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A comparison study between vinyl static cling film and gelatin lifters in the collection of footwear impressions left in dust

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BOSTON UNIVERSITY

ARAM V. CHOBANIAN & EDWARD AVEDISIAN SCHOOL OF MEDICINE

Thesis

**A COMPARISON STUDY BETWEEN VINYL STATIC CLING FILM AND
GELATIN LIFTERS IN THE COLLECTION OF FOOTWEAR IMPRESSIONS
LEFT IN DUST**

by

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ABSTRACT

Footwear impressions are encountered frequently during crime scene investigations. They are considered quite fragile, and collection of this type of evidence after proper documentation is highly recommended¹. A common method of collection for dust impressions is the Electrostatic Dust Lifting technique (ESDL), which requires an electric charge and carries a risk of shock to the user².

A footwear impression collection product that also utilizes static electricity, but without the need for any additional power source was validated in 2011: Arrowhead Forensics' "Stat-Lift™" (Arrowhead Forensics, Lenexa, KS), also referred to as Vinyl Static Cling Films (VSCF). This previous validation study compared the quality of the VSCF collection results to those produced by the ESDL, and found that the VSCF outperformed the ESDL in the level of contrast and detail of the impression on the lift³.

Gelatin Lifters are a well-established method for collecting dust impressions at crime scenes, using a "low-adhesive gelatin" to recover the evidence⁴. This study compares the VSCF (specifically the Stat-Lift™) to the established Gelatin Lifters in several categories, such as contrast, detail, and completeness of impression collected on the lift.

Three common flooring materials were collected for substrates, which included vinyl tile, hardwood, and marble tile. Dust was collected via vacuuming and emptied into a container. A volunteer then stepped into the container and created dust impressions on the substrates, reapplying dust between impressions. The impressions were created in triplicate: three Stat-Lifts™ and three Gelatin Lifters for each substrate. The impressions were subsequently photographed. These photographs were randomized and anonymized before being sent to three competent forensic footwear examiners. Every photograph was evaluated by each of the examiners using a series of questions with a ranking system as a guide.

After the results were returned from the volunteers, they were organized by category and examined. Gelatin Lifters ranked higher than the Stat-Lift™ in each category, ranging from the visibility of the impression, lack of distortion, observance of delicate or fine details in the impression, and their suitability for comparison purposes.

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LIST OF ABBREVIATIONS

ALS	Alternate Light Source
DNA	Deoxyribonucleic acid
ESDL	Electrostatic Lifting Device
NIST	National Institute of Standards and Technology
OSAC	Organization of Scientific Area Committees
PVC	Polyvinyl Chloride
RAC	Randomly Acquired Characteristic
V	Volts/Voltage
VSCL	Vinyl Static Cling Film

1. INTRODUCTION

1.1 Impression Evidence

The foundations of forensic footwear examination can be dated as far back as the early “hunter-gatherer” era in human history, when our ancestors developed and relied on methods of locating prey animals by identification of their foot impressions, or tracks⁵. In the more contemporary world, this ability to recognize patterns within shoe impressions has branched into a useful tool for the field of criminal investigations; the oldest recorded instance being from 1786, where Scottish investigators linked a footwear impression related to a murder investigation to a specific individual’s shoe. This case and its subsequent trial not only utilized comparative techniques to link a footwear impression left at the scene of the crime to a suspect, but also included tracings of the impressions, created in an effort to preserve and better visualize the outsole detail^{1,6}.

A “footprint” or “shoeprint” is considered a type of *impression evidence*. That is, it has retained the characteristics of an object (the footwear, i.e. a shoe) through the effects of direct physical contact to a substrate (i.e. mud, snow, flooring). This contact between the footwear and the substrate can create an impression in multiple ways. Dust or debris residue on the outsole of a shoe can be transferred to a receiving surface creating a two-dimensional impression, or the footwear can deform the receiving surface, such as by stepping into malleable mud, or walking through pooled blood and creating a three-dimensional impression⁷⁻⁸. Footwear impression evidence can be an invaluable tool in reconstructing the events and history of a criminal incident, as most investigations tend to hinge on connecting a suspect or victim to a crime scene, or vice versa^{9,10}. This can be

done in a multitude of ways, such as through the collection of fingerprints, “trace” evidence such as hairs and fibers, and biological substances that may generate a probative DNA (Deoxyribonucleic acid) profile. It is fair to note, however, that footwear impression evidence can be, and is, often overlooked^{11,12}.

In theory, footwear impressions should be as abundant at a crime scene as any other type of evidence. A criminal must enter, exit, and move around within a location, and it is therefore reasonable to assume that in doing so, evidence of what they were wearing on their feet may have been left behind¹³. A lack of success in the recognition and subsequent recovery of many footwear impressions may stem from a lack of proper education or training of first responders in the specific field. It may also originate from a lack of understanding of the utility of such evidence. Footwear impressions may also be transient and can be easily destroyed by being walked over, intentional means, or damaged by environmental conditions⁸⁻¹⁴.

1.2 Dust Impressions

Locard’s Exchange Principle in forensic science states that “every contact leaves a trace”, and was devised by Dr. Edmond Locard, a pioneer forensic scientist from France¹⁴. Dr. Paul L. Kirk, a forensic scientist who helped head the Criminology program at UC Berkeley in America, expanded on Locard’s principle when he stated: “Wherever he steps...even unconsciously, will serve as a silent witness against him.”¹⁵

This statement certainly applies to a type of footwear impression that is particularly overlooked in crime scene investigations: the dust impression. This is a type

of two-dimensional impression that occurs when trace materials (i.e. “dust”) are removed from a surface by a shoe (a negative impression), or imparted onto the surface by the shoe (a positive impression)¹⁶. Essentially, when a shoe tracks across a surface, it transfers particles of dust onto the flooring, or removes particles of dust from the flooring: and this leaves a pattern of the bottom of the shoe, or outsole, behind³. A dust impression will be most visible on smooth, flat surfaces, and will be more difficult or improbable to detect on rough or uneven terrains, such as carpeting. If observed and recovered, these shoeprints are often high resolution and can contain multiple RACs (Randomly Acquired Characteristics)¹⁷. A randomly acquired characteristic in impression evidence observation are accidental markings on an impression that are considered “unique” and are valuable in comparing an impression to a known shoe¹⁸.

1.3 Oblique Lighting

Dust impressions are incredibly common, but routinely prove to be latent in “normal” lighting conditions: that is, typical illumination that originates from above and creates an even lighting and minimizes shadows. “Oblique lighting” is a term used to describe a technique that can be used by crime scene investigators and law enforcement to search for and photograph multiple types of evidence, such as tool marks, indented writing, or dusty footwear impressions¹⁹. The investigator can take a light source, such as a flashlight or an ALS (Alternate Light Source), and hold it above a surface at a sharp low angle¹¹. This can allow previously unseen details in an impression to be visualized by increasing contrast on the impression²⁰.

While oblique lighting is considered to be the most effective technique in visualizing possible footwear impressions left in situ, the background noise and texture of the substrate may reduce the quality and quantity of characteristics present. In this case, removing or collecting the impression from the substrate would allow for better visualization¹⁴.

1.4 Collection Techniques For Footwear Impression Evidence

When a possible dust impression has been located, it is best practice to photograph the unaltered impression prior to any enhancement or collection¹⁴. Dust impressions in particular are prone to degradation and are easily destroyed, and photography allows an examiner an opportunity to look back at the original impression^{22,23}. This form of documentation provides clarity on how the evidence location is related to the overall crime scene, its condition when discovered, and with respect to examination quality photographs can be used for future impression processing and comparison. While it remains paramount to take these initial photographs, impression evidence, particularly dust impression evidence, can prove challenging to capture on camera¹⁴.

In order for evidence in this category to provide more useful information to a forensic footwear examiner, it should, if possible, be collected after it has been photographed. Because these impressions are delicate in nature, it is important that a trained technician utilizes the most effective method of collection that is suitable for the situation¹⁷.

1.4.1 Static Electricity: Historical Methods (ESDL)

The concept behind lifting a footwear impression left in dust through the use of static electricity originated in Tokyo, Japan with police sergeant Sancyasu Toma, and was improved upon by a police officer in Shikoku, Japan by the name of Kato Masao. Masao developed the first “electrostatic lifting device” or “ESLD”. This machine could generate 14,000 volts (V) and be used with a vinyl sheet and an electrode plate. Placing the vinyl sheet on top of the dust impression, then applying voltage creates static electricity, allowing the dust impression to adhere to the vinyl sheet. This original device used a permanent lifting plate, so only one impression could be lifted at a time and then photographed, as the vinyl was set up for one usage. Outdated electrostatic devices also needed two lifting surfaces, with a positive and a negative charge²¹.

Today, modern Electrostatic Lifters are commonplace as a recovery method of two-dimensional dust impressions. These devices have multiple, separate pieces of vinyl that can be removed and stored properly after each recovery of an impression. They also use portable battery power to create a static electric charge on the vinyl lifts. The difference in charge that results between the substrate and the vinyl forces dust to attach itself to the lifting surface, and the new surface for the impression will retain this charge so that the dust particles are immobilized. ESDLs are typically utilized on dry, hard surfaces such as hardwood floors or doors, with some success on substrates like clothing and paper^{7,14,17}.

The operator of an ESDL needs to use extreme caution when the substrate is metal, as the production of the static electric charge can cause shock or electrical damage if not used correctly. It also can create a shock on any collection surface if it is not grounded correctly.

1.4.2 Stat-Lift™

In 2011, a new static lifting product was validated that eliminated the need for an external electrical charge: Arrowhead Forensics' "Stat-Lift™" (Arrowhead Forensics, Lenexa, KS). The manufacturer describes Stat-Lift™ as a "revolutionary, cost effective way to recover, transport, and preserve impressions"²⁴.

Stat-Lift™ is a trademarked product that uses Vinyl Static Cling Films (VSCF), a product that is used more traditionally for purposes such as window graphics and protective coverings. VSCF are a form of polyvinyl chloride (PVC) with plasticizers, create a malleable product that can adhere to surfaces without leaving a sticky or glue-like residue after it has been removed³.

Like the ESDL, Stat-Lift™ uses static electricity for its mechanism of collection. Unlike the ESDL, however, Stat-Lift™ requires no external source to provide this charge. Instead, it is "the interaction of the different molecular structures of the PVC and the plasticizers" that cause the electrostatic forces and cause the dust particles to stick to the vinyl^{3,25}.

1.4.3 Gelatin Lifters

Gelatin lifters, or “gel lifts” have existed as a forensic collection technique for decades and are one of the standard practices used by law enforcement to collect footwear and latent fingerprint impressions left in dust at crime scenes. This method of collection utilizes a “low-adhesive gelatin” to adhere to the small particles that make up the impression and collect the particles onto the lift, which can then be transported⁴.

Temperature changes have been shown to have an effect on gel lifts, as they begin to melt in temperatures between 40 to 45°C²⁶. It has also been suggested that they lose tackiness from long-term storage, and, if stored improperly, the collected impression may be subject to some distortion. In addition to photographing prior to collection, it is also best practice to photograph dust impressions at or close to the time of collection²⁷.

1.5 Suitability Determinations

The “Organization of Scientific Area Committees for Forensic Science” (OSAC) is an organization that develops standards and is under the umbrella of the “National Institute of Standards and Technology” (NIST). Forensic scientists that practice impression evidence examinations will traditionally offer their findings from “categorical conclusions”²⁸. OSAC proposes standards defining minimum requirements, best practices, protocols, and language that the forensic science community uses for these purposes that are widely accepted.

A “Suitability Determination” in this context is language that was proposed by OSAC to describe a judgement made in regard to the quality of an unknown footwear

impression, prior to any comparison to a known shoe or impression. “Unknown” impressions refer to impressions of an unknown source (i.e. left behind at a crime scene), while “known” impressions refer to ones where the source is known, such as shoes taken directly from a suspect’s feet at the time of their arrest.

OSAC’s standards offers two options for suitability determinations: “Suitable for Comparison”, and “Not Suitable For Comparison”. These determinations allow the examiner to articulate whether a lift “contains sufficient quality and value for a comparison”. If a footwear impression evidence examiner determines a lift to be “Not Suitable for Comparison”, it indicates that further examination should not be performed, as there are no features or characteristics visible that could be compared to another lift or piece of evidence. On the other hand, a “Suitable for Comparison” judgement indicates the unknown impression has sufficient detail and quality to be compared to another item²⁹.

1.6 Study Objective

The purpose of this research study is to compare quality of the impressions collected with gelatin lifters and vinyl static cling lifters, in a way that is designed to mimic casework as much as possible while using reproducible and uniform techniques for the tests. Both gelatin lifters and vinyl static cling film are suitable for a variety of substrates and for multi-purpose uses. This study aims to explore how results of the two collection methods would compare from the same substrates and under the same circumstances.

2. MATERIALS AND METHODS

2.1 Substrate Sample Collection

This experiment utilized three different flooring types as the substrates for the dust impressions. The substrate types were vinyl flooring, marble tile, and prefinished solid wood flooring. Considerations in selecting the substrates were to consider common household flooring types, as well as their size, to ensure each piece could accommodate the size of the footwear chosen for this experiment.

2.1.1 Vinyl Tile

A sample of “SMARTCORE™ (Shaw Industries) Waterproof Interlocking Luxury Vinyl Tile” was obtained from Lowe’s. This sample measured 6” x 9” and is in the color “Palisade Stone”.

2.1.2 Marble Tile

A sample of “Carrara Chateau Polished Marble Tile” was obtained from Floor & Decor. This sample measured 4” x 9” and is a white color with gray marbling.

2.1.3 Hardwood

A sample of “Bruce™ (AHF Products) Natural Select Red Oak Smooth Solid Hardwood” was obtained from Floor & Decor. This sample measured 5” x 9” and has a natural, light finish.

2.2 Matrix/Dust Material Selection

Dust was collected from the collection tank of a Dyson V8™ on three occasions, each after a week of general vacuuming of a single floor, six-room apartment unit that had both hardwood flooring and carpet. The three samples were combined into one container.

2.2.1 Matrix/Substrate Trials

Prior to the decision to utilize dust samples collected from a vacuum cleaner, there were multiple trials for different possible matrices. Specifically, the use of “Arrowhead Forensics” product “Latent Fingerprint Powder” in the colors “Gray” and “Black” as well as a 24” x 24” “Greystone Square” step stone made from concrete by the brand “Pavestone”.

The logic behind utilizing fingerprint powder was to create a reproducible method of applying a very fine substance to the shoe before creating an impression. In practice, however, the process of either dusting the fingerprint powder onto the shoe before stepping, or stepping into a pre-poured amount of the powder and then stepping, both led to less than ideal results. The dust from the vacuum was found to be an adequate combination of fine material that created an impression on the substrates without clumping and still providing ample detail.

2.3 Shoe Selection and Characteristics

The right shoe from a previously worn pair of “Club C 85” Reebok brand sneakers in size 6.5 (women’s) was selected for this experiment. The shoes had been worn consistently for approximately 6 months prior to testing (exclusively by the same individual), and therefore had some pre-existing wear and possible RACs. Once testing started, the shoes were no longer worn unless in the context of creating the dust impressions for this experiment to avoid creating any new or additional wear or characteristics.

2.3.1 Added RACs and Wear

The shoes had been purchased approximately six months before the experiment took place, and were worn consistently. There were wear characteristics on the outsole from their continuous use. These shoes were intentionally chosen over brand-new shoes without any wear in an attempt to have realistic characteristics on the outsoles.

Although some pre-existing RACs were present on the outsole, additional RACs were imparted manually through the use of a scalpel. This was necessary because in preliminary experiments, the pre-existing RACs were not clear and the experiment required that examiners be able to report any observed RACs. The placement of a deep cut (an obvious RAC) (see Figure 1) in the center of the toe area produced a feature that would be expected to be visualized in an impression.



Figure 1. Outsole Pattern of Selected Shoe with RACs

2.3.2 Manner of Deposition

Every dust impression, irrespective of substrate or lift type, was created in the same manner. The right Reebok sneaker was worn on the right foot and the individual stepped directly into the container of previously collected dust, and then took two regular steps on an unused piece of butcher paper. The third step with the right foot landed on the substrate, where the individual remained for approximately five seconds. After five seconds, the individual slowly stepped off, leaving behind an impression of the dust matrix onto the substrate.

2.4 Cleaning of Dust Between Steps/Impressions

The substrates were cleaned and allowed to dry between each deposition/collection. This included before the first impression was made on each substrate. The substrate was cleaned with a moistened, clean microfiber cloth and a spray of Lysol® All-Purpose Cleaner. It was then wiped again with a separate clean microfiber cloth and allowed a few minutes to completely dry. Between each deposition, the butcher paper was changed as well.

2.5 Gelatin Lifters

Nine “Arrowhead Forensics” “Gel Lifters” in “Black” that measured 5.2” x 14.4” were used for this experiment. The description given for this product by Arrowhead Forensics states that the product can be used “to lift fingerprints, shoe prints, dust marks, and micro traces”. The description states that they are composed of a low-adhesive gelatin that can lift evidentiary material from “almost every surface”⁴.

2.6 Stat-Lift Lifters

Nine “Arrowhead Forensics” “Stat-Lift”™ vinyl impression lifters that measured 9” x 14” in the color “Black” were used for this experiment. The description given for this product by Arrowhead Forensics states that the “Stat-Lift”™ is a revolutionary, cost effective way to recover, transport, and preserve impressions”.

Both the Stat-Lift™ and the Gel Lifters were purchased in black for increased contrast, as well as so that they would not be easily distinguished from one another after being photographed for examination purposes during the study.

The experimental collection process using Stat-Lift™ followed a video tutorial released by Arrowhead Forensics. The process included gently removing the protective backing of the individual Stat-Lift™ sheet, carefully applying the Stat-Lift™ over the dust impression on the substrate. One hand was used to carefully hold the Stat-Lift™ in place, while the other hand gently pushed down on and moved in straight motions to effectively spread the Stat-Lift™ over the impression. Finally, the Stat-Lift™ was removed from the substrate by taking the top of the lifter and pulling it slowly off the substrate in one motion.

2.7 Camera, Photography, and Lighting Arrangements

A Nikon (Nikon, Shinagawa-ku, Toyko) model “Z7” camera with a Nikon model “Nikkor MC 50/2.8” 50mm lens was used for photographing the lift for future examination. All of the photographs were captured on the same day, in the same session, with the same camera mounted at the same working distance from lifts on the copy stand.

Oblique lighting was used for every photograph to gain optimal detail and adequate contrast between the gray/dust colored impression and the black lift. Oblique lighting was achieved by using two flashlights and attaching them to the copy stand at a low angle (approximately 10 degrees) to illuminate the impression.

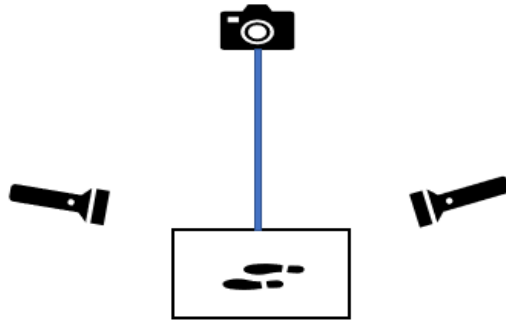


Figure 2. Camera and lighting arrangement

2.8 Grading System/Questionnaire

Three caseworking forensic scientists competent in footwear/impression examinations and comparison volunteered for this project. The volunteers' experience in forensic impression analysis ranged from approximately six years to over twenty years, and all three had experience with gelatin lifters but minimal to no experience with Stat-Lift™. The 18 photographs of the collected lifts (three Stat-Lift™ and three gel lifts for each substrate) were randomized and disseminated to each examiner. Any identifying information on the lifts was cropped or blurred out. Each lift was then given a random number (randomized by writing the numbers 1-18 on small pieces of paper, and having a third party who was not related to the project select them from a container).

With the 18 photographs, each examiner was also supplied with 18 identical questionnaires. Each questionnaire was labeled with the numbers 1-18, so that they would be used for the appropriate lift photograph.

The questionnaires included a series of questions designed to provide an assessment of various features of the lift by each examiner. The first six questions were on a sliding scale of 1-9. Below is an example of how the sliding scale appeared to each examiner, showing Question 1. Each question had a space for comments below, to be utilized by the volunteer, if desired.

Question 1: How much of the outsole was collected or is visible on the lift?

Less than half			Half			Most/all		
1	2	3	4	5	6	7	8	9

Figure 3. Example of Questionnaire Format

The questions on the form with the scale from 1-9 were as follows:

1. How much of the outsole was collected or is visible on the lift?
2. How do you rate the contrast between the dust impression collected and the background color of the lift itself?
3. Is the lift clear enough to visualize fine detail (textures or RACs)?
4. Is the lift clear enough to visualize wear?
5. How would you rate your ability to discern an overall outsole design?
6. Can you rate a level of distortion for the lift?

The rating scale for these questions indicated 9 as being the highest score, or “best” possible answer in terms of a usable, clear, full, and quality lift, and 1 being the lowest

possible answer and thereby indicating an unusable and low-quality lift. In the Results section below, you will see a total of 18 tables: one for each flooring type to correspond to the 6 questions asked of the examiners that involve giving a number rating.

Underneath each table, there is a percentage score or “rating” for the Stat-Lift™ and a percentage score or “rating” for the Gelatin Lifters. This score was determined by adding the total score from all three runs from all three examiners for each lifting method on the specific flooring type for each particular question. The total number of points that a lifting method could have received was 81, since the question had a total score of 9 and each question was answered three times (from the runs of each lift method) by three examiners. Therefore, the total number of points received was divided by 81, the total number of *possible* points, and then multiplied by 100 to create a percentage score. This number was rounded to the nearest whole number.

The final question of each questionnaire asked:

“Please rate the lift/impression’s suitability for comparison”, and allowed the possible answers of:

- A. Unsuitable for Comparison
- B. Suitable for Class Characteristics Only
- C. Suitable for Identification Purposes

This question aimed to implement a version of the previously mentioned OSAC suitability ratings, and asked each volunteer to decide: if they had a “known” evidentiary item to compare to the “unknown” impression they were rating, how successful could

they be in this comparison? If the volunteer answered A, it indicated that they would not be able to even begin a comparison, due to the poor quality of the lift/impression. If they answered B, it indicated that they may be able to compare “class” characteristics”, or “measurable features of an item that indicate a restricted group source based on design factors determined prior to manufacture”³⁰. A class characteristic is one that allows for an item to be put within a larger group (i.e. a “Reebok” sneaker), but does not allow for an examiner to individualize the item to be in a category all of its own, or to identify it. If the volunteers answered C, it indicated that they would be able to use the lift in a comparison to make an identification, that is, that they could find RACs or “Marks on an object produced by the random imperfections or irregularities on the surfaces of the tools used to manufacture the object”³⁰. If a lift shows RACs and other characteristics and earns a “C” answer, the quality and quantity of the characteristics present can be used to perform a comparison.

3. RESULTS

The results from the questionnaire will be presented on a question by question basis, to best reflect how each lifting method performed. An evaluation in this manner allows for an accurate comparison, and gives more insight into where the two methods differed.

3.1 Visibility/Completeness of Impression Rating

These tables and percentage ratings underneath showcase the numerical responses from Question One in the questionnaire.

Table 1. Vinyl Flooring Results for Question 1. Numerical responses to evaluating the visibility and completeness of the lift, with 1 indicating less than half of the lift was collected, and 9 indicating most or all of the lift was collected.

Lift Method	Examiner 1			Examiner 2			Examiner 3		
	Run 1	Run 2	Run 3	Run 1	Run 2	Run 3	Run 1	Run 2	Run 3
Stat-Lift™	7	9	9	8	8	9	9	9	9
Gel Lifters	8	9	9	9	9	9	9	9	9

Visibility/Completeness of Impression Rating for Vinyl Flooring:

Vinyl Flooring Stat-Lift™: 95% score

Vinyl Flooring Gel Lifters: 99% score

Table 2. Hardwood Flooring Results for Question 1. Numerical responses to evaluating the visibility and completeness of the lift, with 1 indicating less than half of the lift was collected, and 9 indicating most or all of the lift was collected.

Lift Method	Examiner 1			Examiner 2			Examiner 3		
	Run 1	Run 2	Run 3	Run 1	Run 2	Run 3	Run 1	Run 2	Run 3
Stat-Lift™	9	5	5	9	7	6	9	9	9
Gel Lifters	8	9	6	8	9	9	9	9	9

Visibility/Completeness of Impression Rating for Hardwood Flooring:

Hardwood Flooring Stat-Lift™: 84% score

Hardwood Flooring Gel Lifters: 94% score

Table 3. Marble Flooring Results for Question 1. Numerical responses to evaluating the visibility and completeness of the lift, with 1 indicating less than half of the lift was collected, and 9 indicating most or all of the lift was collected.

Lift Method	Examiner 1			Examiner 2			Examiner 3		
	Run 1	Run 2	Run 3	Run 1	Run 2	Run 3	Run 1	Run 2	Run 3
Stat-Lift™	5	9	9	9	9	8	9	9	9
Gel Lifters	7	9	8	9	9	9	9	9	9

Visibility/Completeness of Impression Rating for Marble Flooring:

Marble Flooring Stat-Lift™: 94% score

Marble Flooring Gel Lifters: 96% score

3.2 Contrast Between Impression and Lift Rating

Table 4. Vinyl Flooring Results for Question 2. Numerical responses to evaluating the contrast between the impression and the lift, with 1 indicating poor contrast and 9 indicating good contrast.

Lift Method	Examiner 1			Examiner 2			Examiner 3		
	Run 1	Run 2	Run 3	Run 1	Run 2	Run 3	Run 1	Run 2	Run 3
Stat-Lift™	1	5	6	6	4	7	3	3	5
Gel Lifters	8	9	9	8	9	9	7	8	8

Contrast Between Impression and Lift Rating for Vinyl Flooring:

Vinyl Flooring Stat-Lift™: 49% score

Vinyl Flooring Gel Lifters: 93% score

Table 5. Hardwood Flooring Results for Question 2. Numerical responses to evaluating the contrast between the impression and the lift, with 1 indicating poor contrast and 9 indicating good contrast.

Lift Method	Examiner 1			Examiner 2			Examiner 3		
	Run 1	Run 2	Run 3	Run 1	Run 2	Run 3	Run 1	Run 2	Run 3
Stat-Lift™	8	3	1	7	3	3	5	2	2
Gel Lifters	8	9	5	8	8	8	6	9	4

Contrast Between Impression and Lift Rating for Hardwood Flooring :

Hardwood Flooring Stat-Lift™: 42% score

Hardwood Flooring Gel Lifters 80% score

Table 6. Marble Flooring Results for Question 2. Numerical responses to evaluating the contrast between the impression and the lift, with 1 indicating poor contrast and 9 indicating good contrast.

Lift Method	Examiner 1			Examiner 2			Examiner 3		
	Run 1	Run 2	Run 3	Run 1	Run 2	Run 3	Run 1	Run 2	Run 3
Stat-Lift™	3	3	6	5	2	6	2	3	5
Gel Lifters	3	9	9	4	9	9	2	7	7

Contrast Between Impression and Lift Rating for Marble Flooring:

Marble Flooring Stat-Lift™: 43% score

Marble Flooring Gel Lifters: 73% score

3.3 Ability to Visualize Fine Detail Rating

Table 7. Vinyl Flooring Results for Question 3. Numerical responses to evaluating the fine detail visible on the lift, with 1 indicating unable to visualize and 9 indicating able to confidently discern fine detail.

Lift Method	Examiner 1			Examiner 2			Examiner 3		
	Run 1	Run 2	Run 3	Run 1	Run 2	Run 3	Run 1	Run 2	Run 3
Stat-Lift™	5	5	5	4	5	7	5	6	6
Gel Lifters	9	9	9	9	9	9	9	9	9

Ability to Visualize Fine Detail Rating for Vinyl Flooring:

Vinyl Flooring Stat-Lift™: 59% score

Vinyl Flooring Gel Lifters: 100% score

Table 8. Hardwood Flooring Results for Question 3. Numerical responses to evaluating the fine detail visible on the lift, with 1 indicating unable to visualize and 9 indicating able to confidently discern fine detail.

Lift Method	Examiner 1			Examiner 2			Examiner 3		
	Run 1	Run 2	Run 3	Run 1	Run 2	Run 3	Run 1	Run 2	Run 3
Stat-Lift™	9	3	1	6	3	3	5	4	6
Gel Lifters	9	9	6	7	9	9	8	9	9

Ability to Visualize Fine Detail Rating on Hardwood Flooring:

Hardwood Flooring Stat-Lift™: 49% score

Hardwood Flooring Gel Lifters: 93% score

Table 9. Marble Flooring Results for Question 3. Numerical responses to evaluating the fine detail visible on the lift, with 1 indicating unable to visualize and 9 indicating able to confidently discern fine detail.

Lift Method	Examiner 1			Examiner 2			Examiner 3		
	Run 1	Run 2	Run 3	Run 1	Run 2	Run 3	Run 1	Run 2	Run 3
Stat-Lift™	2	5	7	6	4	7	7	6	3
Gel Lifters	2	8	9	7	9	9	6	8	8

Ability to Visualize Fine Detail Rating for Marble Flooring:

Marble Flooring Stat-Lift™: 58% score

Marble Flooring Gel Lifters: 81% score

3.4 Ability to Visualize Wear Rating

Table 10. Vinyl Flooring Results for Question 4. Numerical responses to evaluating the ability to visualize wear, with 1 indicating unable to visualize and 9 indicating able to confidently discern wear.

Lift Method	Examiner 1			Examiner 2			Examiner 3		
	Run 1	Run 2	Run 3	Run 1	Run 2	Run 3	Run 1	Run 2	Run 3
Stat-Lift™	5	3	5	6	6	8	6	6	7
Gel Lifters	9	9	7	9	9	9	9	9	9

Ability to Visualize Wear Rating for Vinyl Flooring:

Vinyl Flooring Stat-Lift™: 64% score

Vinyl Flooring Gel Lifters: 98% score

Table 11. Hardwood Flooring Results for Question 4. Numerical responses to evaluating the ability to visualize wear, with 1 indicating unable to visualize and 9 indicating able to confidently discern wear.

Lift Method	Examiner 1			Examiner 2			Examiner 3		
	Run 1	Run 2	Run 3	Run 1	Run 2	Run 3	Run 1	Run 2	Run 3
Stat-Lift™	9	1	1	7	4	4	7	4	6
Gel Lifters	9	9	5	8	9	9	8	9	9

Ability to Visualize Wear Rating for Hardwood Flooring:

Hardwood Flooring Stat-Lift™: 53% score

Hardwood Flooring Gel Lifters: 93% score

Table 12. Marble Flooring Results for Question 4. Numerical responses to evaluating the ability to visualize wear, with 1 indicating unable to visualize and 9 indicating able to confidently discern wear.

Lift Method	Examiner 1			Examiner 2			Examiner 3		
	Run 1	Run 2	Run 3	Run 1	Run 2	Run 3	Run 1	Run 2	Run 3
Stat-Lift™	4	6	7	8	6	7	7	6	7
Gel Lifters	1	9	6	9	9	9	6	8	9

Ability to Visualize Wear Rating for Marble Flooring:

Marble Flooring Stat-Lift™: 72% score

Marble Flooring Gel Lifters: 81% score

3.5 Outsole Design Visibility Rating

Table 13. Vinyl Flooring Results for Question 5. Numerical responses to evaluating the ability to determine outsole design, with 1 indicating unable to discern any outsole design and 9 indicating confidently being able to discern outsole design.

Lift Method	Examiner 1			Examiner 2			Examiner 3		
	Run 1	Run 2	Run 3	Run 1	Run 2	Run 3	Run 1	Run 2	Run 3
Stat-Lift™	7	8	9	7	7	9	9	9	9
Gel Lifters	9	9	9	9	9	9	7	9	9

Outsole Design Visibility Rating for Vinyl Flooring :

Vinyl Flooring Stat-Lift™: 91% score

Vinyl Flooring Gel Lifters: 98% score

Table 14. Hardwood Flooring Results for Question 5. Numerical responses to evaluating the ability to determine outsole design, with 1 indicating unable to discern any outsole design and 9 indicating confidently being able to discern outsole design.

Lift Method	Examiner 1			Examiner 2			Examiner 3		
	Run 1	Run 2	Run 3	Run 1	Run 2	Run 3	Run 1	Run 2	Run 3
Stat-Lift™	9	5	3	8	7	5	9	8	9
Gel Lifters	9	9	7	8	9	9	9	9	9

Outsole Design Visibility Rating for Hardwood Flooring:

Hardwood Flooring Stat-Lift™: 78% score

Hardwood Flooring Gel Lifters: 96% score

Table 15. Marble Flooring Results for Question 5. Numerical responses to evaluating the ability to determine outsole design, with 1 indicating unable to discern any outsole design and 9 indicating confidently being able to discern outsole design.

Lift Method	Examiner 1			Examiner 2			Examiner 3		
	Run 1	Run 2	Run 3	Run 1	Run 2	Run 3	Run 1	Run 2	Run 3
Stat-Lift™	4	8	9	8	8	8	9	9	3
Gel Lifters	6	9	9	9	9	9	9	9	9

Outsole Design Visibility Rating for Marble Flooring:

Marble Flooring Stat-Lift™: 81% score

Marble Flooring Gel Lifters: 96% score

3.6 Lack of Distortion Rating

Table 16. Vinyl Flooring Results for Question 6. Numerical responses to evaluating the ability to determine a level of distortion for the lift, with 1 indicating that the lift is very distorted and 9 indicating that there is little to no distortion.

Lift Method	Examiner 1			Examiner 2			Examiner 3		
	Run 1	Run 2	Run 3	Run 1	Run 2	Run 3	Run 1	Run 2	Run 3
Stat-Lift™	3	4	5	4	5	7	3	3	6
Gel Lifters	6	9	7	9	9	8	7	9	9

Lack of Distortion Rating for Vinyl Flooring:

Vinyl Flooring Stat-Lift™: 49% score

Vinyl Flooring Gel Lifters: 90% score

Table 17. Hardwood Flooring Results for Question 6. Numerical responses to evaluating the ability to determine a level of distortion for the lift, with 1 indicating that the lift is very distorted and 9 indicating that there is little to no distortion.

Lift Method	Examiner 1			Examiner 2			Examiner 3		
	Run 1	Run 2	Run 3	Run 1	Run 2	Run 3	Run 1	Run 2	Run 3
Stat-Lift™	9	5	5	6	7	8	6	7	6
Gel Lifters	9	9	9	7	8	9	9	9	9

Lack of Distortion Rating for Hardwood Flooring:

Hardwood Flooring Stat-Lift™: 73% score

Hardwood Flooring Gel Lifters: 96% score

Table 18. Marble Flooring Results for Question 6. Numerical responses to evaluating the ability to determine a level of distortion for the lift, with 1 indicating that the lift is very distorted and 9 indicating that there is little to no distortion.

Lift Method	Examiner 1			Examiner 2			Examiner 3		
	Run 1	Run 2	Run 3	Run 1	Run 2	Run 3	Run 1	Run 2	Run 3
Stat-Lift™	8	9	5	7	8	8	6	6	9
Gel Lifters	9	7	9	8	9	9	2	9	9

Lack of Distortion Rating for Marble Flooring:

Marble Flooring Stat-Lift™: 81% score

Marble Flooring Gel Lifters: 88% score

3.7 Overall Rating Comparisons

These percentages were created by taking the total sum of answers for each flooring type in each category (Stat-Lift™ or Gel Lifters) and dividing it by the total possible points (81 multiplied by 6 questions, equaling 486 total possible points), then multiplying by 100 to create a percentage out of a perfect score of 100.

3.7.1 Vinyl Flooring Overall Comparison

The total averages of all results from all six questions for the Vinyl Flooring are as follows:

Stat-Lift™: 68%

Gel Lifters: 96%

3.7.2 Hardwood Flooring Overall Comparison

The total averages of all results from all six questions for the Hardwood Flooring are as follows:

Stat-Lift™: 63%

Gel Lifters: 92%

3.7.3 Marble Flooring Overall Comparison

The total averages of all results from all six questions for the Marble Flooring are as follows:

Stat-Lift™: 72%

Gel Lifters: 86%

3.9 Suitability Ratings

This study found that all 18 lifts were rated at least a “B” rating, or that each volunteer felt that every lift would be able to be used for a class characteristic comparison to another lift in casework.

For the Stat-Lift™ on the vinyl flooring, five of the lifts gained a “C” answer, indicating that they were considered suitable for identification purposes. The other four in this category gained a “B” rating.

For the Stat-Lift™ on the hardwood flooring, five of the lifts gained a “C” answer. The other four in this category gained a “B” rating.

For the Stat-Lift™ on marble flooring, seven of the lifts gained the “C” answer, and only two lifts gained just a “B” rating.

All nine of the gelatin lifters on the vinyl flooring gained the highest “C” rating.

All nine of the gelatin lifters on the hardwood flooring gained the highest “C” rating.

All nine of the gelatin lifters on the marble flooring gained the highest “C” rating.

4. DISCUSSION

The rating system designed for this study showed the Gel Lifters outperformed the Stat-Lift™ in every individual category. This brief discussion will explore some of

the comments made by the examiners, as well as some of the author's observations made and documented when preparing the experiment.

It should be noted that this is a limited study, using three common flooring materials that were all non-porous, and did not explore different types of impressions outside of a true "dust" impression. This study also did not explore different temperatures of substrates and how each lifting method would perform based on notable changes to heat or cold, as the lifts were all prepared and photographed at a basic room temperature. Moreover, in this study, lifts were photographed immediately after the dust impressions were collected from the substrates; in actual casework, it may not be possible to photograph lifts immediately. Additionally, this research did not investigate how the lifts "held up" over time, and did not allow time to examine possible distortion or loss of detail that may result from long term storage.

4.1 Visibility/Completeness of Impression

The difference in performance in this category was not extreme, both the Stat-Lift™ and the Gelatin Lifters maintained a rating of 80% or above for all three substrates. A rating of 100% would indicate that the impression on the lift was easy to visualize. The volunteer examiners commented that the Stat-Lift™ was given lower ratings due to the

lightness of the impression on the lift, which made it more difficult to visualize whether or not was complete.

4.2 Contrast Between Impression and Lift

The Gel Lifters greatly outperformed the Stat-Lift™ in this category. This ties in with the previous comment of the lightness of the Stat-Lift™, which perhaps affected the contrast between the dust impression of the lift. Examiners commented that it was very easy to distinguish the impression from the black background, but some examiners commented that the Stat Lift background appears “grainy” or “pixelated” which caused lower contrast

4.3 Ability to Visualize Fine Detail

The Gel Lifters greatly outperformed the Stat-Lift™ in this category. Examiners noted that class characteristics were apparent in the Stat-Lift™ impressions, while RACs and class characteristics were very apparent on the Gel Lifters.



Figure 4. Side by Side RACs on lift comparison (Left: Stat-Lift™, Right: Gelatin Lifter)

4.4 Ability to Visualize Wear

Again, the Gel Lifters ranked far better than the Stat-Lift™ for this portion of the examination. Wear ties in with fine detail, in that a lift must be clear and visible in order to fully appreciate and regard it. Examiners again commented that a “grainy” quality to the impression on the Stat-Lift™ created difficulty when trying to determine if a portion

of the impression was wear or simply noise from the dust and background quality of the lift.

4.5 Outsole Design Visibility

Both lifting mediums ranked highly in this category. The Stat-Lift™ only fell below an 80% rating in the case of the hardwood flooring. The hardwood flooring was natural wood, and therefore had some lines and textures to it, which may have made the detail of the outsole design more difficult to visualize. For both lifting mediums, examiners commented that they could see class characteristics and the tread design of the impression, which would be useful in determining shoe type in an examination.

4.6 Lack of Distortion

The Stat-Lift™ performed poorly on the Vinyl flooring in this category, earning a 48% rating as compared to the Gel Lifters 90% rating. The Stat-Lift™ increased its rating for the hardwood and marble substrates. The author did notice that the vinyl flooring had the least amount of grip to it, and had a shinier and less slip-resistant surface, which may have directly accounted for this. The Gel Lifters are tacky, allowing them to gently

adhere to a surface, which seems to have greatly minimized distortion caused by slippage.

4.7 Suitability for Comparison Ratings

While the majority of Stat-Lift™ performed at a “B” rating for the lifts, indicating that each impression on the lifts could be used in a comparison with a known shoe, many were rated at a “C” level, indicating that they could be utilized for identification purposes in a comparison. Every Gelatin Lifter performed at a “C” rating in this question, which demonstrates that each lift that was created using this method would be useful in a casework comparison and identification setting and use.

5. CONCLUSIONS

This study provided empirical data that Gel Lifters provide a better surface for clearer and more detailed lifts of dust impressions when compared to the Stat Lift™ product. The Gel Lifters outperformed the Stat Lift™ in impression visibility, contrast, lack of distortion, retention of detail, and completeness of impression collection from the substrate.

The collection process for the Stat Lift™ and the Gel Lifters is similarly straightforward. As previously mentioned, this was a limited study, and future research using these lifting techniques could explore possible variation or degradation from

storage conditions, additional types of substrates, additional environmental conditions during collection, and additional matrices.

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