Practical Automated Picking and Packing

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1 Abstract

A brief study of materials handling automation, and evaluation of a potential business based on current Internet order fulfillment equipment and practices. Internet retail today relies heavily on manual labor for order fulfillment. However, with staggering growth in Internet retail and labor intensive order fulfillment processes, companies will increasingly turn to automation to enable growth and make better use of the people they have.

The materials handling automation industry is dominated by a small number of very large companies. These companies manufacture products that handle products by the pallet or case, but have very limited solutions for split case picking. The dominant type of solutions these companies offer, such as pick-to-light or wearable RF terminals, only help human pickers to identify what needs to be picked, but does not do the actual picking. This thesis explores the business potential for automation capable of split case picking. The thesis format is that of a strategic business plan for a new fictional firm, "Practical Automated Picking and Packing."

2 Executive Summary

2.1 Business Concept

Practical Automated Picking and Packing (PAPP) will provide key enabling technologies for Internet retail by creating products that reduce manual labor requirements for order fulfillment. Internet retailers currently rely heavily on manual labor for fulfillment and operations. However, with staggering growth in Internet retail and only a limited supply of labor, companies will increasingly turn to automation to enable growth and make better use of the people they have.

The materials handling automation industry is dominated by a small number of very large companies. These companies manufacture systems that handle products by the pallet or case, but have very limited solutions for split case picking. The dominant type of solutions these companies offer, such as pick-to-light or wearable RF terminals, only help human pickers to identify what needs to be picked, but does not do the actual picking. PAPP differentiates itself from these other companies in that we will focus on the physical manipulation of individual items (split case picking). Lowering the amount of manual labor required with automation will reduce the per-order costs of fulfillment, and allow companies to offer more products for sale without worrying about the associated staffing issues.

PAPP's launch product will be the robotic picking system. The product will be a complete solution to the problem of picking and stocking multiple SKUs, reducing the need for human pickers. The product will be unique since it will be able to handle a wide variety of products. There are no known products with comparable features currently available in the market today. With a target price of $40k per manipulator, the customer

should be able to recover the cost of the system within a year. The product rivals current automation in cost, but provides the value of both current automation and human pickers. The price also provides an attractive margin for PAPP to achieve a rapid breakeven.

PAPP's key success factors are being able to create a quality product, getting third party system integrators to incorporate our products in their proposals, and erecting barriers to entry for competitors. With a quality product that is in high demand and difficult to duplicate, PAPP will be in a good position for harvesting. The company will require 2 years and $2 million to develop the product. After that, the company should be able to break even with its first major customer. Because we will seek funding from potential customers, PAPP should be assured of capturing a major account.

2.2 Market and Customers

PAPP's customers will be either Internet retailers or order fulfillment companies, since they have large split case picking requirements. In discussions with officers of Amazon.com and SmarterKids.com, their companies would be interest in a robotic picking systems to replace the current automation and labor, but currently have no such solution to turn to.

Internet retail was only 1% of the $1.3 trillion US retail market in 1999. However, it is expected to grow to 15% of the retail market by 2004. This level of growth in Internet retail implies that merchants will continue to spend an increasing amount on materials handling equipment. General materials handling equipment sales have consistently grown over the past decade, and are now more than $65 billion a year.

2.3 Competition and Competitive Edge

The materials handling industry is dominated by a small number of very large companies. These companies offer similar solutions with only minor differentiating features, at comparable prices. They can charge extremely high premiums for their relatively simple pick-to-light and RF terminal products because they have established brand names and can provide the entire package of equipment including conveyers and sorting systems. Because these large companies enjoy large margins with little perceived competition they have no incentive to innovate, since it could obsolete their current products and destroy the existing high margin revenue stream. These companies' research dollars are probably better spent in improving equipment that will be used across many industries, such as conveyer belts and case sorting systems. Because of this, PAPP believes it will enter the materials handling market unopposed by these large companies. However, because these companies are large, have credibility, and can offer a full product line, it does not make sense to engage in long-term competition with these major manufacturers. As such, PAPP is open to harvesting and being purchased by one of these larger materials handling companies.

2.4 Finances

PAPP believes it can make a gross margin in excess of 90% on its robotic manipulators. At this price, PAPP should be able to recover the $2 million development cost after selling only 54 units. A single major customer could consume over 54 units, and bring the company to breakeven. Positive cash flow begins with the first unit sold.

3 The Company and the Industry

3.1 The Industry

Whether order fulfillment is done in-house or contracted, Internet retailers have a heavy fundamental reliance on manual labor. There is a growing number of Internet retailers, but a limited supply of labor, forcing companies to turn towards automation to make better use of people. The materials handling automation market is dominated by a relatively small number of equipment manufacturers. Internet retail focuses on distributing items individually instead of by the case or pallet, and makes new demands on materials handling infrastructure.

Internet retailers rely heavily on manual labor for order fulfillment. In 1999, Amazon.com employed approximately 7000 people to do order fulfillment[1]. Others lessen the strain on their fulfillment systems by limiting the number of SKUs offered through on-line sales.[2] Very small and very large retailers normally do distribution on their own, while mid-sized retailers outsource distribution. On-line retailers shipping less than 100 orders a day are often ignored, while companies shipping >400 orders a day are sometimes able to get contractors' attention and outsource their distribution. Companies shipping over 1000 orders a day typically outsource their fulfillment, and companies with over 10,000 orders a day typically do fulfillment themselves.[3] Whatever the amount of technology or scale of the operation, the core of fulfillment today depends on manual labor.

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[1] Jeffery Wilke during his winter visit to the MIT LFM department.
[2] Stacie S. McCullough. Mastering Commerce Logistics, The Forrester Report, August 1999
[3] Stacie S. McCullough. Mastering Commerce Logistics, The Forrester Report, August 1999

There are a small number of large manufacturers in the materials handling automation industry with few entrants, serving the automation needs of the growing number of Internet retailers. Materials handling automation is dominated by manufacturers like Rapistan Dematic, Remstar International, White Systems, PEEM, and Eskay. Though there are some small equipment manufacturers, these larger companies tend to dominate the market.[4] The number of Internet retailers continues to grow each year. Internet retail is expected to go from 1% to 15% of the US's total retail market over the next 4 years.[5] With such growth in order volumes, the market for materials handling equipment is bound to grow. Because PAPP will focus on the handling of individual items, this is a very favorable trend.

Internet retail demands distribution to focus more on the level of individual items than before. As a Forrester report states, "Focus on parcels – not pallets. Online, manufacturers like Nike must deliver small packages to individual customers – not to loading docks at retail stores or distribution facilities. To fill small orders accurately and efficiently, companies must create infrastructure to expedite the flow of pieces – not pallets."[6] Because many of the large materials handling companies have already invested in the marketing and development of their current systems, have a large installed base, and make a large margin on their current product, they may not be eager to aggressively develop new and radically different infrastructure to obsolete their old products. Should PAPP create sufficient demand for its product, larger materials handling companies may

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[4] Based on the 4/10/00 interview with Real Time Solutions technical sales support director Mark Diehl.
[5] Forrester Research (www.forester.com)
[6] Stacie S. McCullough. Mastering Commerce Logistics, The Forrester Report, August 1999

be more inclined to buy the company as opposed to developing a competing product from scratch. This will potentially allow for a quick harvest of the company.

3.2 The Company and the Concept

PAPP's charter is to develop technologies for automated materials handling of individual items and small parcels, in order to reduce or eliminate the reliance on manual labor. Reducing the amount of manual labor in fulfillment will lower our customers' per order and total operating cost. The reduced hassle of hiring and managing a workforce also eases the customers' entry into Internet retail.

We differentiate ourselves from the industry in that we will focus on providing a mechanical system to physically manipulate (pick, move, place, etc.) a wide array of products to reduce the actual amount of human handling required in distribution centers. Current automation in picking either improves the efficiency of manual labor, or only handles specific types of items. The most popular automation systems for picking today are either pick-to-light or RF terminals. These are information systems that seek to maximize the efficiency and accuracy of human pickers by helping human pickers identify the items that need picking. The company still has to keep a workforce capable of meeting picking requirements. Most Internet retailers use either pick-to-light, RF terminals, or a combination to aid in fulfillment. Systems that do eliminate people from the picking process, such as A-frame systems, require products to be rugged and stackable since items are loaded into dispensers, like bullets into a magazine, and dropped down chutes into moving crates. This rough handling limits the number of products for which this system is practical. Avon (cosmetics) is a prime example of a company that uses this type of system.

Reducing the amount of manual labor in order fulfillment will lower per order costs. Though retailers with sufficient volume can generally outsource fulfillment for less than 10% of sales, the retailers still suffer a recurring cost, not to mention the setup and ongoing fees.[7] If fulfillment was taken in-house and the money spent on fulfillment labor was used to purchase infrastructure that could do the same job, not only would variable costs drop significantly, but retailers would also be able to realize a tax savings by depreciating the equipment. This translates into significant per order and total operating cost savings.

The reduced hassle of hiring and managing a workforce also eases the problem of fulfillment for companies entering Internet retail. Fulfillment operations like American Fulfillment Center (Austin, TX) rely on 7 temp agencies to provide enough labor to meet their capacity needs.[8] Companies in an Ernst & Young study indicate that the top internal barriers to selling online are insufficient resources, which include people and money.[9] A fulfillment solution that only requires an infrastructure investment with a nominal recurring cost will greatly ease the process of entering online retailing.

3.3 The Product

Because one of the most labor-intensive tasks in fulfillment is picking, our launch product will be a robotic picking system. The product will be a complete solution to the problem of picking for multiple SKUs, reducing the need for human pickers. The product will be unique since it will be designed to handle products of different dimensions. We project the time for a customer to recover costs to be approximately a

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[7] Stacie S. McCullough. Mastering Commerce Logistics, The Forrester Report, August 1999
[8] www.amful.com
[9] The Second Annual Ernst & Young Internet Shopping Study, 1999 p 28

year. We are the first company we know of to attack the problem of picking a wide array of products with mechanical automation. Current automation technologies have greater restrictions than our product. The technology for this product could be ported over to future materials handling technologies.

Our company's launch product is the robotic picking system. The product will be a track mounted robotic manipulator that can pick items from shelving units, as they are needed to fulfill orders. The robots will be seven degree-of-freedom gantry robotic arms, with articulating motion and a custom designed clamp type manipulator with an extra "indexing" finger to aid in item acquisition from the shelf. The configuration where the robot is separate from the shelf would resemble the "Video Juke Box" built by ST Robotics in England[10], where a robotic arm retrieved videocassettes from a shelf. The system PAPP intends to build will be different in that our robotic manipulator will be able to handle a variety of objects, and not just videocassettes. The extra finger in the design serves to draw out the object for gripping by the clamp style hand. Robots will be easily added or removed from their tracks for either maintenance or capacity adjustment. The robotic system will be self-configuring, and capable of dividing work among the multiple robots on each track. The robotic system has several restrictions that limit the range of products that can be handled. The arm only handles rectangular objects weighing less than 5 pounds (this initial weight restriction will allow robots to have better performance with less powerful hardware, and thus less risk of injury to humans in the area). The object cannot be more than 6 inches across or thinner than a quarter inch at the point of handling. The object must also be rugged enough to tolerate the lateral

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[10] www.robotics1.dial.pipex.com

pressure exerted by the clamp type manipulator without damage. Other manipulator types may be designed to allow the robots to handle products with other characteristics.

Where appropriate, this system will be a complete solution to the problem of picking and eliminate the need for a human picker. The design also allows for the manipulators to restock the shelves as well. The system will be able to retrieve an item on command, and place it on a desired location, such as a conveyer belt, AGV, or even a passing tilt tray. The real value in the product will stem from the ability to handle the wide array of product and replace human pickers. This competency could also produce spin-off products, such as automated stocking systems for retailers, or infrastructure for reverse logistic systems in return centers.

The proposed product will be unique since it will handle individual items (not cases and pallets) automatically. There are no known commercially available systems designed for this function. Automation that dispenses individual items is mainly designed to handle high volumes of small, uniform, and sturdy products that can be treated roughly, limiting the practicality of such a system. Where information technologies such as RF terminals and pick to light require both a large capital investment and a sizable labor force to make use of the equipment and do the actual work, we offer infrastructure to replace the old infrastructure and the people that used to do the picking.

The target price of $40k per robotic arm allows customers to recover their cost for the system in a year through salary savings. Customers will also be able to achieve subsequent tax savings by depreciating the equipment they purchased in later years.

PAPP will patent key technologies to protect its market base from imitations for as long as possible. Because both our technology and application are well known to us, our patents will aim specifically to protect our technologies from competitors. After the first major customer installation, we expect other distributors will seek to adopt our products to achieve similar operational cost savings. Our customers' competitors will be pressured to adopt our product in order to achieve similar operational cost savings, since the scenario will resemble escalation in an arms race. Should the market grow and significantly larger companies try and enter, PAPP will be able to leverage its product and presence to harvest the company.

The only competing technologies for the wide range of products we intend to work with are RF terminal and pick-to-light. Automated picking will essentially remove the human picker from the system. Typical pick-to-light systems cost from $150 to $250 per SKU in large operations, and only give an indication of what must be done so that a human can do it. We can provide a better value to the customer with our automated materials handling by reducing labor as well as providing accurate picking.

Our materials handling technologies could be ported over to other applications, creating multiple revenue streams from the same researched technology. The ability to autonomously pick and place items could lead to devices such as automated stocking systems for large brick and mortar retailers.

3.4 Entry and Growth Strategy

We intend to grow the company to the point where it would be attractive for other materials handling companies to buy. Our key success factors are being able to produce a quality product, getting third parties excited about incorporating our products into their

project proposals, and erecting sufficient barriers to entry to complicate entry by larger materials handling companies. In order for the company to grow, Internet retailers must have either sufficient growing pains or aversion to growing pains in order to adopt our product. Pricing will be fixed per unit. Distribution will be handled based on the account. We intend to start with a limit of 2 major accounts in the first two years to limit liability and make ourselves attractive to potential buyers.

PAPP's success lies in our ability to: 1) produce a robust high quality product, 2) get consultants to include the solution in their recommendations, and 3) erect barriers to entry that will prevent larger companies from easily creating competing technologies. Because we seek to replace human labor, the product must be flexible enough to handle a large fraction of the range of products that people handle today. The product must also be robust to minimize disruption to customers' distribution operations. For the customer base to adopt the product freely, the system must be relatively simple to install and use. Successful installations will spur consultants and system integrators to consider our products in their projects.

The company's growth depends largely on the growth patterns and behavior of Internet retailers. Without growth in split case picking, our company cannot grow. Further, our company must provide a value that is better than using people for picking in order to grow. Reasons Internet retailers would adopt our system include: increasing product throughput, reducing handling costs, or reducing the dependence on labor.

Pricing will be fixed per unit, at $40k per manipulator. Since the product's pricing is based on value (more close tied to the cost of employing a person) and not manufacturing cost, $40k per unit is justifiable. A customer can expect to get more

productive hours of work from the unit in a year than could be expected by a human. The price also helps the company reach breakeven with relatively few units (see Figure 1).

We intend to start with at most 2 major accounts in the first 2 years of sales. Limiting our growth will help us to refine the product and make sure there are no serious problems with the system. If a problem with the product is discovered and the installed base is very large, in addition to potentially severe financial consequences, the company could lose its credibility in the industry. Limited product availability and a large number of potential customers wanting to buy the product will help to make the company look more attractive to larger automation companies who would be interested in buying PAPP. Larger companies such as Fanuc Robotics (General Electric), White, or Rapistan Systems would be able to incorporate our technologies into their own product offering for potentially significant future sales. The apparent strategic fit should facilitate a successful harvest.

Figure 1: Prices and number of units for breakeven.

Price	Margin	B/E Units
15000	81.7%	163
20000	86.3%	116
25000	89.0%	90
30000	90.8%	73
35000	92.1%	62
40000	**93.1%**	**54**
45000	93.9%	47
50000	94.5%	42

Should we fail to sell the company after three years, we will continue to sell our product to Internet retailers or other split case picking operations, and train system integrators in the installation and use of our product. We expect to be able to capture at least 30% of the major distributors by year 5. To keep steady growth, the same technology used in our original product may be applicable to developing spin-off products, such as automated stocking systems for retail stores.

4 Market Research and Analysis

4.1 Customers

Our initial customers will be Internet retailers and possibly order fulfillment companies, since they have high split case picking requirements. PAPP will initially target large retailers to gain sales volume and credibility. Several companies have stated they would be interested in a robotic picking system, so we believe the technology has the potential to capture at least 30% of the major distributors.

PAPP plans to establish credibility and significant growth potential as quickly as possible by acquiring an attractive customer base. Target launch customers include Amazon.com, Barnes & Noble, and Fingerhut. It may be difficult to sell to these large companies since the decision makers may be difficult to reach. However, should we get their attention and elicit a decision to try or buy, "Internet time" will speed our product's penetration into the customer's company and quickly lead to breakeven with a single account. Major deciding factors will be performance, reliability, scalability, and cost effectiveness.

Several companies have expressed interest in the product. Major Internet retailer Amazon.com VP and GM of operations, Jeffrey Wilke, expressed interest in the product, stating that he believed automation would play a larger role in the future of order fulfillment. Amazon seeks to grow its number of SKUs by over 100% in 2000, as part of its strategy to be the world's largest store.[11] This SKU explosion is characteristic of retail category busters, and will cause fulfillment to become increasingly difficult, creating more incentives for Amazon to adopt an automated picking technology.

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[11] Time Magazine, December 27,1999

SmarterKids.com CEO David Blohm stated that they currently outsource fulfillment, but will bring operations in-house when their volume grows. His main reason cited for wanting automation was to avoid dealing with labor and related issues. The robotic picking system should become a major piece of fulfillment infrastructure and ease companies' entry into Internet retail, positioning PAPP as a high potential company.

4.2 Market Size and Trends

Both Internet retail sales volume and materials handling automation purchases have grown steadily in recent years. Internet sales volume has grown rapidly since its inception, and is expected to grow considerably over the next 5 years. Fulfillment infrastructure sales have also grown steadily over the past decade. This growth trend makes it reasonable to expect fulfillment infrastructure sales will continue to grow.

Internet retail sales volume has grown rapidly in the past and is expected to grow considerably over the next 4 years. Forrester research predicts Internet retail will go from 1% to 15% of retail in the US by 2004. Amazon has aggressively built out distribution centers to allow ample room for company growth. They have 7 distribution centers in the United States totaling over 3 million square feet of space, and house over 1 million SKUs. Though their largest distribution center already has more than 10 miles of conveyer belts, their 800,000 square foot site is still 90% empty, leaving plenty of room to grow and fill with infrastructure.[12]

Fulfillment infrastructure sales have grown steadily over the past decade. Consumption of materials handling equipment in general has grown to over $65 billion

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[12] Time Magazine, December 27,1999

per year.[13] This figure includes equipment for manufacturing and construction as well as distribution.

4.3 Competition and Competitive Edges

The material handling industry is dominated by a small number of very large companies. The companies offer generally similar solutions, with comparable prices and performance, and only minor differences. The large margins for current automation gives little reason for these companies to innovate, which is why PAPP will have the opportunity to enter the market and capture key accounts.

Materials handling is dominated by a small number of very large companies. Players include industry leaders such as Mannesmann Dematic (Rapistan Systems) and Pinnacle Automation (White). These companies offer comparable picking solutions, differing subtly in features, interfaces, and service. The most popular automation solutions for split case picking are, pick-to-light, RF terminals, or some combination of the two. As margins for these products are quite high,[14] there is little reason for the companies to obsolete their current products.

PAPP believes it can attract a major customer and sell its product because of the lack of innovation in the materials handling industry. Since the market leaders enjoy large profits on their current products, they will encounter severe internal resistance to begin working on any project that disrupts revenue from their cash cows. This dynamic should provide PAPP with an opportunity to bring a superior product to market with no competing product. Provided we are able to capture a key major customer and erect

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[13] Material Handling Industry of America Online – www.mhia.org
[14] See Appendix A

sufficient barriers to entry, PAPP should be in a good position to be sold to one of the industry leaders.

4.4 Sales Strategy

PAPP will market its product to targeted customers based on value. PAPP is primarily interested in selling its products to companies that will provide sufficient publicity and credibility in the industry to set the company up for harvesting. Once companies begin to demand the functionality our solution provides from the materials handling equipment manufacturers, we will be in a position to market the company.

PAPP will market the robotic picking system to Internet retailers, using our ability to reduce labor and increase throughput as major selling points. A reduction in labor eases the task of management, and lowers the cost per order. Since equipment can be depreciated, companies can also realize a tax savings by using our automation instead of manual labor. The robotic picking system will also allow for companies to expand their number of SKUs carried while minimizing the need for additional labor.

PAPP is primarily interested in selling to large distributors. Not only will a major distributor allow for a quick breakeven, but will help the company to gain credibility and recognition as quickly as possible. Targeted customers include:

- Amazon.com
- Fingerhut
- Barnes & Noble
- Toys "R" Us

We plan to service at most 2 major accounts in our first 2 years of operation. Two major accounts should draw sufficient attention to the major materials handling manufacturers to become interested in acquiring the company.

The major manufacturers have a history of growth through acquiring companies. Framing the company as a dot-com enabler will help manufacturers take part in the Internet fanfare, and market themselves to the Internet retailing industry. PAPP would become a valuable asset in this regard.

4.5 Ongoing Market Evaluation

PAPP will focus on its customers' happiness with the product by limiting the number of major customers to two, and limiting the product offering to the robotic picking system. Because PAPP will initially be a one-product company, we will be able to focus all of our attention on the customer's satisfaction with the product. Because we will limit the number of major customers we take on, we will be able to provide ample attention to their needs and desires.

5 The Economics of the Business

5.1 Gross and Operating Margins

Gross margin on the hardware sold will be high (>90%), and should quickly offset development costs. Operating costs will be kept low in several ways. Initial development costs can be kept low as most of the robotic hardware can either be outsourced or developed by reverse engineering existing models. Software will dominate the development effort. Manufacturing will be outsourced, minimizing overhead until a first customer is captured.

The gross margin on robotic hardware will be greater than 90% (see Figure 2), with our initial price assumption of $40k per robotic arm. Assuming the cost to employ a picker is $15/per hour, the cost to employ the picker for an entire year (without any overtime, which is unlikely) is $31,200. In a wave-picking scenario[15], the robot costs only 1/3 more than employing a person, but has 3 times the duty cycle[16]. The robotic solution may be even more attractive for manning large aisles with slower moving SKUs when the pick rate is relatively low. This characteristic may become more common if retailers are seeking to maximize their SKU diversity.

Figure 2: Cost Estimates.

Component	Cost
Robot Hardware	
Servos, Motors, and Brakes	700
Controller Board	100
Body	350
Vision Systems	250
Bar Code Scanner	100
Other Electronics and Mechanics	200
PC Controller	1000
Total Cost	$2,750
Storage and Track Units	
Shelves	200
Robot Track (per foot)	25

Operating costs will be kept as low as possible. Hardware development will be minimized as robotic hardware can either be outsourced or reverse engineered from existing models. Though outsourcing may be easier and faster for quick deployment, reverse engineering existing systems and optimizing them for picking will both help the company achieve its high margins and develop hardware expertise. Hardware development will probably be the most capital-intensive task, as the company will have to invest in hardware components and electrical test equipment. Software development will dominate the development effort in terms of time and energy. Since the key developers will be working for equity and a small salary from the company, cash expenditures will be kept as low as possible.

[15] See Appendix B (12.1)
[16] See Appendix B (12.2)

After the first account is acquired, the actual manufacturing and production of robotic arms, tracks, and shelving will be outsourced. Outsourcing allows the company to avoid heavy investments in manufacturing equipment. The arms will be tested for 100 hours before being shipped.

5.2 Profit Potential and Durability

The profits from this business are high. However, the profit stream is only semi-durable, due to potentially large competitors who might enter the market to compete.

The gross profit margin is approximately 90%. In the short term, our profits will be high and durable, as there will be virtually no other companies offering our type of robots.

Should our light industry robots become popular, it will be very difficult to hold off competitors. Though our manipulator designs can be patented, other companies may find other ways of handling products equally well and develop rival infrastructure. Potential entrants include robotics firms such as GE Fanuc, ABB, etc. These companies may not enter the market to compete, as they may see it as outside of their core business of manufacturing robots with different specifications and desirable traits. Materials automation firms will also have some aversion to entering the market, as their current product lines are much simpler and yield even higher gross margins.

5.3 Fixed, Variable, and Semi-Variable Costs

Fixed costs will be kept relatively low during the first 2 years, as we only need to maintain the lab and staff salaries (which are low, as the primary compensation will be in the form of equity). Most of the team members are willing to take pay cuts because of

their equity stake in the company. Variable cost is slightly high since manufacturing is outsourced. Other significant variable costs will be incurred when PAPP expends time and money in trying to win a customer through site visits and trials, or during product installations.

5.4 Months to Breakeven

Break even should occur with our first major customer. At the initial price of $40k, PAPP only needs to sell 54 units to break even. A single major customer could easily consume more than 54 units in a single distribution center. The company is expected to breakeven during year 4.

5.5 Months to Reach Positive Cash Flow

Positive cash flow will begin with the first customer. However the revenue is not expected to be constant. The high margins will allow individual sales to sustain the company for months at a time. Positive cash flow (acquisition of our first customer) is expected to occur early in year 3.

6 Marketing Plan

6.1 Overall Marketing Strategy

We will market our product in several ways. Before the product is even ready, we intend to approach potential major accounts and solicit their investment in the company. Since breakeven can occur with one major account, this avenue results in a win-win situation for both PAPP and the investing company. Failure to find a major investor/customer may delay or prevent the launch of the company, as other financing will need to be found.

Should the company be unable to find a major investor/customer, marketing efforts will begin with demonstrating the product at materials handling trade shows. Attracting major accounts is the first priority. Demonstrations at trade shows should attract the attention of some Internet retailers looking for fulfillment equipment. Though our target customers are the major retailers, PAPP will sell its products to smaller businesses to establish some credibility, grow a customer base, and encourage consultants to integrate our products into their projects. For the company to be sold successfully, PAPP requires high market demand and earnings. Without a major credible retailer as an account, the probability of success drops from near certainty into the realm of uncertainty.

Unless deemed necessary, initial sales will be domestic. The US seems to be the center of Internet retail, and most of the world has relatively inexpensive manual labor, detracting from the appeal of our product. International travel will also increase the cost of doing business. Unless the overseas account is a major company that can help PAPP establish credibility and growth, negligible effort will be placed in marketing our product to overseas customers.

Since the majority of retailers do their most significant amount of sales during the holiday season, we expect most customers to focus on their own operations during this time. As such, any sales to customers will have to happen during the first half of the year, with installations and test runs of the system finishing no later than the end of the third quarter.

6.2 Pricing

PAPP will sell the robotic pickers for $40k. Shelving will be sold for $500 a unit, and tracks for the robot will be priced at $50 per foot. Any price concessions will be made with the shelving and robotic tracks.

Internet retailers that invest in pick-to-light technologies typically spend millions of dollars on a system[17]. With the incremental cost of adding an SKU typically around $200, a 1 million dollar investment only grows an already existing pick-to-light system by 5000 SKUs (assuming a system is already in place). The pick-to-light system also requires the purchase of shelves and hiring of human pickers to actually do the picking. A 1 million dollar investment in PAPP equipment could provide 25 robotic pickers, 200 shelf units (assuming 25 SKUs per shelf unit), and 500 feet of robotic track. Further gains are that robotic pickers will be able to reach items well out of reach for human pickers, allowing for higher shelves and better use of space in the distribution center.

With a price of $40k per robotic picker, the gross margin will be about $37,250 (93%). The non-trivial price will help the robot command some respect in the market. Because we will be first to market, and offer a significant value proposition to the customer, PAPP is justified in charging this premium for its product. The price is not prohibitive enough to preclude purchases by smaller retailers, and provides a potentially large leap in customers' operational efficiency.

Because fulfillment is an integral part of Internet retailers' operations, PAPP will offer free service for the first year after installation. After that, a service agreement will be available to customers. Though the service agreement could be a profitable operation,

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[17] Based on the 4/10/00 interview with Real Time Solutions technical sales support director Mark Diehl.

it is likely that price concessions may also be made on service to protect the margin of the product, and will most likely be a breakeven or lower profit operation.

7 Design and Development Plans

We are just finishing the conceptual phase of development. There are major technical challenges, including manipulator design as well as firmware and software development. The cost of developing the product is estimated at 2 million dollars.

The product is very early in the development cycle. The next tasks are to construct a prototype / proof of concept model. Model robots are being selected on which to focus the reverse engineering effort and to serve as the basis of our product. We currently have core team members with expertise in controls, software, mechanical systems, and computer vision. To round out the team, we need to add another mechanical engineer and programmer with information technology and systems integration .expertise.

The major technical difficulties that lie ahead are welcome challenges for the team. Designing hardware and software that meets our performance specifications will be challenging to any engineering team, and the more unique the solutions we develop, the more barriers to entry we can erect in the form of patents. Because our application is very clear, PAPP should be able to create concise patents that protect the developed technology and its application in automated materials handling. The design of the robotic manipulators and shelves need to be tackled before full-scale software development can begin.

The projected cost of development is 2 million dollars. Included in this figure are the initial capital equipment investment, raw materials, and overhead and salary for 2 years of development.

8 Manufacturing and Operating Plan

We plan to locate our operation in the outskirts of Boston. The Boston area provides us with many resources, among them prospective employees and a wealth of talent from the nearby universities. Our main facilities will consist only of lab space to develop the prototypes. After prototypes are completed, warehouse space will be needed for development and testing.

Manufacturing will be outsourced once orders are received. Because we only require lab space and a modest amount of equipment, we will be able to keep costs fairly low. Our main activity will be research and development, so there are few operating concerns until development is complete.

9 Critical Risks, Problems, and Assumptions

There are several risks involved in this venture. We can mitigate risk with forethought and effort to successfully start the business.

- Large Internet retailers fail to invest:
    - Evaluation: because there are relatively few Internet retail giants with cash to spare, it may be difficult to get investment dollars from them for longer-term gains. These companies may just be interested in their short-term survival.
    - Contingency: Our target retailers should have sufficient cash to invest something in the company. If not, the company can seek venture capital or seed funding from the government (small business association or loan for

minority entrepreneurs) to get us started. The primary purpose of getting the retailers to invest something is to secure them as customers in the future.

- PAPP fails to secure sales from a large Internet retailer:
    - Evaluation: It is possible that reputable companies will refuse to do business with us because we are a small operation.
    - Contingency: PAPP's survival is not totally dependent on obtaining a large customer. PAPP can breakeven with a number of small accounts.
- Pick-to-Light and/or RF terminal systems drop in price:
    - Evaluation: Given the amount of time pick-to-light systems and RF terminals have been in the market, price reduction does not seem to be that serious a threat. Because the primary value for the customer lies in replacing the picker, price drops in the current automation will have minimal impact on PAPP.
    - Contingency: PAPP's pricing is highly value based, and not cost based. The company can cut prices considerably and still make margins > 50%. However, price-cutting will slow the time to breakeven.
- Robotics or Materials Handling firms respond with competing products:
    - Evaluation: In the short term, it is unlikely these companies will enter into direct competition. Their product line is much simpler and commands margins higher than those sought after by PAPP. In the long-term however, if PAPP builds a large market and demand, these larger companies are bound to enter into the market. Competition among materials handling companies seems for the most part quite light. Over years of competition, the companies

have not engaged into price wars or the like. However, their stronger brands and full range of products may pose a considerable threat to the company.

- Contingency: PAPP will be the first to market with its product and technology. PAPP could leverage its product, customer base, and know-how to harvest the company.

- Higher than expected sales volume:
  - Evaluation: In the very best case for marketing, companies see the value of replacing pickers with machines (where possible), and inundate the company with orders. As with most technology adoption, it is unlikely that many companies will adopt the product immediately. However, after some time in the market with satisfied customers, the company should begin to attract more attention.
  - Contingency: If the company gets more orders than expected, the company can source other manufacturing houses. Because the robots will be reverse engineered and made of generally available parts (gears, motors, etc), additional manufacturing capacity should not be difficult to find.

    The surge in orders should also make PAPP more attractive to larger materials handling firms and in good position for harvesting.
- Lower than expected sales volume:
  - Evaluation: With cash being tight for Internet companies, it is possible that they are not building out infrastructure for distribution and are relying on outsourcing. PAPP will work to minimize this risk of low order levels by

securing potential customers as investors with some equity stake in the company.

  - Contingency: Because manufacturing is outsourced, the company's fixed costs are kept low. There is no manufacturing equipment or personnel that needs to be constantly utilized. This limits PAPP's losses to the development costs and equipment. If PAPP only receives a very small number of orders, the company can build the units by hand, still outsourcing the track and shelving. Should the company fold, most of the equipment used for development can be salvaged and sold, lessening losses.

- Delays in design and development:
  - Evaluation: Due to the complexity of the system, it is possible there will be some delay in the development of the product. However, because we are a small company, there will be little press to cause negative PR. The worst possible case would be to finish development and testing at the end of the third quarter or beginning of the fourth quarter, as that is when retailers will focus primarily on their businesses and not take the time to consider or test new infrastructure.
  - Contingency: PAPP can absorb several months of delay in the schedule with minimal financial impact, as most of the key members are willing to take severe pay cuts in order to survive. Any down time from the holidays can be used to improve upon the product.
- Inadvertent patent violation:

- Evaluation: There are several patents on robot designs and algorithms. The existence of a patent is not enough to interrupt our development. The patent holder must be aware of our infringement and bring it to our attention. However, past experience in the high tech industry shows that unless the technologies and claims are focused on our precise application, patents will be relatively simple to get around.
- Contingency: Developers will conduct patent searches as part of the literature review during development to minimize the number of infringements. Should it be discovered that a technology infringe on a patent after deployment, PAPP will either seek to obtain permission to use the patent (probably in the form of paying a royalty), or modify the technology to not infringe.

- Utter failure in development effort:
  - Evaluation: Though the challenges of creating the robot are not insurmountable and the team is composed of highly skilled engineers, for one reason or another, it may be that PAPP fails to build a practical solution. With a precedent of success by other robotic companies in building item storage and retrieval systems, it is not likely that PAPP will fail.
  - Contingency: PAPP has several options for company survival. PAPP could leverage knowledge of distribution systems and become a system integrator or consultant. Maybe more attractive, PAPP could easily move into building high quality pick-to-light systems. PAPP could either sell the product at the going rate for margins even higher than that of the robotic systems, or become a cost-quality leader. Introducing competition into the market will probably

cause the larger materials handling companies to either come down in price or further innovate their product and services. PAPP could also offer to be bought out and leave the market, allowing the materials handling companies to save their margins while allowing PAPP a financially graceful exit.

10 The Financial Plan

10.1 Breakeven Analysis

At the assumed price of $40,000, the company will recover the initial $2 million investment after selling the 54th unit. This breakeven figure is conservative, since it does not take into account revenue from shelves, tracks, service agreements, or leasing programs. These products and services will take the brunt of any price concessions, so breakeven is based solely on the sale of robotic manipulators. Breakeven is expected to occur sometime during year 4, given that the product is ready by the end of year 2 and sales commence during year 3.

10.2 Income Statement & Balance Sheet

PAPP will be very low on cash by the end of year 2, and needs sales to have cash in year 3. Since projections only call for a test system of about 25 units, this should not be a difficult proposition. The sales revenue is primarily needed to support development. Development and innovation must remain strong throughout the company's operation, to allow the company to continue successful operations should the company fail to be sold. Continued development also gives the company the appearance of being a valuable acquisition to larger manufacturers.

Because our main customers will be reputable companies, we do not expect to have bad accounts. Since we do not expect to conduct sale activities during the fourth quarter, there should be no accounts receivable to carry over into the next year. Similarly, since we will not pay manufacturers for product until after shipment, there should be no accounts payable to carry over into the next year either.

See Figures 3, 4, and 5 for pro forma income statements and balance sheets.

10.3 Cash Flows

See Figures 6 and 7 for pro forma cash flows.

Figure 3: Pro Forma Financial Statements by month for year 1.

Financial Statements - Fiscal Year 1 ($000)	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9	Month 10	Month 11	Month 12	FY
Income Statement													
Development	-235.4	-41.4	-41.4	-41.4	-41.4	-41.4	-101.3	-78.9	-78.9	-78.9	-78.9	-78.9	-938.2
Marketing	0	0	0	0	0	0	0	0	0	0	0	0	
G&A	0	0	0	0	0	0	0	0	0	0	0	0	0
Total operating expenses	-235.4	-41.4	-41.4	-41.4	-41.4	-41.4	-101.3	-78.9	-78.9	-78.9	-78.9	-78.9	-938.2
Income (loss) from operations													0
Interest expense	0	0	0	0	0	0	0	0	0	0	0	0	0
Interest income	0	4.4	4.3	4.2	4.1	4	3.9	3.7	3.5	3.3	3.1	2.9	41.4
Net interest	0	4.4	4.3	4.2	4.1	4	3.9	3.7	3.5	3.3	3.1	2.9	41.4
Net income (loss)	-235.4	-37	-37.1	-37.2	-37.3	-37.4	-97.4	-75.2	-75.4	-75.6	-75.8	-76	-896.8
Balance Sheet													
Cash and cash investments	1764.6	1727.6	1690.5	1653.3	1616	1578.6	1481.2	1406	1330.6	1255	1179.2	1103.2	
Prepaid expenses	4.6	4.2	3.8	3.3	2.9	2.5	2.1	1.7	1.3	0.8	0.4	0.0	
Total current assets	1769.2	1731.8	1694.3	1656.6	1618.9	1581.1	1483.3	1407.7	1331.9	1255.8	1179.6	1103.2	
Capital Equipment	170	170	170	170	170	170	190	190	190	190	190	190	
Less accumulated depreciatio	0	0	0	0	0	0	0	0	0	0	0	0	
Net plant and equipment	170	170	170	170	170	170	190	190	190	190	190	190	
Total assets	1939.2	1901.8	1864.3	1826.6	1788.9	1751.1	1673.3	1597.7	1521.9	1445.8	1369.6	1293.2	
Accounts payable	0	0	0	0	0	0	0	0	0	0	0	0	
Accrued expenses	174.6	174.2	173.8	173.3	172.9	172.5	192.1	191.7	191.3	190.8	190.4	190.0	
Total current liabilities	174.6	174.2	173.8	173.3	172.9	172.5	192.1	191.7	191.3	190.8	190.4	190.0	
Stock	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	
Retained earnings	-235.4	-272.4	-309.5	-346.7	-384	-421.4	-518.8	-594	-669.4	-745	-820.8	-896.8	
Total stockholders' equity	1764.6	1727.6	1690.5	1653.3	1616.0	1578.6	1481.2	1406.0	1330.6	1255.0	1179.2	1103.2	
Total liabilities and equity	1939.2	1901.8	1864.3	1826.6	1788.9	1751.1	1673.3	1597.7	1521.9	1445.8	1369.6	1293.2	

Figure 4: Pro Forma Financial Statements by month for year 2.

Financial Statements - Fiscal Year 2 ($000)	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9	Month 10	Month 11	Month 12	FY
Income Statement													
Development	-93.9	-78.9	-78.9	-78.9	-78.9	-78.9	-101.3	-78.9	-78.9	-78.9	-78.9	-78.9	-984.2
Marketing	0	0	0	0	0	0	0	0	0	0	0	0	0
G&A	0	0	0	0	0	0	0	0	0	0	0	0	0
Total operating expenses	-93.9	-78.9	-78.9	-78.9	-78.9	-78.9	-101.3	-78.9	-78.9	-78.9	-78.9	-78.9	-984.2
Income (loss) from operations													
Interest expense	0	0	0	0	0	0	0	0	0	0	0	0	0
Interest income	2.5	2.5	2.3	2.1	2	1.8	1.6	1.3	1.1	0.9	0.7	0.5	19.3
Net interest	2.5	2.5	2.3	2.1	2	1.8	1.6	1.3	1.1	0.9	0.7	0.5	19.3
Net income (loss)	-91.4	-76.4	-76.6	-76.8	-76.9	-77.1	-99.7	-77.6	-77.8	-78	-78.2	-78.4	-964.9
Balance Sheet													
Cash and cash investment	1011.8	935.4	858.8	782	705.1	628	528.3	450.7	372.9	294.9	216.7	138.3	
Prepaid expenses	13.8	12.5	11.3	10.0	8.8	7.5	6.3	5.0	3.8	2.5	1.3	0.0	
Total current assets	1025.55	947.9	870.05	792	713.85	635.5	534.55	455.7	376.65	297.4	217.95	138.3	
Capital Equipment	190	190	190	190	190	190	210	210	210	210	210	210	
Less accumulated depreciation													
Net plant and equipment	190	190	190	190	190	190	210	210	210	210	210	210	
Total assets	1215.55	1137.9	1060.05	982	903.85	825.5	744.55	665.7	586.65	507.4	427.95	348.3	
Accounts payable	0	0	0	0	0	0	0	0	0	0	0	0	
Accrued expenses	15	202.5	201.25	200	198.75	197.5	216.25	215	213.75	212.5	211.25	210	
Total current liabilities	15	202.5	201.25	200	198.75	197.5	216.25	215	213.75	212.5	211.25	210	
Stock	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	
Retained earnings	-988.2	-1064.6	-1141.2	-1218	-1294.9	-1372	-1471.7	-1549.3	-1627.1	-1705.1	-1783.3	-1861.7	
Total stockholders' equity	1011.8	935.4	858.8	782	705.1	628	528.3	450.7	372.9	294.9	216.7	138.3	
Total liabilities and equity	1026.8	1137.9	1060.05	982	903.85	825.5	744.55	665.7	586.65	507.4	427.95	348.3	

Figure 5: Pro Forma Financial Statements for years 1 through 5.

Financial Statements - Overview ($000)

	Year 1	Year 2	Year 3	Year 4	Year 5
Income Statement					
Revenue			1000	3000	7000
Total cost of goods sold			68.75	206.25	481.25
Gross margin			931.25	2793.75	6518.75
Development	-938.2	-984.2	-720	-800	-850
Marketing	0	0	-160	-400	-680
G&A	0	0	-80	-80	-170
Total operating expenses	-938.2	-984.2	-960	-1280	-1700
Income (loss) from operations	-938.2	-984.2	-28.8	1513.8	4818.8
Interest expense	0	0	0	0	0
Interest income	41.4	19.3	4.2	3.5	49.6
Net interest	41.4	19.3	4.2	3.5	49.6
Income (loss) before taxes	-896.8	-964.9	-24.6	1517.3	4868.4
Net income (loss)	-896.8	-964.9	-24.6	1066.8	3246.7
Balance Sheet					
Cash and cash investments	1103.2	138.3	113.8	1631.0	6499.4
Prepaid expenses	5	15	20	20	25
Total current assets	1108.2	153.3	133.75	1651	6524.35
Capital Equipment	190	210	210	210	210
Less accumulated depreciation		38	80	122	164
Net plant and equipment	190	172	130	88	46
Total assets	1298.2	325.3	263.8	1739.0	6570.4
Taxes Payable	0	0	0	450.5	1621.7
Accrued expenses	195	187	150	108	71
Total current liabilities	195	187	150	558.5	1692.7
Stock	2000	2000	2000	2000	2000
Retained earnings	-896.8	-1861.7	-1886.3	-819.5	2427.2
Total stockholders' equity	1103.2	138.3	113.8	1180.5	4427.2
Total liabilities and equity	1298.2	325.3	263.75	1739	6119.85

Figure 6: Pro Forma Cash Flow by month for years 1 & 2.

Cash Flow - Fiscal Year 1 ($000)	Start-up	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9	Month 10	Month 11	Month 12
Sale of Stock	2000												
Sales	0	0	0	0	0	0	0	0	0	0	0	0	0
Purchases	0	0	0	0	0	0	0	0	0	0	0	0	0
A/R Collections	0	0	0	0	0	0	0	0	0	0	0	0	0
A/P Payments	0	0	0	0	0	0	0	0	0	0	0	0	0
Office	2	2	2	2	2	2	2	2	2	2	2	2	2
Wages	0	37.5	37.5	37.5	37.5	37.5	37.5	75	75	75	75	75	75
Utilities	0	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Phone	2	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Insurance	5	0	0	0	0	0	0	0	0	0	0	0	0
Capital Equipment	170	0	0	0	0	0	0	20	0	0	0	0	0
Software	10	0	0	0	0	0	0	0	0	0	0	0	0
Other	5	1	1	1	1	1	1	3.4	1	1	1	1	1
Cash Flow	1806	-41.4	-41.4	-41.4	-41.4	-41.4	-41.4	-101.3	-78.9	-78.9	-78.9	-78.9	-78.9

Cash Flow - Fiscal Year 2 ($000)	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	0	0	0	0	0	0	0	0	0	0	0	0
Purchases	0	0	0	0	0	0	0	0	0	0	0	0
A/R Collections	0	0	0	0	0	0	0	0	0	0	0	0
A/P Payments	0	0	0	0	0	0	0	0	0	0	0	0
Office	2	2	2	2	2	2	2	2	2	2	2	2
Wages	75	75	75	75	75	75	75	75	75	75	75	75
Utilities	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Phone	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Insurance	15	0	0	0	0	0	0	0	0	0	0	0
Capital Equipment	0	0	0	0	0	0	20	0	0	0	0	0
Software	0	0	0	0	0	0	0	0	0	0	0	0
Other	1	1	1	1	1	1	3.4	1	1	1	1	1
Cash Flow	-93.9	-78.9	-78.9	-78.9	-78.9	-78.9	-101.3	-78.9	-78.9	-78.9	-78.9	-78.9

Figure 7: Pro Forma Cash Flow for years 1 through 5.

Cash Flow - Overview ($000)						
	Year 1	Year 2	Year 3	Year 4	Year 5
Sales	0	0	1000	3000	7000
Purchases	0	0	68.75	206.25	481.25
A/R Collections	0	0	0	0	0
A/P Payments	0	0	0	0	0
Office	26	24	50	55	60
Wages	675	900	960	1280	1700
Utilities	9	9	9	12	12
Phone	3.8	1.8	2.5	3	3.5
Insurance	5	15	20	20	25
Capital Equipment	190	20	20	5	5
Software	10	0	15	5	5
Other	19.4	14.4	20	20	20
Cash Flow	-938.2	-984.2	-165.25	1393.75	4688.25

10.4 Financial Assumptions

1. Revenues
    a. Selling price for each manipulator will be held at $40,000 for all customers, unless breakeven can be ensured by a price reduction (through a quantity buy agreement or similar contract).
    b. Product will be ready for first office application (FOA) after 24 months.
    c. Bank account interest rate is 3%.
    d. Since our primary customers are major retailers or distributors, there should be no bad accounts.
2. Warranty
    a. All equipment will have a one-year warranty.
    b. Because of the large margins, warranty expense will not have a significant impact on the business.
3. Marketing Expense
    a. Because management will approach target accounts, marketing expenses will be kept low
4. Research & Development
    a. The initial R&D effort will take 24 months
    b. The company will spend at most $75,000 on each employee per year for the first 3 years, in the form of a salary and benefits. The employees' main financial incentive to stay will be an attractive stock plan.
5. Taxes
    a. Assume a 35% effective tax rate

6. Receivables
    a. No new sales transactions are expected to take place in the 4th quarter of any year, as the holiday season normally diverts our customers' attention to their immediate operations.
    b. Because there should be no bad accounts, and business in done by the third quarter, accounts receivable should be clear by the end of each year.
7. Inventories
    a. The only stock kept will be to support customer service and potential leasing programs.
    b. Because manufacturing will be outsourced, no stock will be held unless it is to be installed at a customer site.
8. Accounts Payable
    a. Assumes 30 days
    b. Because business is conducted in the first 3 quarters of the year, there should be nothing left in accounts payable at years end.
9. Additional Cash Requirements
    a. Assumes equity cash infusions, and therefore no interest costs.
10. Manufacturing
    a. No heavy capital equipment will be required, since manufacturing will be outsourced.

11 Proposed Company Offering

11.1 Desired Financing

PAPP seeks to raise $2 million dollars for its first 2 years of operation for product development and deployment. We will seek to obtain the entire $2 million from investors who would potentially be future clients of the company.

The company plans to incorporate and authorize 100,000 shares of common voting stock. 15,000 shares will be issued to the founders for their initial contributions. An additional 40,000 shares will be issued to outside investors to raise the $2 million needed to start the company. The remaining 45,000 shares will be reserved for the founders, initial and future employees in incentive stock option programs, vesting over 4 years.

The shares being sold pursuant to this offering are restricted securities and may not be resold readily. The prospective investor should recognize that such indefinite period of time. Each purchaser will be required to execute a Non-Distribution Agreement satisfactory in form to corporate counsel.[18]

11.2 Investor Returns

Since we intend to sell the company to a major materials handling firm around year 5, PAPP's investors will be able to harvest their investment at that time. Assuming the company is sold at the end of year 5 with a P/E of 20, the company should be valued at $93.8 million. Initial investors who put in $2 million will receive $37.5 million, yielding a ROI of 1875%.

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[18] Standard statement for private companies offering securities for sale. Timmons, Jeffry A. New Venture Creation: Entrepreneurship for the 21st Century, 1999

12 Appendix A

12.1 Pick-to-light

Some pick-to-light systems employ a simple PC controller with serial interface to a display panel with a starburst LED display and at button. White quoted the price for the first 'light' in a pick to light system as approximately $75,000, with additional lights costing ~$200. At the low end of the market, the average price for a large system is $150 per 'light'. The author and associate engineer estimated the lights/panels to cost no more than $20 to manufacture.

13 Appendix B

13.1 Picking

"Wave-picking" is the term used when people pick aggregations of items ordered, and not just items for a particular order. In pick-to-light systems, people normally cover a particular area for wave-picking. The example chooses a wave-picking scenario since it is an easier comparison, substituting a robot for a human picker. Wave-picking is an alternative to "Serial-picking", where people progress through the warehouse picking items to fill orders one by one.

13.2 Duty Cycle

Assuming a person works only 8 hours a day, then the duty cycle would be 8/24 = 1/3. A robot could potentially be operational 24 hours a day, and thus have a duty cycle of 1, which is three times that of a person.