University of Central Oklahoma

W. Roger Webb Forensic Science Institute

& Jackson College of Graduate Studies

Edmond, Oklahoma

ADVANCED CRIME SCENE MAPPING AND TECHNOLOGY COURSE DESIGN

By Jennifer C. Johnson

University of Central Oklahoma

A THESIS

SUBMITTED TO THE GRADUATE FACULTY

in partial fulfillment of the requirements

for the degree of

MASTER OF FORENSIC SCIENCE – DIGITAL FORENSICS

April 2021

Advanced Crime Scene Mapping and Technology Course Design

Thesis Title

Jennifer C. Johnson

Author's Name

4/10/2021

Date

Jackson College of Graduate Studies at the University of Central Oklahoma

A THESIS APPROVED FOR

Master of Science in Forensic Science - Digital Forensics

By

Dr. Mark R. McCoy

Committee Chairperson

Dr. Wayne Lord

Committee Member

Caitlyn Porterfield, M.S.

Committee Member

Committee Member

Abstract

The purpose of this project is to develop an Advanced Crime Scene Mapping and Technology course that aims to strengthen crime scene documentation and mapping skills, enhance cognitive abilities, and introduce students to advanced digital technologies that are gaining popularity in several forensic science disciplines. In particular, recent advancements in 3D laser scanning, mapping, and drone technology have presented the fields of crime scene investigation and reconstruction with many exciting new possibilities for potential uses. However, due to several limitations regarding the cost of equipment and training, the availability of resources, time constraints, and limited knowledge, it is often difficult for agencies to integrate new tools into their investigative processes. This course endeavors to help alleviate some of these issues by providing students with a basic knowledge and understanding of relevant new technologies while keeping them firmly grounded in the fundamental principles of crime scene processing and reconstruction. The content and structure of this course are designed to be flexible so it can accommodate rapid changes in technological advancements and device regulations. As such, complete instructions and tutorials are not included for specific brands of equipment and software, but instead focus on general concepts and procedures that can be generally applied to most similar devices.

Keywords: forensic science, crime scene processing, crime scene reconstruction, education, curriculum, total station, 3D scanner 3D scanning, reflective learning, drone

Table of Contents

Acknowledgements

I have more gratitude than I could ever find space to express it, but will endeavor to convey the deep appreciation I have for those at the Forensic Science Institute (FSI) and the friends and family who have supported me throughout this project and beyond.

To Dr. Mark McCoy, my graduate advisor and professor from whom I took the majority of my courses. Thank you for your enduring patience through my constantly evolving thesis project ideas, classroom shenanigans, and helping me finally push through to the finish. When I first visited the FSI to learn more about the program, you were the first person I met with and it left a big impression, helping me decide to return to school after many years away. Little did we both know that our initial meeting was the first of many over the next several years, and I am grateful for your constant support and patience throughout all that time.

To Dr. Wayne Lord, not only as a thesis committee member but as a mentor and adventure buddy. Although I never had you as a professor in a normal classroom, I learned more from you over the years than could fill a course curriculum. I am grateful for your support, for your ideas, reflections, and life lessons, and for helping me broaden my perspectives through your example and guidance. Whether it's sand volleyball, sailing off the coast of Maine studying Wildlife Forensics or just general tomfoolery, I am very grateful for the time I've gotten to know and learn from you.

To Caitlin Porterfield, my committee member, colleague, and friend. You are one of the kindest, most charitable and hardworking people I've ever met, and you'll never know how much you've helped me to learn and grow both as a person and as a student. You inspired and helped me to get involved in so many different student and professional organizations, service projects, and community events, both within forensic science and without. I am always inspired by your selfless hard work and positive attitude, and the way you press on even through great

trial and difficulty. Thank you for all your help with this project, and even more so for your example and friendship. You are amazing!

To Dr. Dwight Adams, FSI's director and driving force. Thank you for accepting me into the graduate program and for later providing me with a job, both of which gave me the opportunity to face new challenges while starting a new chapter in my life. I am very grateful for the opportunity I had to both learn and work at the FSI, and really appreciate the trust you put in all of us and the support and protection you gave us. The environment within the FSI is very special, and I know it takes an incredible person to build, cultivate, and maintain such an extraordinary place full of extraordinary people. Thank you for your support and generosity, and for the inspiration you give to your students.

To Mr. Craig Gravel, for helping me access the technology, equipment, and software I needed for this project. I am grateful for the courses I took from you in Advanced Crime Scene and Reconstruction, and later for the opportunity to guest lecture about 3D technology and participate in classroom demonstrations while I learned about different mapping devices.

To Janie Womble and Debra Clark, for all the love, support, and fun over the years! Thank you for everything from helping me register for classes, letting me borrow your keys when I locked mine in my office, lending a supportive hand or friendly ear, helping me with my thesis, and for all the fun times playing volleyball or going to lunch. You ladies are wonderful and amazing, and I absolutely loved working with you!

To all the rest of the FSI faculty and staff, I wish I had space to write a specific thank you to all of you, but the acknowledgements would be longer than my thesis! You are all family to me and I am so grateful and appreciative for each and every one of you. My time spent at the FSI has been some of the best of my life, and has changed me in so many ways. I am grateful for all

the knowledge and insight you've imparted, the strength and confidence you've shown, and the great kindness and humor with which you live your lives.

I would also like to acknowledge Curtis Ferguson of the Oklahoma City Police Department Crime Scene Unit for mentoring and training me in the use of a 3D scanner during my internship there. I want to also thank the National Society for Women in Forensic Science and its amazing members, who helped answer questions, obtain real information about needs and concerns currently encountered in the field, and for being loving and supportive in many other ways. Finally, I would like to thank my dear parents, family, and friends who supported me throughout this degree and cheered me on all the way to the finish.

Thank you all, I am so exceedingly grateful for the great light you bring into the lives of those around you despite the darkness we see throughout our life and work. Your examples and attitudes give me hope and strength, and I endeavor to carry forward what I've learned from you and be for others what you have all been to me. Thank you.

Introduction

As advancements in technology continue to grow, so do the number of fields these innovations can be applied to. Many tools developed for a specific task or industry have evolved and been adapted for use in other areas. Forensic science, as an inherently multidisciplinary field, is in a unique position to benefit from many of these new developments.

Forensic Science employs a wide range of disciplines that are collectively applied to help resolve civil and criminal legal issues. Even though the various specialties within forensics are quite varied from one another, they work together toward a shared objective and all build on the same foundational principles and values. Some of these commonalities include the use of sound methodologies for analysis, keeping thorough documentation throughout an investigation, and providing unbiased conclusions. Mutually valued competencies include those of acute observation, attention to detail, sharp critical thinking and problem solving skills, and adaptability.

These underlying standards remain constant even though procedures, practices, tools, techniques, and regulations may change over time. Each discipline within forensic science experiences these changes at varying rates and expresses different attitudes towards them, allowing some areas to adopt new technologies more readily than others.

Crime scene processing and reconstruction are two such fields that have begun to embrace some of these exciting new and newly adapted technologies, such as 3D scanners and drones. Although these devices boast many purported benefits, their widespread adoption is hindered by several limiting factors. Some of these impediments include cost, availability of resources, accessibility of training and materials, time constraints, differing attitudes and expectations, and rules regarding validity, reliability, and admissibility in courts when used as demonstrative evidence.

However, despite these continual adjustments and impediments, the primary objectives and basic principles within forensic science remain the same. In order to maintain foundational standards while remaining flexible to rapid changes, vital skills such as critical thinking, problem-solving, and learning how to learn become even more important as they strengthen an investigator's ability to adapt.

With these considerations in mind, the purpose of this project is to develop an Advanced Crime Scene Mapping and Technology course that aims to build upon foundational knowledge while focusing heavily on sharpening the cognitive skills that will help students best prepare to enter the dynamic field of forensic science.

Statement of Problem

In such an extensive and growing field as forensic science, it can often be difficult to keep up with the constant flow of new scientific advancements, emerging technologies, and evolving legal regulations amid the usual struggles for adequate funding, availability of resources, properly trained personnel, and demands on time.

Even though new tools such as 3D scanners and drones are intended to help save time and produce enhanced results, the time and cost it takes to obtain, train and become proficient in them can deter many from embracing their use. Those agencies who are able to acquire newer technologies often find that unless individuals are already familiar with or willing to put in the time and effort to learn them, the tools and training provided often go unutilized.

Additionally, each agency trains their investigators according to their own regulations, practices and accessible equipment. While they all follow the same foundational forensic principles, the specifics can vary widely from agency to agency.

With so many factors playing a role in the adoption and implementation of new technologies, the ability to adapt and learn becomes an increasingly important skill for students to acquire before entering the field.

Background

Advancements in technology seem to move at an ever increasing rate, and yet their adoption and implementation into certain fields can progress very slowly. This can be attributed to many different factors, both from a practical standpoint as well as an environmental one. Some disciplines are hesitant to integrate new tools out of tradition or disinterest, while others simply do not have the resources or personnel necessary to acquire and operate them.

Innovations and advancements in the 3D sector have been especially prevalent of late, with the rise of 3D scanners, drones, 3D printers and other similar devices. Many of these tools have been developed for other industries such as construction, architecture, engineering, archaeology, and the medical field. These technologies continue to evolve and be adapted for use in an ever increasing range of fields, and even include equipment, software, and other solutions specifically designed for crime scene mapping and reconstruction.

While 3D and computer-based mapping technologies are currently receiving a lot of attention due to recent advancements that have made them more commonplace and accessible, their design and development has taken place over many years.

The concept of 3D scanning began as early as the 1960's, although still primitive, expensive, and time consuming. Throughout the 1980's and 90's, 3D scanning continued to evolve through experimentation with light and laser technology while aided by advances in computing (Edl et al., 2018). Similarly, total stations (electronic instruments designed to measure various angles and distances) originally designed for land surveying, also appeared in the late 1960's (National Museum of American History, n.d.).

The adoption of advanced digital mapping tools from other industries is not unprecedented in crime scene reconstruction, although their acceptance has been slow and their common usage irregular. For example, total stations have been successfully implemented in accident reconstruction and crime scene mapping since the early 1990's (Joice, B., 2008), but this still does not mean that every investigative unit is equipped with one.

Every tool is designed for a specific task or purpose, and the understanding and proper utilization of each tool dictates its value and effectiveness within any given field. Total stations are a quick and accurate means of collecting both vertical and horizontal measurements over wider areas, which is especially advantageous for larger accident or crime scenes that need to be processed and cleared quickly. However, they are not as easy or as beneficial to use in smaller areas, and so are only used for the scenarios they are best suited for.

As relative newcomers to crime scene processing and reconstruction, 3D scanners can also collect vast amounts of data quickly and accurately, and are more effective and easier to use in smaller spaces than total stations. However, unlike the total station, the purpose and capabilities of 3D scanners are much less understood. This is just one of several contributing factors that slow their adoption and integration into forensic science.

Cost is one of the greatest barriers preventing many law enforcement agencies from acquiring and implementing advanced documentation technology. Financial considerations often extend much further than a new piece of equipment, as additional hardware, software, accessories, training, and maintenance costs often accompany each device.

Not only are the devices themselves generally expensive, they also require powerful software to analyze and process the data collected. These applications must often be purchased in addition to the equipment and can be just as expensive as the devices themselves. Many pieces of

equipment also need routine maintenance after they have been purchased, and some even require annual software subscriptions that must be renewed regularly to continue use. In addition to selling equipment and software, companies also encourage the purchase of extra accessories that may or may not be actually necessary, furthering overall cost.

The amount of information gathered from a scanner or drone can be immense, and while paired software packages are designed to convert this data, powerful computer hardware is also needed to process the input and allow the software to run effectively. These machines can likewise be costly, as they require above-average technical specifications for its CPU (processor), RAM (memory), storage space, and a high-end graphics card to properly handle the collected data.

Another common issue faced when trying to integrate newer technologies, in particular the 3D laser scanner, is that of training. As these technologies are still fairly new and not yet commonly encountered in everyday life, they are often unfamiliar and require additional training to understand and operate properly. The cost of training itself can be very high, and not widely available or accessible. Several device manufacturers keep a tight hold over resources and training, requiring users to pay for instruction or to physically attend workshops that are only available in specific locations. These sessions usually have high tuition costs, and travel and accommodation expenses must be paid as well.

Time is another frequent obstacle. Especially for those without any background in digital reconstruction or scanning technology, the learning curve to acquire such skills can be steep. Many law enforcement agencies are usually backlogged with caseloads and do not have the extra time for extended training or experimenting with new tools. As a result, the most familiar and

comfortable methods to complete a task are often preferred to meet deadlines instead of trying to incorporate an unfamiliar tool into their normal routines.

Attitudes and expectations also play a decisive role in their integration, as perceptions regarding value and benefit often determine whether the new tools will be regularly used and accepted. Expectations regarding ease of use and accessibility are sometimes met with disappointment when it is discovered that these are only achieved after much training and experience. A lack of understanding and familiarity with certain types of equipment can also lead to confusion and frustration when the devices don't do what investigators assumed they would. However, once investigators come to understand their function and purpose, are willing to use them, and are sufficiently trained to operate them effectively and efficiently, they can save a great deal of time and produce valuable results.

There is also growing pressure to use newer technologies, whether it be due to success by other agencies or disciplines, or by those in the legal system who wish to see their results as demonstrative evidence in the courtroom. This in particular can pose a challenge, as the perceived expectations and uses of a tool and its real practical application can be at odds. For example, being able to present a full 3D model of a crime scene to a jury may sound impressive and appealing, if it has no real forensic value and was not necessary for a particular investigation, it's creation could be viewed as an unnecessary use of an investigator's precious time.

Fortunately, many of these concerns are beginning to lessen. As the demand for devices such as 3D scanners and drones rise in both commercial and industrial sectors, so does the amount of available and affordable training and resources. Prices for equipment and software are also dropping, as companies strive to provide products for regular consumers, whereas in the past many of these tools were only realistically available to larger companies.

Many investigative agencies have already begun to incorporate advanced computer-based mapping technology into their workflows. This trend is expected to continue, as 3D tools start to pass from novel to normal, unaffordable to accessible, and investigators move from apprehensive to comfortable.

Purpose

The purpose of this project is to develop the structure for an Advanced Crime Scene Mapping and Technology course that will introduce students to relevant new computer-based mapping tools currently used in the fields of Crime Scene Processing and Reconstruction. Throughout the course, students will revisit basic traditional documentation and mapping techniques augmented by advanced components designed to deepen understanding, enhance key cognitive abilities, increase practical experience, and lay a foundation on which to build new skills.

To accommodate the fast pace at which new technology evolves and advances, the course will concentrate more on the fundamental concepts of these technologies rather than on specific devices and applications. Although students will train on the particular brands of equipment and software available in the classroom, focusing on teaching general terminology, principles of functionality, and common usage will make it easier for students to translate their skills and knowledge to similar devices encountered in the field.

As these tools become increasingly more common, it is important to begin familiarizing students with the benefits and challenges of these new technologies, and to understand both their advantages and limitations. By doing so, students will not only be better prepared themselves, but their attitudes, understanding and experience can aid agencies in integrating new tools more smoothly and at less cost.

Curriculum Development

This course is designed to become available to students after several prerequisite courses have been completed. Concepts from previous instruction have been included for review and foundational purposes, but are accompanied by advanced topics and new information that has not yet had the opportunity to be explored in depth or introduced in previous courses.

Just as the core principles of forensic science remain the same amid external changes, this course aims to strengthen standard skills and knowledge while the overall structure remains flexible to accommodate updates in technology and regulations. No matter how advanced or how prevalent new mapping technology becomes, they are still merely tools to assist investigators in the completion of tasks. While these devices can help enhance processes, save time, and produce favorable results, they are not a substitute for solid foundational knowledge and training, nor do they replace manual skills and experience. This course aims to help students better understand and appreciate the new opportunities that advanced mapping technology can provide, while still recognizing the importance of standard training and core skills.

Course Components

To accomplish these objectives, the course consists of several components designed to help students expand knowledge, enhance cognitive skills, gain practical experience, and become more confident learners. The specific components are as follows:

Instruction

Instruction sections contain lectures and material that help prepare students for upcoming exercises and assignments. They include relevant reviews of previously learned concepts and terminology, introductions to new information, and provide additional resources for students.

Demonstration

Demonstration sections provide students with up-close instruction on actual devices and software, and present information in practice rather than in theory. They allow instructors to

demonstrate how lecture material is practically applied in the field, and to prepare students for upcoming assignments and exercises. These sessions act as an important bridge between mental learning (being presented with information) and physical learning (gaining knowledge through experience).

Practical Exercise

Practical Exercises serve as the primary mechanism for reinforcing concepts and facilitating learning through hands-on experience. Practical exercises generally require more class time, preparation, and equipment than other course components, and are often broken into several segments. Each segment generates documentation and material that will be used in subsequent sections.

Practical exercises also require students to work on their communication, teambuilding, and time management skills in addition to practicing physical and cognitive abilities. These are valuable traits for a crime scene investigator, and their development and improvement will help students be more successful in the field.

Lab Exercise

Lab Exercises are designed to take place in a computer lab or similar setting, where each student is able to participate directly in the exercise and (ideally) does not have to share equipment or materials with others as they do during practical exercises. Although working individually, students are encouraged to talk, discuss, ask questions, and aid one another during lab exercises.

Class periods spent in the computer lab utilize several course components, much like practical exercises, to help students gain hands-on experience with the material presented. Labs also provide an environment that is more open to experimentation and exploratory learning, as

students are often directed to find their own resources or discover their own solutions when encountering issues.

Cognitive Skill

Cognitive Skill sections provide information and activities designed to highlight and develop particular cognitive skills that aid investigators in crime scene processing and reconstruction. This instruction helps students build an awareness of cognitive skills and how they are practically applied in the field. It also trains students to recognize and strengthen these skills within themselves as they learn through personal experience.

Activity

Activity sections contain tasks that are on a smaller scale than practical exercises and come in several forms. Some activities help prepare students for an upcoming practical exercise by highlighting a particular concept or skill, while some have students observe, reflect, and discuss after an exercise. Each activity is an interactive learning experience to help improve communication, team-building skills, and enhance personal learning processes.

Sharpen Skills

Sharpen Skills sections provide instruction and resources designed to further develop physical skills that are beneficial in crime scene processing and reconstruction. These sections are often incorporated into lab and practical exercises that allow students to interact with the presented material and sharpen their skills through physical experience.

Assignments

Assignments allow students to work individually on tasks that apply or improve upon what was learned previously. These assignments also create documentation that will be used during subsequent discussions and activities, giving students the opportunity to evaluate their work and better understand their importance and purpose. At the end of the course, assignments

will also be used as a discussion point as students will be required to look back over past work and identify changes, improvements, and discover patterns in their learning development.

Learning Log

A Learning Log, also called a Reflection or Question Log, allows students to gain a better understanding of their own learning strengths and weaknesses, how to better identify and analyze issues, learn to articulate needs and to become more self-sufficient problem solvers (Gibbs, 1988). They can help students not only ask questions but actively seek for answers, not only experience events but to analyze them, and not only passively learn but to act on and apply new knowledge.

The ability to become an active participant in one's own learning process through inquiry, reflection, and action can be translated to many fields (Torbert, 1972), but it is particularly beneficial for forensic investigators. Crime scene units are faced with new and unique problems daily, are responsible for the observation, preservation, and communication of the information they encounter, and must work responsibly and effectively within a team.

While these skills can be powerful tools by themselves, the further advantage of requiring the extensive use of a Learning Log throughout this course is to help students get into the habit of taking detailed, relevant, and meaningful notes while in the field. Crime scene investigators often only get one shot at documenting and processing a crime scene, and may not be called to testify on it for months or even years afterwards. This makes it imperative for investigators to take as many detailed notes as possible during a case, both to help themselves remember details at a later time and to communicate information clearly to others involved in an investigation.

The purpose of the Learning Log in this course aims to achieve both mental and practical learning objectives to help students better assess, evaluate, understand, communicate, and act.

Students who are able to see more clearly, understand more deeply, adapt more quickly and are more comfortable facing the unknown will be better prepared for a career in forensic science.

Reflect & Discuss

Reflect & Discuss sessions take place at the end of every subunit and help students better understand their personal learning processes. While Learning Log assignments are generally completed individually, Reflect & Discuss sessions give students the opportunity to vocalize and share their responses with others. By comparing and contrasting experiences, thoughts, and results, students are exposed to other perspectives and opinions that can help improve their individual learning styles and broaden their knowledge bases.

Reflect & Discuss structures vary, as some involve the entire class while others have students break into smaller groups. Sessions are facilitated by the instructor, however students are encouraged to take the discussion in whatever (relevant) direction they feel will benefit them the most. Included discussion prompts are mainly taken from previous associated Learning Log assignments, and help the instructor guide students if they struggle leading the discussion themselves and to keep them on track. These prompts also include special questions designed to help connect experiences and concepts, and to help summarize and prepare for the next subunit.

Course Outline

Please Note: Although this paper contains a detailed course outline with instructions, additional course content such as lecture presentations, instructor notes, worksheets, and additional resources are not included as some are still in development. **If interested in these materials, please contact the author directly.**

The course is broken down into the following sections:

- Unit 0: Course Introduction
- Unit 1: Introduction to Visual-Spatial Cognition and Literacy
- Unit 2: Foundations in Crime Scene Mapping and Documentation
- Unit 3: Advanced Crime Scene Sketching
- Unit 4: Introduction to Advanced Crime Scene Technology
- Unit 5: Total Station
- Unit 6: 3D Scanner
- Unit 7: Drone
- Unit 8: Court Testimony and Other Considerations

Course Outline with Component Details and Instructions

UNIT 0: Course Introduction

📍 Course Introduction

📈 Instruction: Syllabus Day

Purpose

- To introduce students to course units, major assignments, class expectations, and learning objectives.

📈 Instruction: Introduction to Learning Logs

Purpose

- To introduce students to the concept of Learning Logs, why they are being used throughout the course, and their benefit to crime scene investigation.

🔎 Learning Log: First Entry

- At the end of the *Introduction to Learning Logs* lecture, students will be presented with their first Learning Log assignment.

- Students will make their first entry about their initial impressions and attitudes toward this assignment.
- A list of question prompts are included as a guide. Students are encouraged to read through each question and consider the answers, however they are **not** required to answer every question in writing. Students are to choose whichever questions they feel are the most relevant to their experience and provide written answers for them in order to complete their Learning Log assignments.

📝 **Semester Assignment: Learning Logs**

- Students will be required to turn in their Learning Logs at the end of the semester.
- Learning Logs do not need to be typed or in a finalized form.
    - Students are encouraged to use some kind of notebook to keep their entries organized, allowing them to simply turn in their notebooks at the end of the semester.
    - A notebook is also preferred as students will be required to take Learning Log notes during exercises and activities (Learning Log Field Notes), and a notebook is light and portable.
    - If students do not use a notebook or keep their Learning Log entries together, they will need to combine and organize them before turning them in.
- Learning Logs need to be completed before the final *Reflect & Discuss: Final Course Reflections* session.
- Completed Learning Logs will be used during *Reflect & Discuss: Final Course Reflections* and will be turned in at the end of class.
- **Note:** While grading this assignment, instructors will not be reading Learning Logs in their entirety, but will be checking them for completion, effort, and improvement.

📝 **Semester Assignment: Lab Notebook**

- Students will be required to turn in an organized Lab Notebook at the end of the semester containing assignments completed throughout the course.
- Lab Notebooks need to be completed before the final *Reflect & Discuss: Final Course Reflections* session.
- Completed Lab Notebooks will be used during *Reflect & Discuss: Final Course Reflections* and will be turned in at the end of class.

UNIT 1: Introduction to Visual-Spatial Cognition & Literacy

📈 Instruction: Learning to See - Visual Evidence and Image Analysis

Purpose

- To introduce concepts pertaining to perspective, perception, image analysis, and visual evidence.
- To review court rules concerning the admissibility, reliability, and authenticity of relevant evidence.
- Discuss cognitive bias as related to visual evidence and image analysis.
- This information will be revisited throughout the course as it relates to specific advanced documentation technology in each unit.

📈 Instruction: Learning to Learn - Visual Spatial Cognition & Literacy

Purpose

- To introduce students to visual-spatial cognitive skills and how they pertain to forensic science and crime scene investigation.
- Familiarize students with visual-spatial concepts and terminology that will be revisited and applied throughout the course as exercises, activities, and assignments are designed to highlight certain cognitive skills.
- These skills are intended to help students become more adaptive to new information and situations, and more successful and confident learners.

UNIT 2: Foundations in Crime Scene Mapping and Documentation

📈 Instruction: Basic Crime Scene Processing Review

Purpose:

- To review certain crime scene processing concepts and terminology that will be used and referred to throughout the course.
- These topics will be revisited as they relate to specific advanced documentation technology in each unit.

📍 Scene Swap

Summary

- In this two-part practical exercise, students will be divided into two teams, each processing a different crime scene and producing rough "final" documentation.
- This documentation will be swapped with the other group, and each team will then attempt to reconstruct the other groups' scene based on the documentation provided.
- Students will not be informed ahead of time that they will be reconstructing the other groups' scene.

🚩 Practical Exercise: Scene Swap Part 1 (Process Scene)

Purpose

- To review basic crime scene processing methodology and techniques.
- To help the instructor gauge what may need to be further reviewed and focused on throughout the remainder of the course.
- To help the instructor gauge student ability, knowledge, skill, and attitude.
- This exercise is meant to be a bit haphazard with very little review and guidance provided by the instructor beforehand as it allows students to discover, experience, identify, and raise awareness of issues for themselves.
- In discovering what they need and how to articulate those needs, students can start learning how to function and communicate more effectively and efficiently within a team.

Materials

- Evidence.
- Evidence markers.
- Cameras (2).
    - Camera memory card.
- Documentation supplies.

- Measurement tools.

Preparation

- Make sure cameras are in good order and ready to use.
    - This includes making sure the battery is charged, memory card is present and cleared, and any other accessories are also ready for use.
- Set up two crime scenes.
- Set up specifics, such as location (indoor or outdoor), types and amount evidence used, etc. are determined by the instructor, with the exception that one item **must** be on a vertical surface (up in a tree, on a wall, over a railing, etc.) or at a discernibly higher/lower elevation than the other items so it requires additional measurements/considerations to be taken into account when documenting.
    - Measuring objects on vertical surfaces or different elevations is often more difficult to document and conceptualize, which will provide an extra challenge and require students to exercise problem solving and spatial competency skills.
    - This will also tie into later sections that introduce concepts for thinking in 3D, and will refer back to this exercise and the difficulties encountered.

Instructions

- Divide students into two teams.
- Each team will decide among themselves who will measure, photograph, sketch, and document.
- Students will also be required to make Learning Log Field Notes while processing their scene in addition to the normal documentation required to help them complete the following *Learning Log: Scene Swap Part 1 (Process Scene).*
- Students will also be responsible for cleaning up their scenes and returning equipment and materials to their proper places when finished.

Notes for Instructor

- As students will be swapping scene material, it may be helpful to keep each scene's evidence, student documentation, and camera memory cards (if possible) together so the instructor will not have to relocate all of the materials used and reassemble them for *Practical Exercise: Scene Swap Part 2 (Reconstruction)*.
    - If not possible to keep items together, make sure to take note of what pieces of evidence were used in each scene so that students will have all the matching materials and documentation they need for their reconstructions.

🔎 Learning Log: Scene Swap Part 1 (Process Scene)

- How well do you think your team documented your scene?
- Which skills and knowledge did you remember from previous courses?

- Which skills and knowledge do you need to learn or review?
- Which part of the scene processing went the smoothest? Why?
- What obstacles or issues did you encounter? Why?
    - How did you address these issues?
    - How did you solve them?
- When issues were encountered, how did you respond? Why?
    - Could you have reacted differently?
    - Would/could you react differently in the future?
    - Why or why not?
- Did you feel you made your documentation clear and meaningful?
- Would you feel comfortable submitting this documentation in real life?
    - Why or why not?
- What did you or your group do well? Not so well?
- Any realizations or learning breakthroughs?

📝 Assignment: Prepare "Final" Documentation Scene Swap Part 1 (Process Scene)

- Teams will be responsible for preparing the rough "final" documentation for their scene, and will need to decide among themselves who will be responsible for each part.
- If there is time at the end of class, students can prepare this documentation as a group.
- Documentation does not need to be anything fancy, just readable.
- All written documentation (such as notes, measurements, etc.) generated during the exercise, along with any sketches or notes that have been further cleaned up/finalized should be included, and hard copies made for ease of use and reference.
- Photographs do not need to be printed unless the instructor would prefer it, as students can preview them on a camera or other device.
- All documentation must be turned in by or at the beginning of the class period in which this documentation will be swapped with the other group.

💬 Reflect & Discuss: Scene Swap Part 1 (Process Scene)

Purpose

- To help students begin learning how to reflect back on their experiences and articulate their perceptions by communicating them to others.
- Require students to evaluate how well they think they did after Part 1 so that they can re-evaluate again after Part 2 and compare perceptions when they have gone through both the processing and reconstruction experiences.

Guided Discussion Prompts

- *Refer to Learning Log: Scene Swap Part 1 (Process Scene)*

🚩 Practical Exercise: Scene Swap Part 2 (Reconstruction)

Purpose

- This exercise is valuable for its ability to reveal and highlight problems, new considerations, gaps in knowledge, etc. through personal experience.
- This exercise is meant to be a bit haphazard with very little review and guidance provided by the instructor beforehand as it allows students to discover, experience, identify, and raise awareness of issues for themselves.
- It also provides a good foundation for students to begin learning how to better communicate, the importance of good crime scene processing methodology and documentation, and attention to detail.
- This particular reconstruction process also allows students to face difficulties and frustrations that will help prepare them to begin learning how to handle more challenging situations in the future while raising awareness of differences in perception and perspective.
- They can also start learning how to provide better documentation and information so that the issues they encounter during this exercise can be alleviated or avoided in the future.
- This experience is meant to generate a stronger response and more questions than *Practical Exercise: Scene Swap Part 1 (Process Scene)*, and really highlight issues and areas of improvement.

Materials

- Evidence, Documentation, and camera memory cards from *Practical Exercise: Scene Swap Part 1 (Process Scene.)*
- Measurement Tools.
- Cameras (or other device to view images).

Instructions

- Students will break into the same teams as in *Practical Exercise: Scene Swap Part 1 (Process Scene)* and will be given the other teams' documentation.
- Teams will then be tasked with reconstructing the other teams' scene based on the documentation provided.
- Teams are not allowed to speak with or ask any clarifying questions to the other team, as they must rely solely on the documentation alone.
    - Although investigators can ask questions to other investigators while in the field, there are circumstances where they cannot (cold cases, retirements, etc.).
    - The challenge of not having everything they need and not being able to get it creates strong impressions for remembering what is required for successful documentation.

    - It also highlights those areas of most importance, and having experienced not having what is needed, students are more likely to remember and include them in their own future work.
- Students will also be required to make notes in their Learning Log Field Notes to include questions, concerns, needs, and issues they encounter to help them complete *Learning Log: Scene Swap Reconstruction*.
- Students will have the opportunity to discuss and ask questions concerning documentation, etc. to the opposite team during the *Reflect & Discuss: Scene Swap Overall Reflections.*

🔎 Learning Log: Scene Swap Reconstruction

- How close do you think your reconstruction was to the original? Why or why not?
- Were you confident in the accuracy of your reconstruction? Why or why not?
- What aspects of the documentation were the easiest to interpret? Why?
- What aspects of the documentation were the most difficult to interpret? Why?
- What questions would you have liked to ask the other team?
- If you weren't sure about something, how did you respond or handle the situation?
- Where did you place items that you weren't sure exactly where they went?
- What would have made this reconstruction easier?
- When issues were encountered, and how did you respond? Why?
    - Could you have reacted differently?
    - Would/could you react differently in the future?
    - Why or why not?

🎲 Activity: Scene Swap Reconstruction Review

Purpose

- To allow students the opportunity to examine and evaluate a scene reconstructed using the documentation they produced.
- To help students begin understanding the importance of different perspectives and processes, and how to reflect back in order to move forward.

Instructions

- Once both teams have finished their reconstructions, they will be allowed to go and examine the other team's scene to see how they did.
- Make sure students are aware of this so they don't clean up their scene before the other group gets a chance to see it.
- As it is likely that one team will finish before the other, the team that finishes first can use the waiting time to work on their Learning Logs.

- To make sure there is a little time for this activity, students may need to be stopped at a certain point in their reconstruction, whether they are finished or not.
- During this activity, students will need to record observations, questions, and impressions in their Learning Log Field Notes to help them complete the following Learning Log assignment.
- When finished, students will again be responsible for cleaning up both scenes.

🔎 Learning Log: Scene Swap Reconstruction Review

- How close was the other teams' reconstruction to your original scene?
- If not, what could have contributed to the errors?
- Do you remember enough about your original scene to make a good comparison?
- Did the other team interpret your documentation the same way you intended them to? Why or why not?
    - Why do you think they may have interpreted it differently?
    - What could you have changed or included in your documentation to help avoid interpretation errors?
- Did it look like there were any similarities between the issues you encountered while reconstructing and what you observed from the other team's reconstruction?
- After seeing the other teams' reconstruction using your documentation, does your confidence level in your own reconstruction change? Why or why not?

📝 Assignment: Scene Swap Overall Reflections

Purpose

- To have students look back over their experience as a whole and start to identify personal response patterns and areas for improvement.

Instructions

- Students will look back over their Learning Log and Learning Log Field notes taken throughout the Scene Swap exercise and reflect on what they notice.
- Direct the student's attention to their attitudes and impressions concerning each segment, and reflect on how those attitudes and perceptions did or did not change throughout the process.
- This assignment will be used during the following *Reflect & Discuss: Scene Swap Overall Reflections.*

Overall Reflection Prompts

- Think back over your overall experience (processing, reconstruction, reviewing).
- What changes did you notice in your responses throughout the exercise?

    - These can include how you viewed the assignment, expectations, your responses and reactions, how the team evolved, new knowledge gained, etc.
- If doing this whole exercise over again, what you would do differently? Why?
    - Provide evidence and reasoning, or if unsure be honest about it.
- Was this experience useful? Why or why not?
- What could you have done to make it more meaningful?
- What stuck out to you the most?
- Did you experience any new realizations or learning breakthroughs?

💬 Reflect & Discuss: Scene Swap Overall Reflections

Purpose

- To help students begin understanding the importance of different perspectives and processes, and how to articulate issues and find solutions.
- To help students learn how to function and communicate more effectively and efficiently within a team.

Instructions

- After reflecting back on their overall experiences outside of class, students will now have the opportunity to discuss what they discovered with their peers.
- Students are encouraged to make notes in their Learning Logs about what they hear during this discussion, especially if they are able to get answers to previous questions they had.

Guided Discussion Prompts

★ *Refer to Assignment: Scene Swap Overall Reflections.*

- *Refer to Learning Log: Scene Swap Reconstruction Review.*
- *Refer to Learning Log: Scene Swap Part 1 (Process Scene).*

- What questions did you have that you would like to ask the other team that you were not able to during reconstruction?

📍 Perspective & Perception

📈 Instruction: Perspective & Perception

Purpose

- To explore the concepts of perspective and perception in more depth.
- To help students understand how identifying issues involving perspective and perception can help solve communication problems and produce better crime scene documentation.

🎲 Activity: Perceiving Communication & Perspectives of Reconstruction

Purpose

- To help students better understand differences in perspective, perception, and communication.

Materials

- Each group will need:
    - 8.5x11 image hidden inside a folder.
    - Paper and pencils for drawing.

Preparation

- Prepare enough "hidden image" folders for each group.
- Each image should be different from one another and be of different subject matter.

Instructions

Part 1:

- Students will be broken up into small groups of 3-4 students.
- Groups should spread out around the room with enough space between them to limit distraction and interference from other groups.
- Each group will receive a secret image in a file folder.
- One student will be chosen to see the picture and describe it to their group members, who must then draw it based on the spoken description only, without seeing the image for themselves.
- Students will decide among themselves who will describe and who will draw.
- Students in each group will all sit so that no one can see what the other is doing, including the describer.
- Groups will have about 5 minutes for the image to be described while the others draw what they hear.
- Describers can say anything they would like, as long as they do not look at what is being drawn.

Part 2:

- When time is up, students will flip over their images and drawings so they cannot be seen and answer and discuss the following questions.
- **Questions:**
    - Describers:
        - How well do you think you described the image?
        - What was the most difficult part in describing the image? Why?
        - What was the easiest part in describing the image? Why?

        - What would have helped make describing easier? Why?
    - Drawers:
        - How well do you think you drew the image based on the description?
        - What was the most difficult part in drawing the image? Why?
        - What was the easiest part in drawing the image? Why?
        - What would have helped make drawing easier? Why?

Part 3:

- When finished discussing Part 2, students are to look at the original image and other drawings within their group.
- Students will discuss and make notes of their reactions in their Learning Logs and answer the following questions.
- **Questions:**
    - Everyone
        - How close were the images to the original?
        - If similar, which parts specifically? Why do you think that is?
        - If different, which parts specifically? Why do you think that is?
        - How close were the drawn images to each other?
        - If similar, which parts specifically? Why do you think that is?
        - If different, which parts specifically? Why do you think that is?
    - Describers:
        - Were you surprised to see the final drawings? Why?
        - What assumptions did you make while describing?
        - How could you have described things differently?
        - Record your reactions to the drawings.
    - Drawers:
        - Were you surprised to see the original image? Why?
        - Did your interpretations of the description differ from the other drawers?
        - What assumptions did you make while drawing?
        - If you were to take on the role of the describer, what would you say to help make things clearer for the drawer?
    - How does this relate to crime scene documentation?
    - What new considerations does this activity make you that you hadn't thought of before?

Part 4:

- When groups are finished discussing, have them place all the images side by side on the tables so they can be easily seen and compared.
- Allow all students time to move around the room and see the other groups' images.
- Students are encouraged to take their Learning Logs with them as they observe the images and take notes about what they see.

Part 5:

- When finished looking over all the images, come back together as a class *for* *Reflect & Discuss: Perceiving Communication & Perspectives of Reconstruction.*

💬 Reflect & Discuss: Perceiving Communication & Perspectives of Reconstruction

Purpose

- To allow students to discuss their experiences within a larger group, and to gain further insight into differing perspectives, communication and perception styles, and documentation considerations.

Guided Discussion Prompts

- ★ *Refer to Activity: Perceiving Communication & Perspectives of Reconstruction.*
- How did the activity go?
- What did you think of this activity?
- Was it helpful? Why or why not?
- Did it make you think? Why or why not?
    - What specifically did it make you think about?
- What did you learn or realize?
- What observations did you make?
- Any similarities to your groups' images to the other groups'? Why or why not?
- Could you discern any similar successes or struggles in your work and the work of others?
- ★ How does this relate to crime scene documentation?
- ★ What new considerations does this activity make you think about that you hadn't thought of before?
- ★ Does this activity help you to better understand the struggles you had with the Scene Swap exercise?
    - Why or why not?
    - If so, what specifically?
- ★ How can you apply what you learned in this activity when documenting your next crime scene?

📍 Foundations in Crime Scene Sketching

📈 Instruction: Foundations in Crime Scene Sketching

Purpose

- To provide a review of important basic sketching concepts that will be referred to and applied throughout the course.
- These topics will be revisited as they relate to specific advanced documentation technology in each unit.

👓 Sharpen Skills: Measurement

Purpose

- To ensure all students understand the differences between measurement systems, how to identify them, and how and when they are each used in the field.

UNIT 3: Advanced Crime Scene Sketching

📍 Manual Drawing with Baseline

📈 Instruction: Baseline Measurement Review

Purpose

- To provide a quick review of baseline measurement techniques.
- These concepts will be revisited as they relate to specific advanced documentation technology in other units.

🚩 Practical Exercise: Baseline

Purpose

- Review and practice baseline measurements.
- To have each student produce their own set of documentation and rough sketches to be used in *Assignment: Baseline Final Sketch (Manual).*

Materials

- Evidence.
- Evidence Markers.
- Documentation Supplies.
- Measurement Tools.

Preparation

- Set up two crime scenes.
- Set up specifics, such as location (indoor or outdoor), types and amount of evidence used, etc. are determined by the instructor.

Instructions

- Divide students into two groups.
- Each student will be individually responsible for:
    - Helping take measurements.
    - Recording measurements.
    - Producing a rough sketch.
    - Take any documentation notes that will be relevant to their sketch.
- No photography is needed as the focus will be on measuring and sketching.
- When finished, students will be responsible for cleaning up their scenes.

🥽 Sharpen Skills: Manual Drawing Skills

Purpose

- Teach students manual drawings skills relevant to crime scene documentation.

📝 Assignment: Baseline Final Sketch (Manual)

Materials

- Graph paper.
- Pencils and erasers.
- Rulers.

Instructions

- Students will create a final hand-drafted sketch from their rough sketch created during *Practical Exercise: Baseline* and using skills learned from *Sharpen Skills: Manual Drawing Skills*.
- Final sketches must include the following:
    - Title.
    - Header.
    - Legend.
    - Measurement Table.
    - Compass Direction.
    - Scale.
    - Main Image.
    - Written accompanying documentation in a finalized format.

🔎 Learning Log: Baseline Final Sketch (Manual)

- Did learning new drawing skills make creating your final sketch easier? Why?
- Did learning new drawing skills make creating your final sketch more difficult? Why?
- What helped the most? What didn’t? Why?
- Is there anything you would like to learn more about?
- How did learning about skills differ from actually practicing them?
- What could make translating knowledge to skill easier?

🎲 Activity: Comparing Manual Drawings

Purpose

- To allow students to observe different approaches, interpretations, and presentations of the same information to broaden their perspectives.

Materials

- Completed *Assignment: Baseline Final Sketch (Manual)*.

Instructions

- Original groups will be further broken down into smaller groups. The size and number of groups will depend on class size.
- Students will be given time to look at each others' final sketches and discuss differences and similarities, ask questions and share new knowledge and ideas.
- **Questions:**
    - Compare and contrast your sketch with the sketches of others.
    - What can or did you learn from them?
    - Did you observe elements or choices made that you **would** like to incorporate into your documentation in the future? Why?
    - Did you observe elements or choices made that you **would not** like to incorporate into your documentation in the future? Why?
    - Are there elements in your sketch that everyone agreed were clear and meaningful? Why?
    - Are there elements in your sketch that everyone agreed were confusing or incomplete? Why?
        - How could you fix these elements to be more clear in the future?
    - Is there anything that you struggled with? Why?
        - How did you handle it?
        - Did others struggle with it as well? Did they resolve it? How?
    - Did anyone help you find a way to make the struggle easier or to help overcome it? How?
- Students are encouraged to help each other discover the roots of problems, find solutions, and share any knowledge or tips they have discovered.
- Students are encouraged to take notes of what they think is interesting, new realizations, etc. that they encounter during these discussions.

💬 **Reflect & Discuss: Manual Drawing & Sketch Comparisons**

Purpose

- To allow students to compare and contrast their final sketches with others who sketched the same scene and exchange learning experiences.

Guided Discussion Prompts

★ *Refer to Activity: Comparing Manual Drawings.*

📍 Introduction to Computer Drawing with Triangulation

📈 Instruction: Triangulation Measurement Review

Purpose

- To provide a quick review of triangulation measurement techniques.
- These concepts will be revisited as they relate to specific advanced documentation technology in other units.

🚩 Practical Exercise: Triangulation

Purpose

- Review and practice triangulation measurements.
- To have each student produce their own set of documentation and rough sketches to be used throughout this unit.

Materials

- Evidence.
- Evidence Markers.
- Documentation Supplies.
- Measurement Tools.

Preparation

- Set up two crime scenes.
- Set up specifics, such as location (indoor or outdoor), types and amount of evidence used, etc. are determined by the instructor.

Instructions

- Divide students into two groups.
- Each student will be individually responsible for:
    - Helping take measurements.
    - Recording measurements.
    - Producing a rough sketch.
    - Take any documentation notes that will be relevant to their sketch.
- No photography is needed as the focus will be on measuring and sketching.
- When finished, students will be responsible for cleaning up their scenes.

📝 Assignment: Triangulation Final Sketch 1 (Computer Free-for-All)

Purpose

- Technology advances quickly, and not every agency has specific programs or protocols for how to finalize documentation, especially on a computer.
- Similarly, each crime scene encountered is different, and investigators are constantly faced with new challenges they may have little to no experience with.
- As such, students must learn to problem solve on their own with very little instruction or guidance, and experience the process of working through it.
- This open-ended exercise also allows students to learn more about their own learning and problem solving processes, and identify what they do successfully and what they can improve on.

Instructions

- Students must produce a final sketch using a computer, but may do it however they like and use whatever tools they prefer.
- Final sketches must include the following:
    - Title.
    - Header.
    - Legend.
    - Measurement Table.
    - Compass Direction.
    - Scale.
    - Main Image.
    - Written accompanying documentation in a finalized format.
- Students will need to turn in a digital copy to the instructor **and** also have a hard copy in hand for *Reflect & Discuss: Triangulation Final Sketch 1 (Computer Free-for-All).*
- Digital copies will be kept by the instructor and used during *Reflect & Discuss: Triangulation Final Sketch 2 (PowerPoint).*

🔎 Learning Log: Triangulation Final Sketch 1 (Computer Free-for-All)

- What program/software did you use to create your final sketch on the computer?
    - Why did you choose it?
    - How did you find it?
- What was the most difficult part of this assignment? Why?
- How did you overcome the challenges you encountered?
- How was using a computer **different** from manually drafting a final sketch? Why?
- How was using a computer **similar** to manually drafting a final sketch? Why?
- Which method do you prefer? Why?
- What do you wish you knew more about?

- What questions did you have while creating your sketch?
    - Did you find answers? If so, where?
- Are there still unsolved challenges you need help with?
- Did you discover any tricks or find any helpful resources that you would like to share with others?

💬 Reflect & Discuss: Triangulation Final Sketch 1 (Computer Free-for-All)

Purpose

- To allow students to discover new learning pathways and options through their peers.
- Help students understand that they share similar struggles, but that there are many possible solutions.
- Help students to practice their articulation and communication skills.

Instructions

- Divide students into smaller groups, but have each group include students who processed both scenes.
- This will allow them to compare sketches of a familiar scene as well as sketches of an unfamiliar one.
- Allow students time to talk about their experiences, show each other their sketches, describe how they created it, what software they used and why, etc.
- Afterwards, come back together as an entire class and have a brief discussion about what was learned.

Guided Discussion Prompts

- *Refer to Learning Log: Triangulation Final Sketch (Computer Free-for-All).*
- ★ What did you hear or learn about that you would like to try yourself in the future?
- ★ Did anyone get help in solving a problem or suggesting something helpful?
- ★ Were you able to help someone else?

📍 Computer Drawing with PowerPoint

- Modules within this subunit require every student to have individual access to a computer and PowerPoint software.
- Instructors will need the ability to present lecture material and show demonstrations from their computer to the entire class while students can follow along on their own computers.
- It is highly recommended to use a computer lab where the instructor and students are all using the same version of software and the same operating systems.

📈 Instruction: Introduction to Digital Tools

Purpose

- To introduce students to relevant digital tools, basic concepts and terminology, common uses, etc.
- To help students understand that while advanced tools can be helpful, they do not replace the need for foundational forensic training and practiced crime scene processing skills.

🕶️ Sharpen Skills: Computer Drawing with PowerPoint

Purpose

- To introduce students to concepts and terminology common to many digital tools and techniques while using a familiar program.
- To help sharpen computer skills and build confidence in using digital tools.

Materials

- Computer loaded with PowerPoint for each student.

Preparation

- All students will need access to a computer, preferably in a computer lab so they are all working on the same version of the software and on the same operating system.
    - Note: Instruction material is for Windows, but resources can be found online for Mac.
- Make sure that all students are able to log onto computers and have access to PowerPoint.

🔬 Lab Exercise: Computer Drawing with PowerPoint

Purpose

- To allow students to actively participate in lecture material by exploring tools and concepts as they are presented.
- To give students the opportunity to practice new skills and experiment with digital tools.
- To demonstrate how to find helpful resources when learning something new and how to use them effectively.

Instructions

- Students will log into their computers and open PowerPoint.
- Students will then follow along with the *Sharpen Skills: Computer Drawing with PowerPoint* lecture slides and complete the tasks and instructions presented therein.

- Give students a little time to complete each task and ask questions to receive help as needed.
- Students are encouraged to talk and help one another during tasks.

📝 Assignment: Triangulation Final Sketch 2 (PowerPoint)

Purpose

- To give students the opportunity to put what they learn into action by revisiting an assignment with new skills and knowledge.
- To allow students a chance to improve on a previous assignment after reflecting on it and learning something new before moving on to another topic.
- To help students see improvements within themselves and build confidence in learning.

Instructions

- Using the same data and sketches obtained from *Practical Exercise: Triangulation* and used for *Assignment: Triangulation Final Sketch 1 (Computer Free-for-All),* students will create another final sketch, this time using PowerPoint.
- If students had already used PowerPoint during *Assignment: Triangulation Final Sketch 1 (Computer Free-for-All),* they are still expected to create another final sketch and incorporate new skills learned.
- In addition to applying what was learned during *Sharpen Skills: Computer Drawing with PowerPoint* and *Lab Exercise: Computer Drawing with PowerPoint,* students will also be expected to improve upon their first computer sketch by incorporating the ideas, suggestions, etc. they learned during *Reflect & Discuss: Triangulation Final Sketch 1 (Computer Free-for-All).*
- Students will need to turn in a digital copy to the instructor and also have a hard copy in hand for the following *Reflect & Discuss: Triangulation Final Sketch 2 (PowerPoint).*

🔎 Learning Log: Triangulation Final Sketch 2 (PowerPoint)

- Was this assignment easier or more difficult than the first computer free-for-all sketch? Why?
- What exactly made certain things easier or more difficult? Why?
- What problems did you encounter? How did you solve them?
- Compare your first and second computer sketches.
    - What did you do differently the second time? Why?
    - What improvements were made?
    - Which final sketch do you feel is better? Why?
- Which sketch do you think is better? Explain.
- Did your confidence level in creating a computer sketch change between your first and second sketch? Why or why not?

- What questions did you have while creating your sketch?
- Did you find answers?
    - If so, where?
    - If not, how or where can you find answers?

💬 Reflect & Discuss: Triangulation Final Sketch 2 (PowerPoint)

Purpose

- To help students see improvement within themselves and among others.
- To allow students to see similarities and differences between their sketches and others, and gain insight and inspiration through different perspectives.

Preparation

- Before this session, look through the students' digital first and second computer sketches that were turned in previously.
- Select pairs of sketches that contain a teaching point or that would be beneficial for the whole class to see.
- These could include sketches that:
    - Showed a lot of improvement between the two drafts.
    - Were obviously (or not obviously) different between the two drafts.
    - Were done particularly well or not well.
    - Had used a technique that was interesting and innovative.
- Decide how to present them to the class so they can be viewed side by side.
    - This could be accomplished by dropping them side by side into PowerPoint with each student having their own slide.
    - Not all pairs have to be shown, but when students make comments and you want to show their drafts while they talk about it, this would be an easy way to retrieve them quickly.

Instructions

- As an entire class, ask the students how the second computer sketches went and open up the room for discussion.
- If students are talkative they can lead the discussion themselves, and the instructor can pull up drafts for comparison as they go.
- The instructor should also show particular draft comparisons they noticed while preparing the images and draw attention to certain aspects for further discussion.

Guided Discussion Prompts

- *Refer to Learning Log: Triangulation Final Sketch 2 (PowerPoint).*
- What differences do you notice between the first and second computer sketches?

- What similarities do you notice between the first and second computer sketches?
- How do the changes affect the clarity and presentation of the sketches?
- Ask the student who created the sketches (especially the ones that changed a great deal) what they changed and why.
- Why did you make certain decisions? Were the same decisions made for both drafts?
- Did your confidence level in creating a computer sketch change between your first and second sketch? Why or why not?

📍 Introduction to 3D

📈 Instruction: Thinking in 3 Dimensions

Purpose

- To introduce students to common 3D concepts and terminology that will be used throughout the course.
- To introduce students to special issues and considerations relating to 3D thinking.
- To help prepare students to work with 3D mapping technology.
- To show students how 3D thinking and related cognitive abilities can be applied in the field.

📈 Instruction: Rectangular Measurements and Vertical/Elevation Sketches

Purpose

- To provide a quick review of rectangular and vertical measurement techniques.
- To start applying 3D concepts and terminology while describing traditional techniques.

🚩 Practical Exercise: 3D Scene Swap Part 1 (Document)

Purpose

- This exercise helps students begin thinking in 3D as well as 2D, and have their attention drawn to special considerations that relate specifically to 3D.
- Although many of the assigned reference points would not be used in an actual crime scene for various reasons (not permanent enough, requires too many extra measurements, hard to reconstruct, etc.) their selection is designed to teach principles of 3D and advanced measuring skills.
- This also aims to help students gain a better understanding of how to choose good reference points and why certain objects make poor reference points.
- Concepts practiced and learned in this section will help build a foundation for 3D mapping using advanced technology.

Materials

- Evidence.
- Evidence markers.
- Cameras.
    - Camera memory cards.
- Documentation supplies.
- Measurement tools.

Preparation

- Make sure cameras are in good order and ready to use.
    - This includes making sure the battery is charged, memory card is present and cleared, and any other accessories are also ready for use.
- Lay out at 2 crime scenes, preferably in two different locations (two rooms, or indoor and outdoor, etc.) where all evidence is placed in 3D space.
    - Examples: Evidence lying on a table, in a tree, on a wall, in a bush, on a shelf, etc.

Instructions

- This two-part exercise is very similar to the first Scene Swap exercise, except on a much smaller scale.
- However, this time students will be notified that they will be switching documentation with another group and performing a reconstruction.
- The class will be divided into two main groups, one at each separate crime area.
- Each group will then be divided into smaller teams or partners (depending on the number of students) who will each document the location of 1 piece of evidence placed in 3D space within their scene.
- Teams and evidence need to be planned so that during *Practical Exercise: 3D Scene Swap Part 2 (Reconstruction)* and *Activity: 3D Scene Swap Reconstruction Reviews* the students will be able to review evidence placement with the team they switched documentation with.

Example:

Group 1: Indoor Scene		Group 2: Outdoor Scene
Team 1A: Evidence 1A	switches with	Team 2A: Evidence 2A
Team 1B: Evidence 1B	switches with	Team 2B: Evidence 2B
Team 1C: Evidence 1C	switches with	Team 2C: Evidence 2C

- It is recommended that the total number of teams are even (even if that means that the number of students within each team differ) as it will make things easier to manage

during *Practical Exercise: 3D Scene Swap Part 2 (Reconstruction)* and *Activity: 3D Scene Swap Reconstruction Reviews*.

- As a team, students will be responsible for:
    - Taking measurements that fix their piece of evidence in 3D space (including orientation).
    - Producing a rough sketch of the evidence.
    - Producing clear documentation of their measurements, reference points, and how they measured.
        - Note: They may likely need to fix their reference point in space as well so the reconstruction team can find exactly where they measured from.
    - Photographing both their piece of evidence, and where they placed their measurements in relation to their reference point.
        - Notify students that these images will **NOT** initially be available to reconstruction teams during *Practical Exercise: 3D Scene Swap Part 2 (Reconstruction)*, which means teams must first try to reconstruct their evidence based solely on the written documentation provided.

- Students will be assigned one specific reference point they must measure from, but may decide for themselves any other reference points.
    - The required reference point must reside in 3D space itself, and also provide several options for where exactly to measure from.
    - Examples: A doorway, a window, round utility pole (or other round object), a sidewalk, counter, a tree, etc.
    - These objects are intentionally difficult to measure from (and are generally unacceptable reference points) and require additional considerations and extra measurements.
    - Students may also decide on which measuring method to use (baseline, triangulation, rectangular, etc.) based on their particular item of evidence, and their chosen methodology noted in their documentation.

- Before students begin, notify them that they will not have a take-home assignment to create “final” documentation as they did previously.
    - This means that by the end of their documenting process, they will need to have created clean documentation, notes, and sketches (albeit rough) before they leave.
- When finished, the piece of evidence will be picked up and placed with their written documentation and camera memory card and turned into the instructor.
- It is recommended to keep these items together to easily redistribute them to the reconstruction teams during *Practical Exercise: 3D Scene Swap Part 2 (Reconstruction).*

🔎 Learning Log: 3D Scene Swap Part 1 (Document)

- How were decisions made about where and how to measure from certain reference points?
- What new considerations did you discover that you hadn't thought about before?
    - These can relate to reference points, measuring in 3D space, documentation, etc.
- Think back to the first *Scene Swap* exercise. After having that experience, what things did you change about your documentation this time?
- What would be the most useful information to include if you had to reconstruct this piece of evidence yourself later? What about for someone else?
- What was the most difficult part of this assignment?
- Did knowing that your evidence would be reconstructed change how you approached the documentation process? Why?
    - What actions did this knowledge prompt you to take?
- Did knowing that the photographs you took would not be available to reconstruction teams change how you approached the documentation process? Why?
    - What actions did this knowledge prompt you to take?
- How clear and thorough do you think your documentation is?
- How confident are you that the other team will be able to reconstruct your piece of evidence properly? Why or why not?

🚩 Practical Exercise: 3D Scene Swap Part 2 (Reconstruction)

Purpose

- Provide students with the opportunity to improve and act upon lessons learned during the first *Practical Exercise: Scene Swap* exercises at the beginning of the course.
    - These lessons could include providing more thorough and specific documentation and improved communication with team members.
- This particular reconstruction process allows students to face new difficulties and frustrations in regards to 3D thinking, consider and discover new issues, and further raise awareness of differences in perception and perspective.
- Further improve students' ability to handle challenging situations through difficult experiences.

Materials

- Evidence, Documentation, and camera memory cards from *Practical Exercise: 3D Scene Swap Part 1 (Documentation)*
- Measurement Tools
- Evidence Markers
- Cameras (or other device to view images)
- Learning Log Field Notes

Instructions

- Students will split back into their original groups, and be sent to the other crime scene area they didn't see during *Practical Exercise: 3D Scene Swap Part 1 (Document).*
- Students will further divide back into their same smaller teams, and be given a piece of evidence from their new scene accompanied by its matching written documentation and camera memory card.

- Teams will be tasked with placing their piece of evidence back where it was based on the documentation they received.
- Students will not be able to ask the original documenting team questions, but they can consult with others in their larger group at their current scene.
- Students should write down any questions or comments concerning issues they encounter in their Learning Log Field Notes.
    - These can include clarifying questions regarding reference points and where/how measurements were made, methodology, discrepancies between documentation material, confusing information, etc.
- **Note:** Teams will have the opportunity to ask the original documenting team these questions for clarification during *Activity: 3D Scene Swap Reconstruction Reviews*, so students should be aware of this beforehand so they can make their Learning Log Field Notes accordingly.

- Teams must first attempt to reconstruct the original placement of their piece of evidence based on the sketch and written documentation **ONLY**, without being able to look at the photographs.
- After they believe they have their placement correct, they may then view the photographs and make adjustments accordingly.
    - If adjustments are needed, students should place an evidence marker where they originally reconstructed the evidence before seeing the photographs and making adjustments.
    - This will allow them to visually compare the differences (if any), and also provide a topic of discussion during *Activity: 3D Scene Swap Reconstruction Reviews.*
- Students are encouraged to make notes in their Learning Log Field Notes concerning these adjustments.

- For teams that finish before others, they are allowed to aid the other groups on their same scene if they need help deciphering documentation.
    - This can provide teams with more perspectives to work with and another opportunity to articulate questions and problem solve as a group.

🎲 Activity: 3D Scene Swap Reconstruction Reviews

Purpose

- To allow students to receive answers to questions taken during reconstruction.
- To practice articulating decisions they've made and why, and help others understand their reasoning and point of view.
- To learn more about the viewpoints and reasoning of others to broaden their own perspectives and expand their knowledge base.
- To help students improve communication skills by practicing asking questions and receiving answers, and discover what kind of questions to ask and how to ask them in order to receive the information they are looking for.

Instructions

- When all teams have finished, teams will be matched with the opposite group's team with whom they switched their original documentation.
- The two teams will review both items of evidence at each scene together.
- At this time students can now ask the opposite team questions, receive clarification, make comments, and help each other understand discrepancies they encountered during their reconstructions.
- Students should ask the opposite team the questions they wrote down in their Learning Log Field Notes while reconstructing and make note of the answers.
    - When perspectives and perceptions differ, students are encouraged to see if they can come to an understanding and discuss solutions to issues.
- ★ Students should pay special attention to the "why" of decisions made and how those decisions were interpreted by someone else.
- Students are encouraged to add any additional thoughts, realizations, or new questions raised to their Learning Log Field Notes.

Example:

- Team 1A and 2A first look at Evidence 1A, which was documented by Team 1A and reconstructed by Team 2A.
- They can ask each other questions, explain reasoning for certain decisions, discover what they did well in their documentation, what could be improved, etc.
- When finished with Evidence 1A, Team 1A and 2A will look at Evidence 2A at the other scene, which was documented by Team 2A and reconstructed by Team 1A.
- They will have the same opportunity to discuss the exercise, but now from reversed roles.

Sample Discussion Points

- Questions written down during exercise regarding confusion, issues, discrepancies, measurements, reference points, etc.

- Discuss why and how decisions were made.
- Discuss intent of documentation choices vs. how they were interpreted.
- Compare the difference (if any) between the first attempt (without photographs, marked with evidence marker) and the second attempt (with photographs, marked by evidence).
    - What caused these differences?
    - What could have made things more clear?
- What did teams do well that helped make the reconstruction successful?
- What could teams do to improve?

🔎 **Learning Log: 3D Scene Swap Reconstruction & Reviews**

- What part of the documentation (notes, sketch, photographs) helped the most in replacing the evidence where it was originally?
- Did you need to make any adjustments to the reconstruction of your evidence after seeing the photographs?
    - How close was your reconstruction to the original?
    - What adjustments did you make?
    - If large adjustments had to be made, what factors do you think contributed to the inaccuracy?
- Did the photographs help make the documentation more understandable or easier to interpret? How?
- Did the sketch, photos, notes, and measurements all line up? Why or why not?
- Were there any discrepancies between the different types of documentation?
- If the images and measurements didn't match up exactly, how did you handle it?

- What information or clarification was absent that would have been helpful to have? Why?
- What did the documenting team include in their documentation that you liked or found very helpful? Why?
- How confident in your reconstruction were you before reviewing with the original documentation team? Why or Why not?

★ What questions did you have for the original documentation team?
- Were they able to provide satisfactory answers? Why or why not?

★ Did their answers make their documentation more clear and easier to understand? Why or why not?

★ What questions did the team who reconstructed evidence based on your original documentation ask you?
- Were you able to provide satisfactory answers? Why or why not?

- ★ Did their questions prompt any new realizations or considerations concerning how to better document evidence?
- ★ If you had to do this exercise all over again, what changes would you make when measuring and documenting your original piece of evidence? Why?
- ★ What specifically did you learn from this exercise that you want to implement in the future when documenting or communicating?

📝 Assignment: 3D Scene Swap Overall Reflections

- Compare and contrast this 3D Swap exercise with the first Scene Swap exercise.
- ★ Did you apply anything you learned from the first swap activity to this second one?
- ★ Did it change the way you approached this exercise?
- Did using what you learned previously make this exercise easier or more successful? Why or why not?
- What did you learn from your peers during the Reconstruction Reviews that helped you understand how to properly reconstruct your piece of evidence?
- ★ What specifically did you learn from this exercise that you want to implement in the future when documenting or communicating?
- ★ Was being able to review and discuss questions and documentation with the other team helpful to you? Why or why not?

💬 Reflect & Discuss: 3D Scene Swap Overall Reflections

Purpose

- To allow students to discuss their overall experiences within the larger group, ask questions, and hear other opinions and perspectives.

Guided Discussion Prompts

- *Refer to Learning Log: 3D Scene Swap Reconstructions and Reviews*
- *Refer to Assignment: 3D Scene Swap Overall Reflections*

🥽 Sharpen Skills: Thinking in 3D

Purpose

- Address issues and questions that arose during the *3D Scene Swap* exercises.
- Provide additional tips, tricks, and techniques for thinking and documenting in 3D.
- Discuss situations in the field when 3D measuring techniques are necessary and times when they are not.

UNIT 4: Intro to Advanced Crime Scene Technologies

📈 Instruction: Introduction to Advanced Technology

Purpose

- Introduce students to the background, history, and applications for relevant 3D technology.
- Introduce students to the basic types, principles, functions, and terminology associated with relevant 3D technology.

📈 Instruction: Special Considerations for Advanced Technologies in Forensic Science

Purpose

- Discuss the benefits, limitations, issues, attitudes, and expectations regarding advanced technology within investigative agencies.
- Introduce students to crime scene specific considerations concerning advanced technologies.
- Discuss advanced technologies in relation to court standards and cognitive bias.
- Introduce concepts regarding precision vs. accuracy, calibration, and validation of tools and software.

UNIT 5: Total Station

📍 Introduction Total Station Operation

📈 Instruction: Introduction to Coordinate Systems

Purpose

- Introduce students to methodology and terminology regarding coordinate systems, etc. that are necessary to understand and operate a total station and other related technologies.

📈 Instruction: Intro to Total Station

Purpose

- Introduce students to the fundamental concepts and terminology associated with a total station.
- Familiarize students with a total station's basic functionality, equipment and software, parts and accessories, and care and maintenance routines.
- Discuss crime scene specific uses and considerations regarding a total station.

📢 Demonstration: Total Station Operation

Purpose

- Provide a physical demonstration and overview of a total station's parts and functions.
- Demonstrate how to set up a total station and how to use it.
- Demonstrate associated roles and responsibilities along with care and maintenance.
- Demonstrate how to transfer the collected data to a memory card or other device so that it can be processed on a computer.
- Provide a bridge between gaining knowledge and gaining experience.

Materials

- **Note:** Specific items may vary depending on type and brand of devices, software, accessories, and instructor.
- Total Station.
- Tripod (if not already attached).
- Prism Pole.
- Data Collector (if applicable).
- Memory cards (if applicable).
- Any other devices or accessories needed for demonstration.

🚩 Practical Exercise: Scan Scene with Total Station

Purpose

- To introduce students to the use and operation of a Total Station at a crime scene.
- To give students the opportunity to build on skills and previous experiences in terms of crime scene documentation, specifically in choosing good reference points in areas that may be difficult.
- To learn to work with the presence of advanced technology at a crime scene.
    - There are often several investigators processing a scene with different roles and responsibilities that must all be accomplished within a certain time frame while all occupying the same physical space.
    - Students will need to learn how to navigate making manual measurements and total station measurements at the same time in the same space.
- To gather both manual and digital data to be used for future exercises.

Preparation

- Make sure the Total Station is in good order and ready to use.
- This includes making sure the battery is charged and the data collector, memory cards, and any other accessories are also ready for use.
- Designate a larger outdoor area that has at least some differences in elevation.
- Place only a few items of evidence within the scene.

Instructions

- As there is only one total station, not all students will be able to use it at the same time.
- Students will be divided into two teams.
- Team 1 will be responsible for measuring the scene traditionally and producing a rough sketch.
- Team 2 will use the Total Station to capture the scene.
- When finished, the teams will switch responsibilities, so Team 2 will measure traditionally and Team 1 will use the Total Station.
- This will result in both Teams having their own set of manual scene documentation and Total Station measurements.

Manual Measurement Instructions

- Students will focus on documenting and measuring evidence, paying special attention to choosing good reference points, especially when working in a larger outdoor area.
- Each team will decide among themselves who will help take and record measurements, sketch, and document.

- Students need to make sure that each member of their team has a copy of their manual scene documentation before the end of class so they can complete *Assignment: Total Station Scene Manual Final Sketch.*

Total Station Instructions

- Each team member will take turns functioning in the various roles of operating the total station so they can begin becoming familiar with the process and equipment.

🔎 Learning Log: Scan Scene with Total Station

Manual Measurement

- How did measuring or sketching this scene differ from previous exercises? Why or why not?
- Did you act on any previous knowledge or experience gained in previous exercises to help with documenting this scene? Why or why not?
- How comfortable do you feel with manual documentation after doing it several times already? More, less, the same?

Total Station

- What was the easiest part of using the Total Station? Why?
- What was the hardest part of using the Total Station? Why?
- Was there a role you preferred over another? Why?
- What additional knowledge or actions could help you better operate the total station?

📝 Assignment: Total Station Scene Manual Final Sketch

- Students will each be responsible for creating a manual (by-hand) final scene sketch based on the traditional measurements they collected together.
- This assignment does not need to be due immediately, but must be completed before *Activity: Understanding Total Station Results vs. Manual Measurements.*

📍 Introduction to Processing Total Station Data

Note:

- Modules within this subunit require every student to have individual access to a computer, appropriate software, and scan data.
- Instructors will need the ability to present lecture material and show demonstrations from their computer to the entire class so students can follow along on their own computers.
- It is highly recommended to use a computer lab where the instructor and students are all using the same version of software and the same operating systems.

📈 Instruction: Processing Total Station Data

Purpose

- Provide more detailed information regarding how collected data is processed and visualized, both in general and specific to the software students will be using.
- Provide reference materials for software tutorials and resources if available.
- Teach students how to read and understand total station scan data.

📢 Demonstration: Processing and Visualizing Total Station Data

Purpose

- Demonstrate how to download and process total station data so that it can be visualized.
- Introduce students to the specific software being used and how to navigate through it.
- Allow students to actively participate in the demonstration by following along using their own computer and individual scan data.

Materials

- **Note:** Specific items may vary depending on type and brand of devices, software, accessories, and instructor.

- Instructor will need:
    - Computer loaded with appropriate software.
    - Total station data for demonstration (can use student data acquired during *Practical Exercise: Scan Scene with Total Station).*
    - Screen projector or similar device to present lecture content and live software demonstration.

- Each student will need:
    - Computer loaded with appropriate software.
    - Total station scan data acquired during *Practical Exercise: Scan Scene with Total Station.*
    - Manual documentation and notes created during *Practical Exercise: Scan Scene with Total Station* .
        - **Note:** The *Assignment: Total Station Scene Manual Final Sketch* does not have to be complete at this time, but their manual documentation and notes are needed.

Preparation

- Make sure software is downloaded, tested, and ready to use on lab computers.

- Make sure students are able to login and access computers and appropriate software.
- Total station scan data acquired during *Practical Exercise: Scan Scene with Total Station* will need to be duplicated so that each student will have a copy of their teams' scan data.
- Students need to bring their manual measurement documentation notes with them to the lab, even if their *Assignment: Total Station Scene Manual Final Sketch* is not yet complete.

Instructions

- The instructor will walk students through the process of how to load total station data into the processing software and how to visualize and read their data.
- Students are to follow along on their own computers using the total station data they collected during *Practical Exercise: Scan Scene with Total Station.*
- Students are encouraged to ask questions at any time so the class can move through this process together.

🔬 Lab Exercise: Processing Total Station Data

Purpose

- This exercise overlaps with *Demonstration: Processing and Visualizing Total Station Data* and allows students time to explore the software, gain personal experience in data processing and visualization, and put knowledge gained during lectures into action.
- To help students learn how to problem solve through communication, cooperation, and exploring alternative resources.
- It may also be helpful for students to sit with their scan teams during this lab exercise so they can help one another.

Instructions

- Students will process their scan data to create a visualization.
- Students are allowed to openly ask questions to the instructor and fellow students, help each other figure things out, and search for help on the internet if needed.

- **Note:** This will likely require at least two class periods, as the first lab day will include processing instructions.
    - If allowed, students could also possibly use the lab on their own time to finish what they cannot during class time.

📝 Assignment: Total Station Visualization Final

- Students need to complete the processing of their total station scan data and print out a copy of the visualization.

- Students will need to have this ready for use during *Activity: Understanding Total Station Results vs. Manual Measurements.*

🔎 Learning Log: Processing Total Station Data

- ★ What expectations did you have about processing total station scan data? Why?
- ★ Did these expectations change after experiencing the process yourself? Why?
- What are your overall impressions or opinions about the total station data visualization process? Why?
- What was most difficult to understand? The easiest?
- What was the most difficult part of this assignment? Why?
- What was the easiest part of this assignment? Why?
- How did you solve problems encountered while processing?
- What new considerations did you discover when processing total station scan data that weren't evident while you were scanning?
- Were there any problems you did not find solutions to?
    - If so, how did you try looking for them?
- Does processing and visualizing scan data help you gain a better understanding of how the total station works and what it does?
- Does understanding how the total station works and what it does make the visualization process easier?
- What would make you more comfortable processing data?
    - These could include additional knowledge, training, practice, etc.

📝 Assignment: Total Station Overall Reflection

- After having scanned and processed, what would you do differently while scanning with the total station to make processing the data easier?
- What additional knowledge or actions do you think would help make scanning and processing easier?
- How was scanning with the total station different from taking manual measurements?
- How was scanning with the total station similar to taking manual measurements?
- Compare and contrast the purpose and results of using a Total Station vs. traditional measurements.

📍 Understanding Total Station Results

Note:

- It is recommended that all modules in this subunit take place in a computer lab so if specific questions arise concerning the software or visualizations they can be pulled up and viewed as a group.

📈 Instruction: Understanding Total Station Data

Purpose

- To teach students how to read and understand total station scan results.

🎲 Activity: Understanding Total Station Results vs. Manual Measurements

Purpose

- To help students see connections, similarities and differences between measuring manually and measuring with a total station.
- Allow students to compare and contrast manual documentation and total station results.

Materials

- Each student will need:
    - Completed *Assignment: Total Station Scene Manual Final Sketch.*
    - Completed *Assignment: Total Station Visualization Final.*

Instructions

- Students will break up into their original teams used during *Practical Exercise: Scan Scene with Total Station.*
- Students will be given time to share, compare, and contrast their final total station results and manual final sketches with others that worked with the same data sets.

Discussion Points

- Compare and contrast results from *Assignment: Total Station Visualization Final.*
    - Do all the total station visualizations match?
    - If they do not match, what specifically is different about them?
    - What could have caused these differences?
    - Should all results match exactly if based on the same data? Why or why not?
    - What problems or issues can you foresee if results between visualizations vary?
- Compare and contrast sketches from *Assignment: Total Station Scene Manual Final Sketch.*
- Compare and contrast total station scan results and manual scene sketches and measurements.
    - Do the manual measurements and total station measurements match up?
    - If they do not match, what specifically is different about them?
    - What could have caused these differences?
    - How could these issues be resolved in the future?
- Compare and contrast the value and purpose of measuring manually vs. measuring with a total station.

- Do you think total station scan results can stand on their own without a final sketch and manual measurements? Why or why not?

💬 Reflect & Discuss: Total Station Overall Reflection

Purpose

- To allow students to openly discuss challenges encountered, changes in expectations and understanding regarding the use of a total station, and provide answers to questions.

Guided Discussion Prompts

- ★ *Refer to Activity: Understanding Total Station Results vs. Manual Measurements.*
- *Refer to Learning Log: Scan Scene with Total Station.*
- *Refer to Learning Log: Processing and Understanding Total Station Data.*
- ★ *Refer to Assignment: Total Station Overall Reflections.*

- What is the value of these two methods of measurement by themselves?
- What is their value together?
- What can one do that the other cannot?
- What kinds of situations would a total station be necessary or useful?
- What kinds of situations would a total station not be necessary or useful?
- Discuss any other questions or comments as needed.

UNIT 6: 3D Scanner

📍 Introduction to 3D Scanner Operation

📈 Instruction: Introduction to 3D Scanner

Purpose

- Introduce students to the fundamental concepts, terminology, and types of 3D scanning technologies.
- Familiarize students with a 3D scanner's basic functionality, equipment and software, parts and accessories, and care and maintenance routines.
- Discuss crime scene specific uses and considerations regarding 3D scanning technology.

📈 Instruction: 3D Scanner Considerations

Purpose

- Familiarize students with common issues, limitations, and special considerations regarding the functionality of 3D scanners in direct relation to crime scene documentation.

📣 Demonstration: 3D Scanner Operation

Purpose

- Provide a physical demonstration and overview of a 3D scanner's parts and functions.
- Demonstrate how to set up a 3D scanner and how to use it.
- Demonstrate associated roles and responsibilities along with care and maintenance.
- Demonstrate how to transfer the collected data to a memory card or other device so that it can be processed on a computer.
- Provide a bridge between gaining knowledge and gaining experience.

Materials

- **Note:** Specific items may vary depending on type and brand of devices, software, accessories, and instructor.
- 3D scanner.
- Tripod (if not already attached).
- Memory cards (if applicable).
- Any other devices or accessories needed for demonstration.

🚩 Practical Exercise: Scan Scene with 3D Scanner (Indoor)

Purpose

- To introduce students to the use and operation of a 3D Scanner at a crime scene.
- To give students the opportunity to build on skills and previous experiences in terms of crime scene documentation, specifically in creating final sketches using a computer.
- To gather both manual and digital data to be used for future exercises.

Materials

- **Note:** Specific items may vary depending on type and brand of devices, software, accessories, and instructor.
- 3D scanner.
    - Tripod (if not already attached).
    - Memory cards for each team (if applicable).
    - 3D scanner paper targets (3 per team).
    - Any other devices or accessories needed.
- Evidence.
- Evidence markers.
- Cameras.
    - Camera memory cards.
- Documentation supplies.
- Measurement tools.

Considerations

- It is recommended not to leave students alone with the 3D scanner, and aid them in moving it while they learn how to handle it.
- Once the first group to use the 3D scanner has finished scanning, it is recommended that the instructor move the 3D scanner to the other crime scene so the other group can use it.
- Make sure that each team is scanning data to different memory cards so that data from the previous group is not overwritten.

Preparation

- Make sure 3D Scanner is in good order and ready to use.
    - This includes making sure the battery is charged, memory cards are present and cleared (if applicable), and any other accessories are also ready for use.
- Make sure cameras are charged and memory cards are present and cleared.
- Print out paper 3D scanner targets, 3 for each team.
- Set up 2 simple crime scenes in separate indoor areas, being sure to avoid too many bright windows.

- It is recommended that the areas chosen have chairs, desks, or other objects that will obstruct the scanner's line-of-sight during at least one scan, if not two.
- Place 4 objects of evidence within each scene.
    1. One item of evidence should be placed on the floor near or between obstructive objects where the scanner may have a hard time capturing it, but would be easily photographed with a camera.
    2. One item of evidence should be placed on a vertical surface, such as a wall.
    3. One item of evidence should be placed openly on an elevated surface, such as on top of a table or chair that is largely unobstructed so should be easily captured by the 3D scanner.
    4. One item of evidence should be placed openly on the floor in a location that should be easily captured by the 3D scanner.
- These evidence placements will be used as discussion points during *Lab Exercise: Verifying Measurements Using 3D Scanning Technology.*

Instructions

- Students will be divided into two teams. Once their tasks are completed, the two teams will switch responsibilities.
    - Team 1 will be responsible for measuring their scene manually.
    - Team 2 will use the 3D Scanner to scan their scene.
- When finished, teams will switch responsibilities (Team 2 will measure traditionally and Team 1 will use the 3D scanner).
- This will result in both teams having their own set of manual scene documentation and 3D scan data.

Manual Measurement Instructions

- Each team will decide among themselves who will help take and record measurements, sketch, document, and photograph.
    - Photographs are required for this exercise so they can be compared to final 3D scan visualizations during *Activity: Comparing 3D Scans to Photographs & Sketches (Indoor).*
- Students will need to make sure that each member of their team has a copy of their manual documentation notes, measurements, and rough sketch in order to complete the upcoming *Assignment: Indoor Scene Final Sketch (Computer) & Documentation.*

3D Scanner Instructions

- Students will be given 3 paper targets to be placed on the walls.
- Students will take turns operating the 3D Scanner so they can begin becoming familiar with the process.
- Teams must take 3 scans, and students should take turns operating the 3D scanner.

- It is recommended not to leave students alone with the 3D scanner, and aid them in moving it between scans while they learn how to handle it safely.

🔎 Learning Log: Scan Scene with 3D Scanner (Indoor)

- What expectations did you have about using the 3D scanner?
    - These can include ease of use, operation, etc.
- Did these expectations change after using it? Why?
- What are your overall impressions or opinions about the 3D scanning process? Why?
- Compare and contrast using a 3D scanner and a total station.
- Compare and contrast using a 3D scanner and measuring manually.
- What new considerations did you discover when using a 3D scanner?
- What was the easiest part of using the 3D scanner? Why?
- What was the hardest part of using the 3D scanner? Why?
- What additional knowledge or actions could help you better operate the 3D scanner?
- How confident are you that your scans captured what you wanted it to? Why or why not?
- How confident are you in the placement of your scanner targets in helping you later process your scans successfully? Why or why not?

📝 Assignment: Indoor Scene Final Sketch (Computer) & Documentation

Purpose

- Build and improve upon previously learned computer sketching skills.
- Provide each student with a completed final sketch that can be compared with their final 3D visualizations during *Lab Exercise: Verifying Measurements Using 3D Scanning Technology (Indoor).*

Instructions

- Create a final sketch (using PowerPoint on a computer) based on the manual measurements taken during *Practical Exercise: Scan Scene with 3D Scanner (Indoor).*
- Create a finalized version of crime scene documentation notes.
    - This does not need to be due immediately, but must be completed before *Lab Exercise: Verifying Measurements Using 3D Scanning Technology (Indoor).*

📍 Introduction to Processing 3D Scanner Data

Note:

- Modules within this subunit require every student to have individual access to a computer, appropriate software, and scan data.
- Instructors will need the ability to present lecture material and show demonstrations from their computer to the entire class so students can follow along on their own computers.

- It is highly recommended to use a computer lab where the instructor and students are all using the same version of software and the same operating systems.

📈 Instruction: Processing 3D Scanner Data

Purpose

- Provide more detailed information regarding how collected 3D scan data is processed and visualized, both in general and specific to the software students will be using.
- Provide reference materials for software tutorials and resources if available.
- Teach students how to read and understand 3D scanner data.

📢 Demonstration: Processing and Visualizing 3D Scanner Data

Purpose

- Demonstrate how to download and process 3D scanner data so that it can be visualized.
- Introduce students to the specific software being used and how to navigate through it.
- Allow students to actively participate in the demonstration by following along using their own computer and individual scan data.

Materials

- **Note:** Specific items may vary depending on type and brand of devices, software, accessories, and instructor.
- Instructor will need:
    - Computer loaded with appropriate software.
    - 3D scanner data for demonstration (can use student data acquired during *Practical Exercise: Scan Scene with 3D Scanner (Indoor).*
    - Screen projector or similar device to present lecture content and live software demonstration.
- Each student will need:
    - Computer loaded with appropriate software.
    - 3D scanner data, manual documentation and notes acquired during *Practical Exercise: Scan Scene with 3D Scanner (Indoor).*
        - Documentation and notes do not need to be in a finalized version at this time.

Preparation

- Make sure software is downloaded, tested, and ready to use on lab computers.
- Make sure students are able to login and access computers and appropriate software.

- 3D scanner data acquired during *Practical Exercise: Scan Scene with 3D Scanner (Indoor)* will need to be duplicated so that each student will have a copy of their teams' scan data.
- It may also be helpful for students to sit with their scan teams during this lab exercise so they can help one another.

Instructions

- The instructor will walk students through the process of how to load 3D scanner data into the processing software and how to visualize and read their data.
- Students are to follow along on their own computers using the 3D scanner data they collected during *Practical Exercise: Scan Scene with 3D Scanner (Indoor).*
- Students are encouraged to ask questions at any time so the class can move through this process together.

🔬 Lab Exercise: Processing and Understanding 3D Scan Data (Indoor)

Purpose

- This exercise overlaps with *Demonstration: Processing and Visualizing 3D Scanner Data* and allows students time to explore the software, gain personal experience in data processing and visualization, and put knowledge gained during lectures into action.
- To help students learn how to problem solve through communication, cooperation, and exploring alternative resources.

Instructions

- Students will process their scan data to create a visualization.
- Students are allowed to openly ask questions to the instructor and fellow students, help each other figure things out, and search for help on the internet if needed.
- **Note:** This will likely require at least two class periods, as the first lab day will include processing instructions.
    - If allowed, students could also possibly use the lab on their own time to finish what they cannot during class time.

📝 Assignment: 3D Scanner Visualization Final (Indoor)

- Students need to complete processing their 3D scanner data and print out a copy of an overhead view of their visualization.
- Students will need to have this completed for use during *Lab Exercise: Verifying Measurements Using 3D Scanning Technology (Indoor).*

🔎 Learning Log: Processing and Understanding 3D Scan Data (Indoor)

- ★ What expectations did you have about processing 3D scanner data? Why?
- ★ Did these expectations change after experiencing the process yourself? Why?
- What are your overall impressions or opinions of the 3D scanner visualization process? Why?
- What was most difficult to understand? The easiest?
- How did you solve problems encountered while processing?
- Were there any problems you did not find solutions to?
    - If so, how did you try looking for them?
- How comfortable did you feel with processing the 3D scanner data?
- What would make you more comfortable processing data?
    - These could include additional knowledge, training, practice, etc.
- What did the scanner capture well? What did it not? Why?
- If scanning the same scene again, what would you do differently?
    - These could include placement of scanner, targets, etc.
- What new considerations did you discover when processing 3D scanner data that weren't evident while you were scanning?
- What processing issues did you run into that could be alleviated by how you scanned?
- Does processing and visualizing scan data help you gain a better understanding of how the 3D scanner works and what it does?
- Does understanding how the 3D scanner works and what it does make the visualization process easier?
- Compare and contrast processing 3D scanner and a total station scan data.

📍 Introduction to Verifying Measurements Using Advanced Technology

📈 Instruction: Verifying Measurements Using 3D Scanning Technology

Purpose

- To deepen the understanding and importance of concepts regarding precision vs. accuracy, verification, validation, margin of error and acceptable significance as it pertains to crime scene processing and reconstruction.
- Teach students how to take measurements within a processed 3D scan using visualization software and compare/verify them against manual measurements.

🔬 Lab Exercise: Verifying Measurements Using 3D Scanning Technology (Indoor)

Note: This Lab Exercise and the following *Activity: Comparing 3D Scans and Photographic Documentation (Indoor)* are meant to take place back-to-back during the same class period if possible.

Purpose

- Give students the opportunity to apply what they have learned during *Instruction: Verifying Measurements using 3D Scanning Technology* using data they collected themselves.
- To help students see connections, similarities and differences between measuring manually and measuring with a 3D scanner.
- To teach students how to compare 3D scans with manual measurements and how to validate those measurements.
- Allow students to compare and contrast manual documentation and 3D scan results.

Materials

- **Note:** Specific items may vary depending on type and brand of devices, software, accessories, and instructor.
- Each student will need:
    - Computer loaded with appropriate software.
    - Completed *Assignment: 3D Scanner Visualization Final (Indoor).*
        - This includes both the printed view and access to the completed scan visualization file.
    - Completed *Assignment: Indoor Scene Final Sketch (Computer) & Documentation.*

Preparation

- Make sure software is downloaded, tested, and ready to use on lab computers.
- Make sure students are able to login and access computers and appropriate software.
- It may also be helpful for students to sit with their scan teams during this lab exercise so they can help one another.

Instructions

- Students are to complete a series of tasks and answer the accompanying questions.

Part 1:

- Students will take digital measurements within the 3D scanner visualization software between all 4 items of evidence and their corresponding reference points.
    - Note that some of these may be difficult if evidence was obscured by objects or not fully captured by the 3D scanner, and other items require both 2D and 3D measurements.

- **Questions:**
    - Is every reference point used clearly visible in the final 3D scan? Why or why not?
    - What could have caused the scanner to not have captured them properly?
    - Can these issues be fixed? How? When (before, during, or after scanning)?
    - Is every piece of evidence clearly visible in the final 3D scan? Why or why not?
    - What could have caused the scanner to not have captured them properly?
    - Can these issues be fixed? How? When (before, during, or after scanning)?
    - If reference points or evidence are obscured or unclear, can you still make accurate digital measurements within the 3D scanner software? Why or why not?

Part 2:

- Students will compare the measurements taken within the 3D visualization software to their corresponding manual measurements.
- **Questions:**
    - Were there any significant differences between your manual measurements and your scanned measurements?
        - If so, what do you think caused or contributed to these differences?
        - Are these differences due to errors that can be corrected? How?
    - If different, which measurements do you believe are the most **accurate**? Why?
    - If different, which measurements do you believe are the most **precise**? Why?

Part 3:

- Students will compare their measurements taken within the 3D visualization software with those of their team members'.
- **Questions:**
    - Were there any significant differences between your digital measurements and those of your teammates'?
    - If each student is working from the exact same data, how can there be differences in analysis?
    - What do you think caused these differences?
    - If errors occurred, how could they be fixed?
    - Do you think varying results invalidate the original data? Why or why not?

Part 4:

- As a team, students will choose an item of evidence that they want to compare digital measurements in greater detail.
- Students will take turns showing each other exactly how and from where their measurements were taken.
- They should also provide reasoning for their decisions (especially if there are significant differences between group members).
- **Questions:**

    - Did individual choices or actions affect the difference between measurement results?
    - Were choices based on documentation (notes, sketch, photographs), on memory, or a combination of both? Or neither?
        - Why would this matter or how could this become important in real crime scene documentation or court submission?
- If students realize they made a mistake or find a better way to take measurements within the software, students are to retake those measurements and make notes in their Learning Log Field Notes about what they changed and why.
- Students are encouraged to help each other discover the roots of problems, find solutions, and share any knowledge or tips they have discovered.
    - **Note:** Students must remember that the purpose of this activity is not to reach the same results based on each other's individual analysis of the data, but to reach similar results based on the original data itself and using similar methodologies.

Part 5:

- As a team, discuss the differences between results and determine whether they fall within an acceptable margin of error.
- Questions
    - If it is decided that differences fall within an acceptable error range, justify and explain why.
    - If it is decided that differences do **not** fall within an acceptable error range, discuss and record potential causes and solutions.

Activity: Comparing 3D Scans to Photographs & Sketches (Indoor)

Purpose

- To help students understand how different documentation methodologies cannot stand alone and must work together to successfully and thoroughly document a crime scene.
- To reinforce concepts regarding perspective and planning ahead.
- To visually demonstrate why advanced tools, while they can provide additional information and beneficial results, are not meant to completely replace other methods of documentation (such as sketching, photographing, and taking manual measurements).

Materials

- **Note:** Specific items may vary depending on type and brand of devices, software, accessories, and instructor.
- Each student will need:
    - Computer loaded with appropriate software.
    - Completed *Assignment: 3D Scanner Visualization Final (Indoor).*

        - This includes both the printed view and access to the completed scan visualization file.
    - Photographs taken during *Practical Exercise: Scan Scene with 3D Scanner (Indoor).*
    - Completed *Assignment: Indoor Scene Final Sketch (Computer) & Documentation.*

Preparation

- Make sure software is downloaded, tested, and ready to use on lab computers.
- Make sure students are able to login and access computers and appropriate software.
- Photographs taken during *Practical Exercise: Scan Scene with 3D Scanner (Indoor)* will need to be duplicated so that each student will have a copy of their teams' set of photographs.
- It may also be helpful for students to sit with their scan teams during this lab exercise so they can help one another.

Instructions

- Students are to complete a series of tasks and answer the accompanying questions.

Part 1:

- Students will take a few minutes to explore their final 3D visualizations and review their teams' crime scene photos.
- **Questions:**
    - Did the 3D scanner capture the entire scene, including all the pieces of evidence, to your satisfaction? Why or why not?
    - If not, what could have caused the scanner to miss information?
        - These could include scanner placement, target placement, environmental concerns, errors in scanner operation, etc.
    - Which piece of evidence did the 3D scanner capture the most of? Why?
    - Which piece of evidence did the 3D scanner have the most difficult time capturing? Why?

Part 2:

- Each student will choose a different piece of evidence to compare with their corresponding photographs in more detail.
    - Note: Depending on the number of students in each group, it is possible that not all pieces of evidence will be looked at closely, or that more than one student will study the same item.
    - If there are more pieces of evidence than students in a group, students should focus on the items that were not captured by the 3D scanner with the desired amount of detail needed to document it successfully.

- Each student will need to find the photographs that show their piece of evidence, both in overall and up -close views.
- Each student will need to locate their piece of evidence on their final crime scene sketch created during *Assignment: Indoor Scene Final Sketch & Documentation (Indoor).*
- **Questions:**
    - What information does the 3D visualization provide that is not evident or easily seen or gathered from the photographs or final sketch?
    - What information do the photographs provide that is not evident or easily seen or gathered from the 3D visualization or final sketch?
    - What information does the final sketch provide that is not evident or easily seen or gathered from the 3D visualization or photographs?

Part 3:

- Within each team, students will share views of their evidence within their 3D visualization and the corresponding photographs.
- Students will discuss, compare and contrast observations regarding the 3D visualization, photographs, and final sketch.
- **Questions:**
    - If only a 3D scanner had been used without taking manual measurements or photographs, would that have been enough information to successfully and completely document your evidence? Why or why not?
    - Would there have been enough information that someone else could reconstruct it accurately? Why or why not?
    - Why is it important to use both forms of documentation rather than the scanner alone?
    - For each piece of evidence, discuss the placements of the 3D scanner and scanner targets and how they could have been placed differently in order to capture more of the scene and important areas in better detail.
    - Discuss different approaches and other actions to try during the next 3D scan exercise that could improve upon their first 3D scan and scan processing results and methodology.

Part 4:

- Discuss attitudes and expectations regarding the use of the 3D scanner.
- **Questions:**
    - What are the pros and cons of each type of visual documentation (sketch, photographs, and 3D scans)?
    - Why is it important to use multiple forms of documentation rather than the scanner alone?
    - Did you take photos differently than you would have if not using the 3D scanner? Why or why not?
    - Why is it important to take photos just as you would when not using the scanner?

- The scans may not turn out, they may not capture the evidence properly, etc.

Part 5:

- Students are encouraged to discuss and share any new realizations, discoveries, considerations, issues encountered, problems solved or unsolved, questions, etc. that they encountered that would be helpful to themselves and others.

🔎 Learning Log: Scan Scene with 3D Scanner (Indoor) Overall Reflections

- What are your overall impressions, opinions, and assessment regarding the use of a 3D scanner at a crime scene?
- What issues could you foresee using 3D scanning in the field?
- **How could those issues be resolved?**
- How and in what kinds of situations could 3D scanning technology be beneficial in the field?
- ★ How did your perceptions and expectations about 3D scanners change between learning about them, operating them, and then processing the data? Why?
- ★ After experiencing using a 3D scanner from initial scan to final visualization, what did you learn and what actions do you want to take next time you scan a scene?

💬 Reflect & Discuss: Scan Scene with 3D Scanner (Indoor) Overall Reflections

Purpose

- To allow students to discuss within the larger group challenges encountered, changes in expectations and understanding regarding the use of a 3D scanner, and provide answers to questions.

Guided Discussion Prompts

- *Refer to Learning Log: Scan Scene with 3D Scanner (Indoor).*
- *Refer to Learning Log: Processing and Understanding 3D Scan Data (Indoor).*
- ★ *Refer to Lab Exercise: Verifying Measurements Using 3D Scanning Technology (Indoor).*
- ★ *Refer to Activity: Comparing 3D Scans to Photographs & Sketches (Indoor).*

📍 3D Scanner Operation (Outdoor)

📈 Instruction: Compass Method

Purpose

- Introduce the Compass Method for creating reference points and measuring from them at a crime scene and related concepts and terminology.
- Relate these principles to 3D scanner placement as students prepare to scan a larger scene.

🎲 Activity: Compass Method Practice

Purpose

- Help students learn how to use the Compass Method and the accompanying tools through practical experience.
- Familiarize students with certain concepts and methods that will direct

Materials

- Cones, flags, or other similar items to mark created reference points. (4 per group).
- Measurement tools.
    - Measurement tapes.
    - Protractor.
- Documentation supplies.

Instructions

- Students will break up into small teams (3-4) and be placed in various areas.
    - These areas can be indoor and/or outdoor, and must include an area where students must use the compass method to establish reference points around a corner.
- Students will be responsible for establishing 4 reference points using the Compass Method.

🔎 Learning Log: Compass Method

- What was the most difficult concept to understand or action to perform using the Compass Method? Why?
- What was the easiest concept to understand or action to perform using the Compass Method? Why?
- How comfortable or confident are you with using the Compass Method? Why?
- What could make you more comfortable or confident using the Compass Method? Why?
- What situations (both indoor and outdoor) would the Compass Method be useful to use at a crime scene? Why?
- Compare and contrast the Compass Method with other measurement methods (baseline, triangulation, etc.).

- What did you learn that you will remember for next time you need to use the Compass Method. Why?
- Based on this experience, what different actions might you take next time you need to use the Compass Method. Why?

📣 Demonstration: 3D Scanner Operation Review (Outdoor)

Purpose

- To review important concepts relating to 3D scanner operation and safety.
- To present and demonstrate 3D scanner procedures and considerations specific to scanning outdoors.

Considerations

- It is important to consider the weather - do not scan in the rain or if it is too windy. Wind can be particularly dangerous, especially if the scanner is not on level ground.
- It is always recommended not to leave students alone with the 3D scanner (especially outdoors), and have someone near the scanner at all times to secure the device if the wind picks up.

Instructions

- The instructor will review with students how to choose safe places to set up the 3D scanner, and how to properly move and secure the scanner once a location is chosen.
    - This is especially important outside as the ground is not usually flat and you do not want the scanner to tip over!
- Review and demonstrate how to level the 3D scanner as outdoor terrain is often uneven and usually requires more adjustments than when scanning indoors.
- Review placement of targets, and demonstrate out to set up spherical targets.
- Discuss placement of targets and “natural” targets/reference points that can be used within the 3D scanner software to help stitch scans together.
- Review considerations for environmental factors, line-of-sight, motion interference, etc.
- Further discuss how to plan a scan before you begin, taking in all necessary considerations.
- Demonstrate how to move around the scanner so it cannot see you, which is necessary when there is nowhere close to hide from it.

🚩 Practical Exercise: Scan Scene with 3D Scanner (Outdoor)

Purpose

- To give students more experience using and operating a 3D Scanner at a crime scene, but in a different environment with new challenges.

- To give students additional practice verifying 3D scanner measurements with manual measurements, but within a larger area.
- To reinforce and further the understanding of perspective, line-of-sight, and the importance of planning and thinking through a multi-step process.
- To gather both manual and digital data to be used for future exercises.

Materials

- **Note:** Specific items may vary depending on type and brand of devices, software, accessories, and instructor.
- 3D scanner.
    - Tripod (if not already attached).
    - Memory cards for each team (if applicable).
    - Spherical 3D scanner targets.
- Evidence.
- Evidence markers.
- Cameras.
    - Camera memory cards.
- Documentation supplies.
- Measurement tools.
- Meter stick.

Considerations

- It is important to consider the weather - do not scan in the rain or if it is too windy. Wind can be particularly dangerous, especially if the scanner is not on level ground.
- It is always recommended not to leave students alone with the 3D scanner (especially outdoors), and have someone near the scanner at all times to secure the device if the wind picks up.

Preparation

- Make sure 3D Scanner is in good order and ready to use.
    - This includes making sure the battery is charged, memory cards are present and cleared (if applicable), and any other accessories are also ready for use.
- Make sure cameras are charged and memory cards are present and cleared.
- Make sure the 3D scanner is in good order and ready to use.
    - This includes making sure the battery is charged, memory card is present, and any other accessories are also ready for use.
- Set up 2 simple crimes in outdoor areas that have several areas of level/even ground so the scanner can be set up safely.
    - Select an area where the students will have to scan around the corner of a building or similarly large obstacle.

    - At least 1-2 pieces of evidence should be placed around corners from each other so they cannot be seen at the same time from every angle.
    - Be sure to place some items at different elevations if possible (on a slope, bush, rock, tree, car, etc.).
- An area that has objects that could create "void" spots in the scan is also recommended (trees, cars, poles, etc.).

Instructions

- Students will be divided into two teams. Once their tasks are completed, the two teams will switch responsibilities.
    - Team 1 will be responsible for measuring their scene manually (including some Compass Method measurements).
    - Team 2 will use the 3D Scanner to scan their scene.
- When finished, teams will switch responsibilities (Team 2 will measure traditionally and Team 1 will use the 3D scanner).
- This will result in both teams having their own set of manual scene documentation and 3D scan data.

Manual Documentation with Compass Method Instructions

- Each team will decide among themselves who will help take and record measurements, sketch, document, and photograph.
    - Photographs are required for this exercise so they can be compared to final 3D scan visualizations during *Activity: Comparing 3D Scans to Photographs & Sketches (Outdoor).*
- Students are to document their scene normally, however they will be presented with a new challenge as they must document a scene around a corner.
- Students must choose at least 2 items of evidence and measure them using the Compass Method.
    - **Note:** During *Activity: Compass Method Practice* students used the Compass Method to create reference points, but in this practical exercise they are to choose reference points as they normally would, and use the Compass Method to document the evidence itself.
- Students may choose any other measuring methodology (baseline, triangulation) for documenting the remaining pieces of evidence based on a group consensus of which methodology would be best in the situation.
    - As more than one measurement method is being used, it will be important for students to document their actions and measurements clearly.
- Students will need to make sure that each member of their team has a copy of their manual documentation notes, measurements, and rough sketch in order to complete the upcoming *Assignment: Outdoor Scene Final Sketch (Computer) & Documentation.*

3D Scanner Instructions

- Students will be given at least 3 spherical targets to be placed on the ground in or around their scene.
- Students are responsible for planning their scan and discussing target placement before they begin.
    - It may help to have students stand where they think their scanners should go and look around and decide on good placement points for the targets as they plan their scan.
- Teams should take at least 4 scans, and students should take turns operating the 3D 3D scanner.
    - During each scan, the student operating the 3D scanner will practice circling it while it is actively scanning so they may understand how to stay close to the scanner without being captured by it.
    - The other students are to move to an area outside of the crime scene or find a hiding place within or near the scene where the scanner cannot "see" them.
- Students are required to place a meter stick in their scene to use later in verifying measurements.
    - The meter stick should be placed in level area if possible, and where it does not interfere with the evidence.
    - The meter stick should also be placed where it can be clearly seen in every scan (if possible).
    - Once placed, the meter stick should not be moved at any time during the scan, as it needs to be in exactly the same location and position in every scan.

🔎 **Learning Log: Scan Scene with 3D Scanner (Outdoor)**

- What expectations did you have about using the 3D scanner for a second time? Why?
- Did these expectations change after using it again? Why?
- Did your impression or opinion of the 3D scanner visualization process after experiencing it for the second time? Why?
- Were you more comfortable or confident operating the 3D for a second time? Why or why not?
- What did you learn from your first 3D scanning experience that you incorporated into this one?
- What actions did you change based on your previous 3D scanning experience? Why?
    - Were these changes helpful? Why?
- What actions did you **not** change based on your previous 3D scanning experience? Why?
- How was scanning outdoors different than scanning indoors?
- What new considerations did you discover about using a 3D scanner outdoors?

- After learning how to process 3D scan data, did you change the way you approached scanning your outdoor scene? How and why?
- After learning how to process 3D scan data, did you change how and where you placed your scanner targets?
    - Why? How did you place them differently?
- How confident are you in the placement of your targets in helping you later process your scans successfully? Why or why not?
- After learning how to process 3D scan data, did you change how you placed the 3D scanner?
    - Why? How did you place it differently?
- How confident are you that your scans captured what you wanted it to? Why or why not?

📝 Assignment: Outdoor Scene Final Sketch (Computer) & Documentation

Purpose

- Build and improve upon previously learned computer sketching skills while presenting new challenges (obstructed crime scene and mixed measurement methodologies).
- Provide each student with a completed final sketch that can be compared with their final 3D visualizations during *Lab Exercise: Verifying Measurements Using 3D Scanning Technology (Outdoor).*

Instructions

- Create a final sketch (using PowerPoint on a computer) based on the manual measurements taken during *Practical Exercise: Scan Scene with 3D Scanner (Outdoor).*
- Create a finalized version of crime scene documentation notes.
    - This does not need to be due immediately, but must be completed before *Lab Exercise: Verifying Measurements Using 3D Scanning Technology (Outdoor).*

📍 Processing 3D Scanner Data (Outdoor)

🔬 Lab Exercise: Processing 3D Scan Data (Outdoor)

Purpose

- To give students further experience processing 3D scanner, but in a different environment with new challenges.
- To reinforce and further the understanding of perspective, line-of-sight, and the importance of planning and thinking through a multi-step process.
- To further enhance the students' ability to problem solve through communication, cooperation, and exploring alternative resources.

Materials

- **Note:** Specific items may vary depending on type and brand of devices, software, accessories, and instructor.
- Instructor will need:
    - Computer loaded with appropriate software.
    - 3D scanner data for demonstration (can use student data acquired during *Practical Exercise: Scan Scene with 3D Scanner (Outdoor).*
    - Screen projector or similar device to present lecture content and live software demonstration.
- Each student will need:
    - Computer loaded with appropriate software.
    - 3D scanner data, manual documentation and notes acquired during *Practical Exercise: Scan Scene with 3D Scanner (Outdoor).*
        - Documentation and notes do not need to be in a finalized version at this time.

Preparation

- Make sure software is downloaded, tested, and ready to use on lab computers.
- Make sure students are able to login and access computers and appropriate software.
- 3D scanner data acquired during *Practical Exercise: Scan Scene with 3D Scanner (Outdoor)* will need to be duplicated so that each student will have a copy of their teams' scan data.
- It may also be helpful for students to sit with their scan teams during this lab exercise so they can help one another.

Instructions

- If necessary, the instructor can review with students the process of how to load 3D scanner data into the processing software.
- Students will process their scan data to create a visualization.
- Students are allowed to openly ask questions to the instructor and fellow students, help each other figure things out, and search for help on the internet if needed.
- Students are encouraged to ask questions at any time so the class can move through this process together.
- **Note:** This will likely require at least two class periods.
    - If allowed, students could also possibly use the lab on their own time to finish what they cannot during class time.

📝 Assignment: 3D Scanner Visualization Final (Outdoor)

- Students need to complete processing their 3D scanner data and print out a copy of an overhead view of their visualization.

- Students will need to have this completed for use during *Lab Exercise: Verifying Measurements Using 3D Scanning Technology (Outdoor).*

🔎 Learning Log: Processing 3D Scanner Scene Data (Outdoor)

- What expectations did you have about processing 3D scan data for a second time? Why?
- Did these expectations change after going through the data visualization process again? Why?
- Did your overall impressions or opinions change after going through the data visualization process again? Why?
- Were you more comfortable or confident processing the 3D scan data for a second time? Why or why not?
- What did you learn from your first 3D scan processing experience that you incorporated into this one?
- What actions did you change based on your previous 3D scan processing experience? Why?
    - Were these changes helpful? Why?
- What actions did you **not** change based on your previous 3D scan processing experience? Why?
- What new considerations did you discover about using a 3D scanner outdoors after looking at your scan data?
- After processing your scan data, what would you change about the way you scanned your outdoor scene? How and why?
- After processing your scan data, what would you change about the way you placed the scanner targets in your outdoor scene? How and why?
- What did the scanner capture well?
    - What did it not? Why?
- What processing issues did you run into that could be alleviated by how you scanned?
- What new considerations did you discover about using a 3D scanner outdoors after processing the scan data?
- Did more experience help you feel more comfortable? Why or why not?

📍 Verifying Measurements Using Advanced Technology (Outdoor)

🔬 Lab Exercise: Verifying Measurements Using 3D Scanning Technology (Outdoor)

Purpose

- To give students further practice applying what they have learned during *Instruction: Verifying Measurements using 3D Scanning Technology* and *Lab Exercise: Verifying Measurements Using 3D Scanning Technology (Indoor)* while developing additional skills.

- Allow students to compare and contrast manual documentation and 3D scan results, including using a meter stick for verification.

Note: This Lab Exercise and the following *Activity: Comparing 3D Scans and Photographic Documentation (Outdoor)* are meant to take place back-to-back during the same class period if possible.

Materials

- **Note:** Specific items may vary depending on type and brand of devices, software, accessories, and instructor.
- Each student will need:
    - Computer loaded with appropriate software.
    - Completed *Assignment: 3D Scanner Visualization Final (Outdoor).*
        - This includes both the printed view and access to the completed scan visualization file.
    - Completed *Assignment: Outdoor Scene Final Sketch (Computer) & Documentation.*

Preparation

- Make sure software is downloaded, tested, and ready to use on lab computers.
- Make sure students are able to login and access computers and appropriate software.
- It may also be helpful for students to sit with their scan teams during this lab exercise so they can help one another.

Instructions

- Students are to complete a series of tasks and answer the accompanying questions.

Part 1:

- Students will take digital measurements within the 3D scanner visualization software for 3 items of evidence along with their corresponding reference points.
    - Two items must be around the corner from one another.
    - The third item must have been measured using the Compass Method.
    - Note that some of these may be difficult if evidence was obscured by objects or not fully captured by the 3D scanner, and other items may require both 2D and 3D measurements.
- Students will also digitally measure the meter stick placed within the scene.
- Questions:
    - Is every reference point used clearly visible in the final 3D scan? Why or why not?
    - What could have caused the scanner to not have captured them properly?

    - Can these issues be fixed? How? When (before, during, or after scanning)?
    - Is every piece of evidence clearly visible in the final 3D scan? Why or why not?
    - What specifically could have caused the scanner to not have captured them properly?
    - Can these issues be fixed? How? When (before, during, or after scanning)?
    - If reference points or evidence are obscured or unclear, can you still make accurate digital measurements within the 3D scanner software? Why or why not?
    - Is making digital measurements on scans captured outdoors different from scans taken indoors? Why or why not?

Part 2:

- Students will compare the measurements taken within the 3D visualization software to their corresponding manual measurements.
- Questions:
    - Were there any significant differences between your manual measurements and your scanned measurements?
        - If so, what do you think caused or contributed to these differences?
        - Are these differences due to errors that can be corrected? How?
    - Were there any significant differences between your digital measurements and the meter stick?
        - If so, what do you think caused or contributed to these differences?
        - Are these differences due to errors that can be corrected? How?
    - Are there more, less, or the same amount of differences between your manual measurements and your scanned measurements compared to those from the previous *Lab Exercise: Verifying Measurements Using 3D Scanning Technology (Indoor)*?
        - What do you think caused or contributed to these differences or lack of differences?

Part 3:

- Students will compare their measurements taken within the 3D visualization software with those of their team members'.
- Questions:
    - Were there any significant differences between your digital measurements and those of your teammates'?
    - If each student is working from the exact same data, how can there be differences in analysis?
    - What do you think caused these differences?
    - If errors occurred, how could they be fixed?
    - Do you think varying results invalidate the original data? Why or why not?

    - Are there more, less, or the same amount of differences between the individual team members' results compared the previous *Lab Exercise: Verifying Measurements Using 3D Scanning Technology (Indoor)*?

Part 4:

- As a team, students will choose an item of evidence that they want to compare digital measurements in greater detail.
- Students will take turns showing each other exactly how and from where their measurements were taken.
- They should also provide reasoning for their decisions (especially if there are significant differences between group members).
- Questions:
    - Did individual choices or actions affect the difference between measurement results?
    - Were choices based on documentation (notes, sketch, photographs), on memory, or a combination of both? Or neither?
- If students realize they made a mistake or find a better way to take measurements within the software, students are to retake those measurements and make notes in their Learning Log Field Notes about what they changed and why.
- Students are encouraged to help each other discover the roots of problems, find solutions, and share any knowledge or tips they have discovered.
    - **Note:** Students must remember that the purpose of this activity is not to reach the same results based on each other's individual analysis of the data, but to reach similar results based on the original data itself and using similar methodologies.

Part 5:

- As a team, discuss the differences between results and determine whether they fall within an acceptable margin of error.
- Questions
    - If it is decided that differences fall within an acceptable error range, justify and explain why.
    - If it is decided that differences do **not** fall within an acceptable error range, discuss and record potential causes and solutions.

Activity: Comparing 3D Scans to Photographs & Sketches (Outdoor)

Purpose

- To help students gain further experience and understanding of how to successfully capture a scene using a 3D scanner by comparing other types of visual documentation.
- Allow students to become more aware of special considerations, issues, methods, and techniques regarding the successful use of a 3D scanner.

- To further the students' ability to think around and think through a problem by learning to reflect, analyze, and recognize cause and effect.

Materials

- **Note:** Specific items may vary depending on type and brand of devices, software, accessories, and instructor.
- Each student will need:
    - Computer loaded with appropriate software.
    - Completed *Assignment: 3D Scanner Visualization Final (Outdoor).*
        - This includes both the printed view and access to the completed scan visualization file.
    - Photographs taken during *Practical Exercise: Scan Scene with 3D Scanner (Outdoor).*
    - Completed *Assignment: Indoor Scene Final Sketch (Computer) & Documentation.*

Preparation

- Make sure software is downloaded, tested, and ready to use on lab computers.
- Make sure students are able to login and access computers and appropriate software.
- Photographs taken during *Practical Exercise: Scan Scene with 3D Scanner (Outdoor)* will need to be duplicated so that each student will have a copy of their teams' set of photographs.
- It may also be helpful for students to sit with their scan teams during this lab exercise so they can help one another.

Instructions

- Students are to complete a series of tasks and answer the accompanying questions.

Part 1:

- Students will take a few minutes to explore their final 3D visualizations and review their teams' crime scene photos.
- **Questions:**
    - Did the 3D scanner capture the entire scene, including all the pieces of evidence, to your satisfaction? Why or why not?
    - If not, what could have caused the scanner to miss information?
        - These could include scanner placement, target placement, environmental concerns, errors in scanner operation, etc.
    - Did scanning an irregularly shaped area or one with large obstructions affect what was captured by the scanner? Why?

    - What could you have done differently to capture the scene more completely?

Part 2:

- Each student will choose a different piece of evidence to compare with their corresponding photographs in more detail.
    - Note: Depending on the number of students in each group, it is possible that not all pieces of evidence will be looked at closely, or that more than one student will study the same item.
    - If there are more pieces of evidence than students in a group, students should focus on the items that were not captured by the 3D scanner with the desired amount of detail needed to document it successfully.
- Each student will need to find the photographs that show their piece of evidence, both in overall and up -close views.
- Each student will need to locate their piece of evidence on their final crime scene sketch created during *Assignment: Indoor Scene Final Sketch & Documentation (Outdoor).*
- **Questions:**
    - What information does the 3D visualization provide that is not evident or easily seen or gathered from the photographs or final sketch?
    - What information do the photographs provide that is not evident or easily seen or gathered from the 3D visualization or final sketch?
    - What information does the final sketch provide that is not evident or easily seen or gathered from the 3D visualization or photographs?

Part 3:

- Within each team, students will share views of their evidence within their 3D visualization and the corresponding photographs.
- Students will discuss, compare and contrast observations regarding the 3D visualization, photographs, and final sketch.
- **Questions:**
    - If only a 3D scanner had been used without taking manual measurements or photographs, would that have been enough information to successfully and completely document your evidence? Why or why not?
    - Would there have been enough information that someone else could reconstruct it accurately? Why or why not?
    - For each piece of evidence, discuss the placements of the 3D scanner and scanner targets and how they could have been placed differently in order to capture more of the scene and important areas in better detail.
    - Discuss different approaches and other actions to try the next time using a 3D scanner to document a scene outdoors.

Part 4:

- Discuss attitudes and expectations regarding the use of the 3D scanner for the second time.

- **Questions:**
    - Did your attitudes and expectations change or differ between your first experience using the 3D scanner (indoors) and this second one (outdoors)?
    - How? Why? Why not?
    - Did you take photos differently than you did during the *Practical Exercise: Scan Scene with 3D Scanner (Indoor)*? If so, why?
    - Were any of the actions or decisions made while scanning and processing the outdoor scene based on what you had learned during the previous indoor scanning exercise?
    - What were these actions or decisions specifically?
    - Why did you change your approach?
    - Did they work out the way you intended?

Part 5:

- Students are encouraged to discuss and share any new realizations, discoveries, considerations, issues encountered, problems solved or unsolved, questions, etc. that they encountered that would be helpful to themselves and others.

💬 Reflect & Discuss: Scan Scene with 3D Scanner (Outdoor) Overall Reflection

Purpose

- To allow students to discuss within the larger group challenges encountered, changes in expectations, understanding, and approaches regarding the use of a 3D scanner, and provide answers to questions.

Guided Discussion Prompts

- *Refer to Learning Log: Scan Scene with 3D Scanner (Outdoor).*
- *Refer to Learning Log: Processing and Understanding 3D Scan Data (Outdoor).*
- ★ *Refer to Lab Exercise: Verifying Measurements Using 3D Scanning Technology (Outdoor).*
- ★ *Refer to Activity: Comparing 3D Scans to Photographs & Sketches (Outdoor).*
- *Refer to Learning Log: Compass Method.*

UNIT 7: Drone

📍 Introduction to Drone Basics, Regulations, and Procedures

📈 Instruction: Intro to Drone & Photogrammetry

Purpose

- Introduce students to the fundamental concepts and terminology associated with drones.
- Familiarize students with a drone's basic functionality, equipment and software, parts and accessories, and care and maintenance routines.
- Introduce students to the fundamental concepts and terminology of photogrammetry and review other 3D scanning methods as they relate to drones.
- Discuss law enforcement and crime scene specific uses and considerations when using a drone.

📈 Instruction: Drone Laws and Airspace Information

Purpose

- Familiarize students with important laws, regulations, considerations, licenses, qualifications, etc. that are generally required for drone operation.
- Introduce students to drone operation procedures and the roles and responsibilities of the various drone team members.
- **Note:** Drone Laws and Airspace regulations have been changing frequently, so it is very important to review the current information and update course materials accordingly.

📈 Instruction: Search Patterns Review

Purpose

- To review common search patterns used while processing a crime scene.
- To discuss how basic search pattern concepts and procedures relate to drone programming and operation.

📍 Introduction to Drone Programming and Operation

📈 Instruction: Drone Programming

Purpose

- Introduce students to basic drone programming, both in general and specific to the software students will be using.
- Provide reference materials for software tutorials and resources if available.

📣 Demonstration: Drone Programming and Operation

Purpose

- Provide a physical demonstration and overview of a drone's parts and functions.
- Demonstrate how to set up a drone and how to use it.
- Demonstrate associated roles and responsibilities along with care and maintenance.
- Demonstrate how to transfer the collected data to a memory card or other device so that it can be processed on a computer.
- Provide a bridge between gaining knowledge and gaining experience.

Considerations

- If flying outside, it is very important to consider the weather - do not fly the drone in the rain or if it is too windy. Wind is particularly dangerous for the drone.
- It is highly recommended not to leave students alone with the drone at any time.

Preparation

- If flying outside, you must follow all airspace rules and regulations.
    - If in close proximity to an airport, hospital with a helicopter pad, etc. special permissions and clearance must be obtained to fly a drone.
        - **Note:** In these situations, it is best to coordinate and receive permission well ahead of time for the specific day and time you intend to fly to avoid scheduling conflicts.
    - Drones are often only cleared to fly in certain areas, so all current regulations must be understood and attended to before use.
    - Always check your specific area for local rules and regulations.
- Make sure the drone is in good order and ready to use.
    - This includes making sure the battery is charged, memory card is present and cleared (if applicable), and any other accessories are also ready for use.

Drone Practice

- Allow students to take turns piloting the drone for a few minutes to become familiar with the controls.

🚩 Practical Exercise: Scan Scene with Drone

Purpose

- To give students experience operating a drone safely.
- To demonstrate how basic concepts (such as search patterns) apply when using advanced technology.
- To reinforce the importance of clear documentation regarding the placement and description of reference points in regards to reconstruction and verification.

Materials

- **Note:** Specific items may vary depending on type and brand of devices, software, accessories, and instructor.
- Drone.
    - Drone controller.
    - Any other devices or accessories needed.
- Documentation supplies.
- Measurement tools.
    - Long measuring tapes.
- Meter stick.

General Considerations

- If possible, areas should be blocked off or marked to avoid interference from outside sources and for the safety of both equipment and people.
- It is highly recommended not to leave students alone with the drone at any time.
- It is up to the discretion of the instructor the level at which students operate the drone.
- Any obstructions present need to be taken into account when planning a flight route and checked by the instructor before flying the drone.
- The operation and programming of the drone must be monitored by the instructor at all times.

Outdoor Considerations

- If flying outside, it is very important to consider the weather - do not fly the drone in the rain or if it is too windy. Wind is particularly dangerous for the drone.
- It is highly recommended not to leave students alone with the drone at any time.
- It is recommended not to fly over any buildings or anywhere too high, especially if allowing students to fly the drone.
- Make sure a location is chosen that allows drone teams to keep the drone within sight at all times.

Indoor Considerations

- If an outdoor area is not feasible due to weather, availability, etc. an alternative may be to use a large indoor area if available.
- Suggestion: Permission might be obtained to fly the drone in an indoor facility, such as an indoor athletics facility, large conference room, etc.
    - If using one of these locations, previous permissions and arrangements will need to be made.
    - The area should be blocked off or marked to avoid interference from outside sources and for the safety of both equipment and people.
- Note that flying indoors has its own set of considerations, as it cannot fly as high and is contained within a smaller area than it would be outdoors.
    - When choosing an indoor area, it is preferred to have a higher ceiling and few if any obstructions (basketball hoops, chandeliers, etc.).

Preparation

- If flying outside, you must follow all airspace rules and regulations.
    - If in close proximity to an airport, hospital with a helicopter pad, etc. special permissions and clearance must be obtained to fly a drone.
        - **Note:** In these situations, it is best to coordinate and receive permission well ahead of time for the specific day and time you intend to fly to avoid scheduling conflicts.
    - Drones are often only cleared to fly in certain areas, so all current regulations must be understood and attended to before use.
    - Always check your specific area for local rules and regulations.
- Make sure the drone is in good order and ready to use.
    - This includes making sure the battery is charged, memory card is present and cleared (if applicable), and any other accessories are also ready for use.
- Be aware that each team will be taking two scans, so plan and prepare for data storage (memory cards, etc.) accordingly.
- Select an area that is large enough for the drone to execute a programmed search pattern safely.

Instructions

- Students will be divided into two teams. Once their tasks are completed, the two teams will switch responsibilities.
    - Team 1 (Drone) will document the scene with the drone.
    - Team 2 (Tape) will take manual measurements according to special instructions.
- When finished, teams will switch responsibilities (Team 2 will pilot the drone and Team 1 take manual measurements).

- This will result in both teams having their own set of manual scene documentation and drone scan data.
- **Note:** Final scans and documentation will be swapped with the other team for use during *Lab Exercise: Verification and Reconstruction (Drone Scan)* and *Activity: Drone Scan Reconstruction Discussion.*
- Notify students that they will be reconstructing the other teams' scene.

Drone Team Instructions

- Students will complete two complete drone scans using the same flight path.
- Students are responsible for planning their drone scan, programming the drone's route, and then operating the drone to collect scan data.
- Each student will be responsible for a different drone team role.
- Students should alternate roles between the two scans.

Tape Team Instructions

- Students will be responsible for creating a very rough sketch, simple measurements, and notes regarding measurements according to the following instructions.

The exercise will proceed as follows:

Part 1: Plan Scans

- Both teams will begin by assessing the area, and plan a drone route based on an appropriate search pattern.

Part 2: Program First Drone Scan / Create and Document Crime Scene

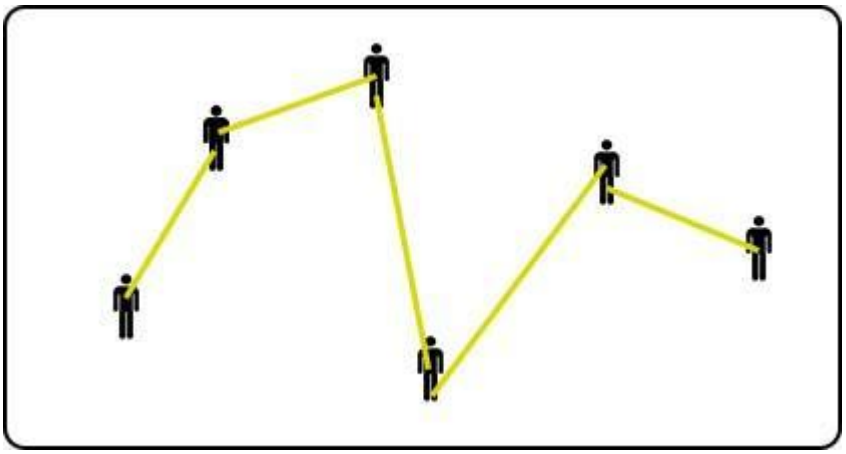
Drone Team:

- Students will program the drone with their chosen search pattern with the aid of the instructor.

Tape Team:

- While Drone Team is programming their first flight, Tape Team students will each take a long measuring tape and spread out over the area being scanned at various distances and angles from each other.
    - Try to get a variation of long and short lengths between students, and not all in the same line as each other, much as you would when placing targets for 3D scanning.
    - Students can either stand, sit, or lay down on the ground.
- One Tape Team student will be designated as captain. They will be responsible for:

    - Stepping back and helping make placement adjustments, as they will have a better vantage point of the whole area than the students being placed.
    - Producing a very rough sketch (only needing to mark roughly where others are placed).
    - Recording measurements between students.
- Each student will stretch a measuring tape between them and one other student, and hold those tapes in place during the drone scan.
    - This will result in each student holding the end of two different measuring tapes.
    - For example:



    - Students will need to find a position where the ends of the tapes will be clearly visible from the air and can be held still for the duration of two scans.
- Once students are settled, the captain will produce a quick rough sketch and assign labels to each person, then go around and record the distances between students.
    - The other team members will aid in giving measurements, but will be unable to write them down themselves as they will have a measuring tape in both hands.
    - Documentation notes should include measurements between each person holding a tape measure, and each reference point (the students) should be clearly labeled.
        - **Note:** Measurements should be written on a separate piece of paper and not written directly on the sketch for this particular activity. A rough sketch without measurements will be needed for *Assignment: Drone Scan Visualization Finals: Part B* and *Lab Exercise: Verification and Reconstruction (Drone Scan)*.
    - Positioned students are also encouraged to help make documentation suggestions as the captain records measurements and notes.
    - **Note:** Although the measuring tapes will be visible in this first scan, they will be removed in the second scan, so documentation notes will be important for reconstruction purposes.

- The meter stick will also need to be placed somewhere in the scene where it will be clearly visible by the drone.
    - The meter stick will stay in place during both drone scans.
- When documentation is complete, the Tape Team captain can position themselves wherever they would like within the scene and does not need to be measured.
    - However, they will need to mark their approximate position on their rough sketch.
- Once the captain has settled and the Drone Team is done programming their flight path, scanning can begin.

Part 3: First Drone Scan with Visible Measuring Tapes

- During flight:
    - Drone Team will be responsible for piloting the drone and fulfilling their various roles.
    - Tape Team will stay very still and hold their measuring tapes steady, and observe the drone in action.
- **Important note:** The Tape Team will need to stay exactly in place for both the first and second scan, so should not move once the first scan is complete.

Part 4: Second Drone Scan without Visible Measuring Tapes

- Once the first scan is complete, the Drone Team will prepare to fly the drone again on the same flight path.
    - **Note:** Be sure they do not override their first scan data!
- While the Drone Team is resetting the drone for another flight along the same path, the Tape Team Captain will leave something to mark their position (like their notes) and go around and help their teammates close or wind their measuring tapes if needed.
    - **Important:** This depends on the types of measuring tapes used. Some can be wound safely from a distance, but those that automatically reel in should not be simply released to zip back toward another student. This could cause injuries!
- Once measuring tapes are safely closed, all Tape Team students will remain in their positions and try to put their hands in the same place they were in when holding the tape.
- The meter stick will not be moved.
- The Tape Team captain will again position themselves where they were previously.
- After both teams are ready, the Drone Team will again send their drone on it’s flight path.

Part 5: Switch and Repeat

- Each team will switch positions, and repeat Phases 2-4.

Final Instructions

- Both teams must turn in their memory cards (if applicable) into the instructor at the end of class.

🔎 Learning Log: Scan Scene with Drone

- What expectations did you have about using the drone? Why?
    - These can include ease of use, operation, etc.
- Did these expectations change after using it? Why?
- Did your opinion or perception of the drone change after experiencing flight operations? Why?
- Compare and contrast using a drone and a 3D scanner.
- Compare and contrast using a drone and measuring manually.
- What are some pros and cons to using a drone at a crime scene?
- What new considerations did you discover when using a drone?
- What was the easiest part of using the drone? Why?
- What was the hardest part of using the drone? Why?
- Was there a drone team role you preferred over another? Why?
- Is there a role that you didn't have the opportunity to fulfill but would like to? Why?
- What additional knowledge or actions could help you better operate the drone?
- How confident are you that your scans captured what you wanted it to? Why or why not?
- Did you do anything while measuring specifically knowing that these would be reconstructed? If so why?
    - Should you only do these things if you know your scene will be reconstructed? Why or why not?

📍 Introduction to Processing Drone Scan Data

Note:

- Modules within this subunit require every student to have individual access to a computer, appropriate software, and scan data.
- Instructors will need the ability to present lecture material and show demonstrations from their computer to the entire class so students can follow along on their own computers.
- It is highly recommended to use a computer lab where the instructor and students are all using the same version of software and the same operating systems.

📈 Instruction: Processing Drone Data

Purpose

- Provide more detailed information regarding how collected drone data is processed and visualized, both in general and specific to the software students will be using.
- Provide reference materials for software tutorials and resources if available.
- Teach students how to read and understand drone scan data.

📣 Demonstration: Processing and Visualizing Drone Scan Data

Purpose

- Demonstrate how to download and process drone scan data so that it can be visualized.
- Introduce students to the specific software being used and how to navigate through it.
- Allow students to actively participate in the demonstration by following along using their own computer and individual scan data.

Materials

- **Note:** Specific items may vary depending on type and brand of devices, software, accessories, and instructor.
- Instructor will need:
    - Computer loaded with appropriate software.
    - Drone scan data for demonstration (can use student data acquired during *Practical Exercise: Scan Scene with Drone.*
    - Screen projector or similar device to present lecture content and live software demonstration.
- Each student will need:
    - Computer loaded with appropriate software.
    - Drone scan data acquired during *Practical Exercise: Scan Scene with Drone.*

Preparation

- Make sure software is downloaded, tested, and ready to use on lab computers.
- Make sure students are able to login and access computers and appropriate software.
- Both sets of drone scan data acquired during *Practical Exercise: Scan Scene Drone* will need to be duplicated so that each student will have a copy of both their teams' scan data.
- It may also be helpful for students to sit with their scan teams during this lab exercise so they can help one another.

Instructions

- The instructor will walk students through the process of how to load drone scan data into the processing software and how to visualize and read their data.
- Students are to follow along on their own computers using the 3D scanner data they collected during *Practical Exercise: Scan Scene with Drone.*
- Students are encouraged to ask questions at any time so the class can move through this process together.

🔬 Lab Exercise: Processing Drone Data

Purpose

- This exercise overlaps with *Demonstration: Processing and Visualizing Drone Scan Data* and allows students time to explore the software, gain personal experience in data processing and visualization, and put knowledge gained during lectures into action.
- To help students learn how to problem solve through communication, cooperation, and exploring alternative resources.

Instructions

- Students will process both sets of their drone scan data to create a visualization.
- Students are allowed to openly ask questions to the instructor and fellow students, help each other figure things out, and search for help on the internet if needed.
- **Note:** This will likely require at least two class periods, as the first lab day will include processing instructions.
    - If allowed, students could also possibly use the lab on their own time to finish what they cannot during class time.

📝 **Assignment: Drone Scan Visualization Finals**

Part A: Complete Drone Scan Visualizations

- Students need to complete processing both sets of drone scan data and print out a copy of an overhead view for each visualization.
- When saving the finished processed files, each student will need to label which scan shows the measuring tapes and which one does not.

Part B: Preparing for *Lab Exercise: Verification and Reconstruction (Drone Scan).*

- Each student will need to create a folder containing files that can be given to another student on an empty portable USB drive.
- The folder must contain **copies** of:
- Final drone scan visualization from the second drone scan (scanned without visible measuring tapes).
- A digital copy of their rough sketch and documentation notes, but **excluding** all measurements taken.
    - These can be scanned into a computer as images.

🔎 **Learning Log: Processing Drone Data**

- What expectations did you have about processing drone scan data? Why?
- Did these expectations change after experiencing the process yourself? Why?
- What are your overall impressions or opinions about the drone scan visualization process? Why?
- How did processing and visualizing drone data differ from processing 3D scanner data?

    - How was it similar?
- How did processing and visualizing drone data differ from processing total station data?
    - How was it similar?
- How did you solve problems encountered while processing?
- Were you more comfortable or confident processing the drone scan data after experiencing similar processes? Why or why not?
- Was processing drone data easier or more difficult than the 3D scanner data? Why?
- Was processing drone data easier or more difficult than the total station data? Why?
- What did you learn from previous scan data processing experiences that you incorporated into this one even though the software is different?
- What new considerations did you discover about using a drone after looking at your scan data?
- What did the drone capture well?
    - What did it not capture well? Why?
- After processing your drone scan data, what would you change about the way you programmed your drone? How and why?
- What processing issues did you run into that could be alleviated by how you scanned?

📍 Verifying Measurements Using Advanced Technology (Drone)

📣 Demonstration: Making Measurements in Drone Scan Software

Purpose

- To demonstrate how to take digital measurements within the drone software on a final processed scan.
- Allow students to actively participate in the demonstration by following along using their own computer and individual scan data.

Materials

- **Note:** Specific items may vary depending on type and brand of devices, software, accessories, and instructor.
- Instructor will need:
    - Computer loaded with appropriate software.
    - Drone scan data for demonstration (can use student data acquired during *Practical Exercise: Scan Scene with Drone.*
    - Screen projector or similar device to present lecture content and live software demonstration.
- Each student will need:
    - Computer loaded with appropriate software.
    - Completed *Assignment: Drone Scan Visualization Finals - Part A.*

- Completed *Assignment: Drone Scan Visualization Finals - Part B* on a portable USB drive.

🔬 Lab Exercise: Verification and Reconstruction (Drone Scan)

Note: This Lab Exercise and the following *Activity: Drone Scan Reconstruction Discussion* and *Reflect & Discuss: Verification and Reconstruction (Drone Scan)* are meant to take place during the same class period if possible.

Purpose

- To give students practice applying what they have learned during *Demonstration: Making Measurements in Drone Scan Software*.
- Allow students to compare and contrast manual measurements and documentation with drone scan results.
- Allow students to apply measurement and verification skills to an unfamiliar scan and compare and contrast them to the original measurements.

Instructions

Part A: Verifying Manual Measurements with First Drone Scan

- Students will take digital measurements between each reference point (person) within their first drone scan.
- Students will compare the measurements taken within the 3D visualization software to their corresponding manual measurements.
- Questions:
  - Were there any significant differences between your manual measurements and your scanned measurements?
    - If so, what do you think caused or contributed to these differences?
    - Are these differences due to errors that can be corrected? How?

Part B: Reconstructing Measurements with Second Drone Scan

- Each student will be paired with a partner from the opposite team they were on.
- Students will switch portable USB drives containing their *Assignment: Drone Scan Visualization Finals - Part B.*
- Students will need to open their partner's second drone scan file (without visible measurement tapes) and take digital measurements using the software according to the labeled reference points on the accompanying rough sketch.
- Measurements will be recorded to be compared during *Activity: Drone Scan Reconstruction Discussion.*

- Students will not be allowed to ask questions of their partner or opposite team members, and any questions they would like to ask should be recorded in their Learning Log Field Notes.

Activity: Drone Scan Reconstruction Discussion

Purpose

- To give students the opportunity to verify and compare the digital measurements taken on their partner's second drone scan and discuss their findings.
- To allow students to ask and discuss any questions they had during *Lab Exercise: Verification and Reconstruction (Drone Scan) - Part B: Reconstructing Measurements with Second Drone Scan*.

Instructions

Part 1:

- Students will pair up with their partner to go over their measurements.
- Students will reveal the original manual measurements from their scene to their partner.
- These measurements should be recorded next to their own digital measurements so that they can be easily compared.
- **Questions**
    - Were there any significant differences between your digital measurements and the original manual measurements of your partners second drone scan?
        - If so, what do you think caused or contributed to these differences?
        - Are these differences due to errors that can be corrected? How?
    - Were there any significant differences between both you and your partner's digital measurements and the original manual measurements in both your second drone scans?
        - If so, what do you think caused or contributed to these differences?
        - Are these differences due to errors that can be corrected? How?
- Students may ask their partner any clarifying questions of their partner and may correct any errors they may have made.
    - If the partner does not know the answer, students may ask their partner's Tape Team captain.
    - **Note:** Students must remember that the purpose of this activity is not to reach the same results based on each other's individual analysis of the data, but to reach similar results based on the original data itself and using similar methodologies.

Part 2:

- Students need to discuss the differences between results and determine whether they fall within an acceptable margin of error.

- **Questions**
    - If it is decided that differences fall within an acceptable error range, justify and explain why.
    - If it is decided that differences do **not** fall within an acceptable error range, discuss and record potential causes and solutions.

💬 Reflect & Discuss: Verification and Reconstruction (Drone Scan)

Purpose

- To allow students to discuss within the larger group and compare their partnership's results and experiences with those of others.

Instructions

- After completing *Activity: Drone Reconstruction Discussion*, come back together as an entire class.

Guided Discussion Prompts

- *Refer to Lab Exercise: Verification and Reconstruction (Drone Scan).*
- *Refer to Activity: Drone Scan Reconstruction Discussion.*

🔎 Learning Log: Scan Scene with Drone Overall Reflections

- What are your overall impressions, opinions, and assessment regarding the use of a drone at a crime scene?
- What issues could you foresee using a drone in the field?
    - How could those issues be resolved?
- How and in what kinds of situations could drone technology be beneficial in the field?
- Compare and contrast using a drone with the total station and 3D scanner.
- How did your perceptions and expectations about the drone change between learning about them, using them, and then processing the data? Why?
- Did you have more confidence scanning and processing the data than in previous units? Why or why not?

💬 Reflect & Discuss: Scan Scene with Drone Overall Reflections

Purpose

- To allow students to discuss within the larger group challenges encountered, changes in expectations, understanding, and approaches regarding the use of a drone, and provide answers to questions.

Guided Discussion Prompts

- ★ *Refer to Learning Log: Scan Scene with Drone Overall Reflections.*
- *Refer to Learning Log: Scan Scene with Drone.*
- *Refer to Learning Log: Processing Drone Data.*
- *Refer to Lab Exercise: Verification and Reconstruction (Drone Scan).*
- *Refer to Activity: Drone Scan Reconstruction Discussion*

UNIT 8: Court Testimony, New Technology & Final Reflections

📍 Court Considerations for Advanced Technology

📈 Instruction: Expert Witness and Court Testimony Considerations when using Advanced Technologies

Purpose

- To review important rules of evidence, admissibility, etc. that apply to the use of advanced technologies at a crime scene.
- Reiterate the importance of creating good documentation in general as well as when specifically using advanced technologies.
- Familiarize students with current and past cases, court rulings, issues, and expectations and perceptions that involve the use of advanced technologies.

📍 New and Upcoming Technologies for Use in Forensic Science

📈 Instruction: New and Upcoming Technologies for Use in Forensic Science

Purpose

- To introduce students to new and upcoming technologies being applied to forensic science.
- Briefly discuss the uses, expectations, benefits, limitations, and possibilities of these newly adapted technologies to forensic science.

📍 Final Assignments and Course Reflections

📝 Assignment: Overall Course Reflections

Overall Learning Log Reflections

- What were your expectations, impressions, or opinion about having to keep a Learning Log when it was first introduced?
    - Did these expectations, impressions, or opinions change throughout the course? How and why?
- Did the way you approach, understand, or view Learning Log assignments change throughout the course? Why?
- Did keeping a steady Learning Log help you in any way?
- Did Learning Log questions help prompt learning or realizations that you would not otherwise have had?

    - Any specific instances?
- Did keeping a steady Learning Log change the way you view assignments or approach situations? Why or why not?
- Did using a Learning Log help you think through and understand assignments and concepts better? Why or why not?
- How can Learning Logs and the Reflective Learning Cycle apply to crime scene investigation?
- How can Learning Logs and the Reflective Learning Cycle apply to life, work, and education in general?

Overall Personal Course Reflections

- What expectations did you have about the course before it began (if any)?
    - How were those expectations fulfilled or not fulfilled?
- Did your expectations about the course change throughout the semester? How?
    - Were these changes positive or negative? Explain.
- What did you learn in this course that you feel was the most important or helpful to you? Why?
- Is there anything you learned from this course that you will carry with you into other classes or into a career? Why?
- Do you feel like your **physical skills** improved throughout the course?
    - If so, any specific skills?
    - How did they improve and why?
- Did certain skills, such as creating final sketches on the computer, improve over time with each related assignment? Why or why not?
- Do you feel like your **cognitive skills** improved throughout the course?
    - If so, any specific skills?
    - How did they improve and why?
- Did the cognitive exercises help you to better understand certain concepts of crime scene processing or understand them in a new way?
    - If so, anything specifically?
    - How were these cognitive exercises beneficial? Why?
- Did you encounter anything in this course that you would like to learn more about or get more experience with? (Can be multiple items).
    - If so, what is it and why?
    - What could you do to gain more knowledge and experience with it?

Overall General Course Reflections

- What did you like **most** about this course? Why?
- What did you like **least** about this course? Why?
- What would you like to **change** about this course? Why?

- What would you like to keep the **same** about this course? Why?
- Any additional comments or questions?

💬 Reflect & Discuss: Overall Course Reflections

Purpose

- To give students the opportunity to reflect and discuss their overall course experience.
- To allow students to compare and contrast their various assignments and experiences and identify areas of change and improvement.
- To provide feedback for the instructor that can be used to improve the course.

Materials

- Each student will need:
    - Completed *Assignment: Overall Course Reflections.*
    - Completed *Semester Assignment: Learning Logs.*
    - Completed *Semester Assignment: Lab Notebooks.*

Instructions

- Students will be divided into 3-4 small groups to allow more students to participate in the discussion.
- Students will be given time to discuss *Assignment: Overall Course Reflections* questions in sections.
    - After each section, student groups should be rearranged so that they get to communicate and discuss with different students.
- Once completed, the class will come back together and discuss these questions as a whole.
- Students are encouraged to take notes of what they think is interesting, new realizations, etc. that they encounter during these discussions.

Part 1: Learning Log Reflections

- Before beginning the discussion, instruct students to look back through their own Learning Logs and make comparisons between entries made at different points in the semester.
    - Students should pay special attention to the earliest entries compared to the most recent ones.
- Once completed, students will be given time to discuss the following questions and those from *Assignment: Overall Course Reflections - Overall Learning Log Reflections*.
- Students are encouraged to show each other sample entries from their Learning Logs while they discuss if they feel comfortable sharing.

    - Every student will have a unique way of recording their experiences, and it is often helpful and informative to see the different approaches, perspectives, and strategies applied toward the same assignment.
- **Questions**
    - In looking back over your assignments from the semester, how did entry quality, effort, benefits, etc. change or not change throughout the semester? Why?
    - Did your attitude contribute to how your Learning Log entries were approached or valued? Why?
    - Did a change in attitude (if applicable) contribute to changes in how your Learning Log entries were approached or valued throughout the course?
        - If so, why did your attitude change and how did it affect your Learning Logs?
    - Did you identify any patterns or changes in your Learning Logs that surprised you?
        - What were they and why?
- **Guided Discussion Prompts**
    - *Refer to Assignment: Overall Course Reflections - Overall Learning Log Reflections.*

Part 2: Overall Course Reflections

- Before beginning the discussion, instruct students to look back through their own Lab Notebooks and make comparisons between assignments completed at different points in the semester.
    - Students should pay special attention to the earliest assignments compared to the most recent ones.
- Once completed, students will be given time to discuss the following questions and those from *Assignment: Overall Course Reflections - Overall Personal Course Reflections.*
- Students are encouraged to show each other examples from their Lab Notebooks while they discuss if they feel comfortable sharing.
    - Every student will have a unique way of recording their experiences, and it is often helpful and informative to see the different approaches, perspectives, and strategies applied toward the same assignment.
- **Questions**
    - In looking back over your assignments from the semester, did you notice any significant changes in the quality, effort invested, improvement, etc. of your assignments throughout the course?
        - If so, what changed and how? Why?
    - Did you identify any patterns or changes in your Lab Notebook that surprised you?
        - What were they and why?

    - Compare your first computer sketch (*Assignment: Triangulation Final Sketch 1 (Computer Free-For-All)*) to your last one (*Assignment: Outdoor Scene Final Sketch (Computer) & Documentation.*
        - Were there any significant differences between these two sketches?
            - If so, what changed and how? Why?
    - Although there may not be many obvious visual differences between assignments, did you experience changes regarding:
        - The degree of confidence with which you completed the assignments?
        - Your level of comfort and familiarity with the concepts, tools, and software?
- **Guided Discussion Prompts**
    - *Refer to Assignment: Overall Course Reflections - Overall Personal Course Reflections*

Part 3: Full Class Discussion

- **Guided Discussion Prompts**
    - ★ Did anyone learn or discover anything new or interesting after looking back through your Learning Logs and Lab Notebook and discussing it with your peers?
    - ★ *Refer to Refer to Assignment: Overall Course Reflections - Overall General Course Reflections.*
    - ★ *Refer to any Assignment: Overall Course Reflections questions and additional questions included in the above Reflect & Discuss sections.*
        - **Note:** It is not necessary for these questions to be discussed again with the entire class, but some may be revisited at the discretion of the instructor or the request of the students.

Part 4: Turn in Final Assignments

- Students are required to turn in their completed *Semester Assignment: Learning Logs* and *Semester Assignment: Lab Notebooks* into the instructor for grading.
    - **Note:** The instructor may choose to use these assignments and grades instead of a traditional final exam.
    - The instructor will determine and inform students when and how these assignments will be returned.

Conclusion

This course outline was created to provide advanced instruction in crime scene mapping and reconstruction, and to introduce basic concepts and operation procedures for relevant computer-based mapping technologies. The course's content and structure aims to achieve this by enhancing mental abilities through cognitive exercises, improving physical skills through practical experience, and teaching students to become a more active participant in their own learning process.

The course was designed to help alleviate common issues faced by investigative agencies when trying to adopt and incorporate new technologies into their workflow. These struggles include concerns for time, cost, availability of resources and equipment, training, attitudes and expectations, and the rapid pace of changing technology. By extending fundamental crime scene skills to include the use of advanced mapping tools, students will be better prepared to encounter these devices in the field. Additionally, knowledge and understanding of their purpose, benefits, limitations, and logistics can also help students ease their integration into agencies that seek to utilize them.

The overall structure and educational design model of this course can also be adapted to serve many different functions and knowledge bases, as it stresses the importance of developing strong learning and cognitive skills through reflective learning and repetition. As such, it can be expanded or condensed to fit individual needs, various time allotments, and numbers of participants.

This flexibility can also benefit various law enforcement and investigative agencies directly, as the basic training concepts and design can be adapted to focus on any specific training need for any duration of time. By embedding training content within a transformative

learning structure, trainees are better able to retain and maintain information and skills while strengthening their own ability to adapt and learn.

Limitations

Many of the same limitations that agencies face regarding the use and adoption of computer-based mapping tools also apply when offering an Advanced Crime Scene Mapping and Technology class. Although course materials and exercises have been designed with these issues in mind, the following limitations are still important to note and require consideration.

Due to evolving technology, access to specific equipment and software, and the experience of the instructor, some course materials cover introductory concepts only, as certain content is subject to change With a few exceptions, they do not include detailed tutorials for the operation of specific brands of equipment and software, as these will be determined by the instructor and the available resources. Lectures and exercises dealing with such topics should be reviewed and updated before being presented.

Additionally, the physical and technological logistics of this course also have several limitations. While many of the scanning devices covered are available, there is generally only one instrument of each type to be shared among several students. This issue could be alleviated by restricting class size, as well as rotating groups during practical exercises involving equipment.

The data collected by advanced mapping tools can generally be copied and provided to multiple students to process individually in the lab, however much of the accompanying software cannot be shared as they only contain or allow single user licenses. Obtaining enough licenses for an entire class can be extremely costly, and is not absolutely necessary when focusing on general concepts rather than specific software.

Fortunately, there are a number of affordable and even free software programs that can process the same scan data, and this number continues to grow. These programs can be used in place of more expensive ones, allowing every student to work on their scan data at one time. However, this is only possible if the available computers can handle the large scan data files and meet the hardware requirements of the software needed to process it.

There is also a concern for both the safety of the students and for the equipment itself. These devices are often very expensive and not easily or readily replaced, so it is highly recommended that students be supervised while operating them at all times. This can be difficult for an instructor when responsible for teams split between several physical areas, but is especially necessary when working with devices such as drones.

Suggestions for Future Research

Although this course's design model and educational structure are complete, peripheral course materials are still in development and will continue to develop as needs and technology change. This particular course and curriculum structure has also not yet been tested in a classroom. In offering this course to students, evaluations and assessments could be made regarding the course's flow, handling of logistical issues, timing, participation levels, and student response. Adjustments could be made to improve the course, and, if successful, this course design could also be applied to other topics of study.

References

Edl, M., Mizerak, M., & Trojan, J. (2018). 3D Laser Scanners: History and Applications. Acta Simulatio - International Scientific Journal about Simulation, 4 (4), 1-5. https://doi.org/10.22306/asim.v4i4.54

Gibbs, G. (1988). *Learning by Doing: A guide to teaching and learning methods.* Further Education Unit. Oxford Polytechnic: Oxford.

Joice, B. (2008). Forensic mapping: The use of total stations and mapping software to produce scale diagrams. Journal of Forensic Identification, 58(1), 15-26. http://vortex3.uco.edu/login?url=https://www-proquest-com.vortex3.uco.edu/scholarly-journals/forensic-mapping-use-total-stations-software/docview/194797886/se-2?accountid=14516

National Museum of American History. (n.d.). Total Station. https://americanhistory.si.edu/collections/search/object/nmah_997336

Torbert, William R., (1972). *Learning from experience: toward consciousness.* New York: Columbia University Press. Retrieved from: http://hdl.handle.net/2345/4242