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Genuine or Reproduction: A Comparison of 3D Imaging Techniques

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Abstract:
 Advancements in technology associated with 3D imaging for both print and digital applications are transforming many aspects of geology. Museums, researchers, and educators are now using 3D models to depict and reproduce fossils, minerals, and crystals for study, thereby reducing the risk of damage to valuable original specimens. This project examined which of the two processes available to Cedarville University geology program produces the best quality digital image and, subsequently, the best 3D printed object of a macroscopic-sized specimen. The first method utilizes the camera on a smartphone to take overlapping photos of the entire specimen (fossil or mineral) – top, bottom, and sides. Then, using free software called Autodesk Remake the images are processed into a digital 3D model. The digital model is then sent to a LulzBot Mini 3D printer for printing. The second method makes use of a NextEngine 3D scanner rather than a camera. The specimen is placed on a rotating pedestal and laser scanners sweep across the specimen as cameras look at how much distortion is created. The scanner data is imported into ScanStudio HD software and a point cloud is created. From the point cloud a 3D model is created for viewing on the computer or for 3D printing. For this study the quality of the digital images and printed reproductions that were derived from the two methods was compared. In the final analysis of the various 3D models (printed and digital) it was determined that the 3D scanning process produced the better quality facsimiles.

Goals:
 The primary goal was to assess Cedarville University’s current capability to scan and 3D print geologic specimens such as minerals, crystals, and fossils. Built into this goal was the desire to see if certain free programs and apps were suitable for the process. Fossils, gemstones, crystals, and certain minerals are often fragile and rare which makes the displaying of them for public viewing inadvisable. Museums and universities use casts of specimens for many displays, but the development of those casts can be quite expensive. Scanning and 3D printing is an inexpensive way to both produce and scale (up or down) geologic specimens. The goal here was to make models that could be used in either a classroom setting or academic displays here on the Cedarville University campus.

Materials and Programs:
Autodesk Remake: Free program that can create 3D models from photographs.
Smartphone: Photography of specimen.
NextEngine Scanner: A laser scanner and camera that makes 3D models.
ScanStudio HD: Program that comes with the NextEngine Scanner which allows for construction and modifications to the model.
Cura 3D Printing Software: Program used to make gcode from 3D models, and can be used for manipulations such as scaling.
Lulzbot Mini 3D Printer: 3D printer used to print models.

Results and Future Efforts:
 The 3D scanning technique proved to be the best method for producing a 3D model that could be printed. However the smart phone process also proved to be viable, but it was unpredictable and at times the method did not produce a usable 3D model. There is not a truly outstanding free program or app that could be utilized to produce a 3D model by way of the smartphone method. Various free apps like Trnio were tested, however. Figure 1 below exhibits the comparison between the printed models that were produced by both methods. While it is somewhat hard to tell from the image, in the 3D scanned model (on the right), the bottom was fully scanned and reproduced, whereas in the model that was produced by way of the smartphone (on the left) the bottom had to be reconstructed in Autodesk Remake. In the model from the 3D scanner there is finer detail and sharper definition which allow for better identification of surfaces. Future goals for this project include fossil restoration, as well as continued scanning and printing of other geologic samples. Minerals will continue to be scanned and printed for use in the classroom to show crystal structure and shape. Using programs like Blender or other 3D editing software it may be possible to restore fossils. The restoration process seeks to repair damage to the fossil that occurred during the fossilization process or during excavation. Once the fossil is scanned, then a manipulation of the 3D model can be made. This would include filling in perforations, rescaling of flattened or distorted fossils, and replacing fragments that have been broken.

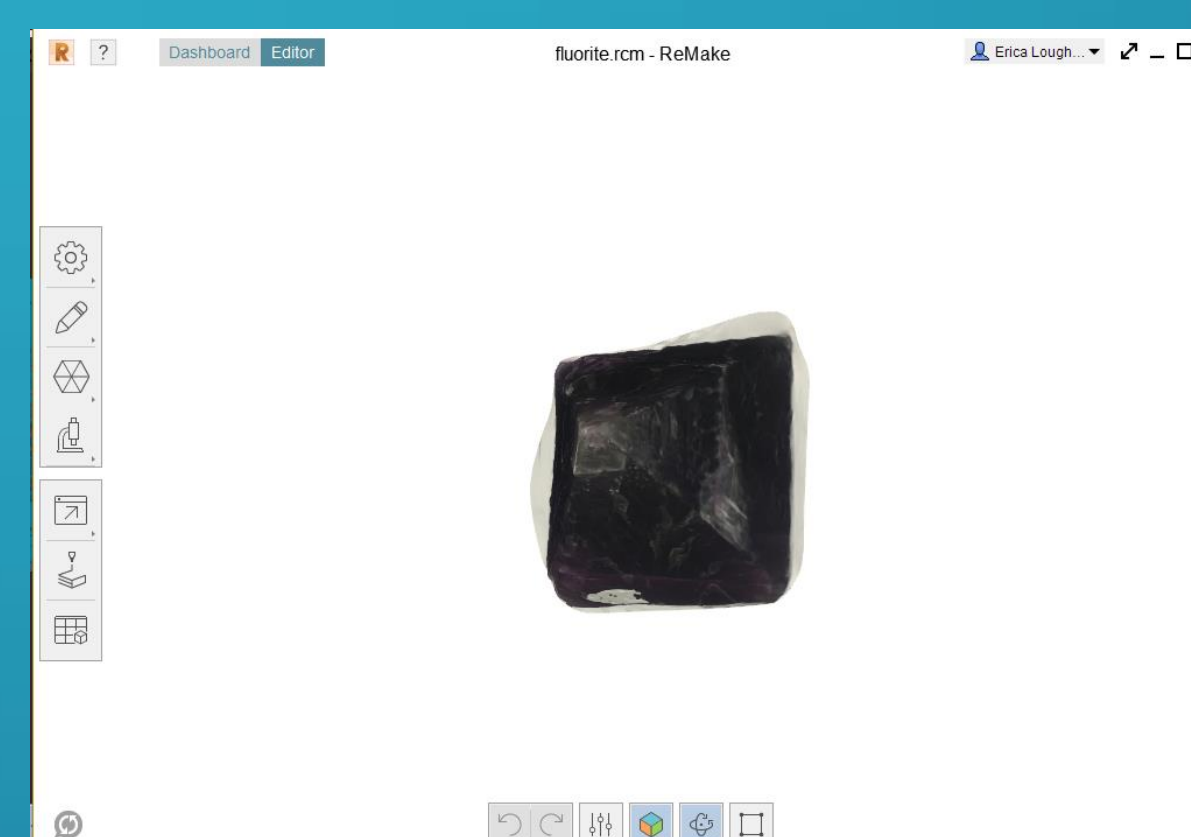
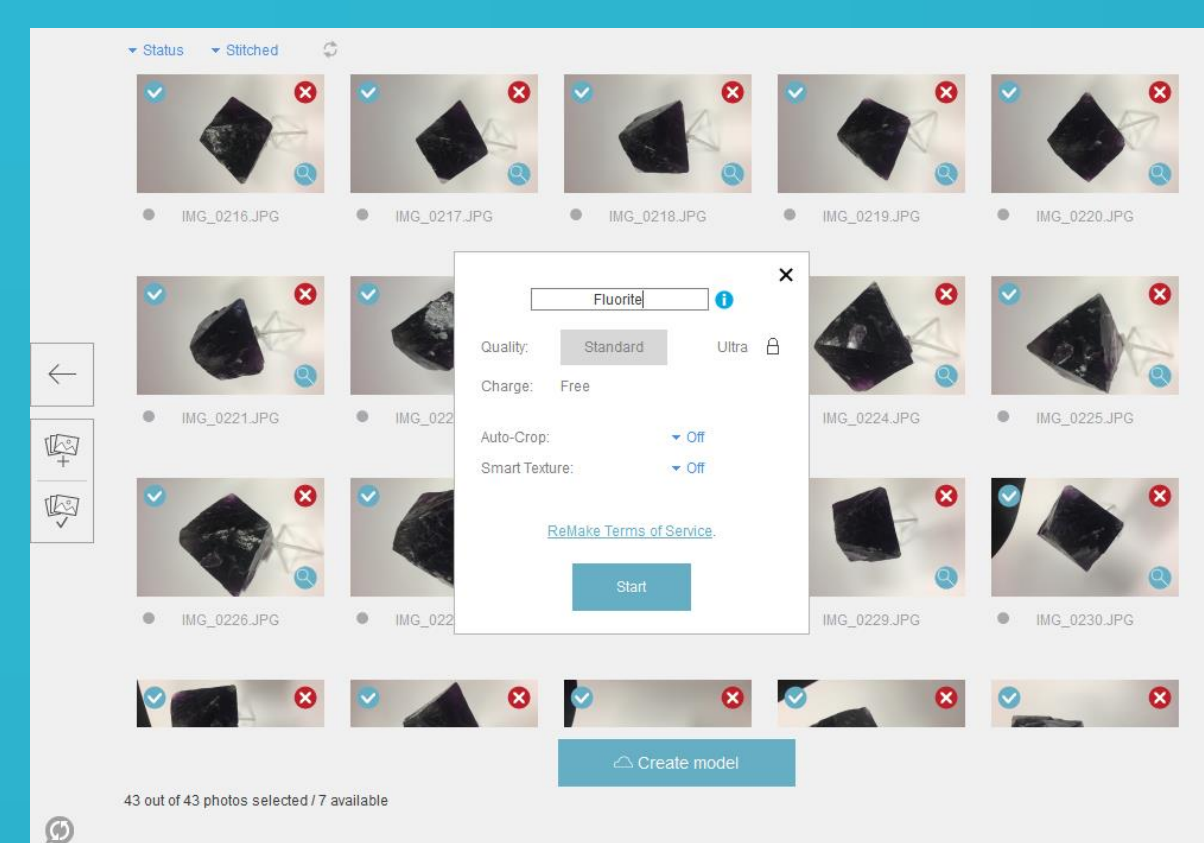
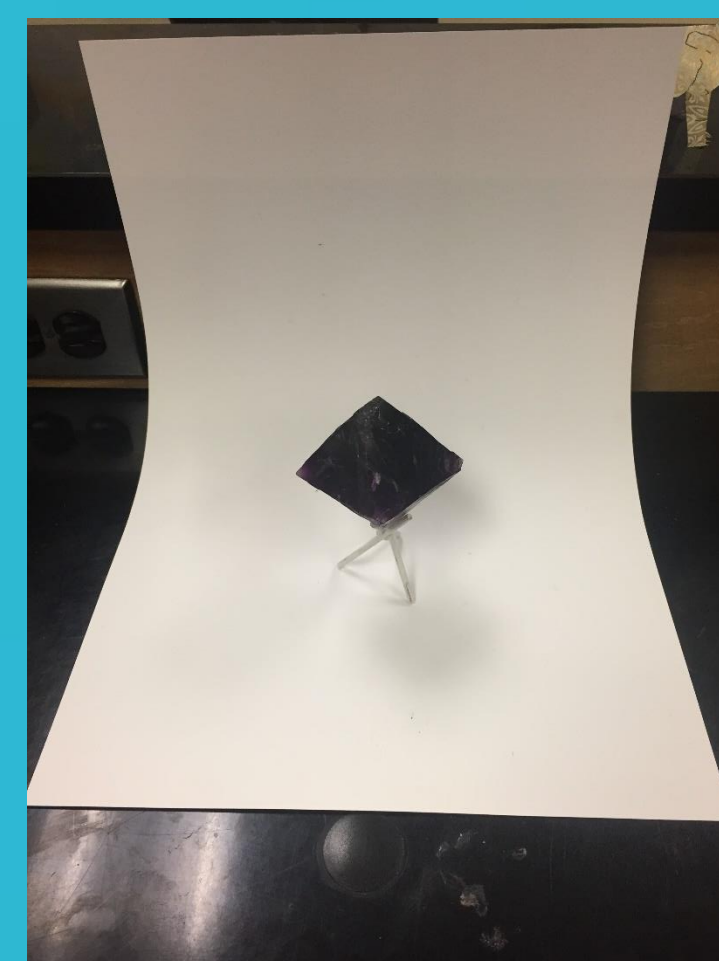
Figure 1. Emerald with 3D Prints.



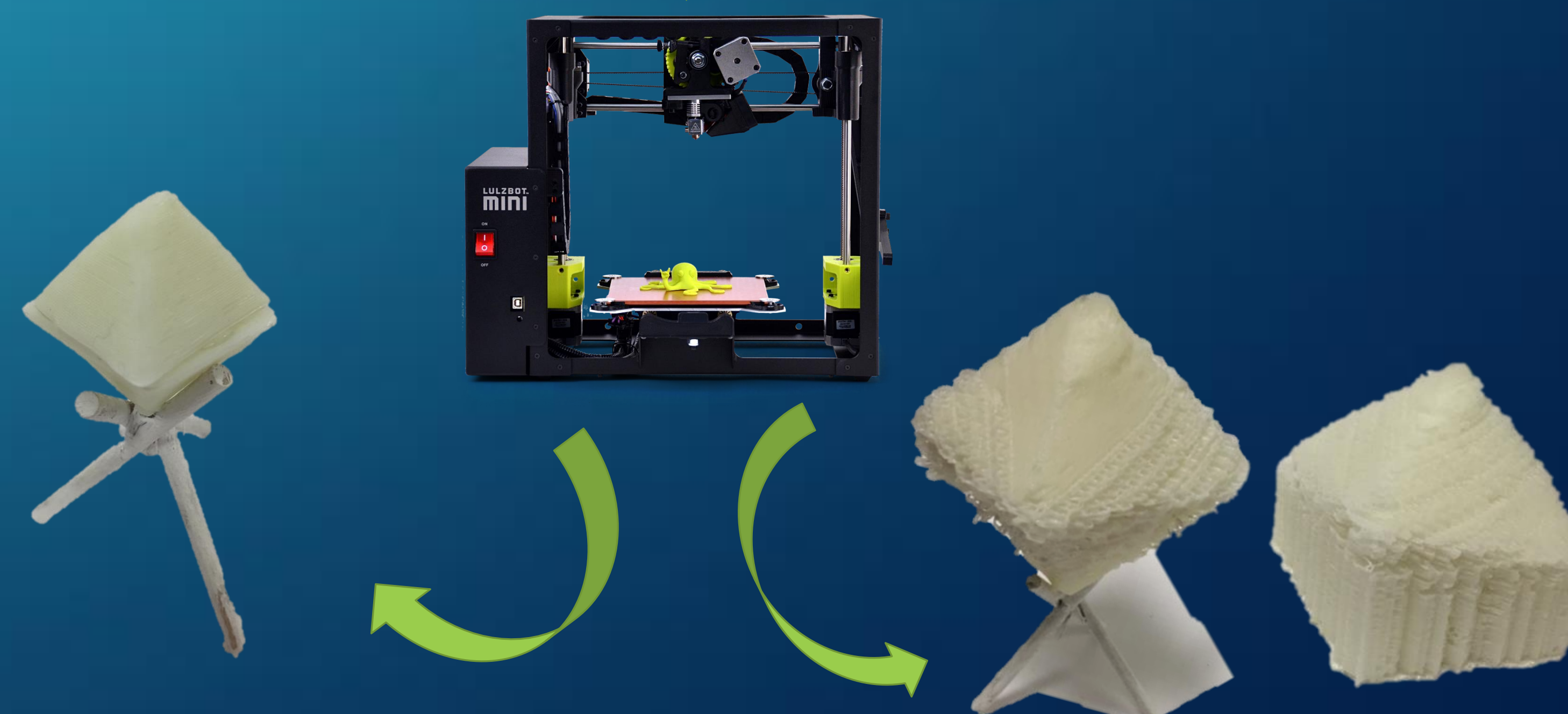
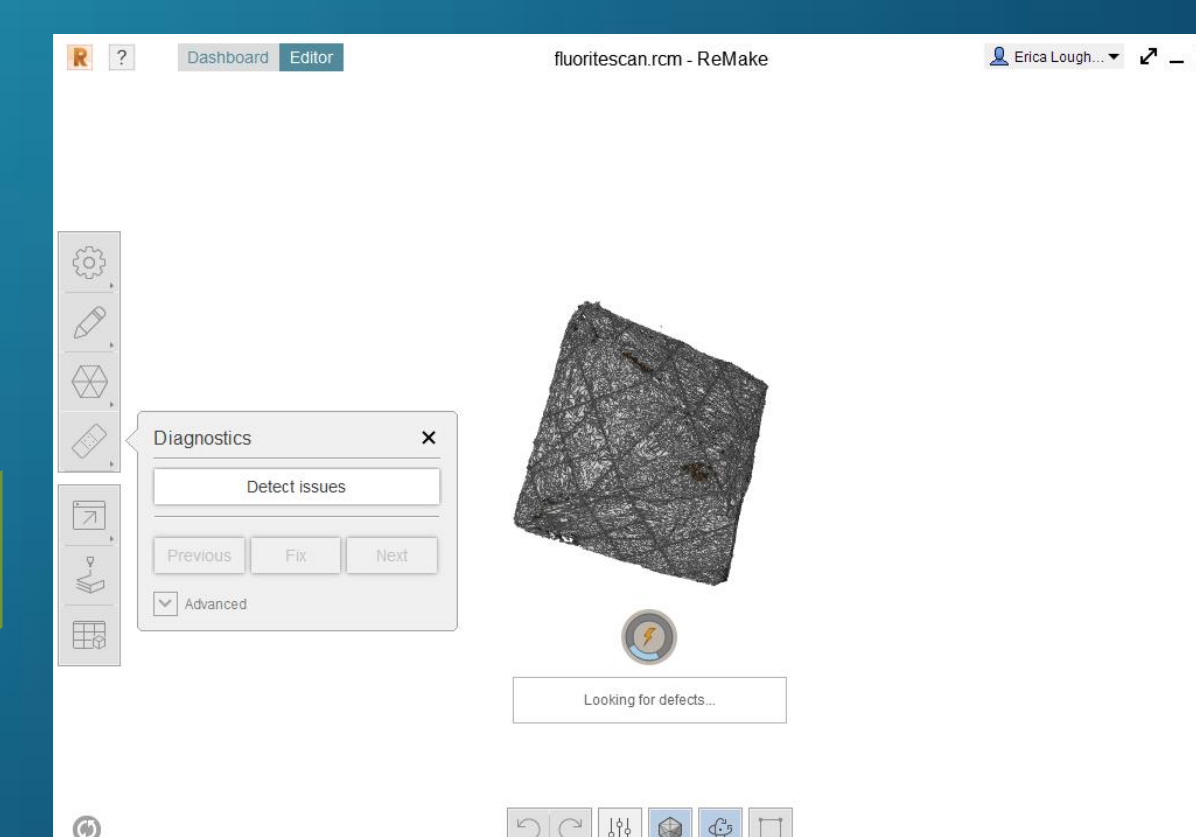
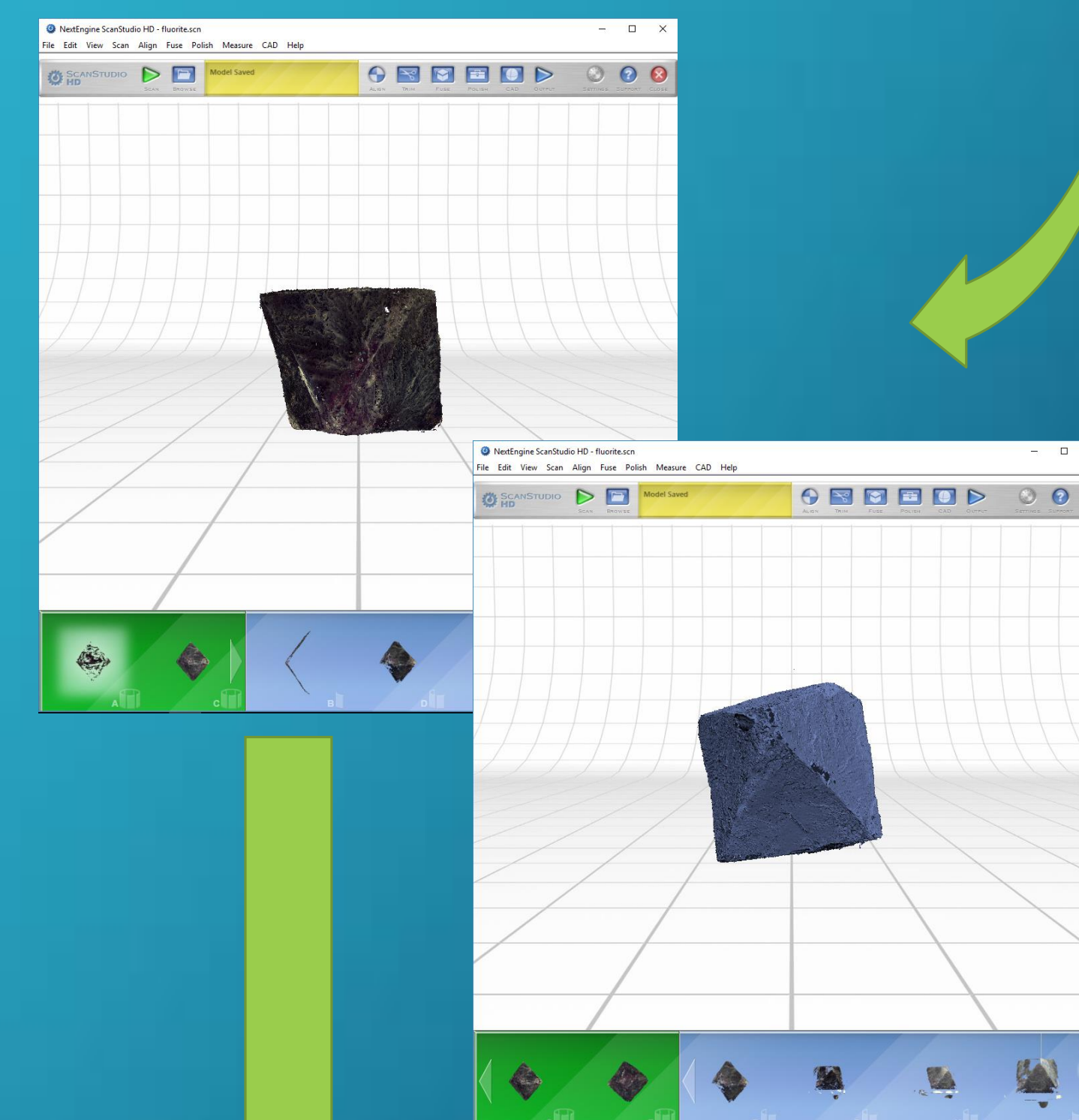
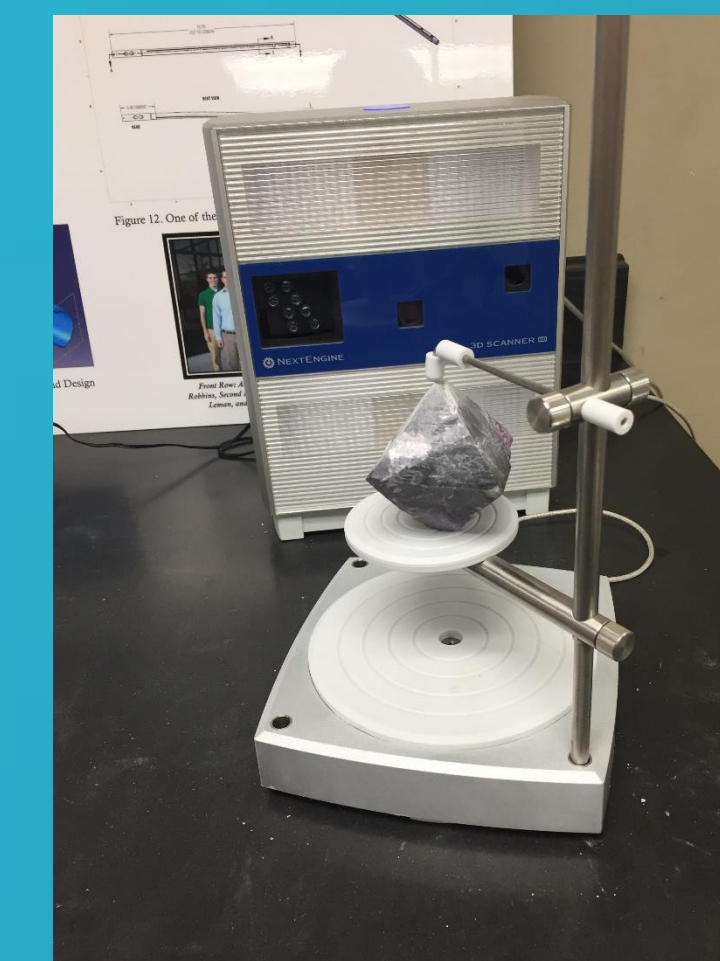
Figure 2. Megalodon Tooth with 3D Print.



Method 1: Smart Phone



Method 2: 3D Scanner



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 We would like to thank professor Tom Rice for his help and guidance on this project. We would also like to thank Dr. Kohl and Dr. Norman of the Engineering Department for the use of their equipment.