Weapon Mounted Less Than Lethal Device

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By

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First responders such as police, swat, DEA, ATF, etc. have the important yet dangerous job of dealing with the most violent criminals in our communities. When a first responder arrives on an assignment, the situation has unknowns that can put the officer or others in danger. With the current options on the market for non-lethal devices, an officer is only right for preparing themselves for the worst outcome by arming themselves with a firearm. This leaves no quick and easy option for an officer to use less-than-lethal force while keeping the option for lethal force readily available. The solution is to combine the option for a non-lethal device and a firearm. According to a famous study by Sgt. Tueller an aggressor can cover 21 feet in 1.5 seconds from a dead stop. The time it takes for an officer to switch from non-lethal means to a firearm is 1.8 seconds. The weapon mounted less-than-lethal device outlined below eliminates that transition time providing both lethal and non-lethal options to a first responder so that lives can be spared.
INTRODUCTION

PROBLEM
First responders face difficult dangerous situations every day. They carry the important job of helping people in dangerous or life threatening situations. A first responder always wants everyone to come out safe. Police and military have several options when dealing with individuals who pose a threat. These devices include lethal and less than lethal. First responders would like to use less than lethal means of apprehending suspects, but this puts the enforcer in danger. Most of the devices on the market right now cause the first responder to either choose the less than lethal option or lethal option. In unknown situations this is not acceptable because the lethal option is most effective at stopping an aggressor.

BACKGROUND
The focus of this design project is to design an apparatus that allows a user to deploy a less than lethal option from the rifle, carbine or shotgun being used. Less than lethal devices are not always effective, this causes concern with first responders causing them to choose their main weapon over their less than lethal options. The device would eliminate the need to transition from lethal to less than lethal force. This less than lethal weapon mount will allow first responders to save lives without risking their own.
EXISTING PRODUCTS

There are many less than lethal products already on the market, few of which are mounted to lethal weapons. One type of less than lethal device is impact devices that attach to the end of the weapon's muzzle as seen in figure 1 (1). These devices serve dual purposes; they mitigate flash from the weapon that would be detrimental to the operator’s vision at night, and they can be used as an impact device. The drawback to this type of device is that it can cause undesired damage to the aggressor. It also forces the operator to be within very close proximity with the aggressor putting the operator in greater danger.

Figure 1. Black rain suppressor
Another impact type device that is used by many first responders is an extendable baton as seen in figure 2 (2). The extendable baton can be effective on aggressors but causes the operator to choose between their main weapon and their baton. The drawback to this type of device is that it can cause a lot of undesired damage to the aggressor. It also forces the operator to be within very close proximity with the aggressor putting the operator in greater danger.

![Figure 2. Asp extendable baton](image)

Another less than lethal option for weapons is a weapon mounted light as seen in figure 3 (3). Weapon lights serve a dual purpose; they can be used for illumination and identification or disorientation. Many weapon mounted lights have a strobe function that can be used to disorient the aggressor and mitigate their night vision weapon lights are completely non-lethal and do no damage to the aggressor. The drawback is that the lights have not physical incapacitation effect on aggressors and are not very effective during the daylight hours.

![Figure 3. Surefire flashlight](image)
Pepper spray is a commonly used less than lethal option for first responders as seen in figure 4 (4). It provides very effective stopping power and is one of the least lethal options available. The pepper spray is sprayed into the aggressor's face and affects their ability to see while causing severe irritation to the mucus membranes in the nose and throat. The drawbacks to pepper spray are that the operator must choose between their main weapon and the pepper spray putting the operator in danger. If a foam-based pepper spray is not used, it can be affected by wind and ultimately affect the operator.

![Fox Labs pepper spray](image_url)

Figure 4. Fox Labs pepper spray

Another very popular option for less than lethal force is a Taser as seen in figure 5 (5). The Taser allows an operator to incapacitate an aggressor from a distance of up to 35 feet. It works by firing two barbs into the skin of the target, after the barbs are in the target's skin the module provides pulses of electricity to overwhelm the central nervous system. This typically incapacitates the aggressor allowing apprehension. The drawbacks are that the operator has to choose between their Taser and their main weapon.

![Taser X3](image_url)

Figure 5. Taser X3
A less commonly used less than lethal option is the use of rubber or bean bag rounds as seen in figure 6 (6). They work by firing a rubber or bean bag based projectile at the aggressor causing severe pain that can incapacitate them. The drawbacks are that an operator must have a dedicated shotgun to use these rounds and choose it over their lethal weapon. The rubber or bean bag rounds can also be lethal if they hit the aggressor in the head or cause internal bleeding.

Another less common less-than-lethal option is a pepper ball launcher. A pepper ball launcher is similar to pepper spray in that it is used to affect the aggressor’s vision and mucus cavities with the advantage of extending its range. The pepper ball launcher has an effective range of 60 feet delivering balls filled with an irritating pepper mixture that breaks upon impact. The drawbacks are that it causes the operator to choose between their main weapon and less than lethal option. See Figure 7 (7)
Another less common less than lethal option is a 30mm launcher as seen in figure 8 (8). These launchers are weapon mountable and allow the operator to have both the main weapon and less than lethal weapon at the ready. The disadvantage is that the less than lethal munitions made for this style launcher are primarily for crowd control or barricaded suspects.

Figure 8. 37mm launcher

In summary there are numerous options for less than lethal force that an operator can choose from. The problem with most of them is that they force the operator to choose between their main weapon and their less than lethal option putting the operator in danger if greater force is needed. With the options that are weapon mounted they are not suited for apprehending suspects because they are either not very effective or cause too much damage to the aggressor.
CUSTOMER FEEDBACK, FEATURES AND OBJECTIVES

SURVEY ANALYSIS

Thirty five surveys were conducted among three major groups. The breakdown of the groups can be seen in table 1. The survey contains a wide range of features that are relevant to the development of the less than lethal weapon mount. For the first half of the survey the potential customers were asked to rank the features based on importance on a scale of 1 to 5. The second half of the survey asked the potential customers to rate their satisfaction of current offerings for less than lethal devices on a scale of 1 to 5.

Table 1. Breakdown of people surveyed

<table>
<thead>
<tr>
<th>People surveyed</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Military or ex military</td>
<td>18</td>
</tr>
<tr>
<td>police or ex police</td>
<td>5</td>
</tr>
<tr>
<td>firearms enthusiasts</td>
<td>12</td>
</tr>
</tbody>
</table>

SURVEY RESULTS

In the first half of the survey people were asked to rate a series of attributes on a scale of 1-5 of what they feel is most important in the proposed product. The averages were taken for the results from the first half of the survey. Table 2 shows the results from the survey.

Table 2. Customer importance ratings of design criteria

<table>
<thead>
<tr>
<th>Customer Importance</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reliability</td>
<td>4.97</td>
</tr>
<tr>
<td>safety</td>
<td>4.94</td>
</tr>
<tr>
<td>Ease of use</td>
<td>4.83</td>
</tr>
<tr>
<td>Durability</td>
<td>4.67</td>
</tr>
<tr>
<td>Price</td>
<td>4.62</td>
</tr>
<tr>
<td>Being ergonomic</td>
<td>4.47</td>
</tr>
<tr>
<td>Size</td>
<td>4.35</td>
</tr>
<tr>
<td>Weight</td>
<td>4.23</td>
</tr>
<tr>
<td>Ease of installation</td>
<td>3.89</td>
</tr>
<tr>
<td>Ease of maintenance</td>
<td>3.74</td>
</tr>
</tbody>
</table>
In the second half of the survey people were asked the same questions as in the first half of the survey, but they were asked to rate how satisfied they were with past products on a scale of 1-5. The averages of the results are shown in the table below.

Table 3. Customer satisfaction of existing products

<table>
<thead>
<tr>
<th>Question Asked</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ease of use</td>
<td>4.5</td>
</tr>
<tr>
<td>Weight</td>
<td>4.4</td>
</tr>
<tr>
<td>Ease of maintenance</td>
<td>4.23</td>
</tr>
<tr>
<td>Ease of installation</td>
<td>4.17</td>
</tr>
<tr>
<td>Durability</td>
<td>4.13</td>
</tr>
<tr>
<td>Size</td>
<td>3.45</td>
</tr>
<tr>
<td>Being ergonomic</td>
<td>3.37</td>
</tr>
<tr>
<td>Reliability</td>
<td>3.1</td>
</tr>
<tr>
<td>Price</td>
<td>2.41</td>
</tr>
<tr>
<td>safety</td>
<td>2.34</td>
</tr>
</tbody>
</table>

Importance Analysis

With the information from the survey and averages showing what the customers importance of features and satisfaction with past products, an importance analysis was performed. For the designers multiplier reliability was made to be 1.2 to make an extra emphasis on reliability. The idea being that if it doesn’t work it becomes useless. The relative weights will be used later on when determining the best design. The top three features for the device were safety, reliability and price.

Table 4 QFD Weights

<table>
<thead>
<tr>
<th>Feature</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>1.0</th>
<th>1.6</th>
<th>2.1</th>
<th>10.6</th>
<th>0.17</th>
<th>17%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety</td>
<td>4.94</td>
<td>1</td>
<td>2.3</td>
<td>5</td>
<td>4.5</td>
<td>10.6</td>
<td>0.17</td>
<td>17%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reliability</td>
<td>4.97</td>
<td>1.2</td>
<td>3.1</td>
<td>5</td>
<td>4.5</td>
<td>9.6</td>
<td>0.16</td>
<td>16%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Price</td>
<td>4.62</td>
<td>1</td>
<td>2.4</td>
<td>4.5</td>
<td>1.9</td>
<td>8.6</td>
<td>0.14</td>
<td>14%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Being ergonomic</td>
<td>4.47</td>
<td>1</td>
<td>3.4</td>
<td>4.5</td>
<td>1.3</td>
<td>6.0</td>
<td>0.10</td>
<td>10%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ease of use</td>
<td>4.83</td>
<td>1</td>
<td>4.5</td>
<td>4.5</td>
<td>1.0</td>
<td>4.8</td>
<td>0.08</td>
<td>8%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Durability</td>
<td>4.67</td>
<td>1</td>
<td>4.1</td>
<td>4.5</td>
<td>1.1</td>
<td>5.1</td>
<td>0.08</td>
<td>8%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Size</td>
<td>4.35</td>
<td>1</td>
<td>3.5</td>
<td>4</td>
<td>1.2</td>
<td>5.0</td>
<td>0.08</td>
<td>8%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight</td>
<td>4.23</td>
<td>1</td>
<td>4.4</td>
<td>4.5</td>
<td>1.0</td>
<td>4.3</td>
<td>0.07</td>
<td>7%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ease of installation</td>
<td>3.89</td>
<td>1</td>
<td>4.2</td>
<td>4</td>
<td>1.0</td>
<td>3.7</td>
<td>0.06</td>
<td>6%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ease of maintenance</td>
<td>3.74</td>
<td>1</td>
<td>4.2</td>
<td>4</td>
<td>0.9</td>
<td>3.5</td>
<td>0.06</td>
<td>6%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
FEATURES AND OBJECTIVES

Based on the survey and QFD a product objectives list was made. The product objectives are the list of features that are taken into consideration. The following is a list of product objectives and how they will be obtained or measured to ensure that the goal of the project was met. The percent relative weight from the QFD is supplied below.

- Safety 17%
  - Selector switch with a safe position
  - Detent to provide positive click consistent with off the shelf components
  - Trigger with greater than 8 lb. pull to prevent accidental discharge
- Reliability 16%
  - Use of highest rated third party products
  - Design consistent with loading factors and loading conditions
  - Torque ratings consistent with standards
- Price 14%
  - Between $300-400 for prototype
- Being ergonomic 10%
  - Design within the natural human range of motion (grip consistent with 80th percentile center of gravity won’t move forward more than 4 inches)
- Ease of use 8%
  - Controls large enough for hand sizes in the 80th percentile
  - Trigger guard for hand sizes in the 80th percentile with measured clearances
- Durability 8%
  - Design factors consistent with expected loading conditions
  - Corrosion resistant material selection
  - Design for impact from 5 foot drop
- Size 8%
  - Hand grip sized to accommodate the 80th percentile of human hands
  - Will not extend past magazine or increase the width by more than 10% or extend past muzzle
- Weight 7%
  - Use aluminum
  - Removal of material in non-essential areas
- Ease of installation 6%
  - Installation with one or zero tools
  - Installs in one step per device
  - Installs instantly
- Ease of maintenance 6%
  - Design that can be taken down in less than 1 minute
  - No tools required
  - Lubrication being optional
CONCEPT GENERATION AND SELECTION

Three different concepts were generated. The bottom mount concept shown in figure 9 attaches to the bottom of a picatinny rail and has very similar controls to that of an AR-15. The front of the device holds all of the electrical components while the rest of the housing holds the fire control group.

![Figure 9 Bottom Mount](image)

The second concept, thumb actuated, shown in Figure 10 mounted onto the side and bottom the rail system. The device would be activated by push buttons on the rear of the device. This thumb actuated model is simpler but does not have any safety features and is also not very ergonomic.

![Figure 10 Thumb Action](image)
The third model generated, top and bottom mount, mounts to the top of the rail system while the fire control group is mounted underneath. This model is more complex than the other two but would have a smaller footprint.

Weighted rating comparison of design alternatives
Scale 1-5

The relative weights from the last column of the QFD were used to perform a weight rating scale to evaluate the design alternatives. The scale is from 1-5 and each individual design was rated based on their perceived qualities. The bottom mount design is the best design with a weighted rating of 2.46, a higher rating than the other two designs.

Table 5 Weighted rating method of selection

<table>
<thead>
<tr>
<th>Design</th>
<th>Weight</th>
<th>Bottom mount</th>
<th>Thumb action</th>
<th>Top mount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety</td>
<td>0.23</td>
<td>5</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Price</td>
<td>0.20</td>
<td>3</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Size</td>
<td>0.14</td>
<td>3</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Weight</td>
<td>0.13</td>
<td>3</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Being ergonomic</td>
<td>0.16</td>
<td>5</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Ease of maintenance</td>
<td>0.12</td>
<td>4</td>
<td>5</td>
<td>4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>3.92</th>
<th>3.53</th>
<th>3.14</th>
</tr>
</thead>
</table>

Figure 11 Top Mount
INITIAL DESIGN AND RESEARCH

Aerosol spray test:

In order to concurrently design the fire control group (FCG) I decided to test how much force it takes to depress the spray nozzle of an aerosol can. A Chatillon force machine was used (figures 12, 13 and 14) to measure the force needed to depress the aerosol spray can nozzle. A program was written for the machine that caused the arm to come down to the top of the spray nozzle, from here it made a touch reference and declared it zero for force and displacement. It was determined that in order to achieve the full spray a displacement of 0.051 inches was needed. The machine then brought the arm down 0.051 inches and held it there for 1 second while the force was read before returning to zero.

Figure 13 Chatillon compression machine

Figure 12 aerosol can setup

Figure 14 Chatillon machine readout and interface
Here are the results from the test

<table>
<thead>
<tr>
<th>Run #</th>
<th>Status</th>
<th>L(1)</th>
<th>H(1)</th>
<th>L(2)</th>
<th>H(2)</th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>-8.12</td>
<td>-0.05</td>
<td>-7.86</td>
<td>-0.053</td>
<td>lbf</td>
<td>inch</td>
</tr>
</tbody>
</table>

With the results this means that the main pivot would be a 1 to 1 ratio. Since there will be a spring on the trigger to provide positive resistance on the trigger so that the mechanism cannot bounce around the ratio will be slightly in mechanical favor of the trigger.

**INITIAL FIRE CONTROL GROUP DESIGN**

The fire control group is the heart of the operation and safety of the less than lethal device. An initial design was made. In order to clarify the operation of the fire control group figures 15-20 show a detailed view of how the fire control group works.
With the safety in the safe position it will block the pivoting movement of the trigger.

Figure 16 Fire Control Group Cam

This picture shows the safety in the Spray position.

Figure 17 Fire control group in Spray position
With the safety in the spray position it will allow the trigger to pivot freely.

Figure 18 Fire control group free pivot

This picture shows the safety in the Taze position.

Figure 19 Fire control group Taze position
With the safety in the taze position it will allows the trigger to pivot within a certain range allowing activation of the switches for the taser without allowing operation of the pepper spray.

Figure 20 Fire control group limited travel
INITIAL HOUSING DESIGN
The housing is the main component of the less than lethal system containing the fire control group as well as allowing the attachment to the lethal weapon. Figures 21-23 show how the housing will hold all of the components and work.

This is a pin that will act as a pin in slot for the front of the housing that will contain the taser module and pepper spray. This will allow free motion for reloading once the catch is released.

Alignment pin that will trap the front part of the housing that will contain the taser module and pepper spray

Figure 21 Housing side profile
Section View of the housing with fire control

The clamping system will be added here in order to clamp onto the picatinny rail

Holes for contacts to interface with the front of the housing that will house the pepper spray and taser module

Figure 22 Housing top view

This is how the micro switch will interact with the safety. (micro switch is not to scale)

Channel for wires to run from the micro switches to the

Figure 23 Housing section view

GEOMETRY CALCULATIONS
The main concern for this project as far as calculations go was the clearances and motion of the geometry.

An actuation distance of .05” was established early on based on a test with an aerosol can. After measurement of the actuation distance of an actual cartridge of pepper spray, it was concluded that full actuation of the pepper spray is anywhere between 0.0937” and 0.1875”. This distance combined with a distance of 0.125 “ to activate the switch before activating the pepper spray gives a total linear distance of 0.3125”.

**Figure 24 Safety Lateral view**

- This point was established as a zero. This is the point at which the trigger contacts the safety in the safe position preventing movement.
- Vertical movement allowed in the Taze position.
- Vertical movement allowed in the mace position.
- Axial view of the safety selector.
Figure 25 Original Trigger model

Using $\sin \theta = \frac{O}{H}$, $\theta$ equals 9.6 degrees
Using $\sin \theta = O/H$ the linear distance traveled is 0.1”.

The linear movement of the original design was only 0.1” in overall.
Working backwards through the trig equations from before it was found that the 1.2” section of the trigger that is stopped by the safety needed to be shortened to .384”. With this calculation came major modification of the receiver, trigger bar, trigger and safety lever.

The linear movement of the newest design is .3125” overall.

The trigger face was brought forward to compensate for the greater travel.

Front housing holds the taser components as well as the pepper spray.

New design based on original

This piece was shortened to allow more travel.
LED Calculations
Since an actual tazer could not be obtained, LED’s will simulate the function of the tazer. A 9 volt battery is going to power the LED but cannot be hooked directly up to the LED without burning it out. A resistor must be hooked up in series to prevent this. This is represented by the equation below. VS is source voltage of 9V. VL is LED voltage specified from the manufacturer and I is the LED current as specified by the manufacturer. An LED has not been selected for the application yet so calculations could not be made. When the LED is selected it will be a simple plugging in of numbers to establish the proper resistor value.

\[ R = \frac{(VS - VL)}{I} \]
FINAL ASSEMBLY DESIGN

The final assembly of Solid Works models is represented by figures 31 and 32. The final model is simply a more refined version of the initial designs.

Weight simulation

Weight needs to be simulated in the front housing where the components sit. Basing off of the Taser m26c the total weight of the device is 19.2 ounces. Assuming that 90% of the weight is the internal components there needs to be a total weight of 17.3 ounces in the front housing. After the total weight of the simulation electronics is weighed, zinc or lead will be added to achieve the needed weight.
FABRICATION

The majority of the prototype was fabricated using a Dimension 1200es 3D printer. It uses ABS plus plastic to print 3D objects in 0.01” layers. The total process took 27 hours to print and cost $201. ABS plus plastic has an ultimate tensile strength of 5220 psi. The parts were oversized to create a “tool safe” design because of lack of experience with the 3D machine that was used. Some of the parts were shaped and sized by hand to get everything to fit; this was because of the oversizing of the parts. The latch to hold the front of the housing onto the main receiver was modified during assembly because of the flimsy nature of the original latch. The latch was replaced by a bolt that goes through the front housing and receiver and is tightened on via a thumb screw.

Figure 34 Parts right out of the 3D printer

Figure 35 wiring the receiver

Figure 36 wiring the front housing
Figure 37 showing the internals and switch placement

Figure 38 Fitting everything together

Figure 39 Fitting the Taser module to the front housing
TESTING

To test the device a simple function check was performed selecting between the modes to check for function with all of the functions performing as expected. The device was tested with an actual pepper spray canister and simulation of the Taser via the led’s.

Along with the function of the devices non-lethal options, the time saved switching between lethal and non-lethal options was also tested. The method for testing the time is as follows; a person in a standing position holding a non-lethal device while also carrying a firearm is prompted to start a timer at the same moment another person starts a timer. While the timer is running the first person drops the non-lethal item to the ground and then draws, aims, and dry fires as quick as possible stopping the time when the timer hears the click. This time averaged out to be 1.8 seconds.

![Figure 40 testing the operation of the Taser simulation](image)

![Figure 41 testing the transition time between lethal and non-lethal means](image)
SCHEDULE AND BUDGET

**Schedule**

The project schedule begins on October 18. The project deadline is on April 18 with final presentations of our project.

Key milestones:
- 3D models created: Nov 15
- Purchase of materials: Dec 27
- Fabrication: Jan 31
- Final testing: Feb 28

<table>
<thead>
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<th>Table 6. Schedule</th>
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<tbody>
<tr>
<td><strong>Concept Sketches</strong></td>
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<tr>
<td><strong>3D Model-Fire control Group</strong></td>
</tr>
<tr>
<td><strong>3D Model-housing</strong></td>
</tr>
<tr>
<td><strong>Calculations</strong></td>
</tr>
<tr>
<td><strong>Electrical Calculations</strong></td>
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<td><strong>Assembly</strong></td>
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<tr>
<td><strong>Modification</strong></td>
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<td><strong>Final Testing</strong></td>
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**Proposed Budget**

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<th>Cost (Proposed)</th>
<th>Item</th>
<th>Cost (Actual)</th>
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<td>3D Model</td>
<td>$201</td>
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<td>Miscellaneous Parts</td>
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<td>Metal Parts</td>
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<td>Pepper Spray</td>
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<td>Taser Cartridge</td>
<td>$20</td>
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<td>Tools</td>
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<td>Total</td>
<td>$258</td>
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WORKS CITED

APPENDIX A RESEARCH

Interview with Dale Myron of Bweaponcraft
601 Ridgedale Road Dayton Ohio 45406 09/08/2012
He has been selling firearms and non lethal devices to law enforcement, military and civilians for 22 years
The most crucial feature of a device for first responders is reliability; they count on their equipment to work all the time. Weight is also an issue with first responders carrying a lot of equipment when on duty. Durability is important because first responders use their equipment harder than most others in society.

Forum thehighroad
Poster: Chuck Perry
Date posted: 09/08/2012
“From an LE standpoint, use of force is a dynamic situation not static. Meaning, once you reach a certain level of force doesn't mean that you are locked in on it and can't move back down to a lesser amount of force. If you are holding a long gun on someone and the situation changes to a non-lethal encounter, you need to make the transition from the long gun to that other thing. In the case of a long gun, this could be awkward and time consuming (sling rifle, transition to spray/taser, deploy). It also gives the actor time to think. If the less lethal option were available onboard the long gun it would eliminate that transitional downtime. I'd still have concerns about such a device. Number one, you have to make sure you pull the right trigger! Two, what will my partner do when I deploy the less lethal device? Hopefully he would recognize that I used the less lethal and not the lethal, or he might pop off a shot in reflex to me.”
The taser is a great product. Something else to consider might be one of the high pressure pepper spray devices, like Kimber sells/sold. I'm thinking of a sudden, MASSIVE deployment of pepper that covers an actor head to waist in a second or less.

Forum thehighroad
Poster: hso
Date posted: 09/08/2012
“It is critically important that neither the lethal nor the non-lethal weapon have any similar ergonomics to prevent confusing one for the other.”

Forum thehighroad
Poster: Texan Scott
Date Posted: 09/09/12
“Rethink: a non-lethal accessory need not be used AGAINST someone ... it could have an ancillary or support function. What about something in the buttstock that sends out an immediate "shots fired" call if the gun goes bang, along with a GPS beacon?”
<table>
<thead>
<tr>
<th><strong>Black Rain Ordnance AR 15 Flash Suppressor Flash Hider</strong></th>
<th>A less than lethal impact device require the user to be within reach of the end of the firearm.</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Black Rain Ordinance flash suppressor serves a dual purpose as a muzzle flash suppression device as well as a less then lethal impact device. This particular device is made for the ar15 platform, but there are other variations made for other firearms that serve the same purpose.</td>
<td>Cost $15 to $140 USD</td>
</tr>
</tbody>
</table>

Black Rain Ordnance Inc. CNC machined flash suppressor with ½ x 28 thread pattern for .223/5.56 Made from 416r stainless steel with serrated and aggressive design to be used as a glass punch, door breech, or less lethal means of control while safely concealing flash. Salt bath nitride for a tactical black finish. Made in the USA.
M720V RAID™ Weapon Light – White and IR Output

Flash lights serve a dual purpose for illumination and disorientation/temporary night blindness. Mounts to the picatinny rail and is adjustable. These types of lights range from $50-$800USD

M720V variable-output "disable" setting to prevent accidental discharges.

highly efficient LEDs are virtually immune to failure since there's no filament to burn out or break.

The M720V comes with a pressure-activated SR07-M720V tape switch (with a 7" cable) that can be positioned where you choose.

If your remote switch becomes damaged or disconnected, rotate your RAID WeaponLight's white-light selector switch to "flashlight" mode and activate it directly via its integral pushbutton dome switch. (This same pushbutton switch provides low navigational white light when "flashlight" mode is not selected.) This selector switch also lets you choose three different white-light output settings: high, medium, or strobe. The IR selector switch, located on opposite side, offers high-, medium-, and low-output settings when IR mode is selected on head.

The M720V attaches solidly to your Picatinny rail via our Swing-Lever™ clamp, which self-adjusts to out-of-spec rails and features a lever lock to prevent loosening from recoil or impact. Built to withstand the rigors of combat, the M720V is constructed of high-strength aerospace aluminum with Mil-Spec hard anodizing for superior toughness and corrosion resistance and optically coated tempered glass for durability and maximum light transmission. It's also O-ring and gasket sealed to keep out dust, dirt, and moisture.

http://www.surefire.com/illumination/weaponlights/rifle-carbine-smg/raidweaponlight/m720v.html

09/09/2012
ASP Batons - 26" Expandable Friction Lock

Asp batons are popular among police agencies as a less than lethal device when used correctly. They can be used as an impact device or used in pressure points to control a suspect.

- High strength durable construction
- Collapsible for small size
- High grip handle
- Corrosion resistant

These batons require the user to be within reach of the suspect and also require switching of hands and lowering of the main weapon. They can also be difficult to use in confined spaces where there is little room to swing.

$81.60 USD

http://www.copsplus.com/prodnum1552.php
09/09/2012
**Fox Labs Foam Pepper Spray**

<table>
<thead>
<tr>
<th>Features</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effective incapacitation power</td>
<td>$15-$40</td>
</tr>
<tr>
<td>Non-lethal</td>
<td></td>
</tr>
<tr>
<td>Foam reduces the chance of being affected by wind and cross contamination</td>
<td></td>
</tr>
</tbody>
</table>

These units require the user to switch hands or not have complete control over the main weapon.


09/09/12
TASER® X3™ ECD

Tasers allow law enforcement to incapacitate an attacker at a distance with little effort. They are generally effective against the majority of people.

There are currently lawsuits against Taser for wrongful deaths. They may not always be effective against extremely large suspects or suspects wearing really thick or tough clothing that the barbs cannot penetrate.

$1599.95 USD

http://www.taser.com/products/law-enforcement/taser-x3-ecd
09/09/2012
12ga Rubber Bullets

- Can be very effective
- Can be used at distances
- Can’t be used at point blank distances
- Can be lethal but is minimal

Rubber Bullets and bean bag rounds need to be used in a dedicated shotgun and cannot have live ammunition mixed in. Can be lethal. $6.95 USD for 5 rounds

http://www.keepshooting.com/12ga-rubber-bullets.html
09/09/2012

Appendix A7
The TAC-700 launcher allows officers to quickly employ rounds and create substantial pepper clouds. This helps officers to gain compliance in crowd control, barricade busting, and many other use of force situations. Agency set trigger options assures the TAC-700 can conform to agency policy while giving officers the right capabilities to achieve their goals. The TAC-700 averages 700 rounds per minute in full automatic with up to 60 ft. target accuracy and up to 150 ft. accuracy for saturating an area with pepper. It is both tactical and compact.

http://www.pepperball.com/products.html
09/09/2012
ST 12" Rear Loading Havoc Launcher

- Mounts to standard picatinny rail
- Reloadable
- Can use a multitude of munitions including tear gas

Mostly used for crowd control or barricaded suspects. They affect anyone in the area of the tear gas. $299.95 USD

09/09/2012
APPENDIX B CUSTOMER SURVEY AND RESULTS

Weapon Mounted Less Than Lethal Device

CUSTOMER SURVEY

First responders have the difficult job of being in the line of danger without always knowing what might happen. They have many options available to them for protection and aid of apprehension in the form of two separate systems lethal and less than lethal. To aid in the development of a new system that allows the combination of a lethal system and a less than lethal system to save time and save lives please complete the survey below.

How important is each feature to you for the design of a new weapon mounted less than lethal device?

Please circle the appropriate answer.  

<table>
<thead>
<tr>
<th>Feature</th>
<th>1 = low importance</th>
<th>2 =</th>
<th>3 =</th>
<th>4 =</th>
<th>5 = high importance</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>N/A</td>
</tr>
<tr>
<td>Price</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>N/A</td>
</tr>
<tr>
<td>Ease of use</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>N/A</td>
</tr>
<tr>
<td>Reliability</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>N/A</td>
</tr>
<tr>
<td>Durability</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>N/A</td>
</tr>
<tr>
<td>Size</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>N/A</td>
</tr>
<tr>
<td>Weight</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>N/A</td>
</tr>
<tr>
<td>Being ergonomic</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>N/A</td>
</tr>
<tr>
<td>Ease of installation</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>N/A</td>
</tr>
<tr>
<td>Ease of maintenance</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>N/A</td>
</tr>
</tbody>
</table>

How satisfied are you with the current offerings of less than lethal devices?

Please circle the appropriate answer.  

<table>
<thead>
<tr>
<th>Feature</th>
<th>1 = very Unsatisfied</th>
<th>2 =</th>
<th>3 =</th>
<th>4 =</th>
<th>5 = very satisfied</th>
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<tbody>
<tr>
<td>Safety</td>
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<td>2</td>
<td>3</td>
<td>4</td>
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</tr>
<tr>
<td>Price</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>N/A</td>
</tr>
<tr>
<td>Ease of use</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>N/A</td>
</tr>
<tr>
<td>Reliability</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>N/A</td>
</tr>
<tr>
<td>Durability</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>N/A</td>
</tr>
<tr>
<td>Size</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
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</tr>
<tr>
<td>Weight</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>N/A</td>
</tr>
<tr>
<td>Being ergonomic</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>N/A</td>
</tr>
<tr>
<td>Ease of installation</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>N/A</td>
</tr>
<tr>
<td>Ease of maintenance</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>N/A</td>
</tr>
</tbody>
</table>

How much would you be willing to pay for this device?

- $50-$100
- $100-$200
- $200-$300
- $300-$500
- $500-$800

Thank you for your time.
<table>
<thead>
<tr>
<th>Zach Barks</th>
<th>Less than lethal weapon mount</th>
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<tbody>
<tr>
<td>9 = Strong</td>
<td>3 = Moderate</td>
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</tbody>
</table>

**APPENDIX C QFD**

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<th>installation time</th>
<th>maintenance time</th>
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<th>price</th>
<th>weight</th>
<th>material removed in non essential area</th>
<th>corrosion resistant materials</th>
<th>material durability</th>
<th>customer importance</th>
<th>designer’s multiplier</th>
<th>current satisfaction</th>
<th>planned satisfaction</th>
<th>improvement ratio</th>
<th>modified importance</th>
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<th>residual weight %</th>
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<td>10%</td>
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<td>5.0</td>
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<td>9</td>
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<td>3.89</td>
<td>1.42</td>
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<td>1.0</td>
<td>3.7</td>
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<td>6%</td>
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<td></td>
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</tr>
<tr>
<td>Ease of maintenance</td>
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<td>9</td>
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<td>4.4</td>
<td>0.9</td>
<td>3.5</td>
<td>0.06</td>
<td>6%</td>
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<td>0.19</td>
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<td>0.18</td>
<td>1.0</td>
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</tr>
</tbody>
</table>

Appendix C1
APPENDIX D PRODUCT OBJECTIVES

Objectives
Based on the survey, the product objectives are the list of features that are taken into consideration. The following is a list of product objectives and how they will be obtained or measured to ensure that the goal of the project was met.

• Safety 17%
  • Selector switch with a safe position
  • Detent to provide positive click consistent with off the shelf components
  • Trigger with greater than 8 lb. pull to prevent accidental discharge

• Reliability 16%
  • Use of highest rated third party products
  • Design consistent with loading factors and loading conditions
  • Torque ratings consistent with standards

• Price 14%
  • Between $300-400 for prototype

• Being ergonomic 10%
  • Design within the natural human range of motion (grip consistent with 80th percentile center of gravity won’t move forward more than 4 inches)

• Ease of use 8%
  • Controls large enough for hand sizes in the 80th percentile
  • Trigger guard for hand sizes in the 80th percentile with measured clearances

• Durability 8%
  • Design factors consistent with expected loading conditions
  • Corrosion resistant material selection
  • Design for impact from 5 foot drop

• Size 8%
  • Hand grip sized to accommodate the 80th percentile of human hands
  • Will not extend past magazine or increase the width by more than 10% or extend past muzzle

• Weight 7%
  • Use aluminum
  • Removal of material in non-essential areas

• Ease of installation 6%
  • Installation with one or zero tools
  • Installs in one step per device
  • Installs instantly

• Ease of maintenance 6%
  • Design that can be taken down in less than 1 minute
  • No tools required
  • Lubrication being optional
# Appendix E Schedule

<table>
<thead>
<tr>
<th>TASKS</th>
<th>Date Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proof of Design to advisor</td>
<td>Oct 14-20</td>
</tr>
<tr>
<td>Concept sketches to advisor</td>
<td>Oct 21-27</td>
</tr>
<tr>
<td>3D Model – Fire control group</td>
<td>Oct 22-27</td>
</tr>
<tr>
<td>3D Model – housing</td>
<td>Oct 23-27</td>
</tr>
<tr>
<td>Calculations</td>
<td>Oct 24-24</td>
</tr>
<tr>
<td>Impact Calculations</td>
<td>Oct 25-25</td>
</tr>
<tr>
<td>Design Freeze</td>
<td>Oct 26-26</td>
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<tr>
<td>Order components</td>
<td>Oct 27-27</td>
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<tr>
<td>Bill of materials</td>
<td>Oct 28-28</td>
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<tr>
<td>Oral report</td>
<td>Nov 1-11</td>
</tr>
<tr>
<td>First report</td>
<td>Nov 12-21</td>
</tr>
<tr>
<td>Fabrication</td>
<td>Nov 22-31</td>
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<tr>
<td>Assembly</td>
<td>Nov 32-32</td>
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<tr>
<td>Testing</td>
<td>Nov 33-33</td>
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<tr>
<td>Modification</td>
<td>Nov 34-34</td>
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<tr>
<td>Final testing</td>
<td>Nov 35-35</td>
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<tr>
<td>Advisor Demo</td>
<td>Dec 1-10</td>
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<tr>
<td>Faculty Demo</td>
<td>Dec 11-20</td>
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<tr>
<td>Oral Presentation</td>
<td>Dec 21-30</td>
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<tr>
<td>Final Report</td>
<td>Dec 31-31</td>
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## APPENDIX F BUDGET

<table>
<thead>
<tr>
<th>Proposed Budget</th>
<th>Actual money spent</th>
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<tr>
<td>Block Aluminum</td>
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<tr>
<td>Miscellaneous Parts</td>
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<td>Pepper Spray</td>
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<td>Tools</td>
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<td>Metal Parts</td>
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<tr>
<td>Taser Cartridge</td>
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<tr>
<td>Misc. electrical</td>
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<td>Total</td>
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