Photographic Documentation of Forensic Fire Scenes

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Overview

- Fire Patterns
- Fire Pattern Analysis
- Two-Dimensional Photographic Documentation
- Three-Dimensional Photographic Documentation
- Future of Fire Pattern Analysis

For Starters… What is Fire?

- Fire = “uncontrolled combustion involving chemistry, thermodynamics, fluid mechanics, and heat transfer.”

What are Fire Patterns?

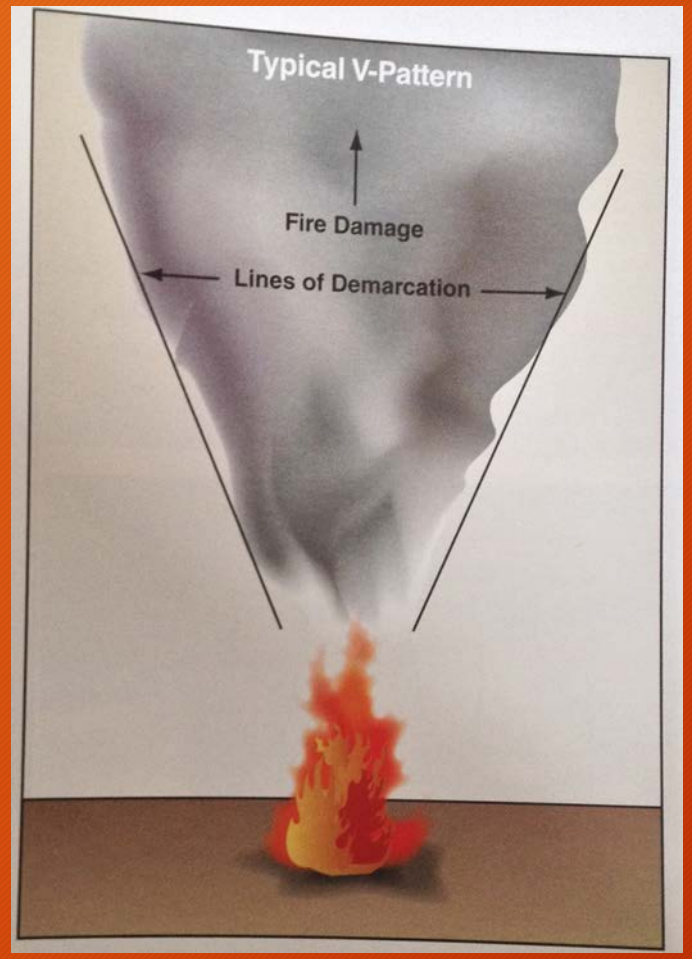
- Fire pattern = the visible or measureable physical effects that remain after a fire.
- Fire patterns result from:
  - Smoke
  - Hot gases
  - Heat
  - Flames

The Creation of Fire Patterns

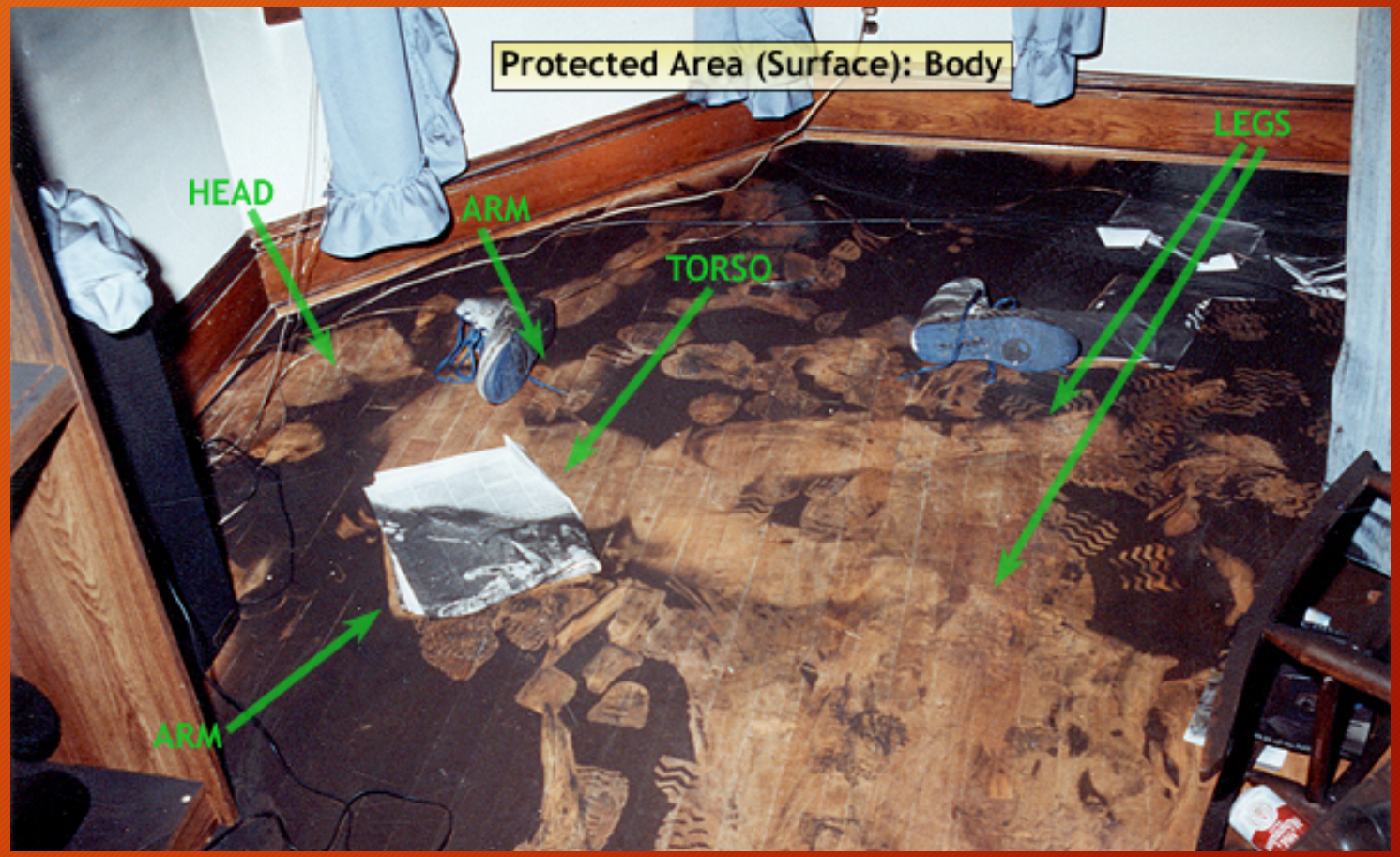
- Fire patterns represent demarcation lines of fire effects upon materials created by the 3D shape of the fire plume being cut by an intervening 2D surface.
  - Wall, ceiling, appliances, furniture, a body, etc.

Iron Man 3

Examples of Fire Patterns: "Classic V"



Examples of Fire Patterns: Protected Surface

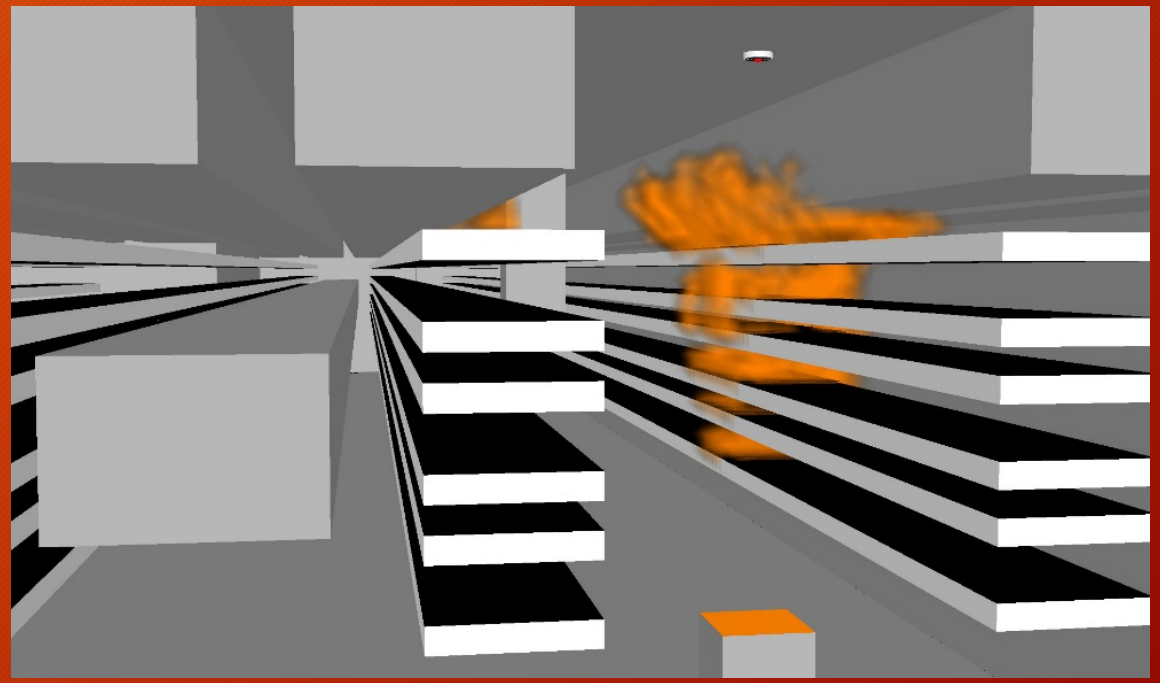


Fire Pattern Analysis

- **Purpose: reconstruct the dynamics of the 3D fire event.**
- **Want to predict fire phenomena and characteristics:**
  - **Fire's origin**
  - **Intensity**
  - **Growth**
  - **Direction of travel**
  - **Duration**

Basic Methods for Fire Pattern Analysis

- Bench-scale modeling
- Full-scale modeling
- Computer modeling



On-Scene Analysis Tools

- Thermocouple trees and heat flux transducers.
- Heat and flame vector analysis, depth of calcination.
- Video and still photography.
- Direct observation.
- Written notes and diagrams.

Two-Dimensional Data Capture

- Record general features of and the relationships with other objects nearby.
- Helpful in determining how the fire spread.
- Documentary photographs – mimic rough sketches *(qualitative)*.
- Metric photographs – like engineering drawings or maps *(quantitative)*.
- 35mm film usually better than digital images.

Digital Images

- Digital photos or videos – image data is stored in a binary format.
- Recording an artifact's surface geometry and its photometric properties.
- Ultimately, allow fire investigator to answer reconstructive questions about the dynamic development of fire patterns.

Problems with 2D Data Capture

- In photography, lighting is everything!
  - Burnt objects are black – absorb light.
  - High reflectivity of charring.
  - Low levels of light in indoor scenes.
- Photographs and diagrams are often not sufficient to capture information on three-dimensional fire dynamics and building construction.

Review:
Purpose of Photographic Reconstruction

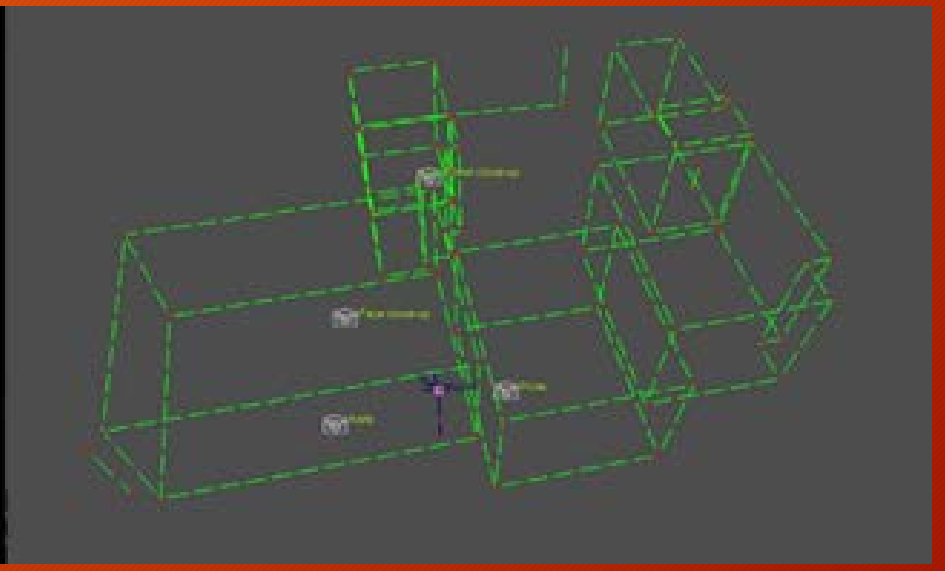
- Fire investigator wants to answer reconstructive questions about the dynamic development of fire patterns.
- Three-dimensional images for a three-dimensional phenomena.
- 3-D imaging can add “quantitative content.”

Emerging Three-Dimensional Imaging Technology

- Use of photogrammetry and computer vision to create 3D images from photographs and video sequences.
  - Typically need a matched pair of images from two different vantage points for 3D reconstruction.
  - Ex: The Italian Job.

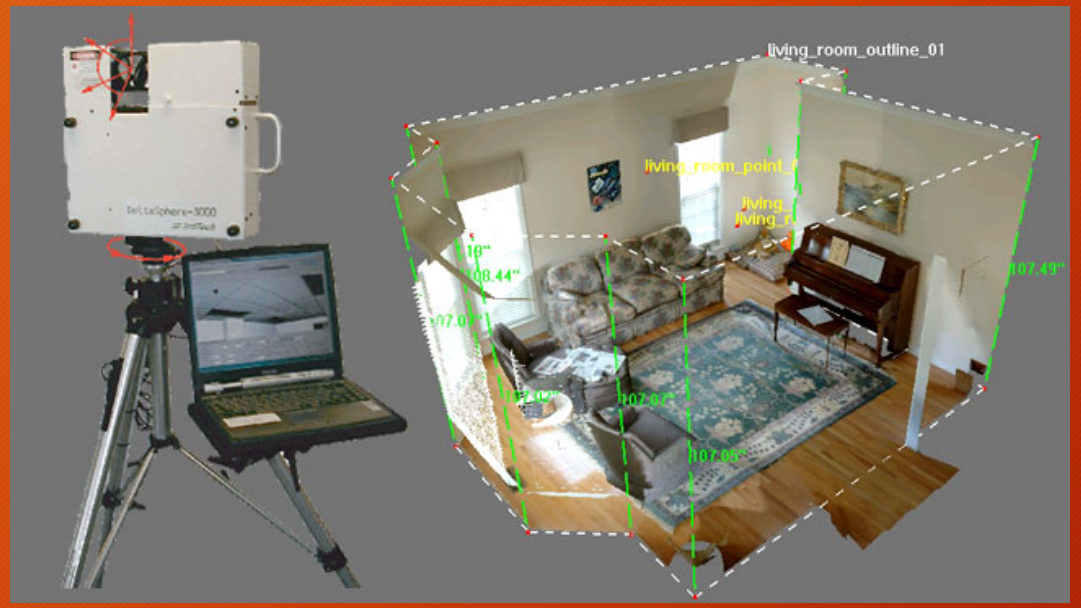
3D Imaging Features: Cameras and Scanning Technologies

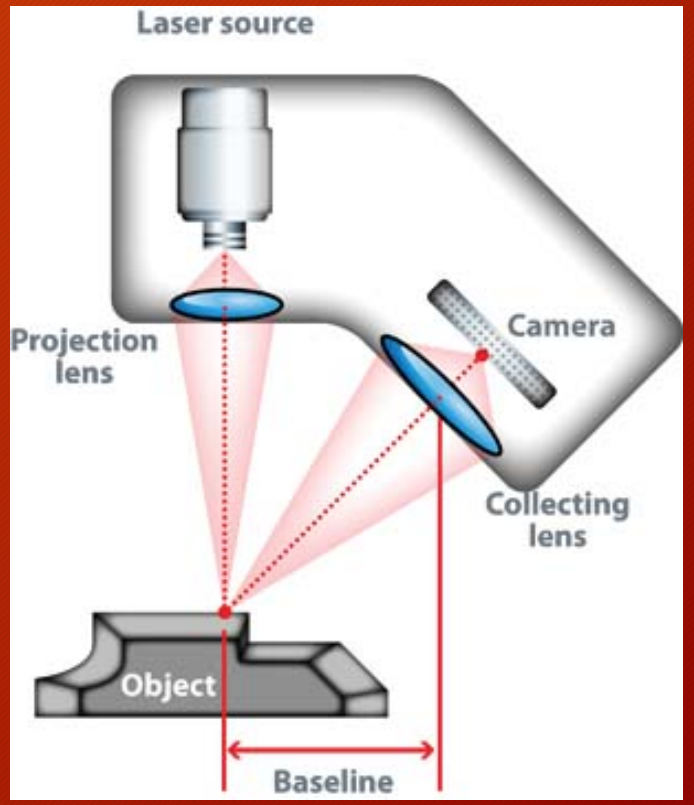
- **Laser 3D scanners/cameras:**
  - Capture depth and volume aspects.
  - Generate digital scene replicas.



How Laser Scanning Works

- **“Sheet-of-light” technique: laser triangulation and sensors to determine light intensity and height and width profiles.**
- **Combination of hardware and software.**





3D Imaging Progression

1. Actual
2. Laser Scan
3. Color Corrected

1 2 3

Newer 3D Scanning Tools

- **Hand-held scanners:**
  - **Use geometric fusion algorithms to generate complete shape scans.**

3D Imaging Techniques: + and -

- **Biggest Pros:**
  - **3D fire analyzed in 3D → truer recreation.**
  - **Do not have to remove evidence from where it was found in the crime scene!**
- **Biggest Cons:**
  - **Very expensive.**
  - **Large and cumbersome instrumentation.**

Creating Fire Pattern Databases

- Pattern recognition: statistical comparison of pattern data against patterns or info extracted from patterns.
  - Like CODIS, AFIS, and IBIS.
- 3D scans will improve fire pattern databases.
- Compare known/unknown scans by:
  - Graphical overlapping.
  - Geometric transformations.

Current State of Affairs

- Currently, fire pattern analysis is quite subjective.
- Databases would shift analysis from subjective interpretations to objective conclusions.
- Better understanding of fire remains → increased reliability of investigator's conclusions.

The Future of Fire Pattern Analysis

- 3D imaging technologies are improving accuracy, precision, variability, and objectivity.
- Recognized by NIJ and NIST as the up-and-coming method for fire pattern analysis.
- Accessibility and use of 3D scanning will increase as the equipment becomes more affordable.
- Overall, will lead to more productive fire investigations by improving quantitative and qualitative analyses.

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Any Questions?