## D8 Comparison of Measurement Error Between 3D Laser Scanning, Total Station Survey, and Photogrammetry Using PhotoModeler®

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After attending this presentation, attendees will be able to assign a confidence level to the method of measurement chosen for their specific purpose.

This study will impact the forensic science community by providing expert witnesses with information regarding the potential levels of error when dimensioning an object using a 3D laser scanner, a total survey station, or PhotoModeler® photogrammetry software.

The devices and software used were a FARO® Focus$^{3D}$ laser scanner with SCENE software, a Trimble® 5000 series total station survey system, and photogrammetry using PhotoModeler® 6 to analyze photos and take measurements. All three methods were compared to known dimensions as determined with a steel tape. Three separate measurements were taken at various points on a tool cabinet. The measurements were taken at the points located at the edge of the wooden top, along the back supporting column, and from a diagonal located along the face of the base (see photographs below).

The FARO® scanner was used at high and standard definitions. The settings at high definition were set to ¼ resolution, which is a point density of .221 inch spacing at 30 feet, and 6x quality, which measures the same point six times and averages the distance. The settings at standard definition were set to ¼ resolution, and 4x quality. Scanning at standard definition required only one-third of the time needed to complete a high-definition scan. Four scans were taken at each setting and were registered by using SCENE software. Each measurement was taken three times and averaged for comparison to the steel tape. The Trimble® total station survey system used direct reflection for point gathering. The points were downloaded and labeled in the Trimble® office application and exported as a .dxf file. The .dxf file was then opened in AutoCAD® and measurements were taken by measuring the 3D length between points. Photos of the cabinet were taken and imported into PhotoModeler®, which was used to construct a 3D model of the cabinet. Measurements between the indicated points were obtained using the PhotoModeler® measuring tool. To obtain the diagonal measurement, an additional line was drawn and measured.

Error was determined by determining the difference between the digital measurement and the steel tape measurement for each point. The calculated percent errors were averaged for comparison. The average percent error for the high definition scans, standard definition scans, total survey station, and PhotoModeler® measurements when compared to the steel tape are 0.18%, 0.27%, 0.38%, and 0.36%, respectively. The maximum percent error for the high definition scans, standard definition scans, total survey station, and PhotoModeler® measurements when compared to the steel tape were 0.22%, 0.33% 0.49%, and 0.63% respectively (see tables below).





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**High Definition Scanner vs. Steel Tape**

| | Steel Tape | Scanner | % Error | Error in In. |
|---|---|---|---|---|
| 1 | 59.375 | 59.256 | 0.20042 | 0.119 |
| 2 | 67.75 | 67.652 | 0.14465 | 0.098 |
| 3 | 65 | 64.856 | 0.22154 | 0.144 |
| AVE | | | 0.18887 | 0.120333333 |

**Standard Definition Scanner vs. Steel Tape**

| | Steel Tape | Scanner | % Error | Error in In. |
|---|---|---|---|---|
| 1 | 59.375 | 59.176 | 0.33516 | 0.199 |
| 2 | 67.75 | 67.6 | 0.2214 | 0.15 |
| 3 | 65 | 64.84 | 0.24615 | 0.16 |
| AVE | | | 0.26757 | 0.169666667 |

**Photogrammetry vs. Steel Tape**

| | Steel Tape | Photo | % Error | Error in In. |
|---|---|---|---|---|
| 1 | 59.375 | 59.496 | 0.20379 | 0.121 |
| 2 | 67.75 | 68.085 | 0.49446 | 0.335 |
| 3 | 65 | 65.278 | 0.42769 | 0.278 |
| AVE | | | 0.37532 | 0.244666667 |

**Survey Station vs. Steel Tape**

| | Steel Tape | Survey | % Error | Error in In. |
|---|---|---|---|---|
| 1 | 59.375 | 59.0016 | 0.62888 | 0.3734 |
| 2 | 67.75 | 67.7964 | 0.06849 | 0.0464 |
| 3 | 65 | 65.2416 | 0.37169 | 0.2416 |
| AVE | | | 0.35635 | 0.220466667 |

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**Digital Dimensioning, 3D Scanning, Error**





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