# Improving Correctional Officer Safety: Reducing Inmate Weapons

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Grantee: Johns Hopkins University – Applied Physics Laboratory

Project Director: Paul J. Biermann, Member Principle Professional Staff

U.S. Department of Justice/Office of Justice Programs

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# Final Report

## *Background*

### Problem Definition

The corrections officer is exposed to a number of hazards that do not exist for many other professions. Surrounded by inmates with a history of violent behavior and materials that can be converted into weapons, many relatively innocuous items have been converted into weapons that have maimed and killed corrections officers. These innocuous items include toothbrushes, locks, safety razors and broken glass. For example, a common misuse of toothbrushes is to sharpen them for stabbing and to reshape them to hold sharp metal blades. These items are introduced into the prison environment from a number of sources:

- Purchased from the commissary such as toiletries and locks
- Stolen or illicitly introduced to the prison environment
- Salvaged or vandalized from prison facilities.

Such items are considered contraband when they are obtained without authorization and modified or used as weapons to threaten the safety and security of correctional personnel, inmates or facilities.

### The Corrections Threat

“In this little city,'' says LaMont W. Flanagan, who oversees the Baltimore City Detention Center, “you have the powerful and the powerless. The shank takes the place of a gun on the street.”[1]

While the FBI's Uniform Crime Reports Law Enforcement Officers Killed and Assaulted (LEOKA) report provides detailed insight into the nature and types of assaults on police officers, there are no comparable details currently maintained for assaults on corrections officers. In 1988, 23 corrections officers were attacked with weapons while 123 were attacked without weapons. In 1990, the last year that data was collected by the Department of Justice, there were 185 assaults on federal corrections officers. Between 1990 and 1995 there was a 33% increase in the number of assaults by inmates on corrections facility staff. In 1990, there were 10,731 reported assaults by inmates on

1 © - The Baltimore Sun, SUN STAFF Ivan Penn, *Lethal handiwork behind prison walls: Search for shanks never turns up all.* 11/17/1997

corrections facility staff; in 1995, there were 14,165 reported assaults. The nature of the assaults has become more severe as well. In 1990, none of the reported assaults resulted in the death of the staff member who was assaulted. By comparison, in 1995, 14 staff members were killed as a result of the assault.[2]

While the threat faced by the police officer is most frequently from firearms, a corrections officer faces an entirely different variety of threats. It is rare for an inmate to have a firearm within a correctional facility. The most common threat faced by correction facility staff is from pointed- and sharp-edged weapons. Most of these are homemade or improvised weapons, obtained through a variety of sources in the corrections environment.

More than twice as frequent are the number of prisoner assaults on other prisoners. Approximately 3% of prisoners are assaulted and injured by other prisoners each year in federal prisons. The probability of similar assaults is almost four times higher in state prisons. A reduction of weapon availability or effectiveness is expected to also reduce the number and severity injuries from prisoner assaults on other prisoners.

### *Progress*

#### Phase 1 - Identification and Evaluation of Unconventional Weapons

To address the data collection and analysis JHU has assembled a working group consisting of 14 members to analyze data in a scientific manner on unconventional weapons, their frequency and cost to the corrections system. The group is made up of 8 members that are practitioners from the correctional community, and 6 members from JHU staff. Note that two original members (in italics) have been replaced by two new members from their same organizations.

| | |
|---|---|
| Suzanne Baker | JHU/Center for Injury Research & Policy |
| Paul Biermann | JHU/APL |
| Lily Chen | JHU/Center for Injury Research & Policy |
| Alex Fox | Mass. Department of Corrections |
| Robert Greene | Montgomery Co. MD Dept. of Corrections & Rehabilitation |
| Jack Harne | NLECTC |

[2] ***Prison and Jail Inmates at Midyear 2001.*** US DOJ, Office of Justice Programs, Bureau of Justice Statistics, http://www.ojp.usdoj.gov/bjs/pub/ascii/pjim01.txt

| | |
|---|---|
| John Kenney | Hamden Co. MA, House of Corrections |
| Jennifer Lincoln | JHU/Center for Injury Research & Policy |
| Julie Mair | JHU/Center for Injury Research & Policy |
| Mike Maloney | Mass. Department of Corrections |
| *Larry Meachum* | *National Institute of Justice* (Retired 12/31/03, replaced by |
| Al Turner | National Institute of Justice) |
| *Robert Palmquist* | *Federal Bureau of Prisons* (reassigned, replaced by |
| John Ely | Federal Bureau of Prisons) |
| Emily Ward | JHU/APL |
| Reggie Wilkinson | Ohio Dept. of Rehabilitation & Corrections |

The survey of correctional agencies was conducted by the Johns Hopkins Center for Injury Research and Policy (CIRP) with input from the working group.

Thirteen states volunteered their corrections institutions for participation in the surveys. After details and questions were addressed, the list was reduced to ten states.

Participating states and the number of institutions contacted in each state:

| | |
|---|---|
| Arizona | 5 facilities |
| Indiana | 3 facilities |
| Louisiana | 4 facilities |
| Michigan | 9 facilities |
| Missouri | 6 facilities |
| New Jersey | 11 facilities |
| Ohio | 6 facilities |
| Pennsylvania | 8 facilities |
| Texas | 16 facilities |
| Utah | 1 facility |

Once a list of institutions was developed, the next step was to telephone, e-mail or write to a contact person at each institution to discuss the project, its rationale, and the advantage to the institution of learning more about the nature of unconventional weapons, their derivation, and the manner in which they are used (Appendix 1). The working group members provided guidance on the sources of information that would be available within the scope of the project and recommendations on achieving a high response rate from the recruited institutions. The group also helped to refine and improve the questions based on their experience.

The forms were designed to elicit, with a minimum of effort on the part of the person filling them out, information about the sequence of events, the nature of the improvised weapon (size, shape, what it was made from and how, etc.) if known, and the consequences (threat vs. physical injury, severity of injury, number of persons injured)(Appendix 1). Each attack was coded/categorized with regard to type of weapon and consequences. The objective of the analysis was to determine which objects merit attention.

The program was required to obtain IRB approval to conduct the phone survey. The submission (Appendix 2) to the IRB review panel required a finalized set of questions which delayed the submission until after the second meeting on May 20th, 2003. Final IRB approval was received by Dr Baker on Aug. 20th, 2003.

The 3rd meeting of the working group was held on December 4th, 2003 at JHU/APL. That meeting produced a prioritized list of targets for engineering solutions to improvised weapons. Using that list JHU/APL staff developed proposed designs for razors, including both blade design and handle material changes, toothbrushes, mop/broom handles and fencing ties. A separate study was started to look at the growing problem of how to detect hard plastic stock and weapons made from it.

The 4th meeting of the working group held April 13th, 2004 at the Johns Hopkins Center for Injury Research and Policy (CIRP) in Baltimore, MD. The primary purpose of the meeting was to review the survey results, review the prioritized list of weapon/threat sources and provide and update on the engineering assessment phase of the project

The results of that meeting were:

- A review of the survey results.

  10 states represented
  157 facilitates narrowed to ~100 facility sample
  From the narrowed field 85 facilities responded

- A review of engineering approaches to the items on the prioritized list of weapons/sources that have shown up most frequently or are perceived as posing the greatest threat.

**PRIORITIZED LIST**:
1. Razors
1. Hard Plastic Stock (Polymer cannot be detected)
2. Personal Locks
3. Toothbrushes
4. Mop/Broom Handles
5. Fencing Material

- A decision to concentrate first on weapons that could cause fatality versus just injury.
- A decision to publish the findings and report in *Corrections Today* magazine, an NIJ journal.
- Discussed the possibility of getting engineering undergrads to play mastermind to find possible ways to make our prototypes into a weapon or having a contest for the correctional officer community to find ways to make a weapon out of the prototypes.
- A decision to schedule the 5th meeting in mid to late August, 2004.

The 5th meeting was held June 8th, 2005 at JHU/APL. The primary purpose of that meeting was to review the prototypes and direct focus on how to get this information to corrections practitioners that would be possible end users..

**Phase 2 - Prototype Design and Fabrication**

This activity started after the 3rd meeting held on December 4th, 2003 at JHU/APL. Based on the prioritized list defined at that meeting, JHU/APL staff developed proposed solution designs for razors, including both blade and handle material changes, toothbrushes, mop/broom handles and fencing ties. A separate study was started of the hard plastic stock detection problem. At the 3rd meeting it was noted that a definitive solution to this detection of non-metals problem would most likely exceed the scope and funding of the current effort. During this reporting period, an updated survey of non-metallic weapons detection technologies was conducted. The results of that updated study are included as Appendix 4.

The approach taken for the toothbrush has been to replace the thermoplastic materials that the traditional items are molded from with a combination of thermosetting polymers. The result is a structure that cannot be melted and therefore cannot be easily

altered to form a weapon. The bulk of the handle uses a softer polymer that cannot be sharpened. The area near the head is a firmer polymer that supports the mechanical loads normally exerted during the brushing action. Only the bristle area is fabricated from traditional materials, although it could be modified if required. See Figure 1. Other variations include adding various fillers to the handle resin that 1) act as a method to cause the handle to crumble and break off in small pieces if an attempt is made to alter or reshape the handle and 2) reduce the volume of resin required to mold the item which will lower the cost of the part.

The same approach was used for the razor handle and could also be used on comb and brush handle, eating utensils and any other common items currently molded from thermoplastic polymers. See Figure 2. Our prototypes were fabricated by casting molds from existing commercial products and then casting the polymers that we selected in those molds to form the prototypes. See Figure 3. In commercial production, the same results could be achieved using faster curing polymers as liquids injected into metal molds very similar to the way the current products are molded using thermoplastic polymers in metal molds.

Figure 1. Thermosetting polymer toothbrush prototype with soft handle.

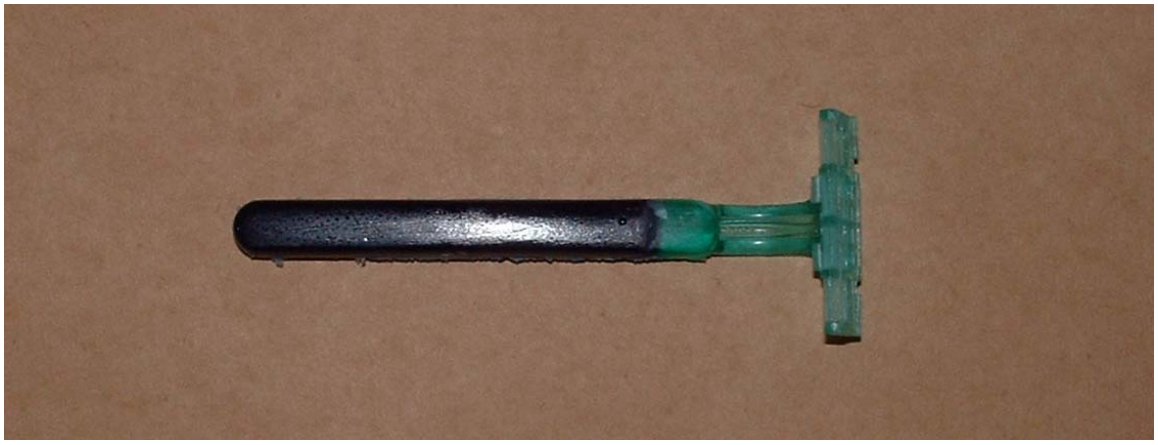

Figure 2. Modified razor handle using non-reformable materials.

Figure 3. Silicone mold for toothbrush prototype.

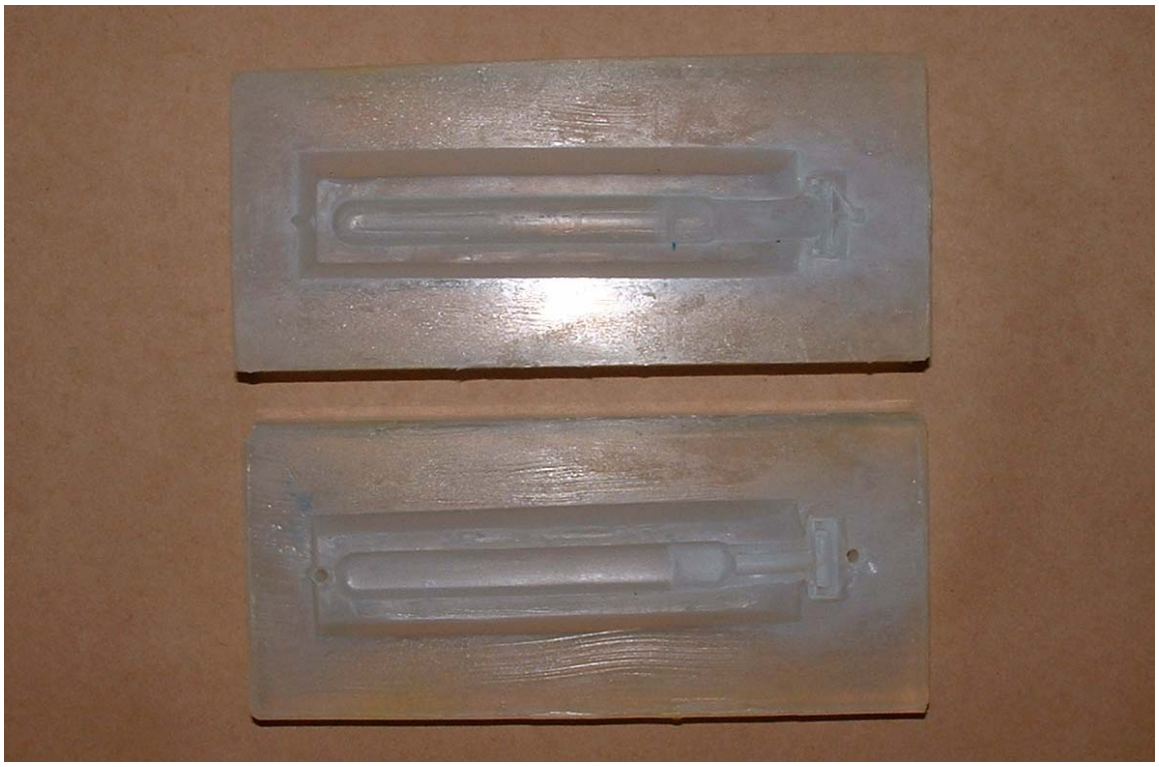

Figure 4. Silicone mold for razor handle prototype.

## Phase 3 - Prototype Evaluation

This activity started at the 4th working group meeting held at CIRP and continued at the 5th meeting which was held June 8th, 2005 at JHU/APL. Prototype handles for razors and toothbrushes have been fabricated incorporating both materials and design changes that will not allow them to be melted or reformed with heat. They also cannot be sharpened by abrasion. Figure 5 shows the remodeled forms for the tooth brush and razor handles. The shapes were modified to allow the use of a cardboard rod stiffener also shown in the image. The original prototypes shown in Figures 1 and 2 used a thin fiberglass rod as a stiffener, but that was switched for the cardboard rod to prevent the extraction of the fiberglass rod which could be used to make a weapon if sharpened. Figure 6 shows the two types of razor handle model and the small insert used to provide interface with the commercial razor head design. The shorter and thicker tapered handle can be fabricated without the use of an internal stiffener. All of the handles are molded using the same rubbery urethane materials as described above. Figure 7 shows the modified razor blade. The slots are cut to within 0.050" of the beginning or thick side of the cutting edge using electron discharge machining or EDM. When the blades are bonded into the holder shown in Figure 2, the slots create weak spots that will break if an attempt is made to remove the blade from the holder. The result is a series of short segments that are very difficult to use in the fashioning of a weapon. The segments could be made smaller if the blade could be designed from the ground up. This design was limited by the existing holes in the commercial blades we extracted from standard throw away razors. Figure 8 shows a prototype mop/broom handle that has been fabricated that will not deliver large side impact forces if used to strike a target. The handle has a stiff syntactic foam core and is covered with a softer flexible foam outer shell to reduce damage when struck against a person. In this example a lightweight broom head has also been fabricated using the stiff syntactic foam material with some internal stiffening rods. The rods can be seen as dark shadows in the head. Figure 9 shows the flexibility of the handle that will bend first and then break before inflicting severe damage.

Figure 5: Modified models for toothbrush and razor handles shown with cardboard rod stiffener.

Figure 6: Two designs for razor handles shown with the hard plastic inserts used to attach the blade holder.

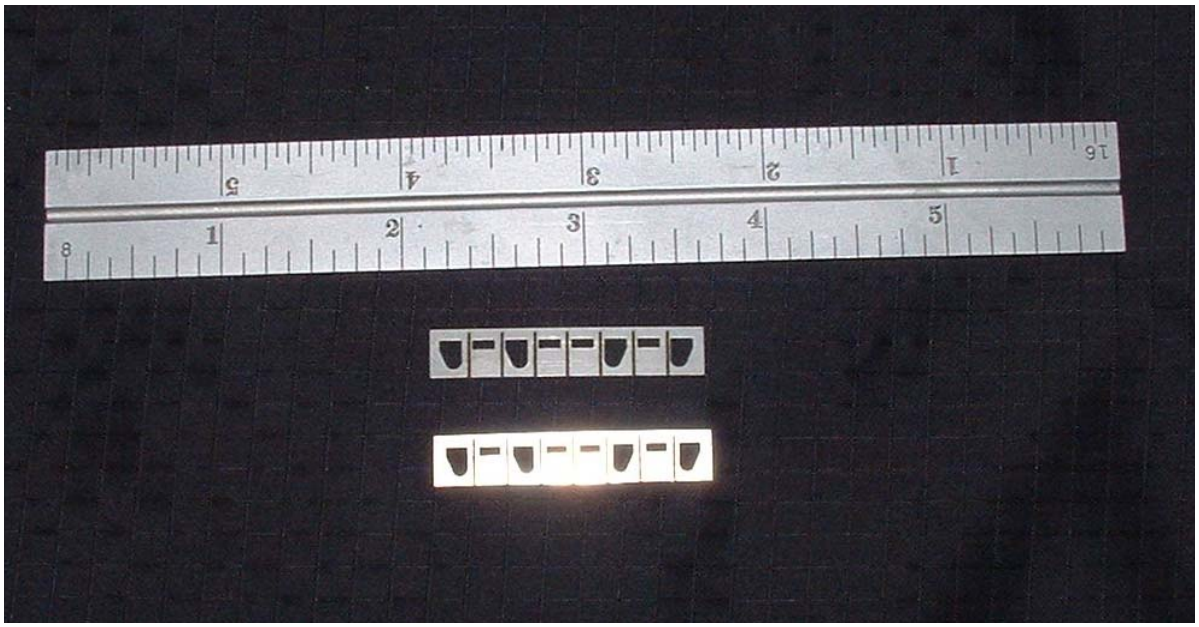

Figure 7: Slotted blades designed to break up when removed from the razor.

Figure 8: Lightweight broom handle and head designed to reduce damage if used to strike someone.

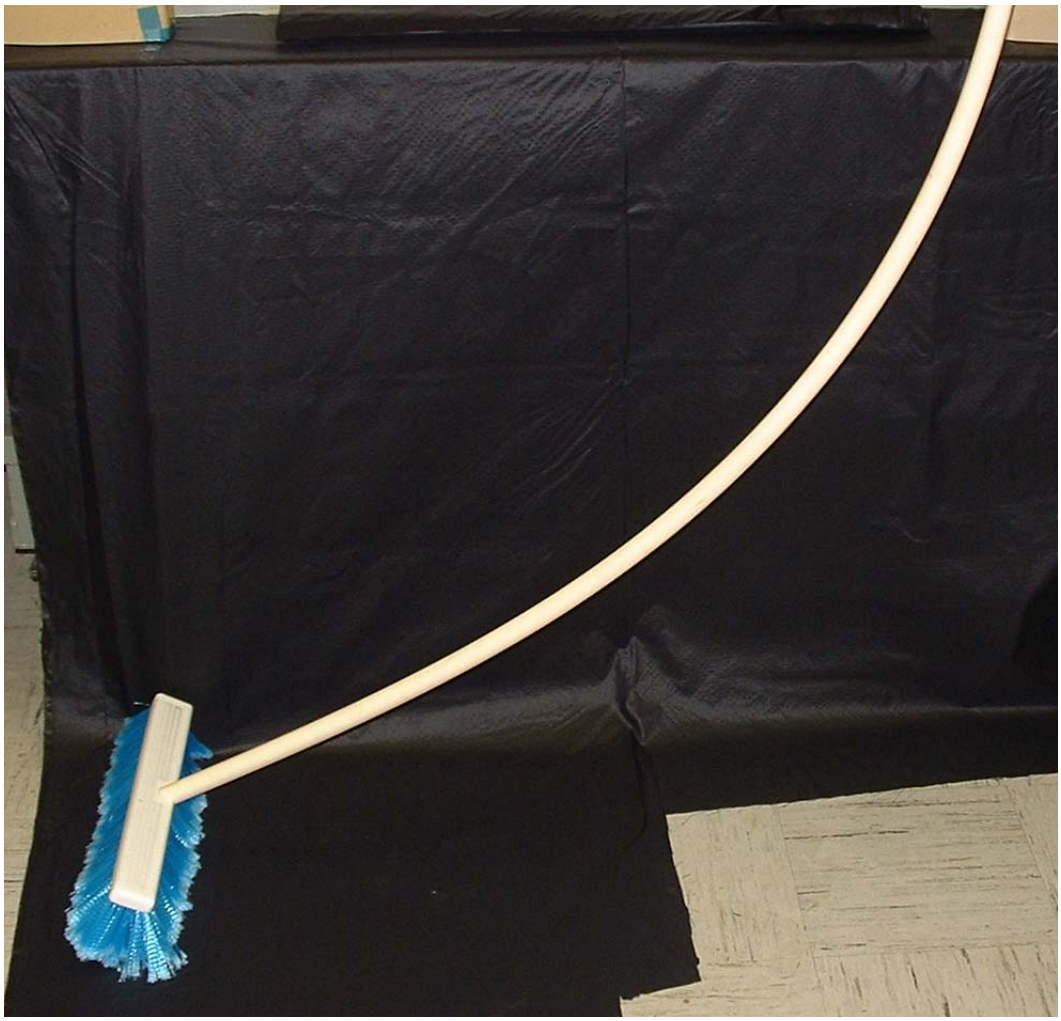

Figure 9: Lightweight broom handle can deflect before breaking.

**Phase 4 - Technology Transfer to the Corrections Community**

This activity was discussed during the 5th working group meeting and continued to the end of the project. During this program we have initiated contacts with UNICOR, part of the Federal Bureau of Prisons. They have a very large manufacturing operation covering numerous technologies including plastics manufacturing. Inquiries have also been received from a number of state and local corrections departments who want to know when these items will be available for them to test. Two presentations on this technology were made during the NLECTC organized training activities at the Mock Prision Riot, 2006, another to NTPAC at their meeting in Sturbridge, MA and to the NIJ Technical Conference in Washington, DC 2006. In addition, articles were written and published in the NLECTC Tech Beat and the ACA Journal. A copy of the ACA article is attached in Appendix 5.

## Summary

The program completed Phase 3 by June 2006. The Phase 4 activities continued through September 2006. Five meetings of the working group have been held and the APL staff has visited five representative corrections facilities at the local, State and Federal level. Surveys have been conducted of the participating state facilities. Data collection and tabulation have finished and a paper has been written and published (Appendix 3). A study of non-metals detection technologies was completed and the results are presented (Appendix 4). Multiple prototypes have been fabricated of most of the proposed solutions for razors, toothbrushes and mop/broom handles. Efforts continue to license the technology for insertion into the corrections system.

## Schedule

JHU/APL's program was originally scheduled to cover a 12-month period. The program has been extended 4 times, once to allow more time for data collection and a second time to allow for further prototype engineering and fabrication activities. The other two extensions were required to meet working group participant's schedules and program staff changes at NIJ. A final extension allowed the Phase 4 activities to continue through end of September of 2006 when the funding expired.

# Appendix 1 –Surveys

**State:**
State prison listserve

## Identifying Unconventional Weapons Fashioned by Prisoners

*Message to be emailed to directors of state prison systems.*

The National Institute of Justice is sponsoring a study of weapons used by or confiscated from prisoners, to learn how many weapons are confiscated, what the weapons were made from, and whether they were used to attack or injure corrections staff or prisoners. The information from the study will be used to identify materials to be modified so that they cannot be used to make weapons. The study has been endorsed by a committee of national, state, and county correctional officials.

The participation of all states would add to the value of the survey. If you would like your state to be included, please provide a list of your *maximum and medium* security facilities, indicating for each one:

Name and location of facility
Security level
Approximate number of prisoners (_____males, _____females)
Contact person (name, phone number, and email)

The contact person could be an investigations officer, disciplinary officer, or other person able to provide the information described below on confiscated weapons and the numbers of weapon-related attacks on and injuries to staff and prisoners. The information would be provided in a pre-arranged ten-minute telephone call from investigators at Johns Hopkins University. The contact person would previously have been provided with a list of the questions in order to prepare the answers.

Not every facility in your state would be contacted, rather a random sample designed to be geographically representative. This is a confidential survey, and no institution or person will be identified. The contact person would be told that their participation is voluntary and that they may decline to answer a question or end the conversation at any time.

We hope that your state will participate in this valuable study. Please indicate your willingness by sending the above information by June 10 to _____,

via email_____

or fax #_____

QUESTIONS TO BE ASKED OF A CONTACT PERSON AT A CORRECTIONS FACILITY

First, please tell me your job title

I would like to know what kind of prisoner-made weapons you are most worried about? What materials or objects are they made from?

Is there another type or source of weapons that you are especially concerned about?

About how many prisoner-made weapons are confiscated in an average month?

How many staff members are there at your institution, including corrections officers, administrative staff, etc.?

What is your inmate supervision methodology? (direct, indirect, both, or other *[if 'other', specify])*

We would like to have the answers to the following questions about weapon-related attacks and injuries in your facility *during the past 12 months*. (Do not include injuries from physical force, fists etc. when no weapon was involved.)

1. How many prison-made weapons were confiscated?

2. How many attacks were there that involved a weapon?

3. For each person who was injured by a weapon,

   Was the person a staff member or a prisoner?
   What weapon was used?
   What was it made from?
   Where did the material originate? (e.g., the metal came from materials in a vocational education shop and the razor blade from the commissary).

   In the case of a staff member:
      Was medical care required?
      How much time did the staff member lose?
      What was the job position of the staff member?
   In the case of a prisoner, was medical care required?

4. What is the most unusual weapon you have seen in the past 12 months?

## Federal:

Federal letter draft

## Identifying Unconventional Weapons Fashioned by Prisoners
## Message to be emailed to directors of federal prisons

The National Institute of Justice is sponsoring a study of weapons used by or confiscated from prisoners, to learn how many weapons are confiscated, what the weapons were made from, and whether they were used to attack or injure corrections staff or prisoners. The information from the study will be used to identify materials to be modified so they cannot be used to make weapons. The study has been endorsed by a committee of national, state, and county correctional officials.

The participation of all high- or medium-security federal prisons would add greatly to the value of the survey. If you would like your prison to be included, please provide the following;

Name and location of facility
Security level
Approximate number of prisoners (_____males, _____females)
Contact person (name, phone number, and email)

The contact person could be an investigations officer, disciplinary officer, or other person able to provide the information described below on confiscated weapons and the numbers of weapon-related attacks and injuries to staff and prisoners. The information would be provided in a pre-arranged ten-minute telephone call from investigators at Johns Hopkins University. The contact person would previously have been provided with a list of the questions (see below) in order to prepare the answers. No information will be sought about the prisoners.

This is a confidential survey, and no institution or person will be identified. The contact person would be told that their participation is voluntary and that they may decline to answer a question or end the conversation at any time.

We hope that your facility will participate in this valuable study. Please indicate your willingness by sending the above information to Professor Susan Baker at Johns Hopkins Bloomberg School of Public Health, 624 N Broadway, Baltimore MD 21205, or sbaker@jhsph.edu or fax 410-614-2797. If you have questions about the study, please call Dr. Baker at 410-955-2078.

QUESTIONS TO BE ASKED OF THE CONTACT PERSON AT A CORRECTIONS FACILITY IN A PREARRANGED TELEPHONE CALL

First, please tell me your job title

I would like to know what kind of prisoner-made weapons you are most worried about? What materials or objects are they made from?

Is there another type or source of weapons that you are especially concerned about?

About how many prisoner-made weapons are confiscated in an average month?

How many staff members are there at your institution, including corrections officers, administrative staff, etc.?

What is your inmate supervision methodology? (direct, indirect, both, or other [if 'other', specify])

We would like to have the answers to the following questions about weapon-related attacks and injuries in your facility during the past 12 months. (Do not include injuries from physical force, fists etc. when no weapon was involved.)

1. How many prison-made weapons were confiscated?

2. How many attacks were there that involved a weapon?

3. For each person who was injured by a weapon,

Was the person a staff member or a prisoner?
What weapon was used?
What was it made from?
Where did the material originate? (e.g., the metal came from materials in a vocational education shop and the razor blade from the commissary).

In the case of a staff member:
Was medical care required?
How much time did the staff member lose?
What was the job position of the staff member?
In the case of a prisoner, was medical care required?

4. What is the most unusual weapon you have seen in the past 12 months?

Thank you very much for your time and interest. If you have any questions about the research, please contact the principal investigator of the study, Susan P. Baker at the Johns Hopkins Bloomberg School of Public Health, 410-955-2078. Questions regarding rights of research subjects can be answered by Ms. Chris Fornwalt, 410-614-5890.

# Appendix 2 - IRB Submission

WEAPONS IRB2 word

## Identifying Unconventional Weapons Fashioned by Prisoners

Susan P. Baker, MPH, Principal Investigator

A subcontract from the Applied Physics Laboratory to the JHBSPH, as part of its project:
"Improving Correctional Officer Safety:
Reducing Inmate Weapons"

1. SPECIFIC RESEARCH QUESTION ADDRESSED

What items commonly found in prisons are modified by prisoners to produce weapons such as knives and then used to attack or injure corrections officers?

Information to answer this question will be collected in a survey of prisons during Phase 1 of a project of the Applied Physics Laboratory. In Phase 2 (not addressed by the School of Public Health), APL will develop ways to modify some commonly found items so they cannot be fashioned into injurious weapons.

2. RATIONALE

According to the 2000 Corrections Yearbook, more than 2400 correctional staff members required medical attention in 1999 following assaults by inmates. Many of the assaults involved unconventional, 'homemade' weapons made by prisoners. Therefore, a survey of correctional facilities will be conducted by the Johns Hopkins Bloomberg School of Public Health to find out more about the weapons.

The corrections officer is exposed to a number of hazards that do not exist for most other professions. Corrections staff are surrounded by inmates with a history of violent behavior and materials that can be converted into weapons. Many items that appear innocuous have been converted into weapons that have maimed and killed corrections officers. Examples of these items include toothbrushes, locks, safety razors and metal torn from ventilators. In illustration, a common misuse of toothbrushes is to sharpen them for stabbing and to reshape them to hold sharp metal blades. The items from which weapons are made are introduced into the prison environment from a number of sources. They may be purchased from the commissary, such as toiletries and locks, stolen or illicitly introduced into the prison environment, or salvaged from prison facilities.

The purpose of the proposed research is to provide information on the frequency with which various weapons are confiscated or used in prisons and the materials from which they are made

3. METHODS

Data collection and analysis will be preceded by assembling a working group consisting of prison wardens, directors of state prison systems, and other practitioners from the correctional community. Prior to our contacting institutions, the working group members will provide guidance on the sources of information and recommendations on achieving a high response rate from the recruited institutions. The group will also help to refine and improve the questions, based on their experience.

The survey of correctional institutions will be facilitated by a listserve of directors of state prison systems that is commonly used by persons on the list to contact other members for providing information, conducting surveys, etc. The president of the association of state corrections directors (a member of the project working group) will use the listserve to send an email (contents attached) to all directors of state prison systems, explaining the project and asking them to provide the name of a contact person in each medium- and maximum-security prison in their state. We anticipate that between 15 and 25 states will provide this information. A stratified random sample of facilities will then be created. The strata will be based upon security level, gender of inmates, and geographic distribution of the prisons -- information that is generally available on the internet. Names of facilities in each stratum will be placed in a box and drawn at random to provide a list of 150 facilities; we expect that 100 of these will be available and willing to be interviewed.

Once the institutions to be contacted are identified, the next step will be to telephone or email the contact person at each institution. Prior to conducting the actual telephone interview, we will set up an appointment for the interview and provide the person to be interviewed (typically the investigations officer in the prison) with a list of the questions that we will ask. This will enable the officer to obtain the needed information from the records that are kept by all prisons on weapons and attacks. Scripts for the initial and follow-up phone calls are attached.

The primary purpose of the questions will be to determine the numbers and types of weapons (including what they are made from) that are most commonly used by prisoners to injure or intimidate corrections officers and others. Initially we will ask the officer about his/her primary concerns, because this will show that we are interested in his/her opinion and also because it will be valuable to know what they perceive as the greatest hazards. Another purpose will be to determine whether the injuries required medical attention or resulted in lost work days for the injured staff member. To quantify the threat to corrections officer health from inmate attack, an estimate of the number of corrections staff in each facility surveyed will be obtained, as well as the number attacked or threatened by weapons during the previous year. Information on weapons confiscated or used against other prisoners will also be obtained; these also represent a threat to corrections staff.

Institutions that do not agree to participate will be analyzed to determine whether the responding institutions are reasonably representative, with respect to size and type of facility (e.g., security level, geographic location.)

(Based primarily on analysis of the data collected, the working group members will identify critical problems that will be then evaluated from a number of aspects including technical feasibility of modification of weapons materials, cost, operational implementation, and acceptance by staff and inmates. A subset of two or three

problems with acceptable technical risks and solutions will be selected for further study in Phase 2 of this program, in which the Applied Physics Laboratory will address the redesign of various objects to reduce the likelihood that they can be used to injure people.)

4. RISKS VS. BENEFITS

There is potential benefit to corrections officers and prisoners who may eventually be better protected from attack with unconventional weapons. There are no risks to the people surveyed, since the name of the person interviewed will be removed from the files once the answers to questions have been entered in our data base. Furthermore, our working group members have assured us that even if the contact person were to become known, there is no chance that responding to the survey could in any way have a negative effect on him or her, including on job status.

5. CONSENT PROCEDURES

In the course of the telephone interview (see script) the person interviewed will have an opportunity to decline to participate, or to end the interview at any time.

6. DISCLOSURE LETTER

Text of the email that will be sent to directors of state prison systems and of the telephone scripts are attached.

7. CONFIDENTIALITY

No names or other identifying information on individuals injured or involved in any way in attacks will be obtained. The name of the person interviewed will be removed from our records at the end of the second interview (or after the initial phone call, if the person declines the follow-up call). Information from all of the facilities will be pooled and no facility will be identified in any publication or release of data. No information will be obtained about prisoners, since this is a study of weapons, not prisoners.

8. COLLABORATION - N/A

9. OTHER IRB APPROVALS - N/A

## Appendix 3 – Survey Results Paper

This has been published in Injury Prevention 2006;12; 195-198

***"Inmate-Made Weapons: Assessing the Injury Risk"***

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The research was initiated by the funding source and analyzed by the investigators.

Abstract

**Background:** Assaults involving unconventional, 'homemade' weapons result in more than 2000 injuries annually to correctional staff members in the United States. The objectives of this study were 1) To describe the weapons confiscated in prisons, the materials from which they were made, and the sources of these materials and 2) To determine the incidence of injuries to inmates and staff and the resulting cost and time lost by correctional staff.

**Methods:** We surveyed 101 state prison facilities regarding weapons confiscated or used in attacks in a 12-month period within 2002-2003.

**Results:** Of the 101 prisons in the sample, 70 provided data, a 69% response rate. A total of 1,326 weapons were either confiscated (1,086) or used to injure inmates (203) or staff (37). The weapons most commonly confiscated or used to attack inmates were shanks (34% and 31%, respectively). Staff members were most often attacked with clubs (54%). The injury rate for one year for inmates was 1.60/1000 *inmates* and for staff was 0.97/1000 *workers.* The cost of time lost and medical care for staff was estimated at $1,125,000.

**Conclusions:** As a result of this survey, the Applied Physics Laboratory at Johns Hopkins University is undertaking the redesign of materials and objects, focusing on commissary items most commonly used to make weapons.

Key words:

Assaults, weapons, prisoners, occupational injuries

## Introduction

Many hazards exist in the correction officer's workplaces that do not exist for most other professions. These workers often have contact with inmates with a history of violent behavior and access to materials that can be used as or converted into weapons. More than 2400 correctional staff members in the United States required medical attention in 1999 following assaults by inmates

[1]. Many of these assaults involved unconventional, 'homemade' weapons made by inmates.

Items that appear innocuous have been converted into weapons that have maimed and killed corrections officers. Examples include toothbrushes, locks, safety razors, metal torn from ventilators, and paper that has been hardened with toothpaste. These items have been modified into daggers, shanks, saps or garrotes [2]. Common misuses of toothbrushes include sharpening them for stabbing and reshaping them to hold sharp metal blades.

The items from which weapons are made are introduced into the prison environment from a number of sources. They may be purchased from the commissary, taken from prison industries, introduced into the prison environment during visitation, or salvaged from prison facilities.

Few details exist about the problem of inmates modifying objects to be used as weapons. In the mid-1990s, a survey was conducted of facilities in the southern United States to determine their experience with problems of inmates making weapons from prescribed medical devices such as knee braces. Thirty-four percent of the facilities responded that indeed medical devices had been "used or altered in a criminal manner." The authors concluded that the illicit use of medical devices by inmates is a legitimate safety concern for prison officials [3].

Case reports in medical journals describe injuries seen in inmates from homemade weapons. One report discussed injuries that occur when dagger-like weapons pierce tissue and then are broken off, embedding the object and leaving an inconspicuous entrance wound resulting in a life-threatening injury [4].

Not all weapons used in prison assaults are manufactured or modified from other items. Some are weapons of opportunity. These would include objects found in the inmate's environment that are grabbed and used in an attack [2]. These types of weapons could include pieces of furniture, broom handles and dustpans.

The objectives of this study were 1) To describe the types of weapons confiscated in prisons, the materials from which they were made, and the

sources of these materials and 2) To determine the incidence of injuries from attacks using weapons to inmates and staff, the weapons used in these attacks, and the resulting cost and time lost by correctional staff.

Methods

We conducted a telephone survey of medium- and maximum-security state prison facilities across the country regarding confiscated weapons and weapons used in attacks in the facilities for a 12-month period within 2002-2003. The facilities were identified from states that volunteered to participate in response to a letter sent from the Association of State Correctional Administrators to the office of corrections in each state. Thirteen states with 187 medium- and maximum-security facilities indicated they would participate. A stratified random sample of 101 medium- and maximum-security facilities was selected based upon security level and gender of inmates.

The telephone surveys had two parts. The initial call confirmed that the facility wanted to participate and identified the person who would collect and provide the weapon and injury information for the facility. A survey questionnaire was then sent to the contact person at the facility. Each facility that participated reviewed its records of weapons confiscated, for instance during “shakedowns,” and of injuries that occurred from weapons in that prison. The second telephone call collected the information from the contact person.

Basic facility information was obtained regarding number of employees and number of inmates. Weapon information included weapons that were confiscated and those that were used in each assault. We did not include body parts (i.e. fists, feet, teeth) as weapons. Time lost from work and hospitalization was recorded when correctional staff were injured.

Weapons were categorized by type of weapon, materials they were made from, and source of materials. Injuries were categorized by person injured, weapon used, and number of workdays lost by correctional staff. Percentages of type of weapons were calculated for confiscated weapons, weapons used to attack inmates and weapons used to attack staff. Leading categories of weapon

materials and sources of materials were also reported. Inmate and worker injury rates were calculated per 1,000 inmate population and per 1,000 worker population.

To estimate the number of lost work days and the cost of injuries suffered by staff, weights were calculated based on sampling fraction of prison facilities by security level for each state.

Lost wages were calculated by multiplying the weighted number of workdays lost by the mean daily wages of each state. Standard estimates of the 2002 salary from the Bureau of Labor Statistics for "correctional officers and jailers" in each state was used for the calculation. If this estimate was not available for a state, the US average salary for "correctional officers and jailers" was used.

The total cost of medical care for correctional staff was based upon the estimated cost of hospitalization and of non-hospitalized injuries. The weighted number of hospitalized injuries was multiplied by a published figure for the average cost of a hospital admission [5]. The weighted number of non-hospitalized injuries was multiplied by a figure for the average cost of a doctor or clinic visit. The figures for average medical costs of hospitalization and non-hospitalized doctor or clinic visits were based on costs of non-fatal consumer product injuries [5]. We assumed that all non-hospitalized injuries were clinic or doctors' office visits, thus making the most conservative estimation.

Validity of the sample was checked by comparing the sampled prisons and all of the prisons in one state. The comparisons indicates that the sample is very good in identify leading categories of weapon.

The Johns Hopkins University, Bloomberg School of Public Health, Committee on Human Research approved the study protocol.

## Results

Of the 101 prisons in the sample, 70 were successfully contacted and provided data that yielded a 69% response rate with ultimately 10 states participating. All of them provided data on weapons used in attacks. However,

one state (16 sampled facilities) did not provide information on confiscated weapons. The rest of the facilities from other states that participated did include information on confiscated weapons.

A total of 1326 weapons were either confiscated (1,086) or used to injure inmates (203) or staff (37) during the 12-month survey period. (Table 1) The weapons most commonly confiscated were shanks (34%), daggers (27%), and razors (22%). The weapons most commonly used to attack inmates were shanks (31%), clubs (21%) and saps (e.g. locks in socks) (17%). The weapons most commonly used to attack staff were clubs (54%), daggers (11%) and razors (11%). 'Clubs' included unmodified objects such as pitchers, hot pots, and broom handles.

The types of weapons used in an attack varied between medium- and maximum-security facilities (Table 2). Weapons used to injure in medium-security facilities were usually shanks (32%), clubs (17%) and saps (15%), while weapons used to injure in maximum-security facilities were clubs (34%), shanks (20%) and razors (15%). The three most common weapons used to injure in mixed-security prisons [shanks (29%), clubs (28%), saps (20%)] were the same as in medium level facilities.

Weapons that were confiscated or used to injure inmates were most commonly made from miscellaneous metal, razors, and locks (Table 3). Staff members were most commonly injured by weapons made from brooms or dustpans, razors, hairbrushes and miscellaneous metal.

In most cases, the source of the materials used to make these weapons was unknown (Table 4). The most common known source of materials for these confiscated weapons and weapons that were used to injure inmates was the commissary. Staff were injured most often by items from unknown sources (generally, these were items commonly found in the environment).

Thirty-seven staff members and 203 inmates were injured during the 12-month survey period. We calculated injury rates per 1000 inmates and per 1000 workers. The injury rate for inmates was 1.60/1000 *inmates* and for staff was 0.97/1000 *workers* (table 5). The injury rate among inmates was similar in

maximum- and medium-security prisons, 1.52 and 1.57/1000 inmates, respectively. The injury rate among staff was highest in mixed facilities – i.e., those with both medium- and maximum-security sections. The high rate of staff injury in this category was due to a single prison where 18 staff members were injured, 14 of them in one melee. If that prison were removed from the calculations, the staff injury rate for mixed-security prisons would be 0.47/1000 workers, similar to the rate for medium- security prisons. The great variability among facilities was further emphasized by the fact that four of the 10 participating states reported no injuries to staff from weapons used by prisoners.

Females comprised less than 5% of the inmates in the 70 facilities. Their injury rate was slightly higher than the rate among male inmates (2.0 vs. 1.6/1000 inmates). There were no injuries to staff in female facilities.

Based on the reported days lost due to these injuries, an estimated 2,531 workdays would have been lost from all facilities in these states during the 12-month survey period. The estimated cost of lost wages due to days lost was $403,901. A conservative estimate of medical costs associated with these 37 injuries to staff members is $721,408. In total, time lost and medical costs of injury to staff from weapons used by prisoners amounted to $1,125,309 in one year for ten states.

## Discussion

With this survey, we enumerated the types of weapons confiscated and used in attacks. The survey revealed that weapons that were confiscated were usually cutting or piercing instruments (83%, razors, shanks and daggers) while 38% of weapons used in attacks on inmates and 57% of weapons used in attacks on staff were blunt objects such as saps and clubs. (Figure 2). Most weapons used in attacks on staff could be classified as weapons of opportunity (e.g., broom handle, pitcher) that were not considered weapons until they were spontaneously used in an attack. A study reviewing types of weapons and patterns of use in a forensic hospital found that psychiatric patients were more

frequently attacked by other patients using weapons made from silverware while staff members were more frequently attacked by patients using pieces of furniture as weapons of opportunity [2].

One reason for the difference in types of weapons confiscated versus those used in an attack might be that weapons that were confiscated could have been made just for defense or intimidation purposes and not intended to be used in an attack. One of the greatest dangers to correctional officers, however, is breaking up inmate-on-inmate fights. The low usage of shanks and daggers in injury to staff is supported by another study in which only 2.3% of the correctional officer injuries were caused by these items [6]. In this same study, the use of weapons other than personal force was found to be positively associated with an increased chance of injury in an attack.

The annual injury rate we calculated for staff was .97/1000 staff members. The overall annual non-fatal injury rate for workers in the United States is 5.4/100 full time workers [7]. Our injury rate is lower because it reflects only those injuries that workers received as a result of an assault using a weapon. We only explored the use of weapons in assaults and did not learn about injuries from other sources such as back strains and falls or from assaults involving physical force. Therefore, this injury rate is not an overall estimate of injury. In a study of battery incidents in a maximum-security hospital, 91% of the 232 batteries did not involve a weapon other than the assailant's body [8]. Another study of assault, battery and injury of correctional officers revealed an injury rate of 16.8/100,000 work hours [6]. This figure would equate to about 8.4 injuries per 1000 workers per year and would include all injuries, including instances where only the assailant's body was used as a weapon or where bodily fluids were thrown at staff.

The cost estimate given is very conservative. Not included in the cost of staff injuries are non-monetary losses such as pain, family dislocation, and changes in the quality of life. In addition to staff injuries, the 203 injuries to prisoners from homemade weapons resulted in costs for medical care and for two staff usually required to accompany any prisoner who traveled to or from an

outside facility for medical care. It has been estimated that the minimum hospital bed cost for an inmate is three times as much as an inmate day in the prison system ($195/day vs. $61.69/day) [9].

Several facilities described some of the ways in which they are combating the problem of inmate-made weapons. In the commissary, some facilities offer only small padlocks and pouched food. Other facilities reduce the amount of personal property an inmate can possess in the facility. They also allow only transparent appliances and small toothbrushes. Some issue razors one at a time and require that they be checked back in after each use. Other ideas shared included painting fence ties a bright color so that it is easy to see when one is missing. Installing security-type screws on light fixtures and securing wall lockers to cell walls was also suggested. Sealant placed around potential weapons-material areas help staff to identify that tampering has occurred. Internal processes mentioned were quarterly searches and internal audits.

In previous studies of violence among prison populations, it was recommended that eating utensils, prison industry tools, and office devices be redesigned because of their frequent use in acts of violence [9]. As a result of this survey, the Applied Physics Laboratory at Johns Hopkins University (JHU/APL) is conducting a study of materials and mechanical design changes focused on commissary items most commonly used for weapons. Razor blades found on disposable razors typically distributed to inmates or available in the commissary are strong enough to retain their shape and cutting function when they are extracted from the plastic handles. These loose blades can then be attached to other materials forming an extended-length blade. The JHU/APL has designed a modified blade that can retain its form in the manufacturing process and during its intended use for shaving, but will break into very short pieces under the mechanical stresses that would occur when an inmate tried to disassemble the razor.

Razors and toothbrushes are low-cost commodity items typically fabricated from thermoplastic polymers that can be reformed using heat to soften or melt the polymer. When it cools, a thermoplastic returns to a solid structure

that can perform its designed mechanical function. An inmate will use heat to soften the polymer handle of a toothbrush enough to allow it to hold blades extracted from razors or other sharpened metallic objects. In other cases, the hard thermoplastic material is abraded against concrete or other rough surfaces to sharpen the end of the handle. The JHU/APL team has shown that the standard polymers can be replaced by thermosetting polymers that are semi-flexible or resilient when cured. The thermosetting materials cannot be melted and reformed. Once fabricated, they retain their shape until they are destroyed, for example by attempts to re-shape them. The flexible material cannot be sharpened by abrading it, thus limiting the inmates' uses of the material for inflicting damage. The materials must be strong enough to perform their designed function, but too weak to function as a shank or knife.

The same materials and design principles can be applied to eating utensils, kitchen tools and possibly some medical items that inmates have converted into weapons. In addition, some of the items of opportunity that have been used as weapons, such as mop or broom handles, could be redesigned to minimize their effectiveness as weapons.

*Limitations*

There are several limitations to this study. Since this survey was not random among states, these findings cannot be generalized to the rest of the country. All states were asked to participate. However, the states and facilities that participated in the survey may be very different from those that did not.

The weapons data were not originally documented by the correctional facilities for the study purpose. Across facilities, there may be different weapon confiscation policies so there may be more weapons than those actually confiscated or recorded. Facilities may also have different procedures once weapons are confiscated. If there is burdensome paperwork, correctional officers may have incentive not to document each weapon confiscated.

*Recommendations*

The following recommendations were developed based on these survey results. A centralized reporting system of confiscated weapons and weapon-

related injuries in prisons should be established to identify the most serious threats. In 1988, the National Academy of Sciences was asked to assess violence in the United States. The academy considered prisons “special places” and spent time reviewing prison violence. One recommendation called for establishment of an injury surveillance system in prisons [10]. This recommended system was intended to collect information on violent events and help direct risk factor research on violence. Such research could lead to violence prevention interventions. A surveillance system could also include information on confiscated weapons. This type of system would help facilities across the country by collecting much-needed data on weapons, sources of material and injury trends that would facilitate risk-factor interventions. If centralized reporting is not possible, we recommend that facilities conduct similar surveillance as this study to identify emerging problems within their facilities.

In 1999, a survey was conducted to determine inmate injury monitoring across all facilities in the US. Of those that responded, 32 (89%) did conduct some form of inmate injury monitoring [11]. However, no centralized location existed for these surveillance systems. In the mid-1990s, Michigan developed a pilot surveillance system to collect information on injuries experienced by inmates. However, this system included little information on the weapon used in an injury or any information on confiscated weapons [12]. The authors could not find any information on centralized surveillance systems for weapons confiscated in correctional facilities.

Facilities should seek measures to further reduce not only injuries to staff but also the risk of inmate-on-inmate violence. The U.S. incarcerates more than 2 million people and that number is increasing; state and federal governments must provide the funding to ensure that both inmates and correctional staff are secure [13]. Anecdotal evidence suggests that many of the weapons are for defensive purposes, often against the threat of sexual assault. Policies altering interaction among inmates and the response of staff members to fights as well as environmental measures such as eliminating blind spots and private showers may reduce injury rates [8, 14]. Although not the focus of this study, inmates’

lack of control over their environment in prison as well as the cost of their injuries makes it incumbent upon the states to ensure their safety.

Inmates are resourceful and probably will always be able to come up with new weapons. Prisons and other places of incarceration, however, are controlled environments and therefore have great potential to reduce the number of weapons in these facilities. {Sentence on APL study} Facilities, equipment, fixtures, and procedures should be continually upgraded to eliminate sources of weapons. Programs like the Vulnerability Assessment Process, where the effectiveness of the overall security system is analyzed [15], could include the identification of source material for weapons and potential hiding places for contraband. Facilities should also share solutions for reducing the materials that can be made into weapons.

Our communications with prison facility personnel had one message in common: they are always on the lookout for homemade weapons and for materials that can be made into weapons. Our results provide guidance for identifying materials and/or objects that should be redesigned so they cannot be modified to inflict injury. In particular, objects such as razors and padlocks that are issued to inmates or purchased from the commissary deserve special attention because prisons have some control over the design and choice of such items. Further research such as that being conducted at the Applied Physics Laboratory should prove useful in eliminating materials that can be modified into weapons.

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**Figure 1: Hairbrush modified into a stabbing device**

**Figure 2: Percent Distribution of Weapons Confiscated or Used in Attack on Prisoners and Staff**

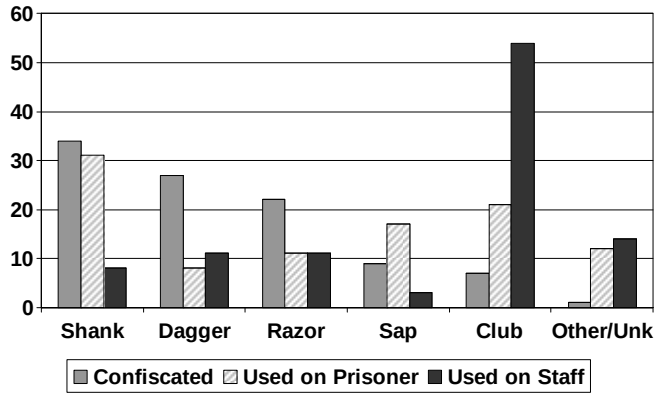

*Table 1: Weapons Confiscated and Used to Injure*

| Weapons | Confiscated | | Injured Inmates | | Injured Staff | |
|---|---|---|---|---|---|---|
| **Description** | **N** | **%** | **N** | **%** | **N** | **%** |
| **Shank** | 364 | 34 | 62 | 31 | 3 | 8 |
| **Dagger** | 292 | 27 | 16 | 8 | 4 | 11 |
| **Razor** | 242 | 22 | 23 | 11 | 4 | 11 |
| **Sap** | 99 | 9 | 34 | 17 | 1 | 3 |
| **Club** | 73 | 7 | 43 | 21 | 20 | 54 |
| **Hot substance** | 3 | 0 | 13 | 6 | 1 | 3 |
| **Other** | 13 | 1 | 2 | 1 | 3 | 8 |
| **Unknown** | 0 | 0 | 10 | 5 | 1 | 3 |
| **Total** | 1086 | 100 | 203 | 100 | 37 | 100 |

**Table 2: Weapons Used to Injure by Security Levels**

| Weapons Used to Injure | Security Levels | | | | | |
|---|---|---|---|---|---|---|
| | Medium | | Maximum | | Mixed | |
| | N | % | N | % | N | % |
| **Shank** | 26 | 32% | 16 | 20% | 23 | 29% |
| **Club** | 14 | 17% | 27 | 34% | 22 | 28% |
| **Sap** | 12 | 15% | 7 | 9% | 16 | 20% |
| **Dagger** | 9 | 11% | 8 | 10% | 3 | 4% |
| **Razor** | 7 | 9% | 12 | 15% | 8 | 10% |
| **Heat** | 6 | 7% | 2 | 3% | 6 | 8% |
| **Other** | 8 | 10% | 7 | 9% | 1 | 1% |
| **Total** | 82 | 100% | 79 | 100% | 79 | 100% |

Table 3: Materials from Which Weapons were Made

| Weapons | Confiscated | | | Injured inmates | | | Injured Staff | | |
|---|---|---|---|---|---|---|---|---|---|
| Description | | N | % | | N | % | | N | % |
| | Misc. metal | 420 | 39 | Misc. metal | 35 | 17 | Broom or dustpan | 15 | 41 |
| Materials | Razor | 242 | 22 | Lock | 33 | 16 | Razor | 4 | 11 |
| Weapons | Lock | 84 | 8 | Razor | 23 | 11 | Misc. metal | 3 | 8 |
| Made From | Misc. wood | 56 | 5 | Hot liquid | 13 | 6 | Brush | 3 | 8 |
| | Misc. wire/rack | 45 | 4 | Hot pot | 7 | 3 | Pen, pencil | 2 | 5 |
| | Misc. plastic | 29 | 3 | Broom handle | 6 | 3 | | | |
| | Other | 181 | 17 | Other | 55 | 27 | Other | 7 | 19 |
| | Unknown | 29 | 3 | Unknown | 31 | 15 | Unknown | 3 | 8 |
| | Total | 1086 | 100 | Total | 203 | 100 | Total | 37 | 100 |

**Table 4: Weapons Confiscated and Used to Injure: Source of Materials**

| Weapons Description | Confiscated | | | Injured inmates | | | Injured Staff | | |
|---|---|---|---|---|---|---|---|---|---|
| | Source | N | % | Source | N | % | Source | N | % |
| Source of Materials | Commissary | 277 | 26 | Commissary | 60 | 30 | Issued | 4 | 11 |
| | Kitchen | 108 | 10 | Issued | 15 | 7 | Staff supplies | 4 | 11 |
| | Housing area/cell | 43 | 4 | Offender | 6 | 3 | Commissary | 2 | 5 |
| | Maintenance | 35 | 3 | Maintenance | 6 | 3 | Maintenance | 1 | 3 |
| | | | | Housing | | | Housing | | |
| | Office | 21 | 2 | area/cell | 5 | 2 | area/cell | 1 | 3 |
| | Issued | 19 | 2 | Dining Hall | 5 | 2 | Storeroom | 1 | 3 |
| | | | | | | | Cleaning | | |
| | Offender | 19 | 2 | Fence | 4 | 2 | supplies | 1 | 3 |
| | | | | Yard | 4 | 2 | Offender | 1 | 3 |
| | Other | 141 | 13 | Other | 19 | 9 | | | |
| | Unk. Source | 423 | 39 | Unk. Source | 79 | 39 | Unk. Source | 22 | 59 |
| | Total | 1086 | 100 | Total | 203 | 100 | Total | 37 | 100 |

**Table 5: Injury rates per prison populations and worker population with 95% confidence intervals**

| Security Level | Total inmate population | Injuries to Inmates | | | | Injuries to Staff | | |
|---|---|---|---|---|---|---|---|---|
| | | # | Rates per 1,000 inmates | | | # | Rates per 1,000 inmates | |
| **Medium Security** | 47,894 | 75 | 1.57 | (1.21, 1.92) | | 7 | 0.15 | (0.04, 0.25) |
| **Maximum Security** | 47,379 | 72 | 1.52 | (1.17, 1.87) | | 7 | 0.15 | (0.04, 0.26) |
| **Mixed Security** | 31,355 | 56 | 1.79 | (1.32, 2.25) | | 23 | 0.73 | (0.43, 1.03) |
| **Total** | 126,628 | 203 | 1.60 | (1.38, 1.82) | | 37 | 0.29 | (0.20, 0.39) |
| | | | | | | | | |
| | **Total staff population** | # | Rates per 1,000 staff | | | # | Rates per 1,000 staff | |
| **Medium Security** | 13,986 | 75 | 5.36 | (4.15, 6.58) | | 7 | 0.50 | (0.13, 0.87) |
| **Maximum Security** | 12,690 | 72 | 5.67 | (4.36, 6.98) | | 7 | 0.55 | (0.14, 0.96) |
| **Mixed Security** | 11,511 | 56 | 4.86 | (3.59, 6.14) | | 23 | 2.00 | (1.18, 2.81) |
| **Total** | 38,187 | 203 | 5.32 | (4.58, 6.05) | | 37 | 0.97 | (0.66, 1.28) |

# Appendix 4 – Current Results on Non-metals Detection Study

**May 2005**

**J. C. Roberts, Ph.D. and P. J. Biermann**

## Background

A comprehensive search was made of the major companies that manufacture security devices and the results are given in the Bibliography. These devices fall into the category of walk through, hand held, passive millimeter wave, active holographic imaging systems and Radio Frequency Identification (RFID) systems. Walk through devices are used in, for example: airports, prisons, banks, office buildings, nuclear facilities, schools, hotels, amusement parks and courthouses. A number of the walk through devices target the ability to monitor high traffic areas with good accuracy to detect small devices. According to manufacturer's claims some can detect magnetic as well as non-magnetic items. Most personal items such as coins, keys, belt buckle, and etc. can pass through a magnetic field undetected (which may be good or bad). Most manufacturers claim that their detection systems can provide uniform detection throughout the entire detector (top to bottom and side to side), some come in waterproof versions and some can be disassembled and moved easily (portable). Other manufacturers target ferrous and non-ferrous items such as disposable prison razors, a piece of a razor blade, metal shanks and handcuff keys. However, none could be found that will detect non-metallic devices such as hard plastic knives.

Hand held detectors are less expensive and can scan closer to the body over the whole body and can pick up a hat pin at a distance of 1 inch from the body. Some have variable sensitivity that allows the scanner to conduct a super high sensitivity search sweep of the body or to scan the feet with less sensitivity to the background metal floor. One hand held device (Mediascan) used for detecting items in body cavities are advertised as being non-intrusive, reliable and inexpensive. It can detect razors blades, knives, hacksaw blades, shanks, nails, drill bits, tools, bullets, etc. The sensors are housed in a frame or a chair and an oral or nasal scanner is mounted on the side of the chair frame. They claim to allow detection of ferrous and non-ferrous metals. One of the weapons that are of

major concern is a knife called the "Busse Stealth Hawk" that is invisible to metal detectors. It is made of a non-metallic laminate known as MP45 and it is 4 ½ inches long. The blade is strong enough to go through steel drums, car windows and door planks without damage to the knife and can be purchased on the web. Metal detectors respond to anything metallic, such as keys, change, belt buckles and metal implant. But it doesn't detect low-metal and non-metal weapons, including plastic explosives.

There are millimeter-wave systems under development which are capable of more accurate imaging of the non-metal items. The FAA is considering two approaches to weapons detection using millimeter wave systems. One system uses active millimeter waves and the other passive millimeter waves. The technology is based on the fact that every object generates electromagnetic emissions at millimeter wavelength with intensity proportional to the object's physical temperature. Millivision, a developer of security products (Northhampton, MA) is developing a system based on passive millimeter waves. It's passive because the wave-imaging camera emits no signal. The technology measures naturally occurring electromagnetic waves produced by the object being viewed. The human body is highly emissive, which presents a 'warm' background on a monitor. Metal objects have near zero emissivity and appear cold against the body. Plastics and ceramics have emissivities higher than metals, but lower than human flesh, so they also have contrast against the body. For reference point they use a black body, which represents zero reflectivity. Table I shows the reflectivity of a number of objects.

Table I Reflectivity of different materials

| Object | Reflectivity% |
|---|---|
| Human skin | 5 |
| Plastics | 30-70, depending upon type |
| Paper | 30-70, depending on moisture content |
| Ceramics | 30-70 |
| Water | 50 |
| Metal gun | 100 |

There is a drawback to this technology and that is cost. Although at the present time it is not cost effective, the technology should be considered for the future. In contrast to the passive millimeter waves, the millimeter wave holographic radar developed by Pacific Northwest National Laboratory (PNNL) uses active millimeter waves for detecting metals, plastic, and other objects. It essentially bounces waves of the object being scanned, then reads and images the reflected waves. Millimeter wave technology could be used to: detect underground mines or metal objects, provide remote searches by law enforcement, image through walls is hostage and terrorist situations, provide video surveillance, provide use in courtrooms and government buildings and act as a vision system for pilots to see through fog, snow, etc. Table II gives a comparison between millimeter wave technology and standard metal detectors.

Table II Comparison between standard metal detectors and millimeter wave technology

| Metal Detection Method | | |
|---|---|---|
| | Metal Detectors | Millimeter Wave Technology |
| Principal of operation | x | x |
| Screens people | | x |
| Detects plastic Weapons | | x |
| Detects explosives | | x |
| Detects narcotics | | x |
| Detects metal weapons | x | x |
| Multiple configurations (e.g. hand, wand, etc.) | x | x |
| Posses no known health threats | x | x |
| FAA endorsed | x | |

Another technology, Radio Frequency Identification (RFID) system, is a type of automatic identification system. The purpose of the RFID system is to enable data to be transmitted by a portable device, called a tag, which is read by an RFID reader and processed according to the needs of a particular application. The data transmitted by the

tag may provide identification or location information. These tags come in a variety of shapes and sizes. Some tags are easy to spot, such as the hard plastic anti-theft tags attached to merchandise in stores. Animal tracing tags which are implanted beneath the skin of family pets or endangered species are no bigger than a small section of pencil lead. Even smaller tags have been developed to be embedded within the fibers of national currency. With this in mind, milli- to micro-size tags could be developed that are placed in plastic knives, forks, etc. so if they were to be whittled into weapons could be detected. Along with regular scanning of the prisoners a thorough scanning of prisons cells would have to be done on a regular basis.

Terahertz waves are generated when electric current is made to oscillate backwards and forwards at frequencies of 0.1 to 10 THz. This means that the electrons that make up the current are changing direction 10,000,000,000,000 times every second! At the 10 THz end of the terahertz spectrum the waves are also referred to as the 'far infrared' and behave more or less like optical waves. At the low frequency end of the terahertz spectrum the waves are know as 'millimeter waves' and behave more or less like radio waves. The terahertz region is the region of the electromagnetic spectrum where radio waves and optical waves merge. Consequently the techniques used for their generation and detection rely on a mixture of optical and radio wave techniques. Such systems might use aerials, lenses, mirrors and circuits. Because of this the technology is often referred to as 'quasi optics'.

At 0.1 THz the waves can be detected using a radio which operates in much the same way as a car radio. The only difference is that the aerial or antenna is only a millimeter long. The whole radio can fit into an area of only 2 $mm^2$. Because of this the technology relies on extremely precise components which until recently have been incredibly expensive (it is not unusual for a single terahertz component to cost more than 75,000 Euros). Due to the expense, terahertz systems have only really been used in areas of technology where cost is not an issue such as Space Science and Astronomy. Recently, however, the cost of manufacture has been dramatically reduced such that newer everyday uses may be envisaged. This has been possible by borrowing some of the technologies that have been developed by the silicon chip industry.

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**Appendix 5 – ACA Article**

Published: Corrections Today, Feb. 2006, pp 68-70

# Improving Correctional Officer Safety: Reducing Inmate Weapons.

## Problem Definition

While the threat faced by the police officer is most frequently from firearms, a corrections officer faces an entirely different variety of threats. It is rare for an inmate to have a firearm within a correctional facility. The most common threat faced by correction facility staff is from pointed- and sharp-edged weapons. Most of these are homemade or improvised weapons, obtained through a variety of sources in the corrections environment. These source items include toothbrushes, locks, safety razors and broken glass. For example, a common misuse of toothbrushes is to sharpen them for stabbing and to reshape them to hold sharp metal blades.

## The Corrections Threat

While the FBI's Uniform Crime Reports Law Enforcement Officers Killed and Assaulted (LEOKA) report provides detailed insight into the nature and types of assaults on police officers, there are no comparable details currently maintained for assaults on corrections officers. In 1988, 23 corrections officers were attacked with weapons while 123 were attacked without weapons. In 1990, the last year that data was collected by the Department of Justice, there were 185 assaults on federal corrections officers. Between 1990 and 1995 there was a 33% increase in the number of assaults by inmates on corrections facility staff. In 1990, there were 10,731 reported assaults by inmates on corrections facility staff; in 1995, there were 14,165 reported assaults. The nature of the assaults has become more severe as well. In 1990, none of the reported assaults resulted in the death of the staff member who was assaulted. By comparison, in 1995, 14 staff members were killed as a result of the assault.[3]

More than twice as frequent are the number of prisoner assaults on other prisoners. Approximately 3% of prisoners are assaulted and injured by other prisoners

[3] ***Prison and Jail Inmates at Midyear 2001.*** US DOJ, Office of Justice Programs, Bureau of Justice Statistics, http://www.ojp.usdoj.gov/bjs/pub/ascii/pjim01.txt

each year in federal prisons. The probability of similar assaults is almost four times higher in state prisons. A reduction of weapon availability or effectiveness is expected to also reduce the number and severity injuries from prisoner assaults on other prisoners.

**Identification and Evaluation of Unconventional Weapons**

To address the data collection and analysis JHU has assembled a working group consisting of 14 members to analyze data in a scientific manner on unconventional weapons, their frequency and cost to the corrections system. The group is made up of 8 members that are practitioners from the correctional community, and 6 members from JHU staff.

| | |
|---|---|
| Alex Fox | Mass. Department of Corrections |
| Robert Greene | Montgomery Co. MD Dept. of Corrections & Rehabilitation |
| Jack Harne | NLECTC |
| John Kenney | Hamden Co. MA, House of Corrections |
| Mike Maloney | Mass. Department of Corrections |
| Al Turner | National Institute of Justice |
| John Ely | Federal Bureau of Prisons |
| Reggie Wilkinson | Ohio Dept. of Rehabilitation & Corrections |
| | |
| Suzanne Baker | JHU/Center for Injury Research & Policy |
| Lily Chen | |
| Jennifer Lincoln | |
| Julie Mair | |
| | |
| Paul Biermann | JHU/APL |
| Emily Ward | |

The survey of correctional agencies was conducted by the Johns Hopkins Center for Injury Research and Policy (CIRP) with input from the working group.

Participating states and the number of institutions contacted in each state:

| | |
|---|---|
| Arizona | 5 facilities |
| Indiana | 3 facilities |
| Louisiana | 4 facilities |
| Michigan | 9 facilities |

| | |
|---|---|
| Missouri | 6 facilities |
| New Jersey | 11 facilities |
| Ohio | 6 facilities |
| Pennsylvania | 8 facilities |
| Texas | 16 facilities |
| Utah | 1 facility |

The survey was designed to elicit information about the sequence of events, the nature of the improvised weapon (size, shape, what it was made from and how, etc.) if known, and the consequences (threat vs. physical injury, severity of injury, number of persons injured).

Analysis of the survey results produced a prioritized list of targets for engineering solutions to improvised weapons.

**Prioritized List**:
1. Razors
1. Hard Plastic Stock (Polymer cannot be detected)
2. Personal Locks
3. Toothbrushes
4. Mop/Broom Handles
5. Fencing Material

**Prototype Design and Fabrication**

Based on the prioritized list JHU/APL staff developed proposed solution designs for each of the items on the list. A separate study was started of the hard plastic stock detection problem.

Prototype handles for razors and toothbrushes have been fabricated incorporating both materials and design changes that will not allow them to be melted or reformed with heat. They also cannot be sharpened by abrasion. In the first models the area near the head is a firmer polymer that supports the mechanical loads normally exerted during the brushing action. Only the bristle area is fabricated from traditional materials, although it could be modified if required. See Figure 1.

The same approach was used for the modified razor handle and could also be used on comb and brush handles, eating utensils and any other common items currently molded from thermoplastic polymers. See Figure 2.

Figure 1. Thermosetting polymer toothbrush prototype with soft handle.

Figure 2. Modified razor handle using non-reformable materials.

Figure 3 shows the remodeled prototypes for the tooth brush and razor handles. The shapes were modified to allow the use of a cardboard rod stiffener also shown in the image. Figure 4 shows the two types of razor handle models. The shorter and thicker tapered handle can be fabricated without the use of an internal stiffener. Figure 5 shows the modified razor blade. The slots are cut to within a short distance of the cutting edge using electron discharge machining or EDM. When the blades are bonded into the

holder shown in Figure 2, the slots create weak spots that will break if an attempt is made to remove the blade from the holder. Figure 6 shows a prototype mop/broom handle that has been fabricated that will not deliver large side impact forces if used to strike a target. The handle has a stiff foam core and is covered with a softer flexible foam outer shell to reduce damage when struck against a person. In this example a lightweight broom head has also been fabricated using the stiff foam material with some internal stiffening rods. Figure 7 shows the flexibility of the handle that will bend first and then break before inflicting severe damage.

Figure 3: Modified models for toothbrush and razor handles shown with cardboard rod stiffener.

Figure 4: Two designs for razor handles shown with the hard plastic inserts used to attach the blade holder.

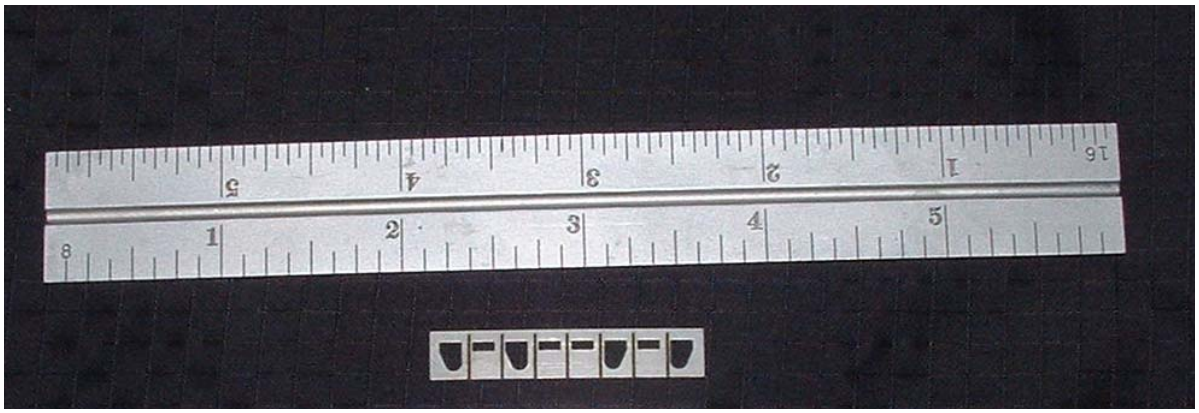

Figure 5: Slotted blades designed to break up when removed from the razor.

Figure 6: Lightweight broom handle and head designed to reduce damage if used to strike someone.

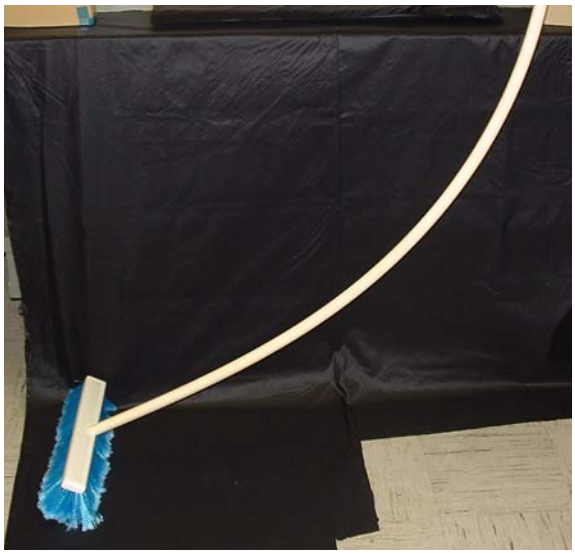

Figure 7: Lightweight broom handle can deflect before breaking.

## Technology Transfer to the Corrections Community

JHU/APL has initiated contacts with UNICOR, part of the Federal Bureau of Prisons. They have a very large manufacturing operation covering numerous technologies including plastics manufacturing. We are also looking at state prison manufacturing facilities and commercial companies that supply the corrections world.