### Footwear Impression Evidence

Evaluation of Design and Physical Size of the Design





Christine Snyder, M.S., CFWE, CSCSA Crime Scene Analyst and Footwear/Tire Track Examiner Seminole County, Florida Sheriff's Office



William J. Bodziak, M.S.F.S., CFWE, D-ABFDE Special Agent FBI, Retired Bodziak Forensics, Palm Coast, Florida

#### Design and Physical Size of the Design

- Are class characteristics
- Associate an item to a group does not identify it as individual
- Almost exclusively originates from the mass production of the outsole, making understanding of manufacturing methods important

#### Shoes in the world

Shoes in the U.S.

Shoes of one design and size in the U.S.

Shoe of one design, size, wear and random features Shoes of one design in the U.S.

Shoes of one design, size and wear in the U.S.

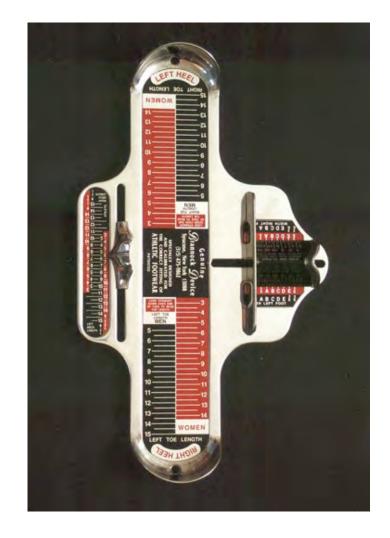
## Terminology

handouts

### Shoe Size (layman's example)

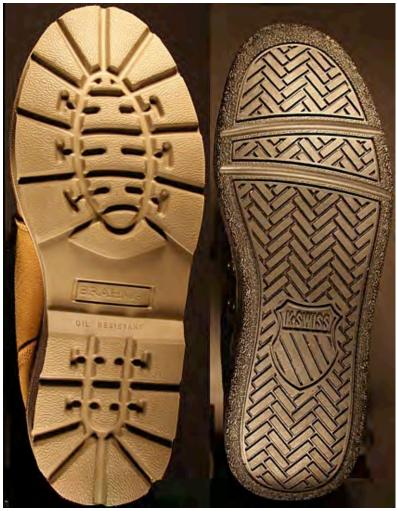
The manufacturer's size they place in the shoe





## Shoe Size (forensic example)

- The physical dimensions of the outsole
- No strict dimensional relationship between manufacturer's "shoe size" and the length and width dimensions of the outsole
- Example: Size 9 work boots physically larger than size 9 athletic shoes



Size 9 boot

Size 9 athletic shoe

## Design Element

- A specific component of a shoe sole as distinguished by its shape features.
- Together with other design elements, in a specific arrangement, it forms the overall outsole design



## Sole Design

A name and/or number used by a manufacturer to describe particular style of footwear having a pattern or arrangement of design elements, such as "K-Swiss Classic Luxury Edition" "Nike Free" "New Balance 609" etc.



## General Sole Design (layman)

- If discussing a sole design in general, then these would all be "similar designs," i.e. herringbone design
- Some layman might even call some of them the "same" design



## Specific Sole Design (expert)

- The specific arrangement of design elements in a full outsole that contain combined features found only in a limited number of identical molds, and in some cases, in only one mold
- Occurs due to "design/size relationship"
- Portions of shoes of different sizes may be very similar or indistinguishable.



- The necessity for a shoe sole, as it increases through the size range, to either have more design elements and/or larger design elements.
- As an example, in this K-Swiss design, the brick size stays the same throughout the size range, but there are other design components; thus the brick pattern does not usually meet the perimeter or other components exactly the same in each size.
- There are many molds for most sizes, but they are computer generated.

Design-Size Relationship (First example)



Larger size

Smaller size

Design-Size Relationship (Second example)

- In this Bruno Magli design there are only 10 molds to cover the size range of 6.5 through 13.
- Each are easily distinguishable because the 10 molds that produced soles for this design were hand-milled using a single template, thus the element size remains the same.



## Design-Size Relationship

(Third Example)

 In this Skechers design, the design content remains the same but is enlarged proportionally throughout the size range



### Corresponds

- When the design and physical size of that design in a crime scene impression are in agreement, it can be said they "correspond"
- "Corresponds" means the design and physical size characteristics in the crime scene impression are sufficiently like the respective portions of the known footwear to conclude that footwear is capable of producing it.



## Physical Size and Shape of Design

- The physical dimension and shapes of a shoe's outsole and its design elements in its entirety or, in the case of a partial impression, of the respective portions.
- This is what an examiner is comparing with a crime scene impression



## Physical Size and Shape of Design

- The crime scene impression (white) fits perfectly beneath the partially transparent known impression (red), providing demonstrable evidence that the design and its physical dimensions "correspond"
- Is best compared by superimposing a known impression of the shoe over the crime scene impression



### Similar (first example)

- A general term used to describe a general design likeness.
- A layman's term and standard
- A different standard than "specific design"



### Similar (second example)

- These shoe soles have some likeness to each other, i.e. they are similar or have components that are similar
- A partial impression of some areas of these shoes could be similar, even though overall the shoes are different designs



## Partial Impression

- An impression not representing an entire shoe outsole
- The majority of crime scene impressions are partial
- Their partial nature does not affect the ability to make a meaningful examination as the impressions may still correspond in design and physical size with the respective areas of the shoe and may contain wear and individual characteristics



### Shoe Perimeter

- The outer border that defines the outer edge of the shoe outsole
- A portion of the shoe perimeter where the interior design terminates
- Not all shoes have this "border" running around the outer sole



### Shoe Perimeter(case example)

 The specific intersecting features of this border with the interior design help distinguish shoes of different sizes and from different molds



#### Design and Physical Size Should be Evaluated First

- Proper Order of Examination to compare design and size first
- Should be established prior to proceeding with the examination of wear and individual characteristics
- Many similar looking designs of same and different brands
- Cases with more than one pair of same design shoes from one suspect or suspects

# Design and Physical Size of Design (facts)

- Number of Designs (easily exceeds 10,000)
  - Substantiated by industry source materials, data bases, shoe sale websites, rapidly changing designs, etc.)
- Number of Sizes
  - Sizing systems, market needs, foot growth, Footwear Market Insight survey
- Shoes sold per year in the US
  - Approximately 2.4 billion pair per year
- Shoes existing from prior years

Design and Physical Size Examination (procedure)

- To prove the design and physical size of that design could have been produced by the shoe
- To prove the design and physical size of that shoe could not have been produced by the shoe
- If unable to do above, establish that insufficient detail is present to reliably reach conclusion

### **Conclusions** (design and size only)

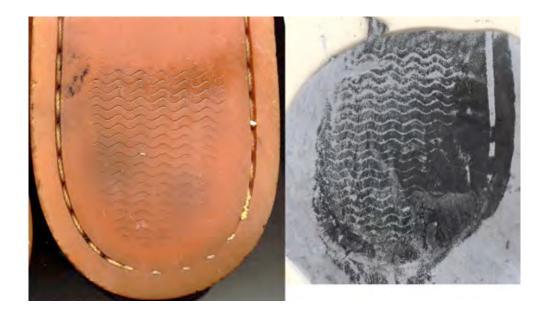
- Elimination confirmable difference in specific design and/or physical size
- May Not Have Made dissimilarities but insufficient detail prevents conclusive elimination
- Could Have Made specific design and physical size of that design clearly correspond and no differences present
- Insufficient detail to reach reliable conclusion

- Elimination confirmable difference in specific design and/or physical size
- Shoe not capable of producing this impression



May Not Have Made

 dissimilarities but
 insufficient detail
 prevents conclusive
 elimination



- Could Have Made specific design and physical size of that design clearly correspond
- Some additional wear in known obtained three weeks later



 Insufficient detail to reach meaningful conclusion



## Manufacturing

- Manufacturing is the source of the class characteristics of design and size
- Some shoes molded exact size
- Some molded shoe soles are oversized and cut down when fitted to uppers
- Some shoes cut from molded outsole stock



## Making the Mold

- Four Basic Methods of Producing the Gross
   Design of the Mold (Texture will be added later)
  - Hand-Milled
  - CAD-CAM
  - EDM (Electrical Discharge Machine)
  - Cast from Model

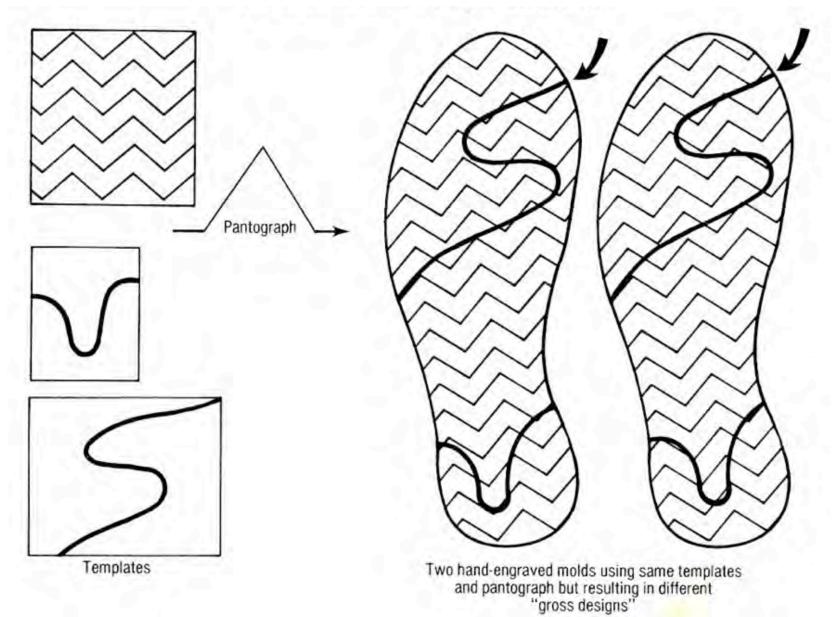
## Hand Milling

- Uses template with design that is guided by hand
- Transfers design to milling bit through pantograph
- Results in many variations from one mold to next both in specific design and within same size
- More costly
- Older technology





#### Hand Milled Method



### Result of Hand Milled Molds

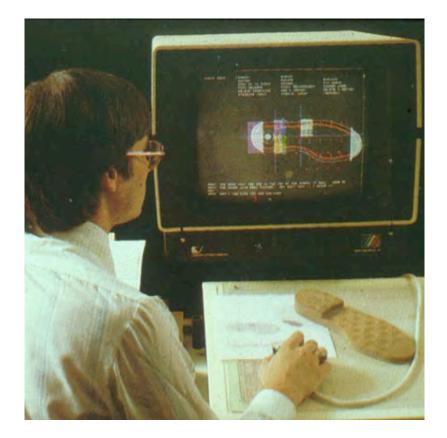
 Two soles of the same style and size but from different molds that were hand milled.



## CAD-CAM

Computer Aided Design-Computer Aided Manufacturer

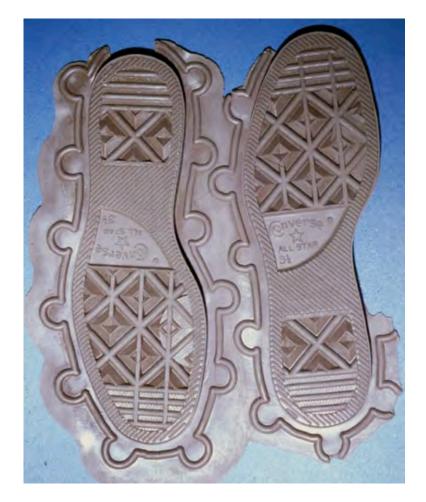
- Designing shoe on computer allows for exact duplication of gross design of many molds
- Ten molds made of the same size and design will be indistinguishable (except for texture)



## CAD-CAM

Computer Aided Design-Computer Aided Manufacturer

- Pairs will be mirror images
- Can produce molds in different factories with same result



## EDM (Electrical Discharge Machine)

- CAD-CAM produces carbon positive of design
- Design is eroded into metal by electrical action
- Much touch up needed
- Not time efficient





## Cast Molds

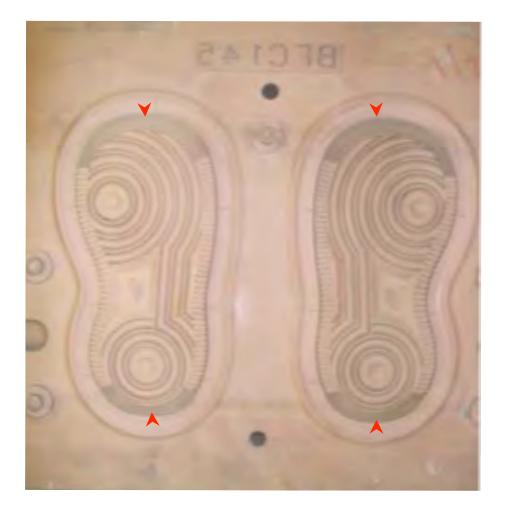
- Range from crude and inexpensive to high tech models
- Results in molds that are identical (except texture is added later)



models

### Cast Molds

- Nike is now using pre-made texture for the star design in the heel and toe of Air Force I shoes
- Multiple molds in each factory will have same texture in those areas only
- Still, molds in different sizes will be different



### Cast Method

- On the left, the master model, from which many plaster positives can be made.
- On the right, a plaster positive for the sole plate just created from the master model.
- The plaster positive will have metal poured around it to form the mold.
- Many molds A,B,C,D etc, can be made from the plaster positive.



### Texture

- Stippling
- Chemical Acid Etch



## Stippling

- A steel die with pattern on tip
- Depth of strike varies
- Normally overlapping strikes





# Stippling

 A hammer is used to strike the die and transfer the pattern into the metal mold





### Hand Stippling

movie



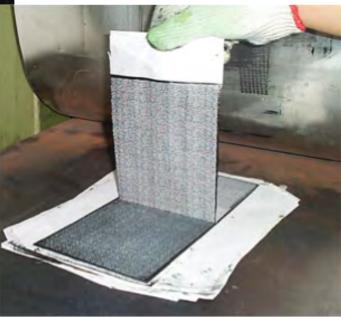
Applying in or other material into design on screen

#### Chemical Acid Etch

Pressing ink from screen to paper



Peeling Paper from Screen - Design Transferred to Paper



#### Chemical Acid Etch

- Apply pattern to mold surface
- Dip in Acid to erode areas around pattern
- Results in transfer of pattern to metal mold







Chemical Acid Etch

### Molding Methods

- Compression Molding (open mold like a waffle iron)
- Injection Molding (closed mold)
  - Unit production
  - Direct Attach
- Open Pour Molding (not as common)

### Cut Soles

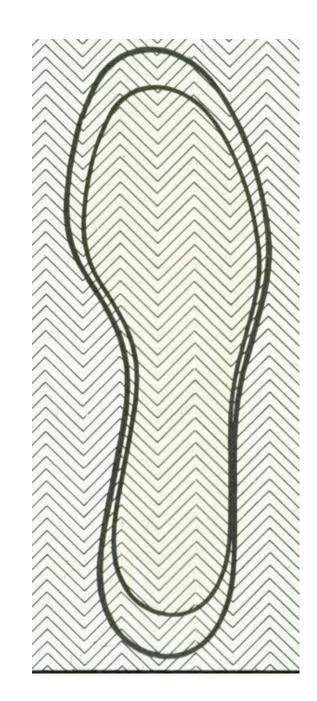
- A small part of the footwear sole population
- Steel die is used to cut through soling material like a cookie cutter.
- Result is normally an outsole that has specific design placement different from most others of that size and design.
- Left and right soles will not be mirror images.





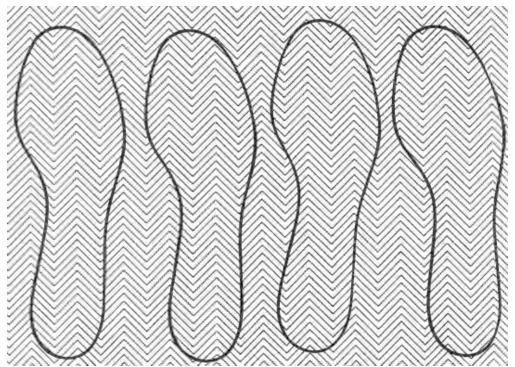
#### CUT SHOES

 Shoes of different sizes cut from common stock can have portions that are the same design/size



#### Cut Soles

- Often cut without any attention paid to left and right soles matching
- Identical cuts from sheet stock can result in many variations
- A reference point can be used to minimize this





### Example of Die Cut Soles

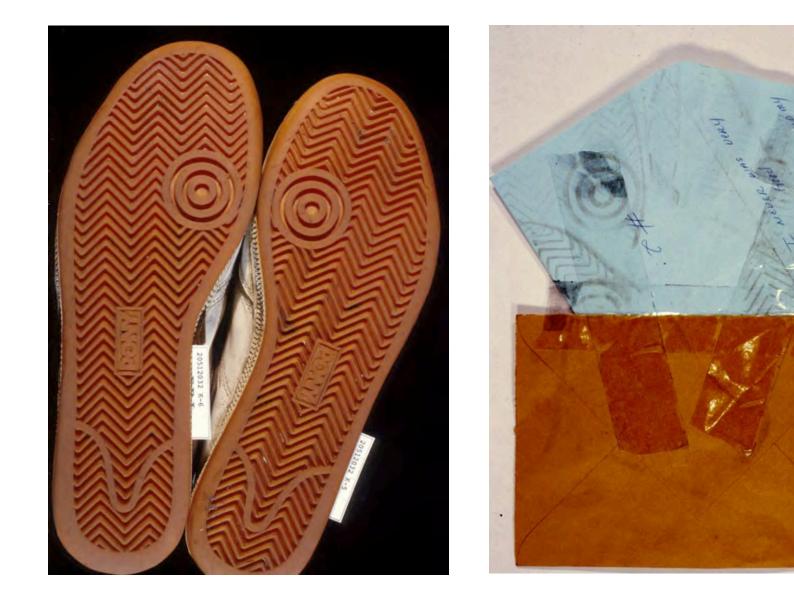


### Examples of Die Cut Soles

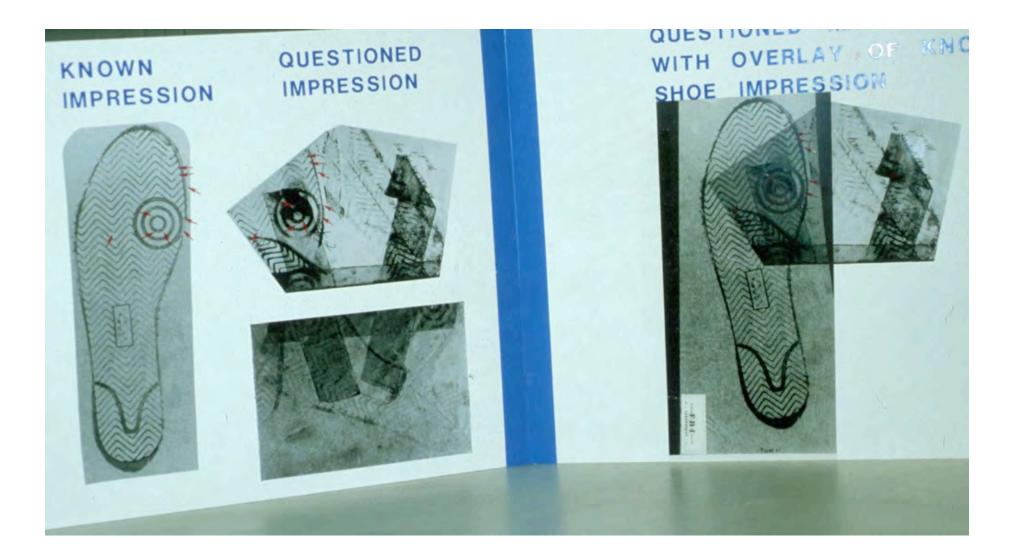
### Other Factors

- The same suspect may own more than one pair of the same or similar design footwear
- Co-suspect may also have similar or the same design footwear
- Design very common or unusual

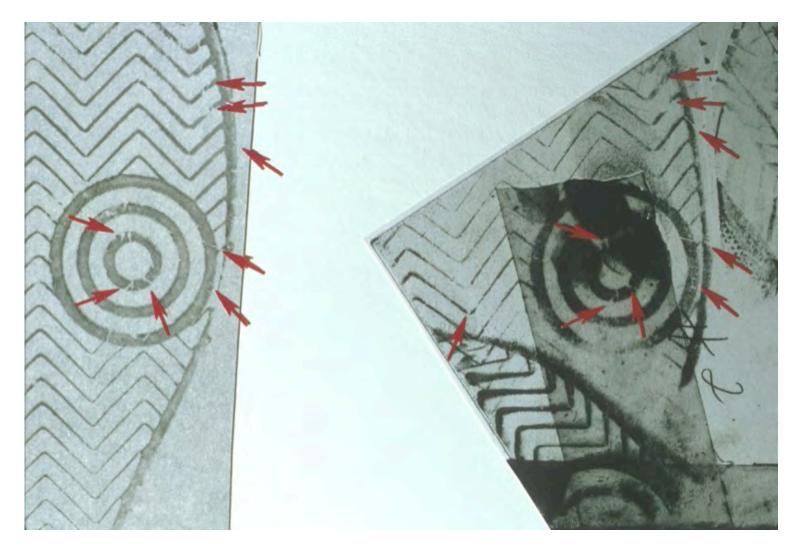
#### CASE EXAMPLE



### CASE EXAMPLE CHART



Case Results: One Identification, but the other impressions could not have been made by those shoes based on different design/size characteristics



## Exam Approach

- Hypotheses
  - The shoe corresponds in design and physical size
  - The shoe does not correspond in design and physical size
  - Insufficient detail or other limitations prevent concluding one or the other

### Inconclusive Results

- There are many reasons why a conclusive association or conclusive disassociation of design and physical size of design cannot occur
  - Poor replication of detail, degradation, contamination, distortion
  - Poor recovery and preservation habits: such as bad photography, lack of casting or lifting, lack of enhancement, improper use of scale, etc.

#### The Standard for Conclusions

Conclusions that a shoe does or does not correspond in design and physical size of that design must have a high standard, leaving no reservation or lack of certainty

### Fragmented Impressions

- Fragmented impressions are those that are very small to the extent that their size is a limiting factor
- A fragmented impression may be so small that it may be insignificant, even if a portion of it might correspond with the known footwear

### Limited Conclusions

- Cases where the impression is fragmented or otherwise limited, particularly if that design is common, will severely restrict any conclusion regarding design and size
- Use of "Cannot Eliminate" in these cases is a prejudicial conclusion

### Blunt Force Pattern Injury

 Example of design but limited ability to make a specific design/size examination due to fragmented impressions, curvature and skin, position of scale and the commonness of the herringbone design



## Shoe Box Case

- No shoes of suspect recovered- only shoe box was found
- Shoe brand of crime scene impression identified as Adidas Ilie Nastasse II
- Samples from manufacturer confirmed impressions in blood next to body were size 8.5, same as on shoe box
- These Adidas shoes only sold at the time in Europe. Suspect recently moved to US from Europe
- Shoe that made bloody crime scene impression same design and corresponded with size 8.5 as Adidas Ilie Nastasse II

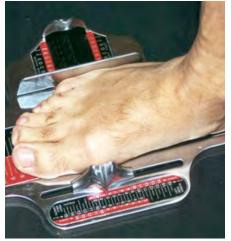




## Foot Size of Suspect

- Brannock Device used in shoe stores to measure foot and "estimate" shoe size
- Measures two lengths-heel to toe and heel to ball
- Width measurement insignificant



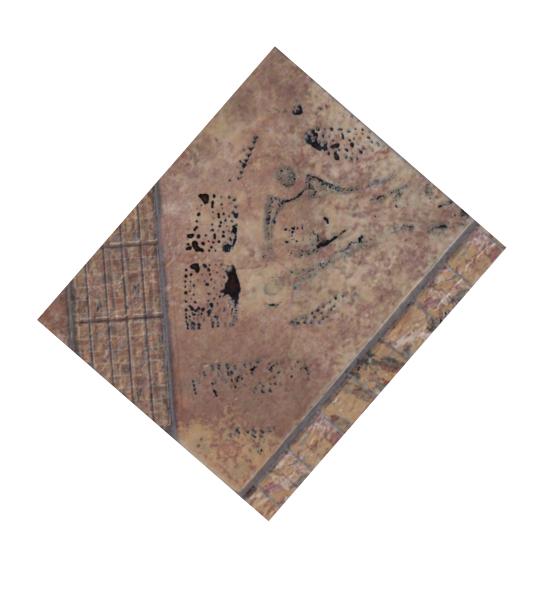


#### Before enhancement



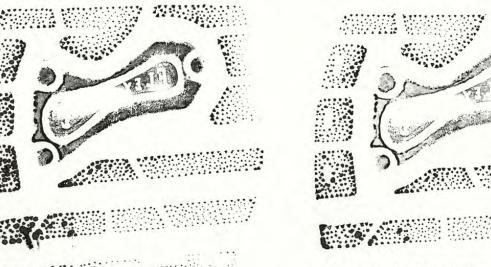
#### After enhancement with Amido Black





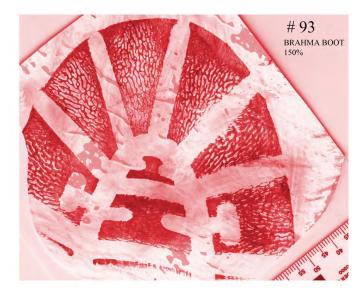






#### Two Known Impressions from Same Shoe



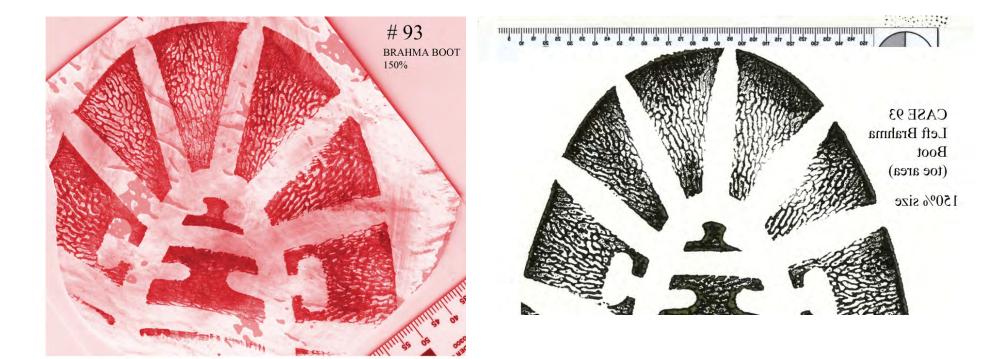


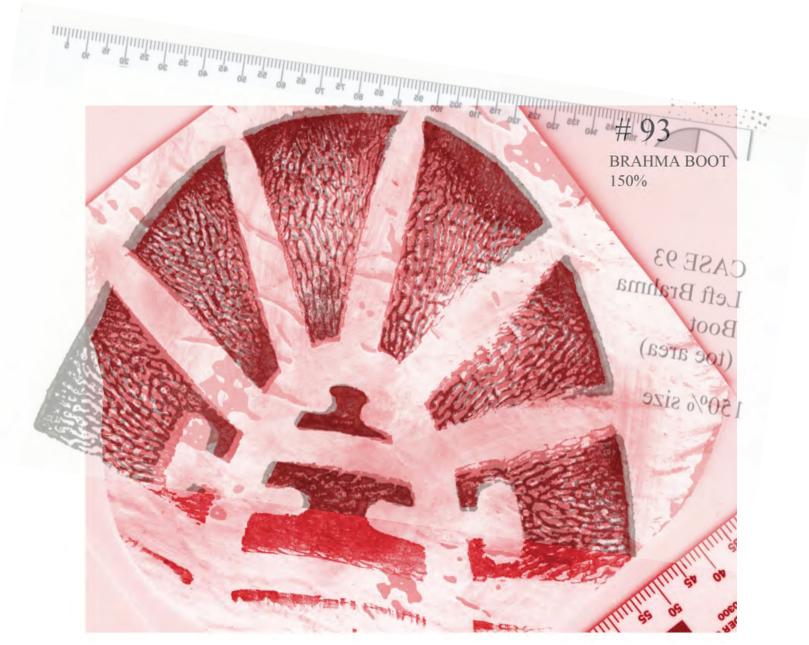
#### Mikrosil lift of Impression



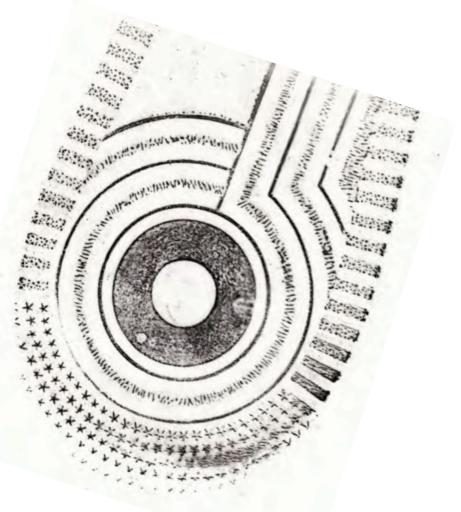
#### Similarities in Chemical Acid Etch Texture







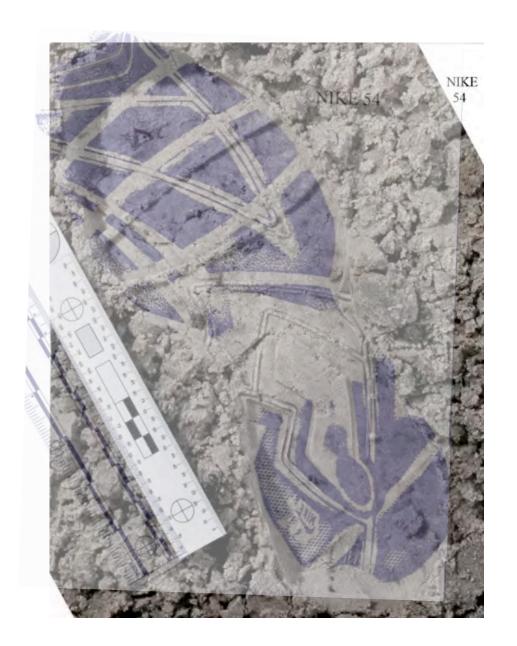
Known Impression Superimposed over Crime Scene Impression 







Questioned Impression with Overlay of Known Shoe Impression



Questioned Impression with Overlay of Known Shoe Impression



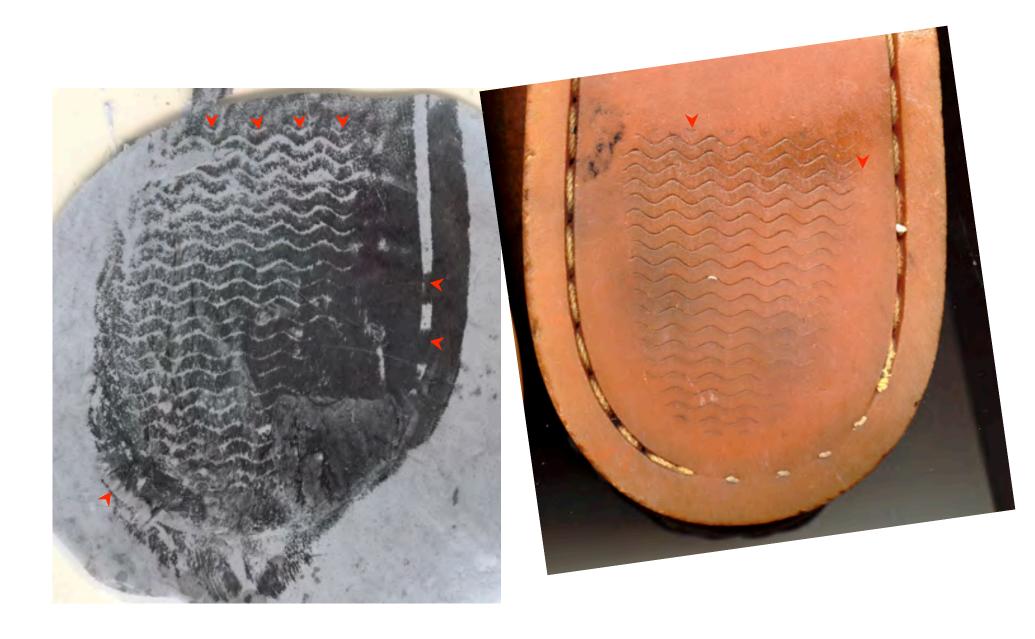
## Does this shoe correspond in design and physical size?



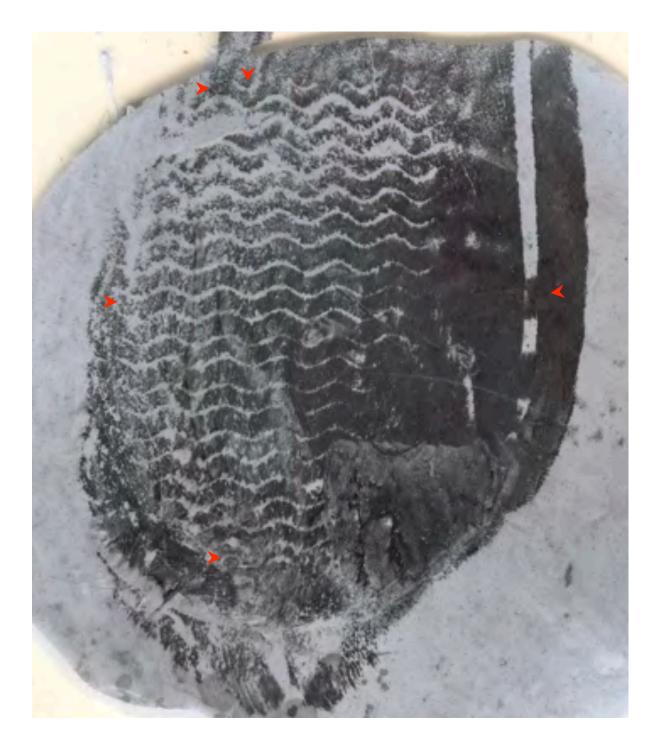


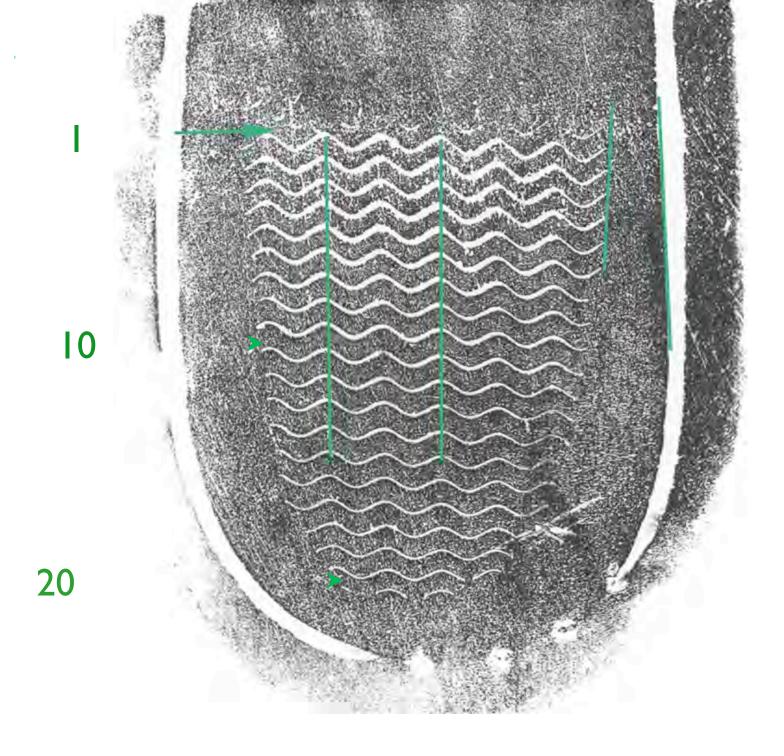
Questioned Impression - Mikrosil lift

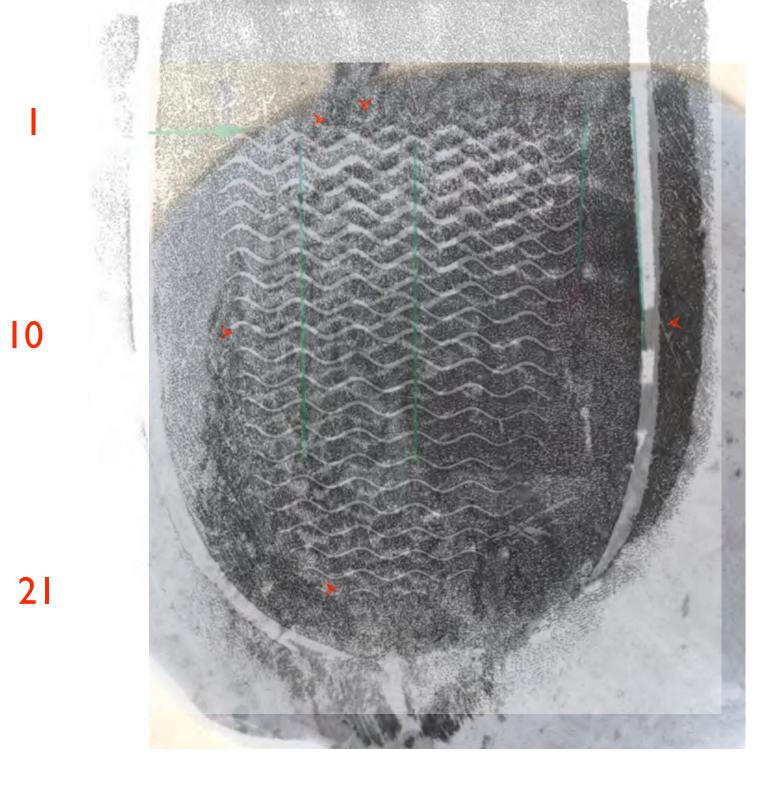
Left Shoe











## Does this shoe correspond in design and physical size?





Questioned Impression - Mikrosil lift

Left Shoe