**Design #2**

**Olfaction Satisfaction**

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NSF Engineering Design Projects:  
Olfactory Stimulation Device

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General Description

The Olfaction Satisfaction Device (See Figure 1) has several main components. These include the base, exterior and interior casing, user interface, fragrance chamber, electrical circuit, power supply, microprocessor and fans. All of these components work together to provide a safe, entertaining experience for the user. The base provides stability for the device and accessibility for the user. The exterior and interior casing will protect the various components of the device from damage as well as prevent user injury by covering potentially dangerous components. The user interface will consist of an on/off switch and two user switches. The on/off switch will be a master key switch so that it is only accessible to supervisors as oppose to the intended user. The two switches, on the other hand, will be tailored to the individuals and have the option of interchanging the two switches. A total of six fragrance chambers will hold the six possible fragrances. Selection of the first switch will choose the desired scent. Activation of the second switch will activate the corresponding fan causing the fragrance to be diffused into the atmosphere. The electrical circuit and power supply will provide power for the switches, microprocessor, and fans. The microprocessor controls the selection and activation of the fans in the fragrance chambers through input from the switches. In addition to the six fans present in the fragrance chambers, a seventh fan is present to clear the air after each scent is dispersed.

Figure 1: Olfaction Satisfaction
Base

The Olfaction Satisfaction Device will be attached to a rectangular base resting on the floor to provide stability and protection. This rectangular base will be constructed from sanded pine plywood sheets (See Figure 2). Plywood was chosen on basis of its strength, stiffness, easy handling, and cost-effectiveness.

3/4 Inch Sanded Pine Plywood

![Diagram of plywood base components]

Figure 2: Plywood Base Components

Using 2 1/2 inch drywall screws and wood glue, a simple square frame will be assembled from the 2 x 0.375 ft and 1.875 x 0.375 plywood pieces (See Figure 3).

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1 Home Depot: Millstead. 3/4 in x 4 ft x 8 ft BC Sanded Pine Plywood – 31.95
The remaining plywood pieces will be attached using the screws and glue to the top of bottom of the square frame creating a box. Carpet will be used to cover the entire box for safety purposes. Although sanded, the plywood has rough edges with the potential to cut, scratch, or splinter an individual. The ascetic appeal of the device will also be improved by covering the plywood box with carpet (See Figure 4).

The amount of carpet needed to cover the box was determined from the surface area of the box:
From this arithmetic, 9 sq ft plus an extra square foot to account for box edges will be needed to adequately cover the box. Industrial staples will be used to attach the carpet to the box. Additionally, tightly-woven, short carpet will be used to minimize thread loosening and removal and to create a more finished appearance.

**Exterior and Interior Casing**

Like the base, the exterior and interior casing will be constructed mainly of sanded pine plywood (See Figure 5). Drywall screws and wood glue will be used to attach the casing to the base as well as attach the individual pieces of the casing together. A frame will be constructed from pieces A and B. Within the interior of the frame on the A1 piece, the five D pieces will be attached with 3 inches in between. The six C pieces will be attached between each of the D pieces (See Figure 6). Piece E will be attached to the top of pieces D and C to create six chambers. Piece F will then be attached to the tops of pieces A and B to enclose the entire device.

In addition, the casing needs coverage for safety purposes. As mentioned in relation to the base, even though the plywood is sanded it still possesses potential for injury especially along the casing edges. Because of this, elephant bark rubber\(^2\) will be used to cover the entire exterior casing (about 5 sq. feet). If budget becomes a problem, only the edges will be lined with the rubber. CX-941 adhesive can be used to fix the rubber in place. Manufactured in the USA with 100% recycled rubber, this material is not only economical but adequately suited for this design. Its suggested applications are weight rooms, pet care, boat decks, and assembly lines.

**Table 1 - Elephant Bark Rubber Specifications:**

<table>
<thead>
<tr>
<th>Property</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hardness</td>
<td>60 Shore A Nominal</td>
</tr>
<tr>
<td>Flame Spread</td>
<td>Less than 1/2&quot; per minute</td>
</tr>
<tr>
<td>Compression</td>
<td>36% at 50 psi</td>
</tr>
<tr>
<td>Tensile Strength</td>
<td>320 psi</td>
</tr>
<tr>
<td>Coefficient of Friction</td>
<td>0.096 dry; 0.089 wet</td>
</tr>
</tbody>
</table>

\(^2\) Rubber-Cal: Engineered Elastomers and Wear Parts – ¼"; 7.50 per linear ft
Figure 5: Casing Plywood Pieces
User Interface

As mentioned in the general description, the user will be able to use two interchangeable switches to choose and select one of six available scents. The two possible are a squish switch\(^3\) and a large touch pad\(^4\) switch (See Pictures Below). Since the device requires two switches to operate, two squish switches and two large touch pad switches will be available.

\(^3\) TFH USA – $49.00  
\(^4\) TFH USA - $69.00  (14" x 5.5" x 4")
This way a user will be able to have both switches as squish switch or both as large touch pad or some other desired combination. Since both of these switches are 1/8 connectors, they can both plug into ¼ adapters. Because of this, only two ¼ adapters need to be included on the exterior of the device. These adapters or plugs can be seen on Piece B in Figure 5.

In addition to these switches, an on/off switch will also be present on the exterior of the device. In order to prevent the user from shutting the device off or turning the device on, the on/off switch will be a SPST key switch only accessible to Passion works supervisors (see picture below). This single pole switch will have three positions (on-off-on) with position two as the key removable position. The on/off switch can also been seen on in Figure 5 on Piece A2. It is located in the back to further decrease accessibility for the user and to enhance aesthetic appeal of the front of the device.

![Key Switch](image)

<table>
<thead>
<tr>
<th>Table 2: Key Switch Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Electrical Capacity</strong></td>
</tr>
<tr>
<td><strong>Dielectric Strength</strong></td>
</tr>
<tr>
<td><strong>Mechanical Life</strong></td>
</tr>
<tr>
<td><strong>Electrical Life</strong></td>
</tr>
<tr>
<td><strong>Operating Torque</strong></td>
</tr>
<tr>
<td><strong>Ambient Temperature</strong></td>
</tr>
<tr>
<td><strong>Angle of Throw</strong></td>
</tr>
<tr>
<td><strong>Maximum Panel Thickness</strong></td>
</tr>
</tbody>
</table>

Next to the on/off switch is a battery compartment door. This door serves to increase functionality of the device by facilitating the battery changing procedure. The door is simply a plywood cut-out in the back of the exterior casing attached with a surface mount hinge. In order to prevent undesired openings of the

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5 Allied Electronics: NKK Switches of America. SK Series 12 mm Miniature Low-Security Keylock Switch - $11.96
battery compartment, it will be held in place using a cam lock\(^7\) designed for wood mounting.

As described earlier, the device exterior also has several holes for fragrance dispersion, air intake and air venting. The first set of six holes can be seen on Piece A1 in Figure 5. Each of the six scents diffuses through one of these six holes into the surrounding atmosphere. In order to prevent unwanted entry into the device, these holes will be covered with wire mesh material\(^8\). In addition to unwanted user entry, it is also desirable to prevent fragrance from entering the surrounding atmosphere when it is not being selected. To accomplish this, six flaps will be used to cover the six holes when they are not activated. These flaps will be square and made out of foam rubber\(^9\) sheeting. Neoprene rubber was chosen based on its resistance to oil, electrical, flame, impact, tear, and weather. It also has excellent abrasion and oxidation resistance. In addition to the six fragrance dispersion holes, an air intake hole and air venting hole will be located on the exterior of the device. The air intake hole can be seen on Piece A2 in Figure 5. Covered with wire mesh material, this hole will simply provide air for the multiple fans dispersing the fragrance. The air venting hole will be located above the six fragrance dispersing holes. Its main role is to continuously pump fresh air into the atmosphere surrounding the device. This disperses activated fragrances so that a newly activated fragrance can be appreciated fully.

**Fragrance Chambers**

As briefly mentioned previously, the interior of the device holds six scent chambers (See Figure 7) divided by the plywood casing. The scent chamber itself will consist of PVC piping. PVC was chosen due to its toughness, strength, durability, impact strength, excellent electrical insulation properties, corrosion resistance, ease of bending and processing, and affordability.

**Table 3: PVC Properties**

<table>
<thead>
<tr>
<th>Specific Gravity</th>
<th>Elastic Modulus</th>
<th>Tensile Strength</th>
<th>Yield Strength</th>
<th>Elongation at Break</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.30 – 1.58</td>
<td>350 – 600 ksi</td>
<td>5.9 – 7.5 ksi</td>
<td>5.9 – 6.5 ksi</td>
<td>40 – 80%</td>
</tr>
</tbody>
</table>

\(^7\) McMaster-Carr. Standard Cam Lock W/Polished Nickel Finish Keyed To C346A, 3/4” Diameter Hole, 7/64” Material Thick - $4.00

\(^8\) McMaster-Carr. Type 316 Stainless Steel Woven Wire Cloth 4 x 4 Mesh, .047” Wire Diameter, 12”x 12” sheet – 11.08 (also try local hardware store for cheap window screen)

The main component of the chamber is a straight piece of PVC piping\textsuperscript{10}. This pipe is NSF listed with a service temperature between 33 - 140°F. Permanently attached to this straight piece is a PVC male adaptor\textsuperscript{11}. This male adaptor will screw into a permanently fixed female adaptor\textsuperscript{12}. These adaptors are also NSF listed with a 140°F working temperature. The length of the straight-male-female apparatus (See Figure 8) will be 6 inches. The female adaptor will be firmly attached to plywood Piece C on the interior side of the scent chamber. This makes the scent chamber removable. By unscrewing the straight-male adapter piece from the female adaptor from the outside, the chamber can be easily pulled out of the device. This allows for facile changing of fragrances, as well as cleansing of the chambers. The wire mesh discussed previously will be attached directly to the outer rim of the PVC chamber so it can be removed along with the chamber for cleaning purposes. This design also allows for various scent sources such as a sponge damp with scented oil or retail fragrance cartridge. Although the choice of fragrance choice and source is up to the client, the initial design will use fragments of an adjustable air freshener\textsuperscript{13}. Of the available fragrance choices, after the rain, apple & cinnamon, citrus sunburst, crisp cotton, vanilla delight, and lavender sage will be used as the six scent choices present in the device. Like the exterior hole of the scent chambers, the interior side will also possess a flap (See Figure 7). This flap will also prevent fragrance dispersion at undesired times. Once the fan is activated, the air pressure generated by the fan will cause the interior flap to rise, diffuse the desired fragrance, cause exterior flap to rise, and

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\textsuperscript{10} United States Plastic Corporation. 1 ½” Gray PVC Schedule 40 pipe – $1.57 per foot.
\textsuperscript{11} United States Plastic Corporation. 1 ½” White PVC Schedule 40 Adapter MPT x Socket - $0.63 each
\textsuperscript{12} United States Plastic Corporation. Schedule 80; Gray F Adaptor Threaded X Socket - $5.18 each
\textsuperscript{13} Renuzit. LongLast Adjustable Air Fresheners - $0.99 each
disperse fragrance into the outside atmosphere. Once the fan is deactivated, the flap will lower to its original position due to lack of external force.

![Diagram of a PVC Chamber]

**Figure 8: PVC Chamber**

**Electrical Circuit**

The electrical circuit is a micro-controller circuit designed to operate the interface of the two switches and the seven fan motors. As previously discussed, each fan motor diffuses a specific scent, and the last fan motor is activated in parallel with the activator switch to cleanse the air as the user selects another scent. Figure 9 illustrates a schematic diagram on the operation of the main electrical components. The circuit operates on a 30 VDC power supply with a minimum voltage of 24 VDC to operate the fan motors and 120 VAC to operate the switches. In order to activate the two switches, the selector and activator switches are ‘on’ when 24V passed through them, but ‘off’ when voltages are less than 24V. The voltage to power the microprocessor is about 5V – 12V to assist the selector switch in operating the selections. The output of the microprocessor will determine which fan motor to activate that diffuses the desire scent upon the activator switch. The main parts of the circuit are the microprocessor to digitally operate the selections and activation and the power supply, to deliver specific voltages and currents throughout the circuit.
Power Supply

Power supply is one of the main components in designing and building the olfactory stimulation device. Therefore to choose the right power supply, there are many electrical specifications needed such as knowing the voltage alternating current (VAC) and the voltage direct current (VDC) of the different components such as the seven fans, the two interchangeable switches and the circuit board. The electrical specifications of the two pluggable switches are estimated to operate at 120 VAC. The specifications of the seven fans can be seen in table 4, where the power supply must output at least 24 VDC to operate one of the six fans and another 24 VDC to operate the seventh fan. The electrical circuit including the microprocessors that controls the switches requires voltage ranging 5V and 12V.

In order for the electrical circuit to function, the circuit requires at least 30V inputs. The power supply to operate our design would be using four 9 V batteries that provide a total of 36 V through the circuit. These four batteries would be placed in series with each other on four inexpensive 9 V battery holders, which can be purchased in RadioShack for as low as $1.00 each and four snap connectors that cost $2.59 each. The total budget to create our own power supply would be less than $15.00.
Microprocessor

The PIC microprocessor must be programmed via assembly code. This code will be generated from the conversion of a C++ program using a code converter. With this in mind, it is necessary to understand the behavior of the PIC microprocessor in response to the user’s inputs.

Note that the design calls for a row of 6 fans. Each individual fan connects to a fragrance chamber. Each fan is responsible for circulating air into and out of the fragrance chamber, allowing the scent to diffuse into the room faster than it would normally. The user interface is responsible for switching between these fans (allowing the user to change fragrances), and for activating the selected fan to facilitate diffusion from the chamber.

The user interface has two switches with which to control the device. One switch controls the fan motors that are responsible for releasing the fragrance from the fragrance chambers. When the switch is connected a digital 1 (or ‘Hi’, ‘true’) is sent to the control circuit. When the switch is not activated, a digital 0 (or ‘Low’, ‘false’) is sent to the control circuit. For identification, this signal will be designated ‘Activate’. Therefore, Activate tells the circuit whether or not to turn on the fan.
Similarly, a user controlled switch will be responsible for telling the device to change which fan will be activated (enabling the user to switch to different fragrances). The signal coming from this switch will be designated ‘Select’. When Select is asserted, the device will rotate the fragrance chambers. When select is not asserted, the device will stop rotating the fragrance chambers when the next chamber is in position with the fan.

Finally, signal ON/OFF will be designated as the signal telling the circuit whether or not the device is turned on or off. When the device is on, ON/OFF will be asserted (i.e. will send out a digital 1). When the device is off, the ON/OFF signal will send out a digital 0. Only the personnel with the right key will be able to turn the Olfaction Satisfaction device on.

At this point, it is necessary to understand how the motors will activate based on the user’s inputs. When the device is off (i.e. ON/OFF is not asserted) the device will not respond to the input from the user interface. When the device is on (i.e. ON/OFF is asserted), it will either do nothing when no input is given from the user interface, activate the fan if Activate is asserted and Select is not asserted, and will not activate the fan if Select is asserted.

This characteristic behavior of the circuit can be described by the flow chart below. This flow chart actually describes a simple C++ program consisting of While loops and simple If/Else statements.
Note that this flow chart consists of initializing an enable scheme for the 6 fans. In Diagram 1, one can see that if the device is not turned on, it will do nothing. When the device is on, it will first check to see if the user has activated the Select input. If Select is not activated, then the program will check to see if Activate is activated. If so, then the device will send power to the fans. Note, however, that only an enabled fan will actually receive the power and activate. Disabled fans will do nothing. If neither inputs are activated, then the program simply sits in a While Loop until the user activates one of the inputs.
Block Diagram 2
If Select is activated, then the device goes into a special loop which is expanded in Diagram 2. The fans are numbered from 000 to 101, following a binary counting method. If the device is on and the Select input is activated, the program enters a series of if/else statements which will change which fan is enabled. The chart follows the progression of 000, 001, 010, ..., 101, 000, 001...etc. therefore, when the last fan is the enabled fan, activation of the Select switch will result in fan 000 being enabled (See Diagram 2)

Fans

As mentioned, the device contains six fan motors designated to diffuse the specific scents and a seventh fan motor to cleanse the air. These fans are known as equipment cooling fans that are compact and easy to install. Although many types of fans exist, this design will use a square fan that is easily mountable with four screws on each corner. The fans are controlled by the micro-controller in the circuit that provides selection with the selector switch as previously discussed in the electrical circuit section.

On each of the six fan motors, the specifications of the fans must be strong enough to open the two flaps on each ends of the tube and diffuse the scent (See Air Flow Calculations). The specifications of the seven fans would be as follows:

<table>
<thead>
<tr>
<th>Table 4: Fan Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimension (Length and Width)</td>
</tr>
<tr>
<td>Dimension (Depth)</td>
</tr>
<tr>
<td>CFM</td>
</tr>
<tr>
<td>Voltage</td>
</tr>
<tr>
<td>Amps</td>
</tr>
</tbody>
</table>

Air Flow Calculations

There are many ways of describing the characteristics of a fan such as power, torque, electrical impedance, etc. But when studying airflow, the characteristics of the fan that one is most interested in are Fan Cross Sectional Area, Outlet Velocity, Velocity Pressure, and the CFM (Cubic Feet per Minute) rating. Each of these characteristics has an effect on the strength and quality of airflow. For this design, air flow through the fragrance chambers is especially important to know. If airflow is bad, then the fragrance will take longer to reach the user, resulting in inadequate stimulation of the olfactory senses in conjunction with the tactile and visual senses. For this reason, it is worth some time to consider what type of fan to use to diffuse the scents outside the device.

CFM is a measure of the volume of air that passes through the fan. For this reason, the units of CFM are, as the name implies, cubic feet per minute. For
example a fan with a CFM rating of 24 will move 24 cubic feet of air through itself every minute. This measure is an important characteristic when looking at a fan because it reveals no only the amount of fragrant air that will be pushed into a room, but also gives an idea of the mechanical forces that the air from the fan can exert on its surroundings.

The next important characteristic of the fan is its Cross Sectional Area. Cross Sectional Area is the measure of the area about which air flows through the fan. Fans with a large Cross Sectional Area can move more air with less rotational velocity from the fan blades. Therefore, if Cross Sectional Area remains constant, then if CFM increases, the speed at which the air flows through the fan must increase.

The speed of the air at the outlet of the fan is referred to as the Outlet Velocity. This quantity is usually given in units of meters per second. Outlet Velocity can be calculated by dividing the CFM rating by the fan’s Cross Sectional Area (in square feet). This quotient, however, will yield a value having units of feet per minute, not the usual meters per second. Therefore, unit conversion is necessary to convert feet into meters (3.28 ft = 1 m) and minutes into seconds (1 min = 60 s). This process yields the following equation for Outlet Velocity from CFM and Cross Sectional Area:

\[
\text{Outlet Velocity} = \frac{\text{CFM}}{\text{Cross Sectional Area} \times 3.28 \times 60}
\]

Velocity Pressure is a term given to the pressure that results when moving air comes in contact with a stationary object such as a building or a wall (or in our case, the flap of the fragrance chamber). This measure is given the unit of the Pascal, which is equivalent to one Newton of force over 1 square meter (N/m²). Velocity Pressure is calculated from the equation:

\[
\text{Velocity Pressure} = 0.6 \times (\text{Outlet Velocity})^2
\]

The constant 0.6 in the equation is derived from the density of air, assuming a temperature of 20°C and average relative humidity.

Since pressure is defined as the force acting on a certain area, Velocity Pressure can be converted into a corresponding force. Therefore, a force \( F_p \) can be calculated from the Velocity Pressure acting on, in our case, the Cross Sectional Area of the flap of the fragrance chamber (a constant .006 square meters by design). Hence, the following equation yields the force \( F \) on the flap of the fragrance chamber:

\[
F_p = \frac{\text{Velocity Pressure}}{.006 \text{ sq. m.}}
\]

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Finally, in the worst case scenario, Olfaction Satisfaction be operated on its side, instead of the normal right side up position. In this case, the flaps of the fragrance chambers will be directly above the fan and parallel to the surface of the earth. In this position the force of gravity acts evenly on the entire surface of the flap. Therefore, the weight of the flap becomes a load \( L = \text{flap mass} \times 9.81 \text{ m/s}^2 \) acting to oppose the force \( F \) from the Velocity Pressure calculated previously. Hence, the maximum mass (in grams) of the flap is observed at the point where \( F_p = L = \text{flap mass} \times 9.81 \text{ m/s}^2 \). Therefore, the Maximum Flap Mass is calculated by:

\[
\text{Maximum Flap Mass} = \frac{F_p}{(9.81 \text{ m/s}^2)}
\]

With these fan characteristics in mind (and a way to interpret them), a comparison between different fans possessing different CFM ratings, Cross Sectional Area, and Outlet Velocities can now be performed. The table below lists fans of various cross sectional areas and CFM ratings along with the corresponding values for Maximum Flap Mass, Velocity Pressure, Outlet Velocity, and force \( F_p \):

**Table 5: Calculations on Fans of Various Cross Sectional Area and CFM Ratings**

<table>
<thead>
<tr>
<th>Fan Cross Sectional Area (ft²)</th>
<th>Fan CFM (ft³/min)</th>
<th>Flap Cross Sectional Area (m²)</th>
<th>Outlet Velocity (m/sec)</th>
<th>Velocity Pressure (Pa)</th>
<th>Force Exerted (N)</th>
<th>Maximum Flap Mass (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.039</td>
<td>18.000</td>
<td>0.006</td>
<td>2.365</td>
<td>3.355</td>
<td>0.019</td>
<td>1.987</td>
</tr>
<tr>
<td>0.039</td>
<td>20.000</td>
<td>0.006</td>
<td>2.628</td>
<td>4.142</td>
<td>0.024</td>
<td>2.453</td>
</tr>
<tr>
<td>0.039</td>
<td>24.000</td>
<td>0.006</td>
<td>3.153</td>
<td>5.965</td>
<td>0.035</td>
<td>3.533</td>
</tr>
<tr>
<td>0.069</td>
<td>19.000</td>
<td>0.006</td>
<td>1.401</td>
<td>1.178</td>
<td>0.007</td>
<td>0.698</td>
</tr>
<tr>
<td>0.069</td>
<td>27.000</td>
<td>0.006</td>
<td>1.991</td>
<td>2.379</td>
<td>0.014</td>
<td>1.409</td>
</tr>
<tr>
<td>0.069</td>
<td>32.000</td>
<td>0.006</td>
<td>2.360</td>
<td>3.341</td>
<td>0.019</td>
<td>1.979</td>
</tr>
<tr>
<td>0.069</td>
<td>35.000</td>
<td>0.006</td>
<td>2.581</td>
<td>3.997</td>
<td>0.023</td>
<td>2.367</td>
</tr>
<tr>
<td>0.069</td>
<td>41.000</td>
<td>0.006</td>
<td>3.023</td>
<td>5.485</td>
<td>0.032</td>
<td>3.248</td>
</tr>
<tr>
<td>0.069</td>
<td>47.000</td>
<td>0.006</td>
<td>3.466</td>
<td>7.207</td>
<td>0.042</td>
<td>4.269</td>
</tr>
<tr>
<td>0.091</td>
<td>47.000</td>
<td>0.006</td>
<td>2.624</td>
<td>4.132</td>
<td>0.024</td>
<td>2.447</td>
</tr>
<tr>
<td>0.091</td>
<td>49.000</td>
<td>0.006</td>
<td>2.736</td>
<td>4.491</td>
<td>0.026</td>
<td>2.660</td>
</tr>
<tr>
<td>0.091</td>
<td>60.000</td>
<td>0.006</td>
<td>3.350</td>
<td>6.734</td>
<td>0.039</td>
<td>3.988</td>
</tr>
</tbody>
</table>

From the preceding table, one can note that a large CFM rating does not necessarily result in a large Maximum Flap Mass. Factors such as the Fan’s cross sectional area effect the degree to which the fan and move air about with enough force to do work on an object (i.e. the flap). The figure below gives a better understanding of how Maximum Flap Mass is related to CFM and Cross Sectional Area:
From this figure, it is easy to see that the fan that produces the largest Maximum Flap Mass has a CFM Rating of 47 and a Cross Sectional Area of 0.069 cu. ft. These characteristics are found in the 1939K65 DC Fan purchased from McMaster-Carr for around 28.69 dollars a piece. Since the design calls for 7 such fans in total, a total cost for fans would amount to 200.83 dollars. This is still within the budget of 750 dollars granted by the NSF funding, although it may prove too expensive still for a commercial market.

Given the how expensive purchasing 7 fans will become, it may be possible to purchase a small, less powerful fan that will perform the same function as the stronger fan so long as the Maximum Flap Mass is not exceeded. Considering the number of light weight and low density plastics that are available on the market, it may be more economical to use less powerful fans in Olfaction Satisfaction. Note from the above figure, that a fan with CFM of 24 and Cross Sectional Area of 0.039 sq. ft. will provide enough Velocity Pressure to lift the flap and circulate air from the fragrance chamber.