VISION EXPERTS: “CAPTURING THE HOLY GRAIL” BUSINESS PLAN

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ABSTRACT

This project investigates the potential viability of commercializing robotics software developed by a UBC engineer. The aim of this project is to provide the inventor with a business plan that will act as a tool to help in obtaining funding for the commercialization of this software. Through research and work, it has been concluded that the possibility does exist to use this software as the basis for a successful company. To that end, a business plan is presented with the goal of helping the developer achieve her goals.

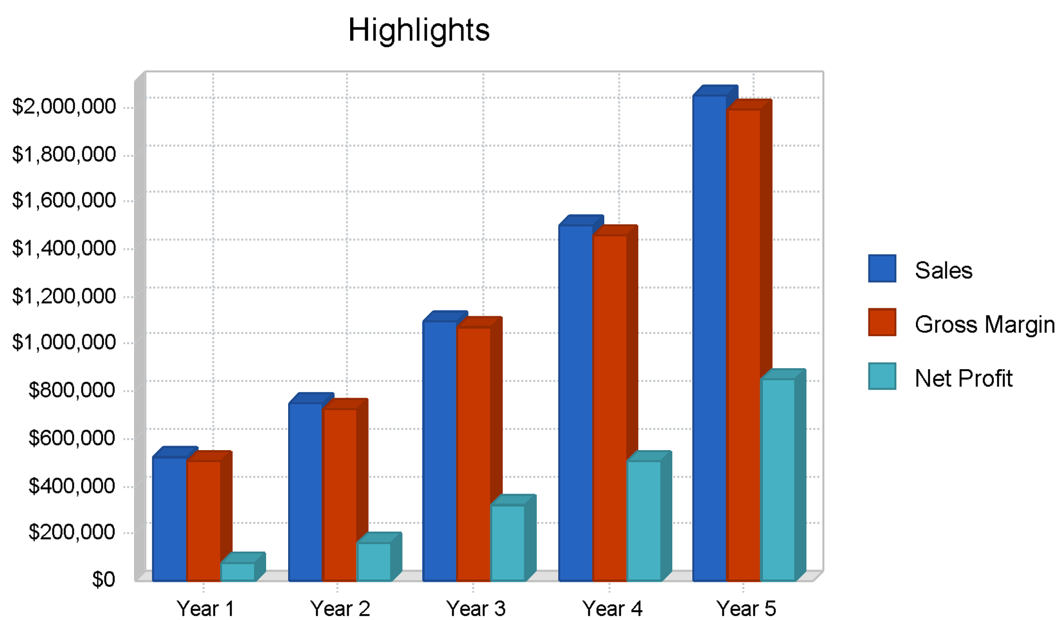
EXECUTIVE SUMMARY

The task of picking parts from bins for use on assembly lines is common in manufacturing. An automated robotic bin-picker has been sought after for decades to improve process efficiency and reduce cost. Several key players in the industrial robotics industry have been working to develop such a vision-guided robotic bin-picking system; however, a robust solution that successfully picks parts nearly 100% of the time has proven elusive because parts are randomly oriented in the bin and obstruct one another, making visual recognition and grasping difficult. Software to quickly and reliably compute the best part to pick up, and the best grasp to use, is a critical component of the system.

Consequently, Vision Experts has developed Optimus Primus (OP), proprietary software designed to increase the reliability, robustness and efficiency of vision-guided random robotic bin-picking (VGR RRB) by increasing the number of grasp options or 'pickable candidates' found in a bin by up to 60%. Unlike other bin-picking solutions, OP provides machine vision software suppliers with a component that is key to making true random robotic bin-picking commercially viable. This unique software could be licensed to machine vision software companies for transfer to random robotic bin-picking applications across the manufacturing sector. The automotive manufacturing market alone represents a $450 million opportunity in software revenues for Vision Experts, and is expected to grow over the coming years.

Operating in the rapidly growing robotics industry, Vision Experts offers investors an exciting opportunity to get in on the ground floor with an emerging company. Vision Experts expects to produce significant returns to shareholders through fast growth and widespread proliferation of OP, as demonstrated in the company financial highlights below.

Figure 1 Financial Highlights



DEDICATION

We would like to thank our families for the wonderful support and patience that we have received throughout our academic careers. We would also like to thank our professors and our cohort for sharing their knowledge with us, and for challenging us.

ACKNOWLEDGEMENTS

First of all, we would like to thank our Senior Supervisor, Elicia Maine for challenging us in our writing, research and thinking and for helping us over the hurdles. Thank you for all of your expert advice, patience, feedback and enthusiasm.

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We thank Donna Dupuis, the developer of the software, for her help and patience in guiding us through the world of vision software. We wish her all of the best, and we know she has a very bright future ahead of her.

A special thanks to Jeff Beis of Braintech Inc. for bearing with us in our attempts to come to "grips" with bin-picking.

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GLOSSARY

Cycle Time	The time it takes a robot to pick up a part and deliver it to a target location
Degrees of Freedom	The set of independent displacements and/or rotations that specify completely the displaced or deformed position and orientation of the body or system
Dunnage	The materials used in holds, bins and containers to stow, brace, protect and structure parts
Machine Vision	"Machine vision is the application of computer vision to industry and manufacturing. Whereas computer vision is mainly focused on machine-based image processing, machine vision most often requires also digital input/output devices and computer networks to control other manufacturing equipment such as robotic arms" (Wikipedia, 2008)
Random Robotic Bin-Picking (RRB)	Picking randomly ordered parts from a bin filled with many of the same part; common in manufacturing
Robustness	Insensitivity (of a grasp in this case) to slight positional errors.
Semi-structured bin-picking	Picking parts from a bin that are not randomly jumbled, but rather loosely constrained or loosely structured
Wire-Frame Model	"…a visual presentation of an electronic representation of a three dimensional or physical object used in 3D computer graphics" (Wikipedia, 2008).

1: COMPANY SUMMARY

Vision Experts is a robotics software company in the early stages of development. Founded by Donna Dupuis, an engineer currently finishing her Masters in Electrical Engineering at the University of British Columbia, Vision Experts will be working closely with UBC's University Liaison Office (UILO) throughout the company's development. A spin-off of UBC and the UILO, Vision Experts will be owned equally (50%/50%) by both the university and the founder/inventor, until further investments are made. The company will leverage both existing and potential industry relationships to grow the business. This includes a partnership with the machine vision vendor, Braintech Inc., which has first option to license OP, once the software is completed. The details of this relationship are further outlined in Section 5. The following sections describe Vision Experts' management team (Section 1.1) and core business model (Section 1.2).

1.1 Management Team

Because Vision Experts is in the early stages of development, the company has yet to hire a complete management team; however, they are actively recruiting for management positions and have filled all of the technical roles. Firstly, Donna Dupuis is an experienced electrical engineer currently pursuing her Masters at UBC. Donna has the technical experience, drive and innovative capacity required to successfully develop OP and other Vision Experts products. She will assume the role of Chief Technical Officer at the company. Secondly, Matt Bauman who is finishing his Masters in Computer Science at UBC will eventually be hired by Vision Experts to assist with technical research, development and implementation. Acting as a Technical Associate, Matt brings with him a strong information technology background and the necessary technical skills required to bring OP to the market and to assist with further innovation and product development.

On the business side, Vision Experts is currently seeking an experienced CEO and, eventually, a Sales Manager. Vision Experts is working with the UBC UILO to try and fill these positions with skilled business professionals with experience building technical start-up ventures from the ground up. Having worked with many start-up companies, the UILO will assist Vision Experts with recruiting for these positions. The following table outlines Vision Experts' personnel plan over the next six years.

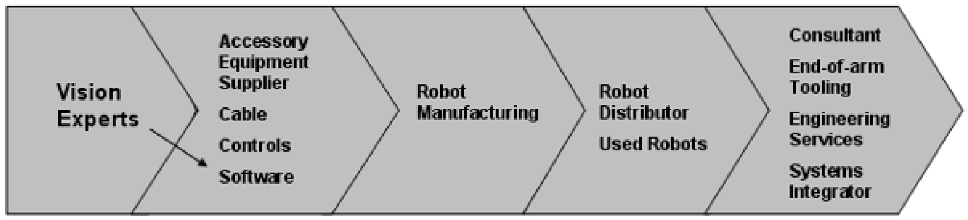
Table 1 Personnel Plan

Personnel Plan						
	Year 0 (2009)	**Year 1 (2010)**	**Year 2 (2011)**	**Year 3 (2012)**	**Year 4 (2013)**	**Year 5 (2014)**
Chief Technical Officer and Founder	X	X	X	X	X	X
General Manager	X	X	X	X	X	X
Technical Associate		X	X	X	X	X
Accounting/Admin. Associate		X	X	X	X	X
Sales Manager			X	X	X	X
Technical Associate #2				X	X	X
Sales Associate #2					X	X
Total People	2	4	5	6	7	7

1.2 Revenue Model

Operating in the machine vision software market, Vision Experts' proprietary technology, OP, will be licensed to machine vision software companies in the robotics industry, who will integrate OP into their random robotic bin-picking software. In order to understand Vision Experts' revenue model, it is important to first understand the robotics value chain, which is briefly outlined in Figure 2 below.

Figure 2 Robotics Value Chain



Source: Kumar & Shim (2007)

Vision Experts, shown on the far left side of Figure 2, will license OP to vision software companies who in turn sell to robot manufacturers. The manufacturers create robot systems for sale to distributors who sell to end-users or systems integrators. The end-users of the robotics solutions to date are largely manufacturing companies. A further description of the robotics value chain is outlined in Section 4.3.

Vision Experts' revenue will stem from two areas. Firstly, the company will receive recurring royalties based on the number of units sold by machine vision software companies such as Braintech. Secondly, they will receive revenue from machine vision software companies based on services performed in the form of software upgrades, support, consulting and customization (also know as non-recurring engineering contracts (NRE's)).

Vision Experts will license their technology by industry or, in other words, based on the end markets that their customers are targeting. Currently, Vision Experts has an existing relationship with Braintech Inc., who has first option to license OP for the automotive market and other specified industries. Braintech is currently focused on the automotive industry and therefore would most likely license OP for the automotive industry alone. This would leave other industries open for licensing deals with other machine vision software companies. The emergence of random robotic bin-picking is expected to open up many new markets and opportunities within manufacturing; markets that machine vision software and hardware companies will actively pursue.

2: PRODUCT AND TECHNOLOGY

The field of robotics is a multi billion-dollar industry, with the industrial robotics market alone worth US $5 billion (Pinto, 2008). An emerging and highly anticipated area of research and development in industrial robotics is bin-picking. Also commonly referred to as the “holy grail of robotic material handling”, bin-picking is the process whereby robots pick parts from bins for use in manufacturing. The following sections describe the problem and opportunities surrounding bin-picking (Section 2.1), the role OP plays in overcoming these problems (Section 2.2) and the development, technological details, and future development of OP (Sections 2.3-2.6).

2.1 Bin Picking

Bin-Picking is described as the activities of recognizing one part within a storage bin containing many randomly oriented industrial parts, grasping and manipulating the recognized part, and delivering it to some target location. For over thirty years, there has been a desire to automate this process using an intelligent robotic system with a robot arm and camera vision system to quickly and reliably identify and locate a part, move to it safely, while avoiding collisions with any objects in the environment (such as the bin or other parts), grasp it, and then remove it from the bin safely. In addition to avoiding collisions, the robot must also keep the part visible to the camera system at all times as it moves towards the part. However, technology in the fields of computers, robotics, and vision and lighting systems has only recently become advanced enough to make an industrially feasible solution possible.

There has been growing interest for a commercially viable randomized bin-picking solution, in particular from the automotive industry. As such, Vision Experts has been involved in a collaborative project between ABB Robotics, Toyota Motors, Braintech Inc. and the University of British Columbia's Advanced Robotics and Intelligent Systems Laboratory in an effort to develop such a system. Vision Experts' contribution to this project focuses specifically on grasp planning and selection- two key drivers that increase reliability and reduce cycle time.

OP will greatly improve the reliability of the vision-guided bin-picking system currently being developed through this collaboration. Without this component, there are many bin-picking scenarios for which attempts to grasp a particular part would fail, costing end-users thousands of dollars and rendering the system unreliable. It is crucial that the final system is highly robust, picking up parts consistently and successfully, nearly 100% of the time. OP will provide the necessary "edge" to move the system towards industrial feasibility.

2.2 Optimus Primus

OP increases the reliability and reduces cycle time as compared to current grasp generation software, such that a commercially-viable vision-guided robotic bin-picking system is now possible for industrial use. OP does this by presenting a novel method for two-fingered grasp generation and target selection for bin-picking of randomized parts (see Figure 3). A densely-sampled set of grasps is generated and evaluated, and the highest-quality grasps are then used to provide more valid picking options in the context of a randomized pile of parts, and to determine the best part to pick up. OP's simulation results show a statistically significant increase in the average number of valid picking options when compared with a typical industrial approach for target selection. For a further detailed description of the OP software, refer to Exhibit B1 in Appendix B.

Figure 3 Two-finger Bin-picking

Source: Braintech Inc.

2.3 Development and Progress to Date

This software is currently in the late stages of development. It has been tested in simulation, and is scheduled for full testing at Braintech's facilities in North Vancouver in the fall of 2008. Simulation results demonstrate that this software drastically increases the reliability of grasps by increasing the number of possible candidate picks by 60% on average over 100 tests – a statistically significant figure. This is extremely important in RRB as the fewer times that the robot needs to be "helped," the better in terms of efficiency.

This simulation also demonstrated that, when compared to current grasp planning software for random part picking, OP helps reduce cycle time by quickly determining the best candidate part to pick. This is key, as reducing cycle times to 10 seconds is considered the threshold of commercial viability. Additionally, OP has not yet been optimized for speed, and hence when attached to Braintech's (advanced) hardware, it will further increase the performance from a timing standpoint.

2.4 Similar Work

Schraft and Ledermann's work is among the most recent and advanced in the area of intelligent pregrasp planning (2003). In their work, a robot system for intelligent picking of chaotically stored objects is presented. It avoids collisions well, and is decently fast, taking approximately ten seconds to compute a good pick; however for the bin-picking system to which Vision Experts is a part, the target time for an entire cycle of picking up a part and delivering it to some target location is ten seconds, necessitating a much faster pre-grasp computation. Also, in Shraft and Ledermann's work, a laser scanner is used to obtain detailed, reliable depth information of the surface of the pile. In contrast, a stereo camera is used in this project for the same purpose but allowing for much faster performance. Also in Shraft and Ledermann's work, the proposed system fails for parts near the bin walls, and the constraint of part visibility is not addressed either. Thus, there is substantial room for improvement in order to realize a quick, highly robust, and reliable system that could be deployed in industrial applications. Vision Experts' grasp planning and selection software, OP, along with improvements in path planning and modelling from those in their ecosystem, has improved the performance of the bin-picking system to the point where the company expects to see sub-ten second cycle times from their full product tests in the fall of 2008 at Braintech's labs.

2.5 Customization

OP is customizable to all VGR RRB applications: however, the amount of work will be dependent on the specific application or system. The two major factors that determine the effort it will take to customize the software are the type of gripper being used in the application, and the target part that is to be picked. For example, in order to customize the gripper from a two-fingered to a three-fingered gripper, OP would have to account for the degrees of freedom of the gripper. If the fingers of the gripper are equally spaced (and this is fixed), then this would involve a relatively simple modification. For grippers with a wider range of motion where the finger spacing is not fixed, it would entail changing the geometry used for generating a sample grasp, which can be a simple modification or a very complex one, and the time to customize would vary accordingly.

Some other companies use magnetic or pneumatic grippers as opposed to the “fingered” style, which are relatively simple in design and would require minimal customization of the software. Other factors must be considered with respect to the gripper as well. “The major factors that influence the specification for a robotic gripper are jaw style, jaw length and acceleration” (Zajac, 2008, para.17). Again, each of these factors needs to be accounted for when customizing the software for another system.

In terms of the target part, customizing OP to another company’s RRB system is relatively straightforward as long as the other company’s software can recognize the parts, and generate a list of their positions and orientations, or poses as an input to OP. This is the most common form of recognition in VGR, and Vision Experts foresees no issues from this perspective. In all cases, for each new part that is to be used in the RRB process, the software requires a wire-frame model. After the model of the part is supplied, the software generates and evaluates grasp models for those parts offline. This information is then used in the 'real-time' phase of the simulation.

2.6 Future Development

Vision Experts' goals for OP in the near-term are to continue to improve upon the speed at which the software recognizes, and decides on the best part to pick. That said, OP is not currently the bottleneck in the overall process and hence other parts of the solution are relied upon to increase efficiency and to further reduce the overall cycle time. While much of this is dependent on improvements in other pieces of the overall project outside of Vision Experts' scope, it is important to note where the future lies for the ecosystem in which Vision Experts competes.

Future work in the area of 'recognition' is centred around three requirements. First, there is a need to increase number of part hypotheses: currently, because the current commercial software can not recognize everything that is on the surface of the pile, recognition is limited. Second, there is a need to recognize a wider variety of parts to make the system flexible and ubiquitous, which would lead to greater adoption. Third, cycle times need to be reduced, and a decrease in the time it takes to recognize or localize the candidate parts would assist in this.

Future work in the area of physical graspers includes the possibility of picking up multiple parts in a single cycle, which could drastically increase efficiency. Such a system would likely mean adopting a multi-gripper end-effector, and altogether different graspers. Due to their geometry, size, surface material, etc., some parts may require different types of grippers, (i.e. more than two fingers, magnetic, pneumatic, etc.). This would require different approaches to sampling the grasp space tailored to the specific gripper type.

In the near-term, Vision Experts will continue to develop “grasping” focused software for the industrial robotics market, specifically targeting the automotive segment. Over the long-term, Vision Experts believes that the largest future VGR segment is personal robotics, and hence their longer-term work will be focused on developing grasp planning and selection using a five-fingered or ‘hand’ style grasper that will be used in those applications. For a detailed analysis of segmentation, please see Section 3.2.

3: INDUSTRY ANALYSIS

Robots can be traced back to 1921 when Czech writer, Karel Capek, coined the term “Robot” from the Czech term, “rabota,” meaning servant, enslaved worker (Ichbiah, 2005, p. 11). In 1956, Unimation created the first industrial robot, Unimate, intended for the automobile industry to “relieve men of uncomfortable, burdensome and dangerous tasks” (Ichbiah, 2005, p. 28). Since then, the field of robots has evolved into a billion dollar industry focused on the automation of tasks ranging anywhere from painting a car to picking parts out of bins to vacuum cleaning the house. Robots are a growing trend not only being used in industry, but they are also slowly moving into our households. Various improvements in robotics technology are significantly impacting today’s society. As the industry changes and evolves, new and exciting opportunities emerge for innovative companies such as Vision Experts. The following sections discuss the existing state of the robotics industry (Section 3.1), the various market segments (Section 3.2), the competitive landscape (Section 3.3) and lastly, the near-term and long-term markets for Vision Experts (Section 3.4-3.5).

3.1 Vision Guided Robotics (VGR)

Over the past decades, robot scientists and developers have been working on developing “intelligent” robots - robots that can emulate human intelligence by sensing and reacting to their environment and surroundings. Providing a robot with a sense of sight has been the work of many researchers worldwide and remains an integral part of achieving intelligent robotics technology. Using “a camera to retrieve an image, a lighting system for illumination and a processor to process the image," vision-guided robots (VGR) contribute significantly to the efficiency, versatility and effectiveness of robots (Frost & Sullivan, 2005, para. 15). VGR systems are used in various industrial applications today.

Although VGR has made steady progress to date, as industry analyst, Jim Pinto points out, "long-awaited burgeoning growth continues to elude this market because the current generation of products still yields only incremental improvements in manufacturing processes" (Pinto, 2008, para. 1). These constraints, coupled with a lack of understanding in the market, have hindered market adoption over the past years. In 2007, 5000 VGR units were sold worldwide, a number representing only 6% of total industrial robotics sales (Weidinger, 2007). However, VGR sales are expected to climb significantly, to 100,000 units in 2010 for four main reasons: the increase in relative advantage of VGR systems, the increase in compatibility and reliability, environmental factors, and the discovery of the "Holy Grail" of robotics - random robotic bin picking.

In assessing the costs of VGR systems over the years, buying a pair of eyes for a robot has never been more affordable, thereby increasing the relative advantage for buyers. In the 1980's, a 3D VGR system sold for $900,000 compared to $40,000 in 1998 (Teresko, 2002). This reduction in price is the result of reduced computing and component costs, astute packaging of vision systems, simpler and more efficient training and implementation, and economies of scale resulting from increased adoption (Teresko, 2007).

Technical advances over the years have also made VGR systems more reliable and robust than ever before. The emergence of the Internet has significantly reduced the time required to both train and support workers by providing them with factory literacy on how to use the equipment. In assessing environmental factors, businesses in many countries, including the USA and Canada, are experiencing increasing labour costs and increasing demand for higher speed and flexibility. In the USA, where labour costs have reached up to $20 per hour, VGR systems have the ability to reduce those costs to $3-$5 per hour, allowing companies to "keep manufacturing in their own country, while still being able to compete in the world market" (Robson 2006, para. 8). VGR systems also reduce work injuries and thus, increase health benefits. Increasing competition and demand for high speed and flexibility have created a sense of urgency, putting pressure on manufacturers to reduce costs.

Last but not least, the emergence of random bin-picking is perhaps the most important factor that will contribute to widespread adoption of VGR. Random robotic bin-picking "allows robot arms to locate and pick individual parts from a jumble of parts piled haphazardly in a bin," using 3D camera technology (Iverson 2006, para. 1). This technology will save manufacturing companies millions of dollars, eliminating the need for human workers to unload parts from bins. Although several companies have claimed to introduce random robotic bin-picking over the past few years, in reality many of these technologies are structured for semi-random bin-picking (where parts are not 100% random, but rather loosely organized in the bin). Most true RRB systems have only entered the market recently and have mainly been adopted by innovators in the automotive industry.

Like any other immature technology, RRB has faced various constraints in its development, such as the orientation of parts in a bin shifting, changing lighting environments in factories and lack of system reliability and robustness. Due to the nature of the manufacturing industry, which has been the largest adopter of industrial robotics to date, if an RRB system is not accurate 99.9% of the time, an entire assembly line has to be halted and the benefits of the RRB system no longer outweigh the costs. As Jan-Philippe de Broeck of Adept Technologies points out, "there are many difficulties when developing [RRB systems]…but most critical is that the software must be able to reliably send multiple part locations (and vision inspection results) to the robot controller in a very short amount of time to enable the highest throughout" (Robson, 2006, para. 5). Furthermore, customers are weary of random robotic bin-picking systems because of the disappointing results that have surfaced over the past 25 years. A distrust of RRB technology exists in the industry. For this reason, developing a reliable and robust RRB system is invaluable. Many industry experts would argue that most of the constraints listed above will be overcome as RRB technology evolves and the kinks are ironed out. Vision Experts has created OP to address some of the problems and constraints machine vision software companies are facing today.

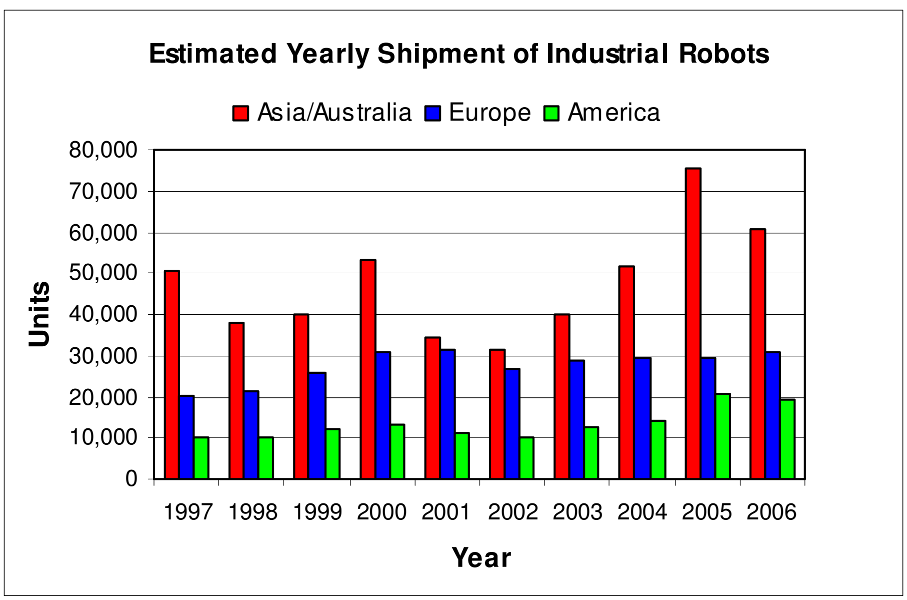
3.2 Market Segmentation

The robotics industry can be classified into three segments – 1) Industrial Robots, which are mainly used in manufacturing industrial automation, 2) Professional Service Robots, which are also used to assist humans in the workplace, but outside of the manufacturing industry, and 3) Personal Service Robots (also known as consumer robots), a sub-set of service robots used to assist, educate and entertain people. Market data on these segments is provided below.

3.2.1 Industrial

As of 2006, the International Federation for Robotics estimated that there were a total of over 951,000 industrial robots in operation worldwide (50% of these in Asia, 33% in Europe, and 16% in North America). The industrial robotics market is the most mature of the three market segments, accounting for a majority of the robots in operation today. In 2006, 112,200 industrial robots were sold worldwide (International Federation of Robotics, 2006), with a value of approximately $5 billion (Pinto, 2008). Over 30% of industrial robotics sales come from the automotive industry, while the electronics industry makes up approximately 23% of sales (Kumar, Bekey & Zheng, 2006). Table 4 below represents the steady adoption of industrial robots from 1997-2006, broken down by major geographical region.

Figure 4 Yearly Shipments of Industrial Robots



Source: adapted from World Robotics (2007)

Vision-guided technology is being used in the industrial robotics market, but in small volumes to date. An RIA-commissioned survey on robot suppliers found (as cited in Automation World, 2005) that VGR units account for only 6.3% of all industrial robot sales with 5,000 VGR units sold worldwide in 2007. However, with new innovations on the horizon such as random-robotic bin-picking and technologies such as OP, VGR sales in the industrial robotics market are expected to dramatically increase over the coming years (Automation World, 2005).

3.2.2 Professional Service Robots

Although a much smaller market than industrial robotics, professional service robotics is expected to climb significantly over the next decade. Professional service robots can be classified as robots that "perform services useful to the well being of humans and equipment, excluding manufacturing operations" (Kumar, Bekey & Zheng, 2006, para. 3). Currently, professional service robots are being used in various industries and applications including health care, agriculture, forestry, mining, defence and military and construction and demolition. Vision-guided systems are increasingly being built into these robots. For instance, in the pharmaceutical industry, vision-guided service robots are used in vial and syringe inspection. They are also used to sort and fill prescription orders. The service robotics market potential and a break-down of applications/industries using professional service robots can be found in Appendix Table A12. The International Federation of Robots forecasts "service robots for professional use to almost double from 40,000 robots in 2006 to over 76,000 robots in 2010" (Weidenger, 2007, para. 5).

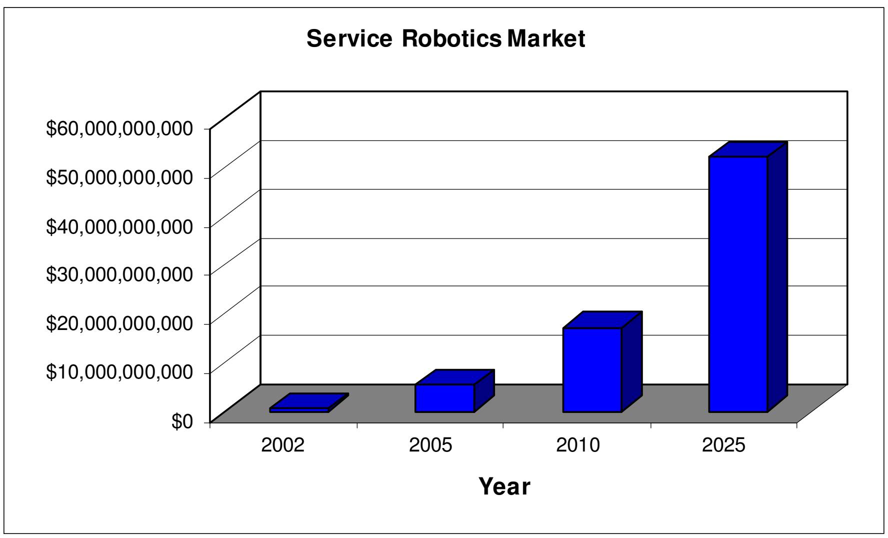
3.2.3 Personal Robots

Considered a sub-set of service robots, personal robots are used to educate, assist, and entertain people in their homes. Companies such as Honda, Toyota and Sony have invested heavily in the development of personal robots or “humanoids.” Several years ago, iRobot unveiled Roomba, a sphere-shaped personal robotic vacuum cleaner that has ‘cleaned up’ with over US $2.5 million in unit sales to date. Domestic robots such as Roomba and entertainment robots such as Sony’s robotic pet dog, Aibo, make up over 99% of the personal robotics market, as is demonstrated in Appendix Table A13. Personal robotics is currently a $5 billion market and is expected to climb to $15 billion in 2015 (ABI Research, 2007). The Japanese Robot Association is predicting that “by 2025, the personal robot industry will be worth more than $50 billion” (Gates, 2006, para.22).

Machine vision is currently being used in personal robots to assist in navigation, object recognition, movement detection and even facial recognition. For OP, this market represents a longer term opportunity because, as these creatures evolve, they will be expected to not only maneuver around, speak, and interact with people, but to perform multiple tasks and chores including grasping objects and picking things up. For instance, domestic robots will be expected to, on command, fetch a spoon from a drawer or pick up a toy off the ground. Although this opportunity may be several years away from true commercialization and widespread market adoption, when it does evolve, there will be tremendous value to be appropriated.

The three markets mentioned above all present significant opportunities for growth and development. Although industrial robots have witnessed the largest adoption rate thus far, personal and service robots also represent a large opportunity in the future. As displayed in Figure 5, in 2005, personal and service robots represented an estimated US $5.4 billion market, expected to grow to $17.4 billion by 2010 and US $ 52 billion by 2025 (Kumar, Bekey & Zheng, 2006). Each of the three segments is at a different point in its maturation and adoption cycle, with industrial robots being the most mature market and thus the most ready and willing to adopt OP.

Figure 5 Service Robotics Market Value (personal + professional)



Source: Kumar, Bekey & Zheng (2006)

3.3 Competition and Value Chain

As of 2007, there were 198 companies competing in the worldwide robotics industry (Robotic Industries Association, 2008). Appendix Table A14 classifies these companies into various groups, all of whom work together to create, develop, integrate and support robotics systems. The robotics value chain, presented earlier in Figure 2, begins with machine vision component companies supplying the software, cables, controls and accessories to the robot manufacturers. The software companies in particular, are responsible for making the robot "intelligent," and providing it with enhanced functionality. These are the companies working on new innovations such as random robotic bin-picking software. Next, the manufacturers combine the software and other vision components with hardware to create a working robot, which is sold to end-users and/or distributors. Lastly, the service section of the value chain includes consultants, engineers and systems integrators who work with end-users to implement maintain and support the entire robotics solution.

OP operates in the machine vision software industry - an emerging industry with yearly sales of approximately $22 million in North America (Kellett, 2006). This industry is only a fraction of the much larger machine vision industry, which had estimated sales of over $1.5 billion in 2006 in North America (Kellett, 2006). In assessing the competitive environment of the industry, strategic partnerships are key. For example, with random robotics bin-picking systems, often hardware manufacturers will work with various vendors, each supplying a different component for the system. Each company varies in regards to their core competencies and areas of focus and many companies compete in more than simply software. For instance, FANUC Robotics of Rochester Hills, Michigan, focuses on an array of areas including software, controls, hardware, support and systems integration.

Machine vision software companies potentially compete with OP on two product levels: 1) with existing semi-structured bin-picking software (where parts are not 100% random but loosely organized in some sort of configuration) and 2) with existing random robotic bin-picking software that is under development. Although most software currently in use today is for semi-structured bin-picking, an increasing number of companies have introduced a technology for totally random robotic bin-picking. Development in this area is quickly progressing and is expected to grow significantly over the coming years for the reasons aforementioned.

In assessing the machine vision industry, it is “important to realize what stage of the innovation cycle machine vision finds itself today” (Zuech, 2000, p. 36). Often researches categorize industries among four stages in the innovation cycle: 1) Research 2) Early commercialization 3) Niche-specific products 4) Widespread proliferation. Consolidation in an industry usually occurs between stages three and four. It is suggested that the machine vision industry falls into stage three of this cycle. The technology has been adopted into niche-specific products and applications but has yet to see widespread proliferation. For the most part, people require a “certain level of understanding of the technology to apply it successfully” (Zuech, 2000, p. 37). Many companies still remain uninformed as to what machine vision is and how it is used. According to vision expert, Nello Zuech (2000), while the industry has witnessed some consolidation, for the most part it remains a fragmented industry, with differentiated products. Appendix Table A14 demonstrates the little consolidation that occurred in the machine vision industry and in the software segment specifically, between 2002 and 2007.

Because Vision Experts is pursuing a licensing strategy, the company will be targeting machine vision software companies with existing random robotic bin-picking software. In many of the current RRB systems, software developers are seeking solutions to further increase the reliability, robustness, accuracy and speed of their systems. Because Vision Experts can supply them with this, it is important to note that the company’s competitors are also considered potential customers.

The main players in the machine vision software industry include Cognex, FANUC, Adept, Shafi, ISRA and Braintech. Cognex has emerged as the clear leader in this industry, while the other companies fight for smaller pieces of the market. Additionally, although some companies claim to have developed RRB systems, in reality most of these systems are for semi-structured bin-picking or are engineered for a specific application and set of parts, as opposed to a flexible system that is configurable to a large number of parts. Identified below is a table and brief description outlining each competitor's basic financial data, value chain activities, and how they compete with OP. Note that revenues are not solely based on machine vision product sales, as many companies compete in more than one industry. Fanuc, for example, is the largest company by far, but derives most of its revenues from other robotics value chain activities (see figure 2) and is not a dominant player in the machine vision software industry.

Table 2 Competitor Analysis

Competitor	*Cognex*	*Fanuc*	*Adept*	*Shafi*	*ISRA*	***Braintech*
Revenue	$225mm	$3.9 billion	$48mm	N/A	$78.9mm	$3.2 mm
Net Income	$26.8	$1.0 billion	$(11)mm	N/A	$7.8mm	$(4.7)mm
Location	Natick, Massachusetts, USA	Mount Fuji, Japan	Livermore, California, USA	Livingston, Michigan, USA	Darmstadt, Germany	Washington, DC, USA
Value Chain Activities	Accessories, equipment supplier, controls, software	Manufacturer, systems integrator, software	Manufacturer, software, used robots	Software	Software, systems integrator	Software
Semi-structured BP	Yes	Yes	Yes	Yes	Yes	Yes
Random BP	In development	In development	In development	In development	No	Yes

*Note: Financial data is from fiscal year 2007
** Braintech is a partner of Vision Experts

Cognex Corporation

Cognex is the largest player in the machine vision software industry with over 400,000 vision systems shipped since its inception in 1981. Providing a broad spectrum of vision products from vision software and vision sensors to entire vision systems, Cognex products are used across a variety of industries and applications including semiconductors, electronics, automotive, food, beverage, health care, pharmaceuticals and aerospace. Mainly focused on the industrial robotics market, the company's vision technology is integrated into various existing semi-structured and random robotic bin-picking systems including systems installed by strategic partners such as Shafi. Systems integrators across the world use Cognex's software and technology.

Fanuc Ltd.

With over 190,000 robots installed worldwide and 20% share of the North American industrial robotics market, FANUC Ltd. is "one of the leading suppliers of industrial robots and robotic systems" (Fanuc, 2008). FANUC offers a full range of products including application software, controls, integrated vision systems, support and training, assembly and hardware. They provide a comprehensive suite of industrial automation solutions, including both semi-structured bin-picking systems and random robotic bin-picking system. However, as FANUC's Materials Handling General Manager, Dick Johnson states (as cited in Iverson, 2006, para. 19), "out of an estimated 10 to 12 Fanuc bin-picking systems being used today in production, only one is totally random." Some systems integrators prefer to use FANUC's hardware combined with Cognex's vision software, however FANUC does produce its own 3D vision software for random robotic bin-picking. FANUC products are used across a variety of industries including aerospace, defence, health care, automotive and many more.

Adept Technology

Adept Technology was established in 1981 and offers a wide range of vision-guided robotics products including industrial robots, controllers, machine vision software, peripherals and components and even remanufactured robots. AdeptSight is the company's main vision software that is integrated into Adept's various robots, which are installed in over 30,000 locations worldwide (Adept, 2008). Winning the 2005 Frost and Sullivan award for excellence in robotic vision guidance, Adept's strong focus on innovation has contributed to its success to date. Adept robots and machine vision software are currently being used in various industries including automotive, food, consumer goods and pharmaceutical. Adept has developed semi-structured bin-picking software and has also demonstrated work on random robotic bin-picking systems.

Shafi Inc.

Established in 1991, Shafi Inc. has implemented over 300 machine vision software systems worldwide. Although a younger company, Shafi is focused on machine vision software, including both semi-structured and random robotic bin-picking software. They are growing their revenues by up to 50% per year and have developed strategic relationships with vision software vendors such as Cognex and robot manufacturers including Motoman, Staubli, Kuka, and Kawasaki. Their staple product, Reliabot 3D, is currently being used in random robotic bin-picking applications across the automotive industry. As Shafi's President points out, "Shafi Inc. installed an early bin-picking system at a customer site in 2003 and has since proven and demonstrated around two dozen different part geometries for random and semi-structured bin-picking, about six of which are being used at customer sites" (Iverson, 2006, para. 29).

ISRA Vision

Founded in September, 1997, ISRA Vision is considered one of the top five companies in the machine vision industry. ISRA employs over 300 people worldwide and ISRA's customers include Daimler, KUKA, ABB, BMW, Volkswagen, General Motors, Ford, MAN Roland, and 3Mamong others. ISRA's core competency is machine vision software and they are focused on supplying standard software solutions for surface inspection, robot guidance and quality control. Within its industrial automation solutions, the company services the automotive, food and packaging and general industries markets.

Currently, ISRA offers semi-structured bin-picking software, but it does not appear as though they are developing RRB software.

Braintech Inc.

A young emerging company, Braintech focuses mainly on machine vision software. With over 170 product installations, the company recently released their new random robotic bin-picking software, which is integrated into their main software platform, eVision factory. The first of its kind, Braintech's 3D software picks parts randomly jumbled in bins and is configurable for a large number of parts, contributing to its flexibility. Braintech has an exclusive channel partnership agreement with ABB, one of the large robotics manufacturers in the world who integrates Braintech's software into their TruView product line targeted at the automotive market. Approximately 99% of Braintech's revenue comes from this partnership (United States Securities and Exchange Commission, 2007). In turn, Vision Experts has an established partnership with Braintech in which Braintech has first option to OP. As a result, Braintech is considered more of a partner and potential customer than a competitor.

The machine vision and robotics industry is a web of strategic partnerships. Machine vision software companies form business relationships with other component and hardware manufacturers such as ABB, FANUC Robotics, Kuka Robotic Group, Yaskawa (Motoman) and iRobot. These partnerships are key to survival and growth in the industry, as a robot requires many different parts to become whole. The robotics industry portrays an innovative ecosystem of various companies working together to produce robot systems. Strategic relationships, as discussed in Section 6, will be a large part of OP's strategy and a key to the company's future success and growth. Partnerships will allow OP to reach targeted markets within the robotics industry. The markets Vision Experts will actively pursue are discussed in further detail below.

3.4 Near Term Markets

In the near term, Vision Experts will be targeting the US $5 billion industrial segment of robotics as the end-users of OP. To date, manufacturing companies have been the early adopters of robotics technology, including semi-structured bin-picking systems. Receiving bins with parts randomly jumbled inside is common in the manufacturing industry and, as a result, these companies have a great demand for random robotic bin-picking solutions. As early adopters of robotics technology, the industrial segment represents a large opportunity for OP.

Random robotic bin-picking and OP have the potential to be used across a variety of end-user manufacturing applications; however some applications and markets lend themselves to the current technology more than others. There are several parameters that make certain markets and industries more likely candidates including:

1. Highly competitive industries, often commodity products, that face pressure to reduce costs through automation
2. Industries with tasks that are dangerous and hazardous for workers
3. Industries that must keep their work environments extremely sanitary
4. Industries dealing with certain types of parts (well-machined, dull on the surface, with sharp features)
5. Industries producing in high volumes so the upfront cost of the RRB solution can be amortized over a large number of systems

Taking into account the above parameters, the early adopters of random robotic bin-picking and thus, OP will likely be in the automotive industry. This industry represents a US $450 million opportunity, and has been the main adopter of vision-guided industrial robotic technology to date, using VGR for an array of applications including sealing systems, materials handling and semi-structured bin-picking. The automotive is a near-term target market for many reasons including the increased demand for flexible automation, the competitive pressures to reduce manufacturing costs and the necessary volumes and "bandwidth to accept new technologies" (Dara, 2008, par. 4). When assessing random robotic bin-picking applications within the automotive market, the picking of cylinder heads, engines, axle shafts, pinions, connector rods, and many other parts are all likely applications. The assembly of products in boxes for placement into cars is another likely application.

Other likely target markets for OP include packaging in the pharmaceutical industry. As Jim Butschli, pharmaceutical packaging expert points out, this industry has been facing decreasing profit margins and the need to increase product variety over the past years. Traditionally companies have outsourced packaging. "Now, a lot of pharmaceutical companies are starting to bring it back in-house to more effectively control their destiny [and increase flexibility]. They are looking at late-stage customization and improving their operational performance" (Butschli, 2008). Pharmaceutical robotics order jumped approximately 20% in 2007 and this industry is increasingly turning to robots for automation solutions (Butschli, 2008).

Packaging in the food industry is another likely candidate for RRB. This industry is highly commoditized and deals with regulations surrounding sanitation and clean work environments. Robotics orders are increasing in this market as well. Metal-working and electronics are two additional manufacturing industries well-suited for RRB. The above target markets all provide a significant opportunity for OP.

3.5 Future Markets

There are many other potential applications that exist for RRB, however some of these markets are immature and would require further development of OP. As many vision experts have pointed out, random robotic bin-picking of bolts is a future application considered to have significant potential in the manufacturing industry. Because of the combined small size and shape of bolts, they are difficult parts to configure to an RRB system; however this is an area Vision Experts will actively pursue, working to adapt their technology towards this application.

A second future target market is personal robotics, a market some analysts predict will be the future of robotics. It is expected to reach $15 billion by 2015 (ABI Research, 2007). Many companies including Toyota and Honda are actively pursuing this market, working on developing “humanoids” to assist, educate and entertain people in their homes. With an aging baby boomer population, 77 million Americans are expected to retire over the next 30 years (Kara, 2008, para. 3). Engineers at the University of Massachusetts, Amherst have created a robot to assist senior citizens in their home. Features include the ability to “recognize medical emergencies and call 911, remind clients to take their medication and help with grocery shopping and cleaning” (Kara, 2008, para. 1). Eventually these robots will be expected to take orders such as going to the fridge to pick up an apple or retrieving utensils from a drawer. Although OP would have to be adapted to these applications, it has the potential to assist with grasping tasks such as these. Personal robotics is a significant future target market.

4: MARKETING STRATEGY

A go-to market plan is an essential component in bringing OP to the markets outlined above. The following sections discuss the competitive advantages and benefits of OP (Section 4.1), the company's planned marketing and sales strategy (Section 4.2-4.3) and a set of milestones and goals that Vision Experts will pursue (Section 4.4).

4.1 Competitive Advantage

Considered the holy-grail of robotics, random robotic bin-picking is a highly sought after technology with the ability to significantly transform the manufacturing industry. To date, however, the technology has failed to prove commercial viability largely due to the lack of robustness and reliability of RRB systems. One of the major difficulties with bin-picking is that a single part can take on virtually any pose within the jumbled pile inside the bin and can easily be obstructed by other parts. Thus, in order to meet the requirement of reliability, a RRB system must determine the optimal pre-grasp configuration (also called grasping approach) for each part. Through taking into account potential collisions, visibility constraints, the part model, the robot model, and the target part location or pose, OP increases the number of grasp options and pickable candidates by up to 60% for a given RRB system. In addition to increasing the number of pickable candidates, OP evaluates and ranks those candidates, returning a top set of picks and associated grasp points for a given set of parts. In turn, this significantly reduces the number of times an RRB system and potentially an entire assembly line must be shut down (costing the companies hundreds of thousands of dollars) due to an "unavailable part" error. This results in reduced cycle times and greater efficiency for end-users. OP provides the necessary edge to move RRB systems towards commercialization and widespread adoption.

The success of OP as a product relies heavily on the adoption of random robotic bin-picking by the manufacturing industry. This adoption will undoubtedly occur, at some time in the future, as RRB offers many companies a competitive edge in increasingly competitive industries, but how soon widespread adoption will occur is not certain. Once commercially viable, RRB systems will largely replace bin-picking processes done manually or with inferior automation solutions. In some cases, RRB will be replacing semi-structured bin-picking systems; however these systems have not been widely adopted to date. The unloading of randomly jumbled parts from bins is common practice amongst manufacturing companies. RRB solutions provide key benefits to a company including:

1) Reducing labour costs – RRB systems replace expensive manual labour and/or inefficient automation solutions. In locations such as North America where labour costs are high relative to the rest of the world, RRB systems can save a company up to $17 per hour of labour. RRB solutions also allow companies to "keep manufacturing in their home country", as opposed to cheaper outsourcing alternatives (Robson 2006, p. 8).

2) Increasing throughput – As Adi Shafi of Shafi Inc. points out, "manual operations often are upstream in a manufacturing line, so a manual operation that [unloads] parts at the upstream station often controls the

throughput of the line. This is amplified when parts are large, sharp or heavy" (Shafi, 2007). Through automating this process, RRB systems benefit the cost structure of the operation, increasing efficiency.

3) Increasing safety – Often unloading heavy or sharp parts from bins is a hazardous task. RRB systems eliminate this danger, increasing workplace safety while saving companies the costs attached to workplace injuries, medical leave, and other health problems.

The return on investment of random robotic bin-picking systems varies depending on the application, company and industry. In addition to the reasons stated above, RRB systems reduce waste and capital investment and increase flexibility. For example, the automotive industry has demanded greater flexibility over the years, as models are being redesigned frequently, resulting in the need for several models to run down the same manufacturing line. As Braintech's Jim Dara points out (2008, para. 4), "hard capital investments can no longer be amortized over several years, greatly benefitting reconfigurable automation such as vision-guided robots."

Although RRB has mainly been implemented experimentally through pilot programs and demonstrations, it is estimated that the ROI ranges between one and two years for a given manufacturing company. As a point of comparison, semi-structured bin-picking systems have been installed in various manufacturing companies including DaimlerChrysler, Delphi, Ford, GM, Honda, Nissan and Toyota, often saving companies "hundreds of thousands of dollars, just for one set of dunnage for one set of parts" (Iverson, 2006, para. 4). In 2005, systems integrator and manufacturer, ABB successfully installed five semi-structured bin-picking systems (which used Braintech's eVision software) for unloading cylinder heads and engine blocks in a West Virginia Toyota plant. The resulting ROI for each system is outlined below:

- Annual Labour Savings: 1 operator @ $75,000 annual burden rate X 2 shifts = $150,000
- Annual Capital investment Savings: Estimated at $100,000 per year by reducing annual investment in racks and dunnage (materials to stow, brace, line and pack parts).
- Total Annual Savings: $250,000
- Average Cell Price: $200,000
- Payback Time: 10 months

Random robotic bin-picking systems will result in even greater long-term cost savings for companies when compared to semi-structured systems, as the costs associated with racks, dunnage and essentially "structuring the bin" will be eliminated all together. The potential ROI and the benefits listed above will push many manufacturing companies to adopt RRB technology, once it is commercially viable. OP is a key driver in bringing random bin-picking to the market and will allow robotic vision software vendors, manufacturers and systems integrators to create reliable, robust RRB systems.

4.2 Go To Market Plan

Product

Vision Experts will focus on marketing improved vision software for RRB systems based on increased functionality and quality. The company will offer superior customer service and support, backed by a 1-year product warranty. Consultations and product updates will be offered on an opt-in basis. As time progresses, Vision Experts will explore opportunities to create and sell complementary products and further develop their existing product line with the goal of creating a product that can handle multiple parts at one time. There are various potential product spin-off opportunities.

Promotion

OP will be directly licensed to vision software companies such as Braintech, Shafi, Cognex, Fanuc and ISRA. In order to build relationships with these firms, a strong promotions and marketing strategy is imperative. Vision Experts will mainly be pursuing a push strategy, marketing OP to the machine vision software companies. In turn, these vision software companies will be marketing their products (with the OP technology integrated in to them) to robot manufacturers.

Initially, Vision Experts will attend various robotics industry trade shows and presentations in order to become familiar with the various players in the space and attempt to build relationships with potential customers. Vision Experts currently has a relationship with Braintech Inc. of North Vancouver, British Columbia. Vision Experts will work on leveraging this relationship and building a brand for the company based on quality products and superior customer service. Vision Experts will also leverage an existing partnership with the University of British Columbia University Industry Liaison Office, whom has existing industry connections. See Section 7.3 for a further description on the UBC UILO relationship.

In order to reach machine vision companies, Vision Experts will engage in advertising and public relations. The company will promote OP in magazines and publications distributed worldwide. It is important to work on building a global reputation, as some of the leading machine vision software companies are located in countries such as Japan and Germany. As demonstrated in Figure 4, Asia and Europe are both very influential in the industrial robotics market. Gaining media exposure is also a crucial element to Vision Experts' strategy. As a start-up company, Vision Experts will leverage the media to create brand awareness amongst the industry.

Lastly, Vision Experts will employ a direct sales force in order to help push OP to the market. Initially, the company will hire a General Manager with sales experience and existing industry contacts. Vision Expert' Sales Strategy is further discussed in Section 5.3.

Through direct sales, media channels, advertising, trade shows and word-of-mouth, Vision Experts will strive to build a brand, not only known amongst machine vision software companies but also robot manufacturers, systems integrators and companies throughout the value chain. Establishing a global reputation amongst the entire robotics ecosystem will increase awareness and develop demand for OP. Building strategic relationships is key in this industry and, consequently, Vision Experts' promotion strategy is an integral component of their marketing campaign.

Place/Distribution

Because Vision Experts is a software company, expenses associated with inventory, product transportation and facilities will be minimal. The company's main form of distribution will be through licensing to machine vision companies such as Braintech, Fanuc, Shafi and others. In turn, these companies will be marketing their products (including OP) to robot manufacturers. Vision Experts will be targeting companies based out of North America, Europe and Asia – the three regions that are home to most of the large machine vision software companies. Given Vision Experts' current relationship with Braintech, the company will initially focus on targeting Braintech as a customer, and then move on to other machine vision software companies.

Price

Vision Experts will be licensing OP to machine vision software companies based on the industry in which they compete. For instance, Braintech could license OP for integration into robots that are sold to the automotive industry, the end-user. Because Braintech is currently exclusively working with ABB, a company focused on robotic applications for the automotive industry, it is likely Braintech will license OP for use in this industry. This leaves OP open for licensing to machine vision software companies targeting other industries.

Vision Experts receives revenue from two sources; firstly, through licensing royalties stemming from sales from their machine vision software customers and secondly, through non-recurring engineering contracts (NRE's) involving customizing OP to a particular customer's part or RRB software. Through market research, Vision Experts estimates the cost of a random robotic bin-picking software system at US $40,000. Because OP accounts for approximately 2.5% of an RRB software system, the company has priced their software at US $1,000 per unit sold. The cost of Non-recurring engineering contracts will vary depending on the customer, however on average they will amount to US $25,000 per contract. Through employing this pricing strategy, Vision Experts forecasts over US $2 million in sales revenue by Year 5.

4.3 Sales Strategy

Vision Experts' main distribution channel will be through a direct sales force; however, in order to generate awareness, Vision Experts will also use advertising, media, trade publications, trade shows and conferences as marketing channels. In Year 2, Vision Experts will hire a Director of Sales and the sales team will grow over the following years. Vision Experts' sales team will be pursuing licensing contracts with machine vision software companies which will produce a recurring revenue stream for the company. Revenue will also be generated through support, consulting, add-on software improvements and through customizing their product to meet a specific customer's needs, also referred to as non-recurring engineering contracts. Outlined below is Vision Experts' year by year sales strategy and forecasts.

2009 (Year 0) - During this time, Vision Experts will be working on developing a working prototype and product which will be completed by Q2 (quarter 2) of 2009. The company will further develop their relationship with Braintech and ABB, with the goal of signing their first sales contract in Q3 2009. During this time, the company will also research and explore additional licensing relationships both locally and overseas. The company will also hire a General Manager to manage and facilitate sales.

2010 (Year 1) - During 2010, the company's first year of sales, Vision Experts will hire an Accounting/Administrative Associate and a Technical Associate to assist the Chief Technology Officer and the General Manager in growing and developing the business.

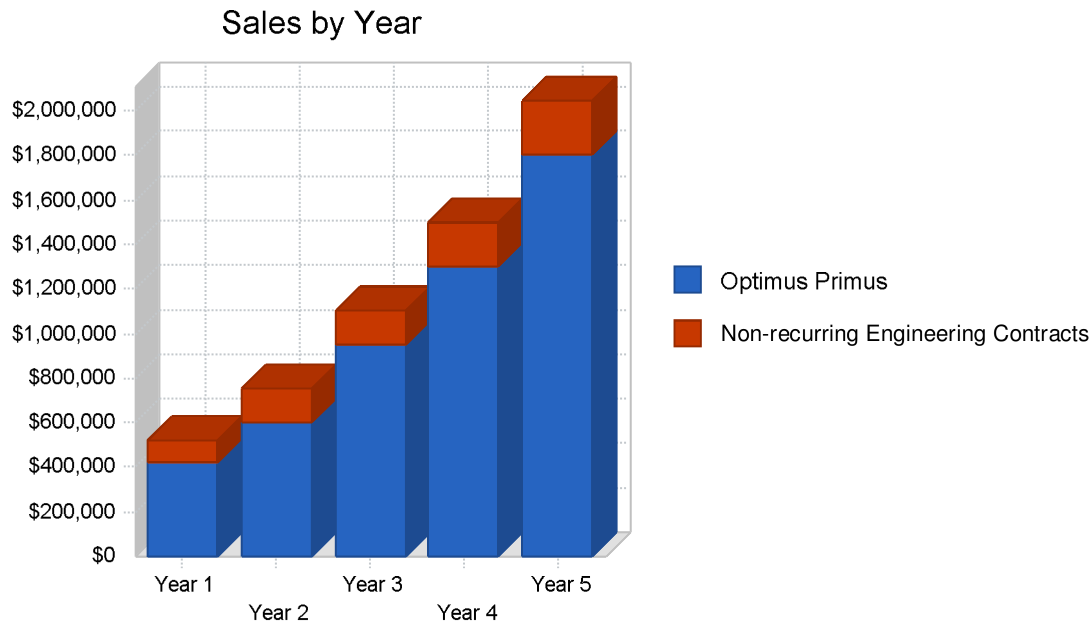
2011 (Year 2) - In Q1 of 2011, Vision Experts will hire and train a Sales Manager who will bring with him/her experience in the robotics industry. The Sales Manager will initiate and build relationships with both existing and new customers and the technical associate and CTO will provide further technical "know-how" and engineering support, customization and implementation.

2012 Onward (Year 3) – In Year 3, Vision Experts anticipates sales revenue of US $1.1 million. The company will continue to grow its sales team as demand increases. Sales forecasts are displayed in Table 3 and Figure 6 below.

Table 3 Sales Forecast

Sales Forecast					
	Year 1 (2010)	Year 2 (2011)	Year 3 (2012)	Year 4 (2013)	Year 5 (2014)
Unit Sales					
Optimus Primus	421	600	950	1,300	1,800
Non-recurring Engineering Contracts	4	6	6	8	10
Total Unit Sales	425	606	956	1,308	1,810
Unit Prices					
Optimus Primus	$1,000.00	$1,000.00	$1,000.00	$1,000.00	$1,000.00
Non-recurring Engineering Contracts	$25,000.00	$25,000.00	$25,000.00	$25,000.00	$25,000.00
Sales					
Optimus Primus	$421,000	$600,000	$950,000	$1,300,000	$1,800,000
Non-recurring Engineering Contracts	$100,000	$150,000	$150,000	$200,000	$250,000
Total Sales	$521,000	$750,000	$1,100,000	$1,500,000	$2,050,000
Direct Unit Costs					
Optimus Primus	$30.00	$30.00	$30.00	$30.00	$30.00
Non-recurring Engineering Contracts	$750.00	$750.00	$750.00	$750.00	$750.00
Direct Cost of Sales					
Optimus Primus	$12,630	$18,000	$28,500	$39,000	$54,000
Non-recurring Engineering Contracts	$3,000	$4,500	$4,500	$6,000	$7,500
Subtotal Direct Cost of Sales	$15,630	$22,500	$33,000	$45,000	$61,500

Figure 6 Sales Forecast



4.4 Milestones

In order to execute the above marketing and sales strategy, several goals and milestones must be met. Table 4 outlines important milestones for Vision Experts over the next few years. The most critical milestone is developing a working product by mid-2009.

Table 4 Milestones

Milestones		
Milestone	Start Date	End Date
Prototype Development	In progress	11/30/2008
Working Product	In progress	05/01/2009
Financing Stage 1	1/1/2009	2/15/2009
Hire General Manager	1/1/2009	Ongoing
Complete contract with Braintech	9/1/2009	Ongoing
Hire Technical Associate	1/1/2010	Ongoing
Sign second customer	9/1/2010	Ongoing
Hire Sales Manager	1/1/2011	Ongoing

These milestones will act as a road map for the company. In order to achieve them, Vision Experts must execute their business strategy, which includes building relationships with key players in the industry. Strategic partnerships are further discussed in Section 5.

5: STRATEGIC RELATIONS AND PARTNERSHIPS

Companies enter into partnerships for many reasons including knowledge sharing, economies of scale, access to additional markets, decreasing transactions costs and maintaining continuity of supply in markets. However, as Steward notes, "The primary objective of a strategic partnership is to create a sustainable, value-generating and enhancing platform on which to do business with specific major customers or suppliers" (1999. p. 39). Vision Experts' goal is to partner with leading vision software companies in an effort to use OP as the catalyst for a commercially viable, true RRB application.

In an ecosystem, such as the one in which Vision Experts is participating, many different parts and/or pieces must come together to make a finished product. A situation such as this brings great benefit, along with great risk. As Adner notes, "If an innovation is a component of a larger solution that itself is under development, the innovation's success depends not only on its own successful completion but on the successful development and deployment of all other components of the system" (2006. p. 101). For a further discussion of the partnership related risks faced by OP, see Section 6.

When a partnership involves the sharing of sensitive or competitive information over time, it becomes necessary to enter into formal arrangements that protect the parties involved. Tomer terms this 'strategic relationship marketing' and provides the successful example of, "…the mutually beneficial joint venture between Fujitsu Fanuc, the Japanese robot vendor, and General Motors…" (1999, p.65). As a small technology-based firm, Vision Experts will have to secure and maintain solid partnerships in order to survive and prosper. Section 5.1 further explores relationships in the robotics industry specifically, Section 5.2 details Vision Experts' current partnerships and Section 5.3 outlines the company's goals for potential future partnerships.

5.1 Partnerships in Robots

In many instances in manufacturing and development, strategic partnerships/relationships are used to leverage the talents of different companies, and to stay competitive. In the robotics industry specifically, finding and maintaining strong strategic partnerships are key to growth and survival. As vision guided robots become increasingly more complex, partnerships have become ever more important to creating cutting-edge technology. Hobday notes that many high-tech products and systems, such as those that Vision Experts is involved in developing, are far more complex than previous mass commodity goods due to the number of customizable parts, the level of skill and knowledge required by those involved, and the novelty of some of the production processes (Hobday, 1998). This leads firms to specialize in specific applications or processes in an effort to become the industry leader in that area. An example of this would be a local Vancouver, BC company, Point Grey Research, who specializes in providing digital camera technology products for VGR technologies. Their cameras are currently being used in the collaborative venture of which Vision Experts is a part.

Another factor influencing the prevalent use of partnerships in robotics, beyond complexity, is volume. As VGR is still a fairly young industry, demand for VGR products is still relatively low, and therefore competing companies attempting to use a 'whole product' strategy to produce systems, would not reap the benefits in learning and scale economies, etc., that come with the increased volumes available through specialization (producing a single part of the system). Because of this, many different 'pieces of the puzzle' must come together to create a whole product capable of performing RRB. As Figure 2, The Robotics Value Chain details, there are a number of different groups of companies who work together to form the robotics industry. Because this value chain is so complex, partnerships are very important and one key strategy is to look globally for these partnerships.

One main type of partnership often used by small tech-based firms is the strategic alliance. Forrest believes that the need for these smaller companies to form alliances, something primarily done by larger organizations in the past, is changing the nature of today's global business economy (Forrest, 1990). She notes that "…changes in the environment in the form of shortened product life cycles, the more rapid diffusion of new technology, and the increasing multi-disciplinary nature of new technology have added to these challenges" (1990, pg.37). As many of Vision Experts' potential customers are located around the globe, it is important to develop a global view/strategy when assessing potential partnerships. Farhoomand (2005) notes that global strategic partnerships can be attractive because:

1. Partners may have already committed to high product development costs
2. Partners may have the skills, capital and know-how you lack
3. Partnerships may help to secure access to markets that would otherwise be difficult to reach
4. Partnerships can provide important learning opportunities

Vision Experts' current partnerships, described in the following section, are a good starting point for this global strategy, as other players in the ecosystem are located around the world.

5.2 Current Partnerships

Vision Experts is pleased to be in a strategic alliance with Braintech and the University of British Columbia, as this ecosystem also involves a number of other companies that are on the leading edge of RRB technology, such as ABB. Vision Experts' most significant partnership centres around their agreement with Braintech Inc., a North Vancouver, British Columbia company, which specializes in the expert design and integration of artificial intelligence for VGR software and solutions. The majority of their revenues to date stem from pose determination, which is providing accurate information as to where the part is relative to the robot. OP enhances Braintech's software by decreasing the average cycle time (the total time to complete a full grasp and drop before beginning the next grasp) and increasing the number of available parts to pick by increasing the number of grasping options on a given part.

The terms of Vision Experts' agreement with Braintech state that, following a successful demonstration of OP, Braintech has a six-month window to decide whether to exercise their 'first option' to license OP, and if they do, both companies have one year to arrive at a "fair price". Vision Experts is confident that each player understands the market and the relationship and will be able to come to an agreed upon price for the software. Conversations with Braintech have indicated that, should the software prove to provide real situation test results as it has in simulation, that this software would be an important piece of the puzzle in commercializing Braintech's RRB software.

This arrangement with Braintech is specifically for the automobile industry (Vision Experts' target market) and 'specified general industry markets'. This term refers loosely to all manufacturing industries that Braintech engages in during the term of the agreement. This means that Vision Experts' ability to target other robotics software companies in these industries will be dependent on Braintech's decision as to whether to enter those industries or not. Should they decide not to, Vision Experts will be free to offer their software to other companies that service those industries. See Section 4.2 for a further description of the market segmentation.

Braintech, in turn, has an exclusive relationship with a leading supplier of industrial robotics, ABB (one of the world's largest engineering companies). Braintech licenses their software to ABB, who integrates and customizes the product to/for end users. Braintech's e-Vision Factory software is so integral to the ABB True View product line that Jerry Osborne, the VP and GM of ABB's robot automation division is quoted saying, "Braintech's e-VF software allows us to quickly build reliable, cost effective True View systems which meet our customers' expanding uses for VGR automation. We have recently announced our intention to make True View our global standard for VGR" (Hafti, 2006, p.10). The deal announced above and signed in 2005 is expiring this year. The two companies are in negotiations for a new deal that would extend their relationship well into the next decade. Based on discussions with Braintech, these negotiations were "going well" at the time of writing this business plan. See Exhibit B2 in Appendix B for a detailed description of the current Braintech and ABB agreement.

Some of ABB's larger customers in robotics include General Motors, DaimlerChrysler, Delphi, Nissan, Honda, Ford and most notably, US Toyota Motor

Manufacturing. Toyota, the world's largest automobile manufacturer, continues to grow faster than any other auto manufacturer. As world oil prices continue to soar, Toyota is seen by most analysts to be the company best positioned to continue to gain market share.

As there is a significant amount of research and development that goes into any of these components before they make it to market and (hopefully) provide revenues for their respective companies, partnerships with capital providers are also very important in helping to create the whole product. In addition to Braintech, ABB and Toyota, Precarn provided funding to UBC in support of this project. Precarn is an independent not-for-profit company that supports the pre-commercial development of leading-edge technologies in Canada. Precarn is funded by the federal government through Industry Canada.

5.3 Potential Partnerships

As noted earlier in this document, should Braintech not choose to exercise their option to license their software for all industries and markets, Vision Experts will be looking to partner with machine vision software companies with existing bin-picking technologies. Some major players in this market include Cognex and Shafi (refer to Section 4 for more information regarding target segments). Vision Experts will be able to customize its grasp generation and target selection for bin-picking of randomized parts to any of these companies' current RRB software, and it is expected that the increases in efficiency and reliability will be similar to those shown in the OP simulation.

In terms of the future development of OP and similar software products, Vision Experts will be attempting to form future partnerships with companies and/or agencies similar to Precarn and the National Research Council of Canada in an attempt to access funding for the future development of their software. See Section 3 for more information regarding future development of our software.

6: RISKS

This section outlines the major internal and external risks that Vision Experts faces.

6.1 Internal Risks

Partnerships/Ecosystem

As described in Section 6, Vision Experts' partnerships present them with opportunities to create synergies in a competitive industry. But, as noted, partnerships come with inherent risks, both internal and others external. The internal risks here have to do with Vision Experts' relationship with their partners and their flexibility within that relationship.

Potential Sole Customer/Partner

Based on the deal described in this business plan, Braintech could choose to exclusively license OP for all manufacturing industries, thus ensuring that Vision Experts has but one customer/partner that they are relying on to market, sell and distribute their product. This is somewhat mitigated by the fact that by the terms and conditions of that deal, Vision Experts must work out a fair price for the software. From Vision Experts' point of view, if this is an exclusive relationship, Braintech may have to provide annual minimums for the term of the agreement. That said, the minimums that Braintech provides may not be enough to sustain the business should sales be low, or should Braintech fail.

Liability of Newness

As a start-up company, Vision Experts lacks history in this market and OP is still in the development stage. Therefore, it is difficult to forecast their future performance and the revenues that the software will generate. The projections must be considered in light of the risks, delays, expenses and difficulties frequently encountered by companies embarking into new markets. Many of these factors are beyond Vision Experts' control, including unanticipated operational, research and business development expenses, employment costs, administrative expenses and technology costs. Vision Experts cannot assure their potential investors at this time that the company's business strategy will materialize or prove successful. Offsetting these liabilities of newness, is the company's current relationship with their ecosystem, specifically with Braintech. Braintech has been a publicly traded company since 1994 and holds a strong position as an industry leader in vision technologies.

Software May Not Perform as in Simulation/Prototype

At the time of writing this business plan, there is a slight possibility that OP will not perform in practice as it has in simulation. Vision Experts has taken every step possible to ensure that the company has replicated a real-world situation, but until the software is tested, the possibility of the software not working as well as it did in simulation cannot be ruled out. Vision Experts is expecting to fully test OP in Braintech's North Vancouver facility in the fall of 2008. A successful test of the prototype will decrease this uncertainty, and a working product will eliminate this risk altogether.

Management Team/Staff

As mentioned in the business plan, it is Vision Experts' plan to hire a management team consisting of a technical associate and a sales manager. As the company is a start-up in the truest sense of the word, it may be difficult able to attract the high caliber of talent required to succeed. This could have a negative impact on development, marketing and revenues.

Funding

As this is a complex technology, there is a risk that the requested funding will not see Vision Experts to the completion of this stage of development, at which time Vision Experts would have to pursue further funding. This will affect the company's current partnerships and will inhibit their ability to expand or even maintain their business operations.

Intellectual Property and Patent Costs

There is a risk that Vision Experts may lose their competitiveness if the company is unable to protect its proprietary technology and intellectual property rights against infringement, and any related litigation may be time-consuming and costly. There is a debate among experts regarding the level of protection that intellectual property and patents provide and whether the costs outweigh the benefits. Patents are costly to obtain, and in many cases, equally costly to enforce. Should Vision Experts decide to pursue a patent on its current software, costs could be as high as $400,000 for a world-wide patent. If the company decides not to do so, they run the risk the software being copied. This risk is somewhat mitigated by the fact that OP is based on complex algorithms and hence is not easily reproduced.

6.2 External Risks

Partnerships/Ecosystem

External partnership risks come mainly from the ability of partners to live up to their commitments, and from the entire value chain in terms of adoption of the technology.

Integration Risks

There are risks in this scenario that intermediaries have to adopt the software/solution before the customer can. In this case, a vision software company (like Braintech) has to adopt it, and subsequently, a robotics company (like ABB) has to adopt it, before the benefits can be seen by the end customer (i.e. Toyota). This could further slow the adoption of the software and in turn affect the projections significantly.

Timing Risks

As Adner notes, "Getting to market ahead of your rivals is of value only if your partners are ready when you arrive" (2006, p.100). The risk that all partners in the ecosystem may not complete their projects in the anticipated time frame must be taken into consideration.

Competition

Robotics software is a highly competitive field, and thus there are many competent players in the market. Many of these competitors have greater financial, technical, sales and marketing resources than Vision Experts. Competitors' software may increase performance or sell at lower prices. Vision Experts cannot predict whether their products will compete successfully with such new or existing competing products. In terms of specific grasp planning at the time of writing this plan, Vision Experts is unaware that any of their competition has a product as capable as OP.

Rapid Technological Change

Somewhat related to the competition point above, the machine vision and vision guided robotics industry is characterized by rapidly changing technology and evolving industry standards. Vision Experts believes that their success will depend in part on the ability to develop and enhance their products and to introduce improved products promptly to the market. Vision Experts can make no assurance that OP will not become obsolete due to the introduction of alternative technologies by competitors. If Vision Experts is unable to continue to develop and introduce new products to meet technological changes and changes in market demands, their business and operating results, including their ability to generate revenues, could be adversely affected.

Distrust (in the industry) of Random Robotic Bin-Picking

As mentioned earlier, a 'true' RRB system has been sought for decades. Each system that has been brought forward to date claiming to be 'fully random' has failed to execute on its promises in reliability and return on investment, or has been shown to be a semi-structured system. This 'never cry wolf' phenomenon may slow the adoption of OP.

Lack of RRB Adoption

Somewhat related to the previous point, to date, adoption of RRB has been slow, mainly because, "…the current generation of products still yields only incremental improvements in manufacturing processes" (Pinto, 2008), as was noted in Section 4. Some of this has to do with the reliability of the overall system, which ensures that average cycle times remain high, hence the return on investment has not been acceptable. Even though OP has helped to remedy this problem, there is a possibility that due to this history, RRB will not be adopted as quickly as predicted.

7: FINANCIAL PLAN/HIGHLIGHTS

The following sections provide Vision Experts' financial statements, funding requirements, forecasts and important assumptions. Detailed monthly financial forecasts for Year 1 can be found in Appendix C.

7.1 Start-up Funding

Vision Experts is seeking an equity investment in the amount of $400,000, which the company will pursue during the latter half of 2008. $238,000 of these funds will be used for short-term start-up expenses and the remainder for first year operational costs. Start-up funding requirements are outlined in Table 4 below.

Table 5 Start-up Funding

Start-up Funding	
Start-up Expenses to Fund	$238,200
Start-up Assets to Fund	$0
Total Funding Required	$238,200
Assets	
Non-cash Assets from Start-up	$0
Cash Requirements from Start-up	$0
Additional Cash Raised	$161,800
Cash Balance on Starting Date	$161,800
Total Assets	$161,800
Liabilities and Capital	
Liabilities	
Current Borrowing	$0
Long-term Liabilities	$0
Accounts Payable (Outstanding Bills)	$0
Other Current Liabilities (interest-free)	$0
Total Liabilities	$0
Capital	
Planned Investment	
Investor	$400,000
Additional Investment Requirement	$0
Total Planned Investment	$400,000
Loss at Start-up (Start-up Expenses)	($238,200)
Total Capital	$161,800
Total Capital and Liabilities	$161,800
Total Funding	$400,000

7.2 Projected Profit and Loss

Vision Experts' sales, gross margin, operating expenses and net profit forecasts from 2010-2014 are outlined in Table 6 and Figure 7 and 8 below. As demonstrated, the company forecasts a positive net profit in Year 1 and by Year 5, has sales of over $2 million and net profit of more than $850,000.

Table 6 Projected Profit and Loss

Pro Forma Profit and Loss					
	Year 1 (2010)	Year 2 (2011)	Year 3 (2012)	Year 4 (2013)	Year 5 (2014)
Sales	$521,000	$750,000	$1,100,000	$1,500,000	$2,050,000
Direct Cost of Sales	$15,630	$22,500	$33,000	$45,000	$61,500
Other Costs of Sales	$0	$0	$0	$0	$0
Total Cost of Sales	$15,630	$22,500	$33,000	$45,000	$61,500
Gross Margin	$505,370	$727,500	$1,067,000	$1,455,000	$1,988,500
Gross Margin %	97.00%	97.00%	97.00%	97.00%	97.00%
Expenses					
Payroll	$286,857	$368,008	$456,008	$548,008	$571,000
Marketing/Promotion	$50,605	$60,000	$66,000	$76,000	$85,000
Depreciation	$0	$0	$0	$0	$0
Rent	$12,000	$12,000	$18,000	$18,000	$22,000
Utilities	$3,600	$3,900	$4,300	$4,300	$5,000
Insurance	$1,200	$1,200	$1,400	$1,400	$1,600
Payroll Taxes	$43,029	$55,201	$68,401	$82,201	$85,650
Other	$0	$1,000	$1,000	$1,500	$1,500
Total Operating Expenses	$397,291	$501,309	$615,109	$731,409	$771,750
Profit Before Interest and Taxes	$108,079	$226,191	$451,891	$723,591	$1,216,750
EBITDA	$108,079	$226,191	$451,891	$723,591	$1,216,750
Interest Expense	$0	$0	$0	$0	$0
Taxes Incurred	$32,424	$67,857	$135,567	$217,077	$365,025
Net Profit	$75,656	$158,334	$316,324	$506,514	$851,725
Net Profit/Sales	14.52%	21.11%	28.76%	33.77%	41.55%

Figure 7 Projected Profit

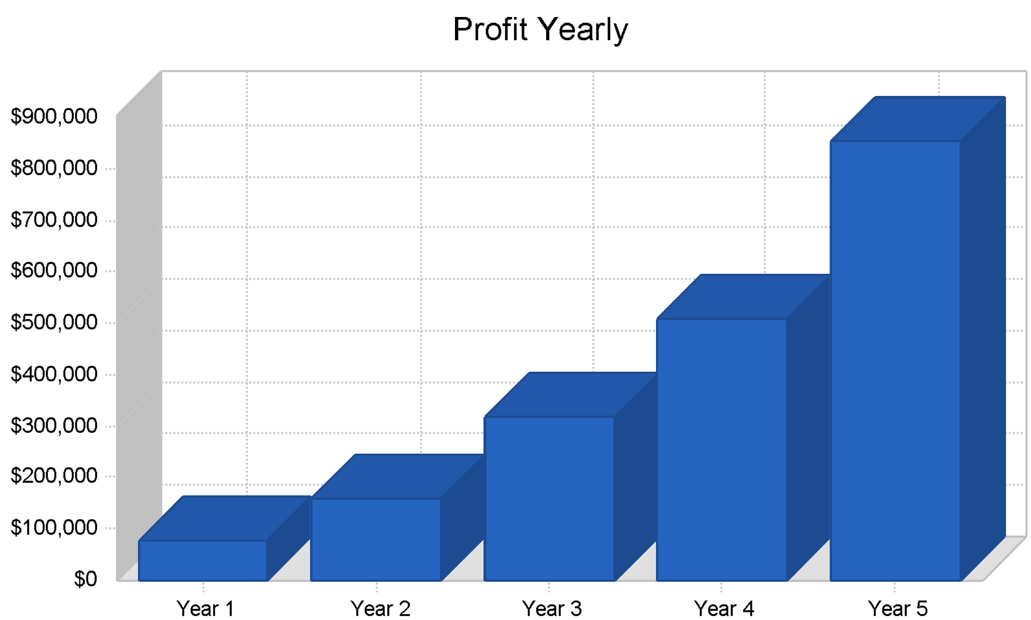
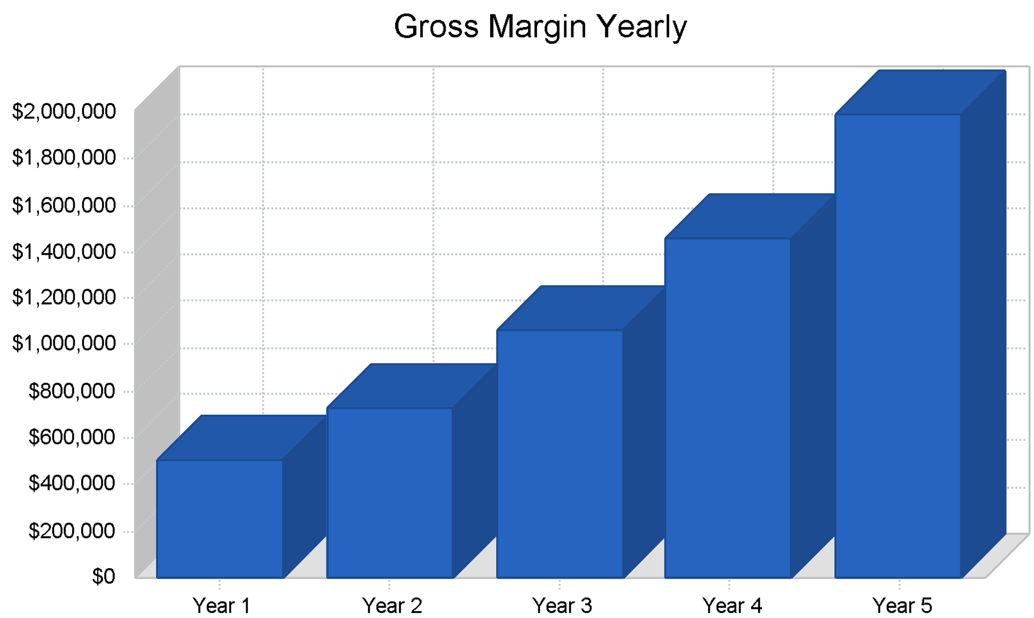


Figure 8 Gross Margin Yearly



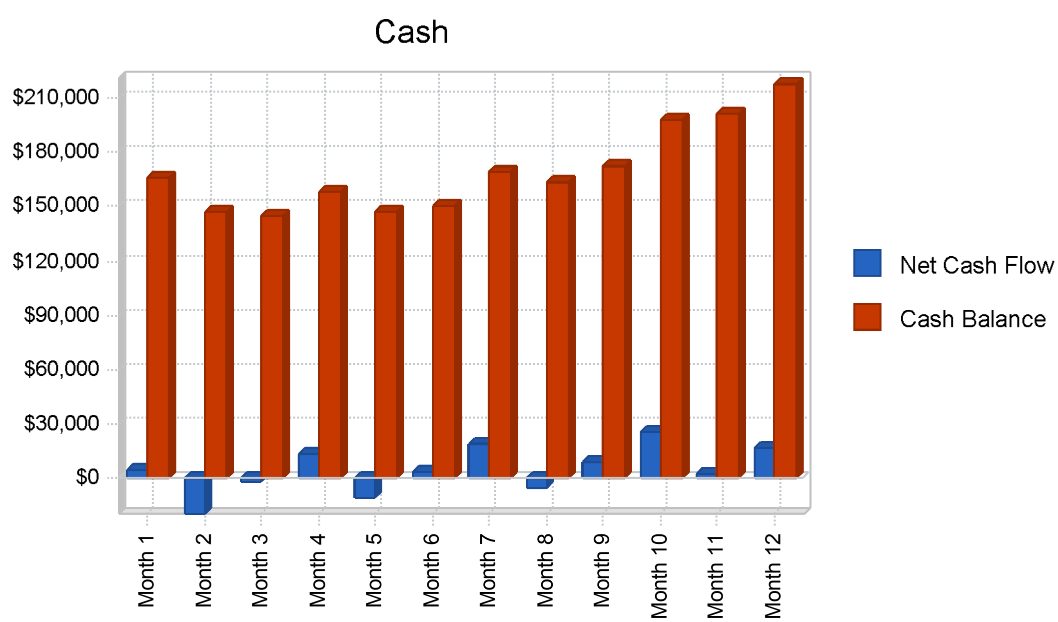
7.3 Projected Cash Flow

Vision Experts projects healthy cash flows in the coming years. Table 7 provides a Pro Forma Cash Flow table, while Figure 9 outlines the company's month by month cash flows for Year 1.

Table 7 Projected Cash Flow

Pro Forma Cash Flow					
	Year 1 (2010)	Year 2 (2011)	Year 3 (2012)	Year 4 (2013)	Year 5 (2014)
Cash Received					
Cash from Operations					
Cash Sales	$390,750	$562,500	$825,000	$1,125,000	$1,537,500
Cash from Receivables	$103,925	$175,929	$257,315	$354,789	$484,710
Subtotal Cash from Operations	$494,675	$738,429	$1,082,315	$1,479,789	$2,022,210
Subtotal Cash Received	$494,675	$738,429	$1,082,315	$1,479,789	$2,022,210
Expenditures					
Expenditures from Operations					
Cash Spending	$286,857	$368,008	$456,008	$548,008	$571,000
Bill Payments	$140,850	$222,913	$319,120	$435,795	$612,333
Subtotal Spent on Operations	$427,707	$590,921	$775,128	$983,803	$1,183,333
Additional Cash Spent					
Purchase Other Current Assets	$6,000	$5,000	$5,000	$5,000	$5,000
Purchase Long-term Assets	$5,000	$5,000	$8,000	$8,000	$8,000
Dividends	$0	$0	$0	$0	$0
Subtotal Cash Spent	$438,707	$600,921	$788,128	$996,803	$1,196,333
Net Cash Flow	$55,968	$137,508	$294,188	$482,985	$825,877
Cash Balance	$217,768	$355,276	$649,464	$1,132,449	$1,958,326

Figure 9 Monthly Cash Flow Year 1 (2010)



7.4 Projected Balance Sheet

A snapshot of Vision Experts' financial condition for the first five years of sales is shown in the Pro Forma Balance Sheet. The company projects a Net Worth of $237,456, ramping up to $2,070,351 in 2014.

Table 8 Pro Forma Balance Sheet

Pro Forma Balance Sheet					
	Year 1 (2010)	Year 2 (2011)	Year 3 (2012)	Year 4 (2013)	Year 5 (2014)
Assets					
Current Assets					
Cash	$217,768	$355,276	$649,464	$1,132,449	$1,958,326
Accounts Receivable	$26,325	$37,896	$55,581	$75,792	$103,582
Other Current Assets	$6,000	$11,000	$16,000	$21,000	$26,000
Total Current Assets	$250,093	$404,172	$721,044	$1,229,241	$2,087,908
Long-term Assets					
Long-term Assets	$5,000	$10,000	$18,000	$26,000	$34,000
Accumulated Depreciation	$0	$0	$0	$0	$0
Total Long-term Assets	$5,000	$10,000	$18,000	$26,000	$34,000
Total Assets	$255,093	$414,172	$739,044	$1,255,241	$2,121,908
Liabilities and Capital					
Current Liabilities					
Accounts Payable	$17,638	$18,383	$26,932	$36,615	$51,557
Current Borrowing	$0	$0	$0	$0	$0
Other Current Liabilities	$0	$0	$0	$0	$0
Subtotal Current Liabilities	$17,638	$18,383	$26,932	$36,615	$51,557
Long-term Liabilities	$0	$0	$0	$0	$0
Total Liabilities	$17,638	$18,383	$26,932	$36,615	$51,557
Paid-in Capital	$400,000	$400,000	$400,000	$400,000	$400,000
Retained Earnings	($238,200)	($162,544)	($4,211)	$312,113	$818,626
Earnings	$75,656	$158,334	$316,324	$506,514	$851,725
Total Capital	$237,456	$395,789	$712,113	$1,218,626	$2,070,351
Total Liabilities and Capital	$255,093	$414,172	$739,044	$1,255,241	$2,121,908
Net Worth	$237,456	$395,789	$712,113	$1,218,626	$2,070,351

7.5 Business Ratios

Various financial ratios can be calculated based on the financial data above. These include profitability, liquidity, solvency, activity, debt and market ratios, many of which are shown below. Some of the highlights include an average return on equity of 40% per year, net working capital of over $230,000 in Year 1 and $2,036,351 in Year 5, and an average asset turnover of 1.6 per year.

Table 9 Ratio Analysis

Ratio Analysis					
	Year 1 (2010	Year 2 (2011)	Year 3 (2012)	Year 4 (2013)	Year 5 (2014)
Sales Growth	0.00%	43.95%	46.67%	36.36%	36.67%
Percent of Total Assets					
Accounts Receivable	10.32%	9.15%	7.52%	6.04%	4.88%
Other Current Assets	2.35%	2.66%	2.16%	1.67%	1.23%
Total Current Assets	98.04%	97.59%	97.56%	97.93%	98.40%
Long-term Assets	1.96%	2.41%	2.44%	2.07%	1.60%
Total Assets	100.00%	100.00%	100.00%	100.00%	100.00%
Current Liabilities	6.91%	4.44%	3.64%	2.92%	2.43%
Long-term Liabilities	0.00%	0.00%	0.00%	0.00%	0.00%
Total Liabilities	6.91%	4.44%	3.64%	2.92%	2.43%
Net Worth	93.09%	95.56%	96.36%	97.08%	97.57%
Percent of Sales					
Sales	100.00%	100.00%	100.00%	100.00%	100.00%
Gross Margin	97.00%	97.00%	97.00%	97.00%	97.00%
Selling, General & Administrative Expenses	82.48%	75.89%	68.24%	63.23%	55.45%
Advertising Expenses	9.71%	8.00%	6.00%	5.07%	4.15%
Profit Before Interest and Taxes	20.74%	30.16%	41.08%	48.24%	59.35%
Main Ratios					
Current	14.18	21.99	26.77	33.57	40.50
Total Debt to Total Assets	6.91%	4.44%	3.64%	2.92%	2.43%
Pre-tax Return on Net Worth	45.52%	57.15%	63.46%	59.38%	58.77%
Pre-tax Return on Assets	42.37%	54.61%	61.15%	57.65%	57.34%
Net Working Capital	$232,456	$385,789	$694,113	$1,192,626	$2,036,351
Additional Ratios	Year 1	Year 2	Year 3	Year 4	Year 5
Net Profit Margin	14.52%	21.11%	28.76%	33.77%	41.55%
Return on Equity	31.86%	40.00%	44.42%	41.56%	41.14%
Activity Ratios					
Accounts Receivable Turnover	4.95	4.95	4.95	4.95	4.95
Collection Days	57	63	62	64	64
Accounts Payable Turnover	8.99	12.17	12.17	12.17	12.17
Payment Days	27	29	25	26	26
Total Asset Turnover	2.04	1.81	1.49	1.19	0.97
Additional Ratios					
Assets to Sales	0.49	0.55	0.67	0.84	1.04
Acid Test	12.69	19.92	24.71	31.50	38.49
Sales/Net Worth	2.19	1.89	1.54	1.23	0.99

7.6 Exit Strategy

Vision Experts plans to pursue either a merger or private sale of the company within 3-5 years. This is most attractive form of exit given their business model, strategic relationships and company structure. The company currently has an established relationship with Braintech, Inc., a machine vision software company who has first right of refusal to OP. Vision Experts has been working with Braintech over the past year and they have expressed interest in OP and will most likely be their first customer. If all goes well with the relationship, Braintech could potentially acquire or merge with Vision Experts.

Through joining forces with another company in the machine vision software industry, Vision Experts will achieve both operating and financial synergies. Currently, Vision Experts has one major product, Optimus Primus. A private sale will provide the resources required to grow the company and pursue further research, development and product diversification.

Taking into account Vision Experts' exit strategy, it is in the company's best interest to maximize profits and in turn, maximize its valuation over the coming years. This will involve pursuing relationships and customers outside of Braintech, in order to keep their options open and to ensure a strong negotiating position when it comes time for a sale. A private sale in 3-5 years will provide strong shareholder returns and a win-win situation for both Vision Experts and the acquiring company.

7.7 Investment Offer

Vision Experts is looking for an investment partner to purchase 45% of the company for $400,000. 10% of the shares in the company will be offered to employees in an effort to attract and retain quality management and employees. Based on that, and assuming a private sale of Vision Experts following Year 5 (2014), the following tables would represent a fully diluted view of the company at that point.

Table 10 Investment Offer

Total Investment	$400,000
Pre-money Valuation	$684,930
Equity Offering	45%
Security	Common Shares
Investor Return (CAGR)	42.5%*

*Valuation determined using the DCF model with a discount rate of 45% over six years.

Table 11 Capitalization Structure

	Invested	Share Class	# of Shares	% of Company
Founders		Common	4,500,000	45%
Employee Option Pool		Common	1,000,000	10%
Investors	$400,000	Common	4,500,000	45%
Total Company Shares Outstanding			10,000,000	100%

APPENDICES

Appendix A Tables

Table A12 Service Robots Installed up to End of 2003

Professional Service Robots	
Category	**No. of units**
Field (agriculture, forestry, mining)	885
Cleaning/maintenance	3,370
Inspection	185
Construction, demolition	3,030
Medical robotics	2,440
Security, defence	1,010
Underwater	4,785
Laboratory	3,060
Others	2,295
Total	21,060

Source: Kumar, Bekey & Zheng (2006)

Table A13 Personal Service Robots Installed up to End of 2003

Personal Service Robots	
Category	**No. of units**
Domestic	607,000
Entertainment	691,490
Assistive	260
Other	205
Total	1,298,955

Source: Kumar, Bekey & Zheng (2006)

Table A14 Competitors in the Robotics Value Chain

Classification	2002		2007		
	Number	Percent	Number	Percent	+/-
Systems Integrator	87	44%	91	46%	+
Accessory Equipment Supplier	74	38%	75	38%	
Engineering Services	71	36%	75	38%	+
End-of-arm tooling	73	37%	68	34%	-
Controls	67	34%	67	34%	
Software	58	29%	44	22%	-
Robot manufacturing	50	25%	43	22%	-
Consultant	44	22%	39	20%	-
Robot distributor	41	21%	36	18%	-
Used robots	20	10%	26	13%	+
Robotics researcher	7	4%	12	6%	+
Cable	14	7%	10	5%	-
Robotic safety equipment			57	29%	
Robot user	35	18%			
Total companies	197		198		

Source: Kumar & Shim (2007)

Appendix B Technical Details

Exhibit B1. Optimus Primus Detailed Description

Vision Experts' Optimus Primus software package increases reliability and reduces cycle time in order to help their partners realize a commercially viable vision-guided robotic bin-picking (VGRBP) system. Such a system needs to be highly reliable; that is, it must be able to continually pick parts out of one or more bins without exceeding an average cycle time per successful pick-and-place operation. To be successful, it is estimated that a bin picking solution should have an average cycle time of 10 seconds or less per operation. Due to the nature of randomly-situated parts within a bin, meeting this requirement is challenging, and is one of the main reasons why randomized bin picking systems have yet to be widely adopted by industry.

For example, given a set of pre-defined grasping points on a particular part and a set of candidate parts within the context of a randomized bin, in many cases the pre-defined grasps are obstructed by neighbouring parts or by the walls of the bin. In such cases, the grasps are not feasible since they result in collisions with the gripper. If there are a limited number of pre-defined grasps, it is possible that all grasps for all candidate parts are infeasible, resulting in no viable options for picking. In some systems, if no valid picking option exists, a second attempt is made at locating a viable candidate; for example, by taking a closer look at the pile, or by mechanically stirring the parts and then re-examining the pile. However, these solutions increase the cycle time.

OP presents a novel method of generating and evaluating a densely-sampled set of grasps, and uses this set to select the best candidate part to pick up. Grasp generation is tailored for a two-fingered gripper as such grippers are commonly used in industry. OP works in two stages: (1) offline generation of many high-quality two-fingered grasps for a given part, and (2) online evaluation of candidate picks using these high-quality grasps to select the most desirable target. For evaluating grasp quality offline, OP combines the quality measures generated from the simulator GraspIt! (Miller and Allen, 2004) with its own measure of grasp robustness, which is described as insensitivity of the grasp to slight positional errors.

Generating an extensive list of grasps for a given part can be computationally expensive, and is very difficult to compute online within the required time constraints. Typically, in the context of industrial bin-picking, *a-priori* knowledge of the part to be picked is available. This allows for offline generation and evaluation of grasps with minimal concern for computation time.

Grasps at multiple positions and orientations are generated by intersecting the space between the gripper fingers with the part at uniform intervals. To reduce the complexity of grasp generation, only planar grasps are considered, i.e., the grasp contact points lie in a plane. This choice enables them to model this space as a bounded 2-D (planar) region located at the gripper fingertips. To evaluate grasps, OP uses the quality measures provided by the simulator, GraspIt!. The GraspIt! quality measures are based on the magnitude of the largest disturbance wrench that can be resisted by a unit-strength grasp. A feasible, stable grasp is considered to be robust (and is, therefore, accepted) if all neighbouring grasps: (1) exist, (2) are feasible (i.e. they will not result in collisions with the gripper), and (3) are stable.

In VGRBP, a 3-D vision system is typically used to obtain a topographical map of the pile surface, providing information for part localization and obstacle avoidance. With OP, each localized candidate part is evaluated based on how many pre-generated grasps are collision-free in the context of the pile, using information about neighbouring parts and obstacles obtained from the vision system. A candidate is considered a valid picking option if there exists as least one collision-free grasp for picking it up. For the purpose of performing statistical trials to test the OP approach, the company performs an evaluation in simulation, for which they have complete knowledge of all obstacles in the pile.

The process of evaluating candidate picks is performed online, and is described below:

1. Select a set of candidate parts to pick.
2. For each candidate pick:

   a) Obtain the transformation that describes the part's pose in the world co-ordinate frame.

   b) Apply this transformation to each potential grasp (which describes the gripper's pose) and check for collisions between the gripper and all obstacles.

   c) Tally the collision-free grasps. If no collision-free grasps exist, eliminate candidate.

3. Rate the remaining candidates based on the number of available grasps for each and return this rating, along with each candidate's list of available grasps, to the robot control system.

If only the part, the gripper, and the pile configuration were considered, the best picking option would be the one that provides the most available grasps in the context of the pile. However, some grasps may be impossible due to robot joint limits and workspace constraints. An additional step is then required to process the rated candidate list to check for feasibility with the robot's limits before finally selecting the highest-quality feasible grasp for the highest-rated candidate.

The generated grasp list contains only robust grasps. However, due to the limit on online computation time, OP further reduces this list to a set of the highest-quality grasps when evaluating candidates. This results in many good grasping options for the system, and ideally, increases system reliability. Vision Experts believes that OP will help their partners' systems finally reach widespread commercial viability.

Exhibit B2. Braintech/ABB Partnership

<u>Excerpt from Braintech's 2007 SEC Annual Report regarding their agreement with ABB:</u>

On May 5, 2006 we entered into a new Exclusive Global Channel Partner Agreement with ABB for the licensing of our vision guided robotics technologies and software products. The stated purpose of the agreement is to allow ABB to establish a leadership position in the global automobile and general manufacturing vision guided robotics markets by strategically marketing the TrueView family of vision guided robotic systems as their global standard. As part of the new Exclusive Global Channel Partner Agreement, ABB has agreed to guarantee a minimum purchase of our eVF runtime licenses totaling US$10,500,000 for the period ending December 31, 2008. The minimum guarantees are allocated on an annual basis as follows: 2006—$1,500,000; 2007—$3,500,000; 2008—$5,500,000.

In addition to the purchase commitments, ABB has agreed to provide US$300,000 for research and development of a vision guided robotic bin picking technology. In exchange for ABB entering into this agreement, we have granted ABB an exclusive global channel partner license for the use of our software products in the automotive market and in specified general industry markets. As at March 24, 2008 ABB has fulfilled all of its commitments regarding the Exclusive Global Channel Partner Agreement.

Appendix C Monthly Financials (Year 1, 2010)

Sales Forecast

Sales Forecast													
		Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9	Month 10	Month 11	Month 12
Unit Sales													
Optimus Primus		20	22	24	26	29	32	35	38	42	46	51	56
Non-recurring Engineering Contracts		1	0	0	1	0	0	1	0	0	1	0	0
Total Unit Sales		21	22	24	27	29	32	36	38	42	47	51	56
Unit Prices													
Optimus Primus		$1,000.00	$1,000.00	$1,000.00	$1,000.00	$1,000.00	$1,000.00	$1,000.00	$1,000.00	$1,000.00	$1,000.00	$1,000.00	$1,000.00
Non-recurring Engineering Contracts		$25,000.00	$25,000.00	$25,000.00	$25,000.00	$25,000.00	$25,000.00	$25,000.00	$25,000.00	$25,000.00	$25,000.00	$25,000.00	$25,000.00
Sales													
Optimus Primus		$20,000	$22,000	$24,000	$26,000	$29,000	$32,000	$35,000	$38,000	$42,000	$46,000	$51,000	$56,000
Non-recurring Engineering Contracts		$25,000	$0	$0	$25,000	$0	$0	$25,000	$0	$0	$25,000	$0	$0
Total Sales		$45,000	$22,000	$24,000	$51,000	$29,000	$32,000	$60,000	$38,000	$42,000	$71,000	$51,000	$56,000
Direct Unit Costs													
Optimus Primus	3.00 %	$30.00	$30.00	$30.00	$30.00	$30.00	$30.00	$30.00	$30.00	$30.00	$30.00	$30.00	$30.00
Non-recurring Engineering Contracts	3.00 %	$750.00	$750.00	$750.00	$750.00	$750.00	$750.00	$750.00	$750.00	$750.00	$750.00	$750.00	$750.00
Direct Cost of Sales													
Optimus Primus		$600	$660	$720	$780	$870	$960	$1,050	$1,140	$1,260	$1,380	$1,530	$1,680
Non-recurring Engineering Contracts		$750	$0	$0	$750	$0	$0	$750	$0	$0	$750	$0	$0
Subtotal Direct Cost of Sales		$1,350	$660	$720	$1,530	$870	$960	$1,800	$1,140	$1,260	$2,130	$1,530	$1,680

Profit and Loss

Pro Forma Profit and Loss													
		Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9	Month 10	Month 11	Month 12
Sales		$45,000	$22,000	$24,000	$51,000	$29,000	$32,000	$60,000	$38,000	$42,000	$71,000	$51,000	$56,000
Direct Cost of Sales		$1,350	$660	$720	$1,530	$870	$960	$1,800	$1,140	$1,260	$2,130	$1,530	$1,680
Other Costs of Sales		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Cost of Sales		$1,350	$660	$720	$1,530	$870	$960	$1,800	$1,140	$1,260	$2,130	$1,530	$1,680
Gross Margin		$43,650	$21,340	$23,280	$49,470	$28,130	$31,040	$58,200	$36,860	$40,740	$68,870	$49,470	$54,320
Gross Margin %		97.00%	97.00%	97.00%	97.00%	97.00%	97.00%	97.00%	97.00%	97.00%	97.00%	97.00%	97.00%
Expenses													
Payroll		$23,734	$23,764	$23,794	$23,825	$23,856	$23,887	$23,919	$23,951	$23,983	$24,015	$24,048	$24,081
Marketing/Promotion		$3,000	$3,180	$3,371	$3,573	$3,787	$4,014	$4,255	$4,510	$4,781	$5,068	$5,372	$5,694
Depreciation		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Rent		$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000
Utilities		$300	$300	$300	$300	$300	$300	$300	$300	$300	$300	$300	$300
Insurance		$100	$100	$100	$100	$100	$100	$100	$100	$100	$100	$100	$100
Payroll Taxes	15%	$3,560	$3,565	$3,569	$3,574	$3,578	$3,583	$3,588	$3,593	$3,597	$3,602	$3,607	$3,612
Other		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Operating Expenses		$31,694	$31,909	$32,134	$32,372	$32,621	$32,884	$33,162	$33,454	$33,761	$34,085	$34,427	$34,787
Profit Before Interest and Taxes		$11,956	($10,569)	($8,854)	$17,098	($4,491)	($1,844)	$25,038	$3,406	$6,979	$34,785	$15,043	$19,533
EBITDA		$11,956	($10,569)	($8,854)	$17,098	($4,491)	($1,844)	$25,038	$3,406	$6,979	$34,785	$15,043	$19,533
Interest Expense		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Taxes Incurred		$3,587	($3,171)	($2,656)	$5,129	($1,347)	($553)	$7,511	$1,022	$2,094	$10,435	$4,513	$5,860
Net Profit		$8,369	($7,398)	($6,198)	$11,969	($3,144)	($1,291)	$17,527	$2,384	$4,885	$24,349	$10,530	$13,673
Net Profit/Sales		18.60%	-33.63%	-25.82%	23.47%	-10.84%	-4.03%	29.21%	6.27%	11.63%	34.29%	20.65%	24.42%

Balance Sheet

Pro Forma Balance Sheet													
		Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9	Month 10	Month 11	Month 12
Assets	Starting Balances												
Current Assets													
Cash	$161,800	$166,386	$146,842	$144,447	$157,691	$146,835	$150,189	$168,836	$163,294	$172,914	$198,234	$200,749	$217,768
Accounts Receivable	$0	$11,250	$16,375	$11,317	$18,550	$19,575	$15,008	$22,733	$24,000	$19,683	$27,900	$29,908	$26,325
Other Current Assets	$0	$0	$0	$2,000	$2,000	$2,000	$3,000	$3,000	$3,000	$4,000	$4,000	$4,000	$6,000
Total Current Assets	$161,800	$177,636	$163,217	$157,764	$178,241	$168,410	$168,198	$194,570	$190,294	$196,598	$230,134	$234,657	$250,093
Long-term Assets													
Long-term Assets	$0	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000
Accumulated Depreciation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Long-term Assets	$0	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000
Total Assets	$161,800	$182,636	$168,217	$162,764	$183,241	$173,410	$173,198	$199,570	$195,294	$201,598	$235,134	$239,657	$255,093
Liabilities and Capital		Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9	Month 10	Month 11	Month 12
Current Liabilities													
Accounts Payable	$0	$12,467	$5,446	$6,190	$14,699	$8,012	$9,090	$17,936	$11,276	$12,694	$21,881	$15,875	$17,638
Current Borrowing	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Other Current Liabilities	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Subtotal Current Liabilities	$0	$12,467	$5,446	$6,190	$14,699	$8,012	$9,090	$17,936	$11,276	$12,694	$21,881	$15,875	$17,638
Long-term Liabilities	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Liabilities	$0	$12,467	$5,446	$6,190	$14,699	$8,012	$9,090	$17,936	$11,276	$12,694	$21,881	$15,875	$17,638
Paid-in Capital	$400,000	$400,000	$400,000	$400,000	$400,000	$400,000	$400,000	$400,000	$400,000	$400,000	$400,000	$400,000	$400,000
Retained Earnings	($238,200)	($238,200)	($238,200)	($238,200)	($238,200)	($238,200)	($238,200)	($238,200)	($238,200)	($238,200)	($238,200)	($238,200)	($238,200)
Earnings	$0	$8,369	$971	($5,227)	$6,742	$3,598	$2,307	$19,834	$22,218	$27,103	$51,453	$61,983	$75,656
Total Capital	$161,800	$170,169	$162,771	$156,573	$168,542	$165,398	$164,107	$181,634	$184,018	$188,903	$213,253	$223,783	$237,456
Total Liabilities and Capital	$161,800	$182,636	$168,217	$162,764	$183,241	$173,410	$173,198	$199,570	$195,294	$201,598	$235,134	$239,657	$255,093
Net Worth	$161,800	$170,169	$162,771	$156,573	$168,542	$165,398	$164,107	$181,634	$184,018	$188,903	$213,253	$223,783	$237,456

Cash Flow

Pro Forma Cash Flow													
		Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9	Month 10	Month 11	Month 12
Cash Received													
Cash from Operations													
Cash Sales		$33,750	$16,500	$18,000	$38,250	$21,750	$24,000	$45,000	$28,500	$31,500	$53,250	$38,250	$42,000
Cash from Receivables		$0	$375	$11,058	$5,517	$6,225	$12,567	$7,275	$8,233	$14,817	$9,533	$10,742	$17,583
Subtotal Cash from Operations		$33,750	$16,875	$29,058	$43,767	$27,975	$36,567	$52,275	$36,733	$46,317	$62,783	$48,992	$59,583
Additional Cash Received													
Subtotal Cash Received		$33,750	$16,875	$29,058	$43,767	$27,975	$36,567	$52,275	$36,733	$46,317	$62,783	$48,992	$59,583
Expenditures		Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9	Month 10	Month 11	Month 12
Expenditures from Operations													
Cash Spending		$23,734	$23,764	$23,794	$23,825	$23,856	$23,887	$23,919	$23,951	$23,983	$24,015	$24,048	$24,081
Bill Payments		$430	$12,655	$5,660	$6,697	$14,976	$8,325	$9,709	$18,325	$11,713	$13,449	$22,429	$16,483
Subtotal Spent on Operations		$24,164	$36,419	$29,454	$30,522	$38,832	$32,212	$33,628	$42,276	$35,696	$37,464	$46,477	$40,564
Additional Cash Spent													
Purchase Other Current Assets		$0	$0	$2,000	$0	$0	$1,000	$0	$0	$1,000	$0	$0	$2,000
Purchase Long-term Assets		$5,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Dividends		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Subtotal Cash Spent		$29,164	$36,419	$31,454	$30,522	$38,832	$33,212	$33,628	$42,276	$36,696	$37,464	$46,477	$42,564
Net Cash Flow		$4,586	($19,544)	($2,395)	$13,244	($10,857)	$3,354	$18,647	($5,542)	$9,620	$25,320	$2,515	$17,019
Cash Balance		$166,386	$146,842	$144,447	$157,691	$146,835	$150,189	$168,836	$163,294	$172,914	$198,234	$200,749	$217,768

Personnel Table

Personnel Plan													
		Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9	Month 10	Month 11	Month 12
Chief Technical Officer and Founder		$6,500	$6,500	$6,500	$6,500	$6,500	$6,500	$6,500	$6,500	$6,500	$6,500	$6,500	$6,500
Technical Associate		$5,834	$5,834	$5,834	$5,834	$5,834	$5,834	$5,834	$5,834	$5,834	$5,834	$5,834	$5,834
Sales Manager		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Accounting/Admin Associate		$3,000	$3,030	$3,060	$3,091	$3,122	$3,153	$3,185	$3,217	$3,249	$3,281	$3,314	$3,347
TA #2		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
SA #2		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
General Manager		$8,400	$8,400	$8,400	$8,400	$8,400	$8,400	$8,400	$8,400	$8,400	$8,400	$8,400	$8,400
Total People		4	4	4	4	4	4	4	4	4	4	4	4
Total Payroll		$23,734	$23,764	$23,794	$23,825	$23,856	$23,887	$23,919	$23,951	$23,983	$24,015	$24,048	$24,081

Appendix D Important Assumptions

1. Vision Experts licenses their technology to Braintech for the automobile industry only.
2. Braintech licenses exclusively to ABB, who licenses exclusively to Toyota.
3. The auto assembly market is 450,000 stations worldwide, of which Toyota owns 25%, so the potential market through this relationship is 112,500 units.
4. Based on conversations with Braintech, Vision Experts is assuming that their VGRRBP software will sell for $40,000 per installation. They assume that they will be able to work out a deal with Braintech that represents 2.5% of Braintech's gross sales, or $1,000 per installation.
5. Sales Growth rate of 10% per month in the first year.
6. The average NRE charge to the customer will be $25,000, and Vision Experts will average 1 new part per quarter, per customer.
7. Vision Experts has calculated direct cost of sales at 3%, as the company's marginal cost is negligible.
8. Computer Requirements – Vision Experts has decided to expense the computers instead of capitalizing them because depreciation is so high.
9. Vision Experts expects to find a GM for $80K in Year 0, and $100K in Year 1 who will be able to handle the sales duties during that period and manage the business of the company accordingly.
10. Vision Experts will have an employee option pool (totalling 10% of the company by year 5) that would take effect upon an "event" (sale of the company, going public, etc.). This will help to attract the talent required to succeed.

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