

**This document sets forth background materials on the scientific research supporting examinations as conducted by the forensic laboratories at the Department of Justice. It also includes a discussion of significant policy matters. This document is provided to assist a public review and comment process of the related Proposed Uniform Language for Testimony and Reports (posted separately). It is not intended to, does not, and may not be relied upon to create any rights, substantive or procedural, enforceable by law by any party in any matter, civil or criminal, nor does it place any limitation on otherwise lawful investigative and litigative prerogatives of the Department.**

**SUPPORTING DOCUMENTATION FOR DEPARTMENT OF JUSTICE  
PROPOSED UNIFORM LANGUAGE FOR TESTIMONY AND REPORTS  
FOR THE FORENSIC FOOTWEAR AND TIRE IMPRESSION DISCIPLINE**

**Background**

The origin of the principles used in the forensic analysis of footwear and tire impression evidence dates back to when man began hunting animals. At that time, hunters realized that different animals made different tracks and they used this information to identify the type of animal. Using this same premise, investigators began associating patterns observed in impressions at the crime scene with features on the suspects' footwear and tires. The earliest known legal case proceedings where track evidence was used to solve crime dates back to 1786.<sup>1</sup>

Limited information is available on footwear and tire impression evidence prior to the early 1930s but the information available indicates that this type of evidence was collected and analyzed both in the United States and abroad. Much of the early information concerning footwear and tire impression evidence comes from state and local cases.

The FBI Laboratory began analyzing footwear and tire impression evidence in the early 1930s. Most of the analysis by the FBI at this time involved conducting database/file searches to determine the make and model of a shoe or tire that could have made a specific crime scene impression.<sup>2</sup> By the mid-1930s, there were over 200 outsoles in the FBI's shoe print file along with 1800 patterns in the tire tread file. From the 1930s to the 1960s, the analysis of footwear and tire impression evidence was expanded beyond the outsole design or tread pattern to include physical size and spacing (footwear), tread dimensions (tires), wear, and randomly acquired characteristics.<sup>3</sup>

---

<sup>1</sup> Chambers' Edinburgh Journal. No. 6, Saturday, March 10, 1832. According to records, this crime occurred in September, 1786. A suspect was indicted and was advised his shoes and the results of a footwear comparison conducted by the investigator in the case would be used against him at trial. The investigator used a piece of paper to make a life-size cut-out from one of the crime scene impressions. His cut-out made note of "nicks" in the heel area. The cut-out was used to compare against the shoes of a number of other individuals, including the suspect. The investigator identified the suspect's shoe as the source of the impression. This case is generally regarded as the first forensic footwear comparison case.

<sup>2</sup> Footprints and Tire Tread Suggested Procedure in Obtaining Specimen Reproductions for Laboratory Examinations. *FBI Law Enforcement Bulletin*. Vol. 10, No. 8, August 1941, pp. 21-30.

<sup>3</sup> Footprint Examinations and the FBI Rubber Footwear File. *FBI Law Enforcement Bulletin*. Vol. 14, No. 3, March 1945, pp. 7-9.

Today, footwear and tire impression evidence is routinely collected and examined by law enforcement agencies worldwide. In the U.S., examinations of this type of evidence are normally conducted as a sub-discipline within other sections of the forensic laboratory, including trace evidence, fingerprints, questioned documents, and firearms.

## Theory of Footwear and Tire Impression Examinations

Footwear outsoles and tire treads are produced using molds.<sup>4</sup> Each mold is used to mass produce outsoles/treads of the same design and the same size. Although outsoles/treads that are manufactured from the same mold look the same, their features change as they come into contact with a variety of bearing surfaces.<sup>5</sup> Due to this contact, frictional and abrasive forces begin to create wear on the outsole/tread surface. As this wear continues, the outsole/tread surface becomes susceptible to damage. This damage includes nicks, cuts, scratches, and gouges. Stones, rocks, nails, and other items can also become wedged within grooves that are part of many outsole/tread designs. In addition, gum, tape, and other materials can adhere to the outsole/tread surface as well. The damage and/or items that can be found on outsoles/treads are referred to as randomly acquired characteristics (RACs)<sup>6</sup> as they occur by happenstance.

As a shoe or tire comes into contact with a bearing surface, this results in a two-dimensional (2D) or three-dimensional (3D) impression being left on the bearing surface. In a 2D impression, the dust, dirt, grease, blood or other residue previously acquired by an outsole is deposited on a bearing surface in the form of a footwear or tire impression.<sup>7</sup> In a 3D impression,

---

<sup>4</sup> Bodziak, W. *Footwear Impression Evidence: Detection, Recovery, and Examination 2nd Edition*. CRC Press: Boca Raton, FL, 2000, pp. 197-278; Bodziak, W. *Tire Tread and Tire Track Evidence: Recovery and Forensic Examination*. CRC Press: Boca Raton, FL, 2008, pp. 119-137; Cassidy, M.J. *Footwear Identification*. Canadian Government Publishing Centre: Ottawa, Canada, 1980, pp. 67-89; McDonald, P. *Tire Imprint Evidence*. Elsevier Science Publishing Co., Inc.: New York, NY, 1989, pp. 1-19; Nause, L. *Forensic Tire Impression Identification*. National Research Council of Canada Reprographic Services: Ottawa, Canada, 2001, pp. 171-187.

<sup>5</sup> A bearing surface is the surface that receives contact from the outsole of an item of footwear or the tread of a tire; see also Bodziak, W. *Footwear Impression Evidence: Detection, Recovery, and Examination 2nd Edition*. CRC Press: Boca Raton, FL, 2000, pp. 307-328; Bodziak, W. *Tire Tread and Tire Track Evidence: Recovery and Forensic Examination*. CRC Press: Boca Raton, FL, 2008, pp. 193-208; Given, B. et al. *Tire Tracks and Tread Marks*. Gulf Publishing Company: Houston, TX, 1977, pp. 44-46; Nause, L. *Forensic Tire Impression Identification*. National Research Council of Canada Reprographic Services: Ottawa, Canada, 2001, pp. 227-234; Bodziak, W. et al (2012). Determining the Significance of Outsole Wear Characteristics During the Forensic Examination of Footwear Impression Evidence *Journal of Forensic Identification* 62(3): 254-276; Davis, R.J., et al (1977). A Survey of Men's Footwear. *Journal of the Forensic Science Society* 17(4): 271-285; Fruchtenicht, T.L. et al (2002). The Discrimination of Two-dimensional Military Boot Impressions Based on Wear Patterns. *Science & Justice* 42(2): 97-104; U.S. Department of Transportation, National Highway Traffic Safety Administration. *The Pneumatic Tire*. DOT Publication No. HS 810 561, 2006, pp. 231-285 and 533-593.

<sup>6</sup> SWGTREAD. Standard for Terminology Used for Forensic Footwear and Tire Impression Evidence, March, 2013. [http://www.swgtread.org/images/documents/standards/published/swgtread\\_15\\_terminology\\_evidence\\_201303.pdf](http://www.swgtread.org/images/documents/standards/published/swgtread_15_terminology_evidence_201303.pdf).

<sup>7</sup> Abbott, J.R. *Footwear Evidence*. Charles C. Thomas: Springfield, IL, 1964, pp. 58-59; Bodziak, W. *Footwear Impression Evidence: Detection, Recovery, and Examination 2nd Edition*. CRC Press: Boca Raton, FL, 2000, pp. 8-17; Bodziak, W. *Tire Tread and Tire Track Evidence: Recovery and Forensic Examination*. CRC Press: Boca Raton, FL, 2008, p. 49; Cassidy, M.J. *Footwear Identification*. Canadian Government Publishing Centre: Ottawa, Canada, 1980, pp. 41-65.

an outsole/tread causes a deformation of the bearing surface, resulting in a footwear/tire impression that has the added dimension of depth. 3D impressions are typically found in snow, sand, soil, and mud.<sup>8</sup>

The resulting 2D and 3D impressions can be compared directly to the outsole of an item of footwear or the tread of a tire. These comparisons are conducted utilizing two techniques: side-by-side comparison and superimposition.<sup>9</sup> Side-by-side comparison involves a direct comparison of features found in the footwear/tire impression to features found on a known item of footwear or tire. Superimposition involves the use of a test impression (prepared from a known item of footwear or tire) placed over the footwear/tire impression (recovered from the crime scene) to assess the correspondence in class characteristics and randomly acquired characteristics. The size, shape, and position of each randomly acquired characteristic are assessed by the examiner.<sup>10</sup>

In general, footwear and tire examinations follow a deductive process wherein all footwear and tires in the world are potential sources of a particular footwear/tire impression. By applying the methods of superimposition and side-by-side comparison to assess the correspondence of design, physical size/spacing, and wear, an examiner can reduce the potential sources of an impression to a class of potential sources.<sup>11</sup> The examiner can continue to narrow the potential sources by assessing the size, shape, and position of each randomly acquired characteristic that is observed in the crime scene impression. If these randomly acquired characteristics are also present on the known outsole/tread surface, then an examiner can identify a specific item of footwear/tire as the source of the footwear/tire impression.<sup>12</sup>

---

<sup>8</sup> Abbott, J.R. *Footwear Evidence*. Charles C. Thomas: Springfield, IL, 1964, pp. 59-61; Bodziak, W. *Footwear Impression Evidence: Detection, Recovery, and Examination 2nd Edition*. CRC Press: Boca Raton, FL, 2000, pp. 8, 59-60; Bodziak, W. *Tire Tread and Tire Track Evidence: Recovery and Forensic Examination*. CRC Press: Boca Raton, FL, 2008, p. 67; Cassidy, M.J. *Footwear Identification*. Canadian Government Publishing Centre: Ottawa, Canada, 1980, pp. 7-40.

<sup>9</sup> Bodziak, W. *Footwear Impression Evidence: Detection, Recovery, and Examination 2nd Edition*. CRC Press: Boca Raton, FL, 2000, p. 366; SWGTREAD. Standard for Terminology Used for Forensic Footwear and Tire Impression Evidence, March, 2013.  
[http://www.swgtread.org/images/documents/standards/published/swgtread\\_15\\_terminology\\_evidence\\_201303.pdf](http://www.swgtread.org/images/documents/standards/published/swgtread_15_terminology_evidence_201303.pdf)

<sup>10</sup> Bodziak, W. *Footwear Impression Evidence: Detection, Recovery, and Examination 2nd Edition*. CRC Press: Boca Raton, FL, 2000, p. 335.

<sup>11</sup> Bodziak, W. *Footwear Impression Evidence: Detection, Recovery, and Examination 2nd Edition*. CRC Press: Boca Raton, FL, 2000, pp. 319-335, 366-371; Bodziak, W. *Tire Tread and Tire Track Evidence: Recovery and Forensic Examination*. CRC Press: Boca Raton, FL, 2008, pp. 228-247; Cassidy, M.J. *Footwear Identification*. Canadian Government Publishing Centre: Ottawa, Canada, 1980, p. 92; Nause, L. *Forensic Tire Impression Identification*. National Research Council of Canada Reprographic Services: Ottawa, Canada, 2001, pp. 171-187; Benedict, I., et al. (2014). Geographical Variation of Shoeprint Comparison Class Correspondences. *Science & Justice* 54(5): 335-337; Gross, S., et al. (2013). The Variability and Significance of Class Characteristics in Footwear Impressions. *Journal of Forensic Identification* 63(3): 332-351.

<sup>12</sup> Cassidy, M.J. *Footwear Identification*. Canadian Government Publishing Centre: Ottawa, Canada, 1980, pp. 98-108; Adair, T., et al. (2007). The Mount Bierstadt Study: An Experiment in Unique Damage Formation in Footwear. *Journal of Forensic Identification* 57(2): 199-205; Banks, R., et al. Evaluation of the Random Nature of Acquired Marks on Footwear Outsoles. Research presented at Impression & Pattern Evidence Symposium, August 4, 2010, Clearwater, FL; Stone, R. (2006). Footwear Examinations: Mathematical Probabilities of Theoretical Individual Characteristics. *Journal of Forensic Identification* 56(4): 577-599; Wilson, H. (2012). Comparison of the

## Footwear and Tire Comparison Process

There are different methodologies and processes for conducting a footwear or tire impression examination. The Department shares information regarding some appropriate processes below. The Department does not suggest that the processes outlined here are the only valid or appropriate processes. (Note: footwear includes any type of item worn on the foot, including shoes, boots and sandals.)

### Step 1

The questioned impression is assessed to determine if there are sufficient gross design features observed to conduct a comparison. If there is insufficient detail and clarity observed in the questioned impression, no comparison will be conducted.

### Step 2

If sufficient detail and clarity are observed in the questioned impression, then a comparison will be conducted. The questioned and known specimens are compared to determine whether or not the gross design features correspond. If they correspond, then test impressions may be prepared from the known footwear or tires.

Four areas are compared during this step of the examination process utilizing the methods of side-by-side comparison and superimposition.

#### *Footwear:*<sup>13</sup>

1. Outsole design (pattern on bottom of the footwear)
2. Physical size and spacing (of geometric shapes that comprise the outsole design)
3. Wear (results from contact between the outsole and the bearing surface)
4. Randomly acquired characteristics (occur by happenstance)

#### *Tires:*<sup>14</sup>

1. Tread design (tread pattern on the tire)
2. Tread dimension (physical size and arrangement of geometric shapes that comprise tread design)
3. Wear (results from contact between the tread surface and the bearing surface)
4. Randomly acquired characteristics (occur by happenstance)

### Step 3

Once the comparison step is complete, an evaluation of the observed characteristics is performed and is used by the examiner to formulate an opinion. Generally, the examiner can reach an opinion within the following range of conclusions: identification, probably

---

Individual Characteristics in the Outsoles of Thirty-Nine Pairs of Adidas Supernova Classic Shoes. *Journal of Forensic Identification* 62(3): 194-203.

<sup>13</sup> Bodziak, W. *Footwear Impression Evidence: Detection, Recovery, and Examination 2nd Edition*. CRC Press: Boca Raton, FL, 2000, p. 367.

<sup>14</sup> Bodziak, W. *Tire Tread and Tire Track Evidence: Recovery and Forensic Examination*. CRC Press: Boca Raton, FL, 2008, p. 228.

made, could have made, could not be determined, indications did not make, elimination and unsuitable.

#### **Step 4**

The final step of the examination process is an independent technical review of the case. In this step, another qualified footwear/ tire examiner will ensure that the results are technically accurate, fall within the appropriate range of conclusions, and that the associated case notes/documentation supports the results.

Prior to the report of examination being issued, an administrative review is also conducted to ensure accuracy and adherence to established practices and procedures, and for spelling and grammatical accuracy. The footwear/tire examiners at the Department conduct their examinations in accordance with their own agency's quality management documents and standards.

The above process on footwear/tire examinations adheres to published recommendations of the Scientific Working Group for Shoeprint and Tire Tread Evidence (SWGTTREAD). SWGTTREAD, which is composed of private examiners and government examiners in local, state, and federal laboratories throughout the United States and also internationally, has developed standards and guidelines in the field of footwear/tire examinations.

#### **Policy Considerations**

In 2006, Congress authorized the National Academy of Sciences (NAS) to conduct a study on forensic science which culminated in a 2009 report.<sup>15</sup> While the NAS committee determined that "shoeprints and tire tracks are common types of impression evidence examined by forensic examiners," the committee raised several criticisms pertaining to the footwear/tire discipline, including that "there is no consensus regarding the number of individual characteristics needed to make a positive identification, and the committee is not aware of any data about the variability of class or individual characteristics."<sup>16</sup> The discipline has no defined threshold or number of individual characteristics (aka RACs) required to effect an identification. The size, shape, position, and orientation of each RAC is evaluated in arriving at an identification conclusion.<sup>17</sup> The report continues that "neither IAI nor SWGTTREAD addresses the issue of what critical research should be done or by whom".<sup>18</sup> Subsequently, SWGTTREAD published a list of research ideas specific to the footwear/tire impression discipline on its website.<sup>19</sup> The committee

---

<sup>15</sup> National Research Council (2009). *Strengthening Forensic Science in the United States: A Path Forward* National Academy Press: Washington, D.C. <http://www.nap.edu/catalog/12589.html>.

<sup>16</sup> *Id.* at 149.

<sup>17</sup> Bodziak, W. *Footwear Impression Evidence: Detection, Recovery, and Examination 2nd Edition*. CRC Press: Boca Raton, FL, 2000, p. 344.

<sup>18</sup> *Id.* at 150.

<sup>19</sup> SWGTTREAD. Recommendations for Research. <http://swgtread.org/research/recommendations-for-research>.

also noted that “[w]ith regard to reporting, SWGTREAD is moving toward the use of standard language to convey the conclusions reached.”<sup>20</sup>

---

<sup>20</sup> *Id.* at 150, citing SWGTREAD. 2006. *Standard Terminology for Expressing Conclusions of Forensic Footwear and Tire Impression Examinations*. Available at [http://www.swgtread.org/documents/PDF%20copy/10\\_terminology\\_expressing\\_conclusions\\_03-2006.pdf](http://www.swgtread.org/documents/PDF%20copy/10_terminology_expressing_conclusions_03-2006.pdf).