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LRF INCORPORATED FINAL REPORT
“Development of Baton With Restraining Net”
NIJ Grant #97-LB-VX-K011

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OUTLINE FOR LRF INCORPORATED FINAL REPORT

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LRF INC. REPORT
NIJ Grant #97-LB-VX-K011

The device that the National Institute of Justice (NIJ) awarded a grant to develop is a device invented and patented by Mr. Larry Fay. Mr. Fay invented the concept of a restraining net device after hearing about an officer confrontation through the media. The officer used his baton to restrain the suspect by striking him several times. Mr. Fay's device is unusual in that it is capable of restricting the movement of a subject that is two to seven feet away from the officer. This device is different from others that are currently in development because the net does not cover the suspect, it wraps around the suspect and adheres to itself.

Concerning net projection and trajectory status:

The volume of gas needed to propel the net and catches from previous prototypes has been measured. With this value known, and with the new design of the release mechanism and pathways, we were able to reduce the needed volume of gas needed to propel the net and catches to less than 40 percent of the original volume. With the reduced volume, we were able to make the device smaller, and thus more portable.

The pressure of gas needed to propel the net and catches in previous prototypes was measured by installing measuring devices at different points of the gases passage ways. We found that the force applied to the catches and net was less than eight percent of the original pressure in the canister. By redesigning of the release mechanism and by changing the jet diameter and pathways, we were able to reduce the needed pressure by over 45 percent. By reducing the pressure needed to deploy the net and catches the device will be safer to use.

The jet diameter of previous prototypes has also been analyzed. The information gathered about the volume and pressure of the gas, and the necessary mass of the catches, enabled us to determine the necessary jet diameter. While doing experimental testing of the jet diameters, some surprising information was found using the Kodak Motion Analyzer. The testing showed that proper jet size is important, however; the location of the catches in relation to the location of the net in the housing has proven itself even more important..

With the funding from the NIJ, we have found that the device can be deployed with a disposable 20 gram nitrogen cylinder. In the prototype shown at the demonstration and on the video the cylinder is prepunctured. The gas is then released with a 12 volt solenoid that is powered by two six volt nickel cadmium batteries that are activated with a push button. After analyzing many different

gases, nitrogen was found to be the most effective because of its stability of pressure under different temperatures and circumstances.

We have been in contact with Halkey-Roberts Inc., and they produce a valve that will eliminate the need to prepuncture the cylinder and the solenoid requirement. Their valve will incorporate the needed safety systems in the baton by having a two step release of the net. The first step will remove the cover, and the second step will deploy the net. The jet diameters of the airways going to the catches were found to be most effective when they were sized at 71 percent of the catches size of 5/16 inches diameter. With the catches having 1 1/8 inch hole to travel in and a three thousandths of an inch clearance in the catch holes the catches are able to reach a velocity of 22 feet per second.

At this speed, the net will restrain a suspect in three tenths of a second at a distance of four feet between the officer and the suspect.

Path of the net

The user of the launcher holds the device in a horizontal position. When the net is deployed, it travels away from the user in a horizontal direction. The net is opened by the force produced by the mass of the catches. This allows the net to travel in vertical position and horizontal directions at the same time. This movement will allow the net to travel to the suspect.

Range of the aiming angle is affected by the position and angle that the launcher is held in before deploying the net. One thing that does not change is the distance that the net travels. After the net leaves the launcher, it must travel two feet before it is fully effective, and will still be effective for up to seven feet. This is the distance that a suspect is most harmful to an officer in a hand to hand situation.

Initial velocity of the net and catches have been calculated by using the Kodak Motion Analyzer. As the net comes in contact with the suspect, the forward motion of the net ends, but the catches continue until the mass of the catches are forced to wrap around the suspect. At this point, the suspect's mobility is restricted.

Concerning net design

We have been in contact with several net manufacturers . Many of these companies have allowed us to test nets made from different materials and configurations. From this we have determined that only a few materials were usable because of the limited space in the net chamber. We used one net with a

material called Kevlar, but the configuration of the net we tested was not effective. The Kevlar did however, offer superior strength and a small thread diameter. The Kevlar allowed us to construct a usable net that easily loaded into the limited space of the net chamber. To get nets made from Kevlar and constructed to our specifications, we are having the nets custom made locally by Richard Gibson. These nets are tied by hand. Due to the cost of a manufacturer tooling up to produce nets to these specifications a total of thirty to fifty thousand dollars would need to be spent. Because of the limited number of nets needed at this time the local construction of the nets was a more feasible option.

Nets made from Kevlar thread and made with a square hole design were found to be the most effective. We have been in contact with many different net manufacturers, and have received some quotes of the estimated cost to mass produce these nets.

The company Just Nets has quoted a price of \$3.50 for each net made to meet our specifications.

The dimensions of the net

The overall size of the net, height vs. length ratio and the size and style of the openings in the net had to be tested to insure its effectiveness at restraining suspects as well as minimizing excessive drag in flight. In determining the proper overall size of the net, a reference book called "Humanscale 1/2/3" was used to insure that the net would work for all body types. A few nets were made to this size, but during field-testing they were found to be improperly proportioned and were not effective in suspect restraint. After reviewing the films of the tests, the proper net size was determined.

The loading procedure of the net into the chamber has been found to have an impact on how far and how fast the net deploys. This information was determined by reviewing the films of the net flight using the Kodak Motion Analyzer. From this we have determined the best way of loading the net to allow the net to deploy in a useable, and effective range. This procedure is used in loading the net.

From testing funded by the NIJ, the most effective net size is an oblong net with an overall size of 44" high and 58" long. This size of net has been found to be effective and any variation of suspect size is handled by the elastic cords attached to the catches.

Catch Configuration

The previous baton prototypes used a catch design that lacked the balance and aerodynamics needed, by studying this, we were able to calculate the amount of mass that was needed to deploy the net. From this we designed a new catch. This catch is designed to be effective in restraining the suspect by adhering to the net and is designed to avoid injury to the suspect by having only blunt edges and no sharp points. With proper training in the use of the baton, there is minimal risk of injury to the suspect. The catches will be made of a material that is compatible with the material used in the net housing.

The catch design used in the baton shown at the demonstration has an overall size of 5/16th inch diameter, and a length of 1 1/8 inches. The catches are made up of four rows of catch points with six catch points in each row. The catch will feature a dome nose this will reduce the chance of injury, and will still allow the catch to achieve a speed of 22 feet per second.

Baton development status/plan

The baton prototype will be made from aluminum. Using aluminum allows us to construct the prototype at a reasonable cost and from a material with known strength values. We have spoken with several injection molding companies and they have informed us that once the final design is complete it can be converted over to an injection-molded design. Due to the initial cost of the molds for injection molding, it would not be feasible to produce a prototype like this at this time.

The baton development funded by the NIJ, is made from aluminum and contains a 12 volt power supply. A disposable nitrogen cylinder that is released by a solenoid. The gas deploys a net made from Kevlar with six catches that are attached to the net with elastic cords of various lengths.

Mechanical stress analysis and reliability:

When the baton is built, it will be tested under working pressures and the additional pressure that could occur under extreme circumstances. Due to the manufacturing process used to make the prototypes, accurate stress testing could not be achieved.

Field conditions

When the baton development is complete we will provide a plan as to how and under what circumstances it will be tested. The plan will be devised with the assistance of Officer Richard Pepper. Upon NIJ's approval of the plan, the baton will be tested. The testing will be documented by the use of a portable camcorder. The testing will determine the situations where baton is most effective.

The baton was not tested under field conditions because the device has not been safety certified.

Prototype development status/plan:

The final prototype, head only, will be constructed to the specifications that were determined by previous tests. This prototype will be tested to ensure the proper net release speed to cause deployment of the net. The range of the net travel and the number of times the housing can be used will also be tested. If any changes are needed to achieve the desired results, they will be made to this prototype.

A final baton will be made to include the head assembly, release mechanism, and baton handle. A film showing the results of the final developed baton will be made and turned over to the NIJ.

With the funding from the NIJ, the data that we have collected has shown the device that will be used on the street will have a housing made from injection molding and will feature a two step release system that will provide protection from the occurrence of unexpected deployment. The net would be contained in a housing that is protected by a cap that covers both the net and the catches.

Several suggestions were made at a demonstration held in Rome in regards to the device. It was suggested that the net and housing be separate from the baton. After reviewing the comments, we have determined that the compact size of the device will make that a feasible option.

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