

**Interior Scan of Carole and Barry Kaye Performing Arts Auditorium**

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Class: Terrestrial Laser Scanning, SUR 4150C / CEG 5304C

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# Introduction

Terrestrial Laser Scanning is a technique to capture and record the geometry and texture of an area of interest. This technique yields a unique dataset as each scan can capture the features of an environment at a great level of detail. The created point cloud accurately represents the surface of the project area and displays as a three-dimensional surface. This technology renders traditional surveying techniques. A timely and costly process for this type of project as extensive measurements would be required to obtain the same level of detail. Laser scanning is the ideal technique to represent large complex areas. The data collected can be used to create a three-dimensional model, which can be used to visualize the area, plan for events, and plan for future construction projects.

The project area that the group was interested in was the Carole and Barry Kaye Performing Arts Auditorium located at Florida Atlantic University, in the Boca Raton campus and was scanned using the Leica ScanStation 2. The auditorium is specifically located in the Student Union which is the East of West University Drive and West of Dade Avenue. The Carole and Barry Kaye Performing Arts Auditorium is a 2400-seat venue that was built in 1980 and opened in 1982. The Auditorium has maintained a reputation as one of the most acoustically sound venues in South Florida. The Carole and Barry Kaye Performing Arts Auditorium is the South Palm Beach County, home to a number of regionally acclaimed orchestras as well as a variety of other performances ranging from Broadway stars to nationally acclaimed comedians to internationally acclaimed concerts[[1]](#endnote-1).

This was an attractive place already for the crew to perform the laser scanning on. One of

The point clouds were registered using a laser scanning software, Cyclone. The raw registered point cloud needed to be an accurate representation of the surface of the project area, so that a three-dimensional model could be created from the data. It was then imperative that complete coverage of the auditorium was obtained; however, it was impossible to do so from a single station. Consequently, this project presented challenges when establishing proper locations for the stations and targets that were used in the data collection process. The final product was a three-dimensional model of the auditorium.

The steps followed to complete this project include: survey planning, field operation, data registration, data processing, and quality control and delivery. The area was examined prior to collecting data to plan for the number of station set-ups, locations of each station, and locations of each target. The project area is large and required multiple stations to cover the area. A plan created to facilitate field operation. The locations of the stations were chosen by the amount of surface area of the project area that could be collected during the scans. Stations were placed at the following locations: the middle of the stage, the west side of the building, and the back of the auditorium. These three stations provided enough detail to create a three-dimensional model. The ScanStation 2 collected data at a resolution where points represented 2 by 2 inches at a range of 120 feet. To obtain this high resolution for a field of view of 360° by 270°, each station scanned the project area for about 57 minutes. Three stations yielded three different point clouds, so they needed were registered to a single, unified arbitrary coordinate system. The registration process produced a raw registered point cloud that was then processed to create the final deliverable. The three-dimensional model of FAU’s auditorium is intended to be used for visualization of the area, planning events, and future construction development that may occur by the university.

# Methodology

# Data collection

In carrying out this project, there are several things to take into consideration such as ensuring that the data is collected accurately with little systematic error. Proper operation of the equipment is essential in minimizing these errors. With the help of a student worker, the team was able to successfully set up the first station. The set-up process included: leveling the tripod, safely mounting the scanner on to the tripod, and preforming the final leveling of the scanner. It is very important that the station was set up properly for both the safety of the equipment and the team members. The ScanStation 2 was then connected to a field laptop using an ethernet cable to and to a power supply using a power cord. Any unwanted movement that may have occurred was corrected by once more leveling the scanner. Prior to collecting data, the project database was created in Cyclone. This was done by navigating to the desired project directory and creating a new database. The newly created database was located under the unshared server and was set as the current database in Cyclone. Figure 1 shows two team members and the student worker setting up the first station on the stage.



Figure 1 Setting up Station 1

The team collectively created a plan for the locations of each station. The position chosen for station one was located on the stage in the auditorium. It was decided that a total of three scans would being sufficient to collect the data needed to represent the surface of the building’s interior. An indirect registration using targets will be used after the data collection process, so the plan also included locations for the seven targets that were used. The targets were placed around the auditorium according to the plan. The positions of these targets were chosen in such a way that they were visible from each station set up. Since each station was moved after collecting data to obtain complete coverage of the project area, the targets are needed to tie the three different point clouds created from the stations together.

After the plan was established and the first station was set up, data collection was ready to begin. The scanner displayed a green light once it was prepared to begin the scan. Cyclone Navigator was then opened on the field laptop. A connection to the scanner was established and was selected by double clicking on ‘FAU’. Next, the recently created database was selected. Certain parameters were defined including: the field of view, resolution, and image exposure. The team requested additional lighting in the auditorium from the staff in the Student Union because mere adjustment of the image exposure was not enough to collect well-lit imagery. The station set ups moved around the auditorium in a counter-clockwise manner; moving from the stage, to the west side of the building, and then to the back of the project area. Each scan collected data at the predefined resolution for about 57 minutes. The large amounts of time required to complete each scan limited the team in how many scans could be performed. This time constraint was due to an event that was booked in the auditorium later in the day.



Figure 2 Station 1 with Targets

# Registration

The data collected from the three stations was then downloaded to a USB and transferred to a personal computer. The team then performed the registration on the same day as data collection in the library. Three different stations collected data from three different locations. Each station assigns coordinates to its collected points in its own arbitrary coordinate system with the station being located at (0, 0, 0). Therefore, each scan uses its own unique coordinate system. The goal of the registration process is to align the point cloud in such a way that all three stations are positioned at the origin. The clouds will then align and produce a dense point cloud in a single arbitrary coordinate system using data from the three stations. This alignment can be done using targets, as was the case in this project. Known as the target to target method, this indirect registration allows for an accurate alignment of the point clouds. Seven targets were used as tie point to ‘tie’ the points clouds together. ­ They were evenly distributed throughout the auditorium in all directions to eliminate any bias in the alignment process. The X, Y, Z coordinates of each target differed in each scan, so assigning the same coordinate the corresponding targets aligns the point clouds.

A screenshot of a cell phone

Description generated with very high confidence

![A screenshot of a cell phone

Description generated with very high confidence]()

# Results and Discussion

# One of the most challenging parts of working on this project was the modeling section since the team had to accurately represent everything there was in the point cloud. It is understandable that having a point cloud without modeling, would result in having useless data for future reference.

The way the team worked on this was by modeling evert section and creating distinctive layers in order to isolate the data into separate spaces. There were ***7*** layers created

The way it was done was by a

Please add picture and video if possible

# Conclusion and Future work

Throughout this project, the team has gained experience in working with people to execute a terrestrial laser scanning project. A better understanding of the software needed to work with laser scanning data and the physical activities associated with the process of caring out scans in the field was obtained. Each member of the team has demonstrated the knowledge required to set up the scanner, connect it to the software, and operate it successfully. Once registered, the three completed scans displayed a high level of detail. The registered data aligned with the anticipated results of this project. The raw registered point cloud and the three-dimensional model will be used by the operations manager of the auditorium this summer to provide the necessary measurements and visualization to redesign the technical booth. The three-dimensional model will help the manager visualize potential locations for relocation of the booth. Important questions about this relocation can now be answered such as the amount of available space for a new technical booth. Future projects to improve the layout in the auditorium will now have a database to refer to when gathering measurements. Current building plans may not be available, so this new data could be used to update the building plans.

1. What was particularly interesting about the auditorium scan?
2. If the process or result were not unusual, maybe something your class learned?
3. How they went about it?
4. Something that makes this job/story stand out? (-38)

1. A brief History is provided on the official Fau webpage. <https://www.fau.edu/kayeauditorium/> [↑](#endnote-ref-1)