OSAC RESEARCH NEEDS ASSESSMENT FORM

Title of research need: National Footwear Database/Reference Collection

Keyword(s): Database, National, Footwear, Collections, References

Submitting subcommittee(s): Footwear & Tire **Date Approved:** 07-Mar-2016

(If SAC review identifies additional subcommittees, add them to the box above.)

Background Information:

1. Description of research need:

There is a gap in the U.S. in the area of footwear intelligence. This gap is both technological and programmatic. Law enforcement agencies outside the U.S, such as those in the U.K. and China, are currently gathering footwear intelligence for the purpose of linking crimes and individuals and providing the identity (i.e., the make and model) of the source footwear. However, this effort has never been undertaken at a national level in the U.S. Currently, examiners in U.S. laboratories provide investigators with footwear make/model information based on corresponding features observed in the pattern at the crime scene; but, they make little to no effort to link crimes or link offenders to crimes based on footwear and the impressions they make. This is because there is no national information-sharing infrastructure in place to facilitate this effort at this time. Some agencies have implemented local footwear intelligence programs and have been successful at that level. Just as fingerprints and DNA can serve to link individuals to crimes, footwear and the impressions they leave also have that ability. Therefore, there is additional intelligence that could be acquired from criminal and terroristic acts using footwear. A national footwear database would fill a huge void in the U.S. intelligence arena.

The research described here should focus on creating a prototype for a nationwide IT infrastructure to enable inter-agency communication related to footwear evidence collected from booking stations, crime scenes and laboratories. The infrastructure should be designed around three subsets of information: offender footwear, crime scene footwear impressions and reference footwear. There is a need to extract pattern information, preferably automatically using pattern-recognition algorithms with minimal manual coding, from the footwear patterns represented in the three subsets of the database. The pattern information then needs to be searchable for the purpose of identifying potential links between offenders, crimes and/or reference materials. Currently, there is no nexus between law enforcement and the footwear industry. Therefore, this research should identify potential sources and methods for collecting footwear reference data and inclusion of that data into the database. In addition to gathering footwear intelligence, there is a desire from the footwear/tire community to extract frequency of occurrence of footwear class characteristics, including outsole design (i.e., pattern), and manufacturer's size, for those records contained

in the database. The footwear/tire community envisions an infrastructure similar to that which supports AFIS, CODIS and NIBIN.

2. Key bibliographic references relating to this research need:

AlGarni, G. & Hamiane, M. (2008). A novel technique for automatic shoeprint retrieval. Forensic Science International, 181, 10-14.

David, R. (1981). An intelligence approach to footwear and toolmarks. Journal of the Forensic Science Society, 21, 183–193.

Geradts, Z. & Keijzer, J. (1996). The image-database REBEZO for shoeprints with developments on automatic classification of shoe outsole designs. Forensic Science International, 82(1), 21-31.

Lai, M.-Y. & Wang, L.-L. (2008). Automatic shoe-pattern boundary extraction by image-processing techniques. Robotics and Computer-Integrated Manufacturing, 24, 217-227.

Majamaa, H. (2000). Footwear databases used in police and forensic laboratories. Information Bulletin for Shoeprint/Toolmark Examiners, 6, 133–157.

Milne, R. (2012). Forensic intelligence. Boca Raton: Taylor & Francis.

Milne, R. (2001). Operation Bigfoot, a volume crime database project. Science & Justice, 41, 215–217.

Needham, J. A. & Sharp, J. S. (2016). Watch your step! A frustrated total internal reflection approach to forensic footwear imaging. Science Reports, 6, Article number: 21290. doi:10.1038/srep21290.

Pavlou, M. & Allinson, N. M. (2009). Automated encoding of footwear patterns for fast indexing. Image and Vision Computing, 27(4), 402–409.

Ribaux, O., Girod, A., Walsh, S. J., Margot, P., Mizrahi, S. & Clivaz, V. (2003). Forensic intelligence and crime analysis. Law, Probability and Risk, 2, 47–60.

3a. In what ways would the research results improve current laboratory capabilities?

The results would lay the groundwork for a national resource that could be used by laboratories to collect, search and disseminate information related to footwear impression evidence. Many laboratories in the U.S. are not conducting any type of footwear database searching so this would be a new service provided by many laboratories to their customers. In addition to the laboratories being able to provide make/model information, the national footwear database would enable laboratories to incorporate footwear evidence into their forensic intelligence programs and help investigators identify potential links. A national effort supported by IT and users at various levels of law enforcement (e.g., arresting officers, crime scene techs, laboratory examiners) has potential to grow the database quickly and decrease the amount of time it takes

to provide database search results to the field. The contents of the database could also be used by examiners for comparison purposes. This database has great potential to increase awareness of footwear impression evidence thus increasing the volume of this type of collected from crime scenes and the quality of that evidence.

3b. In what ways would the research results improve understanding of the scientific basis for the subcommittee(s)?

The results of the research could enable the extraction of frequency information for footwear class characteristics, such as make/brand, outsole design and manufacturer's size. This frequency information could be used to help the examiner attribute a level of significance to the class characteristics of the evidence.

3c. In what ways would the research results improve services to the criminal justice system?

Currently, the response time for providing intelligence related to footwear and tire impression evidence pales by comparison to other disciplines such as fingerprints and DNA. Additionally, the information provided is limited to make/model information. However, the outcome of this research could decrease turnaround times for providing footwear make/model information to field personnel who are actively engaged in investigating criminal/terroristic acts. It could also assist field personnel with linking crimes and individuals to crimes. An increase in the use of footwear evidence for intelligence purposes could lead to easier identification of suspects and ultimately more solved crimes. In addition, the class characteristic/ frequency information that could be extracted from the database could provide additional information to the examiner that may improve his/her ability to attribute weight to the evidence and subsequently communicate that weight to the criminal justice system in a transparent manner.

4. Status assessment (I, II, III, or IV): I

	Major gap in current knowledge	Minor gap in current knowledge
No or limited current research is being conducted	I	III
Existing current research is being conducted	II	IV

This research need has been identified by one or more subcommittees of OSAC and is being provided as an informational resource to the community.

Approvals:

Subcommittee	Approval date:	07-Mar-2016

(Approval is by majority vote of subcommittee. Once approved, forward to SAC.)

SAC

1. Does the SAC agree with the research need? Yes [x] No [ ]
2. Does the SAC agree with the status assessment? Yes [x] No [ ]

If no, what is the status assessment of the SAC: [ ]

Approval date: 17-Mar-2016

(Approval is by majority vote of SAC. Once approved, forward to NIST for posting.)