

Scratching the Surface:

Practical Exercises in Toolmark Identification

By Chris Bily

I was hired in 2010 by the West Virginia University Forensic Science Initiative as a curriculum developer to design, amongst other things, a forensic firearm and toolmark curriculum. The curriculum was expected to reach a diverse audience including college students and crime laboratory trainees. A project of this nature had not been previously undertaken in the academic community making this uncharted territory.

In an effort to build a solid foundation for this curriculum, I contacted numerous local, state, and federal crime laboratories across the country for guidance, and one reached back: the Allegheny County Medical Examiner's Office in Pittsburgh. After several phone conversations with Dr. Robert Levine, head of the firearm and toolmark section, I made a trip there to further discuss the particular aspects of the curriculum and how to approach its development.

During my visit, Raymond Everette, one of the firearm and toolmark examiners, took an interest in what I was doing and began sharing some of the materials that he received as a trainee. He also told me about an exercise that he had to complete that involved toolmarks on 35mm film. As he described it and how it was made, the proverbial light began going off in my head. Upon my return to WVU and a trip to Lowes and Walmart, I assembled the items necessary to make a prototype of this exercise. After creating it, I beta tested it on a group of undergraduate students with encouraging

results. As I created and implemented these exercises it occurred to me that this would be appropriate for a high school forensic science class.

Teaching Toolmark Identification in the High School Classroom

Toolmark identification is a fascinating forensic science discipline and one that is equally as fascinating to teach to high school students. The hands-on nature of toolmark identification is particularly appealing to both teachers and students alike. Teachers like it because the materials to make laboratory exercises are readily available, students are enthused about performing the exercises, and the crime scene scenarios are only as limited as the teacher's imagination. Students like it because they get the opportunity to handle, manipulate, and evaluate objects that are part of their everyday lives. The fact that these objects mirror items of physical evidence that are submitted to crime laboratories in criminal cases engages students in a very meaningful way.

The limitation of these exercises, in a classroom setting, is that they almost always involve class characteristics. While class characteristic examinations are certainly a worthwhile endeavor, the true value of toolmark evidence is the ability of a questioned mark from a crime scene or an item of evidence to be identified to a particular tool. In order to accomplish this task a specialized instrument called a comparison microscope

is required (Figure 1). In a crime laboratory this is a standard piece of equipment. In the classroom this is anything but standard. A basic comparison microscope costs anywhere from \$40,000-\$50,000 and this is without upgraded features that would be desirable for teaching purposes. Older used models can be found from time to time on the internet, but these are still cost prohibitive for the typical high school teacher. Even if the purchase of a comparison microscope was financially feasible, its value in a typical classroom of 25 to 35 students would be limited.

The absence of a comparison microscope does not however preclude the possibility of providing students with the opportunity to compare toolmark evidence. There is a simple, cost effective method of developing comparison exercises. Stereoscopic microscopes and inexpensive items found at a local hardware store and Walmart are all that is needed. The following describes the materials and methods required to prepare these exercises. The following materials are needed to



Figure 1

Materials

Lint Free Soft Cloth (not pictured). Inevitably as students handle the film sections they will deposit sweat, oil, and other residue from their fingers onto the film which should be wiped off after each use. A soft cloth will remove these deposits without damaging the striated marks on the film.

Plastic Bags. Used to contain each exercise.

Paper Cutter. Used to cut the film into sections.

Razor Knife. This can be used in conjunction with a straight edge ruler in lieu of a paper cutter.

Ruler. Used to measure out equal lengths of film. This can also be used in conjunction with a razor blade to cut film.

Film. This is the substrate that will accept the toolmarks from the sandpaper.

Sandpaper. This is the tool that will be used to create tool marks on the film.

Hand Held Sanding Block. This item is not an absolute requirement, but it's easier to manipulate the sandpaper with it than without it.

Stereoscopic Microscope. This is the preferred magnification tool to be used when performing these comparison exercises. Using a stereoscopic microscope allows the student to keep their hands free which makes manipulating the film a much less cumbersome task.



Figure 2

Fingerprint Magnifier. This can be used instead of a stereoscopic microscope. A fingerprint magnifier is a hands free, low power, magnifying device used to examine and compare latent and inked fingerprints. They can be purchased from any forensic science equipment vendor (i.e. Evident, Lynn Peavey, Sirchie, etc.) There is no alternative to the fingerprint magnifier other than the stereoscope which is already mentioned in the article. They range in price from \$10 from <https://www.shopevident.com/category/magnifiers/5x-folding-magnifier> to upwards of \$200 from other sources. Alternatively, handheld magnifying glasses are available new from a variety of vendors for \$9 - \$14. But check around in your department; chances are good another faculty member has some of either sitting in storage.

Small Handheld Flashlight. Used with the fingerprint magnifier to highlight the striated marks on the film.

Method

Step 1. Give each film canister a letter or number designation. This will help to keep track of the film when it comes time to make the exercises (Figure 3).



Figure 3

Step 2. Pull the entire length of film from the roll until it separates from the plastic reel. The reel can then be discarded (Figure 4).



Figure 4

Step 3. Place the sandpaper in the holder and place it on top of the film (Figure 5).



Figure 5



Figure 6

Step 4. Put substantial pressure on the block with one hand, grasp the tag end of the film, and firmly pull it across the block until the opposite end of the film is reached. Roll the film up and return it to the canister (Figure 6)



Figure 7

Step 5. Open a new roll of film and repeat steps 2,3, and 4. It is important that each time a new roll of film is used the orientation of the sandpaper block is changed each time. This will insure that the toolmarks are not repeated (Figure 7).

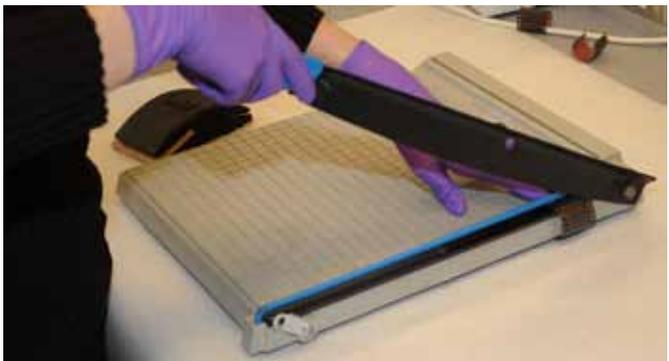


Figure 8

Step 6. Using a paper cutter (Figure 8) or a ruler and a razor knife (Figure 9), the film can be cut into sections. It is recommended that the film be cut into 2 inch to 3 inch sections. These sizes are easy for student to manipulate under a stereoscopic microscope or fingerprint magnifier. When making the cuts be sure that the edge is straight, neat, and clean. This pushes students to make identifications and eliminations based on the striated toolmarks rather than physically matching the ends of the film together. It's advisable that this be practiced on spare film before making the actual exercises.



Figure 9

Step 7. Once the desired number of pieces of film have been cut for a particular exercise, they should be labeled (Figure 10) and placed in a bag (Figure 11).

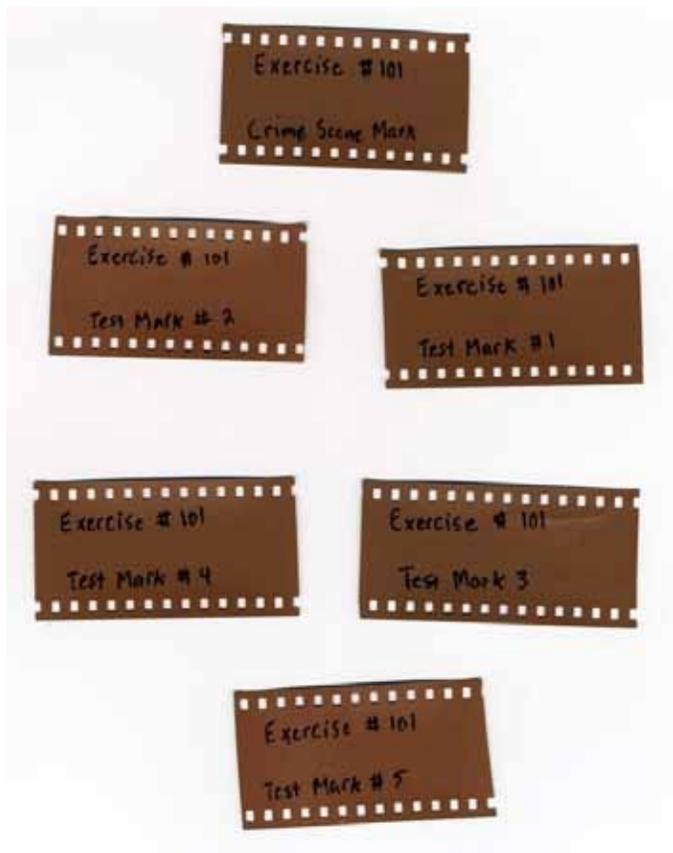


Figure 10



Figure 11

The Comparison Process

Stereoscopic Microscope. The film is laid down edge to edge on the stage and observed through the eyepieces (Figure 12). This is the easier of the two methods.

Fingerprint Magnifier. The film is laid down edge to edge and the base of the fingerprint magnifier is placed on top. The flashlight is held at an oblique angle to highlight the striated toolmarks (Figure 13).



Figure 12



Figure 13

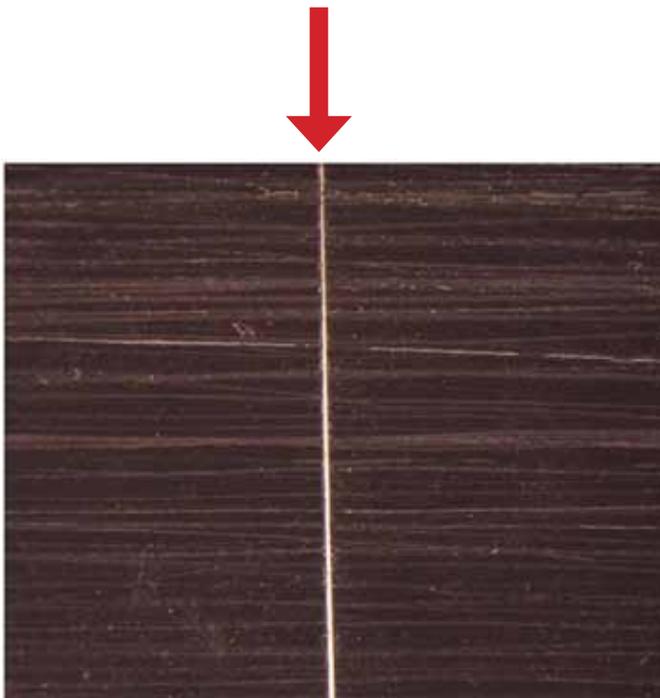


Figure 14

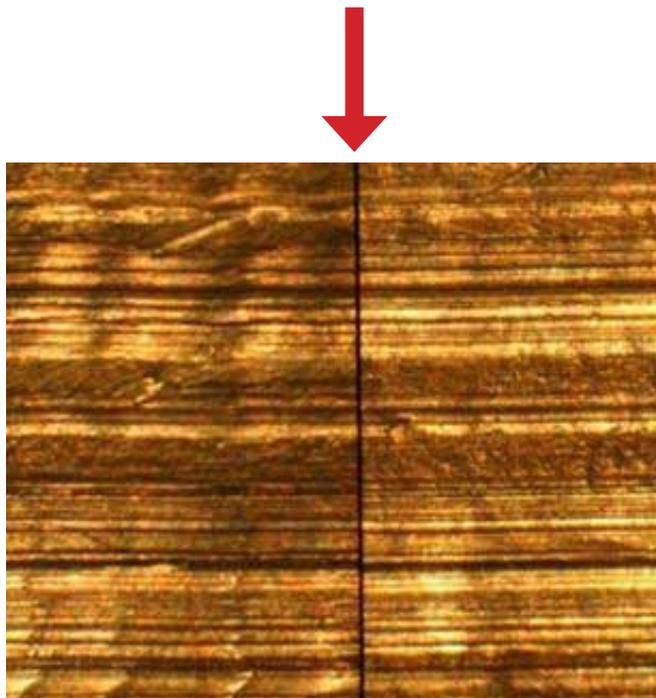


Figure 15

This image (Figure 14) is an example of an identification from the film exercises. The red arrow points to the white space separating the two pieces of film. This would be the equivalent to the hairline that is seen when looking through the eye pieces of a comparison microscope. The image in Figure 15 is an example of an actual toolmark identification. The red arrow points to a black line which is the hairline seen through a comparison microscope. This hair line is used to differentiate the image from the left stage and the image from the right stage.

Tips for Preparing Exercises.

There are several points that should be taken into consideration when making these exercises:

- When making film sections that are going to be identified to each other it is recommended that they be made consecutively. This assures that there is complete agreement of the striated toolmarks on the film.
- The first set of exercises should all have identifications. It is important to build students confidence and ability to make identifications. Later exercises should have known impressions all of which can be eliminated.
- The level of difficulty can be adjusted by using different grits of sandpaper. The higher the grit number the finer the striated marks that will be made.
- Pulling the film across sandpaper twice will create more striated toolmarks which will make the comparisons more difficult.
- If you find film, buy as much as you can! In the age of digital photography this is a rapidly disappearing commodity.

Difficulties Encountered in Making Exercises

A number of obstacles were encountered in the production of these exercises. First, the film has a significant amount of memory. When it is first pulled off the roll it has a tendency to want to coil up on itself. This makes manipulating it difficult and at times frustrating. A colleague of mine suggested pulling the film all the way to the end of the roll, hanging a weight from the end of the film, and allowing it to hang overnight. While I have not tried this, it merits consideration. Another colleague had a suggestion: "After you pull the film out of the canister it wants to roll up again. Try rolling it up the other way, against the curl, securing it with a rubber band around the spooled up film, and letting it rest for 24 hours. This works beautifully with posters that come out of a tube." I have not tried this either, but will the next time I making film sections. Second, making

these exercises requires a significant time commitment. Scoring the film, measuring it, cutting it, and labeling it is very time consuming and tedious. If memory serves me correctly, it took me an entire 8 hour work day to make a set of 20 exercises. Third, cutting the film perfectly straight takes a bit of practice.

Implementation

This exercise can be used any time toolmark identification is taught. I suggest saving this exercise for the last part of a toolmark curriculum. When a toolmark examination is conducted in a crime laboratory it always begins with the evaluation of class characteristics and concludes with a comparison of individual characteristics. Since this is the sequence of steps in an evidence examination, the curriculum should reflect the same logical progression.

Student Reactions

In the time since I first created these exercises I have used them with students from all walks of life including high school students, college students, and forensic practitioners. Regardless of the audience, these exercises have been very well received. Any student that enjoys the puzzle solving aspect of impression evidence will enjoy performing these exercises.

Closing Remarks

These exercises are worth the time, effort, and expense to prepare them. It's a one time commitment and once they have been made they can be used year in and year out. They do an admirable job of providing students with the opportunity to compare individual characteristics of toolmark evidence when a comparison microscope isn't available.

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