Paleontology Digitization Workshop: Vertebrates, Invertebrates, Plants
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3D Digitization of Biological Specimens

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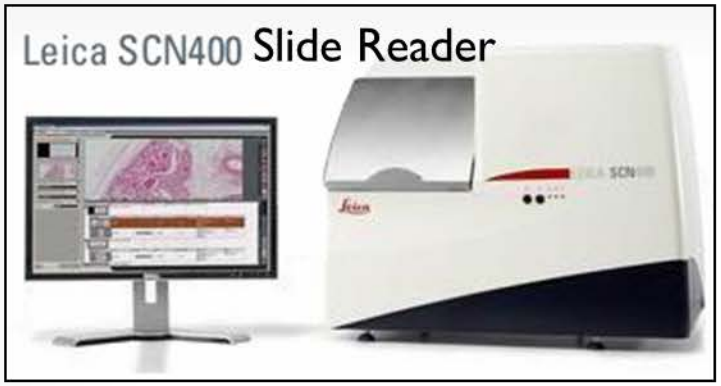
3D Scanning based Digitization

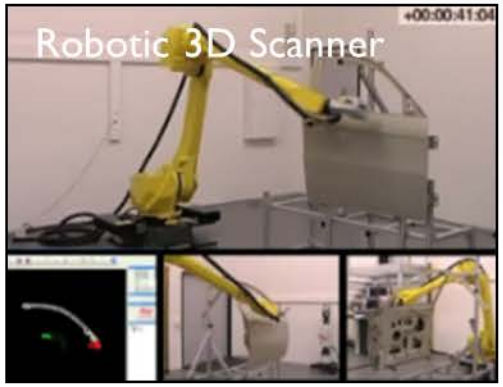
3D Scanning refers to processes that capture geometrical shape (interior and exterior)and color of a real-word object through non-destructive processes and transforms the captured data to a virtual 3D model of the object.

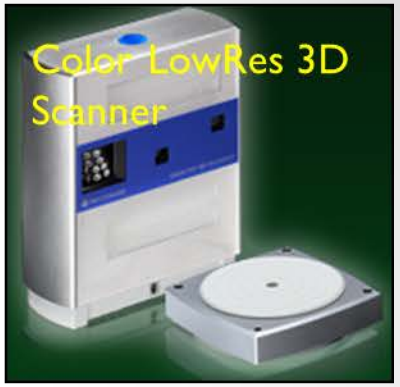
Technology Platforms

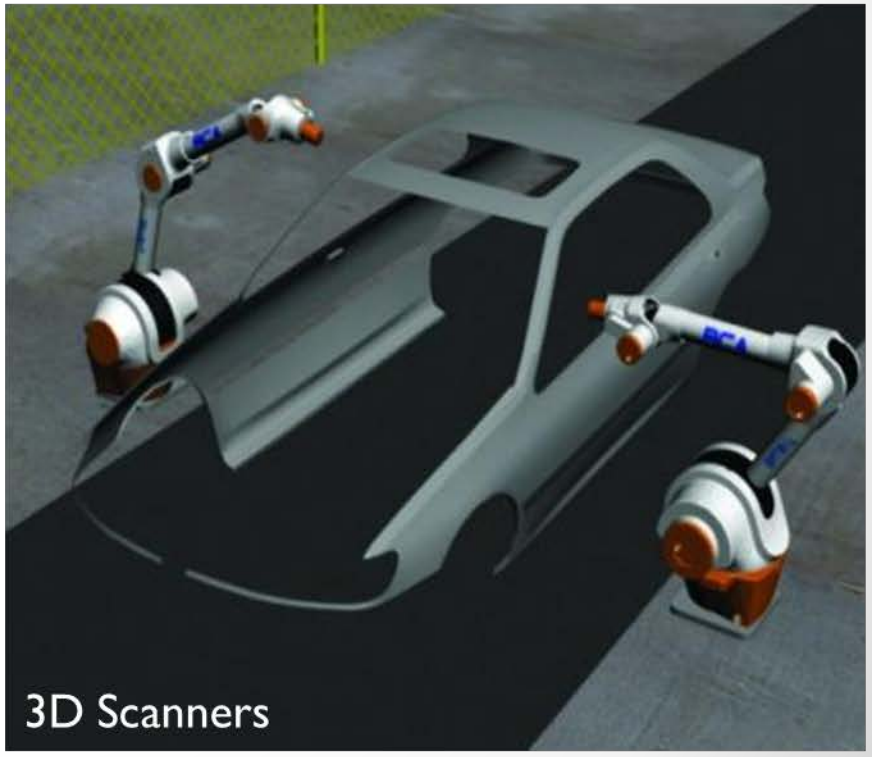
- Photogrammetry
- Laser Beam for External Scanning
- White-Light based Scanning
- Computer Tomography (CT) based on X-ray technology

Equipment List for 3D Scanning



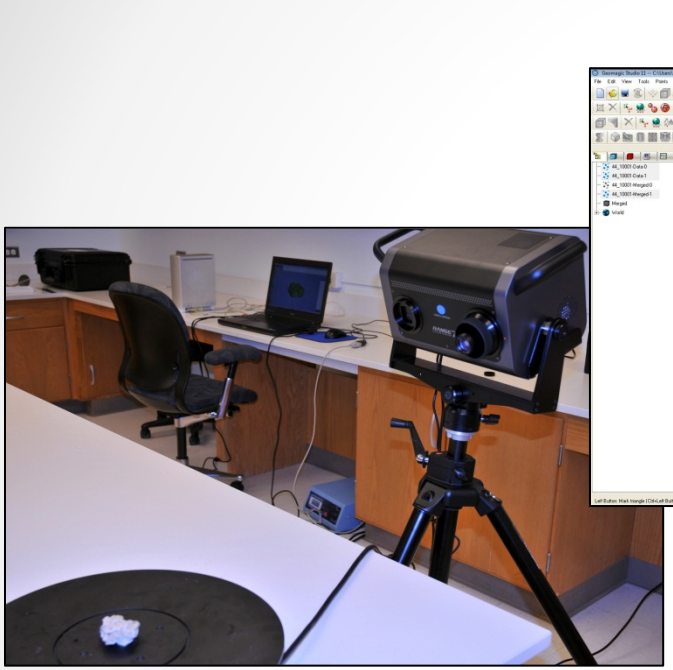


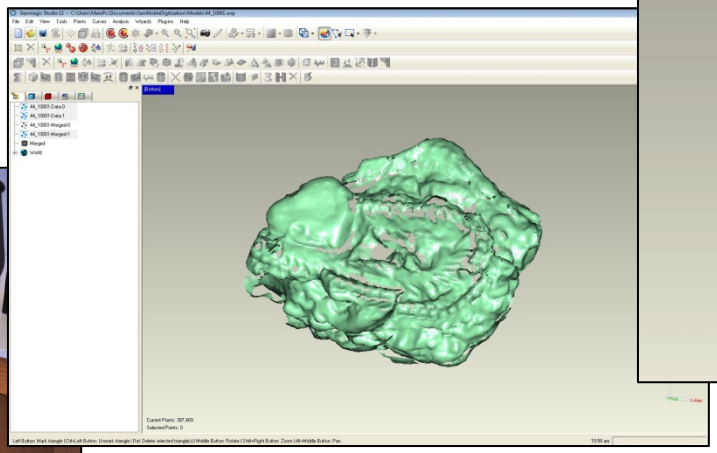




Sample Scans of 3D Objects

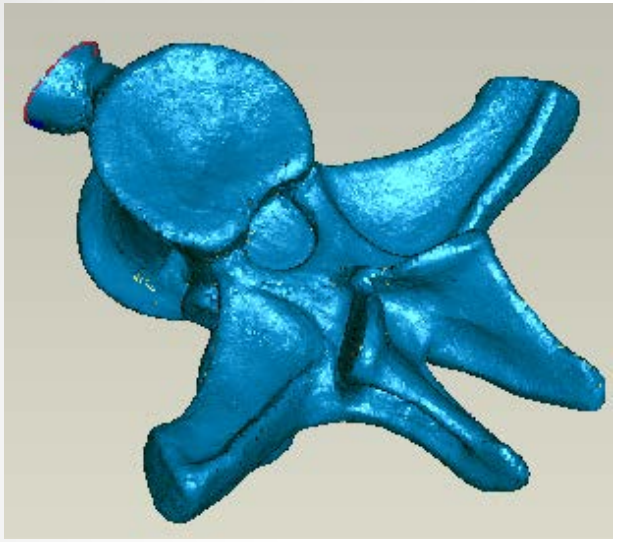
3D Digitization Process





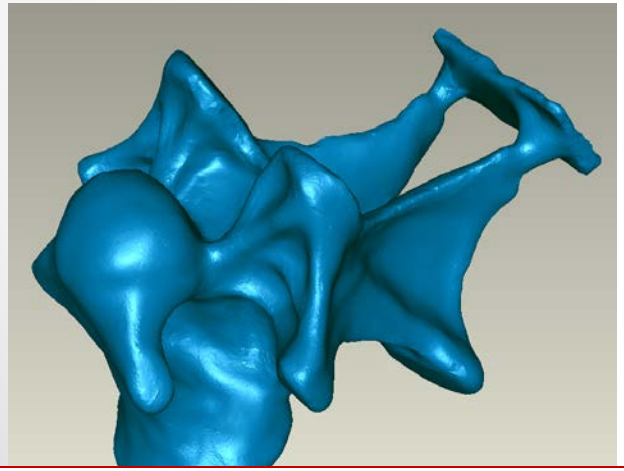
Sample Placement → Laser Scan → Point Cloud Processing → Triangulated Model Processing → Final 3D Model

From Scan to Model – Two Versions



Model 1

- Scan & Processing Time: 1hr
- Resolution: 500K Triangles
- Output File: STL

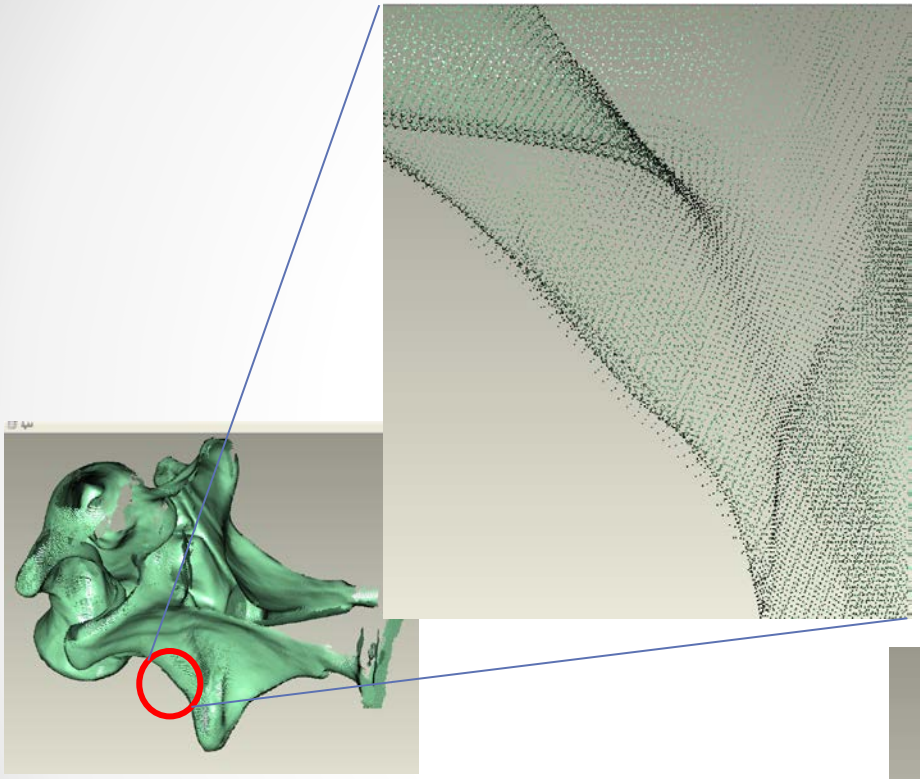


Model 2

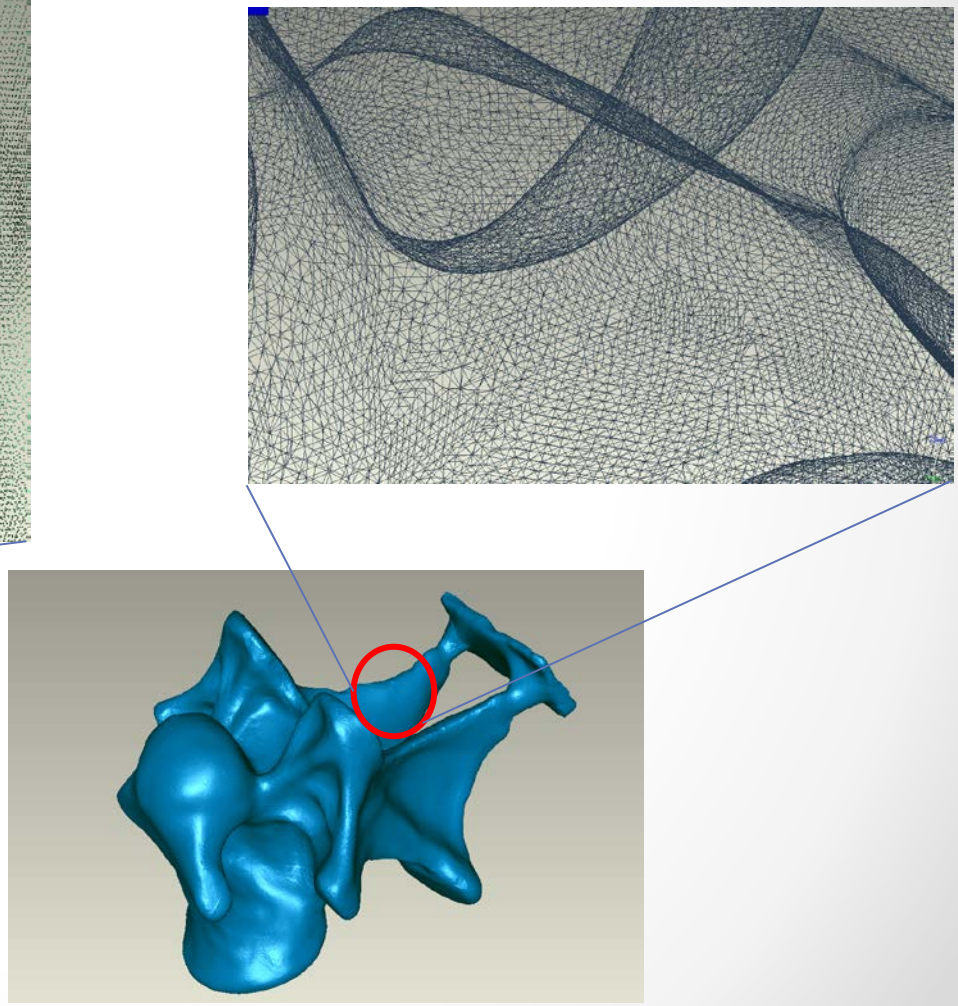
- Scan & Processing Time: 4hr
- Resolution: 5.0 Million Triangles
- Output File: STL

Differences in Quality of final 3D Model between the two versions. The more scan time is taken, generally quality goes up but can result in large scan times and model sizes.

Points and Triangles



POINT CLOUD File



TRIANGULATED MESH File

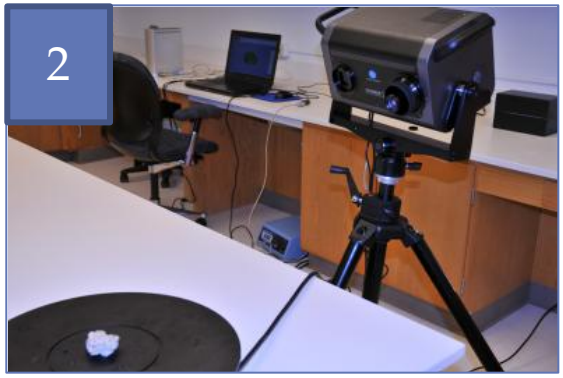
3D File Formats

- Point Cloud File
  - **.XYZ** tab delimited text files
  - **.OBJ** – Similar as above except RGB information embedded

- Triangulated Mesh Files
  - **.STL** – triangular mesh files
  - **.VRML** – triangular mesh files with color information
  - **.IGES and .STEP** – engineering definition files for 3D models.

3D Scanner Technology Platforms

Laser Line 3D Scan - 1



Laser Line 3D Scan - 2

Digital camera

Large Vol. 3D Scan

Hand-held Small Volume 3D Scan

CT Scan

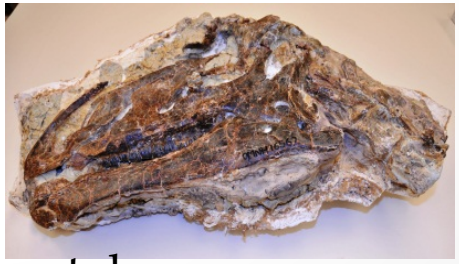
Technology Assessment


Recent Invertebrates


Ornithology

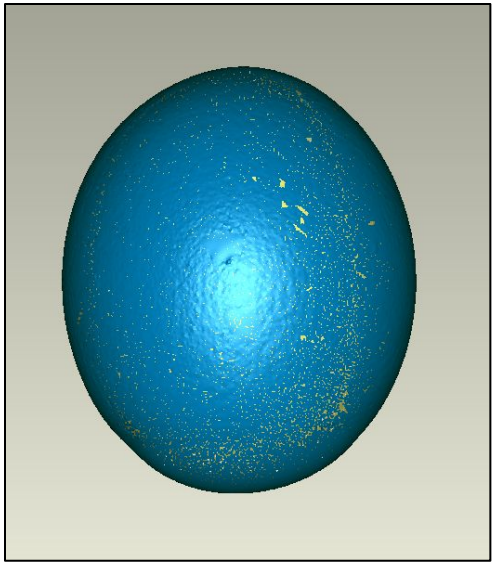
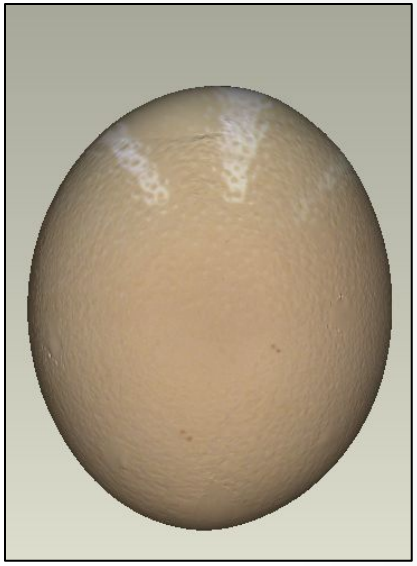

Mammalogy


Herpetology

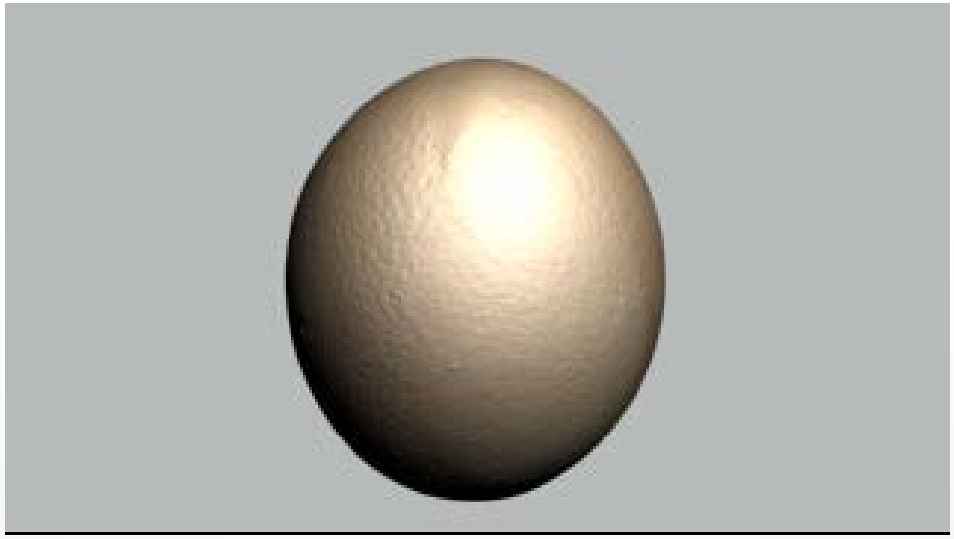



Vertebrate Paleontology

Struthio Camelus (Ostrich) Egg

2,127,869 Points ; 2,744,174 Triangles; Approximate time to scan = **11 min (EQPT#1)**

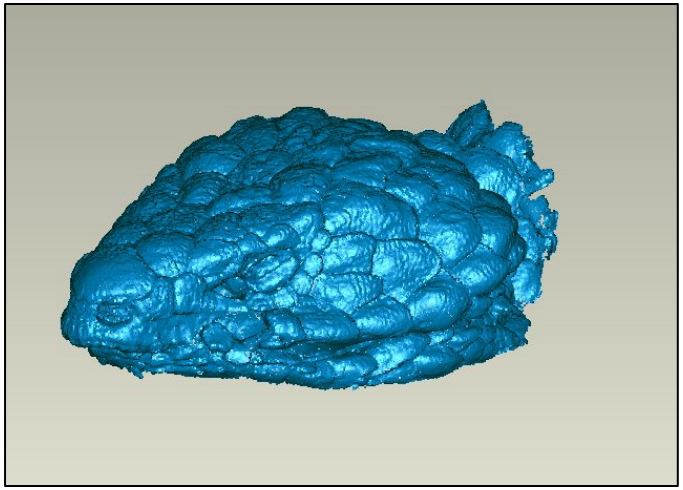


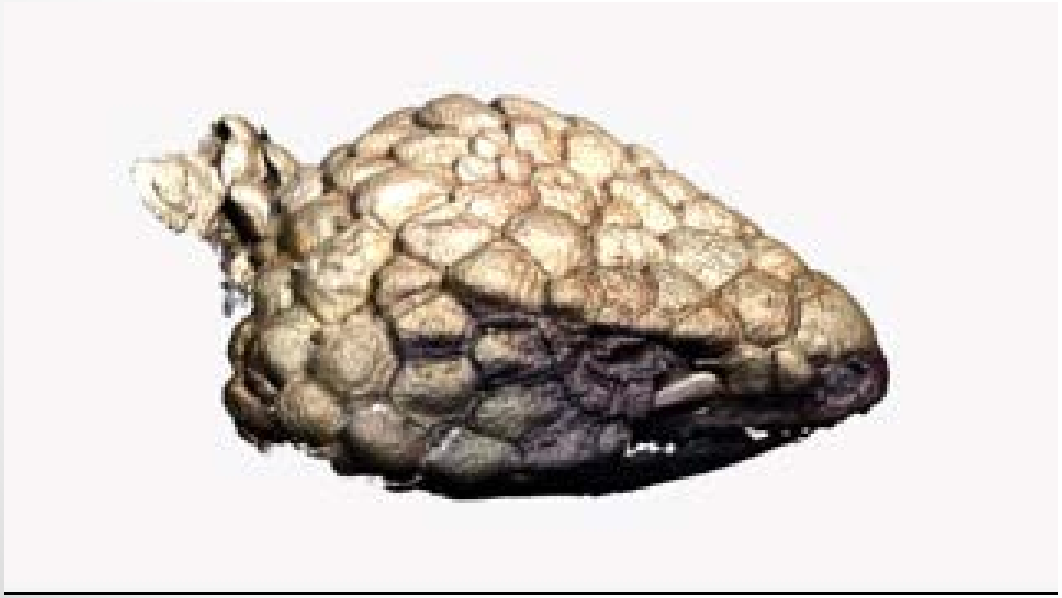
Baltimore Oriole

2,084,216 Points
946,187 Triangles

Approximate time to scan = 36min
(EQPT#1)

Trachydosaurus Rugosa Head

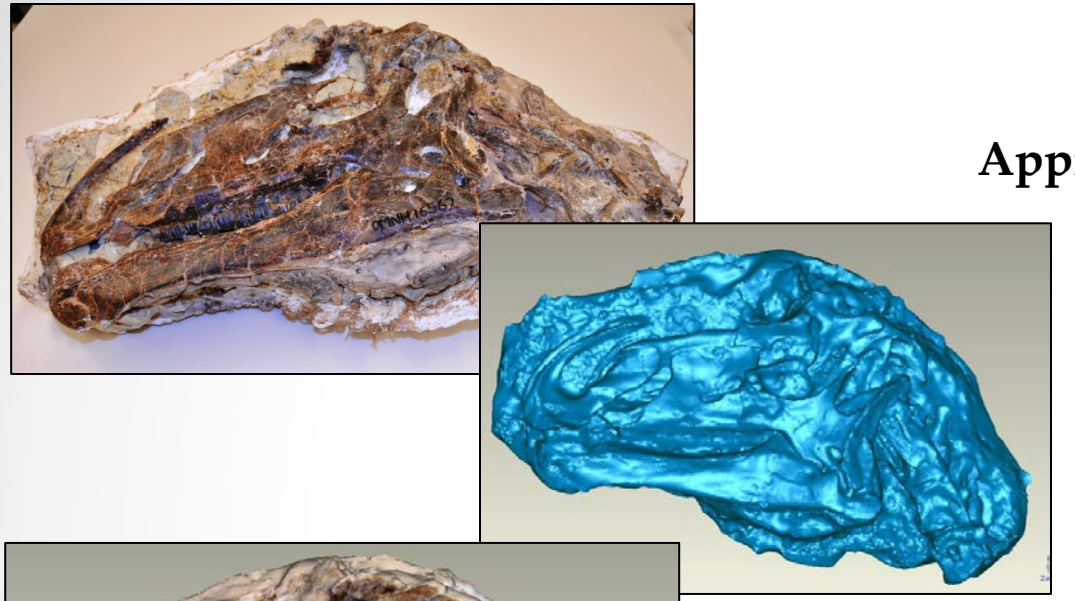




4,405,497 Points
3,021,154 Triangles

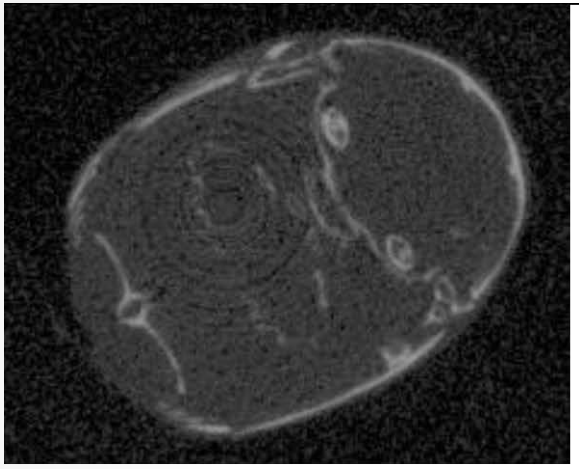
Approximate time to scan = 32 min (EQPT#1)

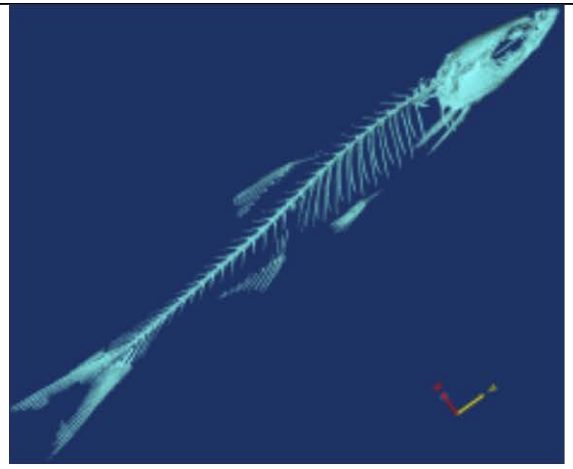
Tenontosaurus Tilletti Skull



295,329 Points
223,740 Triangles
Approximate time to scan = 14min
(EQPT#2 and #4)

CT Scan of Guppy Fish and a Wasp



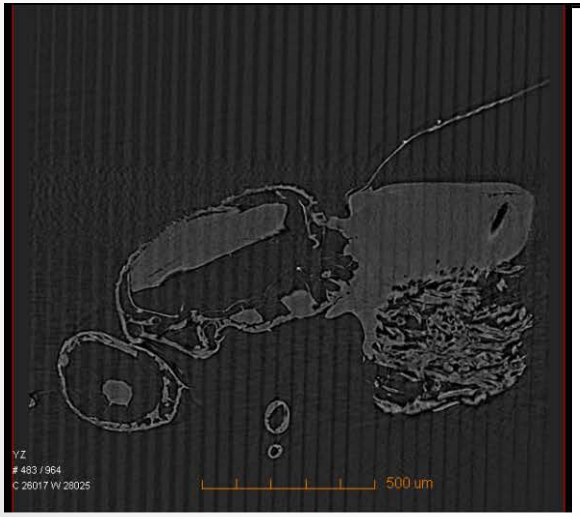


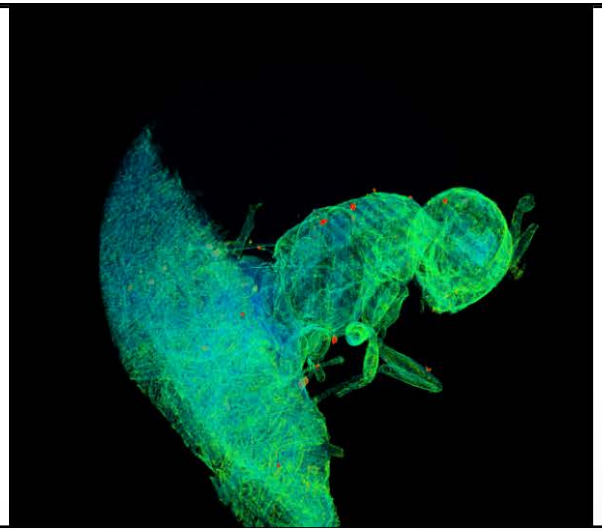
Scanner: ScanCo

Specimen Size: 59.083 mm

Number of Images: 2000

Scanning Time: 65 minutes





Scanner: Xradia

Specimen Size: 1 mm

Number of Images: 500

Scanning Time: 1 hour 30 minutes

(EQPT#6)

Technology Assessment

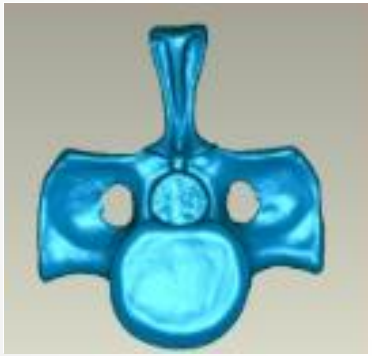
Type of Scanner	Price Approximation	Time Approximation	Automation Level
Laser Tracker, #4 (Leica T-Scan)	$350,000	7-10 min	Possible but expensive
Laser Arm, #5 (Faro Arm Platinum)	$60,000	7-10 min	Possible but expensive
Desktop Laser Scanner, #1 (Next Engine)	$5,000	15-20 min	Semi-automated
Turntable Laser, #2 (Konica Minolta Range 7)	$80,000	10-15 min	Semi-automated
Photogrammetry,#3 (Nikon D300 and Photofly)	$5,000	10-20 min	Possible

Technology Assessment

Original Sample

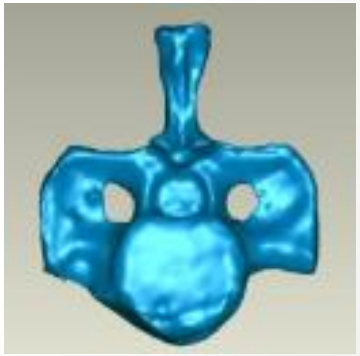
Faro Arm Platinum

Next Engine



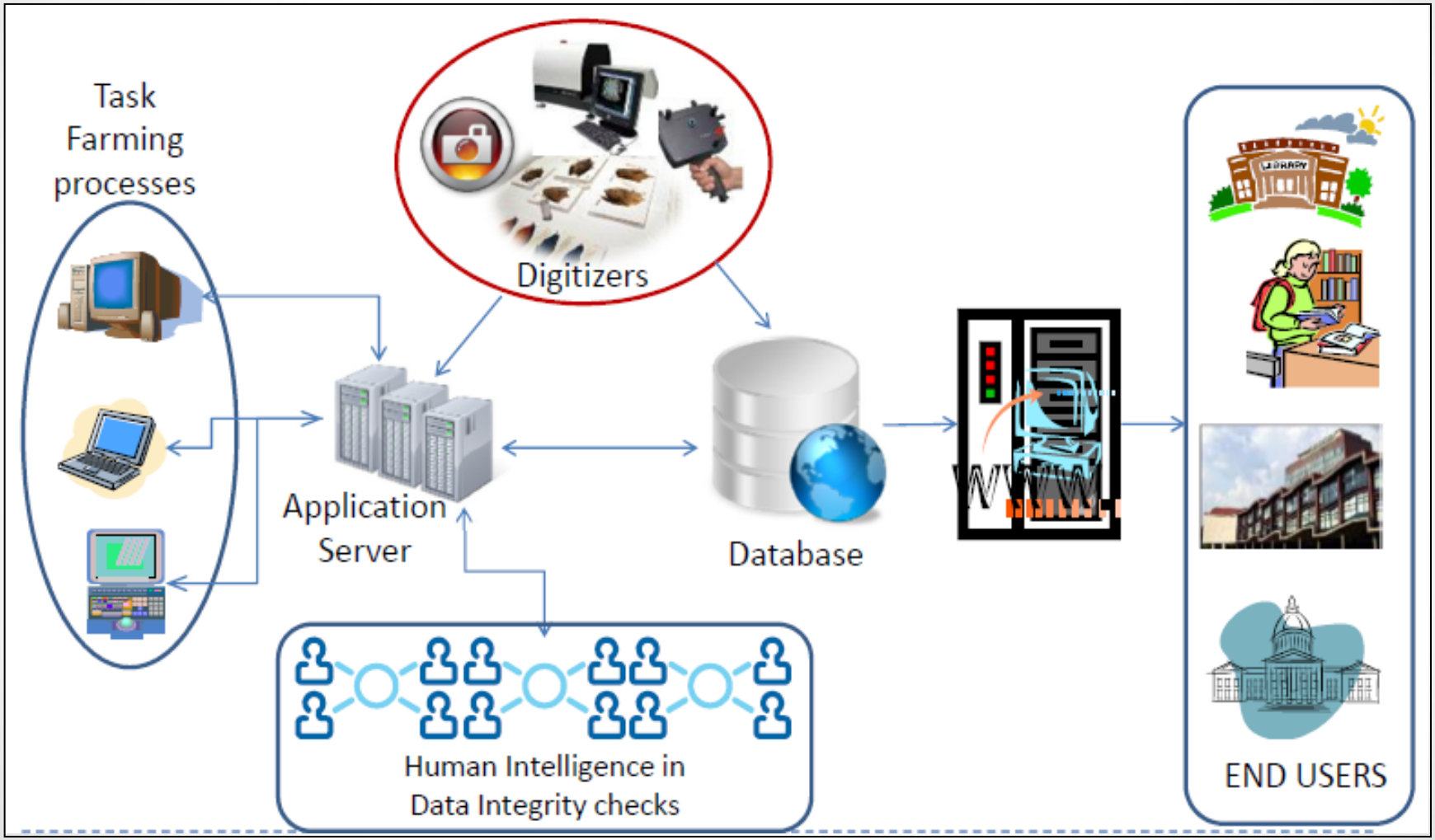
Leica T-Scan

Konica Minolta Range 7



Photogrammetry

High Throughput Digitization Strategy



Technology that must be developed

Tech Thrust 1:
Distributed Computing based 3D Reconstruction Algorithms. To build 3D models of >10 million specimens, distributed computational algorithms through task farming processes must be developed.

Tech Thrust 2:
Workflow Process Planning for High-throughput Non-Contact Measurement. Efficient workflow processes must be developed for rapid digitization with ideas borrowed from lean manufacturing principles.

Tech Thrust 3
Community based Collective Intelligence Algorithms for Quality Control Checks: The collective intelligence of the community will be crowd-sourced to ensure data integrity through web/mobile platforms.

Conclusions

- Slow and can be expensive to implement, particularly (upwards of $100K to $1M).
  - 3D Scanning Technology has matured and widely used in the aerospace, automotive and medical industries.
  - Must implement industrial level hardware and software automation to achieve decent throughput rates.
- Value from a 3D Model
  - Measurements on virtual specimens can be done in 3D.
  - Sectional profile cuts done virtually.
  - CT scans allow interior detail without damage to specimens.
- Not all specimens are conducive for 3D scanning
  - Categorize and prioritize collection specimens that can benefit from 3D scanning.
  - Samples with feathers or fur, transparent objects are difficult to scan
  - Hidden features in specimen are difficult to scan on external laser beam scanners.

Acknowledgement:
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QUESTIONS & DISCUSSION

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