

Forensic Individualization of Images Using Quality and Quantity of Information

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Introduction

As a criminalist for the Indiana State Police Laboratory, I am often asked how many points I need to make an identification. My response is it depends on the quality and quantity of information in both the unknown and known images. In order to determine the source of the unknown image, or individualize the image, an understanding of the source of that image is required. An understanding of the source of the image is required to differentiate between repeatable class characteristics and unique, or random, characteristics.

As a criminalist, I visually examine images that originated from, or represent, a source. The images can be produced from a variety of sources, such as friction ridge skin, shoes, tires, guns or tools. The examination of images consists of visually observing all of the information in the unknown image, analyzing it, and comparing it to all of the information in the known image. Then the examination is a mental evaluation of all the information in both images.

Understanding the source of the image

Friction ridge skin is uniquely arranged. Having been taught this concept, I did not truly understand it until being enlightened by ridgeology. Ridgeology is the study of the uniqueness of friction ridge structures and their use for personal identification.

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Ridgeology is the compilation of studies of the development and growth of friction ridge skin. The uniqueness of the morphology, or shape, of the structure of friction ridge units and ridges is explained by ridgeology. The shapes and arrangements found in friction ridge skin will not be reproduced on any other skin. Not being able to personally observe the development of friction ridge skin, I am grateful for the previous studies documenting its formation and shared with the forensic community via ridgeology .

Friction ridge skin structure is uniquely arranged. It also regenerates itself. The new friction ridge skin will form in the same arrangement as the previous friction ridge skin arrangement. It is also durable. If random trauma occurs to friction ridge skin, damage can occur to the skin. Uniqueness from the trauma is added to the uniqueness of the friction ridge skin. The durability of that uniqueness is affected by the significance of the trauma. This trauma uniqueness can be temporary because of skin regeneration, or very durable because of scarring during regeneration. The scarred area is then durable, unless the friction ridge skin is damaged again. Understanding the durability of friction ridge skin is important for understanding images produced by friction ridge skin. There is no need to ignore any uniqueness in friction ridge skin, no matter the durability of that uniqueness. All uniqueness is valid. All uniqueness should be analyzed, compared and evaluated.

Shoes, tires, guns or tools are produced by manufacturers and have the capability of having shapes and arrangements of characteristics that are not uniquely arranged. These shapes and arrangements can be repeated. Numerous shoes have tread that can be produced from the same mold. So can tires. Guns can be made with the same measurable design specifications. Manufactured items can have repeatable class characteristics. Knowing that these shapes and arrangements can be repeated by a manufacturer is the foundation for the concept of class characteristics or those characteristics that can be repeated. The study of the manufacturing process of source items and observation of source items being mass produced reinforce this concept of repeatable class characteristics.

Either as part of the developmental or manufacturing process, or through normal wear and usage of an item, unique characteristics can be added to or lost from an item. These unique characteristics can be cuts, blemishes, gouges, foreign debris or any significant random change to the original item. Understanding the significance and durability of these unique characteristics is essential when comparing images.

Most manufactured items have class characteristics of structures and formations that are repeated. If random trauma occurs to manufactured items, damage can occur to the surface. Manufactured items do not regenerate themselves when damaged. Uniqueness of the trauma is added to the repeatable class characteristics. The durability of that uniqueness is affected by the significance of the trauma. It is also affected by future wear on the surface at the location of the uniqueness.

The uniqueness can be temporary or very durable. Understanding the durability of the manufactured item and the durability of its unique marks is essential for understanding images produced by manufactured items. There is no need to ignore any uniqueness in an item, no matter the durability of that uniqueness. All uniqueness is valid. All uniqueness should be analyzed, compared and evaluated.

Images produced by a source

The source item can make contact with a receiving surface and transfer its image, which is often recorded with a residue. If a suitable source item makes suitable contact with a suitable surface and transfers a suitable amount of a suitable residue in a suitable manner, and the surface is in a suitable environment, a suitable image should remain on or in the surface. If a suitable developing technique is then used in a suitable manner, a suitable image should be seen.

The source item can also make contact with a receiving surface and transfer its image as a three-dimensional recording. Residue does not need to be transferred. Friction ridge skin and shoes can leave three-dimensional images in surfaces. Guns or tools can leave three-dimensional images in surfaces. Once again, many suitability factors are needed in order for a suitable image to be seen on or in the receiving surface. Just making contact with a surface is no guarantee of a suitable image remaining on or in a surface.

The image that a source item produces will never show all of the quality and quantity of information that the original source item possesses. The developing technique will never show all of the quality and quantity of information that the original source item possesses. The viewing or visualization of the image will never show all of the quality and quantity of information of the original source item. The image is a representation of the original source item. It will not possess all of the information that

the source item has. Information is lost when a representation of the original item is made.

By knowing that the quality and quantity of information varies when an image is deposited by a source item, an understanding of that source item is required for understanding its image. An understanding of how the source item did, or could, produce the image is needed to understand the image.

Analyzing the image

Since an understanding of the image is developed during training, training should never cease. Each and every image should be analyzed as an effort to learn more about the source from which it came. Learning more about the source is training. Knowing that the image is not an exact reproduction of the source item, a variable amount of information is available to continue to the comparison process. The examiner should make an effort to determine the effect the surface had on receiving the image, and to determine the effect that motion had in depositing the image, and then to determine the effect of the processing technique used to develop the image. A conscious effort should be made to determine why the image appears as it does, and to distinguish between repeatable class characteristics and non-repeatable unique characteristics in the source item.

The examiner determines if there is sufficient quality and quantity of information in the image to warrant a comparison. This is determined by training, knowledge, ability, and past experiences with images. As all these factors change, so can the ability of the examiner to determine the source of the image. Each image must be analyzed in its totality. Before the comparison process begins, the known standard images are also analyzed to determine if there is sufficient quality and quantity of information to warrant a comparison to the unknown image.

Figure 1 represents the relationship between quality and quantity of information in an image and the need for the examiner to continue to the comparison process. Notice that there are no numerical values assigned above zero. There is an inability to quantify uniqueness because of texture or shape to the parts of the total structure. The morphology, or contour, of one unique image has a quantity of information that cannot be defined, no matter what generic label is attached to the total formation. Trying to describe unique shapes is an exercise in frustration. Quality also does not have a value assigned. Quality is the clarity of the information in the images. The clearer the visible

information, the more power that information has. The quality of each image may have different value for different examiners. No two examiners will have the same ability to analyze each and every unknown and known image. Quality and quantity of information work together to enable the examiner to determine the source of the image.

Comparison of images

The unknown image is then compared to the known image. Are repeatable class characteristics found in the unknown image? Are repeatable class characteristics found in the known image? Are unique characteristics found in both the unknown and known images? Is there sufficient quality and quantity of information in both the unknown and known images to continue to an evaluation of the comparisons? Figure 2 represents the relationship between quality and quantity of information in images during the comparison process. The determination is made if there is sufficient quality and quantity of information to warrant a significant evaluation.

Evaluation of images

After comparing images, an evaluation of the comparison takes place. A determination is made as to the significance of the agreement or disagreement of the repeatable class characteristics. Then a determination is made as to the significance of the agreement or disagreement of the unique characteristics. Figures 3 and 4 represent the relationship between quality and quantity of information in images during the evaluation process.

A determination is made as to the source of the unknown image. Would another examiner with similar training, knowledge, understanding and experience reach the same conclusion?

Conclusion

The difference between friction ridge skin images and images from many manufactured items is repeatable class characteristics. Many manufactured items do have repeatable class characteristics. Friction ridge skin does not have repeatable class characteristics, no matter the quantity of numerous generic labels that are attached to inherently unique friction ridge skin formations. The labels that are attached to uniquely arranged friction ridge structures enable the encoding, filing and retrieval of fingerprint cards. However, these same labels create

a tendency to diminish the actual uniqueness of friction ridge skin. Since friction ridge skin is uniquely arranged, friction ridge skin images are capable of having only one source. The image cannot have repeatable class characteristics if the source does not have repeatable class characteristics. Insufficient quality and quantity of information in a friction ridge skin image do not give it repeatable class. The insufficient nature of the image does not give me the forensic ability to state that an image from a unique source now has repeatable class and could have originated from a variety of sources.

Images with sufficient quality and quantity of agreement of repeatable class characteristics could have originated from the same source because numerous source items are capable of having the same manufactured shapes and arrangements. A determination of the sole source of an image from a manufactured item must not rely on repeatable class characteristics. The determination of sole source origin must rely on sufficient quality and quantity of unique characteristics, just as is needed to determine the source of a friction ridge skin image. Understanding the source item and the durability of the unique characteristics in the source item is needed to reach a valid conclusion.

I am a supporter of the belief that there is no required minimum number of unique “points” needed to determine the source of an image. First of all, there is no specific definition of what a unique “point” is. A unique “point” is not like any other “point”. The many generic labels attached to unique “points” should not diminish their actual uniqueness. Texture and features and characteristics along a generically defined “point” add quantity to a single “point”. My question would be, How many “points” are in a “point”? Since no forensic science (except some latent print examiners) has a required minimum number of points needed to determine the source of an image, the determination must rely on a combination of quality and quantity of information in the images.

Understanding the source of the image, the difference between repeatable class and unique characteristics in the source item, the durability of both unique and repeatable class characteristics in the source item, that the image of the source item will have less information than the actual source item, and the relationship of quality and quantity of all of the information in the images are the keys to determining the source from which the unknown image originated.

Figures 1 - 4

For the following figures, the vertical and horizontal axes represent an increasing quality and quantity of information present in an image. As either the quality or quantity of information increases, the requirement for the other decreases. The scale of each axis begins at zero and increases indefinitely.

There are no fixed values along each axis. The upper and lower limits of the examiner's threshold are represented by the two curves that border the gray area. The upper and lower limits of the gray area will never intersect with either the quality or quantity axis. If there would be zero quality or quantity to an image, there is no significant image.

The width of the gray area is not defined because the ability of each and every examiner is different. An understanding of the quality and quantity relationship is not an endorsement to individualize images that should not be individualized. An understanding of the quality and quantity relationship is justification for not relying upon an arbitrary number of generically defined unique "points". As either quality or quantity of information increases, the requirement for the other decreases.

In figures 3 and 4, evaluations that fall in the gray or black areas should not assign a presumption of class characteristics when quality and quantity are insufficient. The inability to determine information accurately should not result in a statement of possible, probable or likely individualization or elimination. The examiner's inability is limited due to the quality and quantity of information in the images, and is not justification for stating that an image could have originated from a variety of sources. An agreement of repeatable class characteristics is needed for determining that an image could have originated from a source item.

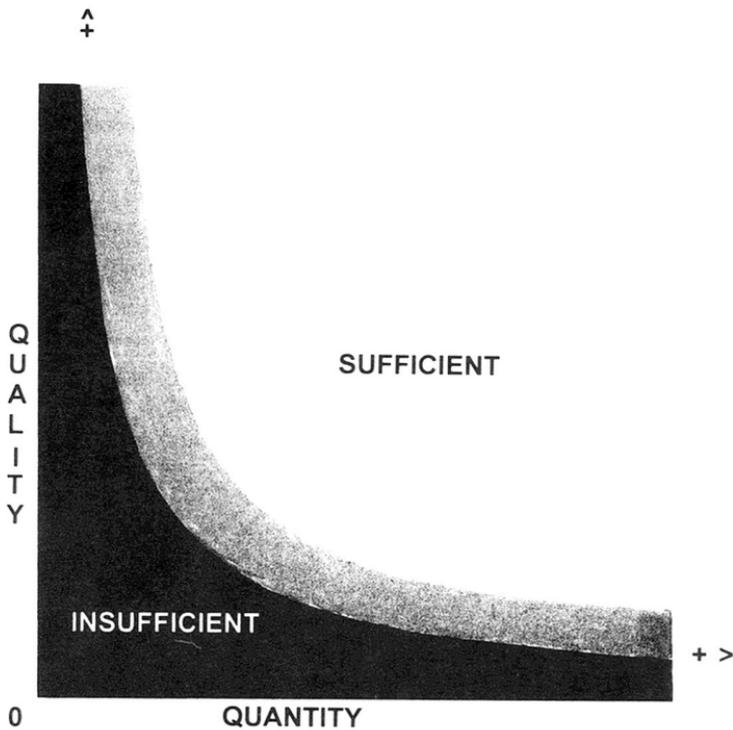


Figure 1

If sufficient quality and quantity of information is present in the image, continue the comparison. If the quality and quantity of information is in the gray area, continue the comparison process. Additional study of the image will take place during the comparison and evaluation of the images. If the quality and quantity of information is insufficient, the image is not suitable for a logical evaluation.

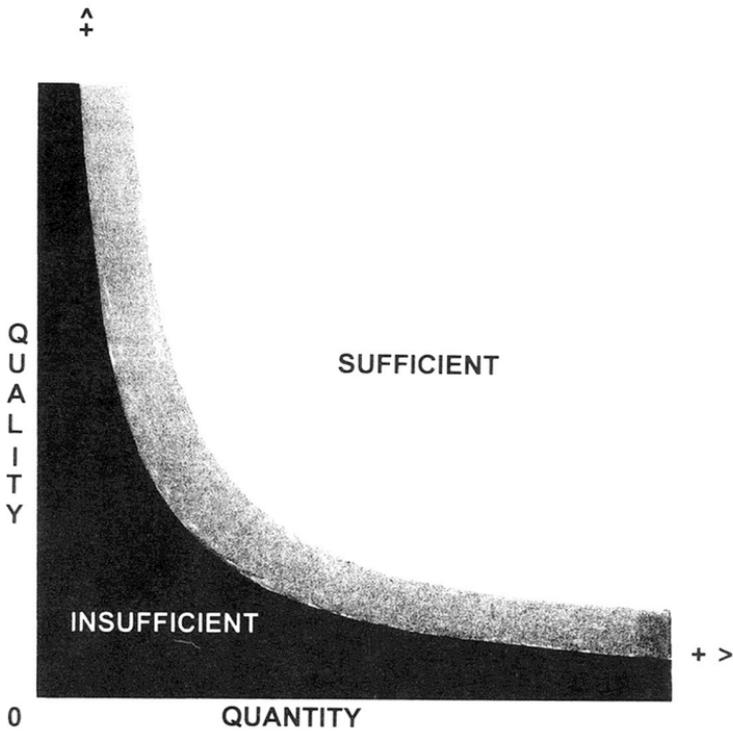


Figure 2

If sufficient quality and quantity of information is present in both the unknown and known images, continue to the evaluation process. If the quality and quantity of information is in the gray area, continue to the evaluation process. Additional study of the image will take place during the evaluation of the images. If the quality and quantity of information is insufficient in the unknown or known image, no logical evaluation can occur.

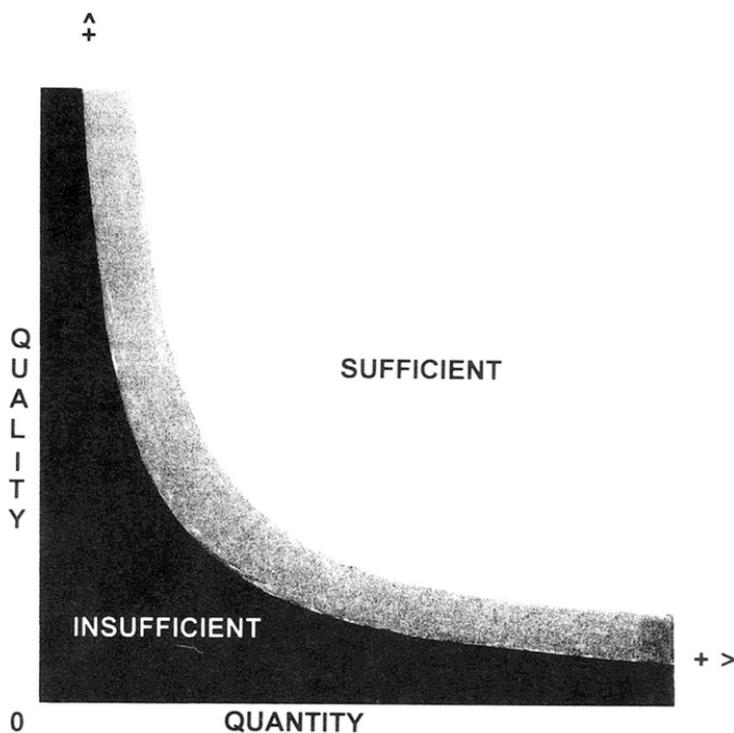


Figure 3

If sufficient quality and quantity of class characteristic information is in agreement, with insufficient quality and quantity of unique characteristic information, then the unknown image could have originated from the same source as the known image because of the varying durability of the unique information in a source item. If sufficient quality and quantity of unique information is in agreement in both the unknown and known images, the unknown image can be individualized as originating from the same source as the known image. If the quality and quantity of information is in the gray area during the evaluation, no class characteristic or individualization determination should take place. The gray area represents doubt and insufficient information. When in doubt, do not determine that class characteristics are in agreement and do not individualize. If the quality and quantity of information is insufficient in the unknown or known image, no class characteristic or individualization determination should take place.

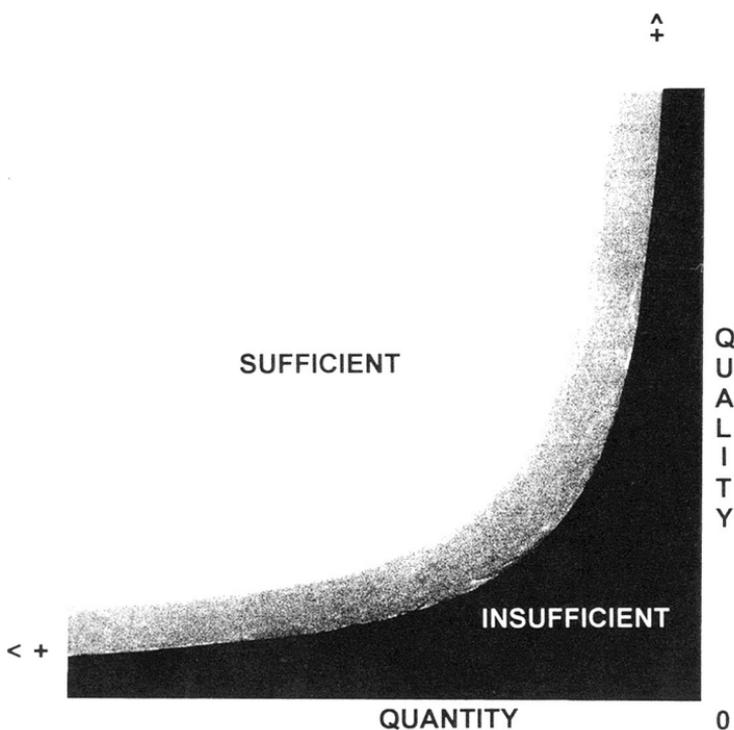


Figure 4

If sufficient quality and quantity of class characteristic information is in disagreement between the unknown and known image, the unknown image did not originate from the same source as the known image. If sufficient quality and quantity of friction ridge skin image information is in disagreement, the unknown image did not originate from the same source as the known image. If the quality and quantity of information is in the gray area, no determination of elimination should take place. When in doubt, do not eliminate. If the quality and quantity of information is insufficient, no determination of elimination should take place.