Concept Development of Smoothie Machine for Convenience Stores

by

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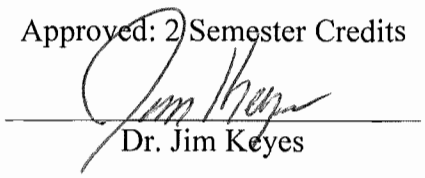

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Abstract

Today, the smoothie industry is a multi-billion dollar industry, where just in the United States reached more than $2 billion in sales in 2006, which meant a growth of 80 percent compared with the last five years. On the other side of the spectrum, the Convenience Stores market represents 60 percent of the entire Mass Grocery Retail market in the U.S., having sales of 507 billion in 2010, and that number is expected to growth to 800 billion in 2013 driven primary for the foodservice segments.

Nevertheless, the food and drink market have experienced significant changes toward healthy products, especially toward smoothies. Due to these changes, customers are demanding fresher quality products ready-to-go at convenience stores. However, the problem existing with Convenience Stores is the lack of natural options offered, which exposed an unexplored niche where a machine capable of producing ready-to-go natural fruit smoothies can be developed.

Throughout this research was performed a five step process of concept development, that addressed the best arrangement of parts, as well as details design and recommendation to further studies.

It can be concluded that the smoothie machine developed in this project represents a huge business opportunity, since there are almost no technologies available that serves this growing market at convenience stores.

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Acknowledgments

First of all, I want to record that this project it is entirely dedicated to my grand mother, as I just to called her "Mi Abila," who had diabetes most of her life until she passed away right before I started this master. It was always her wish for me to come abroad to get a master diploma.

Later I want to thank my parents for all their unconditional support throughout my life. They are always have been my role model and I really wish they can feel proud of all the work done so far.

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Chapter I: Introduction

In recent times, customer preferences have experienced changes toward good-for-you products. However, customers have found a wide range of differences and similarities, in terms of benefits and added functionalities among healthy products. One example is the debate generated in regards to organic and natural products (Berry, 2010).

According to Mintel International, products labeled as "Natural" are the main trend in marketing product introduction within the refrigerated juice category in the U.S., where 65 out of 170 products used the all-natural designation on their labels ("Changes in the Big Beverage Market," 2008). Simultaneously, The Organic Trade Association (OTA) reported that despite the world economic downturn experienced in United States by 2009, the organic segment has shown a stable growth of 5.1 percent, being a $26.6 billion market (OTA, 2010).

This raise in the demand for these types of products has made the smoothie very popular all across the country, despite the premium prices tagged on them. One of the reasons for their success is because smoothies across time have called the attention to those customers looking for new exiting products; given the exotic flavor options and endless combinations in which smoothies can be served (Bendall, 2005).

The frenetic rhythm of modern society has pushed businesses to create better and faster alternatives to customers, in order to provide what they want, in the moment they need it, and at convenient locations. For those reasons, since the 1950's, industries such as the "Fast Food" has been influencing other industries to become more efficient. That is the case of convenience stores, where a regular customer has an average time from the moment they walk in, until they depart of 3 to 4 minutes ("Convenience Store Count," 2010).

In our time, convenience stores play a remarkable role in the market, since most shoppers stop at convenience stores to get what they need in the daily basis ("Big retailers think small, 2004). That is why this industry represents 60 percent of the entire Mass Grocery Retail market in the U.S. ("Convenience Store Count," 2010), with approximate sales of $507 billion in 2009 ("U.S. c-stores," 2009), and nearly 160 million customers served every day ("Convenience Store Sell Time," 2009).

This market outlook represents a huge business opportunity, since there are an increasing demand for healthy products and technologies capable to provide those products in a more effective way. Therefore, this study has the mission to develop a smoothie machine concept capable to fulfill both trends, in an affordable way.

Statement of the Problem

Customers are demanding fresher quality products ready-to-go at convenience stores. The lack of natural options at these stores has addressed an unexplored niche, where ready-to-go natural fruit smoothies can be developed. The study will address this through the development of a smoothie machine.

Purpose of the Study

The purpose of this study is to develop a product concept for an automatic smoothie machine, through the simplification and optimization of processes for smoothie production at convenience stores all over the United States, as well as other countries where healthy products are demanded. This study involves a comprehensive overview of the industry trends, concept development process, terms and definitions, as well as the technologies in which the machine should be build to. Finally, this study provides recommendations to assess, manage, and create further studies that will lead improvements in the design.

Assumptions of the Study

1. The information is provided by reliable sources.
2. The existence of a supplier capable to provide 100 % just-blended frozen fruit required, with no preservative and any kind of complex industrial process to treat the fruits.
3. The meaning of customer refers to convenience stores' operators, as well as the end users.

Limitations of the Study

The study was limited only to the concept development process, which is the main creative process of product development. In addition, across this research the process performed was made individually, even though in some references were performed using teams to develop certain methods.

Methodology

The study was focused on the necessary inputs to begin the concept development process. Later, the concept was developed by performing a five step process that assures a strong understanding of the challenges to design a smoothie machine; as well as, the exploration and evaluation of technologies available in the market. In the research, graphical representations were used to illustrate each part of the product, and then the concepts were synthesized until the final decision was made, with the inputs being taken into consideration. Finally, the final concept was drawn in 2D and 3D to perceive the dimensions, as well as was calculated an estimated of the machine material cost and the machine price.

Chapter II: Literature Review

Overview of food industry

In recent years there have been witnessed an exponential growth in the demand of natural product. Although, it seems an old fashion idea, it is important to consider some facts of the food industry evolution, in order to understand the "whys" of this asseveration.

At the late of the 19th century, along the American continent, it was common seeing rural societies where families ate what they harvested, also where freshness was prerequisite. However, the dramatic growth that occurred in the twentieth century in the United States generated a great impact on the societies of the time, stimulating technological innovation to satisfy the new demands of early modern societies (Toops, 2007).

In 1913, Henry Ford started a revolution which changed the world economy forever with the creation of the mass production system, which proved being successfully applicable for many industries. By that time, this production system helped to manufacture affordable cars and products for the growing middle class (Ford Motors Company ®, 2010).

Also in 1913, the first electric refrigerator was offered (Frigidaire ®, 2008), as a consequence of this innovation, the food industry began to adapt its products, developing frozen food, satisfying the increasing demand of refrigerated products (Toops, 2007).

Furthermore, governments in the U.S. began massive transportation projects, in order to support the economy growth for the coming decades. As a result, cities grew larger because distance became shorter thanks to accessible cars, which eventually stimulated the migration to suburban areas, changing people habits forever.

During the 50´s, the food industry watched the birth of a new industry, where its main character was McDonalds ®. This industry was driven by efficiency and fast preparation, and

eventually this concept was well-known as "Fast Food." Altogether with the invention of the "drive-through," allowed customers to spend even more time in their cars (McDonalds ®, n.d).

Nevertheless, it was not until some scientific research made by the FDA, among other institutions, regarding health problems associated with high consumption of saturated fats and high sugar contents, when customers decided to look again into natural products (Toops, 2007).

In present times, in the U.S. has been noticed an increasing number of illnesses associated with diet problem. For instance, the American Diabetes Association (2011) shown that by 2011 around 18.8 million people were diagnosed with Diabetes in the USA, and this number is projected to rise to 48 million by 2050" (Oza-Frank & Narayan, 2010, para. 1).

Despite these facts, retailers consider products, such as packaged juices and snacks, very popular among customers. However, often times those products contain high levels of sugar, artificial flavors and preservatives; and even the natural options offered at the retailer level have certain amount of these additives.

This situation has created an intense debate about what is considered healthy, natural and organic, reshaping old wisdoms into a more complex reality, where customers' awareness is leading and redefining firms' strategies (Toops, 2007).

Therefore, many business initiatives are trying to develop healthier products, in order to supply the new demand for the coming years. In this matter Toops (2007) affirmed, "We know the food industry does not lead trends, it responds to world events and customers needs by developing technologies and foods that solve problems and deliver what the customers wants" (p. 15).

Natural Products vs. Organic Products

Recently, the discussion about organic or natural products is no longer simple, because both concepts intersect and overlap each others with attributes, such as: local, fresh, sustainable, safe, green, quality, lack of additives, among others (Berry, 2010).

The Hartman Group Inc. explains that organic and natural products are seem as complementary attributes by the time of costumer's decision making; That is why the perception of healthy products is driving them to purchase products that might be more expensive, but with better benefits in the long term (Berry, 2010).

The United States Department of Agriculture (USDA) through the National Organic Program (1990), defines organic production "as a production system that is managed in accordance with the Act and regulations in this part to respond to site-specific conditions by integrating cultural, biological, and mechanical practices that foster cycling of resources, promote ecological balance, and conserve biodiversity" (para. 1).

Also the USDA through the National Organic Standards Board (2005) defines "Organic" is a labeling term that notes products produced under the authority of the Organic Foods Production Act. The principal guidelines for organic production are to use materials and practices that enhance the ecological balance of natural systems and that integrate the parts of the farming system into an ecological whole" (para. 2).

In contrast, consumers understand the term "natural" as what happens to food after has been grown. In other words, it refers to food processes involved during the products preparation. That is why, often time consumers remain skeptical about the term "natural"; since in products labeled as "All-natural" it is possible to find ingredients with complex chemical terms, such as: stabilizers, emulsifiers and preservatives (Berry, 2010).

The U.S Food and Drugs Administration (FDA) has not developed a definition to allow the use of the term "Natural". However, the FDA has not rejected to the use of the "Natural" term if the food does not contain added color, artificial flavors, or synthetic substances (FDA, n.d).

As a consequence, more than ever before the uses of terms as "organic" and "natural" in food products are under controversy, because despite the apparent similarities that can be seen at first, both terms have big differences, in which customer's awareness will play a key role once the decision have to be made (Berry, 2010).

Organic Food in the U.S. Market

The Organic Trade Association (OTA) reported that despite the world economic downturn experienced in United States by 2009, the organic market reached $26.6 billion in sales, showing a growth of 5,1%. As shown in the table below (OTA, 2010).

Table 1.

U.S Food vs. Total food Sales

Category	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Organic Food	6,100	7,360	8,635	10,381	12,002	14,223	17,221	20,410	23,607	24,804
Growth %	21.0%	29.7%	17.3%	20.2%	15.6%	18.5%	21.1%	18.5%	15.7%	5.1%
Total Food (bn$)	498	521	530	535	544	566	598	628	659	669
Growth	5.0%	4.7%	1.7%	0.9%	1.6%	4.2%	5.5%	5.0%	4.9%	1,6%
Organic as % of Total	1.2%	1.4%	1.6%	1.9%	2.2%	2.5%	2.9%	3.2%	3.6%	3.7%

Source: "U.S Organic Industry Overview," by OTA, Copyright © 2010. Retrieved from: http://www.ota.com/organic/mt/consumer.html

Comparatively, based upon a survey conducted by OTA in the industry in 2010, fruits and vegetables represent the main organic segment, leading with 38 percent or $9.5 billion market. However, the organic beverage market represents the fourth most important with 13 percent (OTA, 2010).

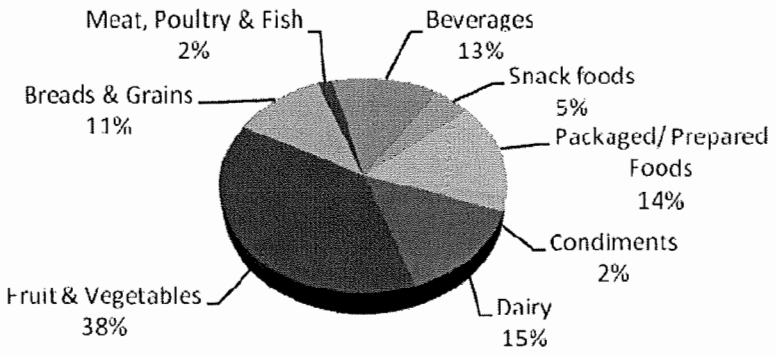

Figure 1. U.S. Organic Food Sales by Product, 2009
Source: "U.S Organic Industry Overview", by OTA, Copyright © 2010. Retrieved from: http://www.ota.com/organic/mt/consumer.html

The Smoothie Industry

Fruit Juice Smoothies or "Smoothies" are healthy beverages made from blended fruits. Smoothies for some people are considered healthy meals served in cups, however for others can also be considered more as snacks or desserts. Due to this versatility smoothies are called "the new beverage and drinkable meal for the future" (JASA, 2000, para. 1).

Nevertheless, in South America, Native American civilizations have known about the benefits of natural fruits for centuries, therefore this region is well known as the "fruit capital of the world". Currently, Brazil is the biggest supplier of exotic fruits in the world (JASA).

Smoothies became popular in the United States, specifically in the west coast, by the mid 60's, with the renaissance of vegetarianism, where restaurants and bars, as a result of this trend, had to adapt their menus to attract these new customers, evolving quickly in order to be able to

supply customers with new exotic tastes and products. By that time, one of the popular choices was the fruit juices or smoothies, an idea borrowed from its American neighbors of the south (JASA, 2000).

According to a specialize publication, a regular smoothie preparation includes (Doucette, 1998):

- Fruit.
- Fruit Juice.
- Ice.
- Sometimes Ice cream or yogurt and fortifying powder.

Nonetheless, contrary to common belief, the term "Smoothie" was not always related to fruit juices, in fact the term was used in several other businesses as a trade name, from car paint to gloves. The first known reference to frozen beverage came during the 70's with the name California Smoothie. However, a juice bar called Smoothie King was the one that imposed the word "smoothie" as is known presently (JASA).

Today, the smoothie industry is a multi-billion dollar industry, that according to Mintel in 2006, just in the United States, smoothie makers reached more than $2 billion in sales, comprised both categories made-to-order and packaged smoothies, which meant a growth of 80 percent compared with the last five years (LaFave, 2008). In addition, Global Industry Analyst (GIA) is expecting that the global market could reach $9 Billion Dollar by 2015 ("Global Smoothies Market," 2010).

Conversely, some experts assure that the smoothie market is not a fast moving trend. They argue that the smoothie market has grown gradually across the years, specifically since the

70's (Doucette, 1998). Despite the diversity of opinions, most experts agree that the raise of smoothies is the result of three foodservice trends (Bendall, 2005).

The first trend is the healthy trend, in which customers reject artificial flavors, demanding real things. In the smoothie case, that meant an increasing demand for fresh fruit smoothies, making it attractive for businesses due to the higher profit margin in comparison to traditional beverages (Bendall, 2005).

The second trend is for customized products, where despite healthy properties, customers demand more variety and functionality, from number of ingredients, such as: combination of exotic fruits, as well as, vitamins and proteins; in order to make unique drinks or signature items (Bendall, 2005).

Finally, the third important trend comes from traditional bars, specifically from cocktails preparation, where alcoholic smoothies are considered popular choices among young adult drinkers, as well as to female customers. Also, smoothies represent an attractive alternative to nonalcoholic drinkers and designated drivers (Bendall, 2005).

Additionally, The Juice and Smoothie Association (JASA), has ranked smoothies in order to categorize the quality levels of the different types of smoothie products. The ranking uses four categories: platinum, gold, silver and bronze.

Platinum Smoothie. It is considered the highest rank of smoothies, and it comprises "made to order" smoothies prepared with organic ingredients. Also, Platinum Smoothies contain fresh squeezed juice and real fresh fruit cuts in its preparation.

Gold Smoothie. This ranking also comprises "made to order" smoothies, with the difference being that theses smoothies are prepared with all-natural ingredients, such as: 100 percent frozen fruit and fruit juice from concentrates.

Silver Smoothie. This type of smoothie uses ingredients based on pre-smoothie mixes or starter bases. In addition, it is considered a Silver Smoothie, if it is made from 100 percent fruit purees. These products are generally served through dispenser machines and slushy machines. And sometimes different bases are blended to create flavor combinations.

Bronze Smoothie. It is considered a Bronze Smoothie if the smoothie does not contain natural ingredients in its preparation, such as pre-packaged or canned smoothies usually found in grocery stores, which contain high amounts of sugar and preservatives.

Smoothie bar categories

Juice bars

The most famous Smoothie franchises are within this category, and it comprises all quick service restaurant operations which specialize in "made to order" smoothies that use fresh squeezed fruit juices in their preparations (JASA, 2000). The United States operates a bit less than 2200 juices bars (IFA, 2010). Companies like, Planet Smoothie, Jamba Juice, and Smoothie King are the major players in the U.S. Smoothie franchise industry (JASA, 2000).

This category of bars does not require extensive space; because equipment's dimensions for the smoothie preparation are generally small; in fact the average size of these Juice bars is about 1000 square feet (Doucette, 1998).

Smoothie Store

This is other main category of Smoothie Bars. This category is basically the same as juice bars, it is specialized in made-to-order smoothies, but with the only difference being that it does not use fresh fruit and fresh squeezed juice in its preparation (JASA, 2000). An illustrative example of this type of smoothie bar is the restaurant McDonald's ®, since each smoothie served in those restaurants is made from 100 percent frozen fruit. In addition, McDonald's ® is the

biggest player under this category with 13,000 restaurants around the country (McDonald's Corp, 2010).

The figure below illustrates more clearly the market share Smoothie Bars franchises in the U.S.

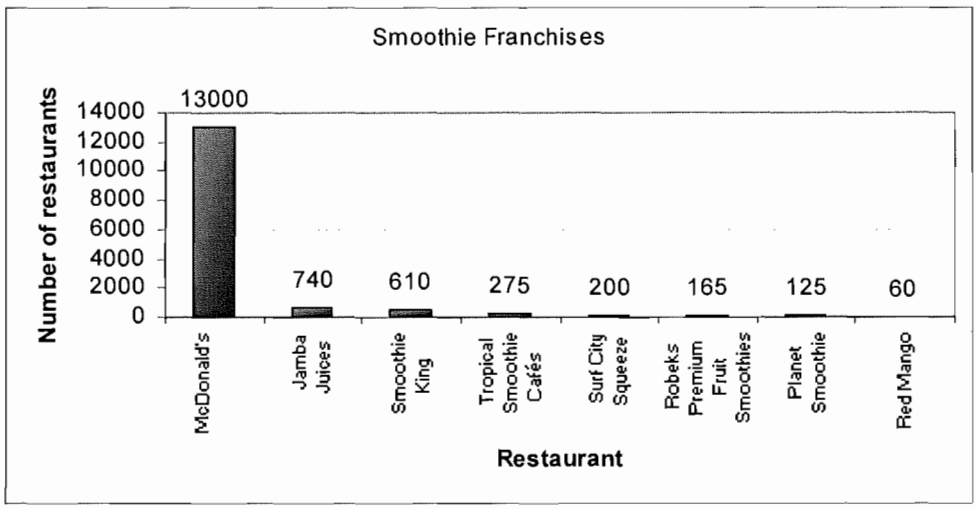

Figure 2. Smoothie franchise bars in the U.S
Adapted from International Franchise Association (IFA) and McDonald's Corp, 2010

Smoothies at Convenience Stores

Convenience stores, due to their importance as the biggest retailer channel in the U.S., are sensitive to all changes in customer preference toward healthy product; for this reason, convenience stores around the country have increased the use of slushy machines that offers 100 percent juices. However, some beverage bars in this business are moving beyond the traditional frozen drinks, by adding new tastes and technologies in order to attract more customers.

That is the case of f'Real ®, a company that has developed an innovative automatic smoothie and milkshake machine, in which customers just select the product from the under counter fridge, where all frozen flavors are located; once the seal is removed, the cup is placed in

a holder that automatically moves upward into the blender until the product is blended in same cup, by using hot water to meltdown the frozen product (Pape, 2010).

Moreover, some stores also are experimenting with made-to-order smoothie style drinks that contain real fruit cuts. However, the addition of natural fruits require extra cleaning and maintenance, and that is something unacceptable for most convenience stores due to the demanding environment in which these stores operate (Pape, 2010).

Smoothie bars equipment

Blender

Smoothies' popularity has led an innovation trend toward a new variety of blenders in order to supply the increasing demand for these products. In the Smoothie business each operator has its niche, because fruit juices can have endless combinations and consistencies. For that reason, blenders are considered as the most important decision to make for operators, since this equipment is the one that makes the product itself (Doucette, 1998).

Therefore, before any decision making, operators should take into consideration several product details to purchase the equipment that best fits their particular niche. For instance, it is important to know what kind of product is intended to blend, whether fresh fruit, frozen fruit or concentrate, since this sort of detail awareness can affect largely the final operator's investment. In addition, it is necessary to know the consistency required of the product, because the use of ice cubes can change the texture to grainy rather than homogenized (Doucette, 1998).

In today's market a wide variety of blenders are available that serve different needs. That is why, it is important to explore the existing categories and features, in order to understand why some blenders are better for some works than others (Bendall, 2005).

The basic machine

In the past basic blenders were the only choice available in the market. These blenders seem to be the type used in household; however, the main difference lies in the quality of the electric motor, since these units use the commercial version of these motors that lasts longer under much tougher use. Even though sometimes the motor's specifications can show the same horsepower as the regular one, but the differences are noticeable (Bendall, 2005).

Among the specifications, these units possess a two-speed motor with 1/3 horsepower, a Jar of 44-ounce or 1.3Lts capacity. Also, these equipments are capable to blend beverages in moderately low quantities, and the cost rounds $100 to $250 (Bendall, 2005).

Smoothie blender

The next levels are more powerful machines. These machines satisfy the needs of most Smoothie Bars. These units possess a one to two horsepower motors; and are built with heavy-duty construction materials, such as: all-metal drive gears and stronger cutting blades. These types of machines are around the $300-500 price range and are capable of blending ice and frozen fruit to an extremely fine consistency without separation of ingredients (Bendall, 2005).

Smoothie machine

The next level up involves powerful blenders with 3 to 5 horsepower. These blenders are built to produce a perfectly mixed smoothie drinks in a matter of seconds. Some of these blenders can be programmable depending on the ingredients, and are capable to sense the strain in the motor to assure the same consistency every time is needed. These machines can cost from $600 to $900 (Bendall, 2005).

Automatic smoothie machine

The latest technology in the blender market comprises of blenders that use high tech features, such as, a microprocessor to control ingredients, mix time, as well as the speed. Those features eventually allow operators to have the same product every time they want it, saving as well labor cost (Bendall, 2005).

In the market can be found the BDI Blendtec ® , this machine is able to manage up to eight different ingredients as well as controlling 64 different preparations. The BDI Blendtec ® operates by using fruit purees, water inlet, and ice dispenser. Once the product is selected the ingredients are dispensed into the container automatically and blended within the same machine. The only manual task is basically the container changing (Blendtec, 2011).

In addition, other simpler equipments are designed to automatically dispense all the liquid ingredients in the jar, by using pre-programmed recipes and later on are blended in a regular unit. In addition, there are some blenders that are capable to clean the container after the smoothie preparation. The cost of this kind of equipment could reach $3,000 to 6,000 (Bendall, 2005).

Nevertheless, one of the most interesting technologies in today's market is the already mentioned f'Real ® automatic smoothie and milkshake machine, which include an under counter fridge, with a cost of $8,000 (Mack, 2010).

Other features

The type of container is one of the choices to be considered while selecting blender. Currently, there are two main container options, the stainless steel one and the polymeric one. The stainless steel containers are durable. However, polycarbonate containers are considered

useful, since they allow operators to see the product inside, controlling better the final consistency (Bendall, 2005).

Whichever, the operator preference about container materials, every smoothie bar must purchase at least twice the number of containers than blenders, in order to avoid stops in smoothie production while cleaning the jars (Doucette, 1998).

On the other side, the feature to be taken into consideration is the use of noise isolation. The noise isolation or Muffler is a polymeric box that covers the entire blender while is working. The average smoothie bar serves approximately 300 people every day, where 5 blenders are usually used at the same time. However, during peak times that number could reach from 8 to 10 blenders running at once. As a result, noise can be issue to everyone around (Doucette, 1998).

For that reason the use of Mufflers is considered a solution to customers and employees, as well as for quiet bars and restaurants, however some operators disagree with that; because some assure that noise attract customer's attention (Doucette, 1998).

Additionally, another popular solution in noise control available in the market is blenders with motors under the counter. These arrangements have several advantages to operators due to its clean appearance and safety features. Under the counter blenders make the bar look much cleaner and less noisy, but on top of that, the blender container tends to be at a better height for easier operation (Bendall, 2005).

Refrigeration equipment

Aside from blenders, most smoothie operators require several types of refrigeration units, in order to be able to manage the wide range of ingredients required in the smoothie preparation. The table below shows the necessary refrigeration equipment in smoothie bars, as well as the costs involved (Doucette, 1998).

Table 2.

Commercial Refrigeration Equipment

Equipment	Use	Price
Ice maker	ice	$1,500.00
Glass door under counter unit	To store perishable product	$1,500.00
Refrigerated table unit	To hold frequently used cold ingredients	$1,500.00
Dip Boxes	To store fresh fruit and Ice Cream	$1,500.00
Total		$6,000.00

Adapted from Ebay Inc. (2011)

Convenience Stores

United States

The U.S. Census Bureau defines Convenience stores, NAICS Code 44512, as: "establishments primarily engaged in retailing a limited line of goods that generally includes milk, bread, soda, and snacks". In addition, the same Bureau defines Gas Stations with Convenience Stores, NAICS Code 44711 as "establishments engaged in retailing automotive fuels, in combination with convenience store or food mart items" (U.S Census Bureau, 2010).

The National Association for Convenience Stores (NACS) highlights that this industry serve nearly 160 million customers per day or 58 billion customers every year in the U.S. Moreover, 79 percent of the convenience stores sell gas, being the primary source for fuel in this country, representing 80 percent of all the gasoline purchased ("Convenience Store Sell Time," 2009).

By the end of 2009, the number of convenience stores in the U.S reached the 144,541, reporting a decrease of 0.2 percent ("Convenience Store Sell Time," 2009). The same year,

convenience stores overall sales reached $507 billion. This industry is expected to grow in the near future, according to Convenience Store News, despite the economic downturn faced in the U.S. in 2008, sales could reach $800 billion in 2013, driven primarily by changes in customer preferences for foodservice ready-to-go ("U.S. c-stores," 2009).

In the chart below is the growth of convenience stores throughout the last five years.

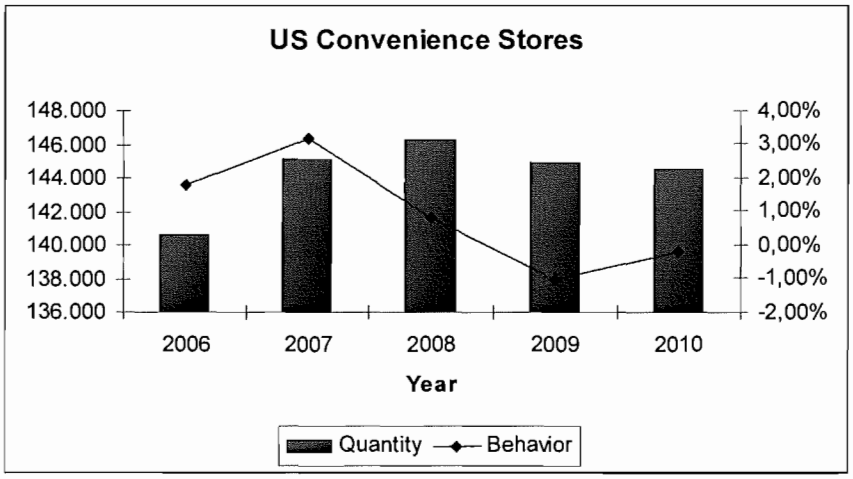

Figure 3. U.S. Convenience Stores
Adapted from NACS (2010)

In the next chart it is shown the top ten states, in terms of number of active convenience stores in each of these locations.

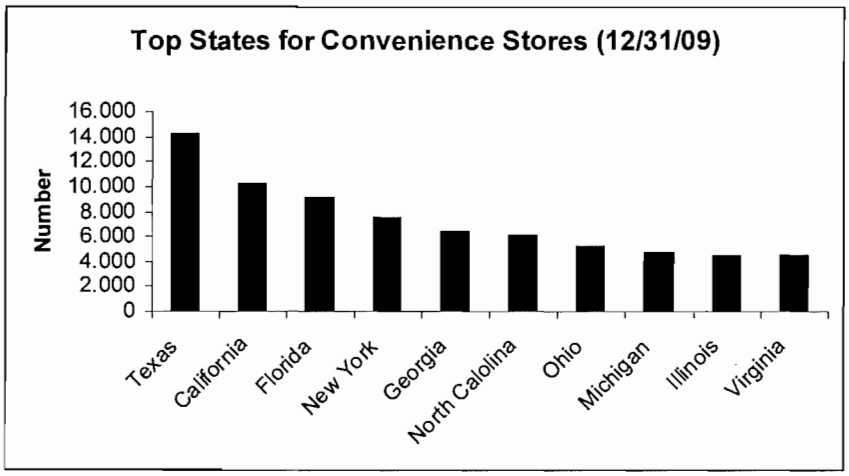

Figure 4. U.S. Top states for convenience Stores
Adapted from NACS, 2010

According to Country Monitor convenience stores have become more important throughout the years; because most shoppers go to large supermarket chains in order to get what they need for their weekly shopping, most of those shoppers prefer convenience stores to buy what they need on a daily basis, such as: snacks, newspapers, food and drinks, gas, among others (Big retailers think small, 2004).

It is unquestionable the importance of Convenience Stores, since this segment represents 60% of the entire Mass Grocery Retail market in the U.S, as is shown in figure 5.

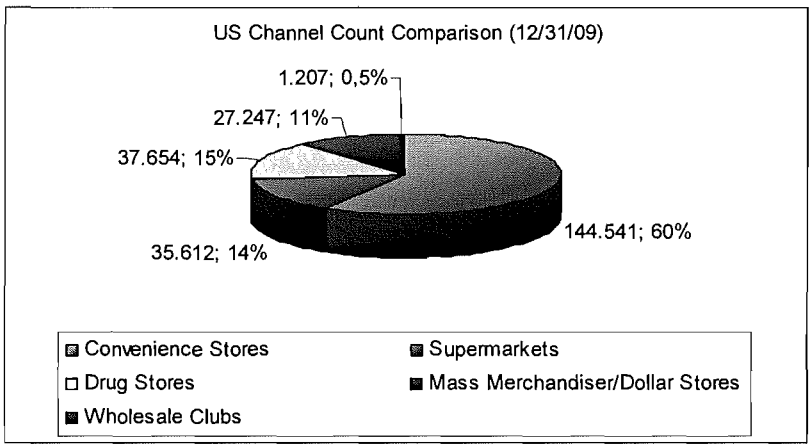

Figure 5. U.S. Channel Count Comparison
Adapted from NACS, 2010

For those reasons, convenience stores are considered a solution for modern life since they offer convenient locations and speedy service. In a study made by the NACS, called "*NACS Speed Metrics Research, 2002,*" a regular convenience store customer has an average time from the moment they walk in, until they depart of 3 to 4 minutes ("Convenience Store Sell time," 2010).

In chart 6 is presented the breakdown of the results obtained by this research.

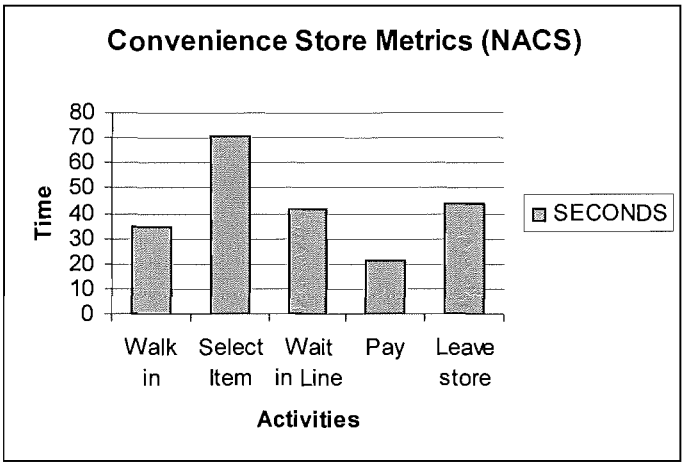

Figure 6. Convenience Stores Metrics
Adapted from NACS, 2010

Despite the high oil prices, more convenience stores are seeking to become restaurants in order to be more profitable, because contrary to common belief, convenience stores do not see significant profit from selling gas. For example, according to NACS, the average retailer sells 4,000 gallons a day, with an estimated 1.5 cents profits per gallon, that leaves a grand total of $60 profit per day from gasoline sales ("Convenience Store Sell Time," 2009).

Therefore, NACS highlights the key importance of food and drink categories for these retailers, since most of their revenues come from these products. An average convenience store makes about $20,000 a month just in foodservice sales ("Convenience Store Sell time," 2009). The chart below intends to present the foodservices sales distribution, in which can be noticed that beverage sales comprise 44 percent of the overall sales (figure 7).

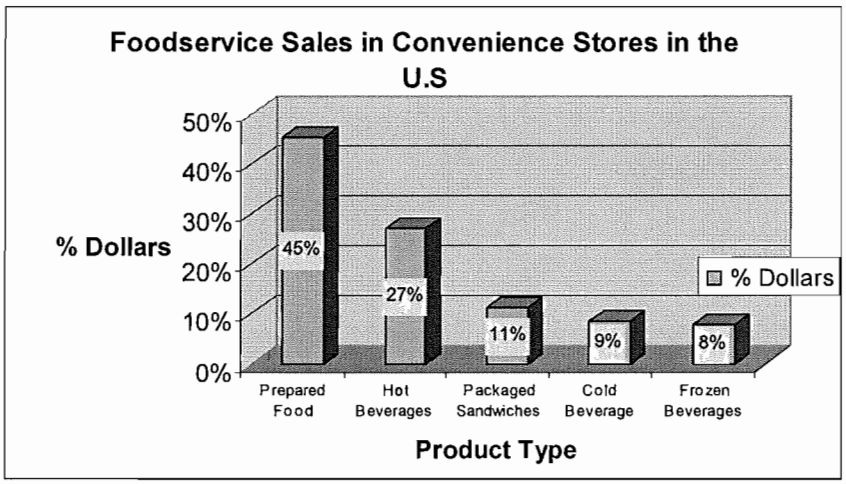

Figure 7. Foodservice Sales in Convenience Stores
Adapted from NACS, 2009

International Market Overview

From the international market standpoint, Japan is the unquestionable leader in convenience stores in the world after the United States. However, it is important to highlight the impressive growth experienced in china within five years (BMI, 2010). The charts below illustrate better the evolution of this sector in the international playground, in terms of quantity and sales.

Figure 8. International Market- Convenience Stores
Adapted from Business Monitor International, 2010

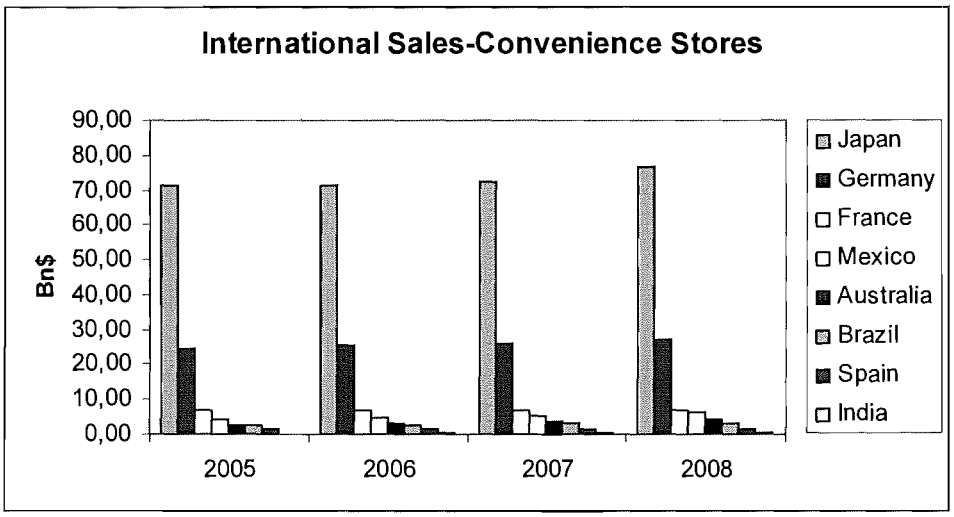

Figure 9. International Sales- Convenience Stores
Adapted from Business Monitor International, 2010

Convenience Store's Equipment

Hot dispensed beverages

The NACS in its study called "*State of the Industry data from 2008,*" explains that more than 95 percent of convenience stores offer hot dispensed beverages, where coffee is the number one hot beverage choice among convenience store visitors, gathering 78 percent of sales within the hot beverages category (Hamaker, 2009). In regards to this matter; the National Coffee Association assures that more than 150 million adult U.S. citizens drink coffee on a daily basis (Hamaker, 2009).

In addition, the same study mentions cappuccino as the second product in sales, representing 13 percent of the hot beverage category. Meanwhile, other hot beverages, such as Teas represent the remaining nine percent in customer preferences. As presented in the figure below (Hamaker, 2009).

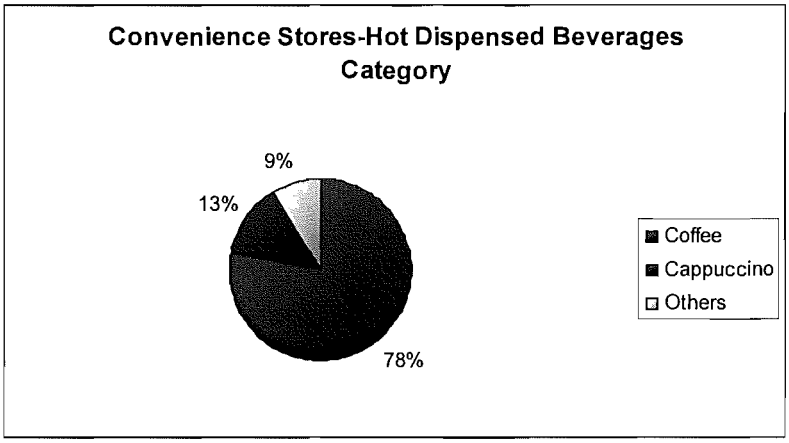

Figure 10. Convenience Stores-Hot Dispensed Beverages Category
Adapted from NACS, 2009

Given the importance of this market segment for operators, in table 3 it is revealed the cost involve in purchasing these kinds of equipments.

Table 3.

Automatic Hot Beverage dispenser

Hot Beverage Dispenser	Features	Price
Coffee, Cappuccino	2 Flavors	$1,000.00
Coffee, Cappuccino, Tea	3 Flavors	$1,450.00
Coffee, Cappuccino, Tea	4 Flavors	$2,100.00
Coffee, Cappuccino, Tea	5 Flavors	$2,386.00

Adapted from Ebay Inc. (2011)

Frozen dispensed beverages

In 1965, 7-Eleven ® introduced the original frozen dispensed drinks or slushy machine as it is known all across the United States. This frozen product came with colorful and sweet flavors that caused, by that time, an immediate impact among young customers (Pape, 2010).

Nowadays, frozen dispensed beverages capture just eight percent of the average sales in convenience stores; these products are still attractive to operators, because the estimated gross

margin of these beverages is up to 50 percent. This gross margin is the reason why, in today's market, 75 percent of all convenience stores have slushy machines in place (Pape, 2010).

Furthermore, Pape (2010) highlights the importance of aligning the customer trend toward healthy products with new product introduction at convenience stores, in order to be able to provide to customers the nutritional and emotional attributes they are looking for in every location. For that reason, some manufacturers are developing 100 percent natural juices for slush machines and in some cases operators have experimented with real fruit smoothies at stores (Pape, 2010).

In table 4 it is exposed the cost involved in purchasing these type equipments.

Table 4.

Frozen Beverage Dispenser

Frozen Beverage dispenser	Features	Price
Slush Machine	1 Flavor	$1,600.00
Slush Machine	2 Flavors	$2,250.00
Slush Machine	3 Flavors	$3,000.00

Adapted from Ebay Inc. (2011)

Product concept development

A product concept development process consists in a creative process based upon customers and the market needs, which is evaluated and provides a concise description of the working principles of a given product and technology (Ulrich and Eppinger, 2008).

One important component of a well performed concept development process is that it assures the developer a good product design in further phases of product development. At the same time, reduces the chances, at least in the short term, of finding better product concepts in

the market, since a well performed process should explore a wide range of alternatives and technologies (Ulrich and Eppinger, 2008).

The following five steps process has been developed by Ulrich and Eppinger, (2008). This process begins addressing the customer needs and the market which the product should be designed for, as well as setting a preliminary target specification of the product that will satisfy those customers. Once that basic information is clearly understood, under a structured approach, the process will follow a five steps method that will eventually lead to a better understanding and design of a product that will better serve the purpose.

Step 1: Clarify the problem

This step is based upon the implementation of a structured approach that helps frame the real dimensions of the overall problem. However before any step further, it is necessary to take into consideration three aspects: the mission statement of the project, the customer needs and the preliminary product specifications. Those inputs will provide to the concept developer with an initial idea of the product to be built, as well as the possible challenges throughout the creation path.

Nevertheless, often times the problem found is too complex to be solved as a single problem; in that case it is recommended to decompose the problem into more manageable sub problems.

This product decomposition is used as a basic graphical representation of the product, where main functionalities needed in the design are established. In this part of the process the deeper the developer goes the larger the alternative functions are; that is why those basic functionalities are usually divided into sub functions, in order to assure that each sub function is simple enough to work with.

Once the problem decomposition phase is complete, developers should focus all their efforts in the most critical sub problems, because that could provide the developer a better chance to create a concept that fulfill better the customer expectations.

Step 2: Search Externally

The external search is essentially an information gathering process that explores existing alternatives from sources that would contribute to solve either the overall problem as well as each of the sub problems in the project. Also, in this stage of the process it is not questioned how feasible technologies and functionalities are, because it is a fact that the more information the developer can gather the better the final concept will be.

There are five main ways to gather information from external sources: lead user interview, expert consultation, patent searches, literature searches, and competitive benchmarking. However, it is researcher's decision to consider which of the source will serve better the purpose.

Step 3: Search Internally

The internal search consists basically in an internal creative process where the developer uses all the information gathered from prior steps, being evaluate possible alternative for the concept, in order to generate as many ideas as possible that will satisfy the requirements.

The internal search can be done individually and in teams, but whichever the course of action chosen, the developer should welcome every idea no matter how infeasible the idea seems to be, because as was mentioned in the step before, the broader the options the better chances the product will have to be successful.

Step 4: Explore systematically

This step consists in organizing and synthesizing every piece of information gathered in prior processes, which will be considered the best possible combinations to solve each of the sub problems. In order to explore the different alternatives, two tools are used to manage the complexity involved in the evaluation process, these tools are: the concept classification tree and the concept combination table.

Concept Classification Tree. Concept classification trees are used to help the evaluation of possible concept alternatives into categories, which makes it easier to view the comparison between technologies. This graphical representation allows developers to focus their attention on the most promising technologies, to avoid wasting time in branches where the limitation can be risky.

Each of the most promising branches can be isolated as a particular problem, in which each branch can contribute with different approaches by offering solutions to the overall concept. Further evaluation of these technologies will, for first time, provide specific details of the concept. Details such as: dimensions, weight, cost among others, can determine whether or not those technologies can be applicable to the final concept.

Concept Combination Tables. A combination table is a graphical representation used to support, in some specific cases, branches in the classification trees where different combinations of promising technologies can be explored further. These combinations assure that the best arrangements of technologies can be implemented in the final concept.

Step 5: Product concept selection

This stage involves the final synthesis of the best concepts into a single concept capable of effectively satisfying the project requirements. The final decision can be made by using

different approaches; however the project owners are the main responsible to decide which approach should be performed in the final decision making. The following methods include:

- External Decision
- Intuition
- Product champion
- Pros and cons
- Prototype and test

Summary

In this chapter was discussed an overview of the food industry, followed by the organic market growth and the smoothie industry. Later, it was discussed the importance of convenience stores in the U.S and worldwide, and finally, it was explained the each of the five step of concept development process.

Chapter III: Methodology

The purpose of this study was to design an automatic smoothie machine, through the simplification and optimization of processes in smoothie production for convenience stores all over the United States, as well as other countries where healthy products are in high demand. The study involves a comprehensive overview of concept development process, terms and definitions, as well as the technologies in which the machine should be built. Finally, the study provides recommendations to assess, manage, and create further studies that would lead to improvements in the design.

This project was based on a five step process of product development that helps to explore and create a more efficient arrangement of parts. These phases are: clarify the problem, external search, internal search, explore systematically and results.

Nevertheless, prior the concept development process, it was necessary to address the preliminary information of the project in order to visualize the initial idea of the product to be designed.

Those preliminary inputs were the following ones:

- Mission Statement.
- Customer Needs.
- Preliminary Specification.

Table 5 consists of the development of the mission statement of the project. Here, the initial idea of the product and the market in which the machine should be focused on were exposed.

Table 5

Mission Statement

Mission Statement	
Product Description	Product should blend, auto-clean, be quiet, user friendly, medium dimension, and quickly make the product.
Benefit Proposition	Multiple flavor combinations with low labor cost and maintenance.
Key Business Goal	Provide the market of convenience stores with 100 percent real smoothies, under the gold category.
Primary market	Convenience store bars.
Secondary market	Fast food franchises and food service business in general
Assumtions and constrains	• Natural fruit requirements can be supplied. • High-tech machine. • Frozen product handling. • The machine will provide product rapidly, taking care of the hygiene standards.
Stakeholders	Purchaser and users, the developer.

Later, based on the assumptions developed in the mission statement, the next step was to identify the next input, the customer needs. However, the customer needs were divided in two categories, since convenience store operators and end users are considered customers.

The preliminary target specifications, were based on the information gained from the customer needs and the mission statement, the basic requirements were established. Also, some of the values exposed in this stage were gathered from the industry information.

Concept Development Process

Clarify the problem

Once the inputs were completely addressed, it was possible to begin the concept development process. Due to the complexity involved in the design of a new smoothie machine, it was necessary to perform problem decomposition. Nevertheless, it is important to highlight that because of the complexity expressed before, it was necessary to divide the process in two levels: the smoothie production process and the cleaning process.

External Search

Subsequently, once the functional decompositions were completed, the external search was performed to gather information from external sources about technologies available in the market. Among the sources used were:

- Internet.
- Literature.
- Benchmarking.

The first action taken was the exploration of related products in use at convenience stores. Later, the blender market was studied, as well as the cost involved in refrigeration equipment to manage smoothie ingredients. Finally, a benchmarking activity was performed to compare the closest technologies.

Internal search

Once the external search was completed the internal search was started. In this step the developer performed a creative exploration of possible solutions to each of the sub problems, by using all the information gathered in prior stages.

Explore systematically

In this stage, all the information was synthesized by using classifications trees and combinations tables. The combinations tables were used any given time the classification tree became too complex to be developed.

Result

Once all the decisions were taken and hardware components of the machine were well specified, it was necessary to illustrate through drawing the solutions to each of the sub-functions, as well as the step-by-step of the process. In those drawings, 3D views of the machine's final arrangement were shown.

Summary

In this chapter the procedure implemented was discussed in the concept creation of a smoothie machine, in which the information was decomposed, analyzed and synthesized until the decisions of each of the machine parts were made.

Chapter IV: Results

The market has experienced significant changes in customer's preference toward healthy products, especially toward smoothies. Thus, the purpose of this study was to design an automatic smoothie machine, through the simplification and optimization of processes in smoothie production for convenience stores all over the United States, as well as other countries where healthy products are demanded. The study involves a comprehensive overview of concept development process, terms and definitions, as well as the technologies in which the machine should be built. Finally, the study provides recommendations to assess, manage, and create further studies that would lead to improvements in the design.

The study was focused on addressing the necessary inputs to begin the concept development process. The concept was developed by performing a five step process. The first step was to assure a well understanding of the challenges involved in the design of a smoothie machine. Later, an exploration and evaluation of technologies available in the market was performed. Additionally, graphical representations were used in the research to clearly illustrate each of the product parts, and the concepts were synthesized until the final decision was made. Later on, the smoothie machine was drawn in detail and a material cost was calculated.

Based on the information exposed on table 5 it was possible to determine the mission statement of the project:

Mission Statement. Design an automatic smoothie machine for convenience stores; that has the capability to rapidly deliver 100 percent real fruit smoothies, under the gold category, at the right price. The smoothie machine will help support the future growth of our primary customers, and increase the well being of our end users.

The customer's needs were divided in two categories, convenience store operators and end users. The result of the process is expressed below.

The following needs were addressed from the store operator's standpoint:

- Low labor cost.
- Easy maintenance.
- Low energy consumption.
- Affordability.

The following requirements were considered in the case of end users:

- Customers can see the product being blended.
- Clean process.
- Friendly user machine.
- The machine should be able to provide the product within a reasonable period of time.

Once the mission statements and the customer needs were addressed, it was possible to determine the preliminary specification of the product to be developed. Among these specifications were found:

- The process should take less than 70 seconds per customer, to provide the product within the average time that it takes a regular customer to select a product at convenience stores.
- The machine should be able to manage solids, liquids and powder.
- The machine should use packaged frozen fruit to assure product freshness.
- The noise level should be between 40-65 DN, which means should be no noisier than a dishwasher.
- The product dispensed per cup should be between 12 OZ (355 ml) and 16 OZ (500 ml).
- Blender should have at least a two horse power electric motor.

- No waiting time between customers.
- The smoothies made by the machine should be under the Gold category.
- The auto cleaning process should use hot water as solvent.

Clarify the Problem

During the problem clarification was necessary to divide the process in two levels: the smoothie production process and the cleaning process.

The figure 11 is the result of the first problem decomposition into basic functions needed in the smoothie production process.

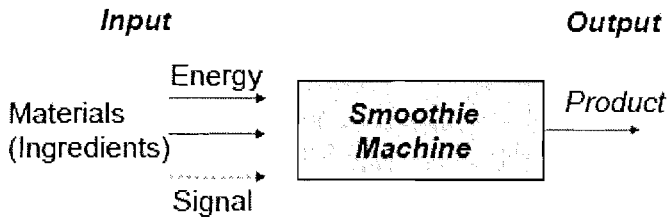

Figure 11. Level I, Problem Decomposition

Subsequently, Figure 12 consists in the first problem decomposition of the cleaning process.

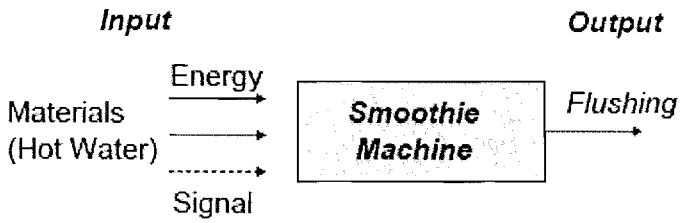

Figure 12. Level II, Problem Decomposition

Once both levels were decomposed, it was necessary to perform a more detailed decomposition. The result of this process can be seen in the next two figures.

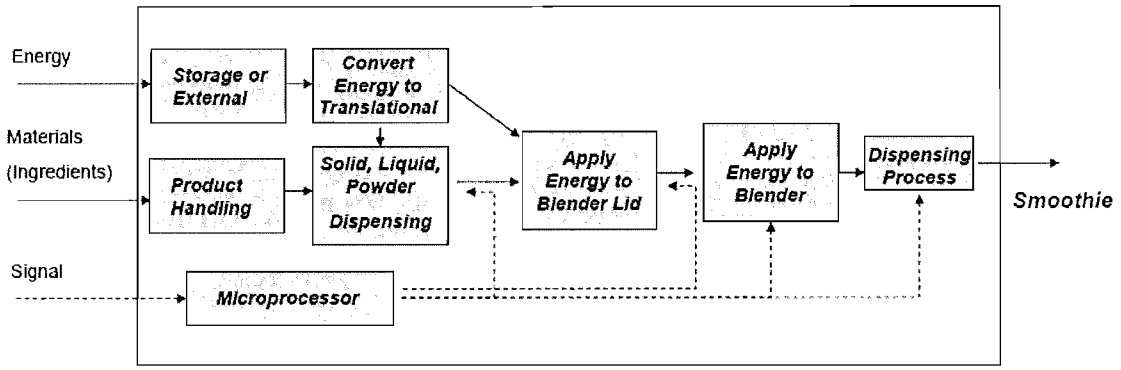

Figure 13. Level I, Functional Decomposition

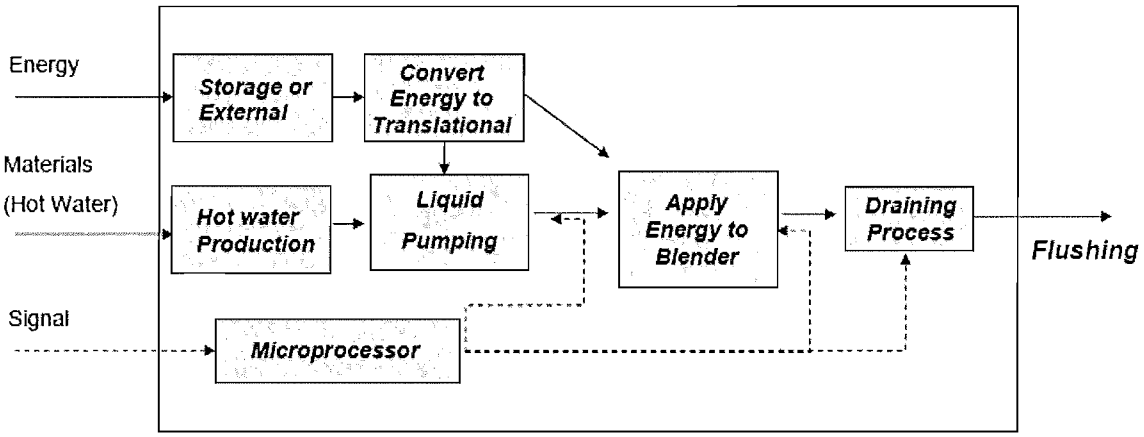

Figure 14. Level II, Functional Decomposition

The above figures indicate the use of a microprocessor, as the one responsible to control each of the sub-functions during the smoothie production and the cleaning process.

External search

Based upon the information gathered from table 3, automatic hot beverage dispensers can vary from prices of $1,000.00 (two flavors) to $2,386.00 (five flavors), being this segment is responsible for 27 percent of the total food service sales in convenience stores.

Moreover, Slushy machines were the next equipment to be studied. Based upon the information gathered in table 4 the price of these equipments can vary from $1,600.00 (one flavor) to $3,000.00 (three flavors). Frozen products are responsible of eight percent of total food service sales in convenience stores.

Afterward, as can be seen in table 6, it was studied the blender market, in order to provide a more accurate general idea of the current technologies used in the smoothie preparation.

Table 6

Blender types and prices

Blender	Type	Unit Price
Basic Unit	1/3 HP	$100-$200
Smoothie Blender	1 to 2 HP, heavy-duty	$300-$500
Smoothie Machine	2 to 3 HP, programmable, Sensitive electric motor	$600-$900
Automatic Smoothie	BDI Blendtec®	$3,000
Machine	F'real ®	$8,000

Additionally, based on the information gathered in table 2, the refrigeration equipment involved in the smoothie preparation can be valued in $6,000.

Later on, based in the information gained from above table, it was possible to perform a benchmarking activity in order to analyze the closer technologies to be outperformed.

As a result, in table 7, the BDI Blendtec ® analysis; and later in table 8 the f'real ® milkshake and smoothie machine analysis can be seen.

Table 7

Benchmarking activity BDI Blendtec ®

Pros	Cons
• Use fruit purees. • Easy product handling, just plumbing systems. • Machine cost $3,000. • Easy manufacturing process. • Some machines are capable to handle automatically ice cube portions. • Low chances of product leaking.	• High-tech features can be overwhelmed. • Require certain level of expertise, since the machine can manage 8 different flavors and 64 combinations. • The target market of this machine is bars, rather than convenience stores. • Requires extra space for product racks (Bag in the box technology). • Within the silver category of smoothie (Fruit puree). • Manual cleaning process. • It can not be seen where products come from while are dispensed. No natural perception.

Table 8

Benchmarking activity f'real ®

Pros	Cons
• Designed to convenience stores. • Moderate acceptance among operators, with 4,000 locations. • Easy to use. • Have under counter refrigerator. • Easy product handling.	• Long shaft, increase vibration and as a result parts fatigue. • Costly equipment, $8,000.00. • Complex manufacturing process, which includes: 273 different pieces; 74 different suppliers. • Within the silver category of smoothie. • During the cleaning process the machine leaks. • It can not be seen the product being blended.

Internal search

Once the external search was completed the internal search was started. Table 9 consists of all the possible solutions to each of the main sub-functions evaluated in the problem clarification process.

Table 9

Level I: Solution to sub-problem product dispensing

Solid	Liquid	Powder
• Auger wire. • Manually. • Auger wire and manually unpackaged. • Linear motion X, Y, Z. • Robot hand.	• Electric water pump. • CO2 driven pump. • Pressure from store. • Manually.	• Hooper-Auger wire. • Air pressure. • Manually.

Table 10

Level I: Solution to sub-problem of product handling

Solid	Liquid	Powder
• Internal freezer. • External freezer.	• Water tank. • External Tap water. • External water bottle.	• Hooper. • Paper bags.

Table 11

Level II: Solution to Sub-problem Hot water

Hot water production	Liquid pumping
• Electric water heater tank. • Tankless electric water heater. • Boiler. • Solar water heater.	• Electric water pump. • CO2 driven pump. • Pressure from store.

Table 12

Solutions to Sub-problem Apply Energy

Lid system	Blending process	Dispensing process
• Linear motion-Z axis. • Angular motion-gear. • Manually	• Automatically activate. • Push button.	• Automatically by draining pipes attached to container. • Manually. • Angular motion to pour product.

Explore systematically

Once all the options were addressed, all the information was synthesized by using classifications trees and combinations tables. The result of this process can be seen in the figures and tables following:

The first process considered was the machine's energy source, because according to the inputs established in the beginning of the process the machine will have high-tech features. For that reason, it was decided to choose the wall outlet as primary source of energy to prevent energy outage during peak hours (Figure 15).

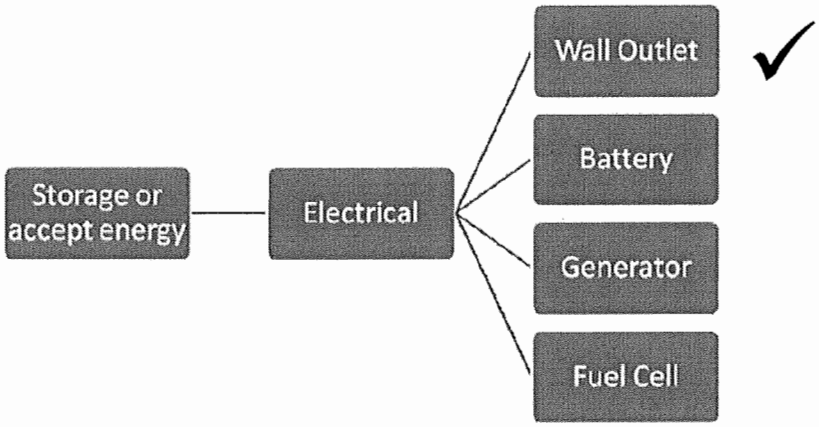

Figure 15. Clasification tree, subfunction energy

The combination table below was performed to explore the best combination of product handling and solid dispensing. This decision was considered critical, since the fruit is the main ingredient used in smoothie's preparation.

The combination chosen it can be seen in the figure and the table below:

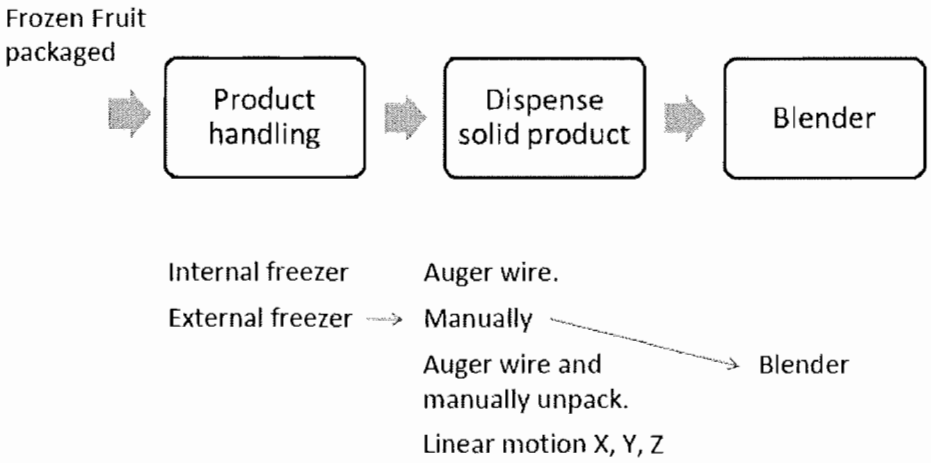

Figure 16. Combination table, Frozen fruit

Table 13

Pros and cons, Frozen Fruit

Pros	Cons
• Proven technology available. • Easy task for costumer. • It helps to reduce machine cost. • Increase customers' interaction in the preparation. • Increase hygiene. • Simpler arrangement of parts. • Reduce technology complexity. • Reduce machine weight. • Long lasting product, since it is packaged.	• Increase the product time selection. • Increase overall process time. • Increase variability.

The linear motion can be used in possible automatic unpacking processes; however it was not taken into consideration because it would have increased dramatically the machine cost.

The following figure and table consist of the result of the sub-function water handling and water temperature. In regards, the water temperature was a pretty straight forward decision, since the product used by the machine is frozen fruit, the water temperature will not make a remarkable difference to the final product.

The water source chosen was the store water, because the convenience stores water can fulfill the two main prerequisite: pressure and cleanness; because most convenience stores are

designed to manage several pieces of equipment that require certain levels of water pressure, such as: hot beverage dispensers, slushy machines and car wash. On the other hand, from the water quality standpoint, the FDA (2011) requires high levels of water purification in order to be able to sell in store beverages.

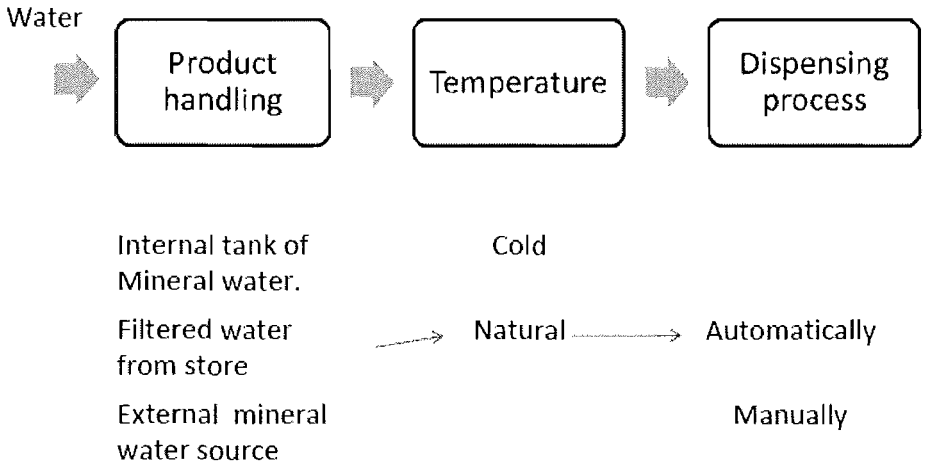

Figure 17. Combination table, cool water

Table 14

Pros and Cons, Cool water

Pros	Cons
• Cheaper. • Simple arrangement of part. • Decrease machine weight. • Easier process to customers. • Proven technology. • Some technologies already in place.	• In case of outage of water the machine cannot operate.

Figure 18 and Table 15 illustrates the best combination found it in the particular case of powder handling and dispensing. The technology used in powder dispensing has been around for centuries and its implementation is relatively cheap and simple.

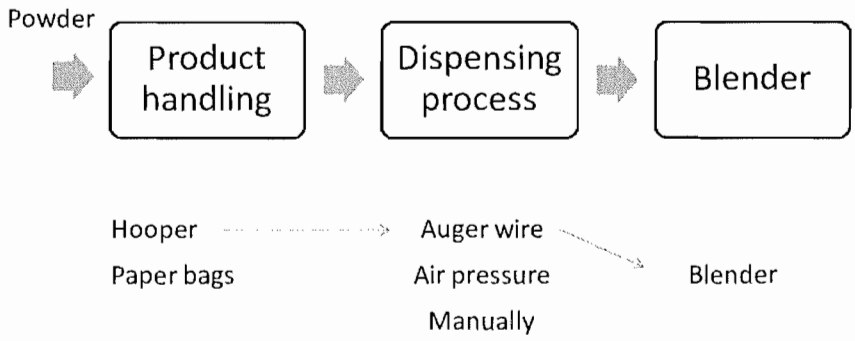

Figure 18. Combination table, automatically powder dispensing

Table 15

Pros and Cons, Automatically Powder Dispensing

Pros	Cons
• Better portion control. • Proven technology. • Reliable and simple technology. • Cleaner process. • Easy to manufacture.	• Increase cost. • Increase the use of parts and technology. • Increase complexity. • The powder portion has to be fixed.

Figure 19 shows the combination chosen in the particular case of hot water production and pumping processes. In addition, table 16 provides several advantages of using a tankless water heater to the overall design.

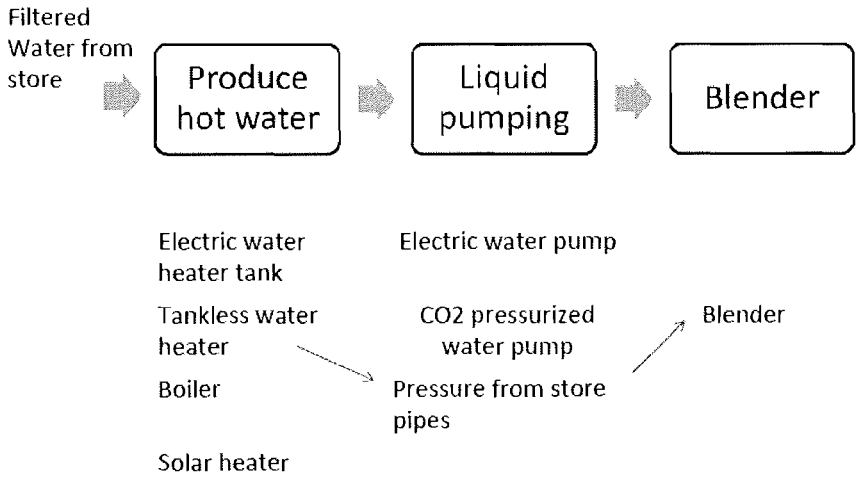

Figure 19. Combination table, Tankless water heater and store pressure

Table 16

Pros and cons, Tankless Water Heater and Store Pressure

Pros	Cons
• Proven technology. • Hygienic. • 60 percent less power consumption. • Dramatically less weight. • Simple arrangement of parts. • Less water consumption. • Increase available space within the machine.	• Limited hot temperature. • Limited hygiene.

Finally the last decisions were made by using classification trees. Figure 20, 21 and 22 show the result of this process.

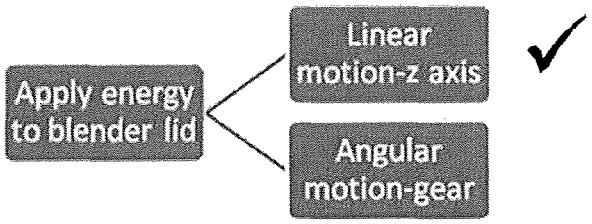

Figure 20. Clasification tree, subfunction Apply energy to Blender Lid

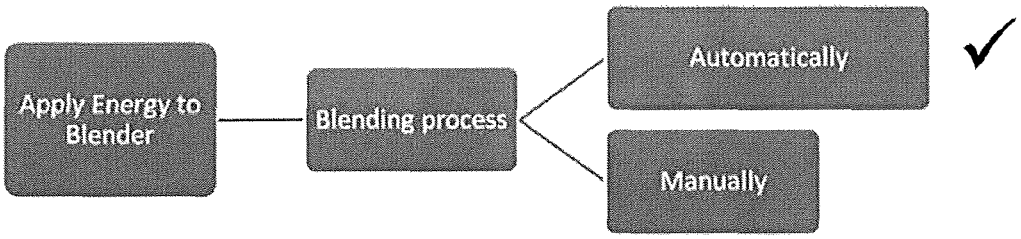

Figure 21. Clasification tree, subfunction Apply Energy to Blender

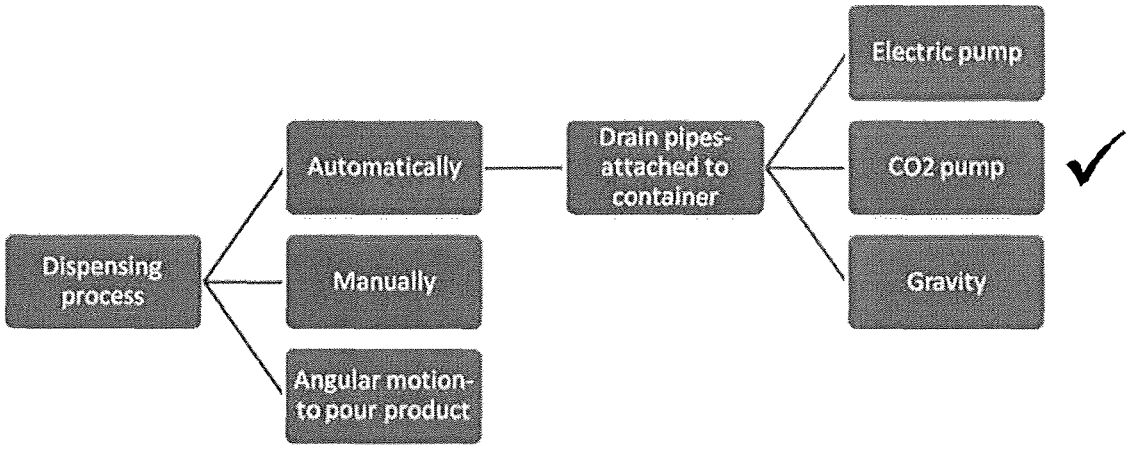

Figure 22. Clasification tree, subfunction Dispensing Process

Figure 22 consists of the result of the final product dispensing processes. This decision was critical, because this design represents one of the differentiation points with the rest of the technologies in the market, aside from the mobile lid in figure 20.

Result

Figure 23 illustrates the solution to the final product dispensing commented in figure 22. This final arrangement includes two blenders in order to avoid waiting time between customers while cleaning. In addition, the container capacity established was 20 OZ or 600 ml; and the serving size was established with 12 OZ or 355 ml per cup. Beside, about the CO2 driven pump was established a minimum discharge capacity of 100 ml/sec or 3.4 OZ/sec

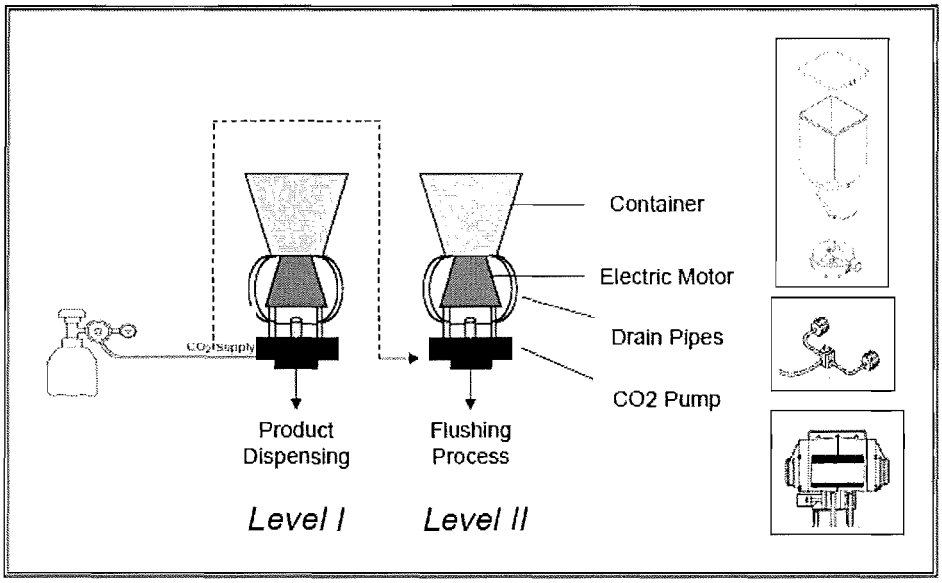

Figure 23. Solution to subfunction Dispensing Process

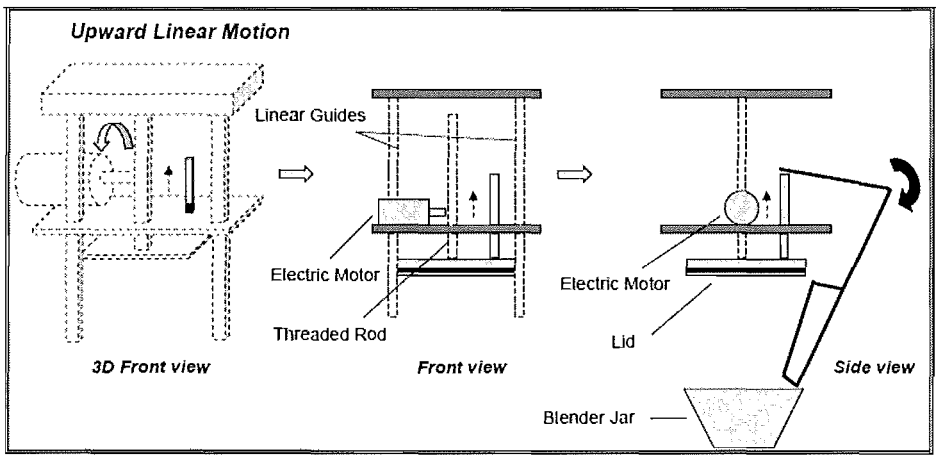

Figure 24. Solution to subfunction Apply Energy to Blender Lid, upward motion

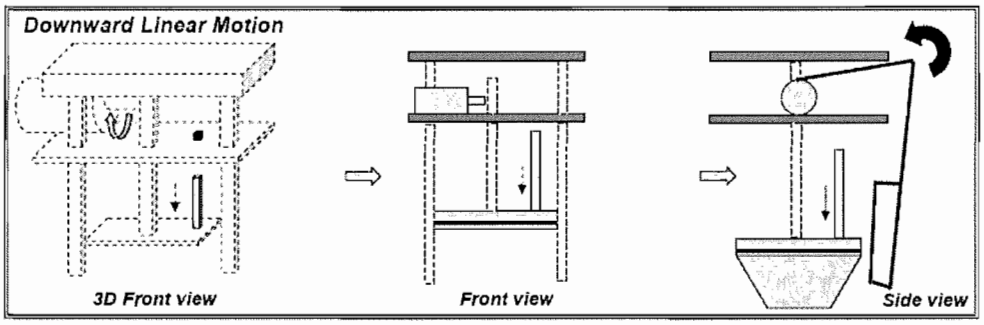

Figure 25. Solution to subfunction Apply Energy to Blender Lid, downward motion

Figure 24 and 25 illustrate the solution expressed in figure 20. It was decided to control the linear motion of each of the lid container by using stepper motors, because it is required that the Lid seals well every time the process is carried out.

Additionally, as can be seen in both figures, the design takes advantage of the linear motion to help control the powder dispenser. Also, when the lid is placed at its maximum height, a pin installed at the top of the lid pushes the mobile dispenser upward, transforming the linear motion into angular motion, placing the powder dispenser in the exact position at internal edge of the blender container.

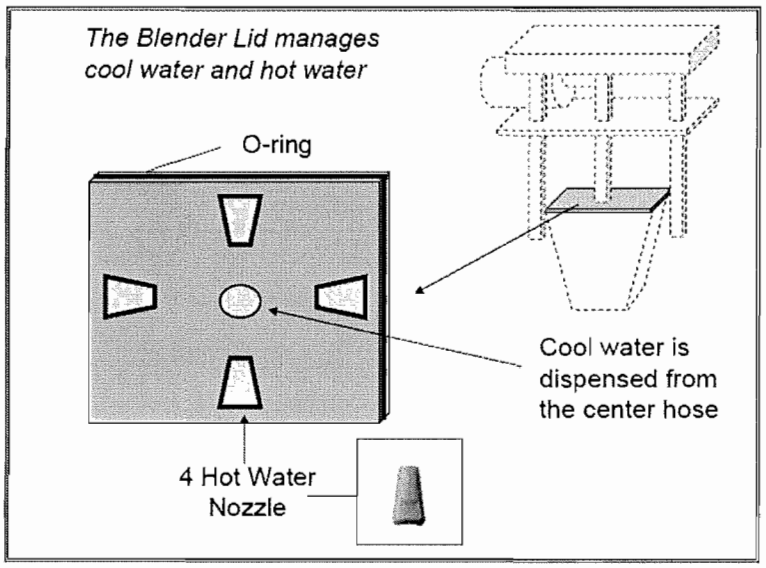

Figure 26. Solution to subfunction Apply Energy to Blender Lid, Lid description

The figure 26 represents the solution of figure 21. Here, four nozzles pointing out to each of the container's walls were used in order to assure the effectiveness of the cleaning process while the hot water is running. Also, it was decided that the cool water is going to be pumped through the container lid.

Each of the drawings below expresses the result of the water handling sub-function. From both figures, it can be interpreted that simplicity is the most important characteristic, since the water supply represents one of the most critical choices to reduce the machine complexity and cost.

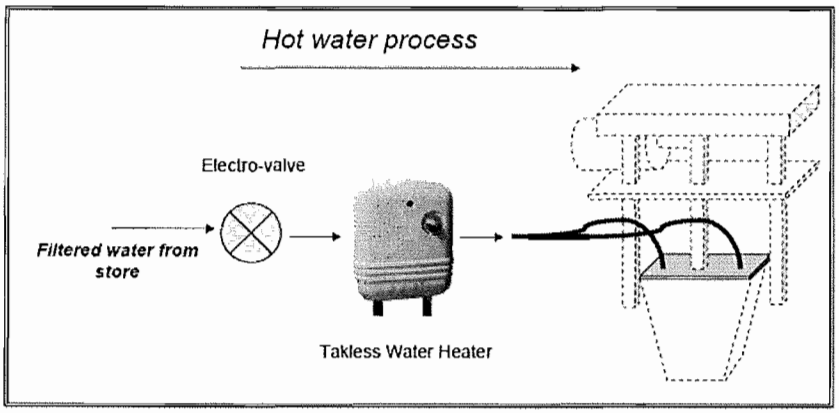

Figure 27. Solution to subfunction Hot water

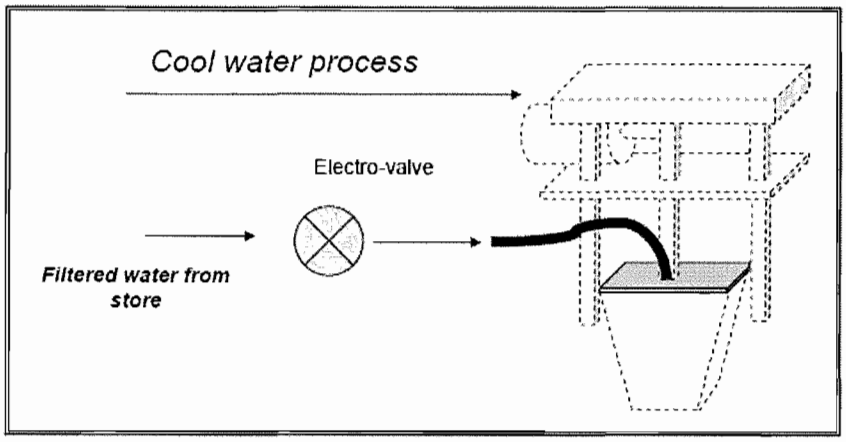

Figure 28. Solution to subfunction cool water

Figure 29 illustrates in more detail the powder dispensing operation, which consists of one hoper with two auger wires at each of the sides of the machine. Every time the blender lid

reaches its highest position, the auger wire will spin one revolution, providing with the necessary amount of product for the smoothie.

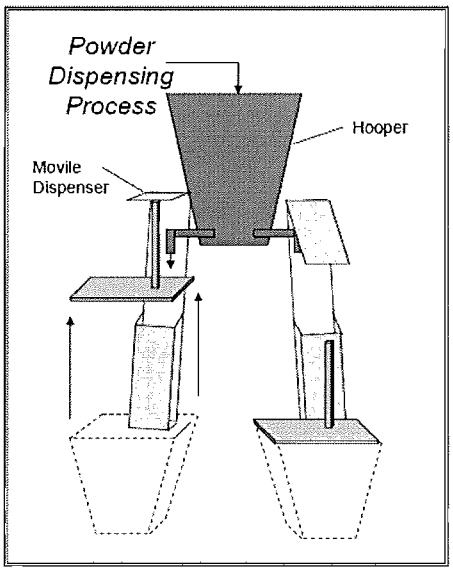

Figure 29. Solution to subfunction Powder Dispensing

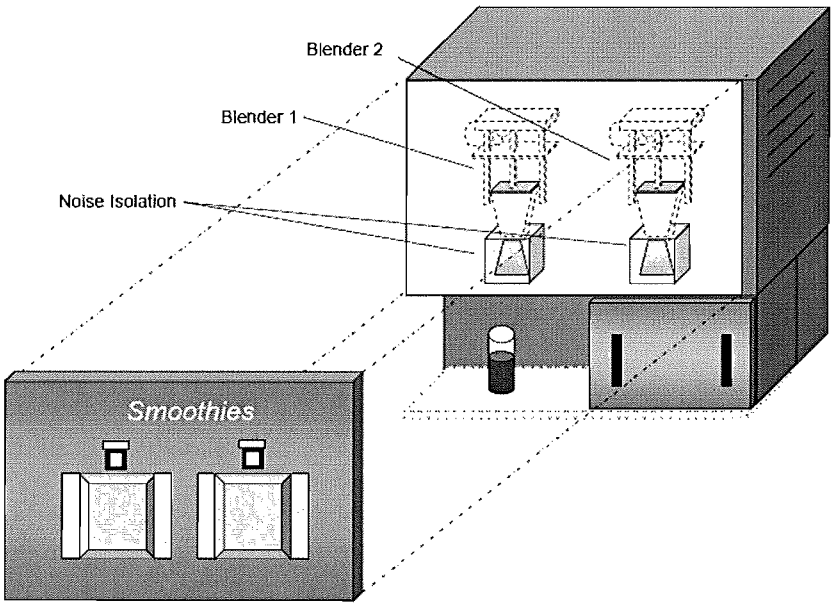

Figure 30. Machine Noise control arrengement

One of the preliminary specification established from the beginning of the process was related to the necessity to control the noise. In this regard to accomplish this requirement each of the blender motors are going to be cover by using noise isolation material (figure 30).

Once, one by one, all problems were solved, it was necessary to illustrate graphically, how the whole system works. The subsequent figures show the step-by-step progression of each of the processes.

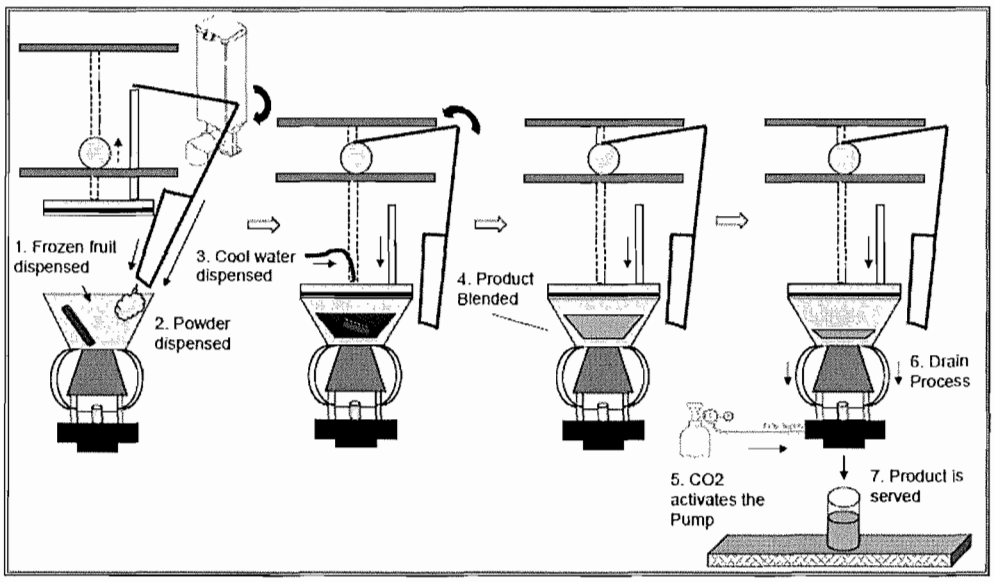

Figure 31. Solution to Process Level I

Figure 31 illustrates the entire level I process in detail. Once the customer has chosen the fruit from the under counter fridge, the frozen fruit is unpackaged and dispensed manually through the machine door, falling into the container. Subsequently, depending on the customer's preference toward sugar, the powder can be dispensed. Afterward, the cool water is dispensed through the container lid, following the blending process. Once the product dispensing process has started and the cup is taken by the customer, the door is closed prepare the machine for the cleaning process.

Figure 32 shows the level II or cleaning process, which is a process made basically by spraying hot water through the blender lid and the whirlpool formed by the blender when activated.

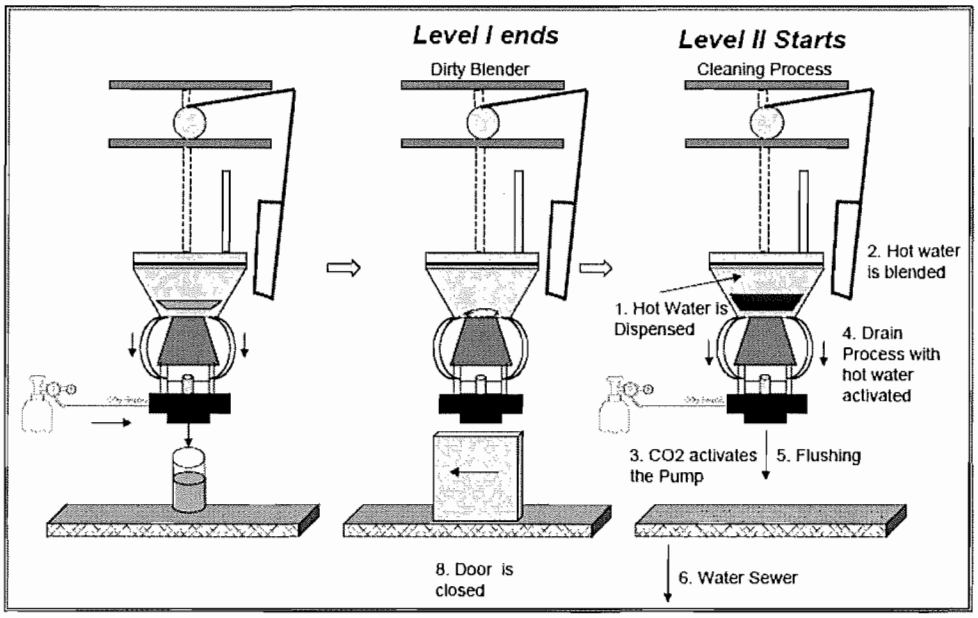

Figure 32. Solution to Process Level II

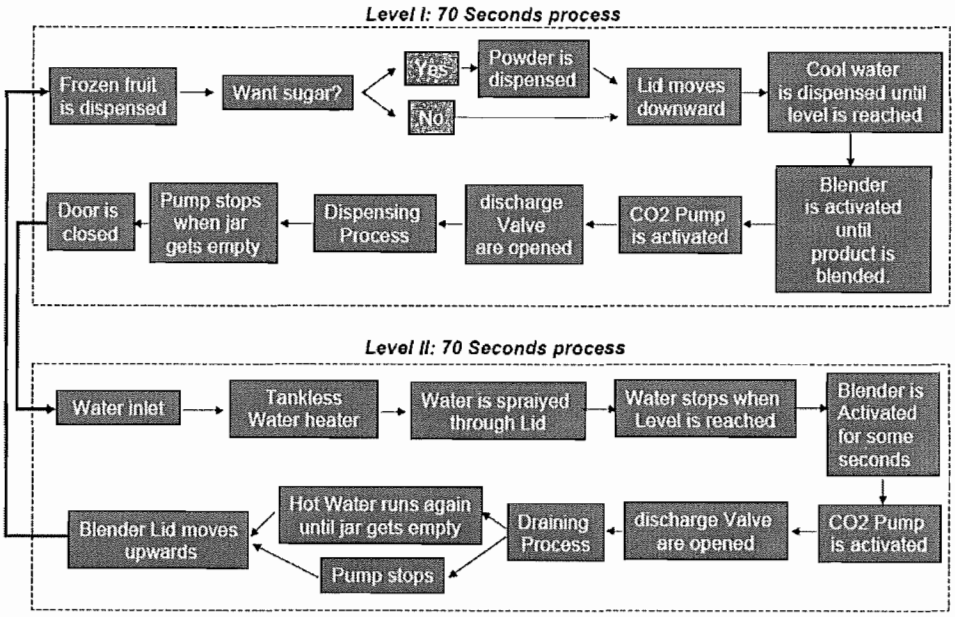

Figure 33. Flow chart of the entire process

The flow chart above shows in detail the process algorithm. From the figure, it can be interpreted that each blender works independently of the other, because the cleaning process must begin immediately after the smoothie is dispensed and the small front door is closed, in order to ensure the effectiveness of the cleaning process.

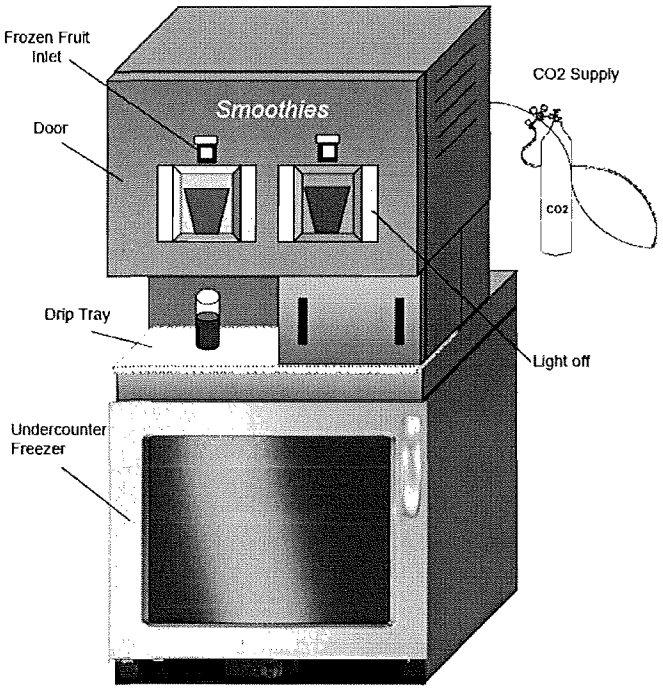

Figure 34. Machine external apperance

The figure 34 shows the machine's final external apperance. As seen in the figure, in order to make the machine user friendly, it uses lights to indicate to customers which blender is available to produce smoothies. For instance, once the little front door is closed the light is turned off, automatically turning on the light of the other blender, guiding the customer to place the fruit in the right container.

Finally, table 17 illustrates the estimated material cost of the machine. In addition, based on table 6 the machine price was set to $6,000.00, in order to place it in between the two similar technologies and $2,000.00 cheaper than the closest one.

Table 17

Material Cost

Item	Quantity	Unit Price	Total
Under counter fridge	1	$1,500.00	$1,500.00
Stepper Motor	2	$20.00	$40.00
Microprocessor	1	$200.00	$200.00
Wiring	1	$5.00	$5.00
Threaded Rod	1	$13.00	$13.00
Linear guide	1	$5.00	$5.00
Bearings	4	$2.50	$10.00
Customized Lid	2	$40.00	$80.00
Blender Jar	2	$25.00	$50.00
Blender motor	2	$100.00	$200.00
CO2 driven Pump	2	$230.00	$460.00
Plumbing	1	$15.00	$15.00
Hooper	1	$20.00	$20.00
Auger wire	2	$1.00	$2.00
Gears and Motors	2	$7.00	$14.00
Internal/Ext panels		$200.00	$200.00
Motor isolation		$10.00	$10.00
Tankless w/heater	1	$200.00	$200.00
Manifold	1	$50.00	$50.00
Total			**$3,074.00**

Adapted from Ebay Inc. (2011)

Summary

In this chapter was discussed the result of each of the five step of concept development process. Also, it was explained the step-by-step of the machine functionalities, as well as the estimated material cost and the machine price.

Chapter V: Discussion

The market has experienced significant changes in the consumer's preference toward healthy products, especially toward smoothies. Due to these changes, customers are demanding fresher quality ready-to-go products at convenience stores.

This market outlook represents a substantial business opportunity through the development of technologies and products that can help to align efforts capable to satisfy the market demand for the coming years. Therefore, the purpose of this study was to develop a product concept for an automatic smoothie machine, through the simplification and optimization of processes for smoothie production for convenience stores all over the country.

Limitations

- The study is limited only to the concept development process, which is the main creative process of product development. In addition, across this research the process performed was made individually, even though some references highlighted the use of teams to develop certain methods.
- Cost estimates are accurate.
- The smoothie market continues growth.

Conclusions

In this project it can be concluded that this machine has large potential, since there are almost no technologies available that serve this growing market at convenience stores. The machine designed has the capability to provide the product every 70 seconds or 55 smoothies per hour. In addition, the convenience stores market is expected to reach $800 billion in sales, in two years time, driven primarily by changes in customer preferences for ready-to-go

food and drinks. Also the price proposed represents a $2000 saving when compared to the closest technology.

Recommendations

Recommendations suggest that further studies be done once the prototyping phase has started. It is necessary to designs an experiment to reduce possible sources of variability during the smoothie production. Besides, it is recommended to measure containers' hygienic level after is used, because if the machine can not meet the required levels, it is suggested to take into consideration the use of a boiler as the source of hot water. In addition, performing a water test is necessary to measure the water quality, because water is a critical ingredient in the smoothie preparation.

It is recommended to test different sizes of containers as well as the amount of water used in the cleaning process to measure the whirlpool formed in order to assure the effectiveness of the cleaning process.

It is suggested to review the pressure capabilities of the store before any equipment is sold, in order to assure the enough pressure is available for proper machine operation.

Summary

In this chapter was discussed an overview of project purpose, followed by the limitation surround the concept development process. Later, it was presented the conclusion of project, and finally, recommendations to further studies were provided.

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