CADRE FORENSICS

TopMatch-3D
High Capacity

3D Virtual Microscopy
Scanning and Analysis System
for Firearm Forensics.

True **3D**

3D Virtual Microscopy Scanning and Analysis System for Firearm Forensics

True **3D**

The TopMatch-3D High-Capacity Scanning and Analysis System consists of the patented High-Capacity 3D Scanner and the TopMatch Analysis Software.

• Industry Leading Tools for Virtual Comparison Microscopy (VCM)

• Fast, Accurate, High-Resolution Scan Capture

• Database Search and Automated Comparison

• Interpretable Scoring Function with Highlighted Regions of Interest

• 15-Holder Tray for Batch Scanning

• Scan, Save, and Share 3D Measurements in ISO Standard X3P Format (ISO 25178-72)

• VCM Client Software Allows Remote Access to Cadre VCM Tools and 3D Scans on Examiner Workstations

• Data Sharing between Locations via Cadre Nexus

With TopMatch-3D High Capacity only one computer workstation is required for 3D scan capture, visualization, analysis, and database search. Additional workstations can be added for remote viewing and collaboration.
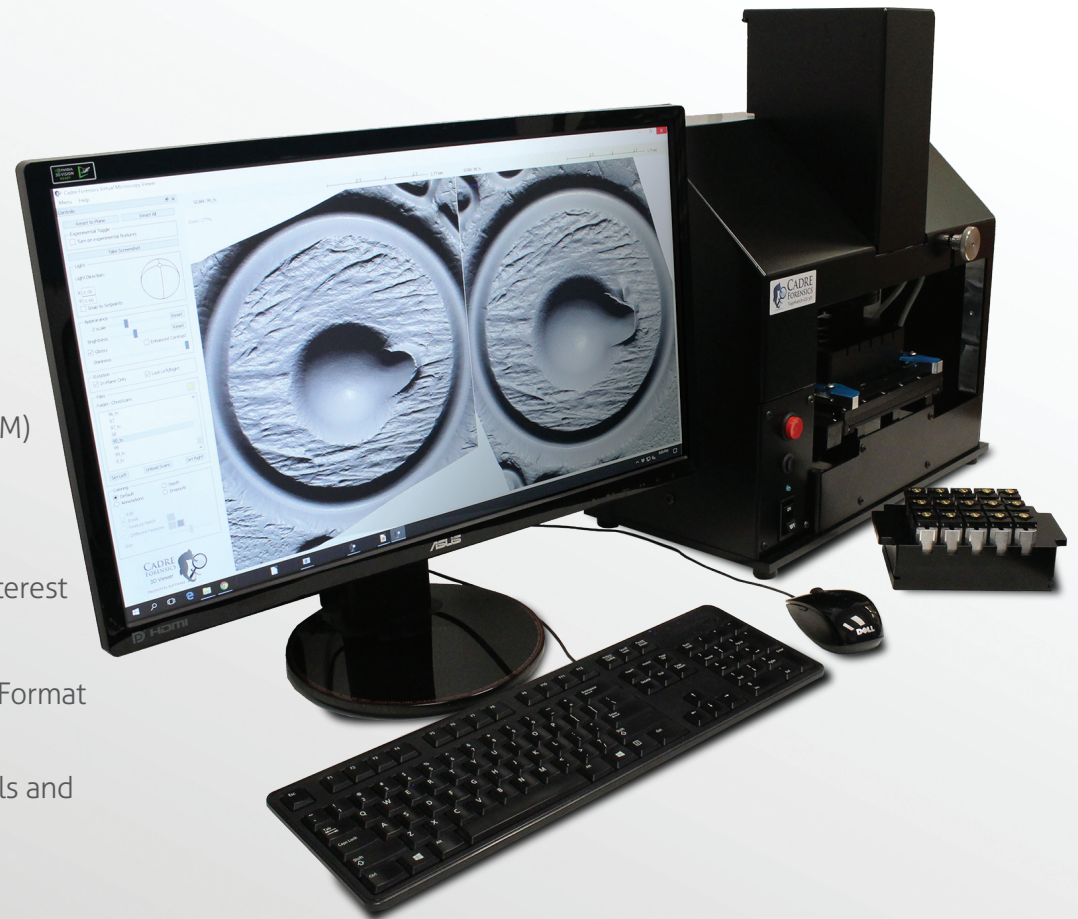
Fast. Accurate. High-Resolution Scan Capture

The TopMatch GelSight sensor can measure toolmark surfaces with micron-scale lateral and depth resolution. When you visualize a scan using TopMatch-3D Virtual Comparison Microscopy (VCM) you are seeing its true high-resolution 3D surface topography. The detail provided via TopMatch-3D VCM often exceeds that visible with a traditional comparison scope.

Because the true high-resolution 3D surface geometry is captured, examiners can adjust a virtual light within the software to bring out individual features for visual comparison.

Fast scan acquisition optimizes an examiner's productivity and can reduce backlog.

15
SPECIMEN BATCH SCANNING TRAY

The TopMatch High Capacity tray holds up to fifteen cartridge cases and microscale references to automate and expedite scanning and QC checks. Shotshell and Bullet trays are also provided. TopMatch's barcode interface allows tray, gel, and cartridge case barcoding to expedite the scan process and improve organization.

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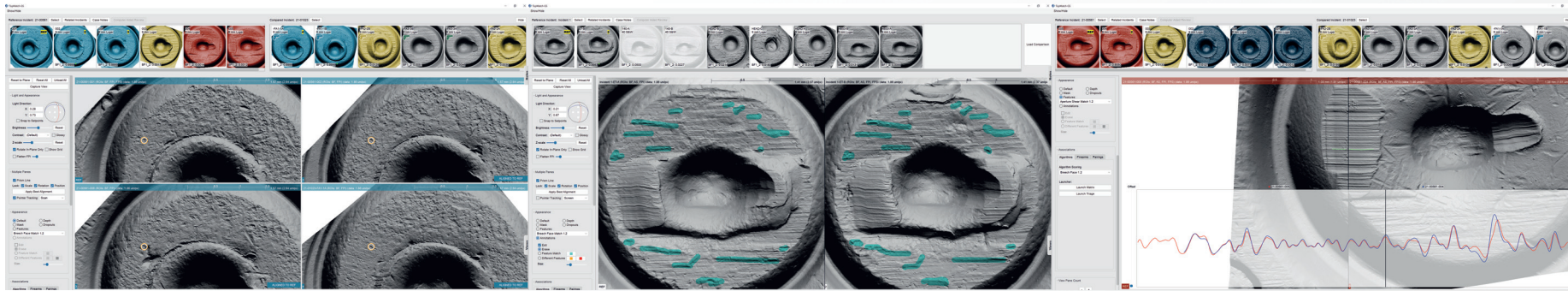
3D Visualization and Virtual Comparison Microscopy

3D VCM doesn't stop at scan acquisition. Cadre's TopMatch software is designed around easy organization of 3D surface data, scan metadata and examiner analyses. Each user has a separate workspace which stores their notes, views, source conclusions, and annotations. This separation supports truly blind verifications. The Case Management functionality provides each user an organized list of tasks. Data can be transferred and accessed remotely, allowing you to create a virtual private database and to engage in off-site review and verification.

Experience the detail yourself. Take a test drive with Cadre's free X3P viewer at

www.CadreForensics.com
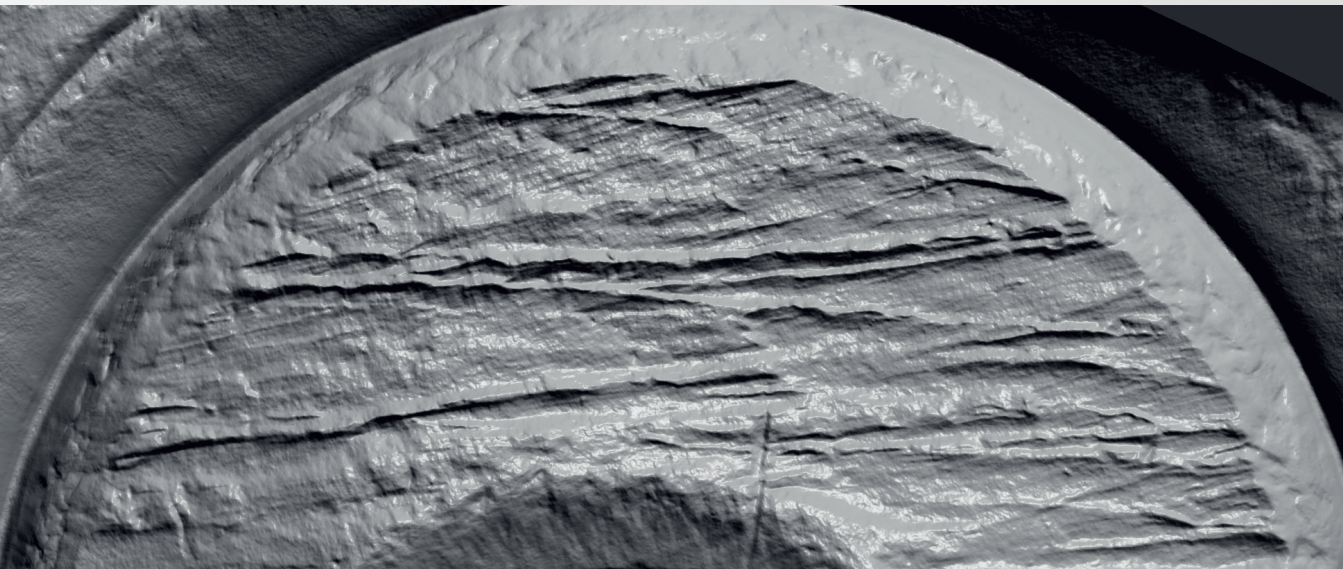
Interpretable Results

Algorithm Visualizations Provide Comparison Insights

Unlike other systems which provide little to no explanation on the details of the comparison results, the TopMatch system can display several types of visual overlays to explain computed scores. Some of the first overlays were introduced by Cadre in 2014. These overlays provide interpretability and facilitate communication of findings to those who are not experts in firearm forensics. Examiners can use the algorithm to perform a micron scale alignment in a single click.

Comparison Confidence

TopMatch has several similarity scores — each score computes a number reflecting the underlying confidence in the comparison and the support for common origin. Scores are part of Cadre's new KISS (Keep It Statistically Simple) model. Specific criteria are used to identify comparisons with the highest likelihood for common origin.

> TopMatch's unique comparison algorithm includes several methods for analyzing topographic features. Cadre's approach identifies geometric structures similar to those considered by a trained examiner.
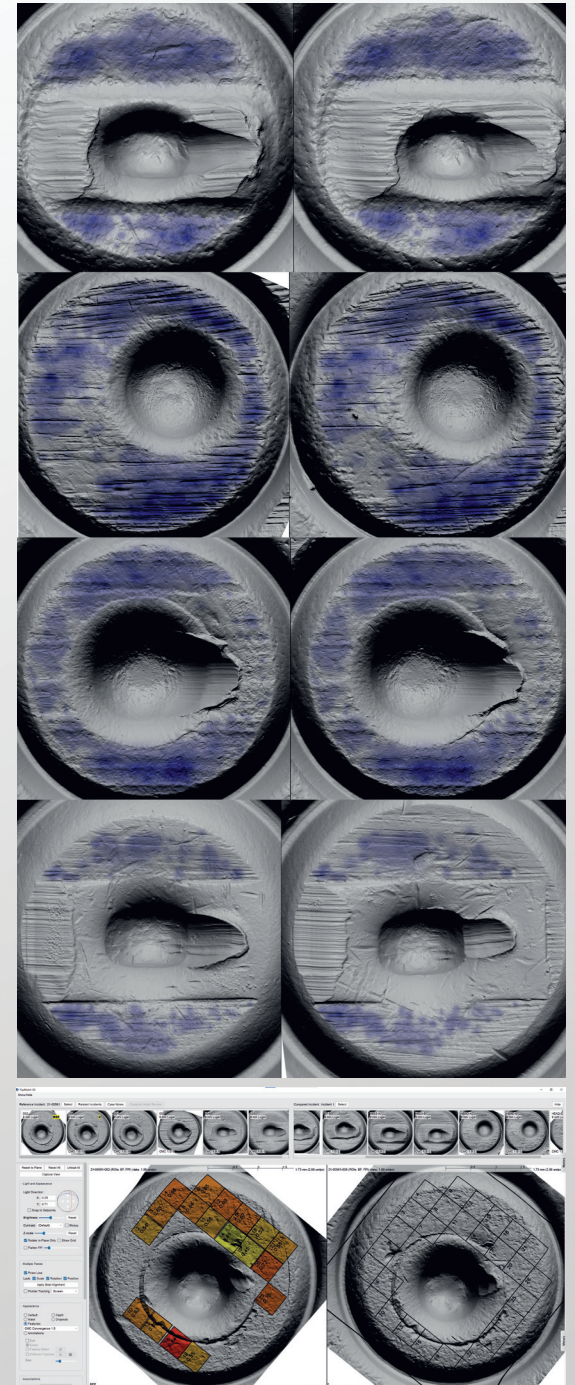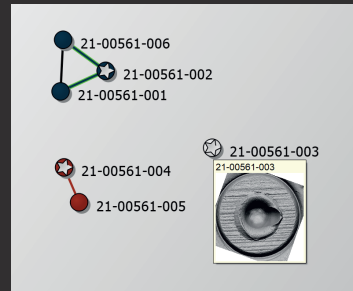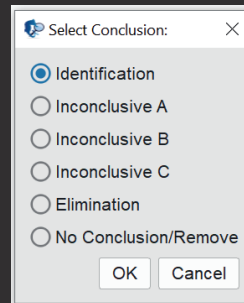
TopMatch: The World's Most Powerful VCM Tools for Examiners

- Virtual Prism line swipes to change specimen field of view similar to a traditional scope.

- Color coded thumbnails provide visual source organization at a quick glance.

- Saved Views are 3D bookmarks allowing the examiner to return to saved 3D setups and lighting at any time.

- Record conclusions on a 3 or 5 point scale

- Triage Graph and Score Matrix allow fast visualization of scan relationships.

- Related Incidents panel provides quick access to other cases with identified specimens.

- Notes provide text based documentation of examiner work.

- Structured Case Note reports can be exported in MS Word format including all metadata, notes, and screenshots.
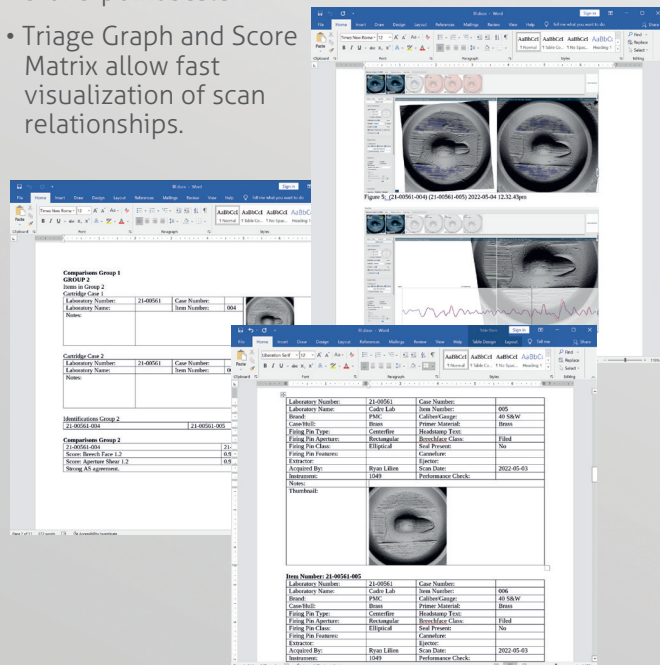
True 3D
from Acquisition through Analysis

Select Conclusion:

- ● Identification
- ○ Inconclusive A
- ○ Inconclusive B
- ○ Inconclusive C
- ○ Elimination
- ○ No Conclusion/Remove

OK   Cancel

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Cadre Nexus

Cadre's acquisition and analysis software can be linked to the Cadre Nexus. The Nexus is a secure cloud-based platform that allows for the storage, retrieval, and search of topographic data. The Nexus is built on AWS GovCloud, a platform designed for government applications, which meets FedRAMP High baseline, U.S. International Traffic in Arms Regulations (ITAR), Criminal Justice Information Services (CJIS), and other regulatory requirements.

- User, Lab, and Region specific access rights
- Access your scans with unique specimen ID
- Share scans between sites
- Upload and download in X3P format

Firing Pin Impressions

Use of a proprietary gel pad improves the resolution of steep slopes allowing high resolution imaging of firing pin impressions. Cadre's optional flattened view improves visibility of individual characteristics.

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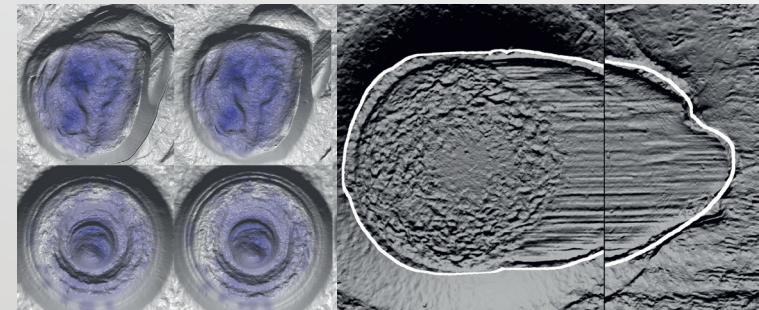
Freely Exchange Your Data
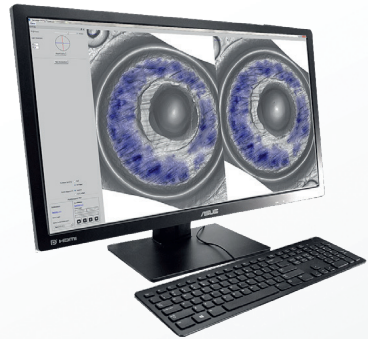
X3P — *XML 3D Surface Profile*

Free to Export It's your data

TopMatch allows you to export scans to share with other labs.

Open File Format

Cadre is a founding member of Open-FMC (Open Forensic Metrology Consortium), a group of government, academic, and private institutions pioneering the use of the open X3P file format (ISO 25178-72) for the exchange of surface topography data. Systems supporting X3P are compatible with each other and can easily exchange data.

Bullets

TopMatch's bullet tray allows scanning of land and groove areas. Submicron depth sensitivity allows matching of striation profiles. Damaged bullets and bullet fragments are best scanned on the TopMatch-3D Portable unit.

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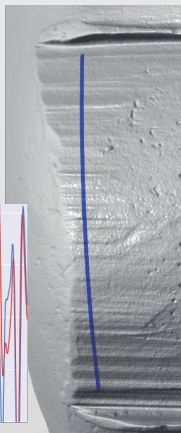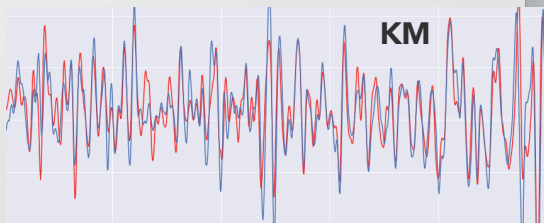
Shear Extraction and Matching

Aperture Shears are extremely useful when comparing two cartridge cases. As a striated mark, shears are correctly compared by measuring the similarity of their linear profiles. The TopMatch-3D scanner can accurately measure aperture shears and the system's robust profile extraction algorithm can characterize a shear's linear profile even when it's distorted. Shears can be compared independently or combined with the breech-face impression to give an overall confidence of match.
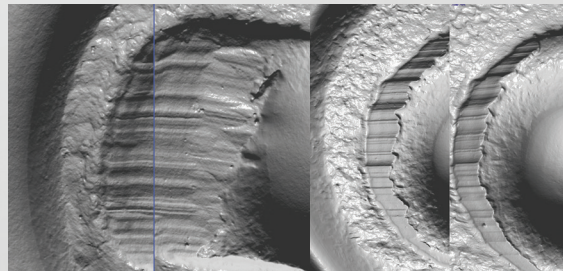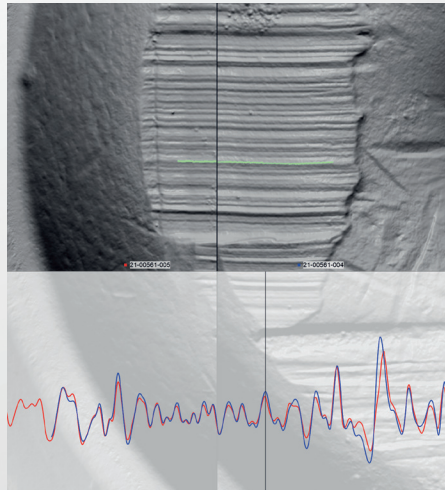

3D visualization and extracted shear profiles from Glock and Ruger test fires measured on the TopMatch system.

Validation
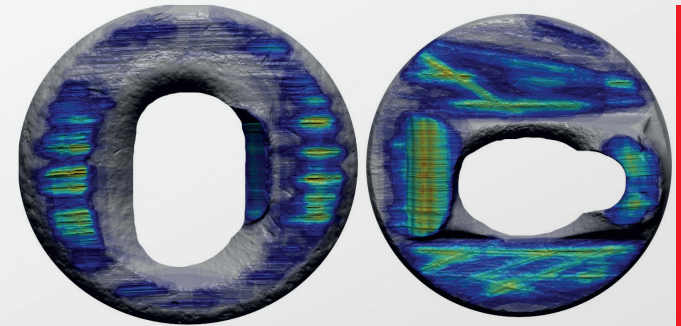
Several Validation Studies support the use of Cadre's VCM tools within the forensic laboratory. This support includes peer reviewed publications and independent studies conducted by the FBI and Canada's RCMP. Studies involving more than 300 participants have been completed at the local, state, national, and international levels. These studies demonstrate performance at or beyond that of traditional microscopy [4,5,6,7,8] and strongly support the use of Cadre VCM in casework.

TopMatch-3D Portable
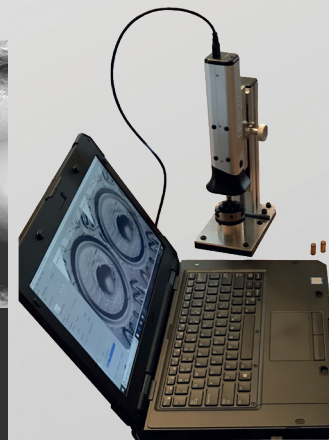
The TopMatch-3D Portable Scanner complements the Desktop system. It acquires scans in seconds using the same patented gel-based scanning process as the desktop and measures at a resolution close to the desktop scanner. The portable system is recommended for scanning damaged bullets and bullet fragments. An included ruggedized laptop allows use outside the forensic lab.

System Specifications

Imaging Sensor & Objective:	12 Megapixels; Telecentric Optics
Imaging Resolution:	Lateral: 0.9 - 1.8 microns per pixel. Typical operation 1.8. Depth: Better than 1 micron
Computer:	Multi-Core High-End Workstation with 28" 4K Display and Solid State Drive
Scanner Dimensions and Weight*:	19" (48.3 cm) wide x 10" (25.4 cm) deep x 21" (53.34 cm) tall; 48 lbs (22 kg) *(not including computer or monitor)
Power:	Standard North America 110V Power Outlet
Software:	TopMatch Workstation (Database, Analysis, Visualization, and Search); Lab Site License for Remote Viewer (Virtual Microscopy, Runs on Examiner Workstation)
Scan Storage Capacity:	150,000 (expandable)
X3P File Format Support:	Yes
System Support:	Full Phone and Email Support; On-Site when Required; Maintenance Package Covers all Hardware and Software

Cadre Forensics

The TopMatch-3D system is designed and developed by Cadre Forensics, an American company with headquarters in Chicago, Illinois. Beginning in 2013, recognizing the need for new technology within the forensic community, three PhDs and an experienced firearms examiner began development of the technology that would become the TopMatch System [1,2,3].

The project developed as an application of their research areas within computer science, engineering, and machine learning. The system's core imaging sensor is based on patented MIT research and is being further developed by GelSight Inc, a small business located in Massachusetts. The sensor utilizes a proprietary nondestructive gel to remove the influence of unwanted optical characteristics on the measurement process, ensuring accuracy, repeatability, and consistent performance.

Cadre contributes to the US economy by utilizing American manufacturing facilities in Illinois, Arizona, and Massachusetts. Final assembly takes place in Illinois.

[1] Johnson and Adelson, "Retrographic Sensing for the Measurement of Surface Texture and Shape", Proc. of the IEEE Conf. on Computer Vision and Pattern Recognition (CVPR), 1070-1077, 2009. [2] Johnson, Cole, Raj, and Adelson, "Microgeometry Capture using an Elastomeric Sensor", ACM Trans. on Graphics, Proc. of SIGGRAPH, 30(46:1-46:8), 2011. [3] Weller, Brubaker, Duez, and Lilien, "Introduction and Initial Evaluation of a Novel Three-Dimensional Imaging and Analysis System for Firearm Forensics", Association of Firearm and Toolmark Examiner Journal, 47(4):198-208, 2015. [4] Duez, Weller, Brubaker, Hockensmith II, and Lilien, "Development and Validation of a Virtual Examination Tool for Firearm Forensics", J. of Forensic Sciences, 63(4):1069-1084, 2018. [5] Chapnick, Meschke, Duez, Weller, Marshall, and Lilien, "Results of the 3D Virtual Comparison Microscopy Error Rate Study (VCMERS) for Firearm Forensics", J. of Forensic Sciences, 66(2):557-570, 2021. [6] Knowles, Hockey, Marshall, "The Validation of 3D Virtual Comparison Microscopy (VCM) in the Comparison of Expended Cartridge Cases", J. of Forensic Sciences, 67(2):516-523, 2022. [7] Meschke, Duez, Chapnick, Weller, Carr, and Lilien, "Results of the 3D Virtual Comparison Microscopy Topography Resolution Study (VCMTRS)" (in preparation). [8] Carr, Chapnick, Duez, Meschke, Weller, Keisler, Kilmon, Oberg, and Lilien, "Results of the 3D Virtual Isolated Pairs Study" (in preparation).
Note: Images in this document do not appear at full resolution. Parts of the TopMatch-GS 3 system and GelSight sensor are covered by granted and pending US Patents. GelSight is a trademark of GelSight Inc.

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