Web3D Design Printing and Scanning WG

formerly CAD Working Group

Activities in support of 3D Visualization for CAX activities

For presentation to SC 4 WG 16 Nov 2018

3D Visualization always involves a dynamic interactive scenegraph with elements of

- 3D Geometry
- Material Appearance (colors, visual properties)
- Navigation and Perspective
- Interactivity

Our 3D visualizations:

- Always refer to external objects, visual appearance is not their primary or sole purpose
- Exist in the world of copyright, licenses, proprietary and intellectual rights, security and authorization needs, version control, traceability,….

Metadata and Annotation

There is a need to clarify terminology and usage. DPS WG recognizes 3 distinct but related concepts.

2 are called metadata!

1. Metadata about the “document” , author, owner, version
2. Metadata about the elements of the scenegraph

… and 1 is called, at least by a CoChair

3. Annotation : A visual feature presenting extended information about some element of the scenegraph. Examples are labels, dimensions, callouts. *Related to term “helpers” from definitions prepared by STEP Geometry Services*

Definitions

Add presentation

Existing STEP or ISO definition
Wikipedia source
Defined by 23301

constructive solid geometry (CSG)
type of geometric modelling in which a solid is defined as the result of a sequence of regularised Boolean operations operating on solid models
Source: ISO 10303-42

boundary representation solid model; B-rep
type of geometric model in which the size and shape of a solid is defined in terms of the faces, edges and vertices which make up its boundary
Source: ISO 10303-42
Provide moredetails on the types of breps

original geometry
Geometry as defined by a modeller (human being) in a CAD tool using CAD authoring functions based on mathematical constructs The original geometry is the first initial geometry construction which holds the design intent.
Note: this is also often **referred to as « native CAD »**. however a native CAD is in fact **referring** to the native CAD **kernel and CAD** format of the CAD tool manipulating the geometry. It therefore may also be any geometry derived from another CAD format).

native CAD
format of a CAD kernel

Scanned geometry
??

exact geometry, exact model
Exact mathematical description of the geometry, including the specific algorithms, without any approximation on any of the mathematical definition.
Discussion : Term exist in P42 but not defined (geometric_link: a corresponding exact model of the solid)
what is the role of the computational algorithm in procedural geometry ? can a procedural geometry be defined as exact
ABF: yes, but we shall be aware that 2 different implementations of the same exact definition may produce 2 different geometries. So an exact geometry interpreted or derived from an original geometry may differ from the original.

procedural model; generative model; history-based model
model described in terms of the operation of a sequence of procedures (which may include the solution of constraint sets), as opposed to an explicit or evaluated model which captures the end result of applying those procedures
NOTE Although procedural models are outside the scope of this part of ISO 10303, they are defined here to make an important distinction between two fundamentally different modelling approaches. The present resource is intended to be compatible with ISO 10303-55, which provides representations for the exchange of procedurally defined models.
Source: ISO 10303-108

explicit model; declarative model; evaluated model
model whose full details are immediately available without the need for any form of calculation
NOTE In the case of product shape models, an explicit (or *evaluated*) shape model is a fully detailed model of the boundary representation or some related type, as defined in ISO 10303-42. More specifically, an explicit model is a model that is not of the procedural or hybrid type, which may contain little or no explicit geometry.
Source: ISO 10303-108

hybrid model
model combining the use of both explicit and procedural representation methods
Source: ISO 10303-108

derived geometry
Representation Change, no inteded shape change: Geometric representation in a format derived from another representation (original, exact or derived) (do not want to use original because we can derive from a derived)
The derivation is a transformation of the geometry which may include another representation method, another format, level of detail simplification and approximations
Ex: a CSG « solid block » can be derived to a « 6 faces Brep »
? Need to provide more examples ?

modified geometry
change the shape, intentional simplification , removal of data ? addition data ?

product and manufacturing information(PMI)
non-geometric attributes in 3D CAD and Collaborative Product Development systems necessary for manufacturing product components and assemblies
NOTE PMI may include geometric dimensions and tolerances, symbols, notes, surface finish, and material specifications.

Source: ISO 10303-62

helpers
Supplemental geometry used to construct or document the geometric model

tessellated geometry
geometry composed of a large number of planar tiles, usually of triangular shape
NOTE Tessellated geometry is frequently used as an approximation to the exact shape of an object.
Source: ISO 10303-42

3D Visualization
visual presentation or
three dimensio
information or
capture of the underst
with users and someti
the data visualized in
Source: ISO 14306:20

- *Is object a good term , can we replace the second « object » by « subject »*
- *Feeling of the depth for the viewer*
- *3D visualization might include interactive capabilities*
- *The dynamic behaviour of objects (movements, decomposition) shoul dbe taken into account)*

display list
series of graphics commands that define an output image

stream
Wikipedia: In computer science, a stream is a sequence of data elements made available over time. A stream can be thought of as items on a conveyor belt being processed one at a time rather than in large batches.
With this definition: any file is a stream of bytes (unix)
Wikipedia : Streaming media is multimedia that is constantly received by and presented to an end-user while being delivered by a provider. The verb "to stream" refers to the process of delivering or obtaining media in this manner;[clarification needed] the term refers to the delivery method of the medium, rather than the medium itself, and is an alternative to file downloading, a process in which the end-user obtains the entire file for the content before watching or listening to it.

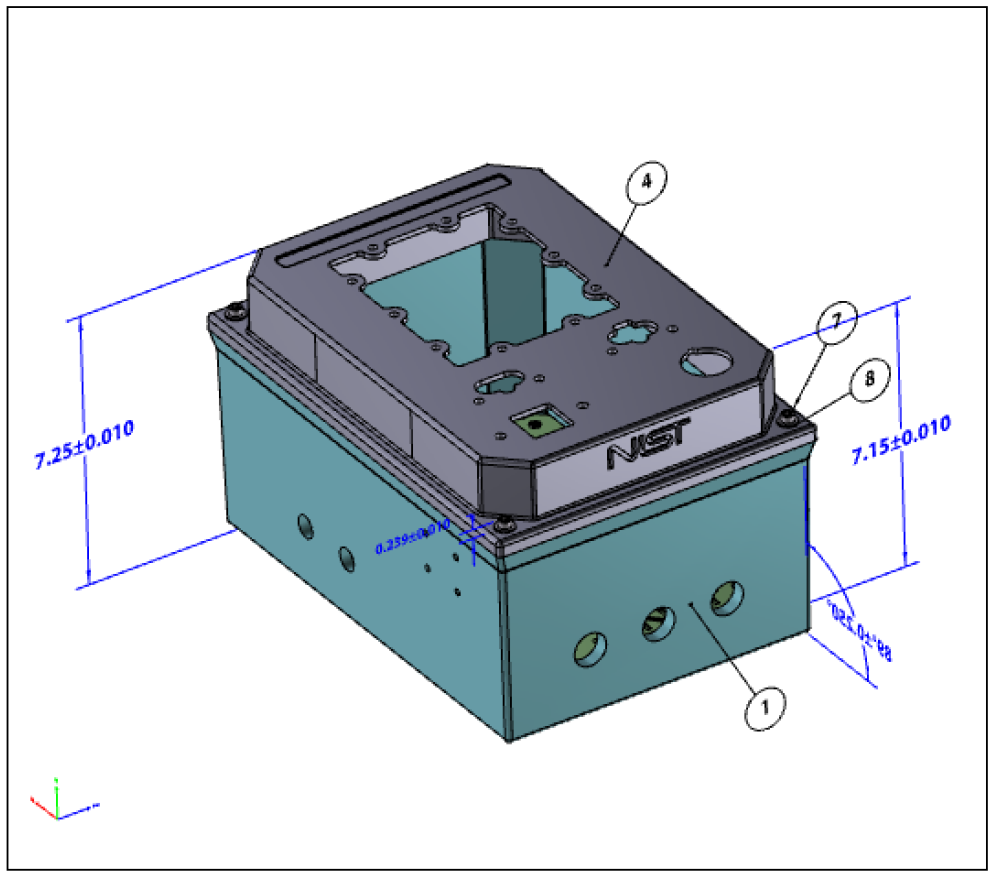
Voxels
not in STEP, seems to be out of scope of this work for version 1

Point Cloud
out of scope of this work for version 1

Annotations Example 1

PDF Document with 3D content

Part No: NIST-7-8-9-10 asm
DRW. NO: NIST-7-8-9-10 DRW
Revision: B4
Title: NIST Container Assembly
Date: 2/28/2017



Bill Of Materials

ITEM NO.	PART NUMBER	MATERIAL	WEIGHT (LB)	QTY.
1	nist_ftc_07_asme1	ABS	3.8822	1
2	nist_ftc_09_asme1	A-Glass Fiber	0.734	1
3	nist_ftc_10_asme1	1060 Alloy	1.121	1
4	nist_ftc_08_asme1	ABS	1.1325	1
5	CR-BHMS	Carbon Steel	NA	4
6	CR-FHM1	Carbon Steel	NA	4
7	HX-SHCS	Carbon Steel	NA	4
8	Narrow FW	Carbon Steel	NA	4

Design Check

	Name	Signature	Date
Drawn By	CPI5	CP	2/21/17
Checked By	OWU	OW	2/23/17
Eng. Approval	FFP	FP	2/25/17

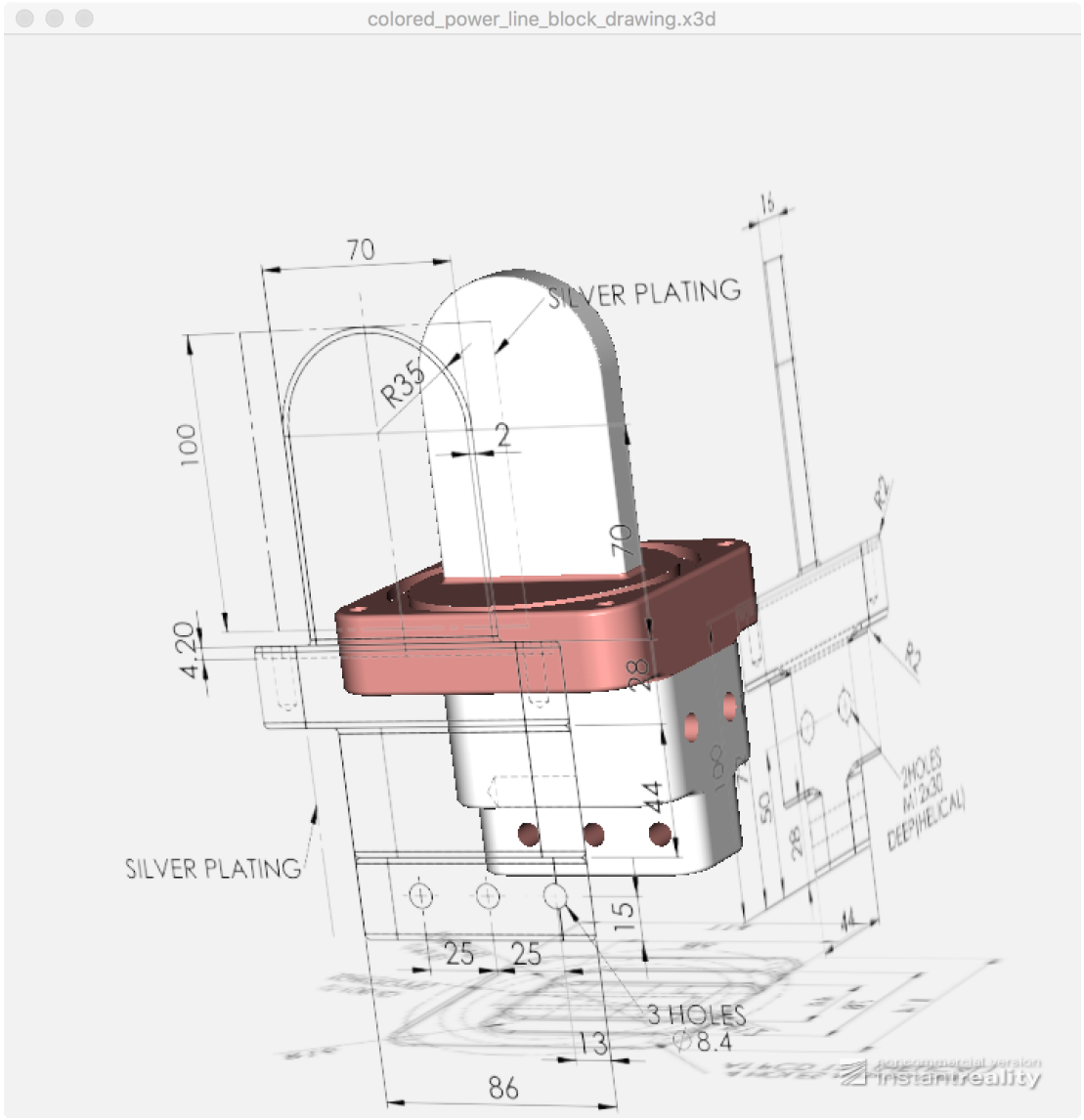
Assembly Notes

1. BILL OF MATERIALS ASSEMBLY ORDER IS AS FOLLOWS: 1, 2, 6, 3, 5, 4, 8, 7

2.DIRECTLY-TOLERANCED DIMENSIONS AND BASIC DIMENSIONS DEFINED ON THE DRAWING TAKE PRECEDENCE OVER DIMENSIONAL DATA DEFINED BY THE MODEL. OBTAIN ALL OTHER DIMENSIONAL DATA FROM THE MODEL. THE MODEL REPRESENTS BASIC DIMENSIONAL DATA UNLESS OTHERWISE SPECIFIED.

3.APPLICABLE STANDARDS:

Annotations Example 2



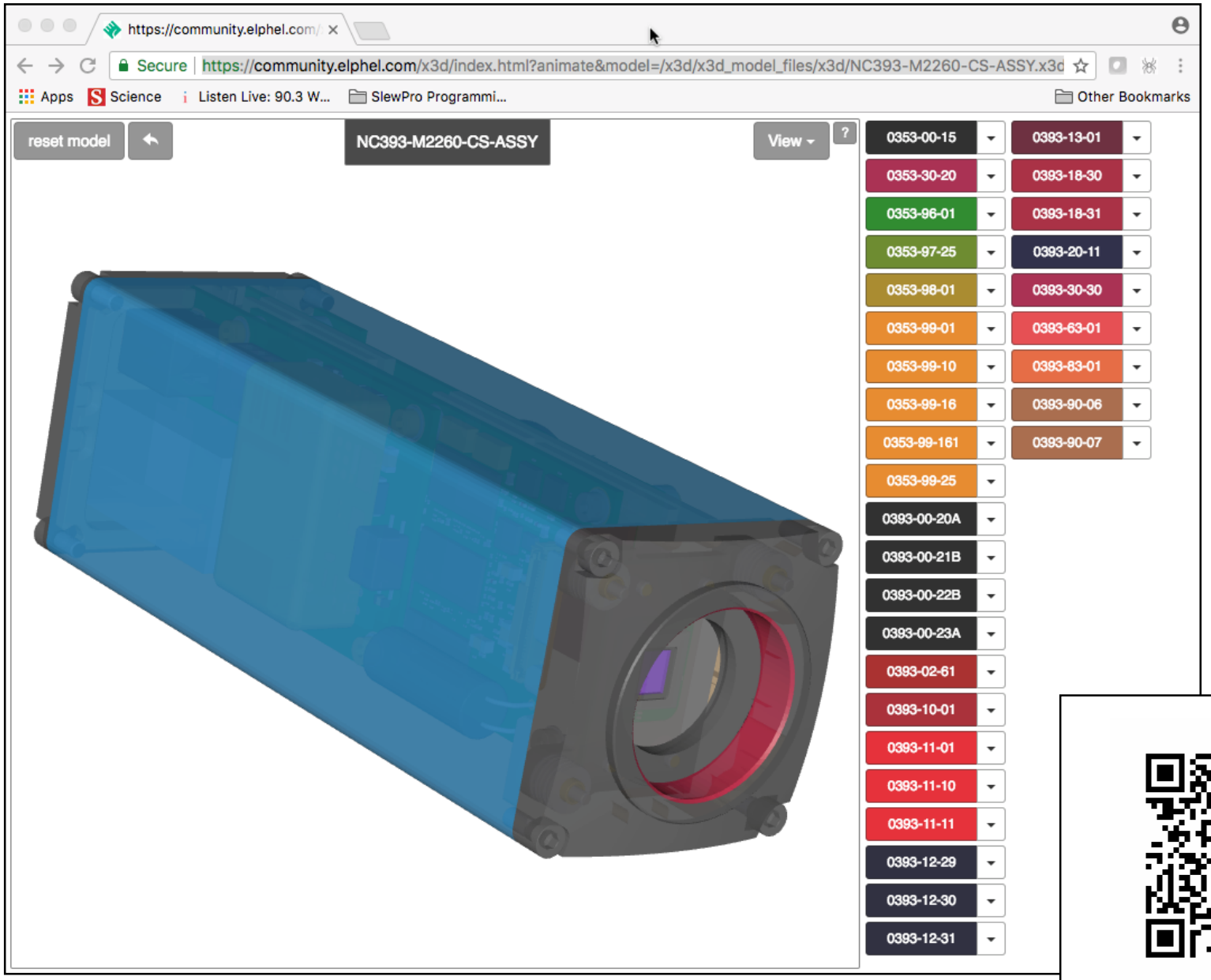
Rendered in X3D
Source was STEP solid model and PNG images for 2D drawings.

Viewable in desktop viewers and on web through WebGL based viewers.

http://kshell.com/pages/step_with_color/index_x_ite.html

http://kshell.com/pages/step_with_color/index_x3dom.html

Annotations Example 3 : Labels and Links



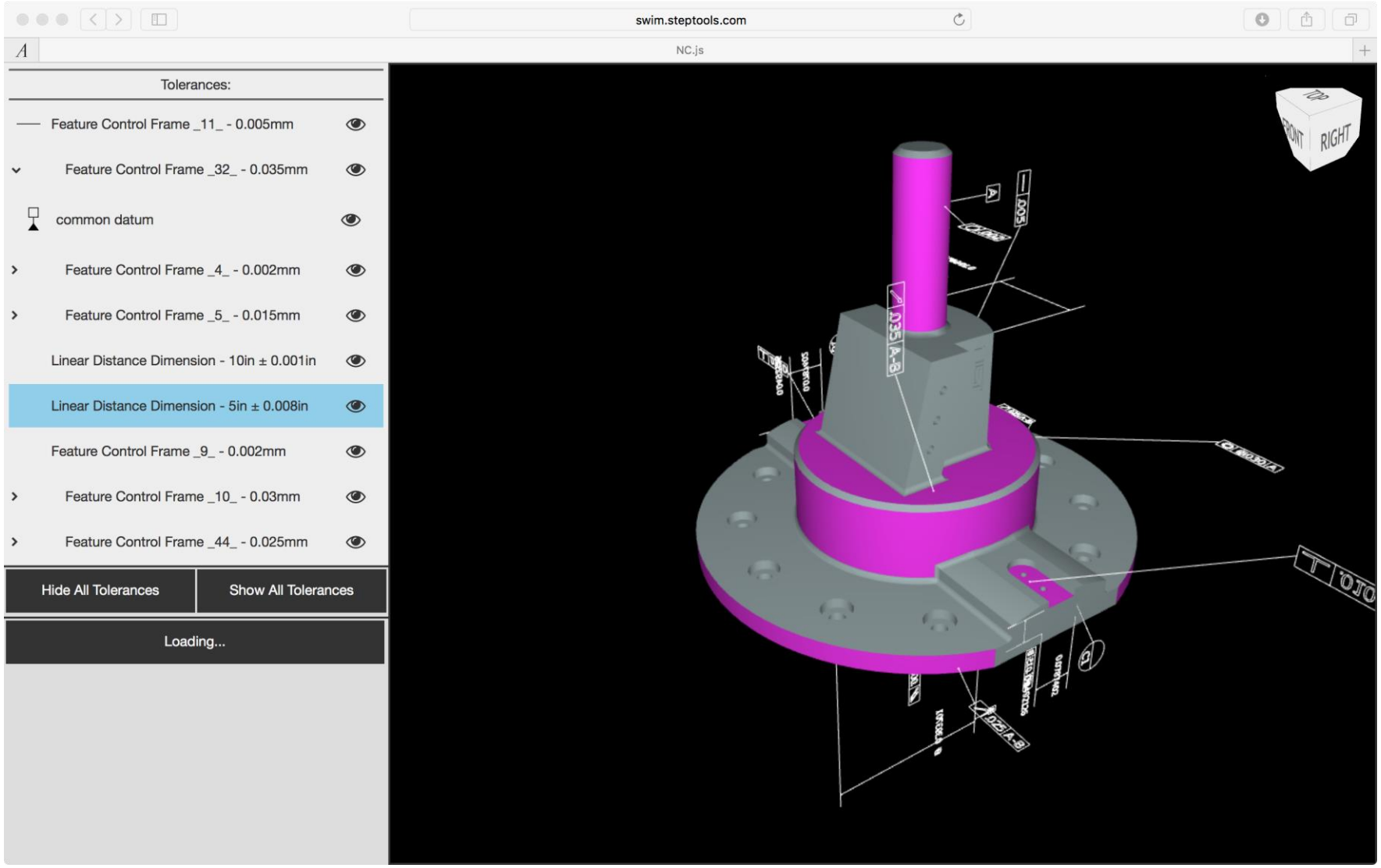
Publish CAD Data on Web for Customers and Suppliers

Elphel Inc.
Salt Lake City, Utah, USA
https://www.elphel.com

Leverage open source software, X3D/X3DOM, and commercial CAD design application to publish CAD assembly models on any web browser.

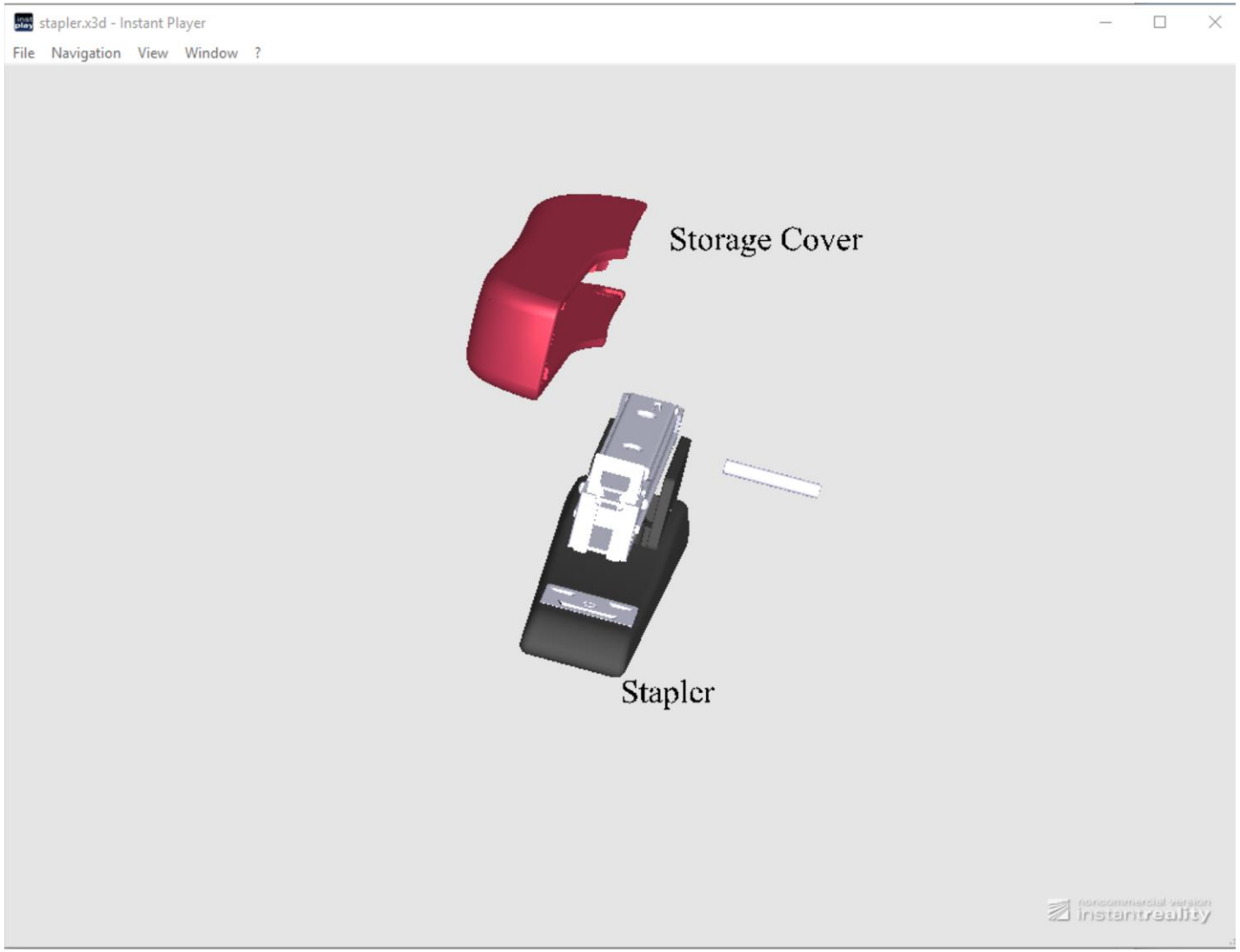
Link: NC393-M2260-CS-ASSY

Annotations Example 4



STEPTool SWIM
[server NC.js]

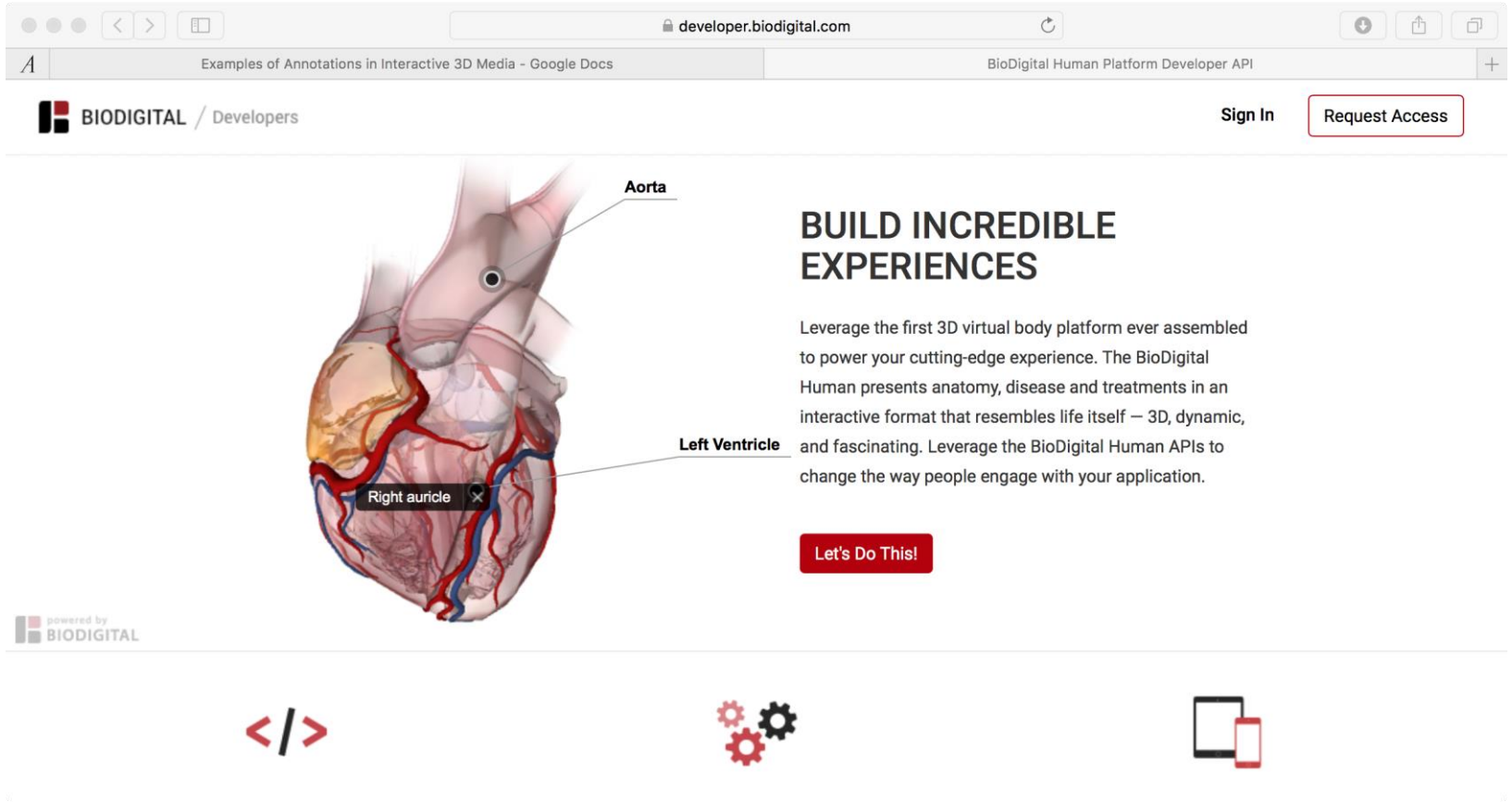
Annotations Example 5



Dynamic labels

X3D using Billboard node

Annotations Example 6



[BioDigital]

2. Metadata

This usage of metadata refers to information specifically applicable to an element of the scenegraph.

It is not by definition visualized but it may be associated with an annotation.
(*recall WG-15 demo, distinction between presentation and semantic GD&T in a STEP export*)

Metadata as implemented in X3D Standard:

- A Set of Metadata nodes which implement typed key-value pairs
  - Keys are strings, no explicit namespace mechanism
  - Value types are the simple type: string, integer, float, Boolean
- Key-value pairs may be aggregated into MedataSet, allowing definition of records or structures
- Metadata nodes are citizens of the X3D standard, can be accessed by the X3D run-time, not just comments in the X3D file.

Weaknesses of X3D Metadata
Not optimum for semantic web and ontology, where facts are encoded as triples *subject-verb-object*, not key-value pairs.

Metadata example: Harvesting DICOM standard terminology for medical privacy

```
<MetadataSet name="DICOM" reference="http://dicom.nema.org">
  <MetadataString name="Recognizable Visual Features" value='"NO"'>
    <MetadataSet name="tag">
      <MetadataString name="GROUP" value='"0028"'/>
      <MetadataString name="OBJECT" value='"0302"'/>
    </MetadataSet>
  </MetadataString>

  <MetadataString name="Burned In Annotation" value='"NO"'>
    <MetadataSet name="tag">
      <MetadataString name="GROUP" value='"0028"'/>
      <MetadataString name="OBJECT" value='"0301"'/>
    </MetadataSet>
  </MetadataString>
</MetadataSet>
```

Metadata example: Harvesting QIF standard terminology for GD&T (Qpids)

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```
<MetadataSet name="QIF 3.0" reference="http://qifstandard.org">
   <MetadataString name="parallelism" value='"ffd07079-aa8e-4bdb-baa2-d84d63c1a98b"'>
</MetadataSet>
```

Metadata usage: reference back to STEP file

```
<CADAssembly bboxCenter="90.0 75.0 38.0" bboxSize="200.0 150.00 84.0" name="as1">
    <MetadataSet containerField="metadata" name="_collection">
     <MetadataString name=”product_definition_formation" value="#6"/>
     <MetadataSet name="STEP:length_unit">
      <MetadataString name="name" value="&amp;quot;millimetre&amp;quot;"/>
      <MetadataFloat name="conversionFactor" value="0.001"/>
     </MetadataSet>
    </MetadataSet>
    ….
</CADAssembly>
```

1. Metadata

- This usage of metadata refers to information about the visualization model – author, copyright, license, date of modification,
- X3D implements as META statements (<meta> tags in XML encoding)
- X3D does not specify what is included, but Web3D Consortium publishes Authoring Hints based on Dublin Core.