Pure Ambition

by

KCC, Inc.

Submitted To:
Dr. Miguel Bagajewicz

Department of Chemical, Biological, and Materials Engineering
University of Oklahoma

Kyla Patterson
Cicely Williams
Clare Hoang

05/05/2006

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

Perfuming is a profitable industry. Each year the retailing of perfumes can range from $208 to $231 million or more, and these sales are generated by approximately 800 fragrances. Although there are high expected sales of perfume, there is also a significant amount of money invested in advertising a new product and in costly ingredients. For example Calvin Klein spent $17.5 million in 1985 to launch Obsession[19], and Sandalwood, a staple scent in most fragrances, costs $1958 per gallon.

KCC, Inc. is a startup company dedicated to delivering premium quality fine fragrances to women. KCC, Inc. is comprised of three owners with equal shares and responsibility in the company. The members are recent graduates from the University of Oklahoma with knowledge in fine fragrances and a strong background in Chemical Engineering. This new partnership strives to deliver quality products for the everyday woman and to make KCC, Inc. a strong and respected company.

1.1 Purpose

KCC, Inc. has prepared this document with the intention of seeking out investors for this business venture.

1.2 Pure Ambition

Pure Ambition is categorized as an eau de parfum, and is formulated to evoke feelings of sophistication, confidence, and energy. Based on consumer wants, the composition and perfume characteristics are specifically determined to meet these demands.

1.3 Objective

KCC, Inc. proposed to engineer a new perfume, Pure Ambition, that captures the perfect scent for the average working woman between the ages of 25 through 55. The formulation is designed with ingredients that are functional in the overall performance of the perfume, and the product's presentation is designed to appeal to consumers' aesthetic requirements. By performing market research surveys and understanding the development of women's fine fragrances, the optimum perfume formulation has been defined to create Pure Ambition. In addition to the perfume formulation and product qualities, a business plan is developed to analyze the economics associated with the product introduction. The analysis is performed to determine the product's economic feasibility over a 10 year period.

2.0 BACKGROUND

There are two main categories of perfumery products, toiletries and household products. Toiletries are defined as fine fragrances, personal care products, cosmetics, and deodorants. Household products are considered to be air fresheners, laundry products, surface cleaners, and disinfectants. The functions of a perfume are to provide a pleasant odor, cover the scent of the base of the product, give a product an identity, provide product concept support, and signify a change in a product. The objective of this product is to create a fine fragrance.

There are three types of fine fragrances: eau de toilette, eau de parfum, and parfum. Perfume types are defined based on their compositions of oil, alcohol and water. The composition ranges for each perfume type is defined in Table 1 below.

Table 1: Composition Definition of Perfume Categories

Types	Total (vol%)	Remainder (vol%)		Total (vol %)		
	Oil	Alcohol	Water	Oil	Alcohol	Water
Parfum	15 to 30	90 to 95	5 to 10	15 to 30	63 to 80.75	4.25 to 7
Eau de Parfum	8 to 15	80 to 90	10 to 20	8 to 15	68 to 82.8	9.2 to 17
Eau de Toilette	4 to 8	80 to 90	10 to 20	4 to 8	73.6 to 86.4	9.6 to 18.4

2.1 Components of Perfumes

There are four basic parts to a perfume that make up components for the formulation:

- Basics – Materials in the perfume that are present at higher percentages, and comprise the basic composition of the smell. Modification of the base, by addition of scents with higher volatilities, creates a unique fragrance. The base is the most important component of any perfume. A basic can be any fragrance or scent that is a not as volatile. This scent can be added to the perfume which will result in a product that meets consumer desires.
- Fixatives - Fixatives are ingredients in the perfume that prolong the odor effect and delay the evaporation rate of volatile materials. The component tends to have no odor, to be miscible in polar and non-polar solutions, and to be at a higher boiling point temperature. The fixative bonds to polar compounds within the perfume through hydrogen bonding, reducing the overall vapor pressure of the mixture. They retain a high concentration of the top and middle notes, and release them slowly over time. Examples of fixatives are vetyver, dipropylene glycol, and diethyl phthalate.
- Solvents - The solvent is the portion of the perfume in which all the components are dissolved. Solvents are used to dilute the mixture in order to increase the surface area of application without isting an excessive amount of the fragrance. It is also used to reduce the intensity of the fragrance of the solution. Solvents decrease the price of

the perfume per milliliter while increasing the amount of applications per bottle. Ethanol is the most common solvent.

2.2 Categories of Perfume Oils

There are three categories that define the performance of the scent within a fragrance. These three notes are categorized as the basics in a perfume.

- Top Note – Notes that are no longer detectable approximately 2 hours after application due their high volatility. These notes will be the first components to evaporate from the perfume. The top notes will create the initial impression of the fragrance. The fragrance of the top notes will be the largest contribution in the perfume's initial smell. Examples of constituents that can be classified in this category are citrus oils, such as lemon, orange, grapefruit, and lime. These scents are what the consumer initially evaluates when considering the purchase of a perfume.
- Middle/Heart Note – Considered the "body" of a fragrance. These fragrances are no longer detectable approximately 6 hours after application. This is due to their moderate volatility, compared to the top and base notes. Examples of constituents that can be classified in this category are floral oils, such as peony, rose, and hibiscus.
- Base Note – These are the most important to the perfumer because they act as a fixative for the rest of the scents. The bottom notes will have the lowest volatility and will be present in the scent for the entire life of the perfume on the skin. These notes are detectable anywhere from 8 to 72 hours. Examples of these constituents are musk oils, and vanillin.

The following chart below shows a pyramidal relationship between the notes. The top notes are usually present in smaller amounts than the middle notes, but the base notes usually account for over half of the scent. The percentage of the scent in the fragrance provided in Figure 1 below is a common percentage breakdown. Other percentages are also possible in fragrances as well.

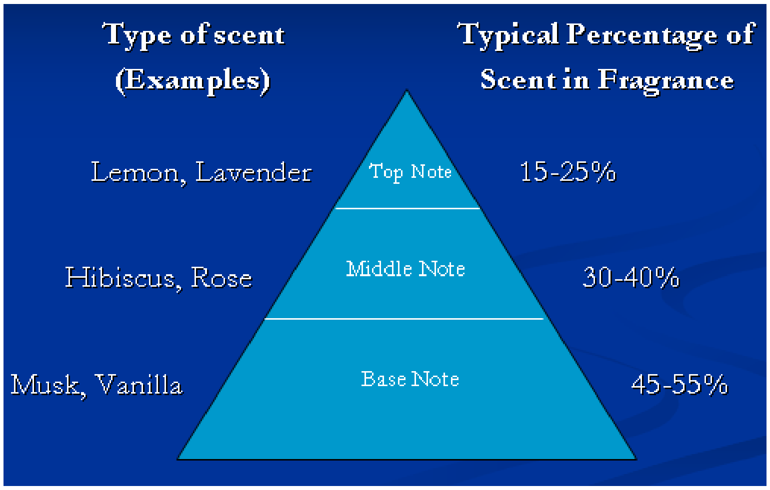


Figure 1: Scent Pyramid- This figure contains the order at which the scents are identified, examples of typical scents, and typical percents of each note composition in a fragrance.[1]

2.3 Perfume Characteristics

Due to the solubility of the essential oils in water, Pure Ambition is determined to be an emulsion. Below is a table of the relative solubility of each oil in water, measured in parts per million.

Table 2: This table shows the solubility and the percent solubility of the perfume scents in water

Scent	Common Compound	Water Solubility (ppm)	Percent Soluble
Rose	Phenylethyl Alcohol	20,000	2
Lemon	Limonene	50	0.005
Hibiscus	Citronellol	190	0.019
Sandalwood	Linalool	2000	0.2
Musk	Musk Ketone	< 1	< 0.0001
Honeysuckle	Phenylacetic Acid	18,000	1.8
Lilac	Terpineol	2900	0.29
Vanilla	Vanillin	10,000	1
Amber	Cyclopentadeconolide	< 1	< 0.0001

Table 2 shows that no essential oil is more than 2% soluble in water, and some of the oils are even less soluble than 2%. Based on this data, Pure Ambition is assumed to be an emulsion. An emulsion is a mixture of two phases that do not blend well. The two phases in an emulsion are known as the dispersed and continuous phases. The dispersed phase is the phase that is easily scattered into the second phase, known as the continuous phase. In the case of Pure Ambition, the dispersed phase is the oil solution while the continuous phase is the aqueous solution, ethanol and water. The aqueous phase is composed of a water and ethanol mixture, while the oil phase is a mixture of the essential oils used in the perfume. Emulsions can either be stable, where the solution does not separate easily, or unstable, where the solution separates quickly. Emulsions usually appear cloudy due to the multiple phase interfaces that scatter light which passes through the emulsion. [25]

Since Pure Ambition is an emulsion, considerations must be taken to ensure the stability of the liquid. A high-speed agitator is initially used to combine the phases. The liquid is then passed through a homogenizing emulsifier to increase the perfume's stability. In this analysis it is assumed that the perfume will reach a relative stability without the addition of an emulsifier.

3.0 EXPERIMENTAL METHOD

The experimental data used in the Happiness function is determined through a survey administered to a representative market segment. The survey questions are designed to impartially obtain relevant information concerning the consumer attributes of a perfume. The survey included both questions related to personal preferences, and also questions that asked the survey participants to characterize unknown fragrances. The survey data is analyzed and incorporated into the Happiness function.

3.1 Perfume Construction

Constructing a perfume requires knowledge of the needs of the consumer, the market, and the engineering required to make the perfume. The needs of the consumer are known as the consumer attributes. These consumer attributes can be defined or modeled by chemical engineering concepts. Below are the consumer attributes is paired directly with their assigned engineering concept.

- Scent – Initial concentration
- Endurance - Time (based on concentration calculations)
- Color – Aesthetics
- Initial Strength – Initial concentration
- Oiliness – Initial concentration of only the essential oils

The engineering concepts for scent, endurance, initial strength and oiliness are manipulated using the concentration of the perfume. The only consumer attribute that does not deal with the concentration of the perfume or any of the components of the perfume is color. Therefore, by changing the composition of Pure Ambition, the customer Happiness can be manipulated to give the desired results (i.e. maximum profit, maximum Happiness, breakeven point, etc.).   As stated from above, these consumer attributes are acquired from the survey administered by KCC, Inc. With these attributes, the company is able to model what the consumers are looking for in a perfume by the development of the Happiness function.

4.0 HAPPINESS FUNCTION

The degree of satisfaction for a perfume from the consumer is defined by a Happiness function. This is a theoretical model of the characteristics that the consumer attributes to products that compose a perfume, and the extent of the effect each one has on the consumers' Happiness. These variables are each designated weights that are also obtained from the survey data, and the following equation is derived for the Happiness function for a perfume.

$$H(perfume) = y_{scent}w_{scent} + y_{endurance}w_{endurance} + y_{skin\ rxn}w_{skin\ rxn} + y_{color}w_{color} + y_{viscosity}w_{viscosity} + y_{init.\ conc.}w_{init.\ conc.} \qquad \textbf{Eq. 4.1}$$

In the equation above, y_i refers to the function derived for each attribute, i. The weight each component has in the overall Happiness of the consumer is referred to as w_i. Each component of the Happiness model is described by a function relating the attribute to a variable in perfume formulation such as composition or concentration. The Happiness function is used to optimize consumer Happiness, demand, profit, and return on investment.

4.1 Scent

The actual scent of the perfume is determined to be the most heavily weighted parameter of the fragrance. The weight designated for this variable is 60% of the total Happiness. The function for the Happiness due to scent is divided into three equivalent functions at 0, 4 and 8 hours from the time of initial application. At these different times, equations are created utilizing the ratio between the composition that the consumers want and the composition of what the actual perfume has. The change in composition over time is due to the volatility of the components. As the volatility of the component increases, the composition of the component in the liquid phase decreases. The scent function is composed of the different fragrant categories of the scent. These categories are citrus, natural, musk, oriental, and floral. The essential oils used are placed into each category that describes it best. For Pure Ambition, the ingredients in the perfume are lemon, rose, honeysuckle, sandalwood, musk, vanilla, hibiscus, peony, and amber. Lemon is categorized as citrus, sandalwood is categorized as natural, musk is categorized as musk, vanilla and amber are categorized as oriental, and rose, honeysuckle, hibiscus, peony are categorized as floral.

The equation for the fragrance composition at initial application or at 0 hour is shown below.

$$\begin{aligned} y_{scent-0hr} = {} & z_{citrus}\left(\frac{x_{have}}{x_{want}}\right)_{citrus} + z_{natural}\left(\frac{x_{have}}{x_{want}}\right)_{natural} + z_{floral}\left(\frac{x_{have}}{x_{want}}\right)_{floral} \\ & + z_{musk}\left(\frac{x_{have}}{x_{want}}\right)_{musk} + z_{oriental}\left(\frac{x_{have}}{x_{want}}\right)_{oriental} \end{aligned} \qquad \textbf{Eq. 4.2}$$

Where: x_{have} = the composition of the scent in Pure Ambition

x_{want} = the composition of the scent wanted as deemed by the consumer

z = the weight the scent holds in the total concentration of the perfume

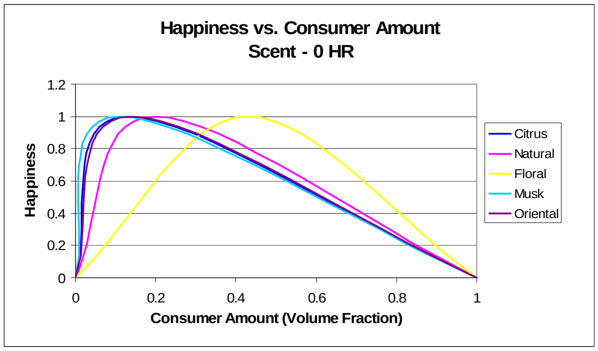
Four hours after initial application, the assumption is made that the top notes of the fragrance are no longer present. This is based on the volatility of the components comprising the top notes. Therefore, the citrus category is completely removed from the equation. The following equation results for Happiness after four hours.

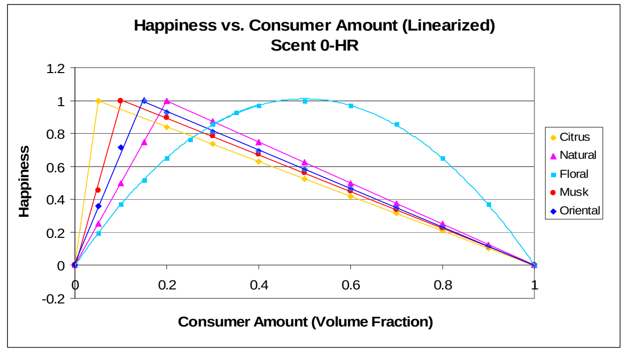
$$y_{scent-4hr} = z_{natural}\left(\frac{x_{have}}{x_{want}}\right)_{natural} + z_{floral}\left(\frac{x_{have}}{x_{want}}\right)_{floral} + z_{musk}\left(\frac{x_{have}}{x_{want}}\right)_{musk} + z_{oriental}\left(\frac{x_{have}}{x_{want}}\right)_{oriental} \qquad \textbf{Eq. 4.3}$$

Again due to the relative volatility of the top and middle notes to the base notes, they are both assumed to deplete eight hours after the initial application. Therefore, the floral category is completely removed from the equation as well. The equation used in the Happiness model for the eight hour time period is shown below.

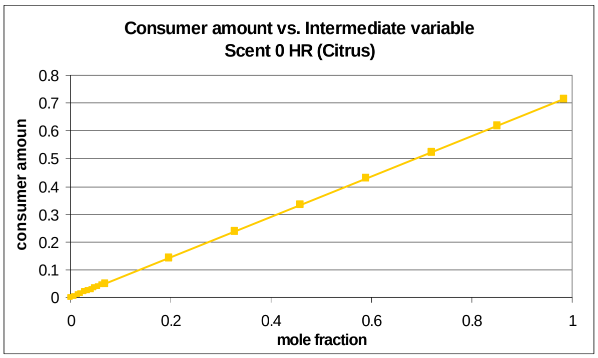
$$y_{scent-8hr} = z_{natural}\left(\frac{x_{have}}{x_{want}}\right)_{natural} + z_{musk}\left(\frac{x_{have}}{x_{want}}\right)_{musk} + z_{oriental}\left(\frac{x_{have}}{x_{want}}\right)_{oriental} \qquad \textbf{Eq. 4.4}$$

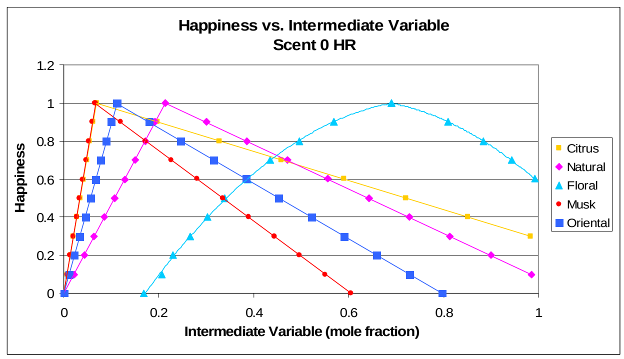
Each scent iss given a weight within the scent function as well as the overall weight the scent holds in consumer Happiness. These two weights, z for each of the three scent functions and w for the Happiness function should not be confused with each other. The weighted value for the scent function , z, is found from the survey data. The z- value is based on the different concentrations of each scent that would be wanted by the consumer within the fragrance. The value of x_{have} for each scent is obtained by using the initial concentration of each component. The value of x_{want} for each scent is also found by using graphs that related the consumer variables, the intermediate variables, and the values of Happiness. Examples of these graphs are shown below.





(a) **(b)**





(c) **(d)**

Figure 2: These figures are representative of the scent profiles at 0-hour.

(a) Happiness vs. Consumer Amount (volume fraction) (b) Linearized Representation of the Previous Figure

(c) Consumer Amount (volume fraction) vs. Intermediate Variable (mole fraction)

(d) Happiness vs. Intermediate Variable (mole fraction)

Figure 2(a) relates the scent Happiness vs. the consumer variable which is in volume fraction of Pure Ambition. This graph is then linearized for simplification of calculation as shown by Figure 2(b) above. Next, a graph of the consumer amount in volume fraction vs. the intermediate variable in mole fraction is constructed shown as Figure 2(c). This graph shows a linear relationship between the consumer amount in volume fraction versus the intermediate variable in mole fraction. With Figure 2(a) through Figure 2(c), the construction of the scent Happiness vs. the Intermediate Variable in mole fraction can be graphed. Figure 2(d) can be used to determine the x_{want} for Equation 4.2 from above for 0 hour. These graphs are also constructed for 4 hours and 8 hours for each category of fragrance.

4.2 *Endurance*

The endurance of the perfume is defined as the length of time after initial application, that the fragrance would still be detectable within a 10 cm radius of the individual wearing it. This distance is assumed based on the reasoning that 10 cm should be the minimum distance that a perfume should be detectable by an individual on the consumer. In the Happiness model, endurance is a component defined by the variables of time and distance. Based on the diffusion of each of the essential oils within the fragrance, the concentration as a function of these variables is defined, C_i (t,z).

Diffusion is the movement of particles from higher chemical potential to lower chemical potential (chemical potential in our case is represented by a change in concentration).[22] Due to diffusion of molecules in the perfume, the scent begins to change immediately after it is applied to the skin. It is assumed that the liquid composition changes with time because a small amount of perfume is constantly depleting as time progresses. The liquid composition, x, is represented by the number of moles of each species that remain in the perfume (on the skin). The perfume that is detectable by the nose in the headspace is the vapor composition, y. When modeling perfume behavior, it is assumed that diffusion only occurs in one direction, and that the surrounding air is not soluble in the perfume mixture.[1] Figure 3 on the next page, displays the major concepts of diffusion. Concentration (C_i (t,z)) is a function of time and distance from the liquid; it is the amount of scent particles in the air that the nose can detect over time.

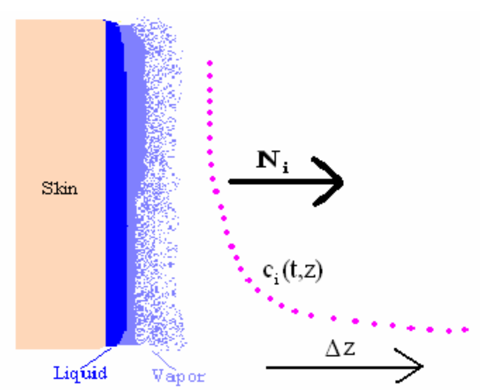


Figure 3 : Scheme of stimulated gas headspace/ liquid perfume system. [1]

Diffusion of the perfume can be described by Fick's second law

$$\frac{\partial y_i}{\partial t} = D_{i,air} \frac{\partial^2 y_i}{\partial z^2} \qquad \textbf{Eq. 4.5}$$

Where y_i is the molar fraction of the scent component in the vapor phase, and $D_{i,air}$ is the diffusion coefficient. The diffusion coefficient is found using the Fuller et al. method.[1]

The concentration profile is solved using two methods. The first method utilized the ideal gas law. The second method is a derivation of Fick's second law. The first method is used to solve for the concentration of each of the components as a function of only time. The second method takes both the time and distance into consideration. Both methods are utilized simultaneously yielding the concentration profile as a function of time and position. The first method begins with Equation 4.6

$$c_i^g = \frac{y_i n_y P}{RT} \qquad \textbf{Eq. 4.6}$$

where y_i is found using Eq 4.7 below.

$$y_i = \gamma_i x_i \frac{P_i^{sat}}{P} \qquad \textbf{Eq. 4.7}$$

Where: y_i = vapor composition $\quad$ x_i = liquid composition

P = pressure of system $\quad$ P_i^{sat} = saturated P for each component

R = gas constant $\quad$ T = temperature of the system

γ_i = activity coefficient for each component

The activity coefficient can be found using the UNIFAC method.[24] To simplify the calculations, the assumption is made that the activity coefficients for each component did not vary due to time and distance. The activity coefficients calculated for the initial compositions for each component is used for all concentration calculations.

The numerical solution for Fick's second law is derived and used to solve for the concentration profile at any time and distance. Assumptions made to manipulate the equation are that the liquid and gas phases are in equilibrium, the perfume only diffuses in one direction, the ideal gas law holds, and each component diffuses separately. This numerical solution is given below as Equation 4.8.

$$\frac{\left(c_z^t - c_z^{t-\Delta t}\right)}{\Delta t} = D\frac{c_{z+\Delta z}^{t-\Delta t} - 2c_z^{t-\Delta t} + c_{z-\Delta z}^{t-\Delta t}}{\Delta z^2} \qquad \textbf{Eq. 4.8}$$

which can be rearranged to form Equation 4.9.

$$c_z^t = c_z^{t-\Delta t}\left(1 - 2\frac{D\Delta t}{\Delta z^2}\right) + \frac{D\Delta t}{\Delta z^2}\left[c_{z+\Delta z}^{t-\Delta t} + c_{z-\Delta z}^{t-\Delta t}\right] \qquad \textbf{Eq. 4.9}$$

Simplyifing Equation 4.10 by knowing that

$$\Delta z = \sqrt{2D\Delta t} \qquad \textbf{Eq. 4.10}$$

gives Equation 4.11 shown below which provides the calculation for the concentration at any time and position, c(t,z).

$$c_z^t = \frac{1}{2}\left[c_{z+\Delta z}^{t-\Delta t} + c_{z-\Delta z}^{t-\Delta t}\right] \qquad \textbf{Eq. 4.11}$$

This equation can then be used to determine what concentration of scent is still detectable after a certain time and considered to endure. A perfume is considered to endure if the concentration of the fastest depleting base note (in this case, sandalwood) at time t, is greater than the odor threshold for that particular component. Odor threshold is defined as the lowest concentration at which an odorant can be recognized for what it is. Figure 4 below shows the concentration vs. the distance at times 1 hour to 8 hours for sandalwood. Similar graphs are created for the other base notes as well. The graph suggests that, as the distance increases, the concentration decreases. As the distance increases from the area of application the concentration should also decreases because the scent molecules are more highly concentrated near to the area of application. The scent molecules will decrease in number the further away the distance is from the area of application. Also, it can be seen from this graph that as time increases the concentration increases and then eventually decreases. This is because as time increases, the concentration in the air will also increase. More molecules will be present. At a certain time, the amount of perfume on the area of application will slowly deplete. This depletion of the perfume will also cause the slow decrease of the concentration of each component in the air.

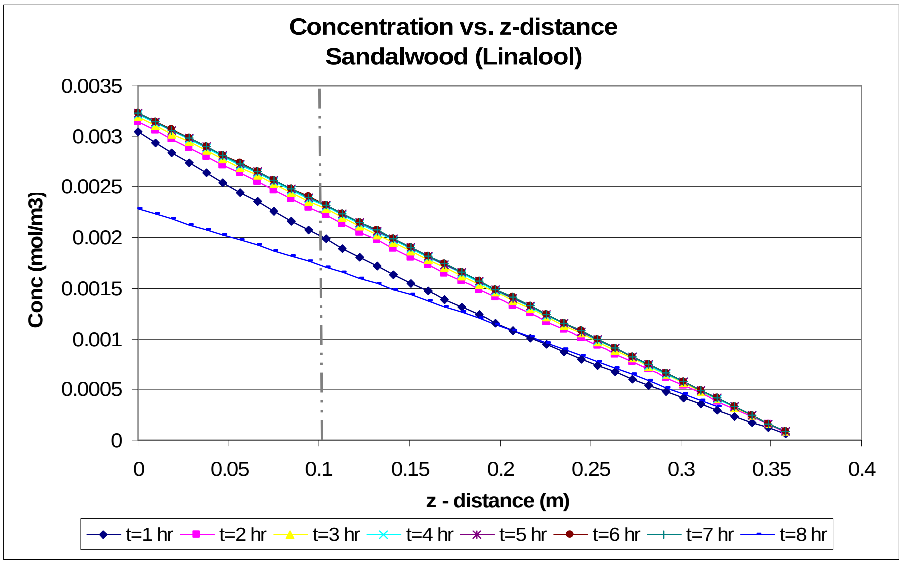


Figure 4: This figure is representative of the concentration changes due to the change in the z-distance.

As mentioned earlier, it is assumed that a distance of 10 cm is the maximum distance a bystander should be able to detect the fragrance. At this distance, the concentration at each time is plotted for all of the base components, sandalwood, amber, musk, and vanilla. The odor threshold for sandalwood has also been graphed. The first base note to cross this threshold determined the endurance of the fragrance. Only the odor threshold of sandalwood is graphed because the odor thresholds for the other base note components are much smaller in value therefore this is the only applicable threshold value. Therefore, it is only necessary to graph sandalwood's odor threshold. The data taken from Figure 4 can be plotted again for a distance of 10 cm shown below.

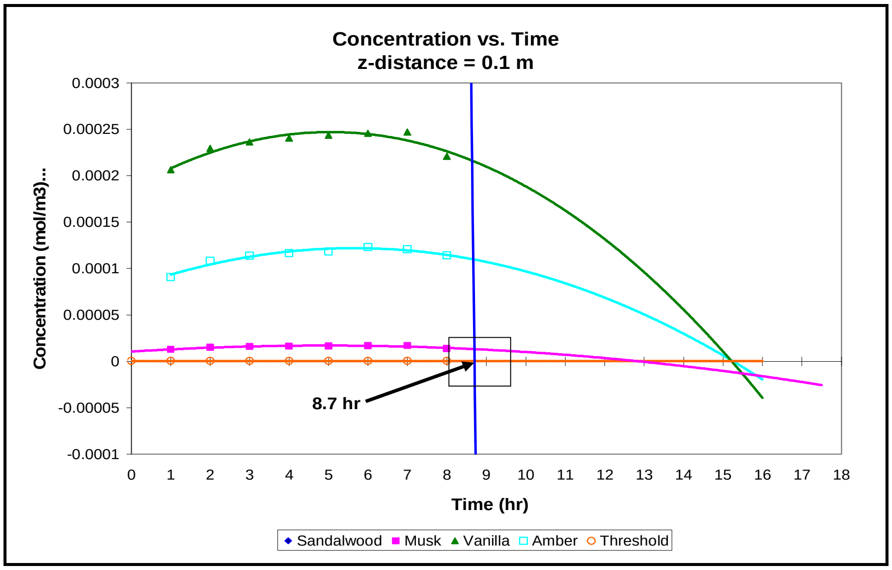


Figure 5: This figure shows the concentration change due to the changes in time for the base notes of Pure Ambition. These values are graphed along with the odor threshold for sandalwood.

Figure 5 shows the concentration versus time for all the base note components. As can be seen by the graph above, sandalwood crosses the odor threshold first at 8.7 hours. Therefore, sandalwood is used to determine the scents endurance. The assumption is made that the perfume should endure for at least 8 hours. If the perfume lasts past 8 hours then the consumer is happy, or if the perfume lasts under 8 hours then the consumer is not happy at all. Therefore, Equation 4.12 is developed to define the Happiness of the endurance.

$$y_{endurance1} w_{endurance} = \left(OV_i \Big|_t^z - Thrs_i \Big|_t^z \right) \times (0.17) \qquad \textbf{Eq. 4.12}$$

With: $y_{endurance1} w_{endurance} = 0 \text{ if } \left(OV_i \Big|_t^z - Thrs_i \Big|_t^z \right) < 8$

$$y_{endurance1} w_{endurance} = 1 \text{ if } \left(OV_i \Big|_t^z - Thrs_i \Big|_t^z \right) \geq 8$$

Where: OV = odor value and Thrs = odor threshold

The odor value is defined as the ratio between the concentration of that odorant component in the headspace and its odor threshold.[1] As stated from above, the odor value and odor threshold for sandalwood is used because it is the fastest depleting base note. This is apparent because its vapor pressure is significantly higher than the other base notes: musk, vanilla, and amber. Therefore, it diffuses quickly and is considered the fastest depleting base note. The weight for endurance, w, is assigned 0.35. This means that endurance contributes to 35% of the Happiness function.

4.3 Oiliness

The oiliness of the perfume is directly related to the concentration of the essential oils in the perfume. A perfume that contains a large concentration of essential oils will result in an oily residue on the consumer's skin after the aqueous phase evaporates and excess oil is left on the skin. In contrast, if too little of a concentration of essential oils are used, the consumer's skin can be left feeling dry with little or no fragrance. As shown in Table 1, the three types of perfumes are defined by differing volume percentages of constituents. For an eau de parfum, the essential oil volume is limited to a range of 8% to 15%. This range is used as upper and lower boundary conditions, and is applied to the concentration of essential oils in the perfume. The following function is then derived to determine the amount of happiness the consumer experiences due to the oiliness of the liquid.

$$y_{oilinenss} w_{oiliness} = \left\{ \begin{matrix} 1 & low < c_{oil} < high \\ 0 & if\ not\ met \end{matrix} \right\} * (0.01) \qquad \textbf{Eq. 4.13}$$

With:

c_{oil} = the total concentration of essential oils in pefume

low = the lowest acceptable concentration of essential oils in an eau de parfum

high = the highest acceptable concentration of essential oils in an eau de parfum

This equation is applied to the total essential oil concentration in the perfume. As shown by the constraints above, the consumer is deemed to be completely unhappy if the concentration did not meet the specifications for an eau de parfum, but is 100% happy if it did.

4.4 *Initial Concentration*

The concentration of the fragrance immediately after initial application is determined to contribute to 1% of the consumer's Happiness. Although the exact value for this parameter would have to be determined experimentally, a reasonable approximation is obtained analytically. Based on the initial concentration of each component, the total mass of the oils in the fragrance is calculated. The total mass of air surrounding a person is also determined using an approximation for the composition of air. Based on the relationship between these two at initial application, the concentration in air is determined. This is then compared to the known concentration of a popular, similar fragrance. The difference in these is then normalized and incorporated into the Happiness model. The following function is determined to model this trend.

$$y_{init.conc.} w_{init.conc.} = \left\{ 1 - \left(\frac{|C_A - C_W|}{C_W} \right) \right\} * (0.01) \qquad \textbf{Eq. 4.14}$$

Where: C_a = actual concentration of perfume

C_w = wanted concentration of perfume

4.5 *Color*

The color of the perfume is determined to contribute to 3% of the consumer's Happiness. The color of the perfume packaging is found to be linked to the consumers' Happiness through emotions, as explained in the background. The color determined to most personify the characteristics of Pure Ambition is red. Since the consumer's Happiness is dependent on the package color, Pure Ambition's packaging is determined to be red to appeal to the target market. In the Happiness function, this variable is defined as a constant and Happiness due to the color of the liquid is defined as one. This is then combined with the weight that color holds on the consumer's Happiness.

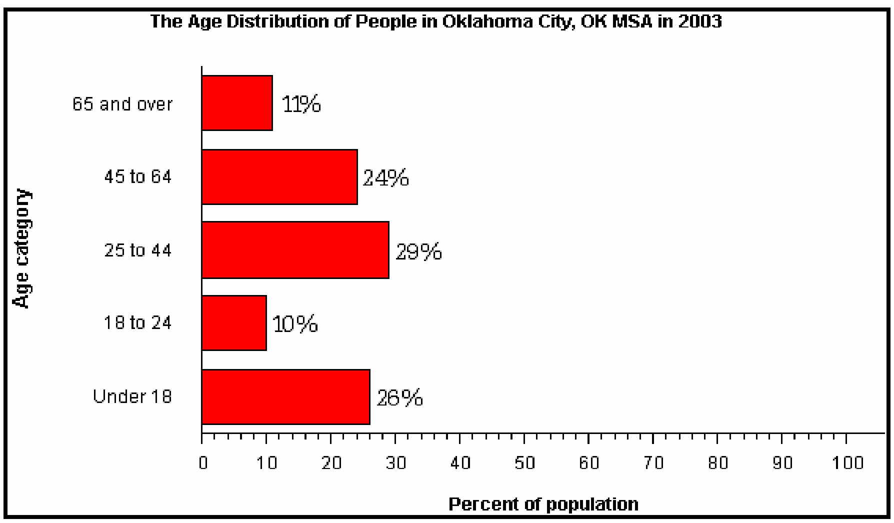
$$y_{color} w_{color} = K * (0.03) \qquad \textbf{Eq. 4.15}$$

Where: K = constant = 1 for the color red

5.0 THE MARKET

KCC, Inc. initially launched Pure Ambition in Oklahoma City and its surrounding areas. This target area is chosen to test the product and to save on initial costs. If the product is successful, then further expansion will be considered. According to the U.S. Census Bureau, there are approximately 1.3 million people living in the Oklahoma City MSA in 2003.[1] The OKC MSA includes Oklahoma City, Bethany, Yukon, Mustang, El-Reno, Guthrie, Edmond, Moore, Norman, Del City, Midwest City, Choctaw, and Shawnee. The OKC MSA population is comprised of 51% women and 49% men. Therefore, there are approximately 663,000 women located in the Oklahoma City MSA. Figure 6 shows a breakdown of age groups in OKC MSA.

Table 3: The age distribution in OKC MSA for 2003 provided by the U.S. Census, Bureau [1]



5.1 Target Market

KCC, Inc., more specifically chose to aim its efforts towards satisfying females from the ages of 25 to 44. This decision is made based on the assumption that women from the ages of 25 to 44 are career women with stable incomes and are more likely to spend money on a luxury item such as perfume. From Figure 6, it can be assumed that the women in this age group contribute to

29% of the population. KCC, Inc. assumes that they only appeal to approximately 127,000 women who are potential buyers of Pure Ambition.

5.2 *Distribution*

KCC, Inc. is targeting its distribution of Pure Ambition to the malls across the OKC MSA. There are currently 8 malls located within the OKC MSA. KCC, Inc. plans to distribute its products to the perfume kiosks located in each of the malls. The company will supply each kiosk with 100 bottle shipments each month. It is assumed that the initial amount of bottles distributed would meet the demands of the consumers; adjustments in distribution will be made. The volume size of the bottle is chosen to be 1.7 oz (50 mL), which is a standard volume size for most fine fragrances.

5.3 *Advertising*

Advertising is defined as the activity of attracting public attention to a product or business by paid announcements in the print, broadcast, or electronic media.[2] The types of advertising media can be broken down into newspaper, television, direct mail, radio, magazines, and online. Figure 7 and Table 3 list the different types of mediums, their profiles, and the average costs.[3]

Table 4: The table represents the various types of media and their advertising qualities and costs for one week.

Costs of Advertising Mediums		
Medium	**Basis**	**Cost/week**
Newspapers	2’’ x 2’’ ad	$1,300
Television	30 seconds of prime-time	$16,500
Direct Mail	1000 4x6 postcards	$125
Radio	2 hour rotation	$100
Magazines	w/ 16 week contract	$1,000
Online	per website	$50

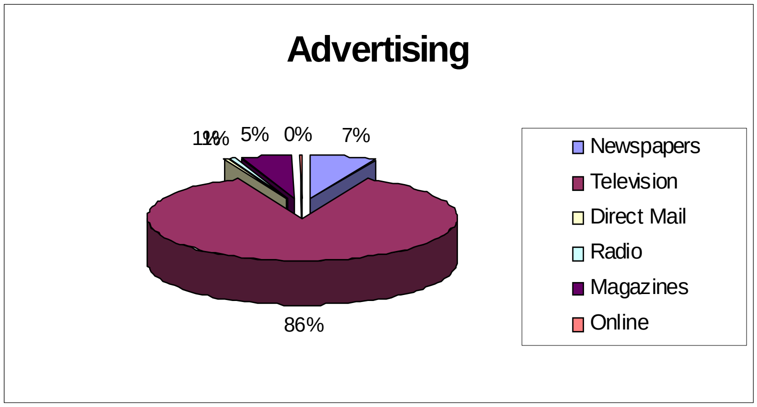


Figure 6 : The pie graph represents the basic breakdown of each advertising medium for one week.

6.0 DEMAND AND PRICING

Due to the complexities of demand sizing, two models taken from microeconomics are used to construct a relationship between the demand, product cost, and happiness, as well as the price, demand, and happiness of the competition. Initially, the demand of Pure Ambition is assumed to only have constraints based on the budget of the consumer. The following demand model is used to develop a relationship between Pure Ambition and the competition:

$$\beta \mathrm{p}_1 d_2 = \alpha \mathrm{p}_2 d_2 \frac{d_1^{\alpha}}{d_2^{\beta}} \qquad \textbf{Eq. 6.1}$$

where α represents the ratio of the knowledge of both products and β represents the ratio of consumer happiness obtained from both products. The variables p_1, p_2, d_1 and d_2 represent the product price for both products and the product demand for both products. The inequality in Eq. 6.2 simply states that the sum of the profit made from both products equals the total sales for the product. By setting this inequality equal to the equality, and assuming that both companies can fully meet their respective demand based on the capacity at hand, equations 6.1 and 6.2 are solved simultaneously for the demand.

$$\mathrm{p}_1 \mathrm{d}_1 + \mathrm{p}_2 \mathrm{d}_2 <= \mathrm{Y} \qquad \textbf{Eq. 6.2}$$

Although the budget model can determine the demand accurately when only price is the deciding factor, it doesn't take into account a maximum demand.   When the sum of the two products' demands, exceeds the total demand available, the budget model is exchanged for the fixed demand model. The demand model and fixed demand model equations are shown below.

$$D = d_1 + d_2 \qquad \textbf{Eq. 6.3}$$

$$d_1 = \left(\frac{\alpha}{\beta}\right)^{\frac{1}{1-\alpha}} (D - d_1)^{\frac{1-\beta}{1-\alpha}} \qquad \textbf{Eq. 6.4}$$

These two equations are also solved simultaneously for the demand.

The α value used in these equations is determined by taking the average value of α over the life of the project. As can be seen by Figure 8 below, when Pure Ambition is initially introduced to the market, consumer awareness will be very low. Aggressive advertising will be used to increase consumer awareness of the perfume and an analysis of this will be shown later in the business plan. Although α will initially increase rapidly when the product first becomes available, over time advertising will become less effective. Eventually complete consumer awareness will be reached and α will reach unity.

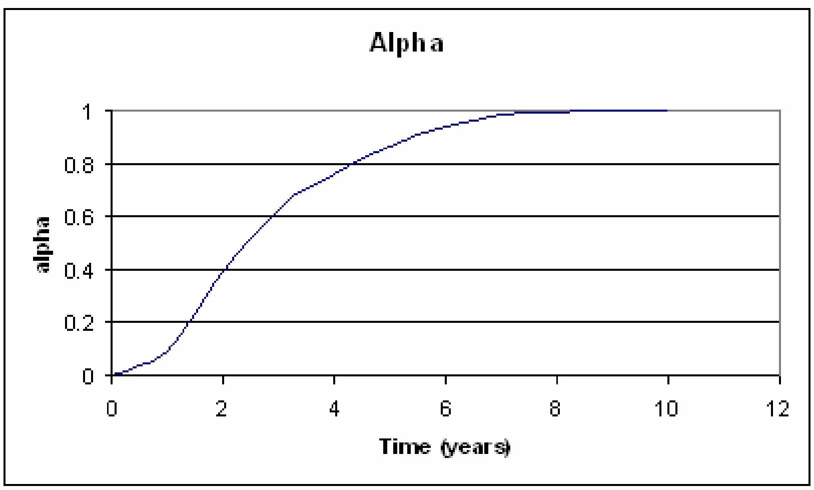


Figure **7: This is a graph of alpha vs. time of project life. This graph shows the projected trend of alpha.**

The β value in this equation is determined by ranking the characteristics of the happiness function of both Pure Ambition and the competition on a scale from one to ten to normalize the happiness of each product. The ratio between the two could then be calculated.

7.0 PRODUCTION PROCESS

KCC, Inc. has developed a manufacturing process that is advantageous to the company's current goals while also taking into account future prospects for the company. KCC, Inc. has evaluated the different capacities and sizes of the equipment within a reasonable range of costs. The actual capacity for the production of Pure Ambition is 665 L/year. The capacity is determined by an optimizing model that takes into account consumer needs, selling price of the competitor, capacity of the competitor, and selling price for Pure Ambition. The process is simple in design and requires little maintenance.

7.1 Process Flow Diagram

The equipment material chosen for this process is 304 stainless steel. This decision is based on the material's resistance to side reactions occurring at changing temperatures and equipment corrosion.[4] Below, Figure 9 shows the process flow diagram for the production process.

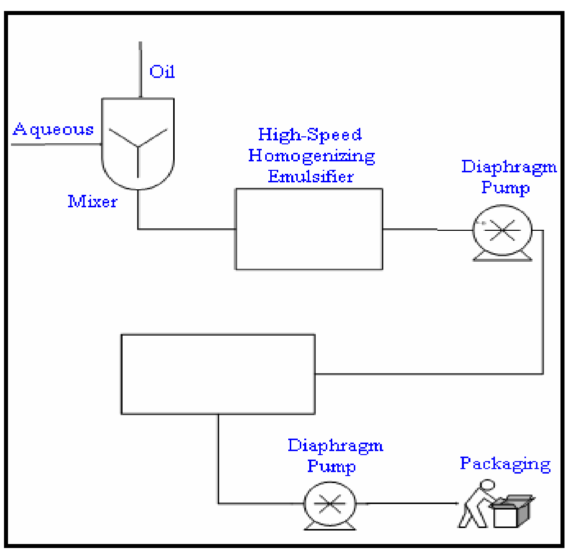


Figure 8: Process flow diagram for producing Pure Ambition

The process flow diagram involves one mixer containing a motor and a SS Rotary double-coned blender. The design has a mixing capacity of approximately 5 m^3 with a consumption of approximately 10 kW per hour. The high speed homogenizer is approximately 1.05 m^3 in dimension, rotates at 1800 rpms, at approximately 2 hp.[23] The storage tank has a holding capacity of 8 m^3. Two diaphragm pumps are included, each with a capacity of 0.1 m^3/day. The capacity of the equipment is determined by estimating that production could never exceed the amount of potential buyers within the OKC MSA, which as previously stated, is estimated to be 13,300 women. It is assumed that each woman only purchases Pure Ambition once every year resulting in approximately 665 L/year of perfume if 1.7 oz bottles are chosen. Therefore, at maximum capacity, 665 L/year is produced. If the operation is carried out 16 hours/day for 260 days/year, that equates to 0.16 L/hour. Cost estimates for the packaging equipment, which involves a bottling design, are determined by consulting Turbofil Packaging Machines, LLC.[5] The equipment design contains two parts: one section that fills the perfumes and one section that caps the bottles. The system moves at a rate of 10 bottles/min. Most of the equipment sizing, with the exception of the packaging equipment, is determined using PT&W.[4]

7.2 Equipment Pricing

The pricing for the equipment is determined knowing the process flow rates and energy capacity needed to run the process. The cost of the equipment is listed in Table 4 below, which also shows the total purchased equipment price of $48,000.

Component	Basis for Estimate	Cost ($)
Purchased equipment:		
Mixer	w/ motor (Fig 12-46) SS Rotary double-cone blender	17,500
Homogenizer / Emulsifier	Fong Hwang Enterprise Co. Ltd.	5,200
Storage Tank	0.1 cubic meter (Fig 12-52)	2,700
Pump	2 pumps (Fig 12-21)	2,800
Filler/Bottling Machine	Turbofil Packaging Machines, LLC	20,000
Total Purchased Equipment		48,200

Table 5: This table contains the cost breakdown of the equipment needed

8.0 RESULTS

The perfume formulation is based on a consumer model that determines the best formulation for any given variable (i.e. max/min profit, max/min ROI, and max/min Happiness) for the target market. The formulation model is dependent on the scent, endurance, color, oiliness, and initial concentration of the fragrance. The optimal formulations for the maximum Happiness and for the maximum ROI based on these consumer attributes are reproduced in Table 5 shown below. Table 5(a) gives the formulation that maximizes the return on investment for Pure Ambition while Table 5(b) gives the formulation that maximizes Happiness for Pure Ambition.

Table 6: Perfume formulation for Pure Ambition

(a) Perfume formulation for Pure Ambition at maximum ROI
(b) Perfume formulation for Pure Ambition at maximum Happiness

PERFUME FORMULATION ~ 76% Happiness		
Ingredients	**Volume%**	**Function**
Alcohol	76.5	Carrier
DI Water	8.5	Diluent
Peony	0.26	Top Note
Lemon	2.98	Top Note
Honeysuckle	0.26	Middle Note
Hibiscus	0.26	Middle Note
Rose	0.26	Middle Note
Amber	1.73	Base Note
Vanilla	1.73	Base Note
Sandalwood	0.54	Base Note
Musk	6.99	Base Note

(a)

PERFUME FORMULATION @ ~80% Happiness		
Ingredients	**Volume%**	**Function**
Alcohol	76.5	Carrier
DI Water	8.5	Diluent
Peony	0.5	Top Note
Lemon	2.32	Top Note
Honeysuckle	0.5	Middle Note
Hibiscus	0.5	Middle Note
Rose	0.5	Middle Note
Amber	1.09	Base Note
Vanilla	1.09	Base Note
Sandalwood	3.85	Base Note
African Musk	4.65	Base Note

(b)

9.0 ECONOMIC ANALYSIS

KCC, Inc. chose to analyze the economics of the company over a 10 year period. The company looked to optimize the return on investment (ROI) and the customer satisfaction (Happiness) of the product during the project's 10 year life span. It is to the company's advantage to assess the numerous factors that determine the economic feasibility of the project. The estimations, formulas, and assumptions are based upon PT&W.[4] The expected accuracy of the economic feasibility falls in the range of 20 to 30%.[4] The values taken from this text are updated to current values using the Marshall & Swift cost index for 2006. The capital investments of the company, raw materials, operating labor, total product cost, revenue, depreciation, and cost evaluation are considered in this section. KCC, Inc. decided to use the perfume formulation that maximized ROI throughout the Economic Analysis section as an example of the procedure that is undertaken. Similar tables can be found in the Appendix for the perfume formulation that maximized Happiness.

9.1 *Capital Investments*

The capital investments of the company are based on a fluid processing plant design. This method required the determination of the total equipment cost which, as stated earlier, is approximately $48,000. With this value an estimation of the fixed capital investment (FCI) and total capital investment (TCI) is determined. Table 6 below shows the breakdown of the expenses and their estimates.

Table 7: This table shows the expenses due to the capital of the project.

Component	Basis for Estimate	Cost ($)
DIRECT COSTS		
Total Purchased Equipment		48,200
Installation	47% Purchased equipment cost	22,654
Instrumentation and controls	36% Purchased equipment cost	17,352
Piping	68% Purchased equipment cost	32,776
Electrical	11% Purchased equipment cost	5,302
Offsite		
Building	18% Purchased equipment cost	8,676
Yard Improvement	10% Purchased equipment cost	4,820
Service Facilities	70% Purchased equipment cost	33,740
Total Direct Cost		173,520
INDIRECT COST		
Engineering	33% Purchased equipment cost	15,906
Construction	41% Purchased equipment cost	19,762
Legal expenses	4% Purchased equipment cost	1,928
Contractor's fee	22% Purchased equipment cost	10,604
Contingency	44% Purchased equipment cost	21,208
Total Indirect Plant Cost		69,408
Fixed Capital Investment	Direct cost + Indirect cost	242,928
Working Capital	15% of Total Capital Investment	42,870
Total Capital Investment		285,798

These values are calculated by determining the direct and indirect costs of the process which is based on the total equipment cost. The FCI is found to be approximately $243,000 and the TCI is found to be $286,000 with a working capital (WC) of $43,000 which can be seen from Table 6 above.

9.2 Raw Materials

Raw materials used in the formulation perfume impact the feasibility of the project significantly. The perfume oil makes up 15% of the volume of the perfume. Although this is a relatively small volume, the oil is the most expensive component in the perfume compared to the ethanol and water. Since the prices of the oils vary widely along with the product quality, it is difficult to decide on the best raw materials for consumers within a reasonable cost range for KCC, Inc. The company has decided to use absolute essential oils, which are the purest form of essential oils, at the lowest possible cost. Based on ease and efficiency for KCC, Inc., the essential oil costs for the fragrance are determined by using prices of the products provided by Internet sites.[6] Table 7 below lists the prices for each component of Pure Ambition.

Table 8: Table shows the price of the essential oils and the capacity of the perfume

Raw Materials Pricing			
Component	**Capacity (L/yr)**	**Price ($/L)**	**Price ($/yr)**
Ethanol	509	8	4030
Water	57	0.26	14
Peony	1	1770	1770
Lemon	3	1650	4950
Honeysuckle	1	1632	1632
Hibiscus	1	1452	1452
Rose	1	9240	9240
Amber	2	9422	18844
Vanilla	2	8400	16800
Sandalwood	4	7410	29640
Musk	5	2142	10710
TOTAL RAW MATERIALS COST			**99082**

From the data in the Table above, the essential oil cost is approximately $95,000. The total raw materials cost which includes the oil, alcohol, and water is calculated to be approximately $99,100.

9.3 *Operating Labor*

An estimation for the operating costs based on the operating labor is determined for the project. It is assumed that the operation is run with two men per shift and two shifts per day. The process is carried out for 8 hours per shift and for 260 days out of the year. The labor is made up of one engineer (skilled) and one operator (unskilled) per shift. The engineer and the operator's wages are $25/hr and $15/hr for each man, respectively. Based on these assumptions, the operating costs are calculated to be $166,400 annually.

9.4 *Total Product Cost*

The total annual product cost is dependant on two main factors: the raw material costs and the operating labor costs. These factors also affected the total product cost significantly when they are varied. For this reason, minimizing the raw material costs and the operating labor costs are important to the overall cost evaluation of the project. The lower the total product cost is, the higher the profit the company made per year. A table representative of the procedure used to calculate the total product cost is shown below.

Table 9: This table shows the cost breakdown and the assumptions used to calculate the total annual product cost for the first year of the project.

Component	Basis for Estimate	Cost ($/yr)
I. MANUFACTURING COST		
A. Direct production costs		
1. Raw materials		99,084
2. Operating labor	2 men(1 skilled, 1 common)/shift, 2 shifts/day, 260 days/yr, 8 hours/shift, $25/hr for skilled and $15/hr for common	166,400
3. Direct supervisory and clerical	15% of Operating labor	24,960
3. Utilities		
Process electricity	50000 kWh, $ 0.045/kwh	2,250
Facility electricity	Estimated to be 20000 kwh, $ 0.045/kwh	900
4. Maintenance and repair	7% of FCI	17,005
5. Operating Supplies	15% of Maintenance and repair	2,551
7. Laboratory charges	15% of Operating labor	24,960
8. Patents and Royalties	assumed to be zero	0
Subtotal		**338,109**
B. Fixed charges		
1. Local taxes	Average populated area, 2% of FCI	4,859
2. Insurance	1% of FCI	2,429
Subtotal		**7,288**
C. Overhead Costs	50% of Operating labor, Supervision, and Maintenance	**104,182**
II. GENERAL EXPENSES		
A. Distribution and selling costs	5% Total product cost	28,236
B. Research and development	5% of Direct production costs	16,905
C. Advertisement	Will decide advertisement later	70,000
Subtotal		**115,142**
TOTAL ANNUAL PRODUCT COST	Manufacturing cost + General expenses	**564,721**

Another factor that significantly influenced total annual product cost is advertising. For KCC, Inc.'s purposes approximately $70,000 is allocated by the company to cover the costs of advertising in the first year of production and distribution of Pure Ambition. In the second and third year, the advertising cost reduces to $50,000 per year to diminish expenses. For the remainder of the following years, the advertising cost is reduced again, this time to $20,000 per year. This strategy is to prevent the over-saturation of the product which would negatively affect the product's appeal to its consumers. Depreciation also played a significant role in the total product cost, but its effects will be considered later in the text. All of these factors are taken into consideration when the total product cost for each year is calculated. As can be seen from Table 8 above, the total product cost for the first year minus the depreciation is calculated to be approximately $565,000. The total product cost for each year may vary.

9.5 *Revenue*

Revenue, also commonly referred to as sales, played a large role in determining economic feasibility for the company. The revenue of the product is determined by the production capacity per year and the price per product. KCC Inc. assumed that the demand for the product is also equal to the production capacity for the company. KCC, Inc. had determined with thorough analysis that the optimal selling price of the product is $60 per bottle. Therefore, the revenue for Pure Ambition is determined to be approximately $800,000 for each year.

9.6 *Depreciation*

Depreciation is a non-cash expense that reduces the value of assets due to wear and tear, corrosion, and/or deterioration due to age. This expense is calculated with the total annual product cost which then affected the cash flow of the project. The depreciation value is calculated using the straight line method over a recovery period of 5 years. Depreciation is dependent upon the fixed capital investment and the amount of years required for recovery. The company had a FCI of approximately $243,000 (from before) and assumed a recovery period of 5 years. Therefore, the depreciation per year during the recovery period is $48,600.

9.7 *Cost Evaluation*

The cost evaluation is made up of the net profit, cash flow, ROI, and the net present worth (NPW). In this subsection the values for the maximum return on investment and the maximum Happiness will be analyzed. These calculated values can be found in Table 9 and 10 below.

Table 10: This table contains the values calculated for the net profit and the cash flow for each year

(a)Maximum ROI for Pure Ambition (b) Maximum Happiness for Pure Ambition

Years	Revenue	TPC w/o dep	dep	Net Profit	Cash Flow
1	797700	562,164	48585.6	121518	170103
2	797700	542,164	48585.6	134518	183103
3	797700	542,164	48585.6	134518	183103
4	797700	512,164	48585.6	154018	202603
5	797700	512,164	48585.6	154018	202603
6	797700	512,164	0	185598	185598
7	797700	512,164	0	185598	185598
8	797700	512,164	0	185598	185598
9	797700	512,164	0	185598	185598
10	797700	512,164	0	185598	185598
TOTAL	7977000	5231640	242928	1626581	1869509

(a)

Years	Revenue	TPC w/o dep	dep	Net Profit	Cash Flow
1	60	500,308	48585.6	-356742	-308156
2	60	480,308	48585.6	-343742	-295156
3	60	480,308	48585.6	-343742	-295156
4	60	450,308	48585.6	-324242	-275656
5	60	450,308	48585.6	-324242	-275656
6	60	450,308	0	-292661	-292661
7	60	450,308	0	-292661	-292661
8	60	450,308	0	-292661	-292661
9	60	450,308	0	-292661	-292661
10	60	450,308	0	-292661	-292661
TOTAL	600	4613076	242928	-3156013	-2913085

(b)

Table 11: This table shows the net profit, cash flow, NPW, and ROI.

(a) Maximum ROI for Pure Ambition (b) Maximum Happiness for Pure Ambition

AVERAGES	
Net Profit	Cash Flow
162658	186951
NPW	ROI (%)
875303	56.91

(a)

AVERAGES	
Net Profit	Cash Flow
-315601	-291308
NPW	ROI (%)
-2063394	-110.43

(b)

From Tables 9 and 10, it showed that the values vary wildly for the revenue, net profit, net cash flow, net present worth and return on investment. For the perfume formulation that takes into consideration the maximum ROI, the average profit for each year is approximately $163,000. On the other hand, the perfume formulation for the maximum Happiness had an average profit for each year of -$315,600. Table 10(a) showed that the NPW is calculated to be $875,000 while Table 10(b) showed that the NPW is calculated to be -$2,063,394. Knowing these values, the

ROI for determining the maximum ROI and the maximum Happiness is calculated to be 56.91% and -110.43% respectively. All the equations used to solve for the cost evaluation are found in PT&W.[4]

10.0 ECONOMIC SCENARIOS

To evaluate the risks associated with the product, KCC, Inc. determined possible future scenarios and calculated the risk involved for producing and selling Pure Ambition. Three basic scenarios are investigated, periods of high economic conditions, average economic conditions, and low economic conditions. The variability related to these deviations is assumed to be 20%. The company varied each of the raw material costs within a 20% range to determine the risk associated with these costs. The standard deviation of 20% is chosen based on market trend data. The raw material cost is the variable used for the risk evaluation. Since this cost contributed to a large percentage of the total annual product cost, it is reasonably chosen for evaluation.

The Happiness function is determined as a model to define the parameters of the fragrance that will make the consumer satisfied with the product, and therefore, result in a sale. The model used is specific to Pure Ambition and aimed at the specified target market. A graph of the Happiness function versus the return on investment is shown below for Pure Ambition as well as for the Competition.

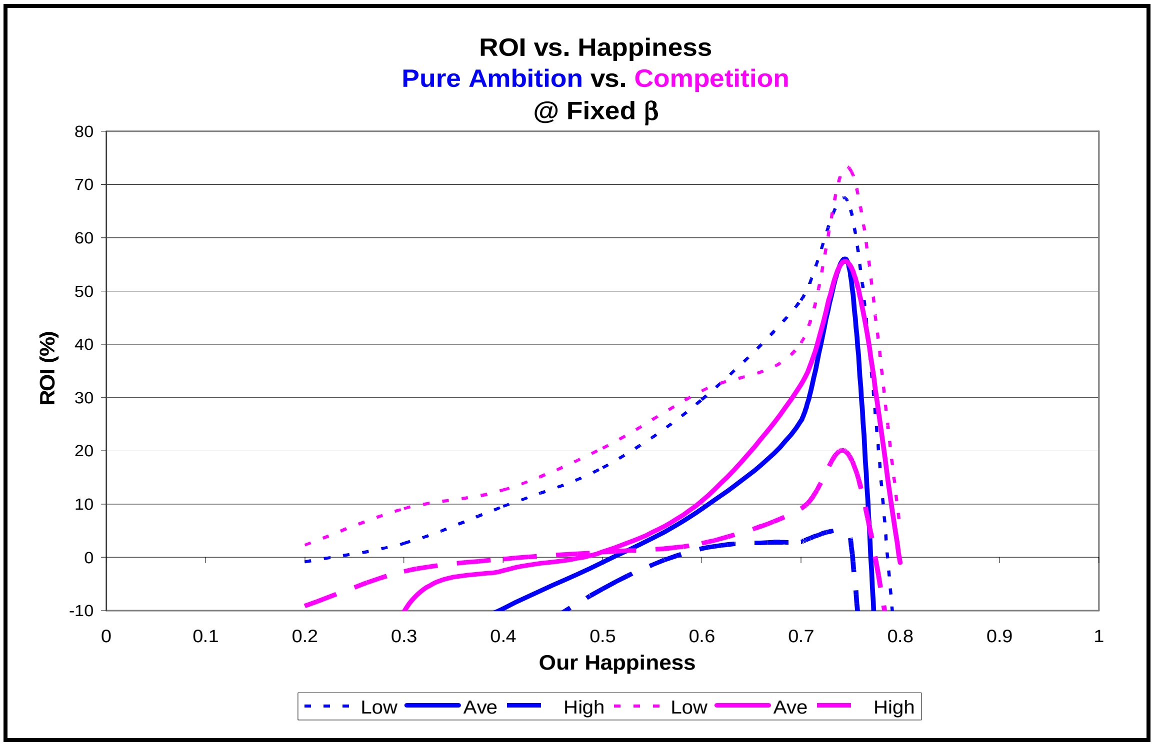
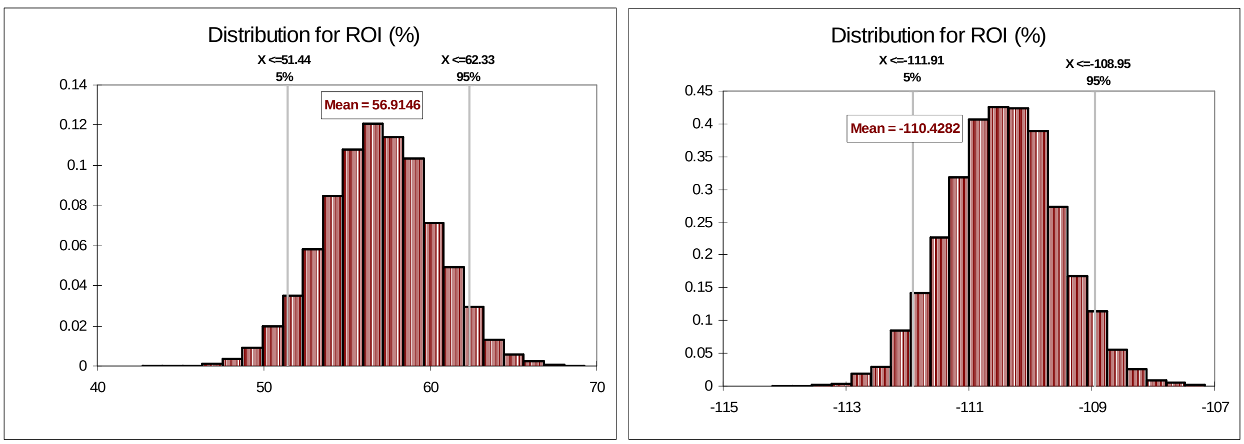


Figure 9: Percent return on investment as result of the Happiness of the perfume

This graph illustrates the relationship between the return on investment and the Happiness. The greater the Happiness the customer perceives, the more demand there is for the product. This results in greater revenue and profit, as shown by the initial positive slope of the line. This is from the range of 20% to approximately 75% Happiness. The increasing cost incurred with increasing Happiness, will eventually override the sales from the high Happiness. Therefore, the ROI will start to immediately decline. This is evident from the range of 0.75 Happiness to approximately 0.8 Happiness. The graph also shows the trends for the low, average and high market for Pure Ambition as well as for the competition. It can be seen that at low market the ROI for both the fragrances has the highest values. At high market, the ROI for both fragrances is also the lowest. The maximum ROI for Pure Ambition occurs at a Happiness of roughly 75%, and this value is approximately 67% at low market values. In order to break even financially, the Happiness should be at or near 45% depending on the market scenario.

10.1 Risk Analysis

The risk diagrams shown below, Figure 11 and Figure 12, represent the risk associated with a 20% variability in the raw materials cost for both a capacity of 665 L/year and 0.5 L/year for the formulation of the maximum ROI and the maximum Happiness, respectively. The output of the process is chosen to be the ROI of the project. Looking at Figure 11, the mean ROI for the maximum ROI formulation and the maximum Happiness are approximately 56.91% and -110.43%, respectively. This graph shows the probability of occurrence for a given range of ROI values. For example, upon iterating @Risk 10,000 times, the calculated 56.91% and -110.43% ROI occurred 12% and 42.5% of the time, respectively.

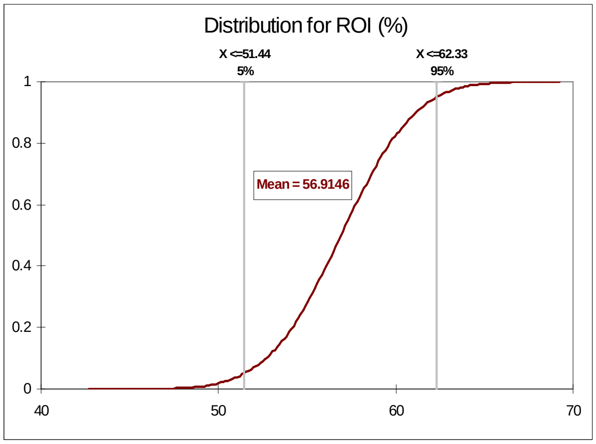


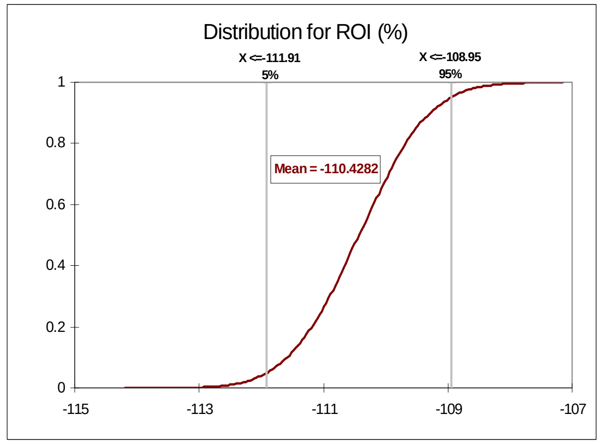
(a) **(b)**

Figure 10: This figure is a histogram showing distribution of risk within 90% confidence

(a) Maximum ROI for Pure Ambition (b) Maximum Happiness for Pure Ambition

Figure 12 on the next page, shows the cumulative probability for a given ROI value. From the graph, it can be concluded that the company has a 100% chance of gaining money for a capacity of 665 L/year capacity, and a 100% of losing money for a capacity of 0.5 L/year. This is based on the 20% variability in raw material costs.





(a) **(b)**

Figure 11: This graph shows a risk curve for 20% variability of raw materials cost

(a) Maximum ROI for Pure Ambition (b) Maximum Happiness for Pure Ambition

10.2 Regret Analysis

A regret analysis is performed on eight different perfume formulations. The different formulations are determined by manipulating the concentration of each essential oil in the fragrance. As the concentration of the perfume changes, the happiness also changes therefore resulting in different economic values such as net present worth and return on investment. The maximum return on investment each formulation gave is calculated for three different market scenarios. These scenarios are based on low, average, and high market cost for the raw materials used in the perfume. A 20% standard deviation is assumed in the raw material prices based on current market trends. The resulting ROI values are used to perform the regret analysis. The table below shows a numerical value directly related to the regret the investor would feel if they invested in any one of the perfume formulations and the market values shifted.

Table 12: This is a table of the regret analysis for the 8 formulations and tree economic scenarios.

Regret				
	Low	Medium	High	MAX
F1	66.09	124.23	110.13	124.23
F2	62.61	74.27	62.31	74.27
F3	55.66	63.23	38.87	63.23
F4	48.4	54.54	25.53	54.54
F5	35.63	44.5	17.98	44.5
F6	16.99	27.97	16.68	27.97
F7	0	0.77	16.47	16.47
F8	90.93	164.45	170.26	170.26
			MIN	16.47

The highlighted value in the table is the overall minimum of the maximum regret for all options. Based on this analysis, formulation F7 at 75% happiness would be the formulation chosen to minimize investor regret.

Overall, three basic types of investing are examined. Traditional investing, which is defined by the investor using the product design that gives the highest profit on the average market, pessimistic investing which deals with the investor choosing the best out of the worst situation, and optimistic investing which is investing in the best option for the best scenario. The graph below shows the trend in the return on investment for each formulation at all three scenarios.

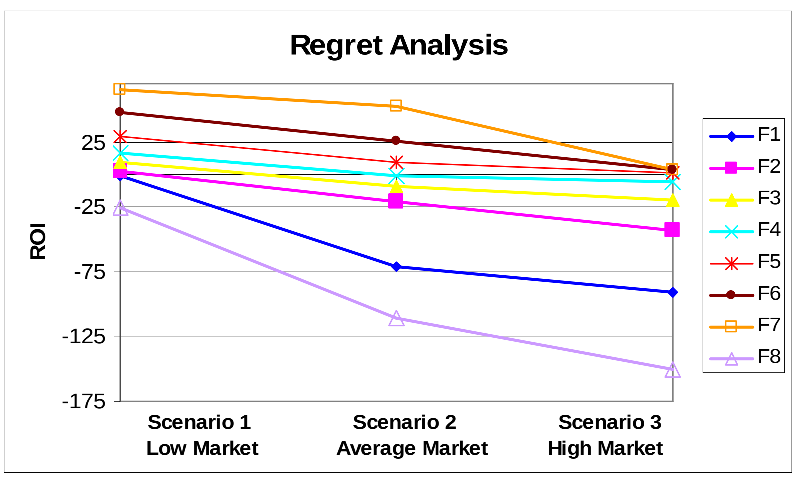


Figure 12: This figure is a representation of the regret analysis in graphical form for the 8 different formulations and the three economic scenarios.

A traditional investor would usually choose to produce this perfume with the formulation of F7, shown by the high value of ROI for the average market. The optimistic and pessimistic investors would also choose perfume formulation F7 for production due the high value of ROI theoretically obtainable on the high and low markets.

11.0 CONCLUSION

- Based on these conditions:
  - Distributing the product in 1.7 oz bottles
  - Product sold at $60 per bottle
- The most customer satisfactory business scenario involved the following:
  - Achieving ~80% customer satisfaction through the Happiness function
  - The average net profit/year for this investment is -$316,000
  - The NPW is -$2,063,000
  - The ROI is -110.43% (over ten years)
  - Pure Ambition is not profitable.
- The most profitable business scenario involved the following:
  - Achieving ~75% customer satisfaction through the Happiness function
  - The average net profit/year for this investment is $163,000
  - The NPW is $875,000
  - The ROI is 56.91% (over ten years)
  - Pure Ambition is profitable.

12.0 SAFETY

Although the equipment used in the perfume process is non-hazardous, a detailed hazardous operations analysis is performed to insure that accidents are kept to a minimum. [See Appendix]

13.0 RECOMMENDATIONS

Based on the analyses KCC, Inc. performed, Pure Ambition is a profitable business venture under certain conditions and constraints. To validate this conclusion, experimental data could be obtained and the analyses performed again, and these values compared to the analytical results represented in this document. Possible characteristics to further analyze would be the odor thresholds, headspace concentrations, and diffusion models.

In addition, as expansion of KCC, Inc. occurs, reevaluation of the economic analysis is necessary to maintain competitiveness in the market. Periodic updates to the Happiness function, and demand model are also necessary in order to deal with the rising market and changes in consumer wants.

Over the ten year life span of this business venture, Pure Ambition is the sole fragrance KCC, Inc. produced. Although this is customary for the initial start-up, it is recommended that a percentage of research and development be devoted to additional fragrances.

14.0 FUTURE PLANS

KCC, Inc.'s long term goal is to become a profitable and successful company within a 10 year period. After this period, expansion is a key objective in the company's future. KCC, Inc. would like to eventually expand their market to the United States' Southern/Midwest region, including all of Oklahoma, Texas, Arkansas, Louisiana, Colorado, New Mexico, Missouri, and Kansas. Dedicated to being an adaptable and opportunistic company, they pledge to continually adjust Pure Ambition to find the perfect fine fragrance for the working woman at a reasonable cost. With these ideas in mind, the company will allot a percentage of their profits yearly to encourage future innovations and expansion.

15.0 REFERENCES

1. Mata, V., Gomes, P., Rodrigues, A. "Engineering Perfumes." AIChE Journal. 51 (2005): 2834-2852.

2. International Flavours and Fragrances. "Making Sense Out of Scents".The Handbook of Cosmetic Science and Technology. Belmay. pp 316-360

3. Ohloff, Gunther. Scent and Fragrances: The Fascination of Odors and their Chemical Perspectives. Berlin. Springer-Verlag. 1994

4. Kraft, P., Swift, K. Perspectives in Flavor and Fragrance Research. Zurich. Wiley-Vch. 2005. pp 7, 35, 61, 94.

5. Frosch, P.J., Johansen, J.D., White, I.R. Fragrances: Beneficial and Adverse Effects. Berlin. Springer. 1998

6. Theimer, Ernst. Fragrance Chemistry: The Science of the Sense of Smell. Rumson, New Jersey. Academic Press. 1982.pp 187, 398, 440.

7. Pybus, D., Sell, C. The Chemistry of Fragrances. Ashford, Kent, UK. Quest International. 1999.

8. Calkin, R., Jellinek, J., Perfumery: Practices and Principles. New York. NY. John Wiley & Sons, Inc. 1994.

9. Perry, Robert H., Green, Don W. McGraw-Hill. 1997. Perry's Chemical Engineers' Handbook. 7th Ed. pp. 4-21,4-22

10. Save-on-Scents. MSDS Peony. 10 March 2006. http://www.saveonscents.com/product_msds.php/products_id/1702.

11. Save-on-Scents. MSDS Lemon. 10 March 2006. http://www.saveonscents.com/product_msds.php/products_id/994.

12. Save-on-Scents. MSDS Honeysuckle. 10 March 2006. http://www.saveonscents.com/product_msds.php/products_id/508.

13. Save-on-Scents. MSDS Hibiscus. 10 March 2006. http://www.saveonscents.com/product_msds.php/products_id/941.

14. Save-on-Scents. MSDS Vanilla. 10 March 2006. http://www.saveonscents.com/product_msds.php/products_id/1026.

15. Save-on-Scents. MSDS Sandalwood. 10 March 2006. http://www.saveonscents.com/product_msds.php/products_id/1032.

16. Save-on-Scents. MSDS Rose. 10 March 2006.
http://www.saveonscents.com/product_msds.php/products_id/580.

17. Save-on-Scents. MSDS Amber. 10 March 2006
http://www.saveonscents.com/product_msds.php/products_id/1024.

18. Save-on-Scents. MSDS Musk. 10 March 2006.
http://www.saveonscents.com/product_info.php/name/African%20Musk%20Fragrance%20Oils/products_id/1159.

19. Honingsbaum, Mark. Dollars and Scents – Gray Market of Perfumes – Scams, Hustles and Boondoggles. Ishington Monthly. July-August 1988.
http://www.findarticles.com/p/articles/mi_m1316/is_n6_-_7_v20/ai_6495570.

20. Carnright Design. Emotional Impact of Color.
http://www.carnrightdesign.com/color4business/emotional_impact_color-3.htm.

21. Pharmco Materials and Safety Data Sheet 10 March 10, 2006
http://www.pharmco-prod.com/pages/SDAmsds40B200.pdf

22. Wikipedia. Diffusion. May 3, 2006.
http://en.wikipedia.org/wiki/Diffusion.

23. Fong Hwang Enterprise Co. Ltd. Emulsifier. May 3, 2006.
http://www.electric-winch-elevator.com/30-bs-004.html.

24. Reid RC, Prausnitz JM, Poling BE. The Properties of Gases and Liquids. New York, NY: Wiley; 1997.

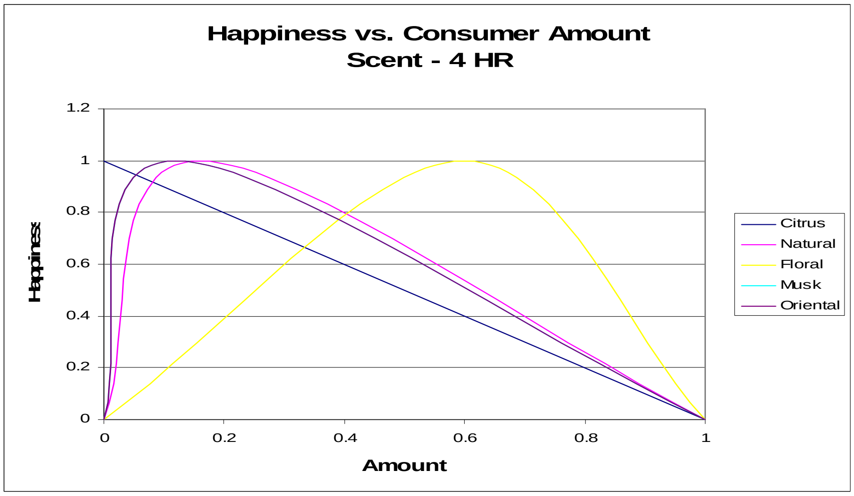
25. Wikipedia. Emulsion. May 3, 2006.
"http://en.wikipedia.org/wiki/Emulsion"

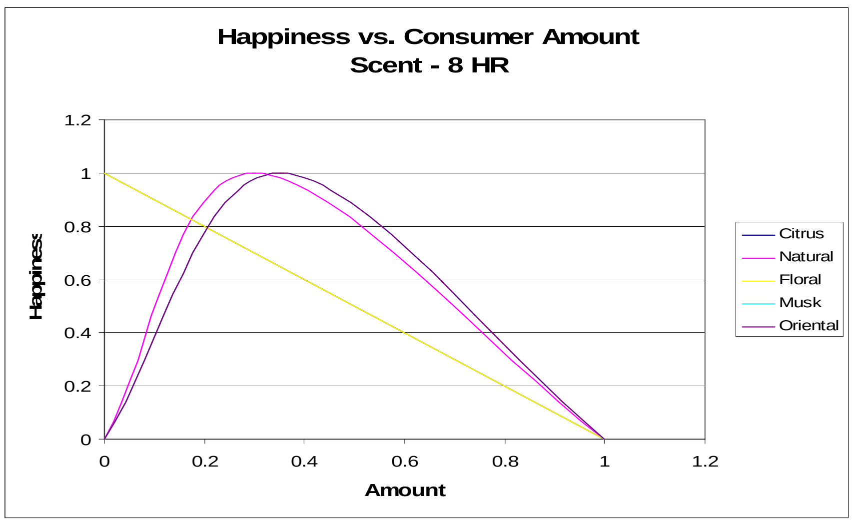
16.0 APPENDIX

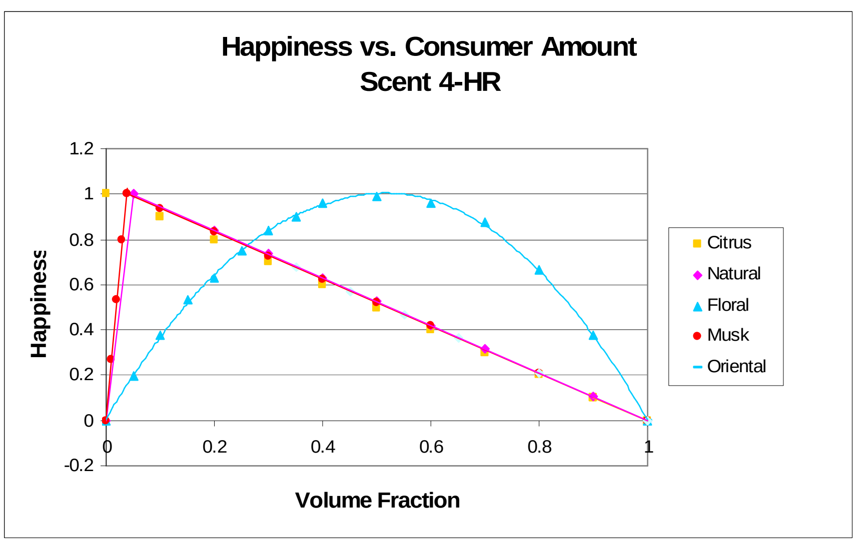
16.1 Appendix A - Hazop

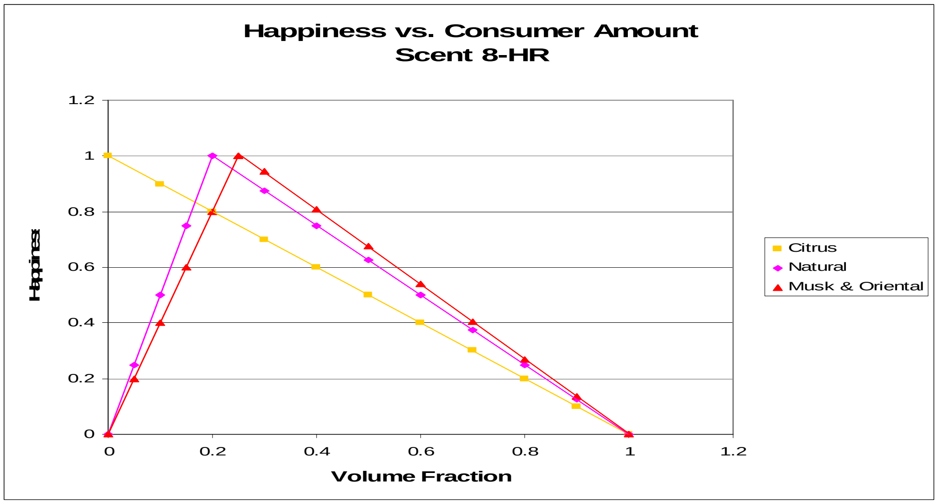
Equipment	Deviation	Cause	Consequence	Safeguards
Mixer	Temperature-increase	unexpected exothermic reaction	denature chemical characteristics, and loose or alter product scents	Add a PID controller and a cooling jacket to the mixer
		controller fails		
		equipment overheats	equipment failure, and denature chemical characteristics, and loose or alter product scents	Regularly monitor and perform routine maintenance on equipment
	Temperature decrease	unexpected endothermic reaction	incomplete mixing occurs	Add a PID controller and a heating jacket to the mixer
		controller fails		Monitor temparature regularly
	Loss of electricity	loss of electric supply	no mixing of product	Add generator to system
		short circuit	equipment failure and no mixing of product	Add fuse, and routine maintenance
	Level more	pump failure	mixing tank overflows	Liquid level alarm
		controller failure		Monitor liquid level regularly
	Level less	tank leak	product loss, and under production	Perform regular tank maintenance
		incorrect pump setting	too much product fed to bottler too fast	Add liquid level controller and connect to pump
		feed to low	pump failure	Add liquid level controller and connect to pump
Pump	Level more	pump failure	mixing tank overflows and less product bottled	Liquid level alarm
		controller failure		Monitor liquid level regularly
	Level less	tank leak	product loss, and under production	Perform regular tank maintenance
		incorrect pump setting	too much product fed to bottler too fast	Add liquid level controller and connect to pump
		feed to low	pump failure	Add liquid level controller and connect to pump
Bottler	Level more	pump failure	mixing tank overflows and less product bottled	Liquid level alarm
		controller failure		Monitor liquid level regularly
	Level less	tank leak	product loss, and under production	Perform regular tank maintenance
		incorrect pump setting	too much product fed to bottler too fast	Add liquid level controller and connect to pump
		feed to low	pump failure	Add liquid level controller and connect to pump

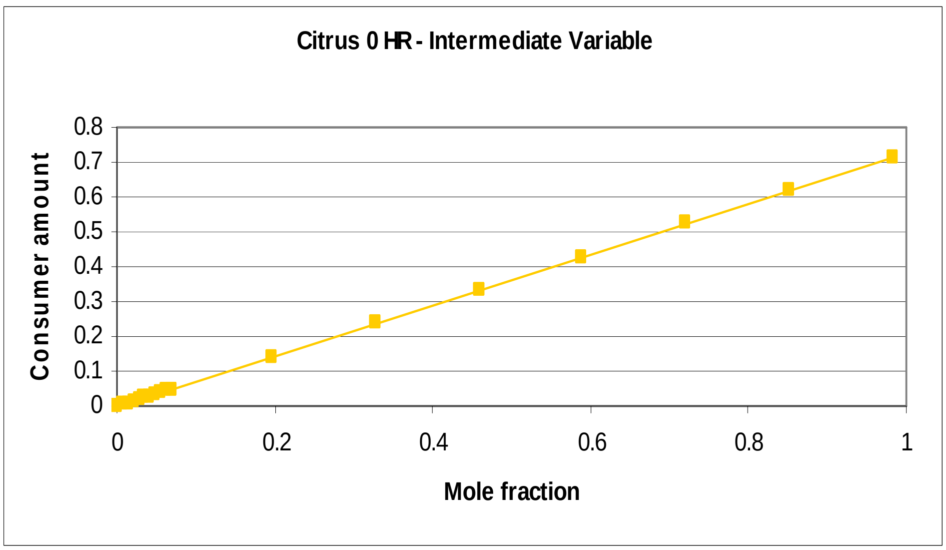
16.2 Appendix B - Happiness Graphs

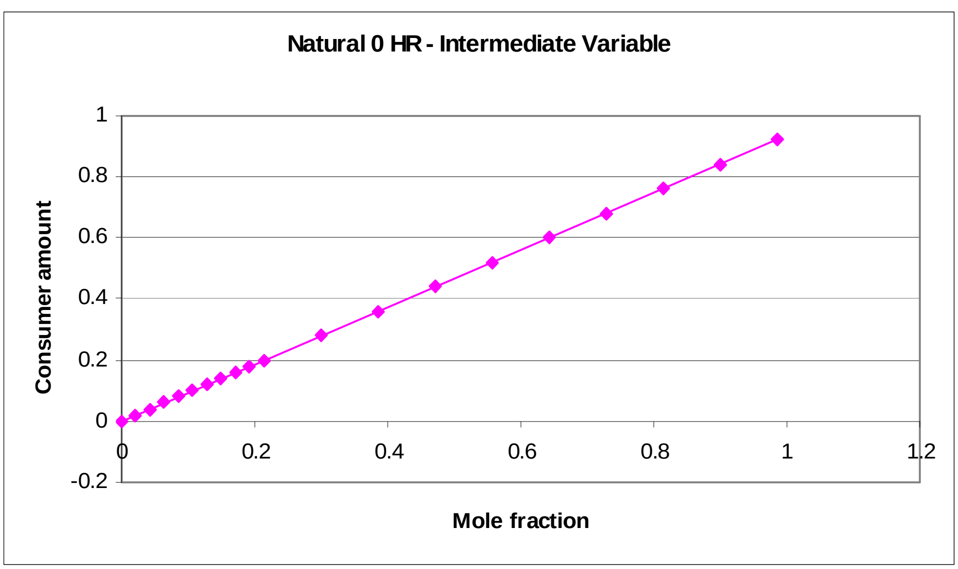


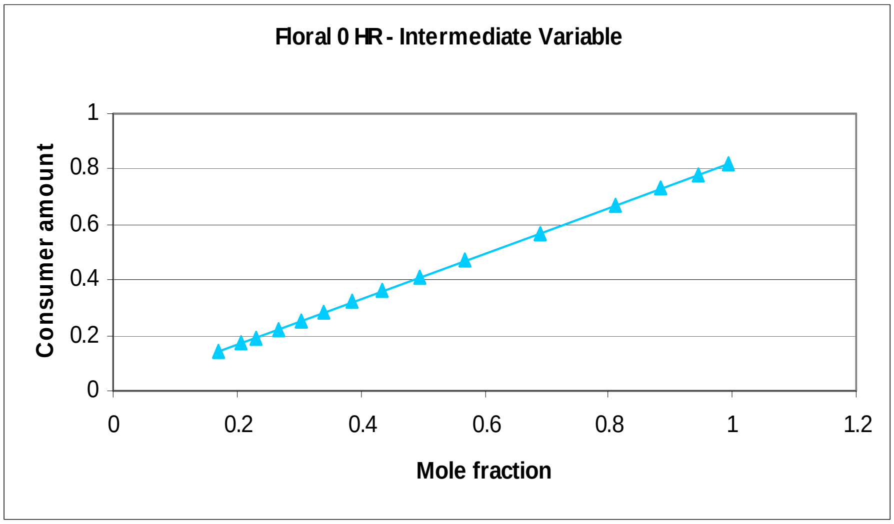


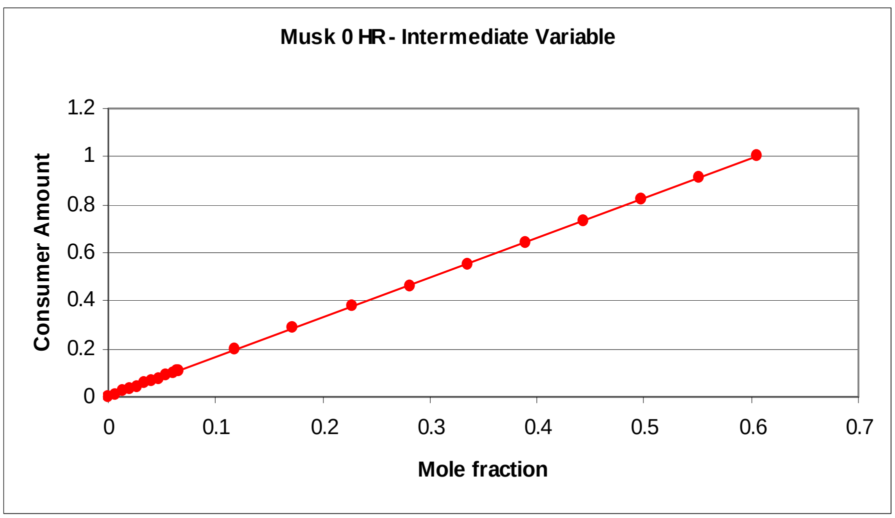



Happiness vs. Consumer Amount
Scent 8-HR
Happiness
Volume Fraction
Citrus
Natural
Musk & Oriental
0
0.2
0.4
0.6
0.8
1
1.2

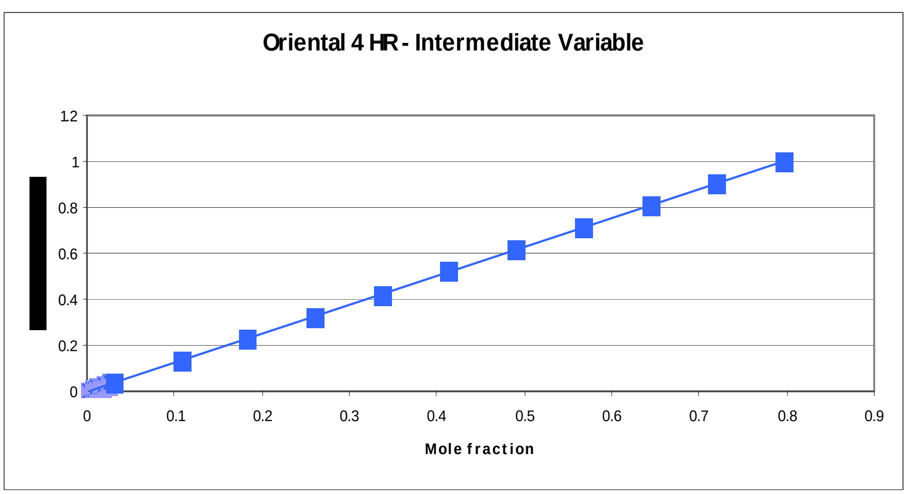

Citrus 0 HR - Intermediate Variable
Consumer amount
Mole fraction
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
1

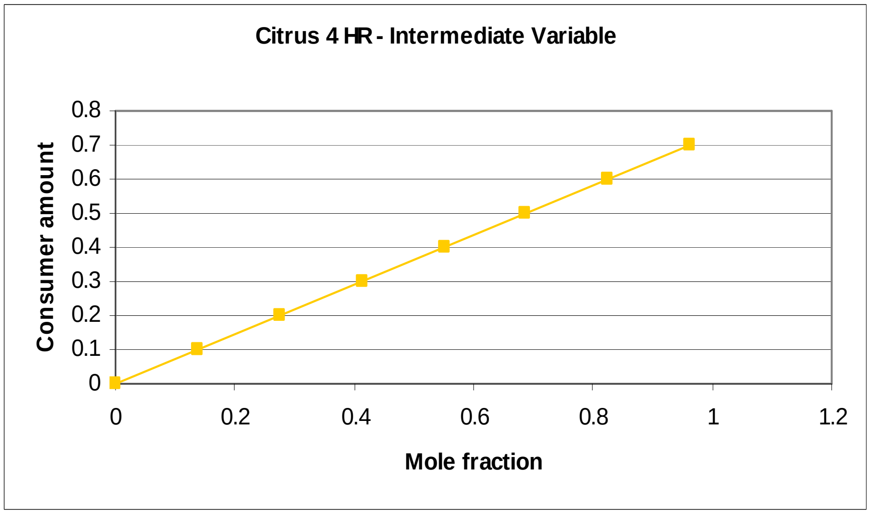

Natural 0 HR - Intermediate Variable
Consumer amount
Mole fraction
-0.2
0
0.2
0.4
0.6
0.8
1
1.2

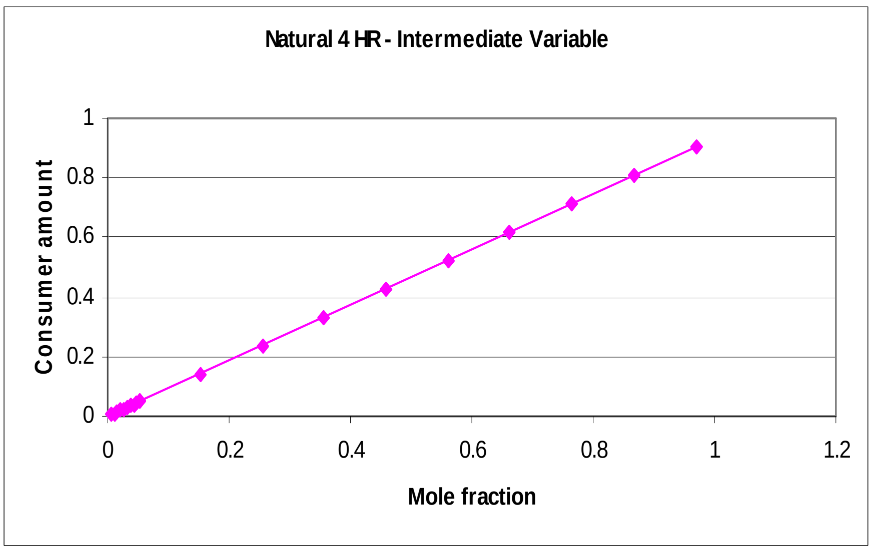

Floral 0 HR - Intermediate Variable
Consumer amount
Mole fraction
0
0.2
0.4
0.6
0.8
1
1.2

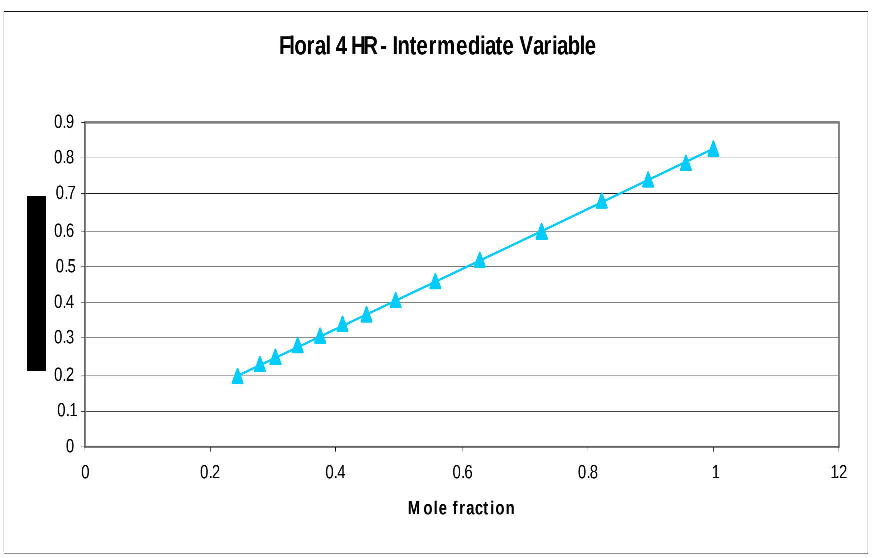

Musk 0 HR - Intermediate Variable
Consumer Amount
Mole fraction
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
1.2

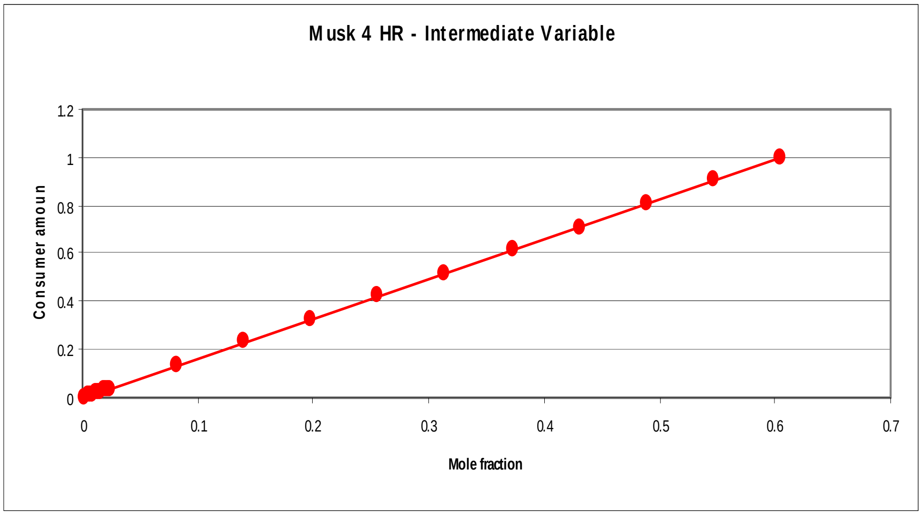
0

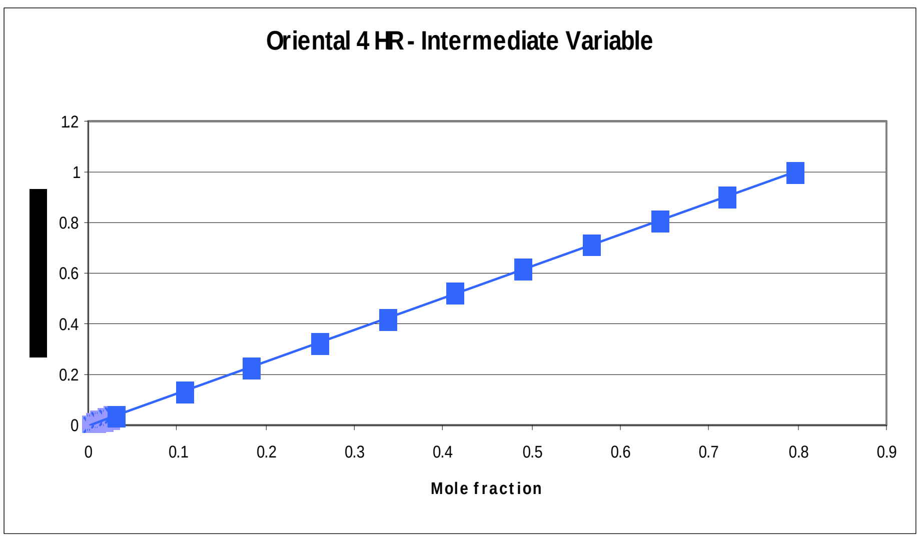

Oriental 4 HR - Intermediate Variable
[redacted]
Mole fraction
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.2

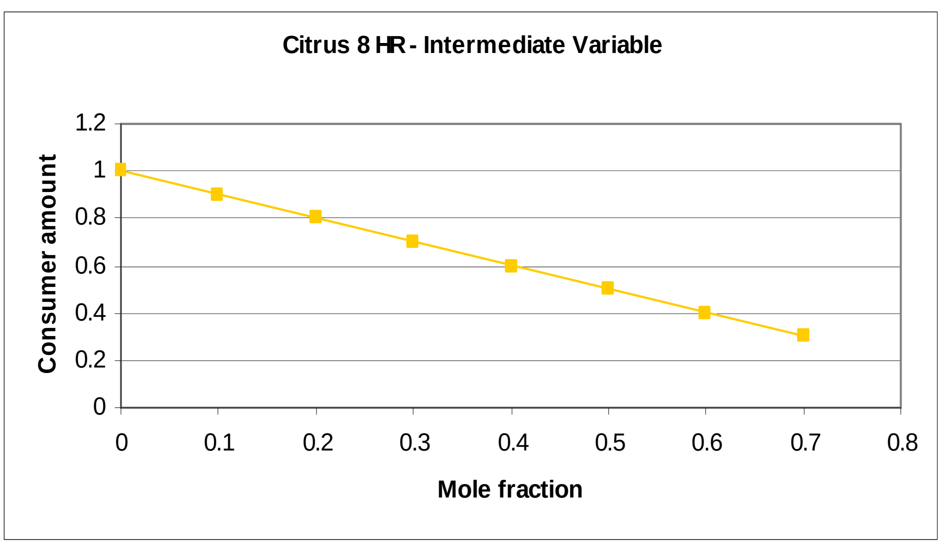

Citrus 4 HR - Intermediate Variable
Consumer amount
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
0.2
0.4
0.6
0.8
1
1.2
Mole fraction

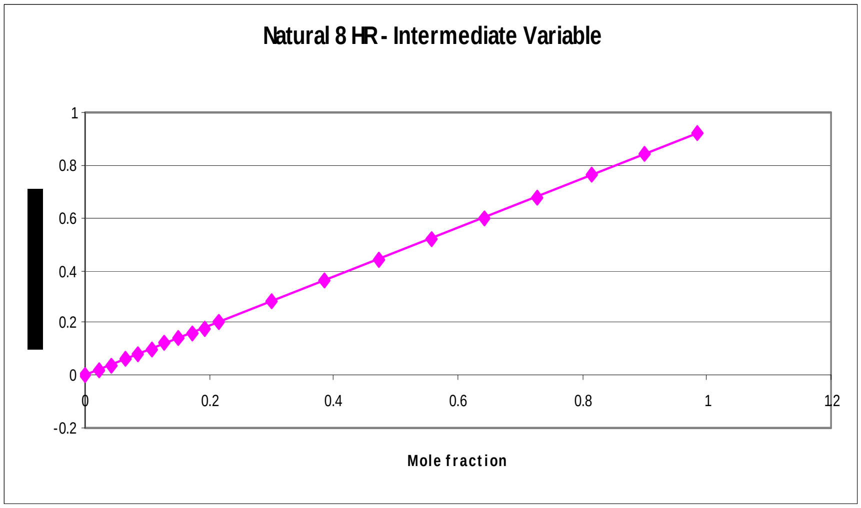

Natural 4 HR - Intermediate Variable
Consumer amount
1
0.8
0.6
0.4
0.2
0
0
0.2
0.4
0.6
0.8
1
1.2
Mole fraction

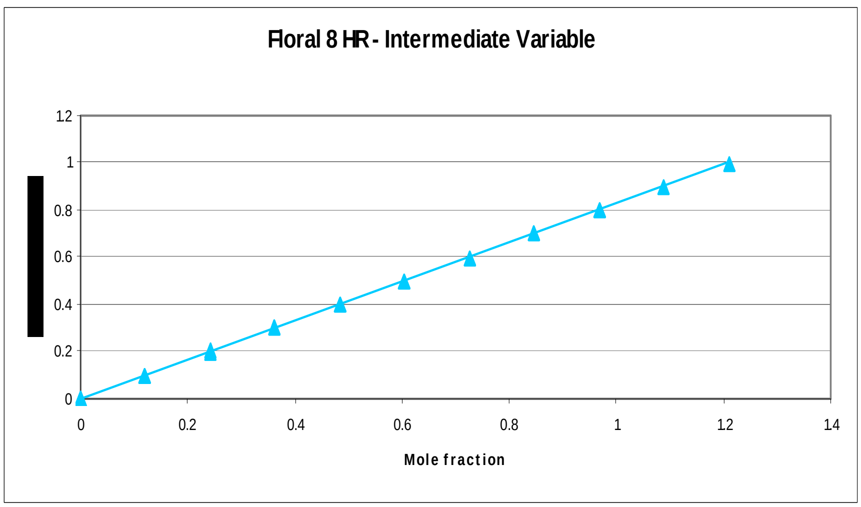

Floral 4 HR - Intermediate Variable
[redacted]
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
0.2
0.4
0.6
0.8
1
12
Mole fraction

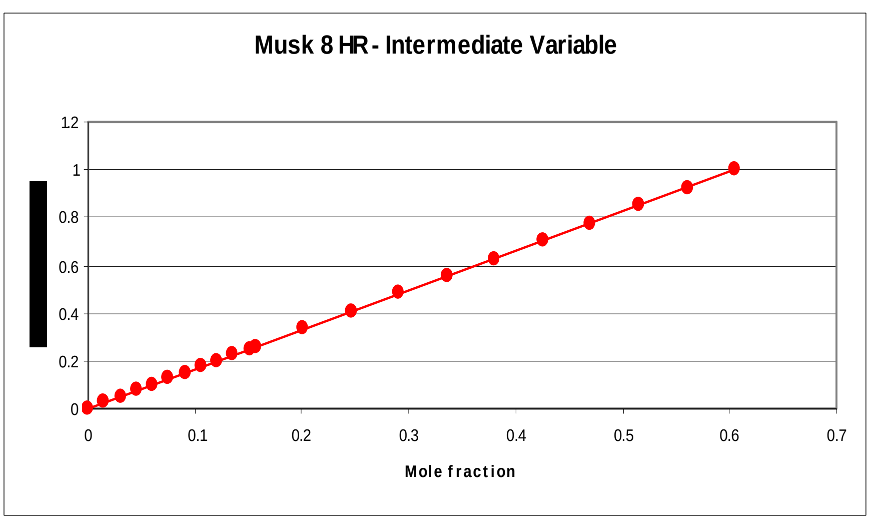

Musk 4 HR - Intermediate Variable
Consumer amoun
1.2
1
0.8
0.6
0.4
0.2
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
Mole fraction

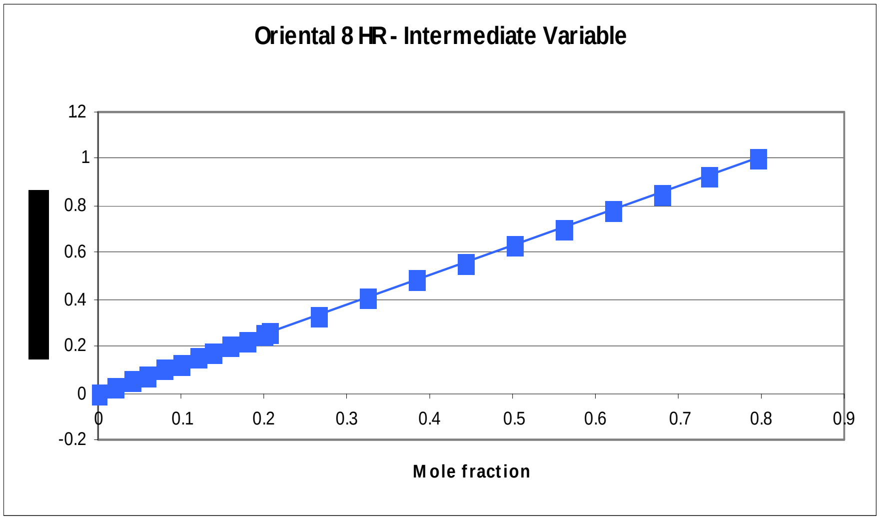

Oriental 4 HR - Intermediate Variable
[redacted]
1.2
1
0.8
0.6
0.4
0.2
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
Mole fraction

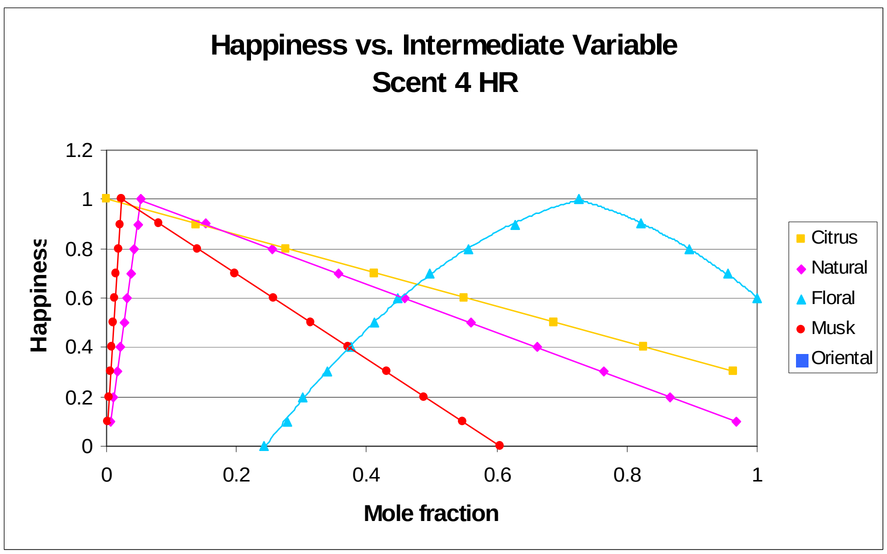

Citrus 8 HR - Intermediate Variable
Consumer amount
1.2
1
0.8
0.6
0.4
0.2
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
Mole fraction

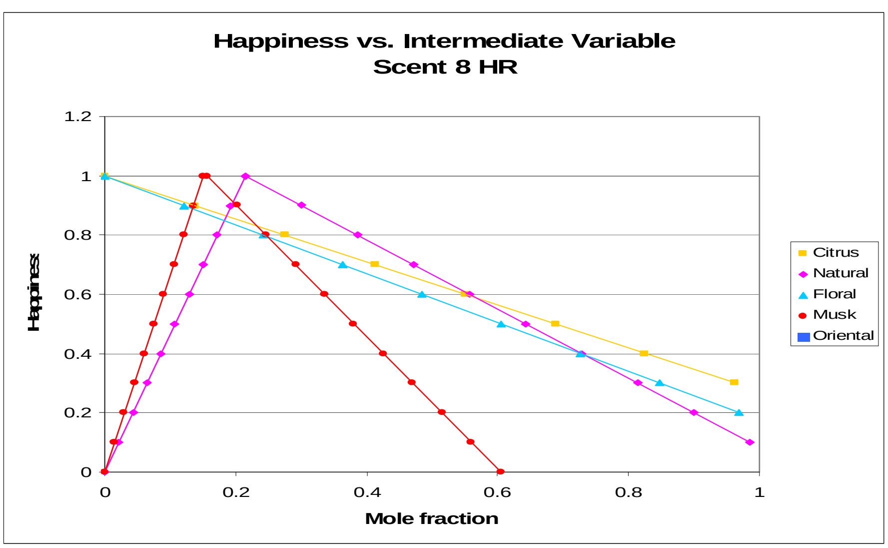

Natural 8 HR - Intermediate Variable
[redacted]
1
0.8
0.6
0.4
0.2
0
-0.2
0 0.2 0.4 0.6 0.8 1 1.2
Mole fraction

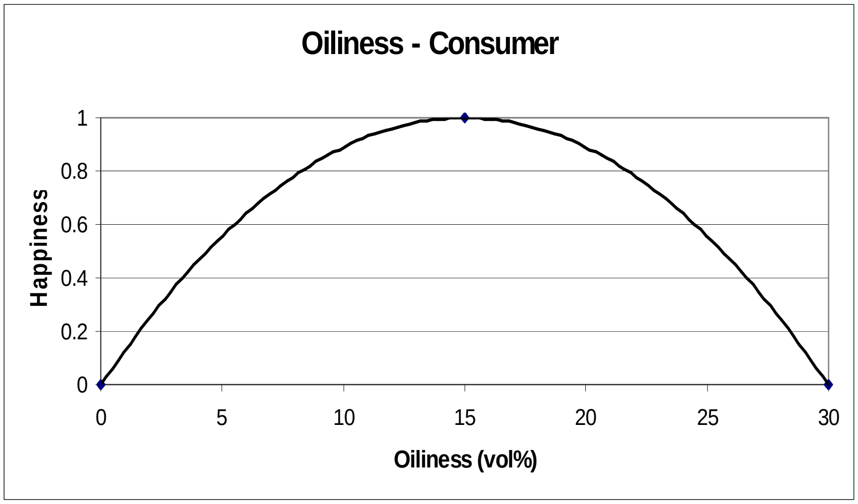

Floral 8 HR - Intermediate Variable
[redacted]
1.2
1
0.8
0.6
0.4
0.2
0
0 0.2 0.4 0.6 0.8 1 1.2 1.4
Mole fraction

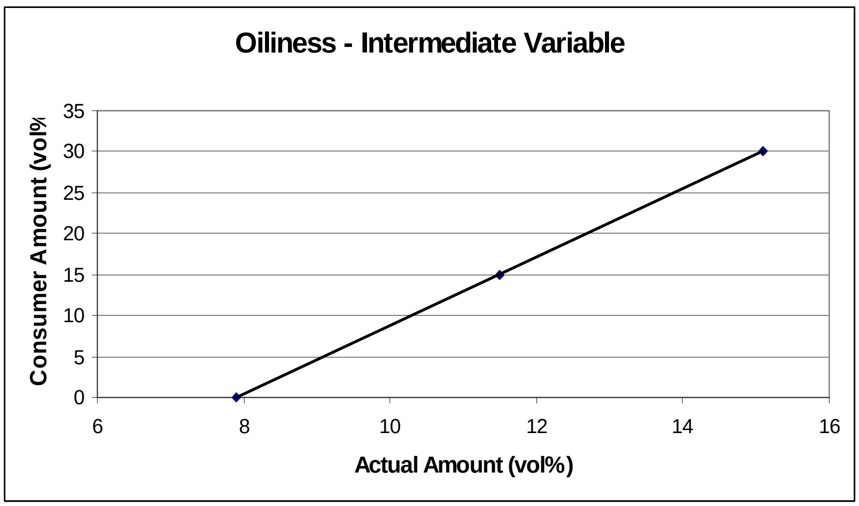

Musk 8 HR - Intermediate Variable
[redacted]
1.2
1
0.8
0.6
0.4
0.2
0
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7
Mole fraction

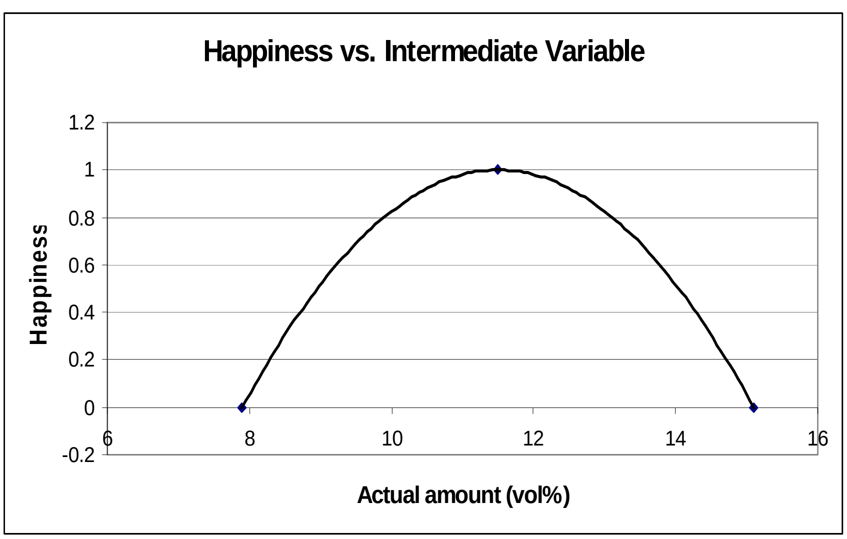

Oriental 8 HR - Intermediate Variable
[redacted]
12
1
0.8
0.6
0.4
0.2
0
-0.2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
Mole fraction

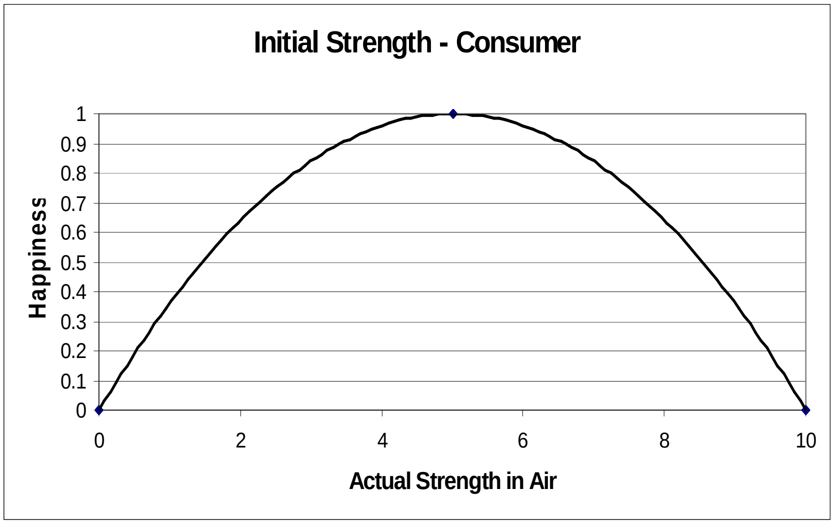

Happiness vs. Intermediate Variable
Scent 4 HR
Happiness
1.2
1
0.8
0.6
0.4
0.2
0
0
0.2
0.4
0.6
0.8
1
Mole fraction
Citrus
Natural
Floral
Musk
Oriental

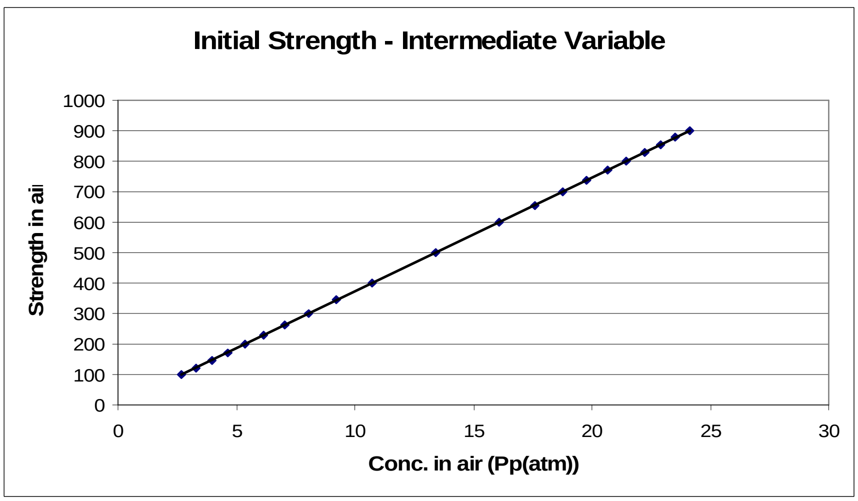

Happiness vs. Intermediate Variable
Scent 8 HR
Happiness
1.2
1
0.8
0.6
0.4
0.2
0
0
0.2
0.4
0.6
0.8
1
Mole fraction
Citrus
Natural
Floral
Musk
Oriental

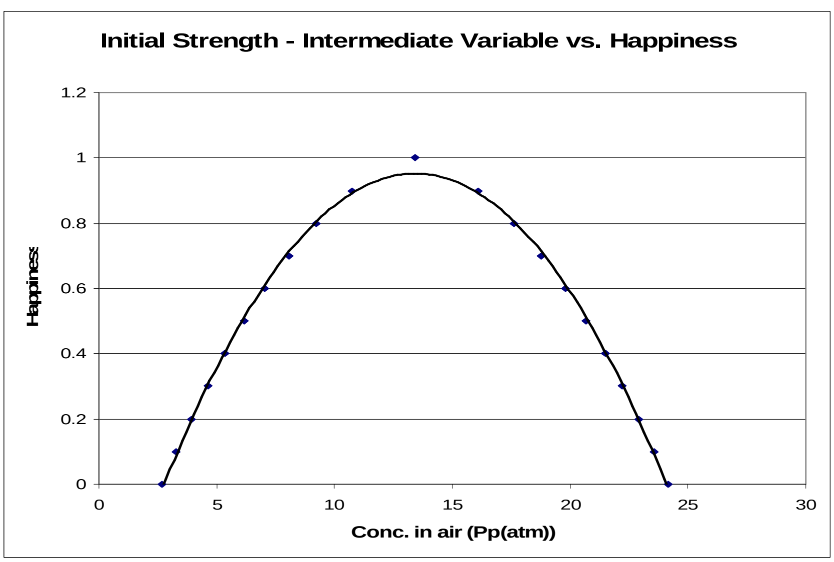

Oiliness - Consumer
Happiness
1
0.8
0.6
0.4
0.2
0
0
5
10
15
20
25
30
Oiliness (vol%)


Oiliness - Intermediate Variable
Consumer Amount (vol%
35
30
25
20
15
10
5
0
6
8
10
12
14
16
Actual Amount (vol%)

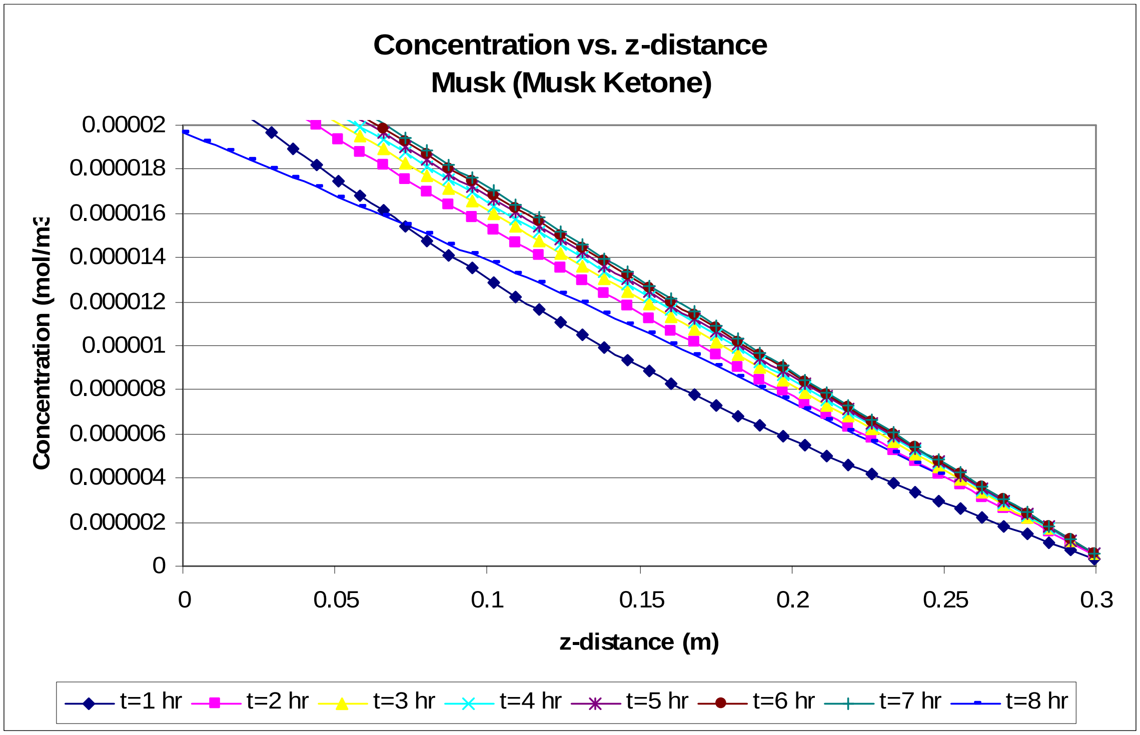

Happiness vs. Intermediate Variable
Happiness
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
6
8
10
12
14
16
Actual amount (vol%)

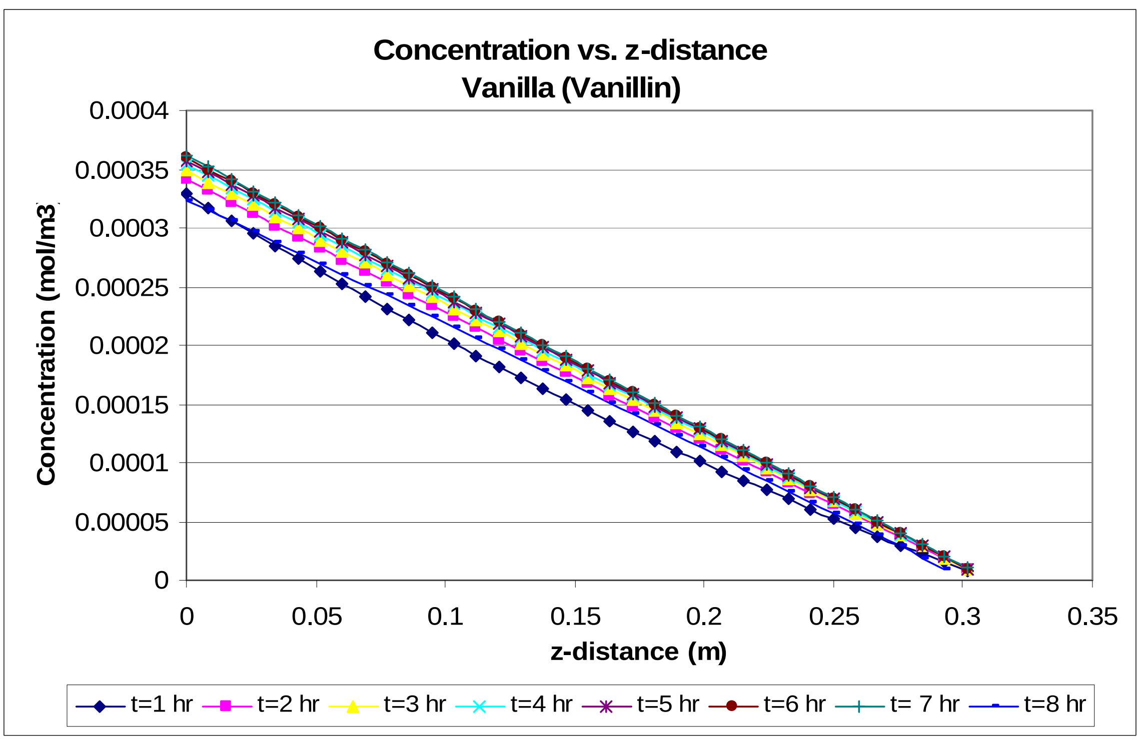

Initial Strength - Consumer
Happiness
Actual Strength in Air
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
2
4
6
8
10

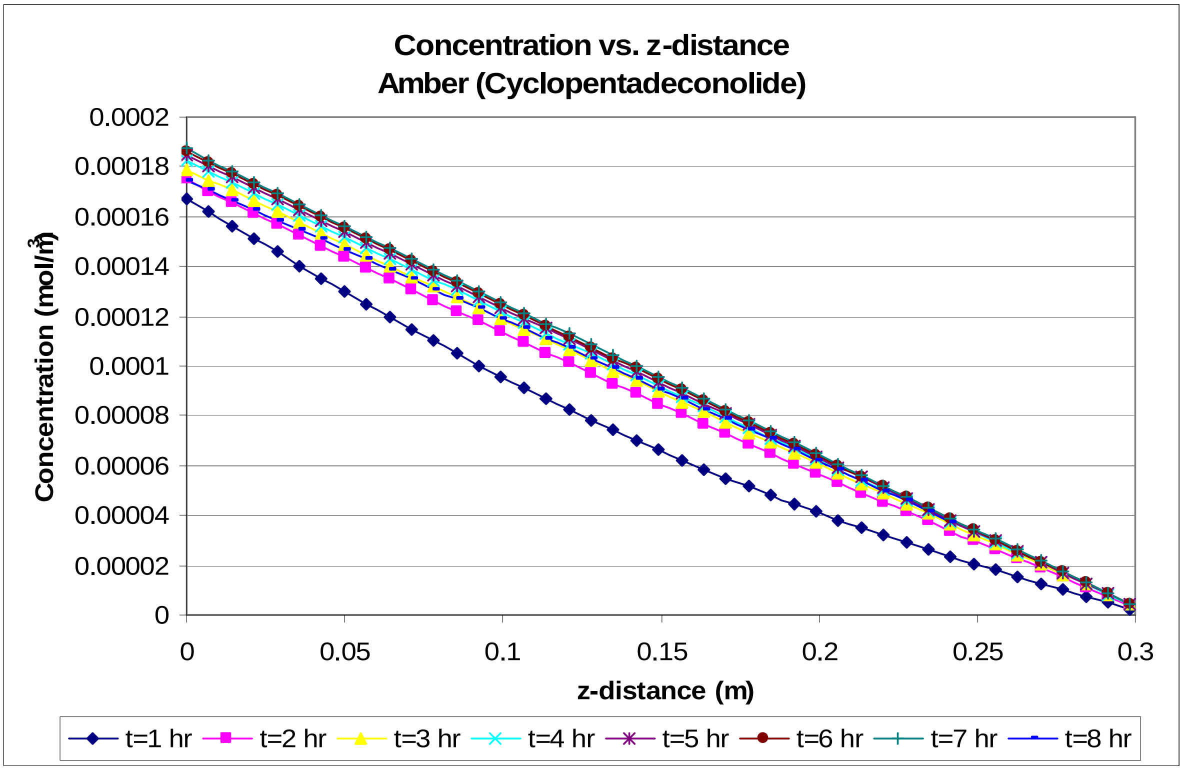

Initial Strength - Intermediate Variable
Strength in ai
Conc. in air (Pp(atm))
1000
900
800
700
600
500
400
300
200
100
0
0
5
10
15
20
25
30


Initial Strength - Intermediate Variable vs. Happiness
Happiness
Conc. in air (Pp(atm))
1.2
1
0.8
0.6
0.4
0.2
0
0
5
10
15
20
25
30

16.3 Appendix C - Concentration Profiles






Concentration vs. z-distance
Amber (Cyclopentadeconolide)
Concentration (mol/m3)
0.0002
0.00018
0.00016
0.00014
0.00012
0.0001
0.00008
0.00006
0.00004
0.00002
0
0
0.05
0.1
0.15
0.2
0.25
0.3
z-distance (m)
t=1 hr
t=2 hr
t=3 hr
t=4 hr
t=5 hr
t=6 hr
t=7 hr
t=8 hr

16.4 Appendix D - Regret Table

ROI						
	Low	**Med**	**High**	**Ave**	**Max**	**Min**
F1	-0.84	-70.61	-90.51	-53.9867	-0.84	-90.51
F2	2.64	-20.65	-42.69	-20.2333	2.64	-42.69
F3	9.59	-9.61	-19.25	-6.42333	9.59	-19.25
F4	16.85	-0.92	-5.91	3.34	16.85	-5.91
F5	29.62	9.12	1.64	13.46	29.62	1.64
F6	48.26	25.65	2.94	25.61667	48.26	2.94
F7	65.25	52.85	3.15	40.41667	65.25	3.15
F8	-25.68	-110.83	-150.64	-95.7167	-25.68	-150.64
MAX	65.25	53.62	19.62	40.41667	65.25	3.15

16.5 Appendix E - Total Product Cost at Max Happiness

Component	Basis for Estimate	Cost ($/yr)
I. MANUFACTURING COST		
A. Direct production costs		
1. Raw materials		43,118
2. Operating labor	2 men(1 skilled, 1 common)/shift, 2 shifts/day, 260 days/yr, 8 hours/shift, $25/hr for skilled and $15/hr for common	166,400
3. Direct supervisory and clerical	15% of Operating labor	24,960
3. Utilities		
Process electricity	50000 kWh, $ 0.045/kwh	2,250
Facility electricity	Estimated to be 20000 kwh, $ 0.045/kwh	900
4. Maintenance and repair	7% of FCI	17,005
5. Operating Supplies	15% of Maintenance and repair	2,551
7. Laboratory charges	15% of Operating labor	24,960
8. Patents and Royalties	assumed to be zero	0
Subtotal		**282,144**
B. Fixed charges		
1. Local taxes	Average populated area, 2% of FCI	4,859
2. Insurance	1% of FCI	2,429
Subtotal		**7,288**
C. Overhead Costs	50% of Operating labor, Supervision, and Maintenance	**104,182**
II. GENERAL EXPENSES		
A. Distribution and selling costs	5% Total product cost	25,143
B. Research and development	5% of Direct production costs	14,107
C. Advertisement	Will decide advertisement later	70,000
Subtotal		**109,250**
TOTAL ANNUAL PRODUCT COST	Manufacturing cost + General expenses	**502,865**