X3D Activities, Summer 2015

SIGGRAPH 2015, Los Angeles

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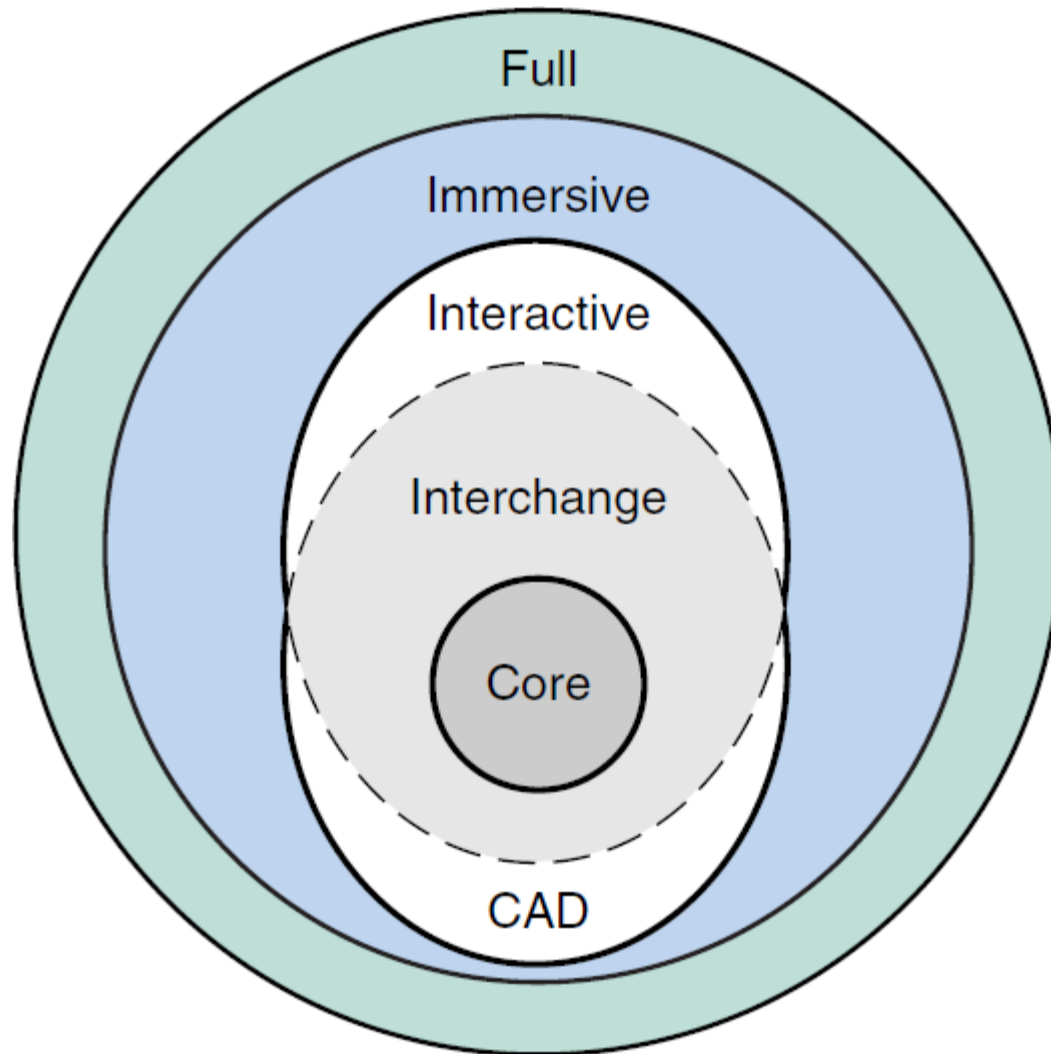# Solid core: X3D Graphics Standard

- Extensible 3D (X3D) Graphics is royalty-free open standard for publishing, viewing and archiving interactive 3D models on the Web.
- Long-term archival stability is an ongoing strength
- Repeatable examples – make it your own!
- Quality assurance ensures stability
- No showstoppers: beyond the plugin barrier
- Breakout velocity is being achieved
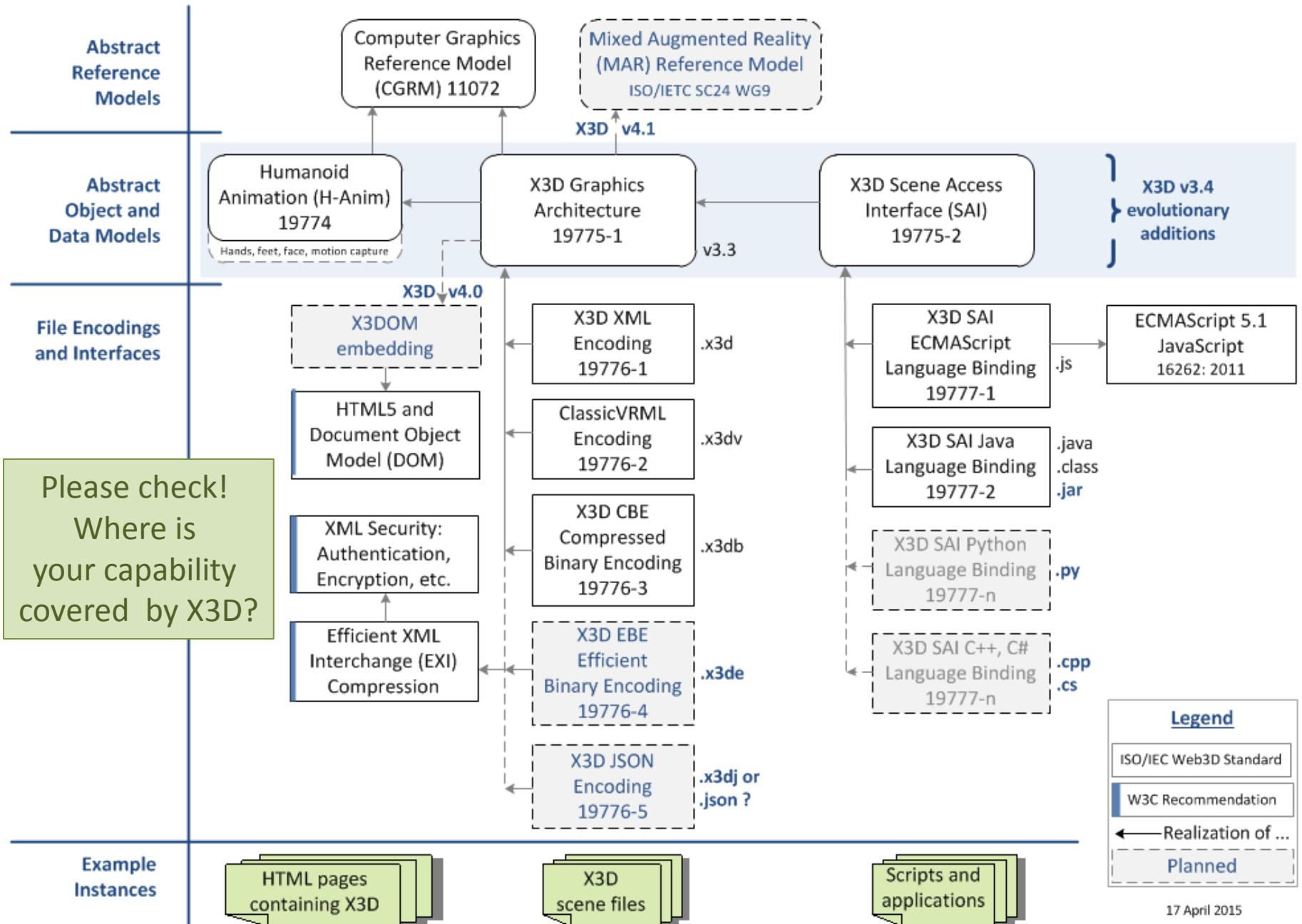
Consistency with diversity
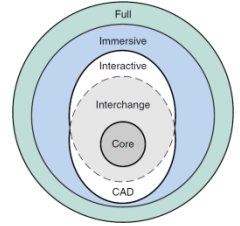
- Single abstract architecture always defines "how X3D works" no matter how it is applied

- Multiple file encodings
  - .x3d means XML for Web, HTML, security, etc.
  - .x3dv Classic VRML (yes, everything still works)
  - *new:* Efficient Binary for small size, streaming
  - *new:* JSON JavaScript Object Notation

- Multiple APIs for software coders
  - JavaScript, Java, perhaps others will be added

Onion diagram: profiles + components

X3D Graphics Standards: Specification Relationships

Abstract Reference Models

- Computer Graphics Reference Model (CGRM) 11072
- Mixed Augmented Reality (MAR) Reference Model — ISO/IETC SC24 WG9

X3D v4.1

Abstract Object and Data Models

- Humanoid Animation (H-Anim) 19774 — *Hands, feet, face, motion capture*
- X3D Graphics Architecture 19775-1
- X3D Scene Access Interface (SAI) 19775-2

X3D v3.4 evolutionary additions

v3.3

File Encodings and Interfaces

X3D v4.0

- X3DOM embedding
- HTML5 and Document Object Model (DOM)
- XML Security: Authentication, Encryption, etc.
- Efficient XML Interchange (EXI) Compression

- X3D XML Encoding 19776-1 — .x3d
- ClassicVRML Encoding 19776-2 — .x3dv
- X3D CBE Compressed Binary Encoding 19776-3 — .x3db
- X3D EBE Efficient Binary Encoding 19776-4 — .x3de
- X3D JSON Encoding 19776-5 — .x3dj or .json ?

- X3D SAI ECMAScript Language Binding 19777-1 — .js → ECMAScript 5.1 JavaScript 16262: 2011
- X3D SAI Java Language Binding 19777-2 — .java .class .jar
- X3D SAI Python Language Binding 19777-n — .py
- X3D SAI C++, C# Language Binding 19777-n — .cpp .cs

> Please check! Where is your capability covered by X3D?

Example Instances

- HTML pages containing X3D
- X3D scene files
- Scripts and applications

Legend
- ISO/IEC Web3D Standard
- W3C Recommendation
- ← Realization of ...
- Planned

17 April 2015

X3DOM and HTML5

- Embed X3D scenes directly into HTML pages
- x3dom.js player means no plugins needed
  - Huge benefit for reaching end users everywhere
- Open source, active community, great support!
- Maturing rapidly: 61% coverage of full X3D
  - needs 20 nodes for X3D Immersive Profile (VRML)
  - needs 14 nodes for suggested HTML Profile
  - Web authors can then publish with full confidence
  - Doable by December 2015? We shall see…

Efficient Binary Encoding (EBE)

- SRC: Shape Resource Container
  - Compressed geometry, streamability
  - Also usable in other encodings
- EXI: Efficient XML Interchange
  - Compressed XML, W3C standard, many codebases
  - Compatible with XML Security: XML Encryption and XML Digital Signature (authentication)
- "Best of both worlds" meets goal requirements, improves upon existing Compressed Binary X3D

JSON: JavaScript Object Notation

- Data structures using JavaScript syntax
- Goal: simple loading of X3D scene graphs within other data-driven visualization libraries
  - Three.js, d3.js, X3DOM, etc. etc. etc. etc.
- Experimental version available for testing
  - Already applied to 3800+ example X3D scenes
  - X3dToJson stylesheet bundled in X3D-Edit
  - Discussing loaders, syntax on X3D Public mail list
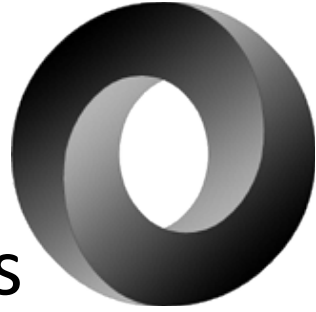
Resources and Hints

- [X3D Resources](#) list and summarize numerous assets that are available to support both X3D Graphics and its compatible predecessor, Virtual Reality Modeling Language (VRML97).

- [X3D Scene Authoring Hints](#) provide collection of style guidelines, authoring tips and best practices to improve the quality, consistency and maintainability of X3D scenes.

X3D Working Groups

- Develop solutions for specific technical challenges and opportunities
- All experience levels welcome!
- Proven process for success, perennial progress
- Open activity + member-benefit activity
- Web3D Consortium provides immense value
- http://www.web3d.org/working-groups

CAD: Computer Aided Design

- Best practices to support Web applications by exporting Computer-Aided Design (CAD) models into X3D

- Geometry and product structure

- Metadata: origins, intellectual property rights (IPR) and licensing

- Now exploring Additive Manufacturing (AM) and 3D Printing and 3D Scanning techniques
  - bits becoming atoms and vice versa

Cultural and Natural Heritage

- Exploring generation, handling, and display of digital 3D data for cultural & natural heritage
- Exemplars, best practices and interoperability
- Archival storage, re-use and adaptation
- Interests are strong and will continue to grow

Geospatial: steady progress

- Partnership with Open Geospatial Consortium (OGC) included City Modeling Competition
- Finish X3DOM support (80% complete)
- Add "slippy map" node for easy mashups
- Keep building server-side example projects
  - STOQS Spatio-Temporal Oceanographic Query System by MBARI
  - 3D Blacksburg by Virginia Tech (VT)
- Considering server installers and linkages
  - Distributed Interactive Simulation (DIS) streaming

H-Anim Human Animation

- Lots of work
  - Medically correct level of detail, composable parts
  - Hands and feet, poses, facial animation
  - Motion-capture streaming, matching BVH
  - Confirming, improving support for skin meshes
- Corresponding standards
  - ISO/IEC 19774, H-Anim functional standard
  - ISO/IEC 19775, X3D Graphics abstract specification

Medical and volume visualization

- Interoperable standards for representing of human anatomy, variety of imaging modalities
- Volume visualization techniques are mature and repeatably implemented
- DICOM partnership for volvis, other topics

Mixed Augmented Reality (MAR)

- Participating in ISO standardization effort that is defining an MAR Reference Model implementable through varied technologies

- Tracking X3D evolution to align, implement

- Slideset and initial ISO Committee Draft (CD) available

New nodes, new possibilities: X3D v3.4

- PTM: projective texture mapping
- Advanced material and lighting models
- Annotations and metadata conventions
- Many others listed on [X3D V3.4 website wiki](#)

- Pragmatic process to steadily extend X3D
  - Functional description written for specification
  - 2 or more implementations (emphasis X3DOM)
  - Example scenes to demonstrate interoperability

X3D Projects Wish List

- Do you want to get involved? Here are many interesting projects with potential for broad impact that are looking for energetic developers.

- Motivated individuals with software development skills and Web authoring experience are welcome to start, or help develop, any of these candidate projects. Diverse talents are needed - maybe you too? There are some serious opportunities here!

- http://www.web3d.org/projects/wish-list

X3D Examples

- [X3D Examples Archives](#) demonstrate how X3D nodes and scenes work. Thousands of scenes are provided in all X3D encodings. Browse individually online or download .zip archives.

- Current total: **3864 scenes** in multiple formats .wrl .x3d .x3dv .x3db x3dom.xhtml .json .html

Quick Links	X3D for Web Authors	X3D for Advanced Modeling	Basic	Conformance Nist	Vrml2.0 Sourcebook	Savage	SavageDefense
Overview, references:	README	README	README	README	README	README	README
Archive examples:	Online	Online	Online	Online	Online	Online	Online
Local examples:	Local	Local	Local	Local	Local	Local	Local
3864 total X3D scenes:	258	63	767	732	415	1234	395
Catalog metadata XML:	Content catalog	Content catalog	Content catalog	Content catalog	Content catalog	Content catalog	Content catalog
Ant build scripts:	build.xml	build.xml	build.xml	build.xml	build.xml	build.xml	build.xml
Build console logs:	build.out.txt	build.out.txt	build.out.txt	build.out.txt	build.out.txt	build.out.txt	build.out.txt
Full download:	zip	.zip	.zip	.zip	.zip	.zip	.zip
Additional details:	see below	see below	see below	see below	see below	see below	see below

X3D Quality Assurance (QA)

- Content is king!
- Ensure correctness through a huge number of tests
- [X3D Resources](#) describes all tests in detail
  - [XML header and DOCTYPE](#) checking for correct document headers
  - [Well-formed XML](#) checking
  - [X3D Specifications: DOCTYPE and Schema Validation](#) checking for valid X3D nodes, fields and values
  - [X3D Schematron](#) rule checking to verify semantic correctness and detect internal-consistency problems
  - [X3D to ClassicVRML conversion](#) checks a variety of legal X3D constructs
  - [Regular expression checking](#) for malformed floating-point numbers and excess leading zeros
  - [X3D to XHTML conversion](#) pretty-print listing to check online URL links, document ROUTE connections, and provide node tooltips
- *New:* [X3D Tidy](#) helps authors automatically correct fixable errors

- 9 separate test suites, all bundled together
  https://savage.nps.edu/X3dValidator
- Also available within X3D-Edit authoring tool

X3D-Edit

- Free open-source editor using Java, Netbeans
- Implements 85% of X3D specification
- Integrates Xj3D player, launches all others
- Monthly updates
- Development and testing of new X3D features
  - X3D Validation: 9 separate Quality Assurance tests
  - X3D Tidy: finds and fixes common scene "gotchas"
  - New release: regularizing workflow

New: author workflow in X3D-Edit

New Documents

Author Workflow
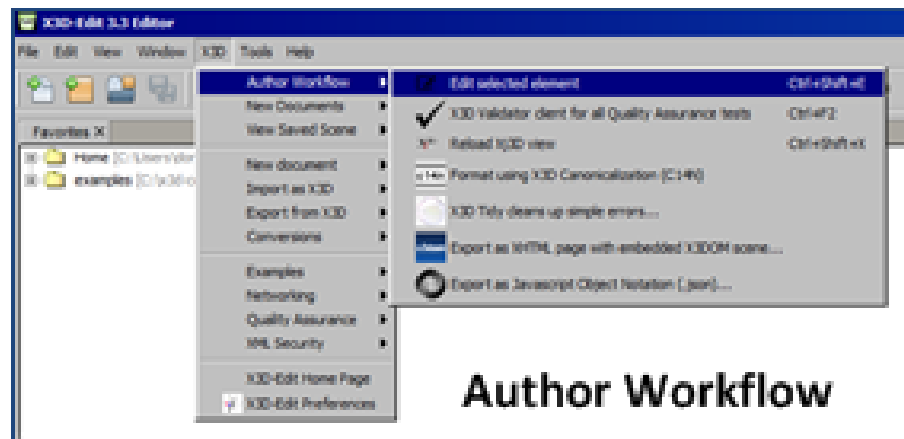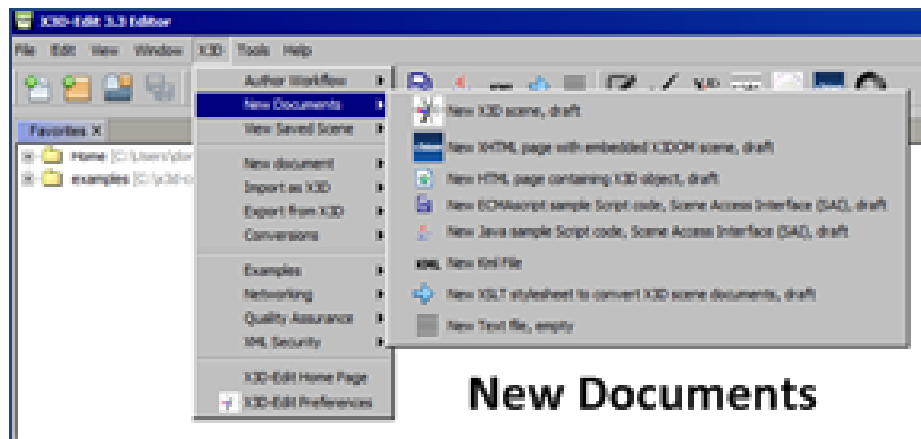
create new file document

XML X3DOM X3D
.x3d .xhtml .html .js .java .kml .xslt .txt

Edit Element
Ctrl+Shift+E

Xj3D Viewer
Ctrl+Shift+X

X3D-Tidy cleanup

JavaScript Object Notation

.x3d .xhtml
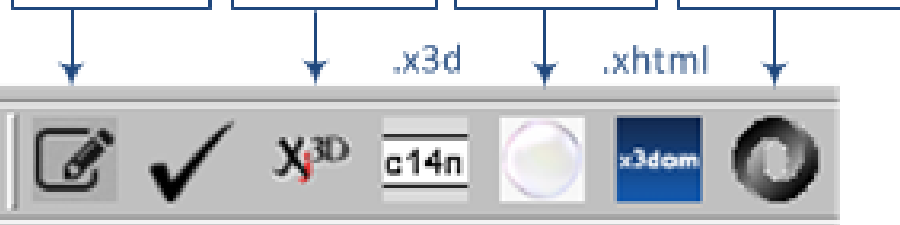
X3D Validator
Ctrl+Shift+F2

X3D C14N Canonicalization formatting

X3DOM .xhtml export

.x3d .json

X3D·Edit 3.3

- [Xj3D](#) is an open-source Java viewer and application codebase for X3D graphics scenes.

- Multiple format-conversion, filter capabilities

- Numerous tool usages including offscreen image rendering of example scene viewpoints

- Bundled in X3D-Edit, AUV Workbench tools

- 68% coverage of X3D v3.3 Specification

CAD and 3D Printing

aka Additive Manufacturing (AM)

aka Digital Thread (DT)

Web based conversion of STEP files --> X3D/X3DOM

Product: SETCO-B035-B-2-8-015
Part file: SETCO Cutting Tool
Download as X3D File
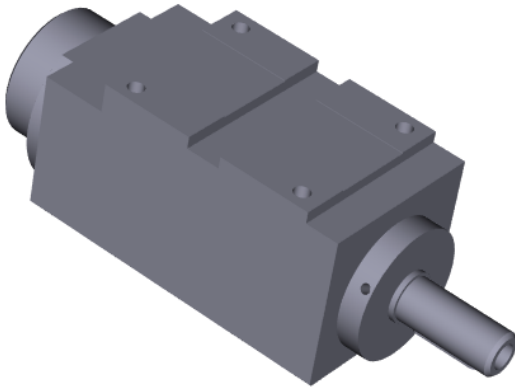
SETCO-B035-B-2-8-015
    SETCO-B035-B-2-8-015_logo_plate_B035
    SETCO-B035-B-2-8-015_spindle_body_B035
    SETCO-B035-B-2-8-015_spindle_shaft_B035B

X3DOM Navigation help

http://spri.kshell.com/siggraph-demo

This webpage displays an X3DOM model generated by direct conversion of a STEP (ISO 10303) file uploaded to a web application at http://spri.kshell.com. The assembly structure defined in the STEP file was automatically mapped into the part-assembly nodes defined in the X3D CADGeometry component, and is used to generate a Javascript-based assembly structure viewer on the page.

The link/QR code above may be used to quickly load the page on mobile device. X3DOM is supported on many recent iOS and Android mobile devices.

contact: Vince Marchetti

vmarchetti@kshell.com

3D printing from STL model

- Now starting to collect test cases, X3D STL etc.
  - [X3D Basic Examples Archive, Additive Manufacturing](#)
  - "Work has begun on creating X3D Additive Manufacturing (AM) example models suitable for 3D printing. Since many Additive Manufacturing designs are produced by Computer Aided Design (CAD) engineering tools, you can also look at the [CAD examples](#) and the [X3D CAD Working Group](#)."

Example: cleat clamp

- Printable cleat from MakerBot ThingiVerse, http://www.thingiverse.com/thing:143653
- Created by Moritz the Maker (user mx5), http://www.thingiverse.com/mx5
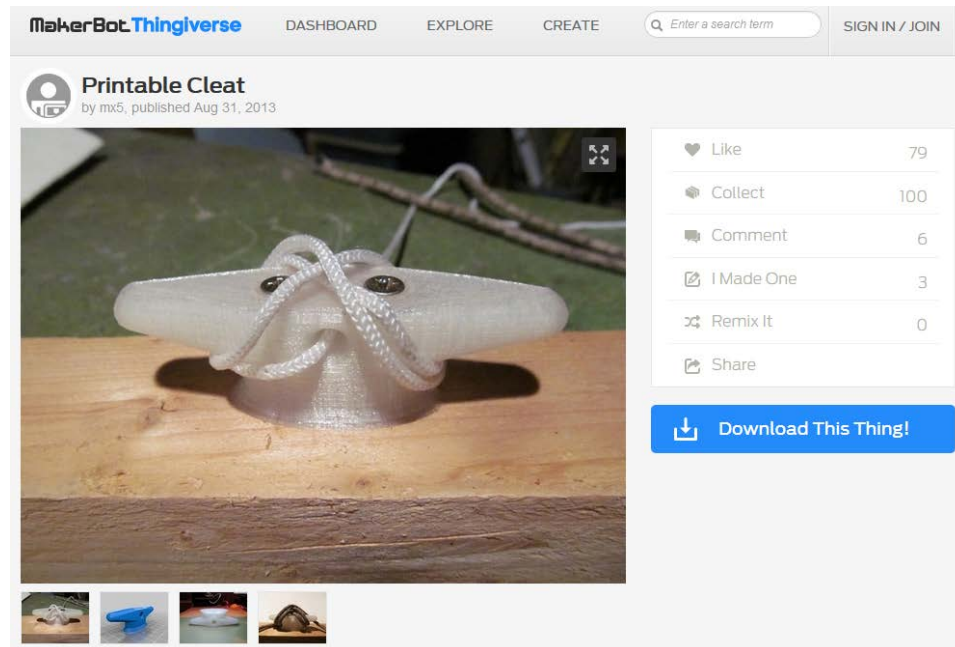
Comparison of STL and SCAD formats

cleat_clamp.stl

```
solid OpenSCAD_Model
  facet normal -0.985784 0.0620661 -0.156132
    outer loop
      vertex -44.6674 0 -1.12054
      vertex -44.7852 0 -0.376604
      vertex -44.7263 0.935713 -0.376604
    endloop
  endfacet
  facet normal -0.998024 0.0628368 0
    outer loop
      vertex -44.7852 0 -0.376604
      vertex -44.7852 0 0.376604
      vertex -44.7263 0.935713 -0.376604
    endloop
  endfacet
  facet normal -0.998024 0.0628368 0
    outer loop
      vertex -44.7263 0.935713 -0.376604
      vertex -44.7852 0 0.376604
      vertex -44.7263 0.935713 0.376604
    endloop
  endfacet

}
```

[… etc.]

cleat_clamp.scad
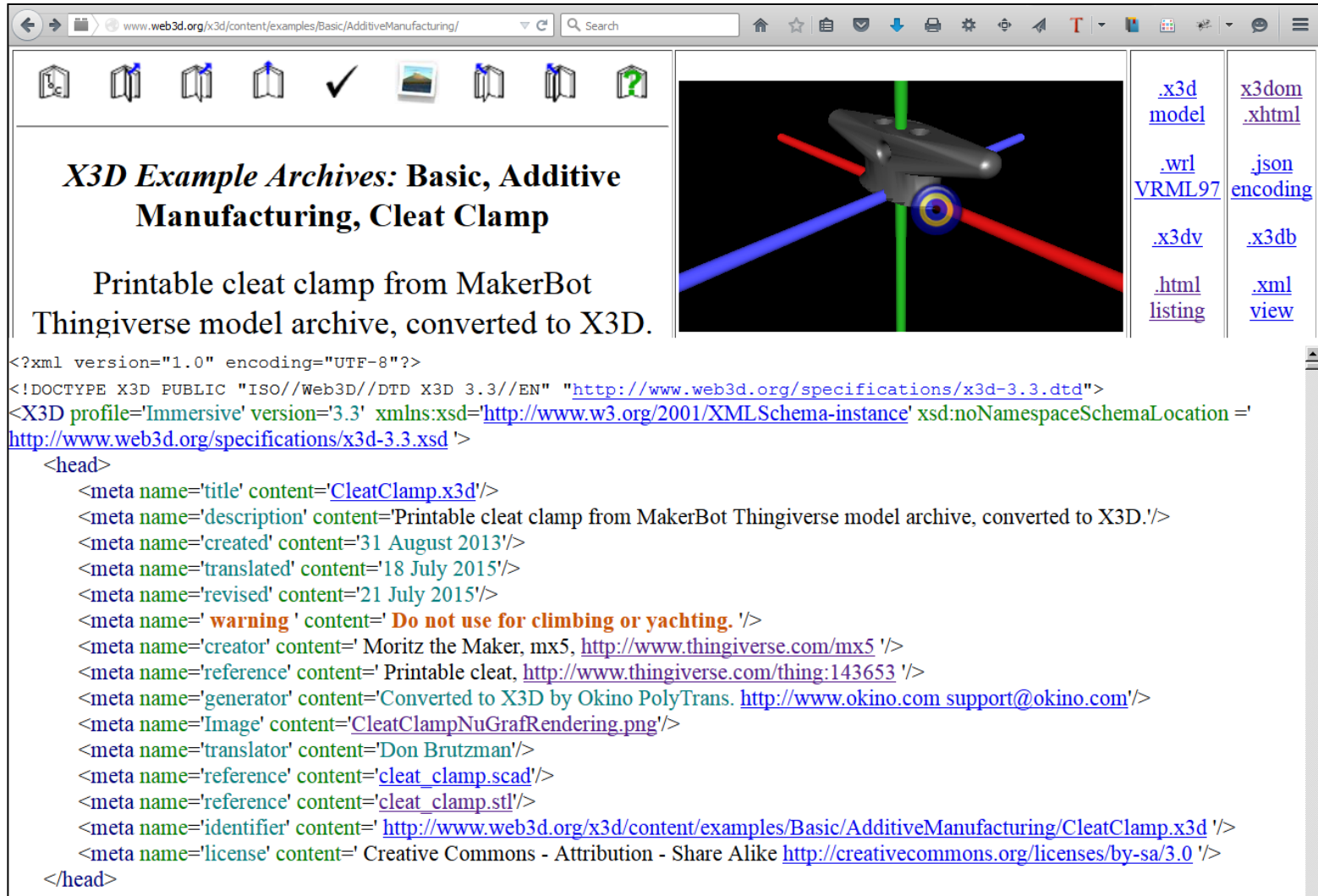
```
module hole( l )
{
difference()
{
rotate( [ 90, 0, 0 ] )
cylinder( r = 6, h = l*1.5, center = true );

for ( a = [ -1, +1 ] )
   translate( [ 0, a*l/2, 0 ] ) rotate( [ 90,
0, 0 ] )
   rotate_extrude()
   translate( [ 6, 0 ] )
   circle( r = 3 );

   rotate( [ 90, 0, 0 ] )
  difference()
   {
      cylinder( r = 8, h = l, center = true
);
      cylinder( r = 3, h = l*2, center =
true );
   }
}
}
```

[… etc.]

X3D includes materials, metadata, links

Cleat clamp conversion Meshlab
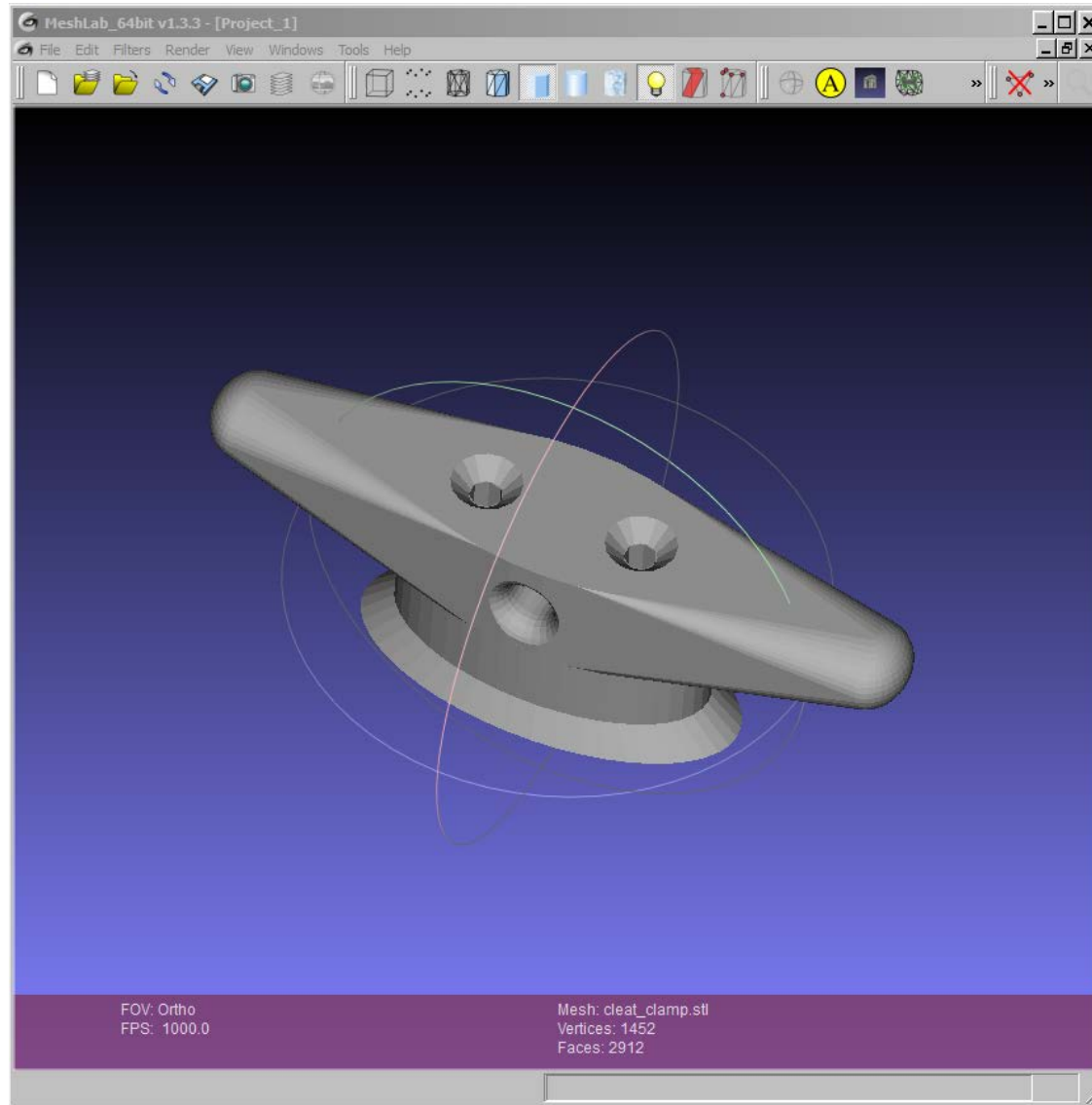
Cleat clamp conversion Okino NuGraf
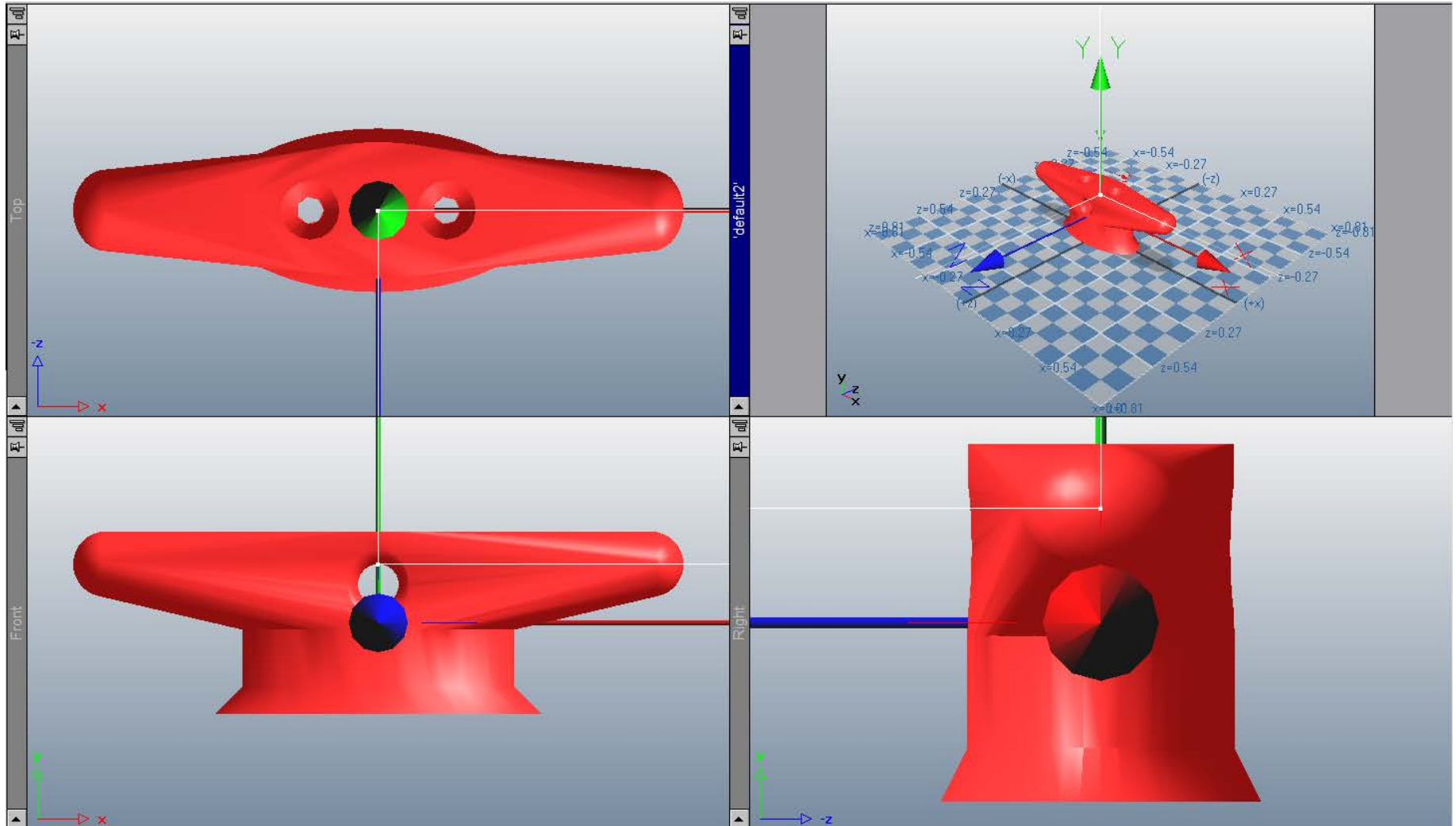
# Model printed using STL mesh

Embed CAD, AM metadata using X3D

- <meta name='**warning**' content='**Do not use for climbing or yachting.**'/>
- Mesh formats have no place for metadata
- It is crucial to know all about it
  - Origin, author, tool, provenance
  - License terms, intellectual property rights (IPR)
  - Links to original design, replacement parts, inventory, maintenance procedures, etc. etc.
- X3D provides all of these capabilities
  - with XML digital signature, encryption, compression

Printing more complicated models…
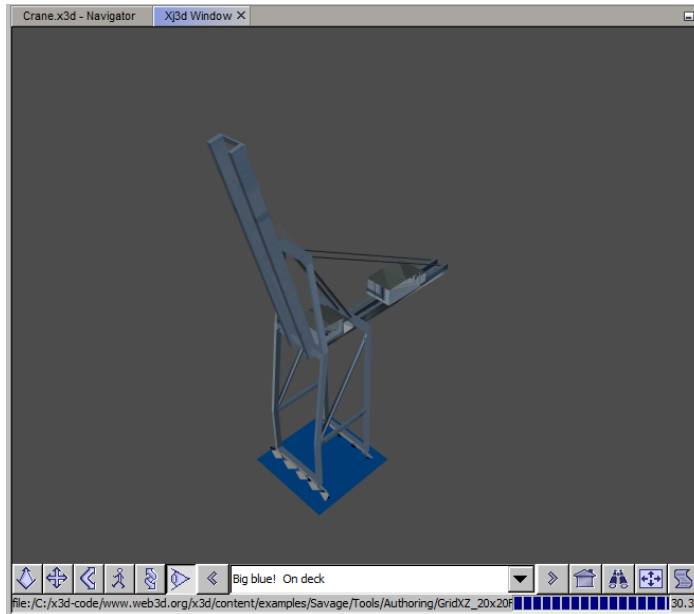
Big naval crane…

… Stonehenge effect?
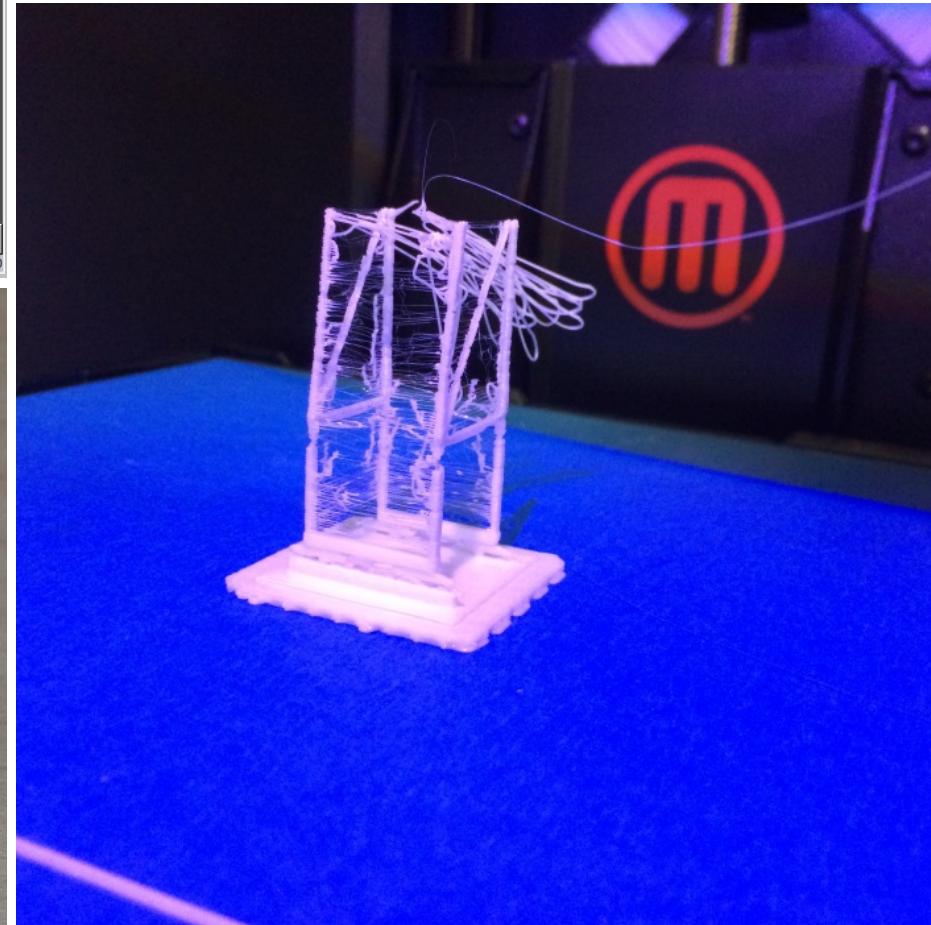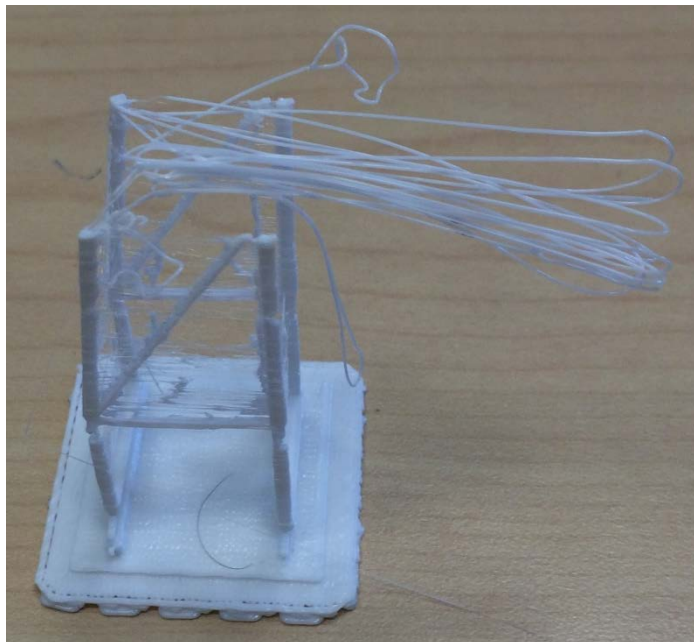
Big difference: units in feet vice inches

This is Spinal Tap! Playing at Stonehenge?!!

Big plans for X3D this year

- Keep charging! Many good things happening.
- Many opportunities to contribute in 2015
  - Weekly teleconferences
  - Public and working-group mail lists
  - Deciding when to merge evolutionary X3D v3.4 nodes with next-generation X3D v4.0
  - December 2015 is goal for several draft specifications
- Regularize, improve our group processes
  - Tracking and resolving specification issues
  - Put specification documents under version control

Our plans continue next year, 2016

- Alignment with Mixed and Augmented Reality (MAR) Reference Model

- Humanoid Animation (H-Anim) improvements

- Consider applying CAD-export design patterns to unlock Building Information Modeling (BIM)

- Web3D Conference 2016 colocated SIGGRAPH in Anaheim, California

But wait, there's (always) more!

- What are you interested in doing with X3D?

- Our community is always open to new ideas and new people who want to join this effort!

- Please <u>let us know what you think</u>

- Happy to discuss, demo on show floor **Booth 1018**

- Have fun with X3D!

Contact

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