ThreeDO Data Dictionary for 3D Objects at Illinois

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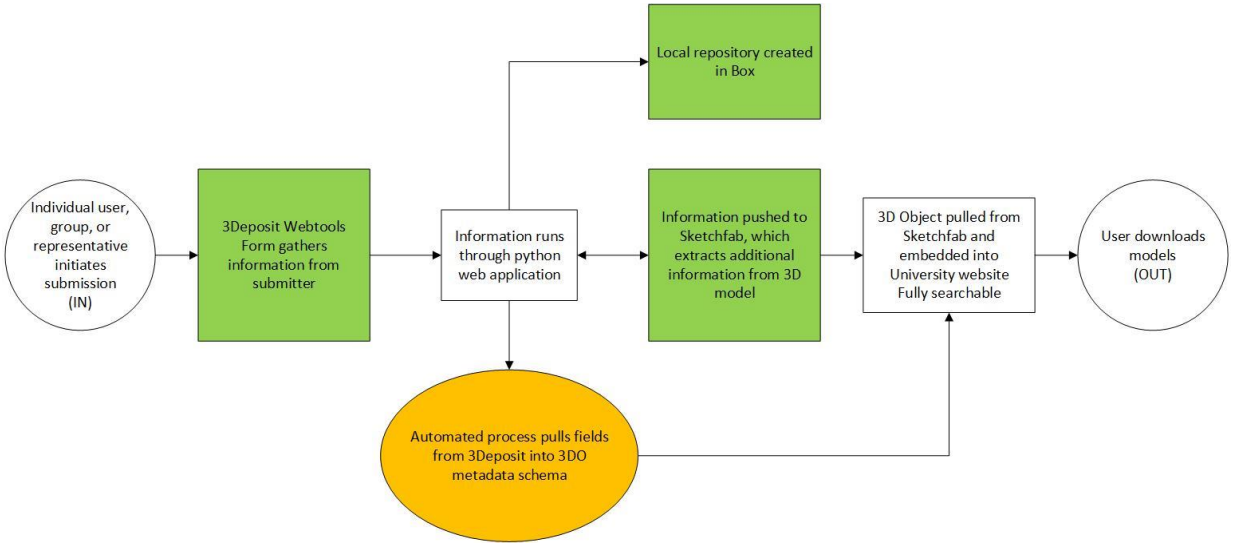
INTRODUCTION

The ThreeDO Data Dictionary is a resource for implementing descriptive metadata for 3D objects. ThreeDO was created to increase searchability of three-dimensional objects created by University-affiliated personnel, which can be interacted with in virtual reality. The Data Dictionary defines descriptive metadata that allows for the searching of 3D objects based on:

- CREATOR: Information about the creator(s) of the object
- FUNDING: Grant information that funded object creation
- COURSE: Course information for which the object was created
- OBJECT: Technical specifications about the object and how it was created
- RIGHTS: Specifications on how each object can be reused

The schema is also meant to describe the technical aspects that will help in future preservation, but it is not specifically a schema for preservation metadata. Rather, the schema has been created to facilitate the searching of 3D objects so that they may be used by members of the University of Illinois community, and the communities of implementers of the schema.

While other schemas, such as COLLADA and X3D, describe 3D objects as well, they do not suit the needs of Illinois. These schemas are meant to provide users with technical information. None of the schemas describing 3D objects that exist at the time of this writing have been finalized. If thorough technical metadata becomes necessary for the University, it is recommended that this schema be amended to suit the needs of the users. The ThreeDO metadata schema will be automatically generated from a user-submitted Webtools form (3Deposit) and from 3D object information pulled from Sketchfab. There is no designated unit or librarian in charge of manually updating the schema, though any librarian from the VR @ Illinois initiative (Undergraduate MediaCommons, Grainger IDEA Lab, Scholarly Commons, CITL) will likely be tasked with quality control and supplementing the schema, at least during the implementation phase.



ThreeDO was built using elements from PREMIS, Dublin Core, PBCore and CDWALite. It uses the schema structure of PREMIS as the foundation, and the idea of 1:1 principal, which specifies that each field describes one object at a time. Type value pairs were also taken from PREMIS, but implemented in a CDWA-like manner, which allows for a more logical relationship linking to authorities within the same tag. Finally, ThreeDO was designed to be intuitive and easy to use. Taking inspiration from PBCore and Dublin Core, each element name was chosen to be human-readable, only essential technical descriptions were included, with the option of expanding fields by integrating additional schemas, and objects were created flexible enough to accommodate many scenarios.

As stated, there are five main elements within the ThreeDO schema. These can be reduced to three main objects: Creator, Funding OR Course, and Object, supplemented by Rights information. This allows for a more accurate representation of depositors and their object and permits searches for both student-created objects in Illinois courses as well as grant funded objects created by faculty. Although funding and course are meant to be interchangeable based on depositor, they can also be included in tandem. The flexibility of ThreeDO also allows for designating an individual creator, multiple creators, or a group. Multiple affiliations allow the University and users to track output based on department. Sub-elements have been created to fill the needs of the University, and are only mandatory if their presence helps provide search filters. Some of these mandatory fields will be incorporated into the 3Deposit webtools form, while all mandatory technical specifications within Object are pre-populated by Sketchfab. This allows for the automation of the metadata creation process, which results in less burden on librarians tasked with metadata oversight.

Within this data dictionary, elements are described as follows:

- Mandatory (M) | Optional (O)
- Repeatable (R) | Non-repeatable (NR)

These descriptors can be found in both the outline, as abbreviations, and within each element table. Some elements contain fields (type, value pairs) that allow for linking with authorities. Although not mandatory, this allows for clearer relationships between the 3D object and external sources. Most of the authorities come from the Course Catalog, PRONOM, and the Library of Congress, although others may apply.

It was expressed to the ThreeDO group that VR @ Illinois would like to incorporate VR scenes, spaces, and 3D video. While these inclusions are out of the scope of the initial ThreeDO schema, the structure does allow for the schema to grow to accommodate them. For instance, *Relationships* can be added to tie together objects that create a scene, or a new container describing video could be added, where sub-elements describing audio and animation could live.

OUTLINE

CREATOR

Semantic unit	1.1. Creator
Semantic components	1.1.1. CreatorName 1.1.2. CreatorStatus 1.1.3. CreatorAffiliation
Definition	A designation that identifies the creator(s) of the 3D object.
Rationale	Each 3D object held within the University must have been created by an individual affiliated with the University.
Data constraint	Container
Repeatability	Repeatable
Obligation	Mandatory
Creation / Maintenance notes	The netID should be used in combination with the individual's first and last name to uniquely identify the creator.
Usage notes	The *Creator* is mandatory whenever a 3D object is submitted. The *Creator* is repeatable if multiple persons worked on a single 3D object.

Semantic unit	1.1.1. CreatorName
Semantic components	None
Definition	A designation that uniquely identifies the *Creator*.
Rationale	Each individual *Creator* must be uniquely identifiable, by both the netID and full name. If the *Creator* is a group, only group name needs to be specified.
Data constraint	Full Name Group Name
Repeatability	Repeatable
Obligation	Mandatory

Creation / Maintenance notes	*Name* can be verified using the University directory. Members of Illinois should be identified primarily with their NetID.
Usage notes	*Name* should be listed *First Middle Last.* *Groups* should be listed by full group names. This element possesses *type* and *value* attributes. *Type* is the name of the identifier (i.e. netID) and *value* would be the Creator's unique identifier (i.e. jsmith45).
Schema sample	<ThreeDO:CreatorName ThreeDO:type="netID" ThreeDO:value="jsmith45">John Smith</ThreeDO:CreatorName>

Semantic unit	1.1.2. CreatorStatus
Semantic components	None
Definition	A designation that classifies the *Creator* based on current status within the University when creating the 3D object.
Rationale	Each 3D object held within the University must have been created by an individual affiliated with the University.
Data constraint	Value should be taken from the controlled vocabulary (see examples).
Examples	Undergraduate student Graduate student Staff Faculty Post-Doctoral Group
Repeatability	Repeatable
Obligation	Mandatory
Creation / Maintenance notes	Status can be verified using the University directory.
Usage notes	Only one value should be recorded for the *CreatorStatus*. If the *Creator* has multiple roles or appointments with the University,

	CreatorStatus should be repeated. If the *Creator* is a group, list all applicable member statuses.
Schema sample	<ThreeDO:CreatorStatus>Graduate student</ThreeDO:CreatorStatus> <ThreeDO:CreatorStatus>Staff</ThreeDO:CreatorStatus>

Semantic unit	1.1.3. CreatorAffiliation
Semantic components	None
Definition	A designation that associates the *Creator* with a department or working group on the Illinois campus.
Rationale	Tracks how many 3d objects were created, by department.
Data constraint	Value should be taken from the course catalog.
Repeatability	Repeatable
Obligation	Mandatory
Creation / Maintenance notes	Status can be verified using the University directory.
Usage notes	Only one value should be recorded for the *CreatorAffiliation*. If the *Creator* has multiple roles or appointments with the University, *CreatorAffiliation* should be repeated.
Schema sample	<ThreeDO:CreatorAffiliation>Engineering</ThreeDO:CreatorAffiliation>

<ThreeDO:Creator>
<ThreeDO:CreatorName ThreeDO:type=”netID” ThreeDO:value=”jsmith45”>John Smith</ThreeDO:CreatorName>
<ThreeDO:CreatorStatus>Graduate student</ThreeDO:CreatorStatus>
<ThreeDO:CreatorStatus>Staff</ThreeDO:CreatorStatus>
<ThreeDO:CreatorAffiliation>Engineering</ThreeDOCreatorAffiliation>
</ThreeDO:Creator>

FUNDING

Semantic unit	1.2. Funding
Semantic Components	1.2.1. FundingAgency 1.2.2. FundingNumber
Definition	A container that provides the information on the funding that sponsored the creation of the *Object.*
Repeatability	Repeatable
Obligation	Optional
Schema sample	<ThreeDO:Funding></ThreeDO:Funding>

Semantic unit	1.2.1. FundingAgency
Semantic components	None
Definition	A designation describes what actions are permissible regarding the object, under the rights statement.
Data constraint	None
Repeatability	Non-Repeatable
Obligation	Mandatory
Schema sample	<ThreeDO:FundingAgency>NIH</ThreeDO:FundingAgency>

Semantic unit	1.2.2. FundingNumber
Semantic components	None
Definition	A designation describes what actions are permissible regarding the object, under the rights statement.
Data constraint	None
Repeatability	Non-Repeatable
Obligation	Mandatory

Schema sample	<ThreeDO:FundingNumber>NIH563400009 </ThreeDO:FundingNumber>

```
<ThreeDO:Funding>
        <ThreeDO:FundingAgency>NIH</ThreeDO:FundingAgency>
        <ThreeDO:FundingNumber>NIH9829000245</ThreeDO:FundingNumber>
</ThreeDO:Funding>
```

COURSE

Semantic unit	1.3. Course
Semantic components	1.3.1. CourseName 1.3.2. CourseInstructor 1.3.3. CourseSemester 1.3.4. CourseYear
Definition	A designation that identifies the University course that the creator(s) of the 3D object created the object for.
Rationale	3D objects held within the University may have been created specifically for course assignments, or be used by instructors as teaching material. The University would like the objects to be searchable by which classes they are affiliated with.
Data constraint	Container
Repeatability	Non-Repeatable
Obligation	Optional
Usage notes	The *Course* is optional as not all objects will be created for/within a course, but highly recommended when the object was created for/within one. *Course* should be repeated if the object is affiliated with multiple courses.

Semantic unit	1.3.1. CourseName
Semantic components	None

Definition	A designation that uniquely identifies the *CourseName.*
Rationale	Identifier values cannot be assumed to be unique across domains; the combination of Type and Value should ensure uniqueness.
Data constraint	Values should be taken from the Course Catalog.
Repeatability	Not repeatable
Obligation	Mandatory
Usage notes	This element possesses *type* and *value* attributes. *Type* is the name of the identifier (i.e. courseID) and *value* is the course abbreviation (i.e. LIS562AO). These values should be taken from the Course Catalog. The *value* attribute should be repeated when a course is listed under multiple titles.
Schema sample	<ThreeDO:CourseName ThreeDO:type="courseID" ThreeDO:value="IS562AO">Metadata in Theory and Practice</ThreeDO:CourseName>

Semantic unit	1.3.2. CourseInstructor
Semantic components	None
Definition	A designation that uniquely identifies the *CourseInstructor*.
Rationale	Identifier values cannot be assumed to be unique across domains; the combination of Type and Value should ensure uniqueness.
Data constraint	Values should be taken from the Staff Directory.
Repeatability	Repeatable
Obligation	Mandatory
Usage notes	*CourseInstructor* should be listed as *First Middle Last.* This element possesses *type* and *value* attributes.

	Type is the name of the identifier(i.e. netID) and *value* is the Instructor's unique identifier (i.e. jsmith45).
Schema sample	<ThreeDO:CourseInstructor ThreeDO:type="netID" ThreeDO:value="rbettivi">Rhiannon Bettivia</ThreeDO:CourseInstructor>

Semantic unit	1.3.3. CourseSemester
Semantic components	None
Definition	A designation for the academic semester the *Course* took place.
Data constraint	Values should be taken from the Course Catalog
Repeatability	Not repeatable
Obligation	Mandatory
Schema sample	<ThreeDO:CourseSemester>Fall</ThreeDO:CourseSemester>

Semantic unit	1.3.4. CourseYear
Semantic components	None
Definition	The year the *Course* took place.
Data constraint	Values should be taken from the Course Catalog.
Repeatability	Not repeatable
Obligation	Mandatory
Schema sample	<ThreeDO:CourseSemester>Fall</ThreeDO:CourseSemester> <ThreeDO:CourseYear>2018</ThreeDO:CourseYear>

<ThreeDO:Course>
<ThreeDO:CourseName ThreeDO:type="courseID" ThreeDO:value="IS562AO">Metadata in Theory and Practice</ThreeDO:CourseName>
<ThreeDO:CourseInstructor ThreeDO:type="netID" ThreeDO:value="rbettivi">Rhiannon Bettivia</ThreeDO:CourseInstructor>

<ThreeDO:CourseSemester>Fall</ThreeDO:CourseSemester>
<ThreeDO:CourseYear>2018</ThreeDO:CourseYear>
</ThreeDO:Course>

OBJECT

Semantic unit	1.4. Object
Semantic components	1.4.1. ObjectTitle 1.4.2. ObjectIdentifier 1.4.3. DateCreated 1.4.4. Description 1.4.5. Origin 1.4.6. SourceFormat 1.4.7. CreatedWith 1.4.8. Geometry 1.4.9. Vertices 1.4.10. FileSize 1.4.11. Textures 1.4.12. Materials 1.4.13. Rigged 1.4.14. Animated 1.4.15. Normals 1.4.16. VertexColors 1.4.17. UVMapped 1.4.18. Tags
Definition	A designation used to identify and describe 3D objects.
Rationale	3D objects need to be described for accessibility and preservation purposes within the university.
Data constraint	Container
Repeatability	Repeatable
Obligation	Mandatory
Usage notes	Designation should be repeated for each object within a file.

Semantic unit	1.4.1. ObjectTitle

Semantic components	None
Definition	A designation that semantically identifies the *Object*.
Rationale	*ObjectTitle* allows creators to name their own objects.
Repeatability	Repeatable
Obligation	Mandatory
Usage notes	Entire category should be repeated for both title and ID.
Schema sample	<ThreeDO:ObjectTitle>Stump in the meadow 1</ThreeDO:ObjectTitle>

Semantic unit	1.4.2. ObjectIdentifier
Semantic components	None
Definition	A designation that uniquely identifies the object.
Rationale	*Objects* can potentially be named the same thing and still need to be identified.
Repeatability	Repeatable
Obligation	Mandatory
Usage notes	This element possesses *type.* *Type* is the name of the identifier (i.e. objectID).
Schema sample	<ThreeDO:ObjectIdentifier ThreeDO:type=”objectID”>95023859e97f44ddb654037c1932f65c </ThreeDO:ObjectIdentifier>

Semantic unit	1.4.3. DateCreated
Semantic components	None
Definition	A designation for the date on which the 3D object was created.

Rationale	Including the date an object was published will aid searchability and preservation purposes.
Data constraint	YYYY-MM-DD
Examples	1991-12-11 2003-03-04
Repeatability	Not Repeatable
Obligation	Mandatory
Usage notes	DateCreated should be in the ISO format.
Schema sample	<ThreeDO:DateCreated>2017-09-17</ThreeDO:DateCreated>

Semantic unit	1.4.4. Description
Semantic components	None
Definition	A designation that gives a human readable summary of the object.
Repeatability	Not Repeatable
Obligation	Optional
Usage notes	Category is optional but highly recommended. *Description* allows the creator of an object to describe their work in their own words.
Schema sample	<ThreeDO:Description>Stump in the meadow 1. A good reference or gameobject to a computer game.Photogrammetry from 97 photos.</ThreeDO:Description>

Semantic unit	1.4.5. Origin
Semantic components	1.4.5.1. Derived 1.4.5.2. RealObject 1.4.5.3. OriginalWork

Definition	A designation that describes the origins of the *object*. The origins of the object is classified as one of three classifications: *derived* from a previous IP, or modeled after a *RealOject*.
Data constraint	Container
Repeatability	Repeatable
Obligation	Mandatory
Usage Notes	Element is mandatory but sub-elements are optional. At least one of the three sub-elements should be chosen. Sub-elements are repeatable and more than one can be chosen to account for an object that has its origins in multiple sources.

Semantic unit	1.4.5.1. Derived
Semantic components	1.4.5.1.1. DerivedTitle 1.4.5.1.2. DerivedCreator
Definition	A designation that describes the IP from which an *object* was *derived.*
Data constraint	Container
Repeatability	Repeatable
Obligation	Optional
Usage Notes	Element is optional, but *highly* recommended for objects that are inspired by another source.

Semantic unit	1.4.5.1.1. DerivedTitle
Semantic components	None
Definition	A designation for the title of an existing IP that the object is derived from.
Repeatability	Repeatable
Obligation	Mandatory

Usage Notes	This element possesses “type” and “value” attributes. If used, “type” should state the name of the authority, and “value” should be the identifier. LOC Subject Headings should be used when available. If not available, another persistent identifier like the UPC should be used.
Schema sample	<ThreeDO:DerivedTitle ThreeDO:type=”UPC” ThreeDO:value=”045496904159”>The Legend of Zelda: Breath of the Wild</ThreeDO:DerivedTitle>

Semantic unit	1.4.5.1.2. DerivedCreator
Semantic components	None
Definition	A designation for the creator of an existing IP that the object is derived from.
Repeatability	Repeatable
Obligation	Mandatory
Usage notes	This element possesses type and value attributes. Type should be the Library of Congress and value should be the unique identifier listed in LOC of the company or institution that holds rights to the object. Contents for value can be taken from Library of Congress Name Authority Headings.
Schema sample	<ThreeDO:DerivedCreator ThreeDO:type=”LOC” ThreeDO:value=”n80155453”>Nintendo </ThreeDO:DerivedCreator>

Semantic unit	1.4.5.2. RealObject
Semantic components	1.4.5.2.1. ExistenceStatement 1.4.5.2.1. Holding

Definition	A designation that indicates if the 3D *object* has its *origins* in a real life object.
Data Constraints	Container
Repeatability	Repeatable
Obligation	Optional

Semantic unit	1.4.5.2.1. ExistenceStatement
Semantic components	None
Definition	A designation that shows whether or not the 3D object has its *origins* in a real-life object.
Data Constraint	Boolean
Repeatability	Non-Repeatable
Obligation	Mandatory
Usage Notes	true=PRESENCE, false=ABSENCE, where “presence” means that the object does have its origins in a real-life object, and “absence” the opposite.
Schema Sample	<ThreeDO:ExistenceStatement>true </ThreeDO:ExistenceStatement>

Semantic unit	1.4.5.2.2. Holding
Semantic components	None
Definition	A designation for information on the institution (i.e. museum/repository) that currently holds the object.
Repeatability	Non-Repeatable
Obligation	Optional
Usage Notes	This element possesses *type* and *value* attributes. *Type* should be the name of the institution that holds the object (i.e.

	sh85127058) and *value* would be the institution's unique identifier for the object. Contents for *type* should be taken from Library of Congress Subject Headings.
Schema Sample	<ThreeDO:Holding ThreeDO:type="LOC" ThreeDO:value="n2005183814">1935.08.2777 </ThreeDO:Holding>

Semantic unit	1.4.5.3. OriginalWork
Semantic components	None
Definition	A designation that indicates if the 3D *object* was created originally by the artist.
Data Constraints	Boolean
Repeatability	Non-Repeatable
Obligation	Optional
Usage notes	true=PRESENCE, false=ABSENCE Used to indicate original art, blueprints, architectural structure, ect.
Schema Sample	<ThreeDO:OriginalWork>true</ThreeDO:OriginalWork>

Semantic unit	1.4.6. SourceFormat
Semantic components	None
Definition	A designation for information on the format of the source file.
Rationale	The file type of objects needs to be represented for the purposes of preservation and accessibility.
Data constraint	File extension examples: .blend

	.obj
Repeatability	Non-Repeatable
Obligation	Mandatory
Usage notes	This element possesses *type* and *value* attributes. *Type* is the name of the registry identifier(i.e. PUID) and *value* is the unique identifier (i.e. fmt/902). PRONOM is suggested as the authority, if applicable.
Schema sample	<ThreeDO:SourceFormat ThreeDO:type="PUID" ThreeDO:value="fmt/1009">.fbx</ThreeDO:SourceFormat>

Semantic unit	1.4.7. CreatedWith
Semantic Components	1.4.7.1. Software 1.4.7.2. Hardware
Definition	A designation for information on the *Software* and/or *Hardware* that was used in the creation of the *Object.*
Data Constraint	Container
Repeatability	Non-Repeatable
Obligation	Mandatory
Schema sample	<ThreeDO: CreatedWith></ThreeDO:CreatedWith>

Semantic unit	1.4.7.1. Software
Semantic components	1.4.7.1.1. SoftwareName 1.4.7.1.2. SoftwareCreator 1.4.7.1.3. SoftwareRightsType 1.4.7.1.4. SoftwareRightsStatement
Definition	A designation that describes the software used to create the *Object.*
Data constraint	Container
Repeatability	Repeatable

Obligation	Mandatory
Schema sample	<ThreeDO:Software></ThreeDO:Software>

Semantic unit	1.4.7.1.1. SoftwareName
Semantic components	None
Definition	A designation that identifies the software used to create the *Object.*
Repeatability	Non-Repeatable
Obligation	Mandatory
Usage Notes	This element possesses an optional type and value attributes. Type is the name of the authority and value is the unique identifier. Include whenever applicable. Library of Congress is suggested as the authority.
Schema sample	<ThreeDO:SoftwareName ThreeDO:type=”LOC” ThreeDO:value=”n 00063653”>Blender</ThreeDO:SoftwareName>

Semantic unit	1.4.7.1.2. SoftwareCreator
Semantic components	None
Definition	A designation that identifies the entity that created the *Software*.
Repeatability	Non-Repeatable
Obligation	Mandatory
Usage Notes	This element possesses an optional type and value attributes. Type is the name of the authority and value is the unique identifier. Include whenever applicable. Library of Congress is suggested as the authority.

Schema sample	<ThreeDO:SoftwareCreator ThreeDO:type=”LOC” ThreeDO:value=”n 2007052974”>Blender Foundation</ThreeDO:SoftwareCreator>

Semantic unit	1.4.7.1.3. SoftwareRightsType
Semantic components	None
Definition	A designation to describe the type of rights that belong to the *Software.*
Repeatability	Non-Repeatable
Obligation	Optional
Schema sample	<ThreeDO:SoftwareRightsType>License </ThreeDO:SoftwareRightsType>

Semantic unit	1.4.7.1.4. SoftwareRightsStatement
Semantic components	None
Definition	A designation that describes what actions are permissible regarding the *Software*, under the rights statement.
Data constraint	None
Repeatability	Non-Repeatable
Obligation	Optional
Usage notes	This element possesses an optional type and value attributes, that can be used to link to the rights statement. Type is the URI and value is the handle.
Schema sample	<ThreeDO:SoftwareRightsStatement ThreeDO:type=”URI” ThreeDO:value=”https://www.gnu.org/licenses/gpl-3.0.en.html”>GNU General Public License</ThreeDO:SoftwareRightsStatement>

Semantic unit	1.4.7.2. Hardware
Semantic components	1.4.7.2.1. HardwareName 1.4.7.2.2. HardwareCreator
Definition	A designation that describes the hardware used to create the *Object.*
Repeatability	Repeatable
Obligation	Optional
Schema sample	<ThreeDO:Hardware></ThreeDO:Hardware>

Semantic unit	1.4.7.2.1. HardwareName
Semantic components	None
Definition	A designation that identifies the hardware used to create the *Object.*
Repeatability	Non-Repeatable
Obligation	Mandatory
Schema sample	<ThreeDO:HardwareName>Nikon D3500 DSLR Camera</ThreeDO:HardwareName>

Semantic unit	1.4.7.2.2. HardwareCreator
Semantic components	None
Definition	A designation that identifies the entity that created the *Hardware.*
Repeatability	Non-Repeatable
Obligation	Mandatory
Usage notes	This element possesses an optional type and value attributes. Type is the name of the authority and value is the unique identifier. Include whenever applicable.

	Library of Congress is suggested as the authority.
Schema sample	<ThreeDO:HardwareName ThreeDO:type=”LOC” ThreeDO:value=”n 80070839”>Nikon, inc.</ThreeDO:HardwareName>

Semantic unit	1.4.8. Geometry
Semantic components	1.4.8.1. GeometryType 1.4.8.2. GeometryAmount
Definition	A designation that specifies the type and amount of shapes that constitute the 3D object.
Data constraint	Container
Repeatability	Repeatable
Obligation	Mandatory
Usage notes	Element should be repeated if the object is made up of more than one geometrical shape.
Schema sample	<ThreeDO:Geometry></ThreeDO:Geometry>

Semantic unit	1.4.8.1. GeometryType
Semantic components	None
Definition	A designation that describes what type of which the shape the 3D object is constituted.
Data constraint	Triangle Quadrangle
Repeatability	Non-Repeatable
Obligation	Mandatory
Schema sample	<ThreeDO:GeometryType>triangle</ThreeDO:GeometryType>

Semantic unit	1.4.8.2. GeometryAmount
Semantic components	None
Definition	A designation for the amount of geometrical shapes that a 3D object is constituted by.
Data constraint	*GeometryAmount* should contain a numerical value.
Examples	40300 54100
Repeatability	Non-Repeatable
Obligation	Mandatory
Schema sample	<ThreeDO:GeometryAmount>40600 </ThreeDO:GeometryAmount>

Semantic unit	1.4.9. Vertices
Semantic components	None
Definition	A designation that specifies the amount of vertices within the 3D object.
Examples	21100
Repeatability	Non-Repeatable
Obligation	Mandatory
Schema sample	<ThreeDO:Vertices>20600</ThreeDO:Vertices>

Semantic unit	1.4.10. FileSize
Semantic components	None
Definition	A designation for the size of the object.
Rationale	File size aids in preservation and archival activities.

Data constraint	A number with no commas
Repeatability	Non-Repeatable
Obligation	Mandatory
Usage notes	Object size should be notated in bytes. In Sketchfab, “model size” was used for this designation.
Schema sample	<ThreeDO:FileSize>476000</ThreeDO:FileSize>

Semantic unit	1.4.11. Textures
Semantic components	None
Definition	A designation for the amount of textures that constitute the 3D object.
Data constraint	Numerical Value
Repeatability	Non-Repeatable
Obligation	Mandatory
Schema sample	<ThreeDO:Textures>3</ThreeDO:Textures>

Semantic unit	1.4.12. Materials
Semantic components	None
Definition	A designation for amount of materials that constitute the 3D object.
Data constraint	Numerical Value
Repeatability	Non-Repeatable
Obligation	Mandatory
Schema sample	<ThreeDO:Materials>1</ThreeDO:Materials>

Semantic unit	1.4.13. Rigged
Semantic components	None
Definition	A designation that specifies whether or not the 3D object is rigged, which allows for easier manipulation of the 3D object.
Rationale	Rigged objects are more easily manipulated by future students, and can be used in art projects, games, movies, or VR experiences.
Data constraint	Boolean
Repeatability	Non-Repeatable
Obligation	Mandatory
Usage notes	true=PRESENCE, false=ABSENCE
Schema sample	<ThreeDO:Rigged>true</ThreeDO:Rigged>

Semantic unit	1.4.14. Animation
Semantic components	1.4.14.1. AnimatedRunTime
Definition	A designation for 3D objects that include animation.
Data constraint	Container
Repeatability	Non-Repeatable
Obligation	Optional
Usage notes	The element *Animation* is mandatory for 3D objects that are animated.
Schema sample	<ThreeDO:Animation></ThreeDO:Animation>

Semantic unit	1.4.14.2. AnimatedRunTime
Semantic components	None

Definition	A designation that describes the length (in time) of the animation.
Data constraint	Numerical value in Hours:Minutes:Seconds:Milliseconds HH:MM:SS:MM.
Repeatability	Non-Repeatable
Obligation	Mandatory
Schema sample	<ThreeDO:AnimatedRunTime>00:00:19:30 </ThreeDO:AnimatedRunTime>

Semantic unit	1.4.15. Normals
Semantic components	None
Definition	A designation that specifies whether or not the 3D object contains normals, a vector in 3D-space that is perpendicular to two other vectors (determined by two edges of a face).
Rationale	Inclusion of normals helps with calculating reflections and back-face culling, which speeds up object rendering.
Data constraint	Boolean
Repeatability	Non-Repeatable
Obligation	Mandatory
Usage notes	true=PRESENCE, false=ABSENCE
Schema sample	<ThreeDO:Normals>true</ThreeDO:Normals>

Semantic unit	1.4.16. VertexColors
Semantic components	None
Definition	A designation that specifies whether or not the 3D object includes vertex colors.
Rationale	Vertex colors define the shape of how a model can be colored.

Data constraint	Boolean
Repeatability	Non-Repeatable
Obligation	Mandatory
Usage notes	true=PRESENCE, false=ABSENCE
Schema sample	<ThreeDO:VertexColors>true</ThreeDO:VertexColors>

Semantic unit	1.4.17. UVMapped
Semantic components	None
Definition	A designation that specifies whether or not the 3D object is UV mapped.
Data constraint	Boolean
Repeatability	Non-Repeatable
Obligation	Mandatory
Usage notes	true=PRESENCE, false=ABSENCE
Schema sample	<ThreeDO:UVMapped>true</ThreeDO:UVMapped>

Semantic unit	1.4.18. Tags
Semantic components	None
Definition	A designation for user-generated tags that describe the subject matter of the 3D object.
Rationale	Tags will aid in the accessibility and searchability of 3D objects. Creators will be able to describe their work using their own tags, and librarians will be able to add tags.
Data constraint	String
Repeatability	Repeatable

Obligation	Mandatory
Schema sample	<ThreeDO:Tags>tree</ThreeDO:Tags> <ThreeDO:Tags>trunk</ThreeDO:Tags> <ThreeDO:Tags>stump</ThreeDO:Tags> <ThreeDO:Tags>reference</ThreeDO:Tags> <ThreeDO:Tags>gameobject</ThreeDO:Tags>

<ThreeDO:Object>
<ThreeDO:ObjectTitle>Stump in the meadow 1</ThreeDO:ObjectTitle>
<ThreeDO:ObjectIdentifier
ThreeDO:type=”objectID”>95023859e97f44ddb654037c1932f65c</ThreeDO:ObjectIdentifi
er>
<ThreeDO:DateCreated>2017-09-17</ThreeDO:DateCreated>
<ThreeDO:Description>Stump in the meadow 1. A good reference or gameobject to a
computer game.Photogrammetry from 97 photos.</ThreeDO:Description>
<ThreeDO:Origin>
    <ThreeDO:Derived>
        <ThreeDO:DerivedTitle ThreeDO:type=”LOC”
ThreeDO:value=”9871628172”>A famous stump</ThreeDO:DerivedTitle>
        <ThreeDO:DerivedCreator ThreeDO:type=”LOC” ThreeDO:value=”n
80155453”>Nintendo</ThreeDO:DerivedCreator>
    </ThreeDO:Derived>
    <ThreeDO:RealObject>
        <ThreeDO:ExistenceStatement>true</ThreeDO:ExistenceStatement>
        <ThreeDO:Holding ThreeDO:type=”LOC”
ThreeDO:value=”n2005183814”>1935.08.2777</ThreeDO:Holding>
    </ThreeDO:RealObject>
</ThreeDO:Origin>
<ThreeDO:SourceFormat ThreeDO:type=”PUID”
ThreeDO:value=”fmt/1009”>.fbx</ThreeDO:SourceFormat>
<ThreeDO:CreatedWith>
    <ThreeDO:Software>
        <ThreeDO:SoftwareName>Blender</ThreeDO:SoftwareName>
        <ThreeDO:SoftwareCreator>Blender
Foundation</ThreeDO:SoftwareCreator>
        <ThreeDO:SoftwareRightsType>License</ThreeDO:SoftwareRightsType>
        <ThreeDO:SoftwareRightsStatement>GNU General Public
License</ThreeDO:SoftwareRightsStatement>
</ThreeDO:Software>
<ThreeDO:Hardware>
        <ThreeDO:HardwareName>MacBook Pro</ThreeDO:HardwareName>

```
            <ThreeDO:HardwareCreator>Apple Inc</ThreeDO:HardwareCreator>
        </ThreeDO:Hardware>
</ThreeDO:CreatedWith>
<ThreeDO:Geometry>
<ThreeDO:GeometryType>triangle</ThreeDO:GeometryType>
<ThreeDO:GeometryAmount>40600</ThreeDO:GeometryAmount>
</ThreeDO:Geometry>
<ThreeDO:Vertices>20600</ThreeDO:Vertices>
<ThreeDO:FileSize>476000</ThreeDO:FileSize>
<ThreeDO:Textures>3</ThreeDO:Textures>
<ThreeDO:Materials>1</ThreeDO:Materials>
<ThreeDO:Rigged>true</ThreeDO:Rigged>
<ThreeDO:Animation>
        <ThreeDO:AnimatedRunTime>00:00:01:62</ThreeDO:AnimatedRunTime>
</ThreeDO:Animation>
<ThreeDO:Normals>true</ThreeDO:Normals>
<ThreeDO:VertexColors>true</ThreeDO:VertexColors>
<ThreeDO:UVMapped>true</ThreeDO:UVMapped>
<ThreeDO:Tags>tree</ThreeDO:Tags>
<ThreeDO:Tags>trunk</ThreeDO:Tags>
<ThreeDO:Tags>stump</ThreeDO:Tags>
<ThreeDO:Tags>reference</ThreeDO:Tags>
<ThreeDO:Tags>gameobject</ThreeDO:Tags>
</ThreeDO:Object>
```

RIGHTS

Semantic unit	1.5. Rights
Semantic components	1.5.1. RightsType 1.5.2. RightsStatement
Definition	A container defining the legal rights of the *Object.*
Repeatability	Non-Repeatable
Obligation	Mandatory
Schema sample	<ThreeDO:Rights></ThreeDO:Rights>

Semantic unit	1.5.1. RightsType

Semantic components	None
Definition	A designation to describe the type of rights that belong to the *Object.*
Repeatability	Non-Repeatable
Obligation	Mandatory
Schema sample	<ThreeDO:RightsType>License</ThreeDO:RightsType>

Semantic unit	1.5.2. RightsStatement
Semantic components	None
Definition	A designation describes what actions are permissible regarding the object, under the rights statement.
Data constraint	None
Repeatability	Non-Repeatable
Obligation	Mandatory
Schema sample	<ThreeDO:RightsStatement>CC BY 4.0</ThreeDO:RightsStatement>

```
<ThreeDO:Rights>
        <ThreeDO:RightsType>License</ThreeDO:RightsType>
        <ThreeDO:RightsStatement>CC BY 4.0</ThreeDO:RightsStatement>
</ThreeDO:Rights>
```