SERVING 3D TO THE WORLD FOR SCIENCE AND EDUCATION: A MODERN MUSEUM MODEL

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Idaho Museum of Natural History
Special thanks to:
• Corey Schou
• Robert Schlader
• Nicholas Clement
• Nick Holmer
• Jonathon Holmes
• Jesse Pruitt
WHAT ARE WE DOING?

• Using technology to digitize entire collections, or entire museums

• Make the “Virtual Repositories” available to any student, any child, any scientist or any enthusiast anywhere in the world at any time.

• Democratize education and research through global analyses and exploration.
WHY ARE WE DOING IT?

• We suspect that important scientific and educational advancements are often not made, or critical connections are missed or overlooked, simply because people do not have access to complete collections or to the often unpublished data connected to them.

• We see this as the future of museum repositories and as a critical means to maintain the relevance of museum collections for the future.
VIRTUAL MUSEUM OR VIRTUAL BROCHURE?

• Existing virtual museums are not comprehensive.
  • Selected representations of collections.
  • High profile specimens or items.
  • Highlighted gallery spaces and new additions.

• Virtual brochures.
  • Emphasis placed on the institution itself rather than the objects housed within it.
THE VIRTUAL HAMPSON MUSEUM
The Virtual Museum has been realised through digital environments and 3-D images so as to give visibility to a few of the most remarkable artefacts included in the collections of the participating Museums involved in the project. To these artefacts have been linked thematic routes and touristic-cultural itineraries created on purpose. The overall resources valorised by the F-MUSEUM innovative product, demonstrate the common ancient matrix on which Europe is found since prehistoric times, guiding visitors to the discovery of our shared European cultural heritage. The various thematic routes available design a unique experience of a highly accessible visit of the Virtual Museum. Visitors are made free to choose objects, themes, language and criteria on which they want to base their virtual journey.
THE VIRTUAL REPOSITORY

• Diverse data assemblages
  • Access
  • Integrate
  • Mine

• House and serve complete inventories.
  • Appropriately associated meta-data.
  • Ontological classifications
  • Representational multi-media

• Content oriented, comprehensive, Virtual Museum
SYMMETRICALLY DISTRIBUTED ACCESS TO DATA

- constraints of locality
- multi-agency ownership
- perishable nature of collections
THE USER EXPERIENCE

• Customizable with open access to information.

• The user defines the galleries parameters on the basis of interest and need.

• The experience is not canned but rather represented by the individual experience and needs of the consumer.

• Predicated by the completeness of knowledge base and not its graphical user interface.
A GRAPHICAL USER INTERFACE

- Represents the information housed within the repository as a virtual environment.
- Incorporates multi-media in hyperlinked structures for intuitive navigability.
- Highly graphical veneers to facilitate spatial exploration of collections, and galleries.
IDAHO VIRTUALIZATION LABORATORY
PHOTOGRAPHY
3D SCANNING

IVL staff technician Nicholas Clement using the Faro Edge Arm to scan a small bird skull.
Scanning a skull of *Bison latifrons* with a Faro Edge scanner and Geomagic Studio
TEXTURE MAPPING WITH PHOTOGRAPHIC OVERLAYS

Scanned artifacts (left), and then with the photo overlay rendered over the 3D lattice (right). From the IMNH Crandall Collection (L-R 1716-2-1991; 4083-2-1991; 1675-2-1991).
DISPLACEMENT MAPS

- Multiple applications for 3D modeling.
- Uses: resolving high resolution detail into low density meshes.
- Incorporating high resolution detail from photographic overlays.
  - Coupled with normal maps which delineate the inside from the outside surface of a model by telling each polygon how to reflect light away from it; displacement maps use the color values in a texture map to create a grey scale alpha.
  - The intensity of grey values in the alpha ‘push’ and ‘pull’ the surface of the polygons to their high resolution positions without needing to increase the mesh density.
- Applied in two main areas of model distribution.
1. DISPLACING AN ALPHA MASK:

- Utilizing the color information from texture, minor details that were missed by the scanner can be reintroduced back into the parent mesh.
- No data are left unused.
- Overall the objects’ volume is not significantly affected.
- Should be used for presentation and distribution as an addition to heritage archival scanning but should not replace the original archival data.
2. DISPLACEMENT MAPS ON LOW DENSITY MESHES:

- 10,000 Polygons
- 2.7 Million Polygons rendered at 10,000

- Color
- Light
- Alpha
- Texture Map
- Normal Map
- Displacement Map
EXAMPLES

• VZAP
• Whales of the world
• Virtual Paleontology
• Forensics
The Virtual Zooarchaeology of the Arctic Project (VZAP) is a virtual, interactive, osteological reference collection for the study of northern vertebrates. VZAP is a dynamic natural history archive which allows students and researchers to examine the complete skeletal anatomies of multiple bird, mammal, and fish species in both 2D and 3D.

VZAP is funded by grants from the National Science Foundation (ARC-0808933, ARC-1023321).

View the Collection
<table>
<thead>
<tr>
<th>Mamal</th>
<th>Fish</th>
<th>Bird</th>
<th>Bird cont.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alces alces</td>
<td>Oncorhynchus clarkii</td>
<td>Ardea herodias</td>
<td>Fratercula cirrhata</td>
</tr>
<tr>
<td>Alopex (Vulpes) lagopus</td>
<td>Oncorhynchus mykiss</td>
<td>Nyctea(Bubo) scandiaca(scandiacus)</td>
<td>Fratercula corniculata</td>
</tr>
<tr>
<td>Bison bison</td>
<td>Oncorhynchus tshawytscha</td>
<td>Corvus corax</td>
<td>Serna virgulianus</td>
</tr>
<tr>
<td>Callorhinus ursinus</td>
<td>Oncorhynchus kisutch</td>
<td>Tympanuchus phasianellus</td>
<td>Serna paradisaea</td>
</tr>
<tr>
<td>Canis latrans</td>
<td>Oncorhynchus nerka</td>
<td>Centrocercus urophasianus</td>
<td>Lars argentatus</td>
</tr>
<tr>
<td>Canis lupus</td>
<td>Oncorhynchus keta</td>
<td>Lagopus lagopus</td>
<td>Lars hyperboreus</td>
</tr>
<tr>
<td>Castor canadensis</td>
<td>Oncorhynchus keta</td>
<td>Lagopus mutus(muta)</td>
<td>Stercorarius pomarinus</td>
</tr>
<tr>
<td>Cerfus elaphus</td>
<td>Oncorhynchus gorusbucha</td>
<td>Branta bernicla hrota</td>
<td>Buteo jamaicensis</td>
</tr>
<tr>
<td>Cyrtophora cristata</td>
<td>Salvelinus namaycush</td>
<td>Dendragapus(Falciennis) canadensis</td>
<td>Stercorarius parasiticus</td>
</tr>
<tr>
<td>Delphinus delphis</td>
<td>Salvelinus alpinus</td>
<td>Cygnus columbianus</td>
<td>Phalaropus lobatus</td>
</tr>
<tr>
<td>Enhydra lutris</td>
<td>Coregonus culpaformis</td>
<td>Nyctea(Bubo) scandiaca(scandiacus)</td>
<td>Stena hirundo</td>
</tr>
<tr>
<td>Gulo gulo</td>
<td>Hypomesus pretiosus</td>
<td>Cygnus buccinator</td>
<td>Pandion haliaetus</td>
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<tr>
<td>Halichoerus grypus</td>
<td>Esux lucius</td>
<td>Asner aliforns</td>
<td>Phalacrocorax pelagicus</td>
</tr>
<tr>
<td>Homo sapiens</td>
<td>Lota lota</td>
<td>Aix sponsa</td>
<td>Phalacrocorax auritus</td>
</tr>
<tr>
<td>Lepus Lepus(Poecilolagus) americanus</td>
<td>Theragara chalogramma</td>
<td>Anas creca</td>
<td>Morus bassanus</td>
</tr>
<tr>
<td>Lontra canadensis</td>
<td>Gadus morhua</td>
<td>Anas acuta</td>
<td>Fulmarus glacialis</td>
</tr>
<tr>
<td>Lynx canadensis</td>
<td>Gadus macrocephalus</td>
<td>Anas clypeata</td>
<td>Puffinus pacificus</td>
</tr>
<tr>
<td>Lynx rufus</td>
<td>Platichthys stellatus</td>
<td>Anas discors</td>
<td>Phoebastria nigripes</td>
</tr>
<tr>
<td>Martes americana</td>
<td>Lepidoptera bilineata</td>
<td>Anas platyrhynchos</td>
<td>Phoebastria immutabilis</td>
</tr>
<tr>
<td>Mustela(Neoision) vison</td>
<td>Reinhardtius stonias</td>
<td>Anas rubripes</td>
<td>Podiceps grisegena</td>
</tr>
<tr>
<td>Odobenus rosmarus</td>
<td>Hippoglossus stenolepis</td>
<td>Anas americana</td>
<td>Podiceps auritus</td>
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<tr>
<td>Odocoileus hemionus</td>
<td>Scomber japonicus</td>
<td>Aythya affinis</td>
<td>Gavia stellata</td>
</tr>
<tr>
<td>Ondatra zibethicus</td>
<td>Apodichthys flavidus</td>
<td>Aythya marila</td>
<td>Gavia immer</td>
</tr>
<tr>
<td>Ursus maritimus</td>
<td>Pholis laeta</td>
<td>Aythya valisineria</td>
<td>Gavia pacifica</td>
</tr>
<tr>
<td>Ursus americanus</td>
<td>Trichodon trichodon</td>
<td>Somateria mollissima</td>
<td>Gavia arctica</td>
</tr>
<tr>
<td>Ursus arctos</td>
<td>Sander vitreus</td>
<td>Somateria spectabilis</td>
<td></td>
</tr>
<tr>
<td>Phoca vitulina</td>
<td>Anoplopoma fimbria</td>
<td>Melanitta nigra</td>
<td></td>
</tr>
<tr>
<td>Phoca vitulina</td>
<td>Myoxocephalus quadricornis</td>
<td>Melanitta fusca</td>
<td>152 species</td>
</tr>
<tr>
<td>Pusa hispida</td>
<td>Myoxocephalus polyacanthocephalus</td>
<td>Clangula hyemalis</td>
<td>223 Total specimens</td>
</tr>
<tr>
<td>Rangifer tarandus</td>
<td>Hemilepidotus hemilepidotus</td>
<td>Bucephala clangula</td>
<td>43894 Images</td>
</tr>
<tr>
<td>Spermophilus richardsonii</td>
<td>Ophiodon elongatus</td>
<td>Mergus serrator</td>
<td></td>
</tr>
<tr>
<td>Ursus americanus</td>
<td>Pleurogrammus monopterygus</td>
<td>Ale alle</td>
<td></td>
</tr>
<tr>
<td>Ursus arctos</td>
<td>Hexagrammos decagrammns</td>
<td>Uria lomvya</td>
<td></td>
</tr>
<tr>
<td>Vulpes vulpes</td>
<td>Sebastes ruberrimus</td>
<td>Cepphus columba</td>
<td></td>
</tr>
<tr>
<td>Vulpes vulpes</td>
<td>Sebastes melanops</td>
<td>Pinguinus impennis</td>
<td></td>
</tr>
<tr>
<td>Gasterosteus aculeatus</td>
<td>Sebastes melanops</td>
<td>Pinguinus impennis</td>
<td></td>
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<td></td>
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</tr>
</tbody>
</table>
VIRTUAL ZOOARCHAEOLOGY OF THE ARCTIC

- Specimens: 230
- 2D Images: 44,466
- 3D PDFs: 6,101
- Files: 13.9 million (this is just to run bones, if we count total files for everything, we exceed 14 million)
- Storage: 430+GB
Specimen rosmarus (Walrus) - Edit

- rosmarus
  - Add New Classification
  - Edit Selected Classification

- Species: rosmarus

- Walrus (Odobenus rosmarus)
  - UWBM 35479

- Add New Specimen Number

- Number | Number Type | Options
- --- | --- | ---
- CMC F1055-1 | Catalogue | Edit | Delete

- Add New Collection
  - Edit Selected Collection

- Male
  - Add New Sex
  - Edit Selected Sex

- Adult
  - Add New Age
  - Edit Selected Age

- 7 4 1972

- Add New Collector
  - Edit Selected Collector

- Robert McGhee

- Canadian Museum of Civilization
  - Add New Repository
  - Edit Selected Repository

- Northwest Territories, Dundas Island
  - Add New Location

- Add New Death Cause
  - Edit Selected Death Cause

- unknown
  - Add New Specimen Link

0 grams

- Add New Specimen Link

- Address
  - Options

  - Edit | Delete
A single image is displayed for each available specimen. If an element does not exist for a specimen, then the next available...
A SHORT VZAP DEMONSTRATION
Online measurement tools give virtual repositories legitimacy by allowing researchers to do analysis from anywhere in the world. Below: measuring apical angle and blade length on a Heliocoprion shark fossil from the Permian (IMNH VP-36504).
2D MEASUREMENT TOOL
CURRENT 3D DATA DISTRIBUTION

- Currently all 3D data is being distributed through Adobe 3D PDF
  - Original scan data without color
  - High resolution model with color
  - Low resolution model with color

- 3D PDF limitations
  - No more than 1 million polygons
  - Only color maps supported
  - Only one model viewable in the same view window
  - Must be downloaded to host computer for viewing

- If you want access to the models in a non PDF format an email request for access must be made
FUTURE 3D DATA DISTRIBUTION

• Models will be accessible through a web based viewer (demo to follow)
  • Allows for multiple resolutions adjustable in real time
  • Allows for different map types (color, normal, displacement, etc.)
  • Allows for multiple models on screen at the same time
  • Handles both polygon and point cloud data
• On screen measurements similar to the 2d measurement tools
  • Multiple linear measurements
  • Angular measurements
  • Area measurements
  • Volume measurements
  • Export measurements to spreadsheets for use in statistical packages
• No request for access to models required
  • Models available through the database directly
NEW 3D TOOLS
The Virtual Zoarchaeology of the Arctic Project (VZAP) is a virtual, interactive, osteological reference collection for the study of northern vertebrates. VZAP is a dynamic natural history archive which allows students and researchers to examine the complete skeletal anatomies of multiple bird, mammal, and fish species in both 2D and 3D.

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Harbor porpoise skull scanned and edited in Geomagic (upper), and then the photo overlays and final rendering is done in ZBrush (lower) (USNM-571765).
VIRTUAL PALEONTOLOGY
IDAHO’S STATE FOSSIL

The Hagerman Horse
Equus simplicidens
HELCOPRION

IMNH 30900
Heliocoprion ergassaminon
HELICOPRION

Animation from CT reconstruction of IMNH-37899.

Jaws for a spiral-tooth whorl: CT images reveal novel adaptation and phylogeny in fossil *Helicoprion*
CONCLUSIONS

• Many Federal agencies, local and regional museums, and universities have specific and spectacular collections that are critical to the global scientific agenda, yet are underutilized because of distance or because the scientific community does not know they exist.

• The Virtual Repository model allows museums to make scientific analysis of their collections possible on a global scale, and to highlight the importance of those collections to their communities.

• This should be the repository and curation model for the century, and it will drive collections use and publication, and firmly establish and maintain the relevance of these collections as key sources of science and enlightenment.
DEMOCRATIZATION OF SCIENCE

• The democratization of science is about using online media to make local, often inaccessible collections part of the world’s scientific agenda.

• Thus allowing distant, often isolated individuals, classrooms or collaborators the opportunity to conduct their own investigations on collections from anywhere on the planet.