The NIH 3D Print Exchange: Developing Tools and Capturing Metadata with X3D

Naval Web-Based Collaboration and Model Exchanges Using X3D
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Branch Chief

Bioinformatics and Computational Biosciences Branch
Office of Cyber Infrastructure and Computational Biology
National Institute of Allergy and Infectious Diseases
National Institutes of Health, Bethesda, Maryland
Create unique web tools that lower the skills barrier to generate bioscientific and medical models

Provide a platform for exchanging biomedical and bioscientific 3D models with the public

Increase adoption of 3D technologies for research and discovery

https://3Dprint.nih.gov
10,000+ unique visitors per month
3,000+ downloads per month
Creating a 3D Model Exchange

Tips, Tricks, and Tools
5 pipelines use open source tools to automatically generate 3D models from over 35 different file types:

- Eliminates skills barrier
- High-quality models
- Scientifically accurate models generated from structures pulled directly from publicly available scientific repositories

Users can contribute their own CAD models – we make them searchable and interactive
Custom Development

Current version

- Pipeline module incorporates 30+ custom scripts
- X3DOM viewer module (necessary for color display)
- Content curation facilitated by parsing XML from public repository structures and importing metadata into the node

New additions in Drupal 8:

- Content/Forms generator module
- Insertion of metadata into X3D header
- Digital Object Identifiers (DataCite, via DOE agreement)

Contributed code to Blender 2.72 and Cura 2.3

Drupal 8 version in alpha testing

Contributed code to Blender 2.72 and Cura 2.3

https://www.drupal.org/sandbox/nih3d print/2467593

3D module working! Took less than 15 minutes to get it working on the site! #DrupalConNA
@NIH3Dprint #drupal4gov
1 Content Type
95+ Fields

- Sluggish performance
- Difficult to manage

9 Content Types
~30-50 Fields

- Faster querying
- More room for content-specific metadata
Queue Management

Queue state

ID[NID]Type|Start date|State|PID|Options
---|---|---|---|---
Clear the queue

Run pipeline for a node

Node ID: [Text box]
Type: [Dropdown]
- Suppress admin e-mail
- Suppress user e-mail
- Force sequential mode
- Skip mesh repair
Go

Recently run nodes

<table>
<thead>
<tr>
<th>NID</th>
<th>Type</th>
<th>Title</th>
<th>Options</th>
<th>Log</th>
</tr>
</thead>
<tbody>
<tr>
<td>6803</td>
<td>Mode</td>
<td>Buffer V1.4/3 scratcholnode Cluster</td>
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<tr>
<td>6802</td>
<td>PDB</td>
<td>CRYSTAL STRUCTURE 3D/4 DSDR COMPLEX WITH ADJACENT CYSTIC FIBROSIS</td>
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Queue log file

Retrieve

Recent run times

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Historical run times

Retrieve
Custom 3D Mesh Repair Tool

This is an ASP.NET 4.6.1 website that exposes the Windows.Graphics.Printing3D.Printing3DModel.RepairAsync() API function to Web clients. It accepts model files via POST (only binary, colorless STL as of this writing), applies the repair logic to them, and returns the cleaned up model.

Requires Windows Server 2016 Anniversary Update or later to run.
X3D for 3D Printing

Interoperability, Portability, and Multipurposing
### File formats

<table>
<thead>
<tr>
<th>Format</th>
<th>Mesh</th>
<th>Binary format</th>
<th>Unzipped</th>
<th>XML</th>
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<th>texture</th>
<th>material</th>
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<td>✔</td>
<td>?</td>
</tr>
</tbody>
</table>
Advantages
• Critical printing parameters are included – quality control for distributed manufacturing
• Makes 3D models “ready-to-print” in a Windows environment
• Incorporates DRM protection

Limitations/Questions
• Emphasis on Windows 10
• Can’t be readily visualized in a viewer
• Can X3D go into the payload?

Opportunities
• X3D doesn’t need to invent a data schema for 3D printing - they did the hard work!
• Builds a case for XML-based formats
• EVERYONE WANTS IMPROVEMENTS TO STL
Cura support for X3D

Still need:

• Save/export 3D scene – e.g., model orientation

• Import/export printer parameters from X3D header

https://github.com/Ultimaker/Cura
https://github.com/Ultimaker/Cura/issues/1090
https://github.com/Ultimaker/Cura/issues/1086
Importance of Metadata

3D model designers want to:
• Track use of the design file
• Compare modified versions
• Indicate original intent
• Provide credit or attribution
• Validate, ensure safety if applicable

Healthcare teams want to:
• Include patient identifiers
• Validate, ensure safety
• Track versions
• Access a model from a PACS system
• Make the model a persistent and permanent part of the patient’s medical record

1. Workshop follow-up information
2. ccRel Data Model

XML can be parsed to prepopulate fields in data repositories, facilitate sharing via APIs, and import/export 3D printing parameters
Future Directions

Beyond 3D Printing
Naval Web-Based Collaboration and Model Exchanges using X3D

PHYSICAL

3D printing

Augmented reality

Stereoscopic viewer

Virtual reality

Haptics

NIH 3D Print Exchange

“NIH 3D”
Powered by NIAID

DIGITAL

20,000+

Interactive 3D on desktop or mobile | mobile device stereoviewer (Google Cardboard, etc.)
3D printer software | Import into gaming engines for AR/VR

Powered by NIAID

National Institutes of Health

Turning Discovery Into Health
Value-add visualization features

Smithsonian “tours” – 3d.si.edu
We built it, so you don’t have to!
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Smithsonian Digitization Team

Vince Rossi
Smithsonian Digitization Team
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