced because the buyer can easily switch to another generic component producer.

Switching Costs of Firms in the Industry

Switching costs play a significant role in this industry. Once a company has approved a supplier the switching costs become significant and the bargaining power of the supplier is increased. Supplier searches and audits are time consuming and expensive. It is to the advantage of the buyer to have carefully written contracts and quality control methods established to minimize having to switch suppliers too often.

Threat of Forward Integration

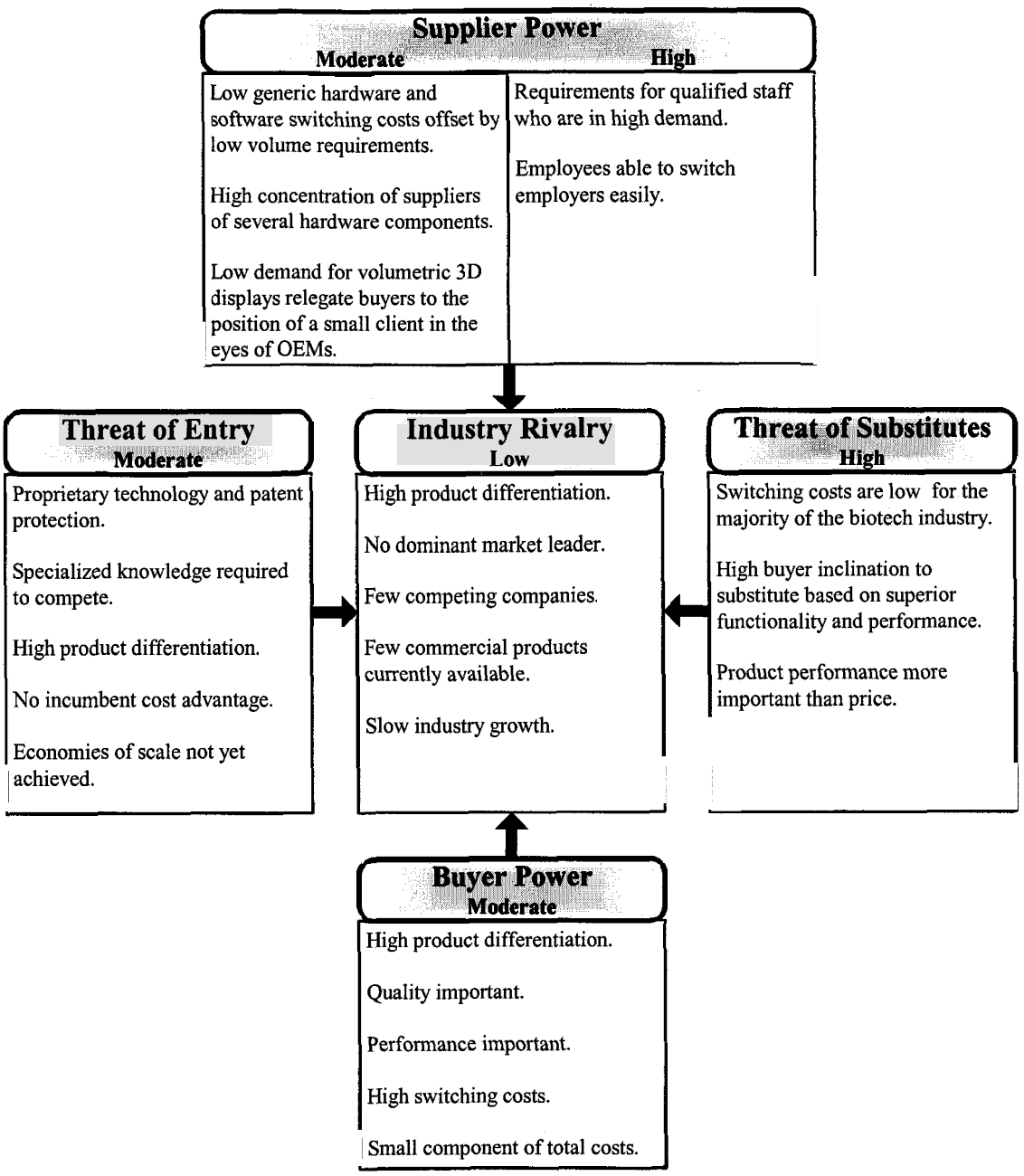
The threat of forward integration by suppliers is currently low. Volumetric 3D display platforms are patent-protected. In addition, until economies of scale can be achieved the profitability of the industry is such as not to attract OEMs to integrate forward. Digital Planet recognizes that OEMs can become a potential competitor when patent protection is lost and economies of scale begin to kick in, as such they are allowing their chosen manufacturer a 10% share of the company.

2.9 Summary of the Volumetric 3D Display Industry Forces Acting on Digital Planet

The impact of the competitive forces in the industry on Digital Planet is summarized in Figure 7. These five factors determine the competition faced by, and the future survival of Digital Planet (Porter 1980).

The industry has the potential for incumbents to be profitable because of the current low industry rivalry, together with moderate buyer power. Moderate barriers to entry complement this to a certain extent, however the danger lies in the barriers becoming lower as patent protection expires. This would allow new companies to enter the market easily and competition among rivals would increase as a result of a greater number of competitors and more product offerings. The threat of substitution is high due to a strong installed base of older technology and other available substitutes. The bargaining power of labour is high, because of the importance of quality specialized labour, which leads to appropriation of some of the potential profitability of the industry by employees.

Figure 7: Competitive Forces in the 3D Display Industry as They Affect Digital Planet



Source: Adapted from Porter, Michael E. (1985). Competitive Advantage: Creating and Sustaining Superior Performance. New York: Free Press.

2.10 Key Success Factors in the Volumetric 3D Display Industry

The analysis of the industry leads to the identification of the key success factors that must be possessed by a company that wishes to compete successfully in this market. Customers within the biotech industry are looking for a quality product with sufficient functionality to meet their needs. The product is required to integrate with their current computer systems and databases and to be an end-to-end customer solution. The product must have performance criteria that can be directly related to an increase in productivity and profitability. This takes an understanding of the needs of the target market segments and how to apply volumetric 3D display to meet these needs. Volumetric 3D display companies must possess effective product differentiation based on close customer-supplier ties, application of specialized knowledge, and the production of a high performance, quality end-to-end 3D display platform solution. Product differentiation will need to be supported by a strong vendor reputation. In addition customization of the product software solution and customer support are necessary so financial viability of the vendor is of importance. The provision of specialized knowledge is dependent on the company hiring and retaining highly skilled employees. If the company does not possess these factors it will not be able to compete and survive in this industry. The key success factors that must be possessed by the industry participants are summarized in Table 2.

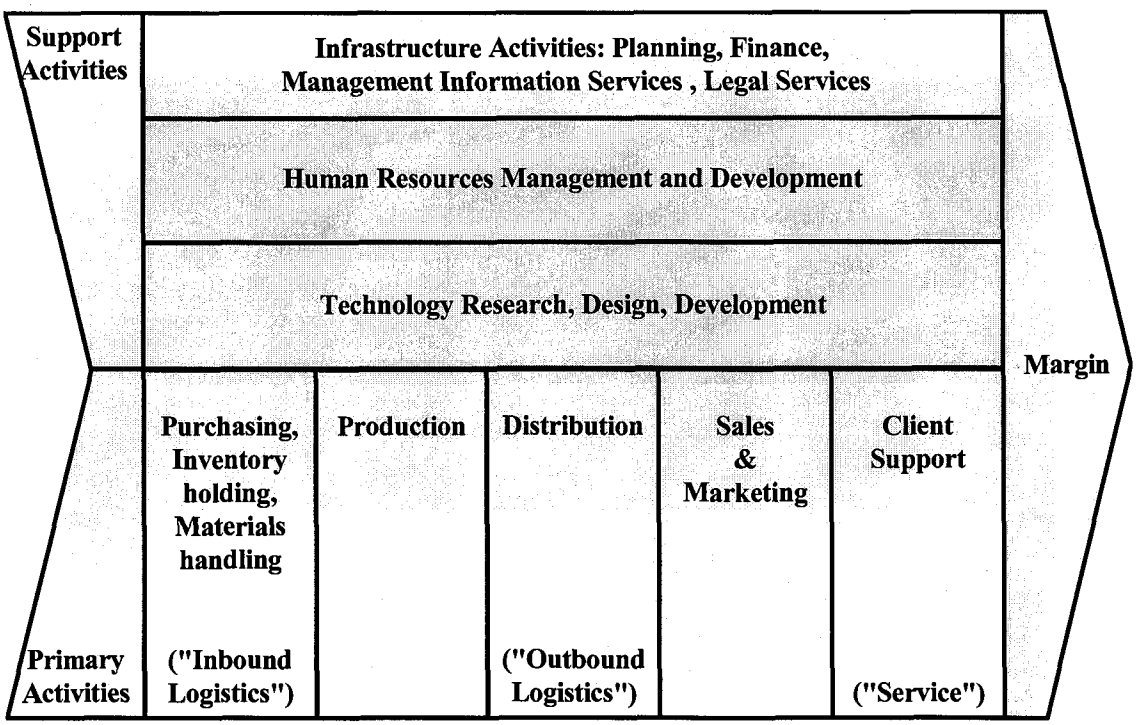
Table 8: Key Success Factors in the Volumetric 3D Display Industry for Digital Planet

- Production of quality performance-oriented 3D display hardware
- Production of quality software
- Production of software that integrates seamlessly with only Digital Planet's 3D display hardware
- Production of software that integrates seamlessly with customer computers and databases
- Intimate understanding of customer needs through close customer ties
- Use of specialized knowledge
- Provision for customization and support services
- Differentiated patented products
- Vendor reputation
- Hiring and retaining skilled employees
- Adequate financial strength

3 INTERNAL RESOURCES OF DIGITAL PLANET

This section will review the internal resources of Digital Planet. In addition, a proposed structure will be discussed for the company as it switches state from a research and development company to a volumetric 3D display systems provider. The review of the internal resources and company capabilities uses Michael Porter's Value Chain as the basis for organizing the components and how they interrelate (Porter 1985). Porter's Value Chain separates activities into primary activities and support activities. The value chain is a graphical representation of how a company adds value to its products and services. Porter's Value Chain as applied to Digital Planet is depicted below in figure 8. Currently Digital Planet, as a research and development company, has its main focus on support activities with little or no emphasis on primary activities.

Figure 8: Porter's Value Chain



Source: Adapted from Porter, Michael E. (1985). Competitive Advantage: Creating and Sustaining Superior Performance. New York: Free Press.

3.1 The Value Chain – Primary Activities

Primary activities of a company are those activities directly involved in the production and delivery of the products or services to the customer. Primary activities comprise of inbound logistics, production, outbound logistics, sales and marketing, and service. Digital Planet currently has no primary activities in the value chain. The following value chain analysis is based on the planned value chain that the company hopes to achieve.

3.1.1 Inbound Logistics

Digital Planet is currently a research and development company. As such, they have no regular inbound logistics system in place. The company intends to become a volumetric 3D display systems provider within the next two years and at that time an inbound logistics system will be established.

The purchased material required for a customer sale is vast and varied. However most of the components for a volumetric 3D display system are not specialized and may be obtained from any large distributor of computer components. Digital Planet lacks the skills and personnel necessary to create such a system. The company is reviewing options to outsource this function to a third party to develop an efficient inbound logistics system. The chosen company will not only help to establish and co-ordinate inbound logistics, but also they will eventually be the systems manufacturer. Alignment of the third party with Digital Planet's goals will be achieved by allowing the third party to acquire a 10% ownership share of Digital Planet. This is a viable option for Digital Planet as it allows

the company to utilize the existing inbound logistics system of the manufacturer while the company concentrates on additional product research and development.

3.1.2 Production

Production or manufacture of volumetric 3D display systems may initially be done in-house if sales volumes are low. It is estimated that, at the commercial introduction of the company's products, the sales volume will be low and thus batch production will be inefficient and costly. Economies of scale will not be achieved at that time and such small volumes will be better assembled in-house. This system is intended to migrate to the production of the volumetric 3D platforms being performed by an outsourced manufacturer. The manufacturer, as mentioned in the sub-section above, will handle inbound logistics and systems production. Digital Planet's products are designed for mass manufacturability hence economies of scale can be achieved once the demand is of a sufficient level.

3.1.3 Outbound Logistics

Outbound logistics will include activities such as order processing and shipping. Initially Digital Planet may combine this function with its sales and marketing team. This is feasible because of the predicted small demand at the onset of commercialization of the company's products. Products may be shipped via a courier such as Purolator™ International, which has an established shipping network across North America. Once demand rises this function may be outsourced. The company is evaluating a direct

shipment method by which the 3D platform will be sent directly to the customer from the production facility.

3.1.4 Sales and Marketing

Digital Planet currently has a small sales and marketing team. This team's current main concern is to establish the future marketing plan for the company. In addition, the team will help to build company and brand recognition at the time of commercialization. A direct sales approach is being evaluated for the introduction of the product. The company believes that this method will best serve their needs because the volumetric 3D display system will be a specialized product for a specific customer market.

The volumetric 3D display system is best classed as an experience good; Digital Planet must therefore address the potential customer's concerns during the sales process. The company intends to construct high quality brochures and utilize in-depth product demonstrations for prospective customers. Product demonstrations may be tailored to each prospective customer's business needs. Additional information will be made available to interested parties through the use of a website.

Digital Planet is also evaluating other sales and marketing methods such as utilizing indirect sales channels through the use of strategic marketing agreements. The chief concern in this area is that there may exist a lack of support, training, alignment and/or incentives for the third party field sales staff. This absence of alignment of objectives may seriously impact sales. Digital Planet can control the issues of objectives, incentives and training in a direct sales channel.

3.1.5 Customer Support

Digital Planet is developing an open architecture structure for its software systems. This will allow customers to eventually customize the 3D imaging platform's functionality to suit their business needs. Digital Planet plans to outsource customer installation and training to a systems integrator. While the volume of sales is low the company will provide these services only if requested. The open architecture of the software will allow for future expansion into different market segments that can also be supported by the use of a systems integrator.

In-house staff working together with the outsourced systems integrator will be responsible for customer support. Customer support will be responsible for providing a help desk for system support, rectification of software bugs and hardware failures (warranty issues), and also to provide post-implementation development services.

Digital Planet also intends to have an independent user group who will meet periodically to discuss emerging and other important customer issues. The user group will allow Digital Planet another venue within which to discuss its product and technology direction and obtain customer feedback.

3.2 The Value Chain – Support Activities

The support activities are those company activities that assist in the effective operation of primary activities. The support activities are infrastructure activities, technology research and development, and human resources. Infrastructure activities include planning, finance, management information services and legal services. Technology research and development focuses on improving the company's product

offerings and services. The human resources department will be responsible for the hiring, training, development, evaluation, compensation and motivation of employees.

3.2.1 Planning

The management team, together with the Advisory Board, performs major corporate planning within Digital Planet. These two teams correspond on a bi-monthly basis to review and update the company's strategy as necessary. The strategic plans establish the high level strategic objectives of the company, which are then translated into functional plans by the management team. The company's strategy is influenced by the needs of their target market, and the actions of the company's competitors. Digital Planet's approach to planning is flexible, and functional plans are modified based on the current internal and external situation.

3.2.2 Financial Management

The Financial Manager is responsible for the fiscal management of the company. The Advisory Board closely follows this function, as the company currently generates no revenues from sales. The current structure of the company as a pre-production research and development entity calls for strict financial management. The company has a clear understanding of the past and current situations, and of the future from a financial perspective. The company has forecasted monthly cash burn rate estimates up to the time of product commercialization. These are compared with actual monthly "burn rates" and adjusted as necessary. The company is also actively working to increase its financial flexibility to be able better to withstand unpredictable economic changes.

3.2.3 Management Information System

Digital Planet has no formal management information system (MIS). The company currently manages its research and development projects using Microsoft® Project and Microsoft® Excel.

3.2.4 Legal Services

Digital Planet utilizes a general counsel who is responsible for preparation of the company's various legal agreements. The general counsel is not a part of Digital Planet's structure, but an outsourced resource. The general counsel helps to ensure the legal protection of the company's intellectual property rights and to limit the company's legal liability.

The company has developed standard non-disclosure agreements for employees who must also sign an employment contract to protect the intellectual property developed in-house. Additional protection includes a non-competitive clause to prevent employees entering into competition with the company.

3.2.5 Technology Research and Development

Product research and development is the core activity of Digital Planet. The company has major strategic alliances with three university teams (see section 1.3.1 Strategic Alliances). These alliances help the company to generate its products and the corresponding provisional product patents. The team consists of technology leaders recognized internationally within their respective fields. These teams are tied to Digital Planet with various legal agreements.

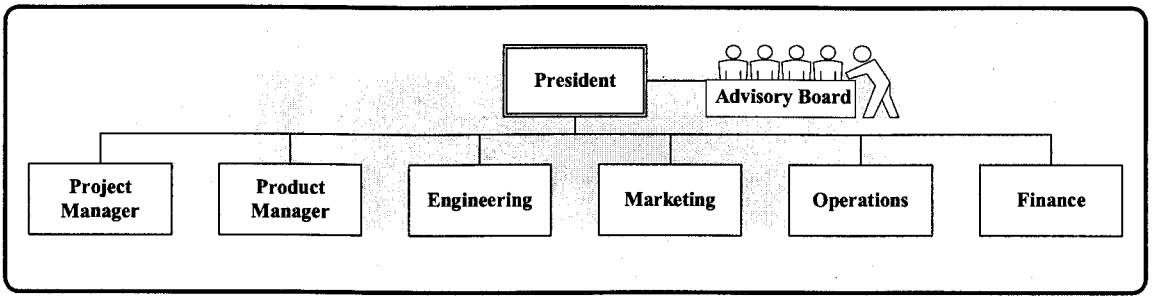
The company is engaged in multi-disciplinary research and development projects to produce an end-to-end volumetric 3D display platform for its target market. Currently, three teams are engaged in perfecting and integrating their prototype to produce the first commercial version of the company's volumetric 3D display platform. Another team is developing the photochromic polymer block for a 3D platform based on a different technology (see section 1.3.2.1 Hardware Products). The company has set research and development goals with associated timelines. The current schedule is to implement the first commercial volumetric 3D platform in two years time.

The research and development teams have access to the biotech market segment experts who help to guide them as to the required functionality and performance needs within the biotech group. Digital Planet's research and development projects have all been designed for a specific market, which has customers with specific application needs.

3.2.6 Human Resource Management and Development

The human resource function is an important activity for Digital Planet. The company depends on qualified staff to manage the organization and to research, design and develop its products. The company's president currently performs all the functions related to human resources, with help from the other departments. Employee retention is not presently an issue due to contractual agreements. However the company is constructing an employee share program that will be implemented in the near future. The expectation is that this will be an important incentive in attracting quality staff in the future. The current company structure is as shown in figure 9.

Figure 9: Current Organisational Structure of Digital Planet



Source: Drawn by the authors of this document (with Microsoft® Visio® 2000).

The company is very conscious of maximizing the use of its financial resources, hence the President also fills the role of Project Manager. The above organizational structure will be modified and restructured at commercialization. The company believes this is necessary to utilize best the skill sets of its employees.

The Advisory Board consists of six members; two additional members will be joining this team in early 2004. The Advisory Board collectively brings diverse technical and business skills to Digital Planet. The technical skills encompass engineering, communications (wireless and other), hardware and software product development, interactive media, nano-fabrication, nano-technology, fiber optics, engineering physics and artificial intelligence. The business skills include operations, finance, international business, sales and marketing, manufacturing, large and small company management and venture financing. In addition these individuals are well recognized in their fields and bring a huge network of contacts to Digital Planet.

3.3 Summary

Digital Planet is a pre-production research and development company. The company plans to introduce its first commercial product within two years. The company presently has not developed any standard primary activities. Digital Planet has well developed secondary activities especially in the area of technology research and development. The resources and capabilities of the company are grounded in highly competent staff and intellectual property in the form of patents. The company recognizes that it will require primary activities at commercialization and is therefore investigating its options.

4 CURRENT STRATEGY OF DIGITAL PLANET

This section will review Digital Planet's current strategy. There are two basic levels of strategy within a company: corporate level strategy and competitive level strategy. Corporate strategy describes where a company competes, and competitive strategy describes how a company competes in its chosen market(s).

4.1 Corporate Level Strategy

Corporate level strategy describes a company's scope. There are three principal dimensions to a corporate strategy: product scope, geographic scope and vertical scope (Grant 1995). Digital Planet is a research and development company attempting to switch focus and become a volumetric 3D display systems provider. The company, since its inception in 1997, has focused its research and development of volumetric 3D systems to specifically meet the needs of the biotech industry. The scope of the product has been effectively expanded because of existing 3D application software standards. These standards encompass multiple markets and allow Digital Planet's products to operate in multiple market segments. However, the company has restricted its product scope to the biotech market segment, as this is its chosen entry market.

Digital Planet, in tandem with its decision to focus its products on the biotech market, has a geographic scope from Canada to the United States (North America). This market is of sufficient size to help the company pursue economies of scale once their product is introduced commercially to the targeted markets.

Digital Planet is currently re-evaluating the amount of vertical integration required to introduce its products commercially. The company intends to limit its involvement

vertically by outsourcing manufacturing, customer training services, customer support and distribution. This leaves the company in a position to focus on additional research and development of both hardware and software components to enhance their product offerings. The company's mission is to concentrate on developing powerful, compelling volumetric 3D products for the future.

4.2 Competitive Level Strategy

The objective of competitive level strategy is for a company to obtain a competitive advantage over its rivals in the volumetric 3D display industry. There are three generic strategies for achieving a competitive advantage: cost leadership, differentiation or focus strategy (Porter 1985). A focus strategy is when a company focuses on a single segment of an industry.

Digital Planet is attempting a differentiation strategy. A differentiation advantage is achieved when a company obtains a premium price for its products, which is greater than the cost of providing the differentiation. Digital Planet has designed its products for a specific market that has specific applications (molecular-scale research and development). Most of the current competitors have not defined their ultimate end users and are only now searching for markets. The product offerings of Digital Planet are differentiated from those of the competitors by the level of functionality offered, the system performance and its flexibility.

4.3 Summary

The corporate and competitive strategies of Digital Planet are based on the use of industry specific knowledge to design specialized volumetric 3D display platforms. This has allowed the company to identify present and future key performance requirements of the biotech market and weaknesses of current competitor offerings. Digital Planet is pursuing a differentiation strategy based on superior product performance and functionality. Their product will provide a full customer solution for the biotech market segment that is involved with molecular-scale research and development.

5 FINANCIAL FORECASTS

The following section contains the pro forma income statement, balance sheet, and cash flow statement for Digital Planet. Three scenarios are presented – "base case", "worst case" and "best case". The forecasted statements are the revenue and profit predictions that the company can expect at the commercialization of its products.

Commercialization of the first product is scheduled for 2005. Digital Planet will require additional financing to meet the commercialization deadline. This section will outline the required level of financing and the proposed method by which it will be obtained.

5.1 Financial Forecast – "Base Case"

5.1.1 Assumptions – "Base Case"

The assumptions of the base case are listed below:

- At least US$500,000 will be raised to cover the expenses related to the first two years of operation.
- It will take two years from the current year (2003) to generate revenue streams from the first small scale, 3D, 360-degree visualization device and the intelligent interface (these two are bundled for the financial plan). Also, intelligent interfaces may be sold as a separate product if they contribute significantly to revenue growth.
- Revenue from sales of photochromic volumetric 3D platforms will occur in three years, which is in 2007.
- The company will remain as a private company within the forecasted years (2005 to 2010).

- Average yearly income tax rate is 40%.
- The annual investment in Research and Development (R&D) will be 25% of annual revenue for the first 5 years.
- A 5% depreciation rate will be maintained after product commercialization from 2005 to 2010.
- Accounts Receivable and Accounts Payable will be maintained at 17% in 2005, and thereafter at 10%.
- General and Administrative (G & A) expenses will be maintained at 15% for 2005 and 10% of annual revenue thereafter.
- Product and resource inventories will be maintained at 5% of annual revenue.
- Cost of Goods Sold will be maintained at 50% of annual revenue for the first three years, and 35% for the latter three years.
- Digital Planet is able to capture 9.8% of total 3D volumetric display market share by 2010.

5.1.2 Pro Forma Statements – "Base Case"

Table 9: Pro Forma Income Statement – "Base Case"

DIGITAL PLANET PRO FORMA INCOME STATEMENT (US$000)						
	2005	**2006**	**2007**	**2008**	**2009**	**2010**
Sales	545	2,239	5,753	9,727	15,943	22,611
Cost of Goods Sold	272	1,119	2,877	3,404	5,580	7,914
G&A	82	224	575	973	1,594	2,261
Research & Development	136	560	1,438	2,432	3,986	5,653
Income from Operations	54	336	863	2,918	4,783	6,783
Interest Income	-	-	-	-	-	-
Interest Expense	-	-	-	-	-	-
Other Income	-	-	-	-	-	-
Income before Tax	54	336	863	2,918	4,783	6,783
Tax (40%)	22	134	345	1,167	1,913	2,713
NET INCOME	33	201	518	1,751	2,870	4,070

Table 10: Pro Forma Balance Sheet – "Base Case"

DIGITAL PLANET PRO FORMA BALANCE SHEET (US$000)						
	2005	**2006**	**2007**	**2008**	**2009**	**2010**
Assets						
Cash	454	510	877	1,984	3,939	6,942
Accounts Receivable	93	224	575	973	1,594	2,261
Inventories	27	112	288	486	797	1,131
Prepaid Assets						
Current Assets	574	846	1,740	3,443	6,330	10,334
Investments						
Net PP&E	-	-	100	200	400	700
Other Assets						
Fixed Assets	-	-	100	200	400	700
TOTAL ASSETS	574	846	1,840	3,643	6,730	11,034
LIABILITIES & EQUITY						
Accounts Payable	41	112	288	340	558	791
Income Tax Payable						
Current Liabilities	41	112	288	340	558	791
Long-Term Debt	-	-	300	300	300	300
TOTAL LIABILITIES	41	112	588	640	858	1,091
Shareholder's Equity	500	500	500	500	500	500
Retained Earnings	33	234	752	2,503	5,372	9,442
TOTAL EQUITY	533	734	1,252	3,003	5,872	9,942
TOTAL LIABILITIES & EQUITY	574	846	1,840	3,643	6,730	11,034

Table 11: Pro Forma Cash Flow Statement – "Base Case"

DIGITAL PLANET PRO FORMA CASH FLOW STATEMENT (US$000)						
	2005	**2006**	**2007**	**2008**	**2009**	**2010**
Beginning Cash Balance	-	454	510	877	1,984	3,939
From Operations						
Net Income	33	201	518	1,751	2,870	4,070
Change in Inventories	27	85	176	199	311	333
Change in Accounts Receivables	93	131	351	397	622	667
Change in Accounts Payables	41	71	176	53	218	233
From Investments						
Capital Expenditures	-	-	100	100	200	300
Other	-	-	-	-	-	-
From Financing						
Equity Financing	500	-	-	-	-	-
Debt Financing	-	-	300	-	-	-
Dividends Paid	-	-	-	-	-	-
Other	-	-	-	-	-	-
Ending Cash Balance	454	510	877	1,984	3,939	6,942

The following is the series of cash flow estimates over the next 7 years – 2 years pre-commercialization and 5 years of revenue generation.

Table 12: Pro Forma Cash Flow Schedule – "Base Case"

DIGITAL PLANET PRO FORMA CASH FLOW SCHEDULE (US$000)							
Discount Rate	30%	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Operating Cash Flows		52	319	820	2,772	4,544	6,444
Cumulative Cash Flows		52	371	1,191	3,963	8,506	14,950
Discounted Cash Flows		$30.61	$145.19	$287.04	$746.61	$941.33	$1,026.98
Total Discounted Cash Flows	$3,177.75						

5.2 Financial Forecast – "Worst Case"

5.2.1 Assumptions – "Worst Case"

The "Base Case" assumptions still apply, but with the following changes as listed:

- Price per product category will be 10% lower than that of the "Base Case".
- The sales volume will be 5% lower than that of the "Base Case".
- Cost of Goods Sold will be maintained at 55% of annual revenue for the first three years (2005 to 2007), and 40% for the latter three years (2008 to 2010).
- Digital Planet's market share in year 2010 is estimated to be 8.4%.

5.2.2 Pro Forma Statements – "Worst Case"

Table 13: Pro Forma Income Statement – "Worst Case"

DIGITAL PLANET PRO FORMA INCOME STATEMENT (US$000)						
	2005	**2006**	**2007**	**2008**	**2009**	**2010**
Sales	440	1,925	5,000	8,380	13,650	19,430
Cost of Goods Sold	242	1,059	2,750	3,352	5,460	7,772
G&A	66	193	500	838	1,365	1,943
Research & Development	110	481	1,250	2,095	3,413	4,858
Income from Operations	22	193	500	2,095	3,413	4,858
Interest Income	-	-	-	-	-	-
Interest Expense	-	-	-	-	-	-
Other Income	-	-	-	-	-	-
Income before Tax	22	193	500	2,095	3,413	4,858
Tax (40%)	9	77	200	838	1,365	1,943
NET INCOME	13	116	300	1,257	2,048	2,915

Table 14: Pro Forma Balance Sheet – "Worst Case"

DIGITAL PLANET PRO FORMA BALANCE SHEET (US$000)						
	2005	**2006**	**2007**	**2008**	**2009**	**2010**
Assets						
Cash	453	446	654	1,364	2,632	4,610
Accounts Receivable	75	193	500	838	1,365	1,943
Inventories	22	96	250	419	683	972
Prepaid Assets						
Current Assets	550	735	1,404	2,621	4,679	7,525
Investments						
Net PP&E	-	-	100	200	400	700
Other Assets						
Fixed Assets	-	-	100	200	400	700
TOTAL ASSETS	550	735	1,504	2,821	5,079	8,225
LIABILITIES & EQUITY						
Accounts Payable	36	106	275	335	546	777
Income Tax Payable						
Current Liabilities	36	106	275	335	546	777
Long-Term Debt	-	-	300	300	300	300
TOTAL LIABILITIES	36	106	575	635	846	1,077
Shareholder's Equity	500	500	500	500	500	500
Retained Earnings	13	129	429	1,686	3,733	6,648
TOTAL EQUITY	513	629	929	2,186	4,233	7,148
TOTAL LIABILITIES & EQUITY	550	735	1,504	2,821	5,079	8,225

Table 15: Pro Forma Cash Flow Statement – "Worst Case"

DIGITAL PLANET PRO FORMA CASH FLOW STATEMENT (US$000)						
	2005	2006	2007	2008	2009	2010
Beginning Cash Balance	-	453	446	654	1,364	2,632
From Operations						
Net Income	13	116	300	1,257	2,048	2,915
Change in Inventories	22	74	154	169	264	289
Change in Accounts Receivables	75	118	308	338	527	578
Change in Accounts Payables	36	70	169	60	211	231
From Investments						
Capital Expenditures	-	-	100	100	200	300
Other	-	-	-	-	-	-
From Financing						
Equity Financing	500	-	-	-	-	-
Debt Financing	-	-	300	-	-	-
Dividends Paid	-	-	-	-	-	-
Other	-	-	-	-	-	-
Ending Cash Balance	453	446	654	1,364	2,632	4,610

The following is the series of cash flow estimates over the next 7 years – 2 years pre-commercialization and 5 years of revenue generation.

Table 16: Pro Forma Cash Flow Schedule – "Worst Case"

DIGITAL PLANET PRO FORMA CASH FLOW SCHEDULE (US$000)						
Discount Rate 30%	2005	2006	2007	2008	2009	2010
Operating Cash Flows	21	183	475	1,990	3,242	4,615
Cumulative Cash Flows	21	204	679	2,669	5,911	10,526
Discounted Cash Flows	$12.37	$83.24	$166.31	$536.03	$671.64	$735.42
Total Discounted Cash Flows	$2,205.00					

5.3 Financial Forecast – "Best Case"

5.3.1 Assumptions – "Best Case"

The "Base Case" assumptions still apply with the following changes as listed:

- Price per product category will be 10% higher than that of the "Base Case".
- The sales volume will be 5% higher than that of the "Base Case".
- Cost of Goods Sold will be maintained at 45% of annual revenue for the first three years (2005 to 2007), and 30% for the latter three years (2008 to 2010).
- Digital Planet's market share in year 2010 is estimated to be 11.2%.

5.3.2 Pro Forma Statements – "Best Case"

Table 17: Pro Forma Income Statement – "Best Case"

DIGITAL PLANET PRO FORMA INCOME STATEMENT (US$000)						
	2005	2006	2007	2008	2009	2010
Sales	594	2,574	6,672	11,078	18,060	25,690
Cost of Goods Sold	267	1,158	3,002	3,324	5,418	7,707
G&A	89	257	667	1,108	1,806	2,569
Research & Development	149	644	1,668	2,770	4,515	6,422
Income from Operations	89	515	1,334	3,877	6,321	8,991
Interest Income	-	-	-	-	-	-
Interest Expense	-	-	-	-	-	-
Other Income	-	-	-	-	-	-
Income before Tax	89	515	1,334	3,877	6,321	8,991
Tax (40%)	36	206	534	1,551	2,528	3,597
NET INCOME	53	309	801	2,326	3,793	5,395

Table 18: Pro Forma Balance Sheet – "Best Case"

DIGITAL PLANET PRO FORMA BALANCE SHEET (US$000)						
	2005	2006	2007	2008	2009	2010
Assets						
Cash	463	592	1,162	2,760	5,515	9,694
Accounts Receivable	101	257	667	1,108	1,806	2,569
Inventories	30	129	334	554	903	1,284
Prepaid Assets						
Current Assets	594	978	2,163	4,422	8,224	13,548
Investments						
Net PP&E	-	-	100	200	400	700
Other Assets						
Fixed Assets	-	-	100	200	400	700
TOTAL ASSETS	594	978	2,263	4,622	8,624	14,248
LIABILITIES & EQUITY						
Accounts Payable	40	116	300	332	542	771
Income Tax Payable						
Current Liabilities	40	116	300	332	542	771
Long-Term Debt	-	-	300	300	300	300
TOTAL LIABILITIES	40	116	600	632	842	1,071
Shareholder's Equity	500	500	500	500	500	500
Retained Earnings	53	362	1,163	3,489	7,282	12,677
TOTAL EQUITY	553	862	1,663	3,989	7,782	13,177
TOTAL LIABILITIES & EQUITY	594	978	2,263	4,622	8,624	14,248

Table 19: Pro Forma Cash Flow Statement – "Best Case"

DIGITAL PLANET PRO FORMA CASH FLOW STATEMENT (US$000)						
	2005	**2006**	**2007**	**2008**	**2009**	**2010**
Beginning Cash Balance	-	463	592	1,162	2,760	5,515
From Operations						
Net Income	53	309	801	2,326	3,793	5,395
Change in Inventories	30	99	205	220	349	381
Change in Accounts Receivables	101	156	410	441	698	763
Change in Accounts Payables	40	76	184	32	209	229
From Investments						
Capital Expenditures	-	-	100	100	200	300
Other	-	-	-	-	-	-
From Financing						
Equity Financing	500	-	-	-	-	-
Debt Financing	-	-	300	-	-	-
Dividends Paid	-	-	-	-	-	-
Other	-	-	-	-	-	-
Ending Cash Balance	463	592	1,162	2,760	5,515	9,694

The following is the series of cash flow estimates over the next 7 years – 2 years pre-commercialization and 5 years of revenue generation.

Table 20: Pro Forma Cash Flow Schedule – "Best Case"

DIGITAL PLANET PRO FORMA CASH FLOW SCHEDULE (US$000)							
Discount Rate	30%	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Operating Cash Flows		85	489	1,268	3,684	6,005	8,542
Cumulative Cash Flows		85	574	1,841	5,525	11,530	20,072
Discounted Cash Flows		$50.09	$222.60	$443.85	$992.09	$1,244.08	$1,361.27
Total Discounted Cash Flows	$4,313.99						

5.4 Financing Options of Digital Planet

Digital Planet estimates that its average "burn rate" will be US$71,000 per month by the end of the first quarter (Q1) 2004. This is expected to increase to US$140,000 per month by the end of 2004 and then continue at this level until commercialization. The burn rate is forecasted to increase because of the changes that will occur in the company as it nears product commercialization. The increased spending will be required as the company begins to change focus from a completely research and development oriented company to a volumetric 3D systems provider.

Digital Planet estimates that it will require a US$5 million cash infusion to meet its product commercialization schedule. This infusion will help to cover the average monthly operating costs and the required internal restructuring that is necessary for commercialization. In addition, the cash infusion will provide the company with a cash reserve of approximately US$2 million.

The company believes that it can raise the desired funding through three rounds of financing. This will be achieved through cash infusions from venture capitalists and the strategic partnerships with other companies. Digital Planet has already secured financing from its chosen manufacturing partner who will receive a 10% ownership share of the company. Two additional financing rounds will be pursued in 2004. Digital Planet is following a flexible financing policy and the percentage of ownership that the company is willing to relinquish will depend on the size of the investment and the strategic alignment of the investor's skills with those required by Digital Planet.

6 ASSESSMENT OF THE OPPORTUNITY OF DIGITAL PLANET

Digital Planet has the technical resources to develop an end-to-end customer solution for the biotech market segment. These resources include highly skilled and internationally recognized personnel, an experienced management team, an Advisory Board that has an extensive amount of business and technical expertise, and intellectual property protected by patents. The company has invested its research and development into four viable products, two hardware products and two software applications. This allows the company some flexibility as any one of these products can be sold separately.

Several strategic alliances enhance the research and development capabilities of the company and ensure that the products under development are in line with the chosen entry market customers' requirements. The strategic partnership with the outsourced manufacturer ensures that Digital Planet has access to an established inbound logistics system with which to procure hardware components. In addition, this allows the company to utilize the manufacturer to assemble the products once the demand is of a sufficient volume.

Digital Planet, however, lacks certain skills that are required to enter effectively into the volumetric 3D display industry and to assume a dominant position. The company will require additional financing to bring its first end-to-end volumetric 3D display platform to market in 2005. The company will need to actively pursue and obtain an additional two to three rounds of financing to raise the estimated US$5 million (section 5.4). Failing this the commercialization of the first end-to-end volumetric 3D platform will not occur on schedule. This could seriously affect the company as the competitors

may gain a significant advantage in terms of an installed customer base and brand recognition if Digital Planet delays their product commercialization.

Digital Planet also lacks the necessary distribution and service infrastructure to launch and support its products effectively. None of the company's existing strategic partners have the required infrastructure to service the chosen market segments. The company will need to outsource both the distribution and support aspects of its products to established vendor(s) who can effectively perform these services within North America. The North American market has established distribution and customer support companies hence this will not serve as a major barrier to Digital Planet. A courier such as Purolator™ can be utilized to handle distribution and to transport products with warranty issues to a service center and then back to the customer.

Market entry and penetration will depend on the marketing strategy adopted by Digital Planet. The marketing strategy must be aligned with the resources and capabilities of the company and must also effectively communicate with the target market. The next section will outline a marketing strategy that Digital Planet may utilize to compete effectively and efficiently in the volumetric 3D display industry.

7 MARKETING PLAN

7.1 Overall Marketing Strategy of Digital Planet

The overall marketing strategy for Digital Planet will consist of a target market and the related marketing mix. Digital Planet is targeting the biotech market segment (section 1.3.3 and 1.3.4) of North America, which will serve as the entry market for the company's products and services as they become available commercially. The marketing mix for the selected entry market segment will consist of the controllable variables that Digital Planet can put together to satisfy the biotech market segment. The marketing mix or the "four Ps of marketing" are: -

Product: everything the target segment receives,

Price: everything the target segment gives up to receive the product,

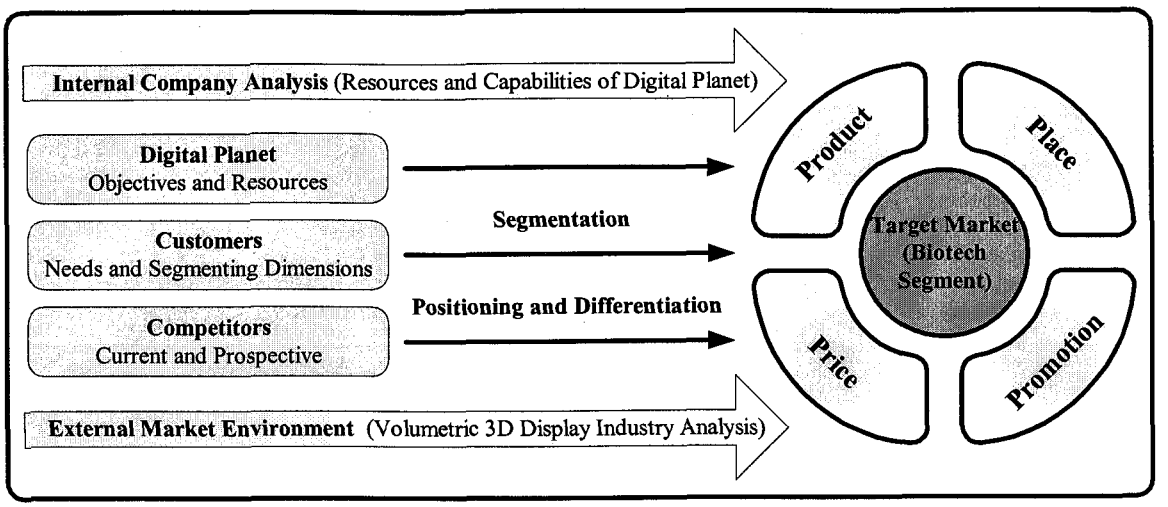
Place: everything that is done to give the customer possession of the product,

Promotion: everything the customer hears about the other three Ps

(Shapiro, Wong, Perreault, McCarthy 2001).

The "four Ps of marketing" are derived from several factors and they must match the target market needs and requirements. Figure 10 depicts the process that was used to build the marketing mix. The process requires a thorough understanding of the target market. This entails careful analysis of the customers' needs, current or prospective competitors, and the company's own objectives and resources. The external market analysis (volumetric 3D display industry analysis) and the internal company analysis (internal resources of Digital Planet) help to refine the marketing mix.

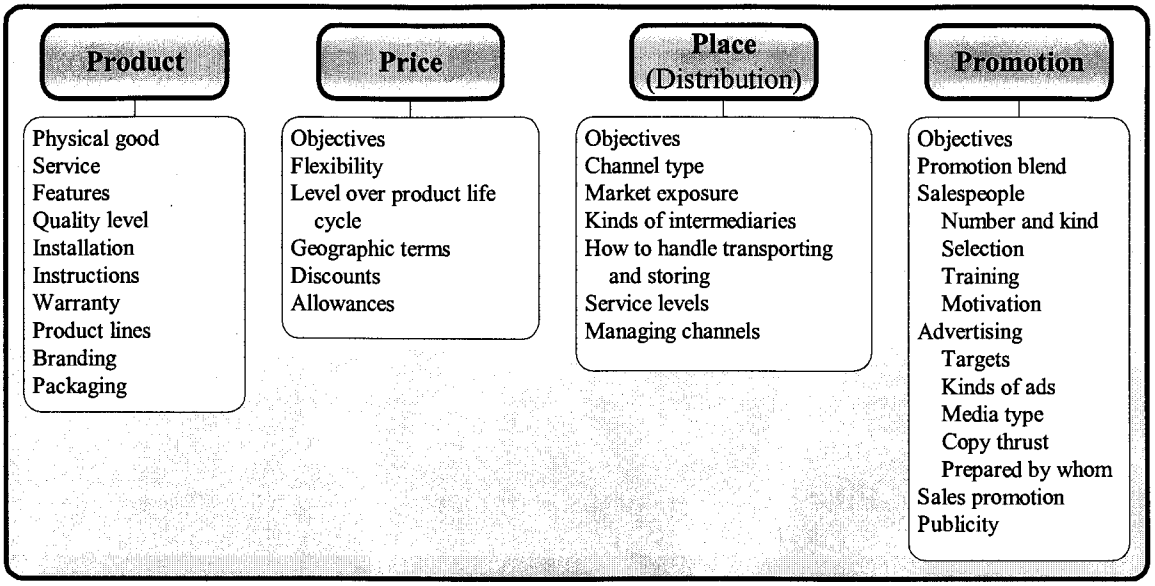
Figure 10: Overview of the Strategic Market Planning Process



Source: Adapted from Shapiro, Stanley J., Wong, Kenneth, Perreault, William D. & McCarthy, E. Jerome. (2001). Basic Marketing—A Global Managerial Approach, (10th ed.).

The "four Ps of marketing" and the areas of concern for each as they apply to Digital Planet are shown in figure 11. Each decision area requires careful decision-making that must not be made in isolation from the other areas. The "four Ps" must be creatively blended so that Digital Planet can create the best mix for its target market. Each of the "four Ps" will be further discussed in following sections.

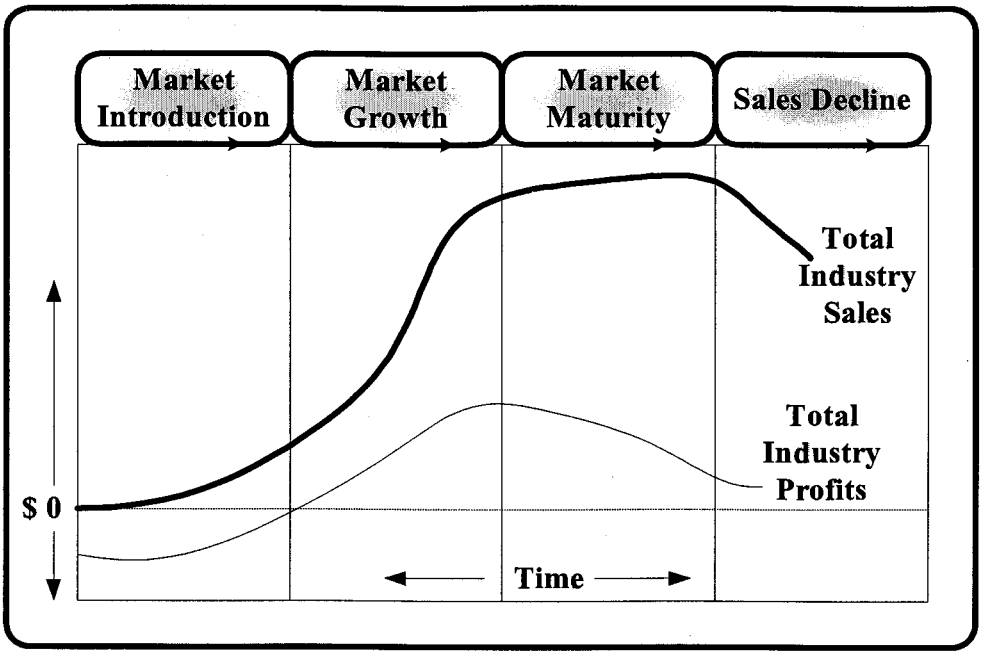
Figure 11: The "Four Ps of Marketing" – Strategic Decision Areas of Digital Planet



Source: Adapted from Shapiro, Stanley J., Wong, Kenneth, Perreault, William D. & McCarthy, E. Jerome. (2001). Basic Marketing—A Global Managerial Approach, (10th ed.).

The marketing strategy is a dynamic plan and must be adapted as factors in the company and in the volumetric 3D display industry change. Currently, the volumetric 3D display industry is in the market introduction stage as shown in figure 12. The marketing strategy will extend from the market introduction stage to the market growth stage. It will discuss some of the major changes that Digital Planet is likely to encounter and suggest possible changes to the marketing strategy.

Figure 12: Typical Product Life Cycle for a Technology Product



Source: Adapted from Shapiro, Stanley J., Wong, Kenneth, Perreault, William D. & McCarthy, E. Jerome. (2001). Basic Marketing—A global Managerial Approach, (10th ed.).

7.2 Product

Digital Planet intends to offer a variety of products to the biotech market segment. There will be two main product offerings: "3D Display – Type 1" and "3D Display – Type 2" (section 1.3.4). Each of these products offers an end-to-end customer solution to the biotech market segment. Table 21 lists the product range of Digital Planet. The other products offered will be one or more subsets of the two main products. The company realizes that to be successful the product benefits must match the needs of the biotech market segment. The research and development oriented strategic alliances of Digital Planet help to ensure that its products are aligned with the target market customers' needs.

Table 21: Products of Digital Planet

Products of Digital Planet	
End-To-End Customer Solution	
	3D Display System – Type 1
	3D Display System – Type 2
	(Includes hardware, software and customer support)
Hardware	
	3D Display – Type 1
	3D Display – Type 2
	(Includes customer support)
Software	
	User Interface (site license)
	Intelligent Program (site license)
Customer Support	
	Maintenance Contracts
	Extended Warranty
	(Help desk access and, bug fixes are not aspects of customer support that are sold)

Digital Planet's market research has shown that the entry biotech market segment values product features, performance and quality over price. They require an end-to-end solution for their volumetric 3D display needs. The need for a volumetric 3D display in applications such as genomics, proteomics, pharmaceuticals, molecular diagnostics and nano-biology has been identified as being critical to the progress and productivity within these areas.

The company will offer both a physical good and a service (customer support). The "3D Display - Type 1" will be commercially available within two years (2005) and the "3D Display - Type 2" will follow three years after. The first product will enter the market in the market introduction stage of the life cycle (figure 12) and the second will enter in the market growth stage.

Product performance, functionality and quality will be emphasized. The aim is to allow the biotech customers to meet easily their critical need and to be able to justify the purchase of the product based on increased productivity figures and reduced project times. The designed end-to-end systems will work in tandem with existing computer hardware and standard 3D software formats. The product package will include installation, operating instructions and/or personnel training if desired, and an extendable warranty program. The product mix is designed to promote Digital Planet's product lines

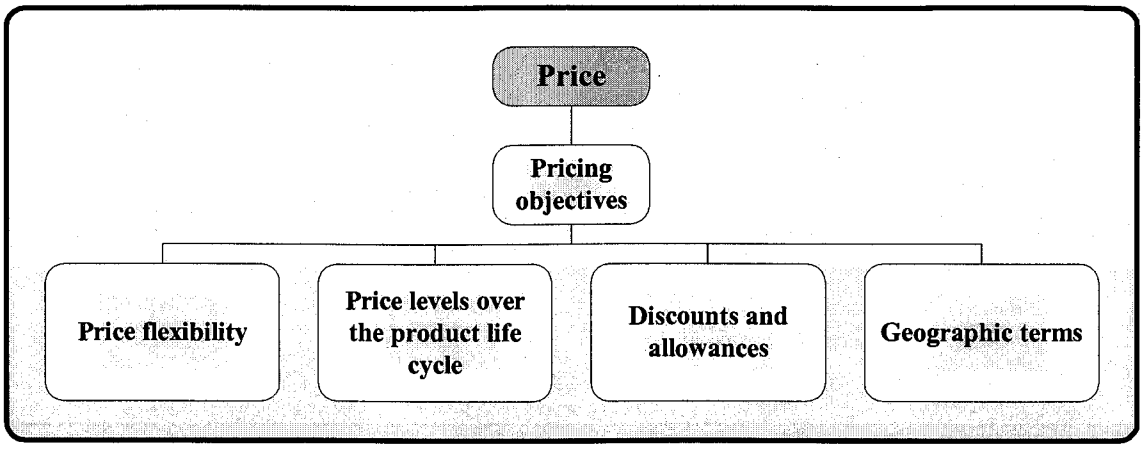
and company name. This will help to establish the company and its brands as reliable and trustworthy in the eyes of the customers.

The product offering will complement the price, place (distribution) and promotion aspects of the marketing mix. One aspect of the product that will be initially muted is product packaging. The main function of packaging in the market introduction stage of the product life cycle will be to prevent damage to the product during transport. However, as the volumetric 3D display industry progresses from the market introduction stage of its life cycle packaging will become important as a means of advertising for the company.

7.3 Price

At the commercialization of its first product Digital Planet will employ a profit-oriented strategy to meet the target return of its investors and maximize its profits. The target return objective will be to pursue long-run profits for the company and this must be balanced with profit maximization in the market introduction stage of the product life cycle. The pricing strategy will take into account four factors: price flexibility, price levels over the product life cycle, discounts and allowances, and geographic terms. (Shapiro, Wong, Perreault, McCarthy 2001). Figure 13 displays the four factors that affect the pricing strategy.

Figure 13: Factors that Affect Pricing Strategies



Source: Adapted from Shapiro, Stanley J., Wong, Kenneth, Perreault, William D. & McCarthy, E. Jerome. (2001). Basic Marketing—A Global Managerial Approach, (10th ed.).

Firstly, Digital Planet will adopt a price skimming policy. There are only a few products in the market that offer static display volumetric 3D technology and the company can charge a premium for its products. The skimming pricing strategy will be used in the market introduction stage of the product life cycle. This will allow the company to earn a sufficient level of revenue and profitability with which to broaden the existing product functionality and increase its product offerings. The pricing level will be changed over time to show a reduction of product price as the product moves into the market growth stage of its life cycle. At that time, lower prices and reduced short-run profits may be more beneficial to the company to widen its installed customer base. Digital Planet will consider a price skimming strategy for the first three years after commercialization dependent on the progress of the life cycle of the product, the external environment and the internal company characteristics.

Secondly, Digital Planet will utilize a geographic pricing scheme for North America. Following similar technology industries such as the automobile industry, Digital

Planet will segment the biotech market for North America into the United States of America (USA) and Canada. These two segments have different willingness-to-pay characteristics, with the US market being willing-to-pay more for the same product than the Canadian market. For customers in the USA, Digital Planet will sell its products at a price approximately 15% to 20% higher than that of the Canadian market segment. Discounts and allowances will be used both as a promotional tool and to induce customers to buy larger volumes of the offered products.

As the product life cycle progresses Digital Planet anticipates that competitors will introduce similar products with similar performance and functionality characteristics. The company intends to implement a gradual 30% reduction of product price offered to the customers. This will be offset by larger volumes sold and the economies of scale that accompany these larger volumes. This meshes with the design of the product as the hardware is designed for mass manufacturability.

7.4 Place (Distribution)

The place objectives revolve around the type of channels employed to reach the end customer and the customer service level desired. The biotech market segment views the company's products as business products. As such, Digital Planet's products in the biotech segment will be used to help produce other products. The biotech customer segment requires a high level of supplier commitment and customer support. This must be addressed by having widespread availability of customer support over the North American target market.

There are several place considerations to be faced by Digital Planet as a producer of volumetric 3D display platforms. Place considerations will include:

- Component parts and materials acquisition, assembly and distribution
- Product installation services
- Maintenance and repair
- Customer support.

The hardware components parts and materials acquisition will be out-sourced to a manufacturer. This manufacturer has a 10% share of Digital Planet and an established supply network with which to acquire the components required to produce the final hardware platform. Initially assembly will be done in-house at Digital Planet, as the projected sales volumes are low. As demand rises, assembly will be out-sourced to the manufacturer to capture economies of scale. The distribution of the final product to the customer will be done directly via a courier such as Purolator™. The courier can also be utilized to transport products with warranty issues to a service center and then back to the customer. The initial transportation costs for such purchased electronic equipment (volumetric 3D display platform) will be borne by the customer and are estimated to have an upper limit of 3% of the selling price (Shapiro, Wong, Perreault, McCarthy 2001).

A systems integrator will be used in addition to Digital Planet personnel to help provide installation, maintenance and repair, and customer support services. The level of interaction between Digital Planet and the systems integrator may vary over time but it is required to capture important customer trends and feedback.

Digital Planet also intends to have a comprehensive website to help customers purchase additional software, provide feedback to the company, allow a convenient

method of direct contact with the company and distribute product information. This aspect will be closely tied to the promotion of the company's products. Software if brought separately will be sold as an internet downloadable file with a compact disc (CD) shipment option utilizing the postal services available in North America.

The future outlook and strategy for place (distribution) may involve several changes as Digital Planet tries to compete in other market segments and as the life cycle of the product progresses. Following similar companies, Digital Planet may find it is necessary to enter into selective distribution contracts. These contracts will involve utilizing a few indirect distribution companies to gain more market exposure and to allow customers other than those in the biotech segment to observe the product.

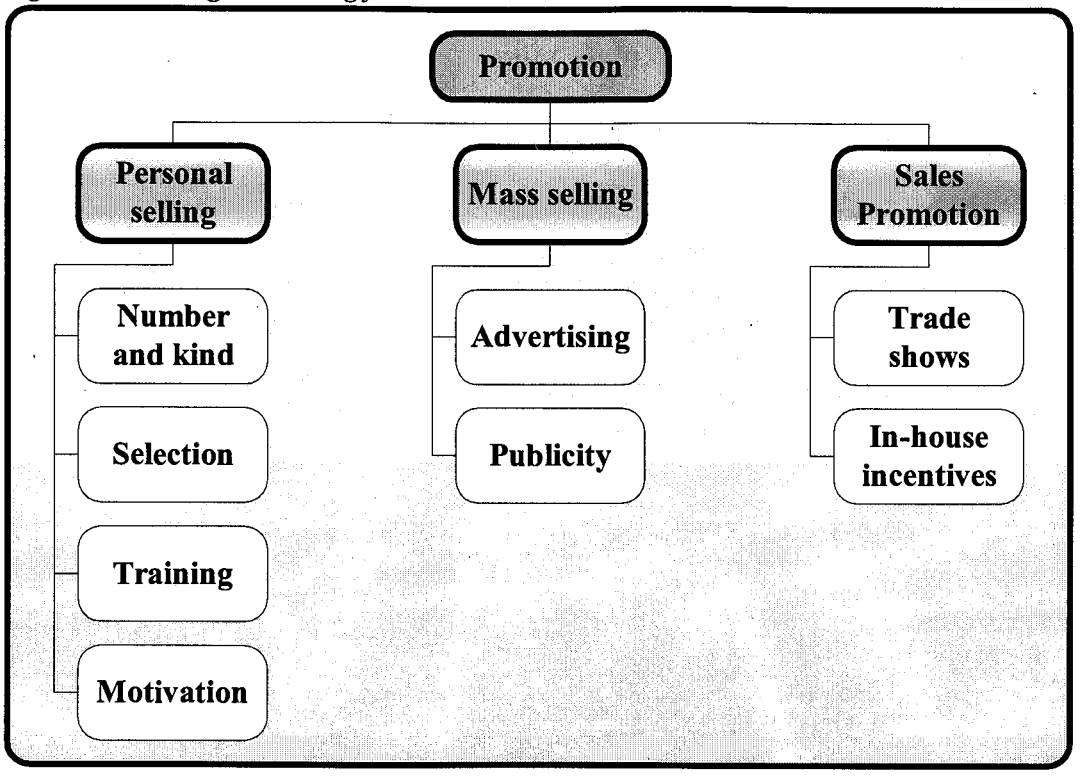
7.5 Promotion

Promotion of the products and the company will be achieved by utilizing a blend of promotional activities. The objective is to effectively reach and communicate with the biotech market segment and to influence their decision to buy Digital Planet's products instead of a competitor's product. In addition, the promotional effort should help to strengthen the company's name and brands. The promotion plan of the marketing mix will consist of a blend of three types of promotional activities: personal selling, mass selling and sales promotion. Figure 14 depicts the promotional areas of interest to Digital Planet.

At the commercialization of the first end-to-end customer product the majority of the promotional blend will consist of personal selling. The estimated budget breakdown is 80% personal selling, with the remaining 20% shared between mass selling and sales

promotion. A small personal sales team (approximately 2 to 4 persons) will be hired and trained. The team must have sufficient technical qualifications to understand and to explain the company's products to the customers. The team will be trained in-house to ensure sufficient familiarity with the products before going into the field. Motivation of the sales staff will be achieved by incentives in the form of sales bonuses.

Figure 14: Strategic Planning for Promotion



Source: Adapted from Shapiro, Stanley J., Wong, Kenneth, Perreault, William D. & McCarthy, E. Jerome. (2001). Basic Marketing—A Global Managerial Approach, (10th ed.).

Mass selling, which consists of advertising and publicity, will be limited in the market introduction stage of the product life cycle. Advertising will be targeted to the biotech segment. Advertising will be accomplished by publishing articles in biotech-specific journals and magazines, and also by establishing a company website. The website

will serve several purposes: as a tool to educate customers about Digital Planet's products, as a means by which to contact the company and sales force, and as an advertising platform to promote the company and its products.

The company will participate in trade shows and technology expositions to help promote sales. This will allow the company to gain more exposure for its products and will also allow other potential customers the opportunity to observe the product and become more familiar with the benefits of the technology.

In the market introduction stage of the product life cycle Digital Planet will use informative advertising. This will help to build primary demand for the general product idea. As the market enters the market growth stage the promotional blend will need to be modified to encourage selective demand for Digital Planet's products. The promotion plan is dynamic and must be continually adjusted as the product progresses through it life cycle and as new customers are targeted.

7.6 Summary

Digital Planet is targeting the biotech market segment as its primary customers for its entry into the volumetric 3D industry. The company realizes that the product benefits must match the customers' needs and has designed its products to meet an identified critical need within the chosen market segment. The marketing mix is one aspect of a successful product launch and will allow the company to compete successfully against its competitors. The company recognizes that the marketing mix must be targeted to the specific target market and that different markets may require different marketing mixes. The marketing mix or "four Ps of marketing" are a blend of strategic decisions that reinforce one another. In addition, it helps to form part of a dynamic strategy that the company can use to compete within the volumetric 3D industry.

GLOSSARY

Bio-informatics – derives knowledge from computer analysis of biological data. Research in bio-informatics includes method development for storage, retrieval, and analysis of the data. Bio-informatics is a rapidly developing branch of biology and is highly interdisciplinary, using techniques and concepts from informatics, statistics, mathematics, chemistry, biochemistry, physics, and linguistics.

Genomics – the study of genes and their function. Genomics aims to understand the structure of the genome, including the mapping of genes and the sequencing the DNA. Genomics examines the molecular mechanisms and the interplay of genetic and environmental factors in disease.

Life science – is defined as any of the branches of natural science dealing with the structure and behaviour of living organisms.

Molecular diagnostics – the art or practice of medical diagnosis at the molecular-scale level.

Nano-fabrication – fabrication techniques dealing in nano sizes (one billionth or 10^{-9}).

Nuclear magnetic resonance – is an imaging technique that does not use radiation.

OpenGL - A set of specifications for a cross-platform 3D graphics application program interface, developed initially by Silicon Graphics Inc. There are several implementations of Open GL, provided by different vendors. Open GL includes routines for shading, texture mapping, texture filtering, anti-aliasing, lighting, geometry transformations, etc.

Opto-electronics – advances electronics that is used to produce optical images.

Pharmacology – is the study of the body's reaction to drugs.

Photochromic material - is a "new material" that undergoes a color change upon excitation with light of a specific wavelength.

Physiology – the study of how living organisms function including such processes as nutrition, movement, and reproduction.

Proteomics – the study of the proteome. It involves the large-scale study of the set of proteins produced by a species, particularly their structures, functions, how they can be modified, when and where they are expressed, how they are involved in metabolic pathways, and how they interact with one another.

Static volume display - a volumetric 3D display that creates a display volume without the need to employ mechanical motion.

Swept volume display - a volumetric 3D display in which the display volume is created by mechanical motion, either vibrational or rotational of a target screen.

Tele-collaborative technology - technology used to collaborate interactively with remote groups.

Three-Dimensional (3D) – involving or relating to three dimensions, thereby giving the illusion of or having depth.

Voxel - The term voxel is used to characterize a volume pixel element (it has an x,y,z spatial position); it is a generalization of the notion of pixel that stands for a picture element.

LIST OF REFERENCES

Aaker, David A. (2001). *Developing Business Strategies.* (6th ed.). New York: John Wiley & Sons, Inc.

Boardman, Anthony E. & Vining, Aidan R. (1996). Defining Your Business Using Product-Customer Matrices. *Long Range Planning. Vol 29*, pp 38-48.

Congressional Budget Office. (2003, September). *Growth in Medical Spending by the Department of Defense.* Retrieved November 3, 2003, from http://www.cbo.gov/showdoc.cfm?index=4520&sequence=0&from=0#anchor

Ethereal Technologies (2003). *Ethereal Partnerships and Affiliations.* Retrieved November 3, 2003, from http://www.etherealtech.com/about.htm

Favalora, Gregg & Lewis, Cameron. (2003). *Spatial 3D: The End of Flat –Screen Thinking, Actuality Systems.* Retrieved November 3, 2003, from http://www.actuality-systems.com/

Frost & Sullivan. (2003). *U.S. 3D Imaging Markets.* Retrieved November 3, 2003, from http://www.mindbranch.com/catalog/product.jsp?code=R1-2322

Global Information, Inc. (2003). *Life Science Tools and Technologies for Bio-Pharma:R&D - Instruments, Tech Platforms, Informatics and Market.* Retrieved November 3, 2003, from http://www.bizintelagents.com/reports/tak12713_bio_pharma.html

Grant, Robert M. (1995). *Contemporary Strategic Analysis: Concepts, Techniques, Applications* (2nd ed.). Cambridge, MA: Blackwell Publishers Inc.

Langhans, K., Guill, C., Rieper, E., Oltmann, K. & Bahr, D. (2003). *Solid Felix: A Static Volume 3D-Laser Display, Proceedings of SPIE* (Vol. 5006). Retrieved November 3, 2003, from http://www.felix3d.com/

Langhans, K., Bezecny, D., Homann, D., Bahr, D., Vogt, C., Blohm, C., Scharschmidt, K. (1998). *New Portable FELIX 3D Display, Proceedings of SPIE* (Vol. 3296). Retrieved November 3, 2003, from http://www.felix3d.com

Langhans, K., Bahr, D., Bezecny, D., Homann, D., Otlmann, Klaas, Oltmann, Krischan, Guill, C., Rieper, E., Ardey, G. (2002) *FELIX 3D Display: An Interactive Tool for Volumetric Imaging*, Proceedings of SPIE. (Vol. 4660). Retrieved November 3, 2003, from http://www.felix3d.com/

LightSpace Technologies, Inc. (2003) *DepthCube™ Technology White Paper.* Retrieved November 3, 2003, from http://www.lightspacetech.com/

Meloni, Wanda. (2002). *The Decline and Resurrection of the 3D Industry.* Retrieved November 3, 2003, from http://www.m2research.com/products/images/The%20Decline%20and%20Resurrection%20of%203D.pdf

Moore, Geoffrey A. (2002), *Crossing The Chasm: Marketing and Selling High-Tech Products to Mainstream Customers.* (Rev. ed.) New York: HarperBusiness Essentials.

Porter, Michael E. (1985). *Competitive Advantage: Creating and Sustaining Superior Performance*. New York: Free Press.

Porter, Michael E. (1980). *Competitive Strategy: Techniques for Analyzing Industries and Competitors*. New York: Free Press.

Roberts, Edward B., Berry, Charles A. (1985, Spring). Entering New Business: Selecting Strategies for Success. *Sloan Management Review*, pp. 3-17.

Shapiro, Stanley J., Wong, Kenneth, Perreault, William D. & McCarthy, E. Jerome. (2001). *Basic Marketing—a global managerial approach, (10th ed.),* 589-612.

Sullivan, Alan. (2002). *Z20/20™ Technology Whitepaper*. Retrieved November 3, 2003, from http://www.3dmedia.com/pdf/z2020_whitepaper.pdf.

TechSpot Forum (2003). *Volumetric 3D Display*. Retrieved November 3, 2003, from http://www.techspot.com/vb/showthread/t-1297.html

Versweyveld, Leslie. (2003, February). *Technological innovations drive United States 3D imaging market to the fore.* San Jose: Virtual Medical Worlds (VMW) Monthly. Retrieved November 3, 2003, from http://www.hoise.com/vmw/03/articles/vmw/LV-VM-02-03-21.html

Yu, Eileen. (2002, May 29). *Biotech is Big Business*. Computer times. Retrieved November 3, 2003 from http://it.asia1.com.sg/specials/biotech20020529_001.html