

# Off the Grid: Perspective Grid Photogrammetry in Crime Scene Reconstruction

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**Abstract:** Photogrammetry, the practice of obtaining accurate measurements from a photograph, is a technique nearly as mature as photography. One of the most rudimentary forms, perspective grid photogrammetry, utilizes an object of known dimensions within the photograph to determine the spatial relationships of evidence in the photograph. By measuring the location of two points, each piece of evidence captured within a photograph may be extrapolated. This enables on scene crime scene investigation work to be completed in a fraction of the time typically required using baseline or triangulation measurements. Spending less time measuring can be advantageous for those crime scenes located in war zones, in situations in which bad weather will disrupt the crime scene, or whenever the time at the crime scene must be minimized.

**Keywords:** perspective grid, photogrammetry, spatial analysis, crime scene photography, crime scene reconstruction, forensic science

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## Introduction

Photogrammetry is the science of determining spatial relationships of objects within a photograph. One of the most rudimentary forms of photogrammetry is perspective grid photogrammetry. Although perspective grid photogrammetry is elementary in nature compared with software applications, its user and budget-friendly characteristics make it a valuable tool for crime scene reconstruction. The instrumentation required for this method includes an object of known dimensions in the photograph, a ruler and a pencil. With these tools, the amount of time required on scene to measure evidence locations within a crime scene may be dramatically reduced. For this technique, square tiles are placed in the low center of the composition of the photograph and used as a scale that may be expanded to encompass all evidence that is

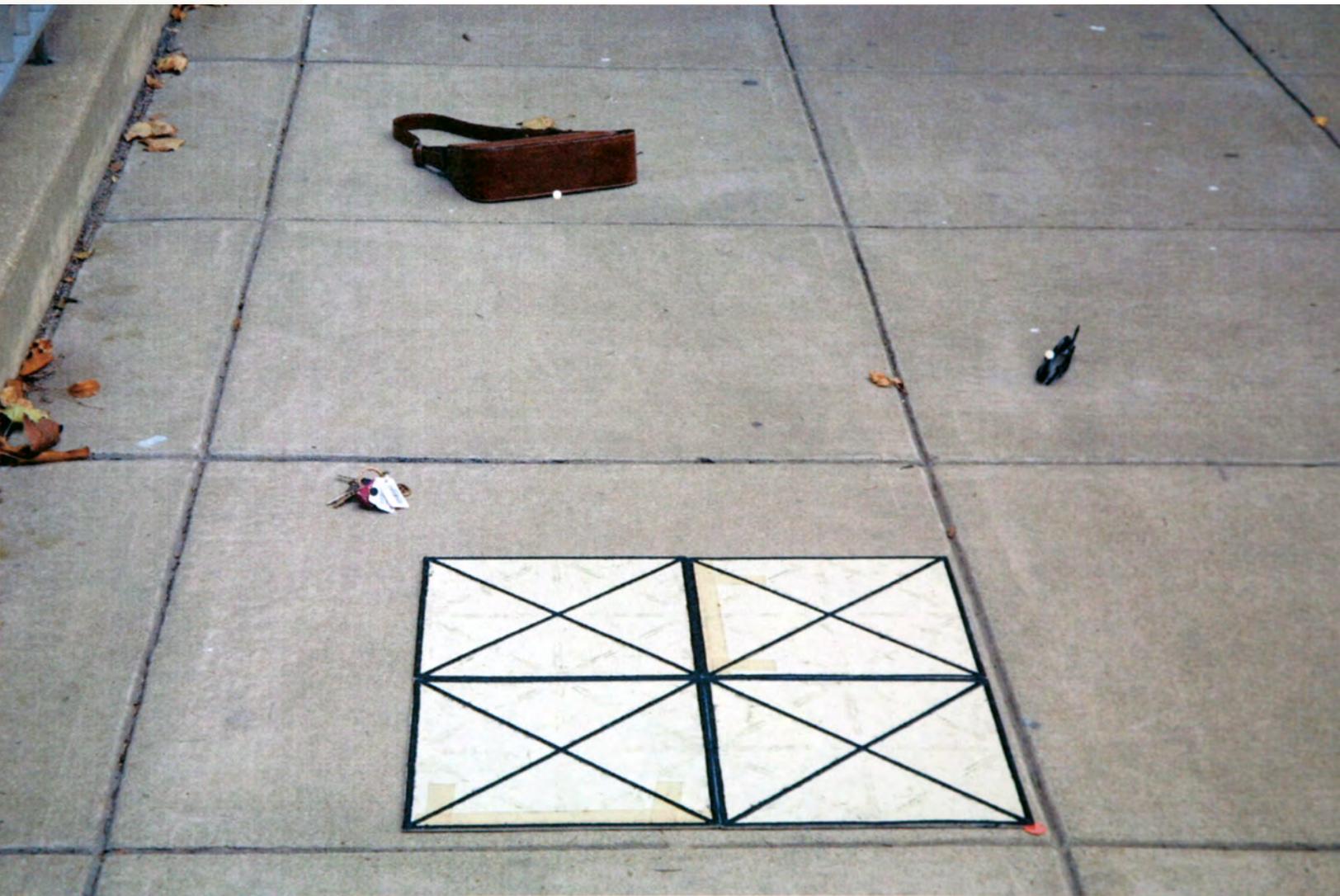
located within the same plane as the grid.

## Method

*(Refer to supplemental online material for a step-by-step tutorial.)*

The first step in this process is capturing a photograph that includes the grid and the evidence of interest. The grid system is a set of tiles of known dimension with the edges marked by drafting tape and the corners crossed with drafting tape such that an 'X' crosses through the center of the tile. The size of the tiles used will be dictated by the size of the scene, with a medium-sized scene requiring four 1'x1' square tiles that creates a 2'x2' grid. For this technique, two points must be measured, the (0,0) point of the grid, or the bottom center, and a point some distance from the (0,0) point, several feet out the Y-line, which is the center vertical line extended from the (0,0) point. When





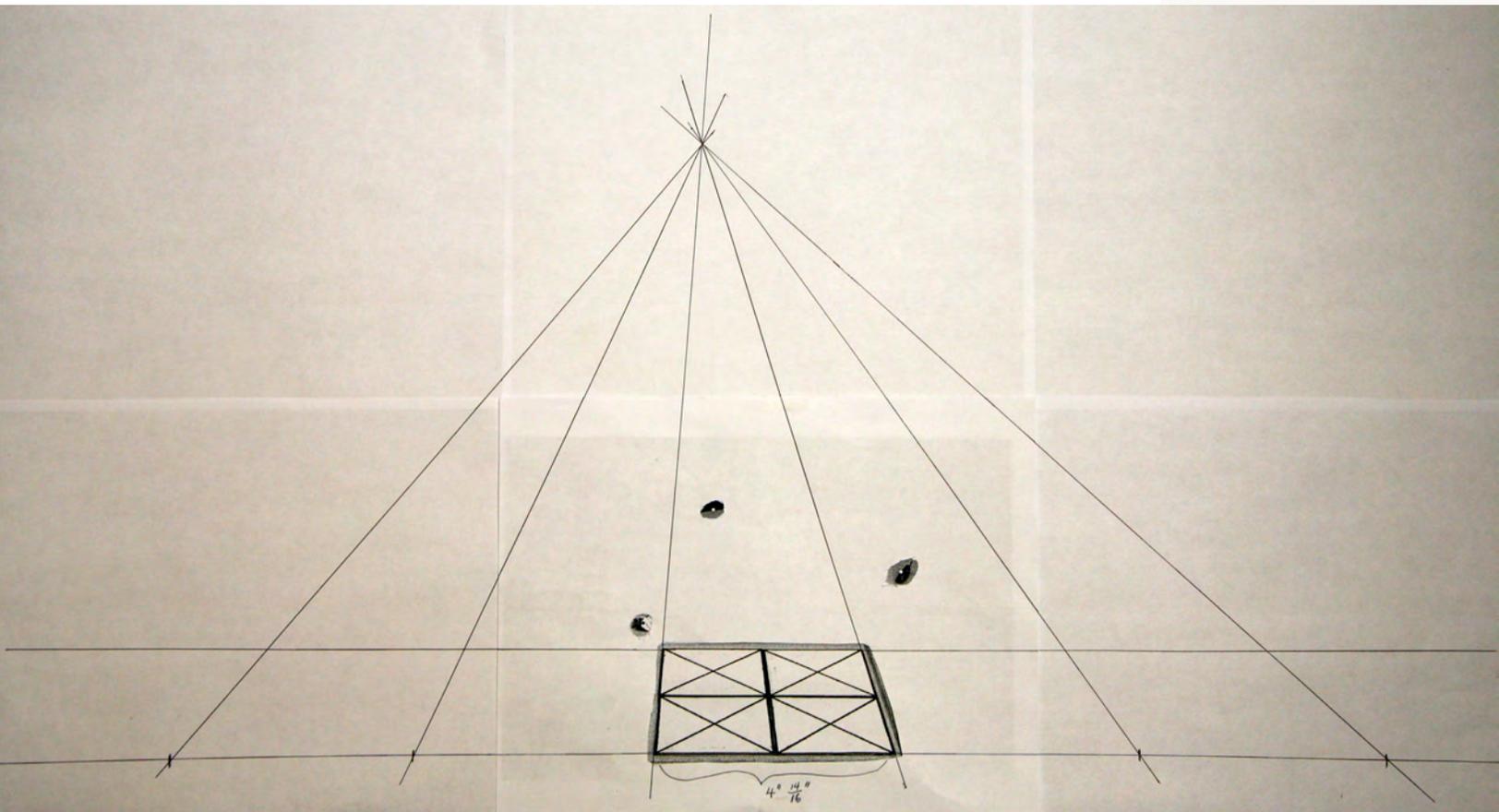
▲ **Figure 1: Example of photograph used for perspective grid photogrammetry.**

capturing the image of the scene with the grid system included, it is vital that the edge of the grid closest to the camera is parallel to the bottom sensor plane of the camera. If this condition is not met, the extrapolation of the grid system will be skewed such that one side of the expanded grid will condense while the other increases in area.

Prior to extending the graph over the evidence, it is helpful to extend the amount of workspace that is used by taping additional sheets of paper to the edges of the photograph. The additional sheets of paper do not need to be added to the side of the photograph below the grid. The extension of the grid begins with extending the bottom line and top line of the grid in both directions. Once this has been completed, the right and left sides of the grid should

be extended upward until the two vertical lines converge. This point will be referred to as the horizon point. This will create an isosceles triangle. Once this has been accomplished, the baseline of the grid within the picture is then measured to the best precision available. This measured distance should then be measured from both lower edges of the grid and marked with hash marks. The same distance is then measured from the marked distance. These hash marks can then be connected to the horizon point to form new vertical lines [1].

After the isosceles triangle has been created, the original grid should have its corners crossed with diagonal lines, extended in either direction such that they intersect all the vertical lines. At the two points in which the diagonals intersect the first two



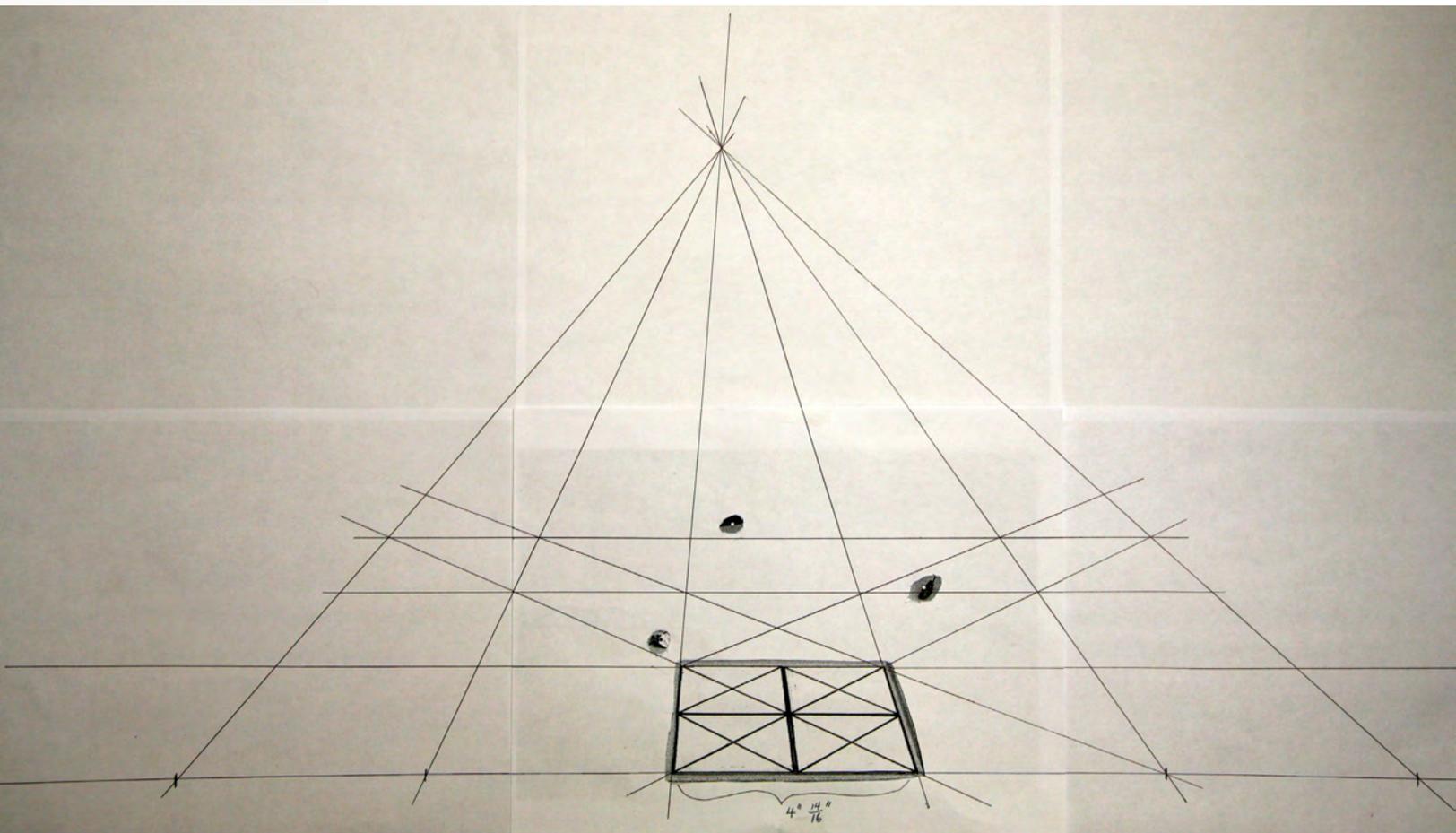
vertical lines, a horizontal line should be drawn connecting the intersection points. A horizontal line should then be drawn that connects the next set of intersection points. With the addition of the horizontal lines, there should be fifteen squares that will each represent 2'x2' of space in the photograph. Any difference in shape, size, or appearance of the squares is the result of viewing the 2'x2' squares in perspective. By crossing the corners of the 2'x2' square immediately above the original grid, additional horizontal lines may be drawn in order to ensure that all evidence is contained within a 2'x2' box [1].

Once all evidence is contained within a 2'x2' box, those boxes may be subdivided in order to locate the evidence more precisely. This is accomplished by crossing the corners of the box of interest and the corners of an adjacent box. The center intersection points of the two boxes may be connected by a horizontal line. The box may be bisected vertically with a vertical line that ex-

tends through the center of the box to the horizon point. It should be noted that for convenience, it is best to only extend each subdivision line through the box of interest; this will prevent a myriad of confusing lines being added to the overall graph. Once the 2'x2' box has been vertically and horizontally bisected, it is now comprised of four 1'x1' boxes. These boxes may be subdivided repeating the steps above by crossing the corners of the box of interest and one of the adjacent boxes. A horizontal line is then drawn through the center intersection points of the two boxes, and the box of interest is vertically bisected by connecting the center of the box to the horizon point. This will create four 6"x6" boxes. The box containing the evidence may then be divided again so that four 3"x3" boxes exist. One important thing to note is that because the film plane is not parallel to the evidence, the perspective of the photograph will make the determination of the center of mass difficult. In order to make the determination as consistent as possible,

▲ **Figure 2: Isosceles triangle resulting for the extension of hash marks to horizon point.**





▲ **Figure 3: Extension of grid system to encompass evidence.**

the center of the bottom edge of the piece of evidence should be used as the measurement point for the evidence [1].

Once all subdivisions have been completed, the location of the evidence is determined from the (0,0) point, or the bottom center of the grid system. The grid system is then comparable to a coordinate plane system with the center line that extends to the horizon point being the y-axis and the bottom baseline being the x-axis. Two feet of distance is covered from the bottom center to the top of the original grid, and one foot of distance to either the right or left side of the original grid. Each full unit of movement in any direction represents two feet of space. Portions of a full unit occur at each subdivision, and the specific location from the point of origin may be determined using these sectors [1].

### Supplemental Information

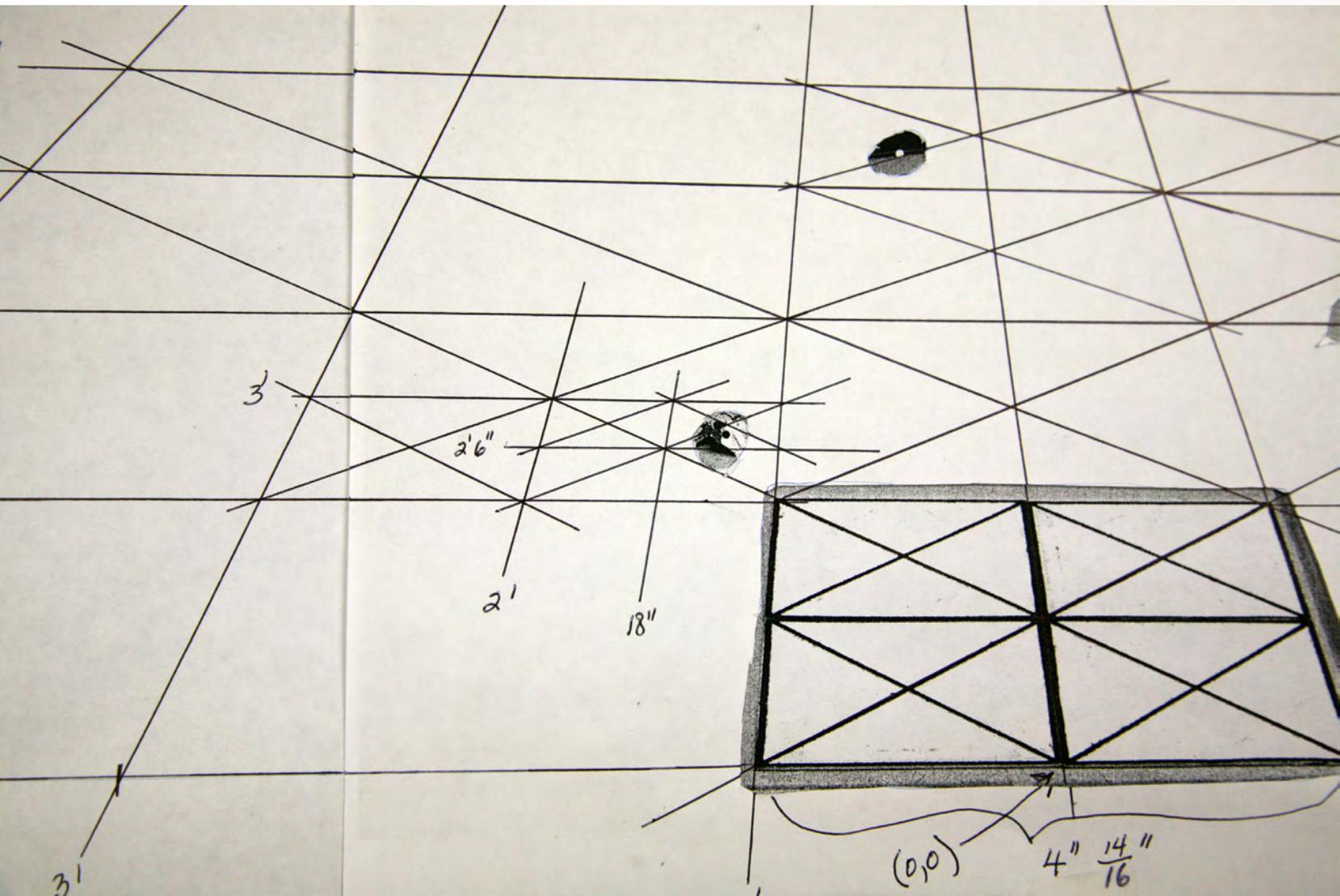
1. Perspective Grid Step-by-Step Tutorial

2. Video Tutorial of Perspective Grid Photogrammetry

### References

1. Robinson, E. M. (2007). Crime Scene Photography. Academic Press/Elsevier. pp. 425-439.





▲ Figure 4: Subdivision of 2'x2' square resulting in evidence contained within a 3"x3" square.



