


SketchUp in digital archives

Software and file format analysis and exploration of the options for digital preservation

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Author(s)	Henk Vanstappen, Datable
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1. Executive Summary

This report investigates the SketchUp software and file format. Sketchup is a software for the creation and visualisation of 3D design. Because of its frequent use, high heritage value and inherent preservation risks, the Flanders Architecture Institute wishes to develop a preservation policy with regard to the SketchUp file format.

The report starts with an overview of the Sketchup software and related tools, followed by a brief introduction in the software's features. The next chapter focuses on the SketchUp files, starting with a description of the geometry model, an exploration of the (undisclosed) internal file format structure and an investigation of the compatibility with other file formats. The last chapter discusses possible risks and vulnerabilities for preservation of SketchUp files on the long term.

SketchUp may be regarded as a stable format which is not at risk to become obsolete - at least not in the near future. Nevertheless, the overall conclusion is that archival institutions will need to take action and have to develop and implement preservation policies for SketchUp files in their archives.

Currently, the most viable approach is to preserve the essential characteristics (the 'significant properties') without relying on specific hard- or software. In practice this often comes down to the migration of files from the original format to a so-called 'archival format' that preserves the essential characteristics as accurately as possible. This archival format is expected to minimize the preservation risks in connection to adoption, platform independence, disclosure, transparency and metadata support. Some of SketchUp's supported export file formats may be eligible for use as an archive format, but the way these different file formats support the required significant properties needs a more thorough investigation.

2. Introduction

Since 2008, the Flanders Architecture Institute has executed and stimulated research in the preservation of born digital architecture archives. Practical experience and previous analyses have shown that Sketchup is a widely adopted format for computer-aided design (CAD) and is frequently used within the architectural design process. This creative use of Sketchup means that the resulting SketchUp files have a high historical and cultural value. But as all digital files, SketchUp files are fragile: bits can be damaged by wear and tear on the carrier. And even if the bits are preserved well, files can become inaccessible because of its dependency on a specific version of specific software on a specific operating system. Where established solutions may exist for less complex files (image, sound), preserving CAD files with its numerous specifications and formats, has proven to be challenging.¹

To meet this challenge, the Flanders Architecture Institute wishes to develop a preservation policy with regard to SketchUp format. This includes (1) the development of guidelines for architects and other archive creators, aimed at the safeguarding of SketchUp files in the medium and long term and (2) the development of a preservation strategy for the trusted digital repositories.

Currently, very little research is available on the SketchUp software and file format in the context of digital preservation. Research projects such as FACADE and DURAARK mention Sketchup, but in depth analysis is aimed at formats such as AutoCAD or preservation formats such as STEP or IFC.^{2,3} To develop a preservation policy, more in-depth knowledge is needed with regard to Sketchup and the Sketchup file format. That is why the Flanders Architecture Institute has commissioned Datable to investigate the history, internal structure, application and possible risks in terms of preservation in the medium and long term of the Sketchup software and file format.

The focus of this report is to give a better understanding of the SketchUp model and file format in terms of preservation risks and the way they can be dealt with. This report was written for an audience of archivists who have to deal with the preservation of SketchUp files,⁴ not so much towards the actual users of the SketchUp software (a whole range of manuals and tutorials is available for them).

¹ Ashenfelder, 2014

² Smith, 2008

³ Beetz e.a., 2013

⁴ For a general introduction to the preservation of CAD archives, see Ball, 2013 and Vanstappen, 2011

3. SketchUp software

SketchUp was originally developed by startup company @Last Software in 1999. The software was released to the public in August 2000 as a general purpose 3D modeling tool.⁵ @Last Software made a successful move by allowing users to place their SketchUp models into Google Earth. After the collaboration with Google to develop a plugin, Google acquired SketchUp on March 14, 2006. Google released both a free version of SketchUp and a paid Pro version.

On June 1, 2012, Trimble Navigation acquired SketchUp from Google.⁶ Trimble Inc. (1978) is a NASDAQ listed company based in Sunnyvale, California. Trimble sells products and services into the land survey, construction, agriculture, transportation, telecommunications, asset tracking, mapping, utilities and mobile resource management industries.⁷ SketchUp is now mainly used in the construction, services, education and manufacturing industries.⁸

SketchUp was quickly adapted by the architectural community because of its intuitive interface. The software plays a major role in different stages of the design process. It is most often used as a visualization tool, along with other design tools such as AutoCAD. Just as physical scale models, a three-dimensional rendering can be viewed from different angles. Applications such as SketchUp give the opportunity to create walkthroughs and other ways to virtually explore a design. Visualizations are often used to show a design to a (potential) client, but they will also give the architect the opportunity to get a better understanding of the design and discover eventual flaws — better than a two-dimensional representation does.⁹ Therefore, a Sketchup file can represent a milestone in the design process.

3.1. Sketchup products and product suites

3.1.1. Product suites

Currently (2019), Sketchup products are offered in a Free, Shop, Pro and Studio bundle.¹⁰ Each bundle is targeted towards a different audience.

	Free	Shop	Pro	Studio
SketchUp for Web	●	●	●	●
SketchUp Pro Desktop			●	●
Trimble Connect/Business	●	●	●	●
3D Warehouse	●	●	●	●
Extension Warehouse			●	●
Desktop Viewer	●	●	●	●

⁵ Bethany (2018)

⁶ <https://www.trimble.com/news/release.aspx?id=042612a>

⁷ <https://www.trimble.com>

⁸ <https://discovery.hgdata.com/product/sketchup-pro>

⁹ Vanstappen (2011)

¹⁰ <https://help.sketchup.com/en/licensing-accounts-and-administration/subscriptions>

Mobile Viewer			●	●
VR Viewer			●	●
Layout			●	●

3.1.2. SketchUp for Web

SketchUp for Web is a SaaS application that runs in a browser only. With the free version, users can create 3D models and save them to the cloud or locally. Files can be saved as a native SketchUp file or exported to DAE, KML or STL files.¹¹ The free version is available for personal use only. Users have access to the 3D warehouse, but can't use the extensions. SketchUp for Web doesn't support dynamic components or solid modeling. BIM features are not supported either. The paid versions (Shop bundle and above) offer extended features, access to the Extension Warehouse and support from Trimble. As a SaaS application, SketchUp for Web is essentially versionless.

3.1.3. SketchUp Pro (Desktop)

Contrary to SketchUp for Web, SketchUp Pro can be used as a desktop application. It has extended functionalities and gives access to the Extensions Warehouse. Also, SketchUp LayOut is included.

SketchUp Make was a free-of-charge desktop version of SketchUp, released by Trimble in 2013. It was available for home, personal and educational use. As of November 2017, Trimble stopped bringing out further releases of SketchUp Make. Although not promoted by Trimble, SketchUp Make is still available for download.¹²

3.1.4. SketchUp LayOut

LayOut is an application that is shipped with SketchUp Pro, to make professional 2D presentations of SketchUp Pro models. SketchUp Pro models can be placed in multiple views on a template (e.g. a house style) and be provided with graphic elements such as titles, arrows, logos and photos for print or screen presentations. LayOut files (extension .layout) can sync with SketchUp files: any edits made to a SketchUp drawing will be instantly updated in the LayOut document. LayOut documents can be exported to JPG, PNG, PDF, DWG or DXF.¹³

3.1.5. SketchUp Viewers

The SketchUp Viewer for desktop is available as a free download. It allows users to view 3D models (orbiting, panning, playing animations), change camera settings or view object properties. Models can be printed as well, but editing or exporting a model is not possible.¹⁴

SketchUp Mobile Viewer enables the storage and sharing of 3D models on an iOS or Android mobile device. The app offers augmented reality (AR) model viewing capabilities for users with an ARKit (iOS)¹⁵ or ARCore (Android)¹⁶ enabled device. The demo models that ship with the app can be used to test out the AR model viewing features. In order to view own models in AR, an active SketchUp Shop,

¹¹ For an explanation of export file formats, see chapter 4.4

¹² <https://www.sketchup.com/sketchup/2017/en/sketchupmake-2017-2-2555-90782-en-x64-exe> (Win) or <https://www.sketchup.com/sketchup/2017/en/sketchupmake-2017-3-116-90851-en-dmg> (macOS)

¹³ <https://help.sketchup.com/en/layout/exporting-or-printing-your-layout-document>

¹⁴ <https://help.sketchup.com/en/sketchup-viewer/sketchup-viewer-desktop>

¹⁵ <https://developer.apple.com/augmented-reality/arkit/>

¹⁶ <https://developers.google.com/ar/discover/>

SketchUp Pro or SketchUp Studio subscription is required. Alternatively, SketchUp Free subscribers can purchase access to the AR Model viewing features on a standalone basis via in-app subscription.¹⁷ Trimble also offers virtual reality (VR) and extended reality (XR) applications for Oculus Rift, HTC Vive or Hololens. As the mobile viewer, these apps are freely available but a subscription is required to upload models.¹⁸

3.1.6. 3D Warehouse

With the 3D Warehouse, users can upload and share their own models to an online platform where other users can find, download and reuse them, e.g. as a component in new models. The warehouse is accessible via the desktop application and via a web interface

3.1.7. Extensions Warehouse

Since the 2013 version, Trimble has increased the possibilities for third party developers to create extensions on the application. As such, they created the Extension Warehouse, allowing users to share and download SketchUp plugins and extensions. To assure the quality of the extensions, developers must submit a request before they can upload extensions.¹⁹

3.1.8. Trimble Connect

Trimble Connect is a way to store, sync, reference, share, and collaborate on design and build projects. After signing up, a user can upload SketchUp, PDF, DXF or IFC files. Trimble Connect allows users to publish, open, import reference files and update SketchUp files from Trimble Connect project folders. To use the service, a Trimble Connect extension has to be installed in the SketchUp application.²⁰

3.2. Developer tools

3.2.1. Ruby API

The SketchUp Ruby API makes interaction with SketchUp models and the SketchUp application possible.²¹ Ruby is a programming language and an Application Programming Interface (API). SketchUp does not rely on having Ruby installed: SketchUp has Ruby packaged inside of it.²²

3.2.2. Sketchup SDK

The SketchUp SDK is available for Mac and Windows and includes the SketchUp C API, the LayOut C API and the SketchUp Importer/Exporter Interface.²³ This SDK allows for more complex functionality and possible performance improvements.

The SketchUp C API is an interface for reading and writing data to and from SketchUp models. This API interacts directly with SketchUp files. The LayOut C API is an interface for reading and writing data to and from LayOut documents. Both APIs can create new documents and read or modify existing documents. The SketchUp Importer/Exporter interface allows creating native SketchUp importer and exporter modules that are available directly within SketchUp as an import or export option.

¹⁷ <https://help.sketchup.com/en/sketchup-viewer/viewing-your-models-augmented-reality>

¹⁸ <https://help.sketchup.com/en/sketchup-viewer/sketchup-viewer-vr>

¹⁹ Bethany, 2018

²⁰ <https://help.sketchup.com/en/sketchup/managing-models-using-trimble-connect>

²¹ <https://developer.sketchup.com/en/content/getting-started>

²² SketchUp 2014, 2015 and 2016 use Ruby 2.0.0. SketchUp 2017 uses Ruby 2.2

²³ https://extensions.sketchup.com/en/developer_center/sketchup_sdk

The SketchUp SDK for C++ is no longer supported since version 2019 M1.²⁴

3.3. Software license

The SketchUp application is commercial, proprietary software. The source code is undisclosed. The license prohibits, among other things:²⁵

- (a) to decompile, disassemble, or otherwise reverse engineer the software;
- (b) to attempt to reconstruct or discover any source code, underlying ideas, algorithms, file formats or programming interfaces of the software;
- (c) to copy, modify or translate any part of the software, create a derivative work of any part of the software, or incorporate the software into or with other software;
- (d) to use or host the software in a virtual server environment.

SketchUp applications may contain or be provided with certain third-party software (including open source software or other software which may be made available in source code form) and data sets, which may be licensed under the third party license.²⁶

Because SketchUp licensing is managed online through a licensing server, the user's computer must be online to add or remove a SketchUp license. Users with a subscription need to sign in on the Trimble account manager before they can use the application.²⁷

3.4. System requirements

System requirements may change with every version of the software. An overview of the supported operating systems is given in the Addenda. The requirements of the current version (2019) are as follows:

Hardware requirements:

- 2+ GHz processor (minimum is 1 GHz)
- 8+ GB RAM (minimum 4 GB)
- 700 MB of available hard-disk space (minimum 500 MB)
- 3D class video card with 1 GB of memory or higher (minimum is 512 MB) and support for hardware acceleration. The video card driver must support OpenGL 3.0²⁸ or higher. Intel-based video cards are not recommended.
- 3-button, scroll-wheel mouse.
- An internet connection to authorize SketchUp and to use some features (e.g. 3D Warehouse).

Supported operating system:

- Windows: 64-bit version of Windows 10, Windows 8+ or Windows 7+, with Microsoft® Internet Explorer 9.0 or higher and .NET Framework version 4.5.2.
- Mac OS 10.14+ (Mojave), Mac OS 10.13+ (High Sierra), and 10.12+ (Sierra) with Safari.

²⁴ <https://forums.sketchup.com/t/developer-announcement-c-api-removal/94943>

²⁵ <https://www.sketchup.com/license/f/sketchup>

²⁶ <https://help.sketchup.com/en/third-party-attribution>

²⁷ <https://help.sketchup.com/en/sketchup/troubleshooting-license-error-messages>

²⁸ Open Graphics Library (OpenGL) is an application programming interface (API) for rendering 2D and 3D vector graphics. The API is used to interact with the graphics processing unit (GPU). OpenGL is open source and platform independent. OpenGL 3.0 was released in 2008.

Older operating systems (Windows Vista and older, MacOS 10.11 and older) don't run the current SketchUp versions. A Linux version of SketchUp isn't available but it is possible to run SketchUp on Linux using Wine.²⁹

SketchUp doesn't support operation in a virtualized environment such as VMWare or Citrix, Boot Camp, Parallels or Remote Desktop Connection (RDC) on any similar platform. The use of these and any other virtualized environments is prohibited by the license agreement.

3.5. Software features and tools

3.5.1. Features history

The table below shows the major releases of SketchUp with an overview of added features and changes in the functionality of the software.^{30, 31, 32, 33, 34} Maintenance releases, which mainly contain bug fixes or improved OS support, are excluded from this table. All features apply to the most advanced version of the software (i.e. SketchUp Pro).

Version	date	New features
1.0.20 (Pre-release)	2000	standard views and rotations, camera tool, shadows, ...; inference drawing tools; extrusion tool (push/pull) and move tool; selection tool; object library; limited import to DWG and DXF, 2D export to graphical file formats.
1.2	2001	self-casting real-time shadows; export individual views in the Epix format; metric units; improved support for importing and exporting AutoCAD DWG files and exporting 3ds max/3D studio viz files.
2	2002	components (v. 2 or or earlier); materials (with imported bitmap) (v. 2 or or earlier); camera positions (v. 2 or or earlier); paint tool.

²⁹ Wine is a compatibility layer that allows to run applications developed for Microsoft on the Linux operating system.

³⁰ <https://help.sketchup.com/en/sketchup/older-release-notes>

³¹ <https://www.c3a.be/software/sketchup-pro/productinfo>

³² SketchUp for Mac users, 2002

³³ Products: Sketchup 4.0., 2004

³⁴ Google Announces the Launch of Google SketchUp 8, 2010

3	2003	new equidistant and tangent inferences; curved polyline behaves as a circle or arc; softened edges; opacity; screen and leader text; output of Tour as VAI video; export to VRML, PDF, EPS; intersection of volumes; wrapping or projecting materials around 3D volumes.
4	2004	Ruby scripting interface; Face Me, which makes 2D components look 3D; Texture Tweaker, enabling textures and photos to be stretched and manipulated across a continuous surface; Follow Me, for pushing and pulling a surface along a path; The Intersector, aiding users in intersecting complex shapes with a single mouse click.
5	2004	updated interface; Outliner palette (view and work with component hierarchies); improved rendering and transparency of bitmaps; improved DWG/DXF, VRML, 3DS and OBJ export; FVX and XSI export; Sandbox.
6	2007-01-09	view models from different perspectives; support of labels; Look-around tool.
7.0	2008-11-17	dynamic components; tabular reporting on model entities; Stylebuilder integrated in application.
8	2010-01-09	A redesigned workflow for geospatial modeling: modelers can now access imagery and terrain data from Google Earth; Solid tools for performing 'boolean' modeling operations (Union, Intersect, Subtract, Trim, and Split); additions in LayOut 3; export to DWG/DXF 2010.
8 M4	2012-08-28	re-branded as a Trimble product.
8 M5	2012-12-19	extended language support: French, Italian, German, Spanish, Japanese, Korean, Traditional Chinese, Simplified Chinese and Brazilian Portuguese, Russian and Dutch.
2013	2013-05-21	Extension Warehouse.

2014	2014-02-27	updated the DWG libraries to support AutoCAD 2013; Ruby API runtime upgraded to Ruby 2.0; Arc tool; faster shadowing; BIM Classifier; IFC export.
2014 M1	2014-06-03	ability to import classification systems that reference external files.
2015	2014-11-03	3-Point Arc Tool; Rotated Rectangle Tool; IFC-import.
2016	2015-11-17	deprecated export of Epix (*.epx) image file format; Trimble Connect integrated in SU; support of reference files on the web (e.g. Dropbox); improved materials library.
2017	2016-11-07	reworked 3D framework (the way models are displayed) with faster rendering of objects and better transparency; The Extension Manager; rewritten Trimble Connect Extension; DWG/DXF Exporter improvements.
2018	2017-11-14	Advanced Attributes to embed information into a model when creating and managing components (e.g. price, size and URL in components or owner and status attributes for each component instance); IFC Export Improvements; natively support the import and export of STL files; rewritten DWG Importer.
2019	2019-02-05	import/export support of DWG/DXF release 2018.

3.5.2. Drawing, Extrusion tool (push/pull) and Follow Me

From the beginning, SketchUp came with a small but intelligent set of drawing tools. These tools support the drawing of circles, polygons, arcs, rectangles and freehand form. SketchUp designing is supported by a system of inference drawing that anticipates the intentions of the user, comparing possible 2D line positions with the main axes and the existing model, allowing interactive drawing in 3D space. With the patented extrusion tool, a user can select a face and drag it up or down to produce and control the depth of a 3D volume.³⁵ The Move tool allows to select an edge and move it to change the shape of the face or volume it is part of. Version 4 introduced the Follow Me tool which allows users to push or pull a surface along a path.

3.5.3. Smoothed edges and sandbox

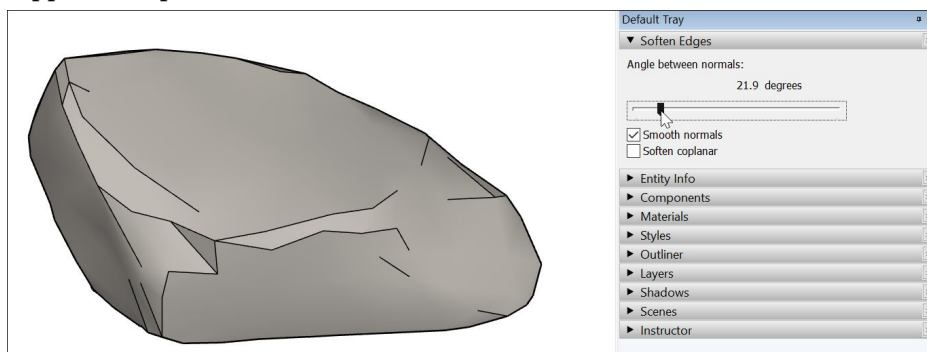
The SketchUp file format meshes all curved shapes, but since version 3 there is a workaround to represent meshed lines or volumes as a smooth line or surface: when a polyline curve is added with the Arc or Circle tools, SketchUp remembers the higher level shape information so that the diameter or the number of line segments can retrospectively be changed. Also, when a curved or freehand

³⁵ U.S. Patent 6628279, granted in September 2003, on the "Push/Pull" technology.

shape is pushed/pulled to create a curved face, these lines automatically appear 'softened' and all internal lines are hidden and the undesirable faceting disappears. One can also 'smooth' curved faces which renders adjoining faces with a smooth tonal gradient again improving output quality.³⁶

Since version 5, SketchUp includes a Sandbox tool to model terrain (the 'ground' on which a model stands). SketchUp uses hidden geometry to achieve this smooth surfaces and edges. Terrain modelling with the Sandbox tool is based on a special type of geometry called a triangulated irregular network (TIN), which basically is a group composed of triangles.

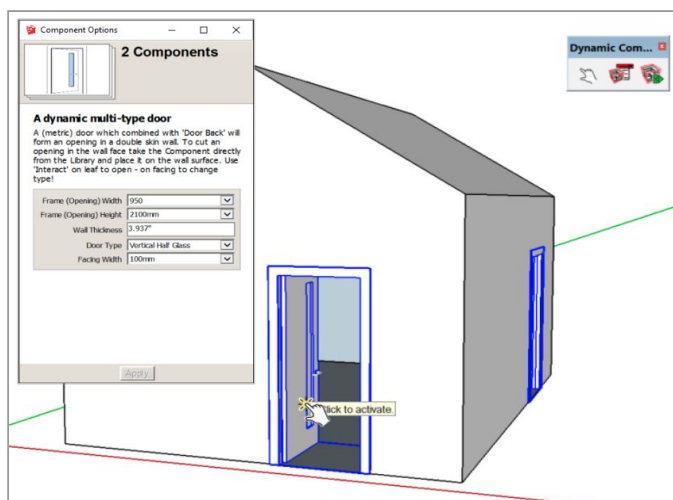
In general, 'smooth' lines on a screen are stored as faceted lines with some 'smoothing' parameters. When a model is exported (e.g. as part of a preservation workflow), it will depend on the export format and the software if and how this can affect the properties of the model (cf. Chapter 4.4. on Supported export formats).



'Smoothed' edges in a triangulated object © Trimble

3.5.4. Dynamic components

In SketchUp Pro a user can add attributes to create dynamic components (available since version 7). This way users can then configure certain aspects of the component, or the component can behave dynamically, e.g. add steps to staircases or pickets to fences as the component is scaled, making the model interactive.³⁷ A user can choose from predefined attributes or create custom attributes.



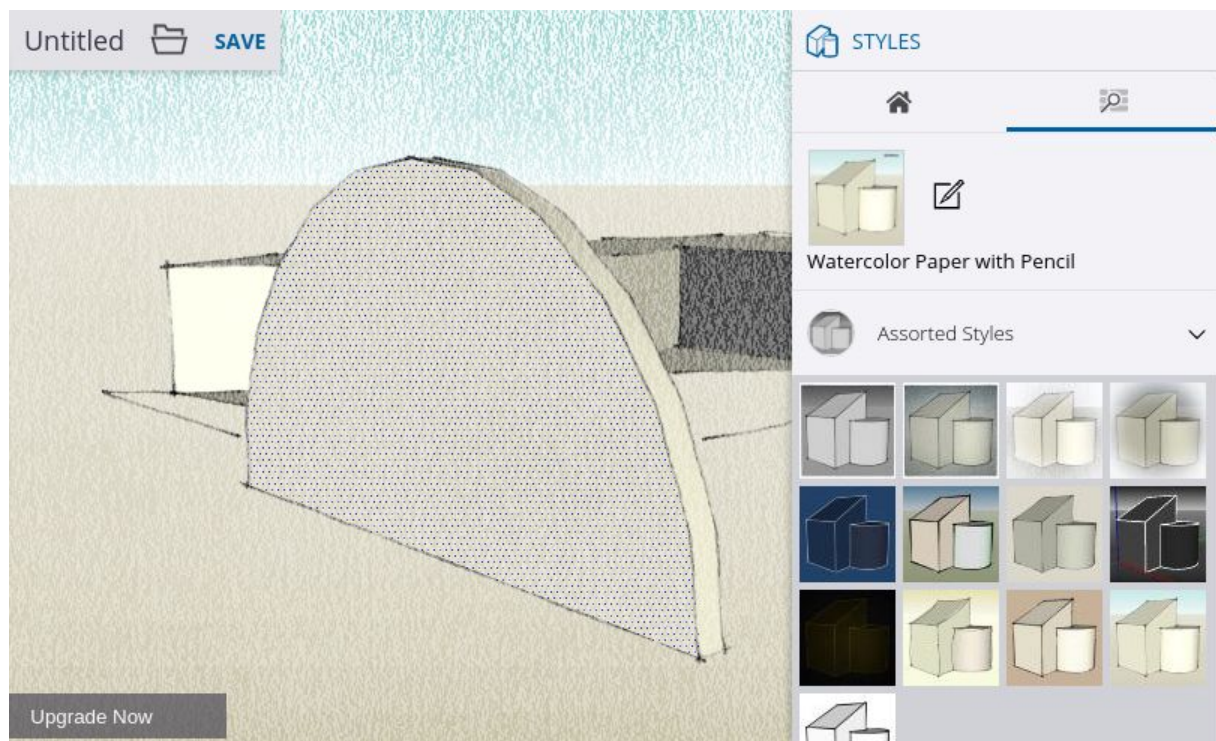
Dynamic component © Trimble

³⁶ http://designer-info.com/Writing/sketchup_3.htm

³⁷ <https://mastersketchup.com/history-of-sketchup/>

3.5.5. Style Builder

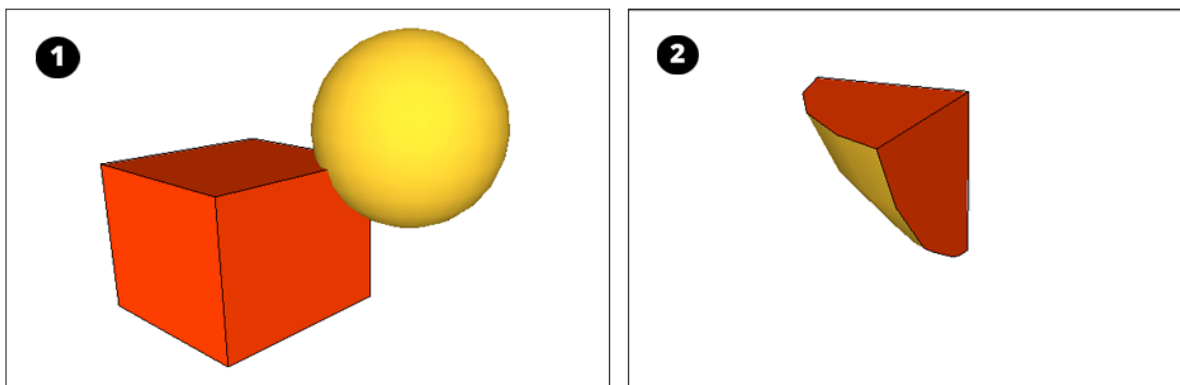
Also since version 7, the Style Builder enables users to create custom styles and apply them to SketchUp models. This way a user can create sketchy-edge styles based pencil lines, pen strokes or thick graphite lines. The style can be created by lines drawn on paper or digitally in an image-editing program.



Style applied to a model

3.5.6. Solid modeling tools

A solid is any 3D model (component or group) that has a finite closed volume. With SketchUp's Solid tools, new shapes can be created by combining or cutting one shape with another.³⁸ Solid tools consist of several operations, such as removing geometry inside overlapping groups or components, merging two or more solid entities, subtracting one solid entity to another, intersecting or splitting.



Creating solids by intersection © Trimble

³⁸ <https://help.sketchup.com/en/sketchup/modeling-complex-3d-shapes-solid-tools>

3.5.7. Geolocation and display in Google Earth

Existing terrains can be imported in a SketchUp model as an image file, as a TIN or as a polygon mesh.³⁹ Until 2017 the satellite images of Google Earth were used in the geolocation function. This was possible because Trimble had agreed with Google when taking over SketchUp that the Google Earth maps and images could be used in SketchUp for five years. After this period, Google has discontinued the possibility for developers to use the Google Earth API. Trimble replaced Google Earth with OpenStreetMaps. SketchUp Pro 2017 and later versions now use image material made available by DigitalGlobe. To increase the difference between SketchUp Pro and the free Make version and to justify the costs for the Pro version, the Geo-location function is no longer available in SketchUp Make 2017.⁴⁰ However, it is still possible to view models in Google Earth, provided that Google Earth is installed locally. Locations can also be added manually by entering the latitude and longitude values of the desired position.

3.5.8. BIM support

Since version 2014, SketchUp has extended its support for Building Information Modelling (BIM). The BIM-Classifer allows the user to enrich the model with metadata to improve interoperability with BIM applications. The classifier tags geometry with industry-standard object types (walls, slabs, roofs...) Geometry must be converted to components first and a classification needs to be imported. This can be an IFC classification, but other standard or custom classifications can be applied too. Models with classified objects can be exported as an IFC file (cf. Chapter 4.4 Supported export formats). A report of all the classified components can be exported as a CSV file with the Generate Report function in SketchUp. The resulting CSV file can be inserted as a table in LayOut. The classification is embedded in the SketchUp file and can be exported as an SKC file.⁴¹

3.5.9. Extensions or plugins

As mentioned before, extensions allow users to add special features to SketchUp. Extensions can be managed from within the desktop application. The Extension Warehouse contains over 700 extensions, in different categories and for different industries. In this context it is worth mentioning that the extension warehouse contains over 180 extensions that support import and/or export to other file formats.

³⁹ <https://help.sketchup.com/en/sketchup/importing-preexisting-terrain-sketchup-and-geolocate-model>

⁴⁰ <https://www.macrocad.nl/nieuws-acties/nieuws/486-wijzigingen-sketchup-3d-warehouse-en-geo-location>

⁴¹ <https://help.sketchup.com/en/sketchup/classifying-objects>

4. Sketchup model and file format

4.1. SketchUp model hierarchy

The SketchUp model supports 3D, polygonal, textured, and shaded models that contain faces, edges, component definitions and component instances. The objects that form a model are called entities. Core entities are the drawing elements, which basically consist of edges. A SketchUp model doesn't support curved entities (e.g. NURBS, B-splines or Bezier curves), point geometries (features represented by a single coordinate) or point clouds.

The API documentation lists the entity classes and subclasses that can be used to interact with a model.⁴² This gives an insight into the structure of an SketchUp model and its entities. A list of these classes is provided in Addendum 3. Most of these classes and corresponding entities have been part of the SketchUp model since version 6.0. In the next chapters of this section, we'll explore the characteristics of some of these entities.

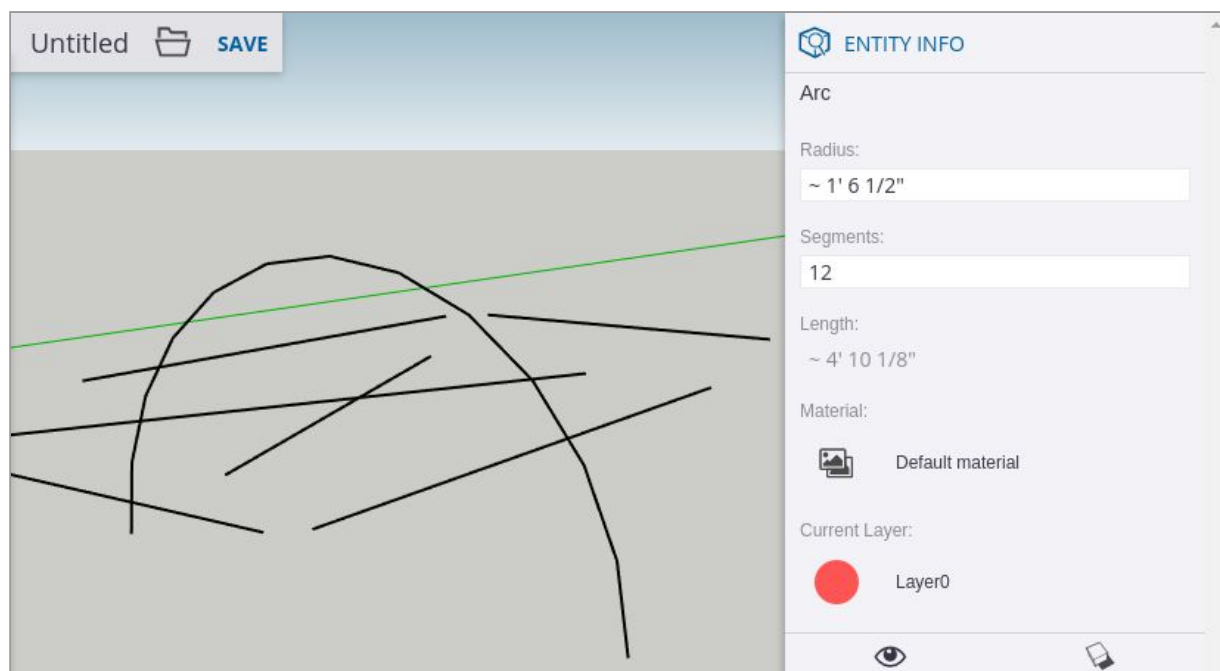
4.2. SketchUp model entities

4.2.1. Edges, arcs, curves and polylines

Edges (also called **line** entities) form the structural foundation of all models. Lines are always straight. Their vertex positions are defined by coordinates in a 3-dimensional space.

An **arc** contains multiple connected line segments (the default is 12 segments), but an arc can be selected and edited as a single entity.

A **curve** entity contains multiple line segments but can define and divide a face like a single line. A **polyline** also contains multiple line segments, but this entity doesn't create faces.



⁴² <http://ruby.sketchup.com>

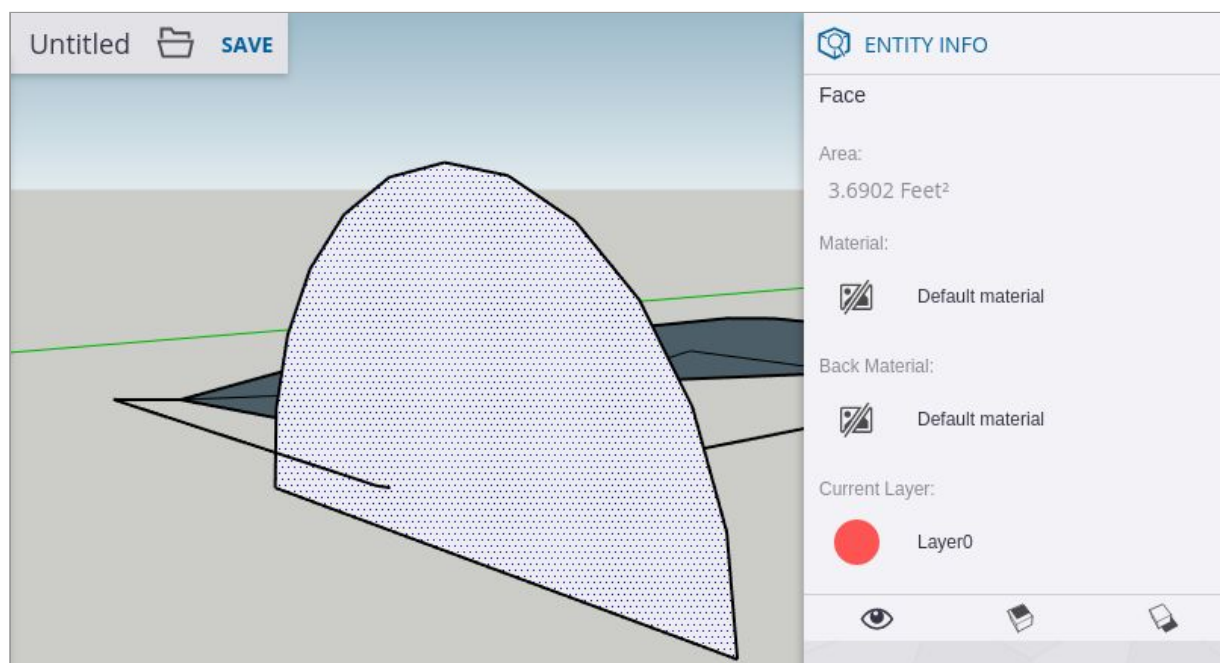
Lines and arc with 12 line segments

Although SketchUp model and file format doesn't natively support complex line definitions (NURBS, B-splines or Bezier curves), some software features and extensions mimic the creation and manipulation of these complex entities. Under the hood they are still defined as a group or component of meshes. When exporting to a format that supports these complex entity definitions, and importing the exported file in an application that support this export format natively (e.g. Rhino or AutoCAD), a segmented line may be interpreted as a curved line.

4.2.2. Faces, circles and polygons

Several joined lines form a **face**. By default, faces are opaque and SketchUp adds shading to some faces. Faces can get their color and texture from materials that are referenced by the face. Faces have a front side and a back side.

A **polygon** has a radius and 3 or more sides. The size of a polygon is measured from a center point, and the number of sides determines the type of polygon. **Circle** entities are nothing but polygons that have a radius and connect multiple line segments. These segments act as a single line in that they can define the edge of a face and divide a face. So basically, a circle is a polygon with a lot of segments. As with complex lines, SketchUp doesn't really support more complex, curved surfaces. But again, these can be created (mimicked) with an extension.

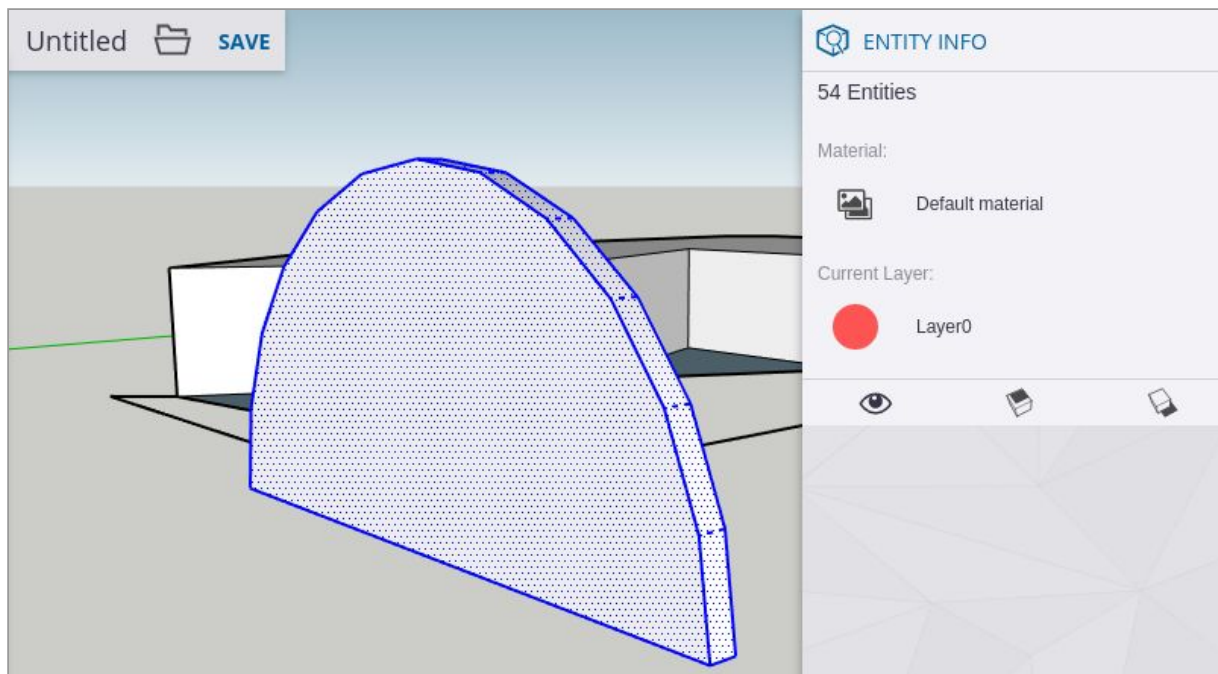


Arc and lines connected to faces

4.2.3. Shapes and solids

Shapes are the three-dimensional volumes, often extruded from two-dimensional faces or created by cutting out other 3D volumes. A **solid** is any 3D model (*component or group*) that has a finite closed volume. Solids can be created by adding, subtracting or intersecting solids. **Surface** entities are the result of combining a number of faces to give the impression of smoothness.

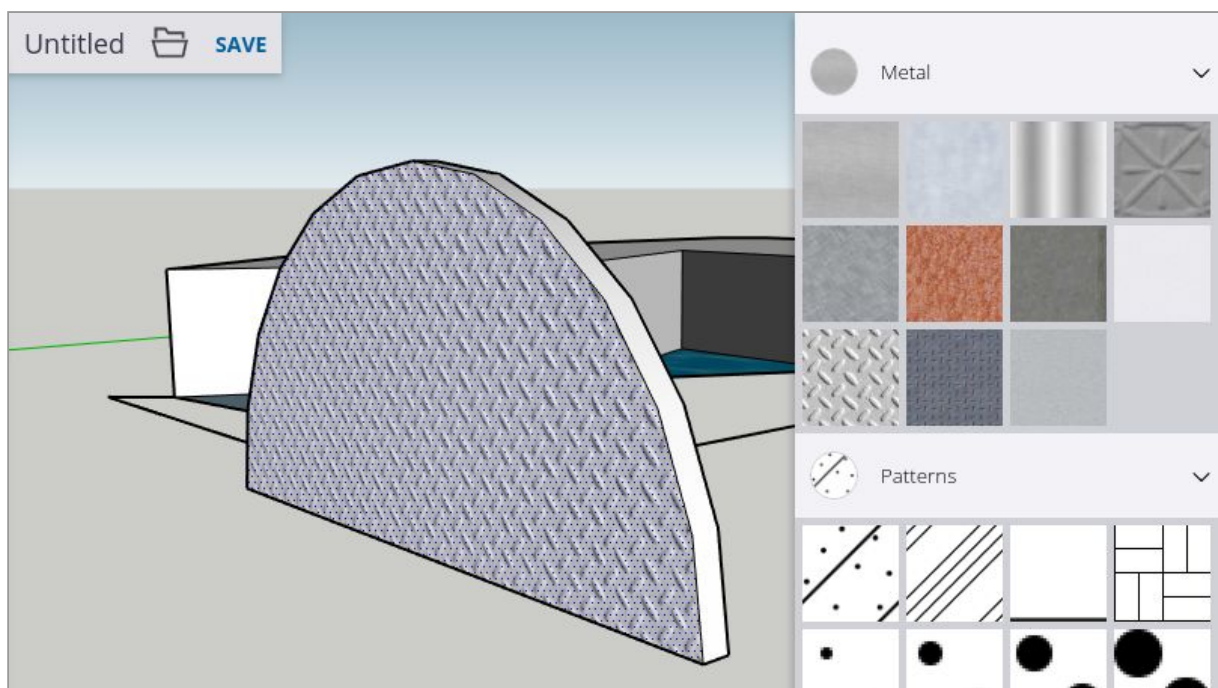
Edges of shapes can be softened or smoothed. When an edge is softened, the edge is hidden, and the faces that the edge bounds become a surface entity. Smoothing an edge adds shading that makes the faces look smooth.



Faces extruded to shape

4.2.4. Color, texture and materials

Colors behave like paint, i.e. one color can be applied to a face. **Textures** add realistic surface materials, such as carpet, tile, grass, wood or glass. Texture materials are applied as raster images (e.g. jpeg files) that are tiled on a face or a single photo to cover a face. By default, these image objects retain the proportions of the file from which they are derived. Image objects can be moved, rotated and scaled. They can also be stretched horizontally or vertically, but they cannot be made non-rectangular.



Color and texture applied to faces

Users can import their own raster image files to create textures or simply apply an image to a face. SketchUp supports the following raster image formats:⁴³

Image file format		Windows	macOS
JPEG	JPEG File Interchange Format	•	•
PNG	Portable network graphics	•	•
EPS	Encapsulated Postscript File	•	•
TIFF	Tagged Image File	•	•
TGA	Truevision Graphics Adapter	•	
BMP	Bitmap image file	•	
PDF	Portable Document Format		•
PICT	Macintosh PICT File		•
PSD	Photoshop Document		•
SGI	Silicon Graphics Image		•

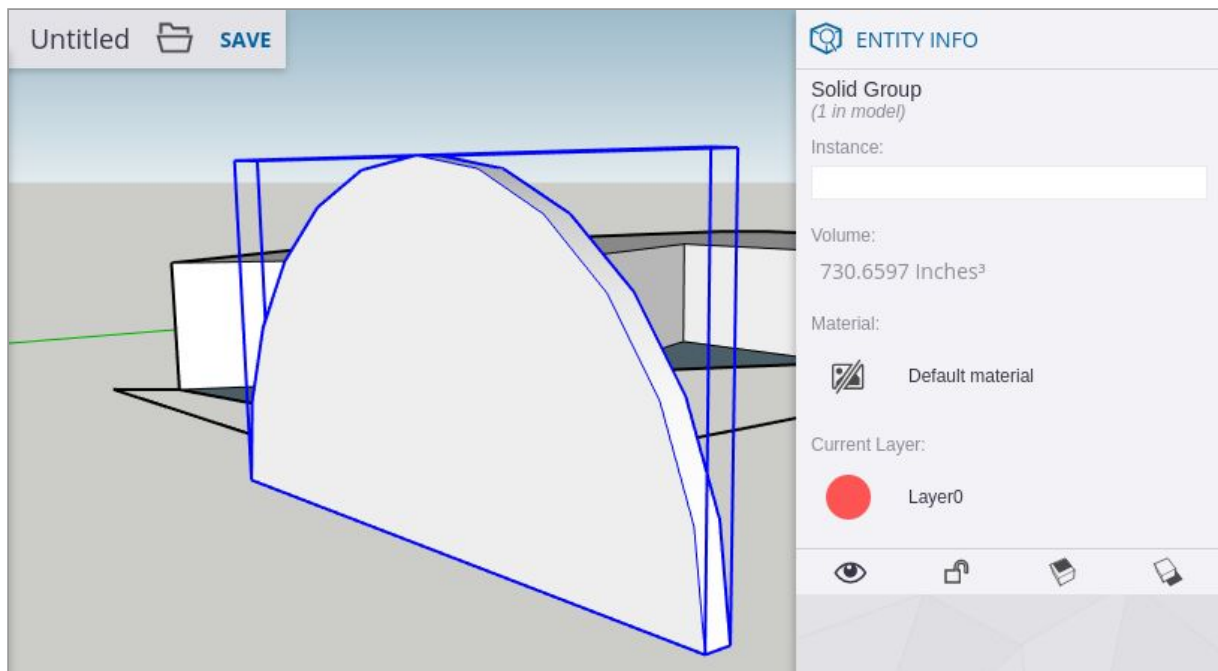
Any color or texture used as a **material** can have transparency properties — enabling to create realistic windows, screens, or see-through walls. Texture and material files are stored as a part of the model and thus embedded in the file, but the materials used can be exported as a separate .skm file to be used in other models.

4.2.5. Groups and Components

Groups are entities that can hold other entities. Groups are commonly used to combine several entities as a single entity for the purpose of performing a quick operation (such as copy or move). They don't require definitions of names, insertion points or special behaviors. Groups are simply a collection of geometry that acts as one object.

Image entities are essentially special groups consisting of a face with an applied bitmap.

⁴³ <https://help.sketchup.com/en/sketchup/sticking-photo-or-texture-face>

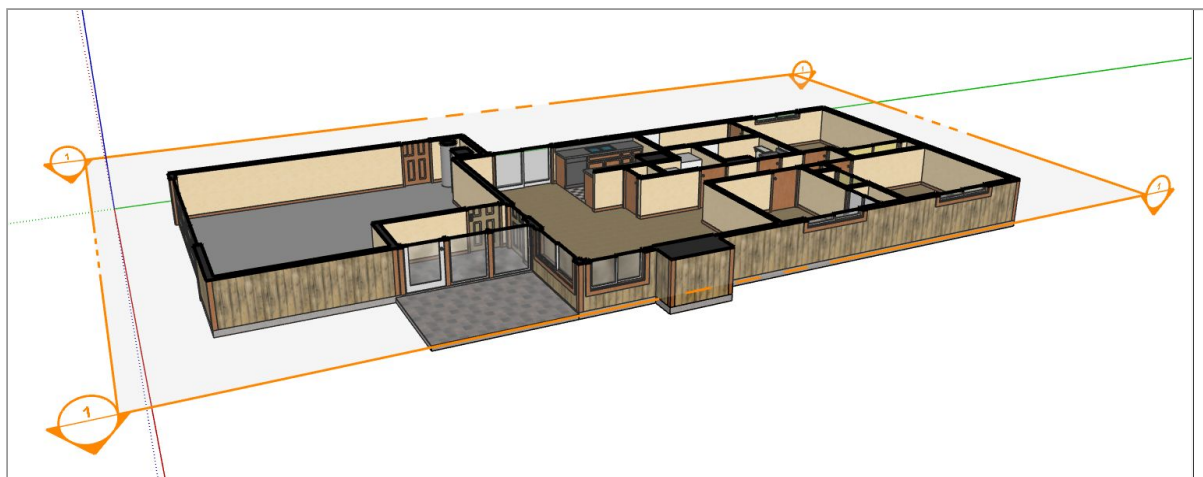


Grouped entity

SketchUp **components** enable to reuse objects, such as a door or a window. Like all geometry in SketchUp, a component is still made of edges and faces. The edges and faces are simply part of a special component group. Components may be created in the model or imported (e.g. from the 3D Warehouse). A **component definition** provides a blueprint for how all components of a specific type appear and behave in the drawing area. When you insert a component into a model, a **component instance** is created, which is based on its definition.

4.2.6. Section Plane

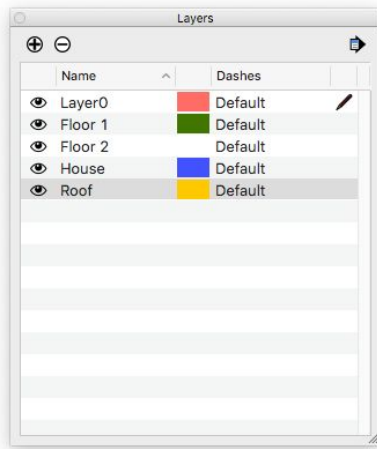
Section planes cut a model along a plane so that you can peer inside the model — without moving or hiding any geometry.



Section plane © Trimble

4.2.7. Layers

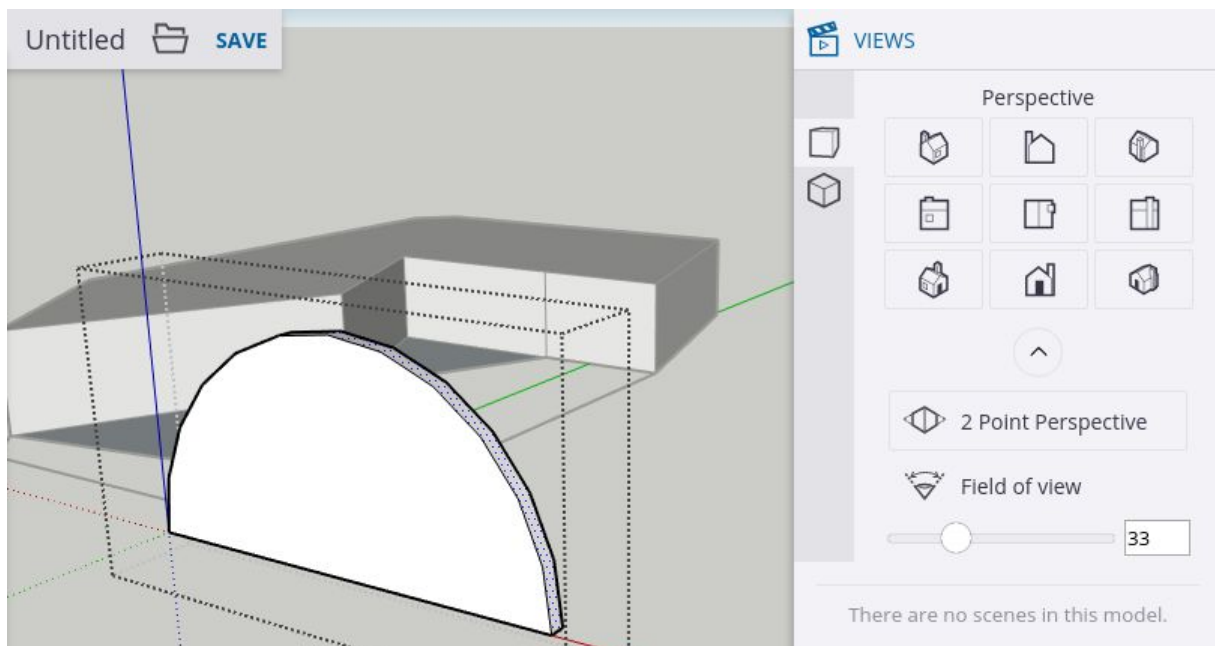
SketchUp supports the use of layers as a means to show or hide entities, groups or components. An entity that is part of a hidden layer can still interact with other entities (in contrast to layers in graphic manipulation software such as Adobe Photoshop).



Layers © Trimble

4.2.8. Visualization entities: fog, lightning, scenes, camera and views

In addition to the navigation tools, SketchUp includes several standard view. **Scenes** store things such as camera standpoints, lighting, layer properties etc.⁴⁴ They can be combined into animations such as shadow studies or walkthroughs.⁴⁵



Views

⁴⁴ <https://help.sketchup.com/en/sketchup/creating-scenes>

⁴⁵ <https://help.sketchup.com/en/sketchup/animating-scenes>

Fog is primarily used as a special effect during presentations. The fog effect mimics real fog, so a 3D model becomes clearer when zooming in, and less clear when zooming out.

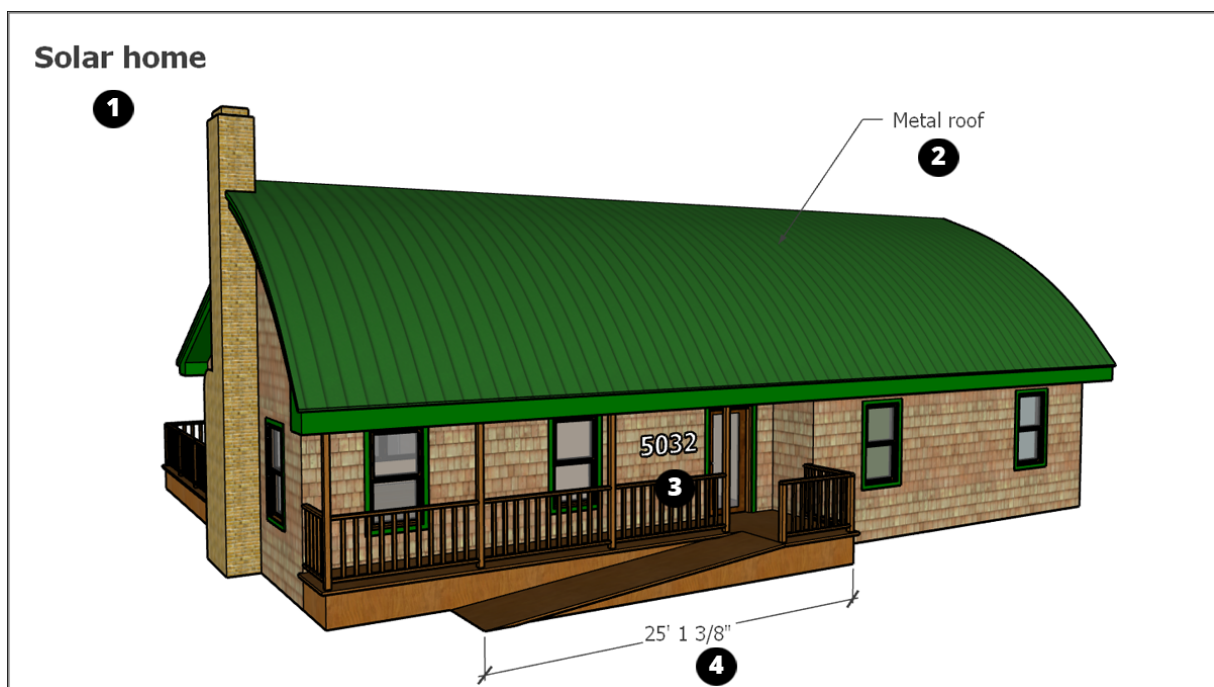
4.2.9. Supporting entities: text, dimensions, guidelines

Three types of text can be added:

- Screen text (1) is fixed to the screen regardless of how a model is orbited
- Leader text (2) is the line or arrow pointing to a model entity.
- 3D text (Callout 3) is made of actual edges and faces that become part of a model.

Dimensions are entities that are linked to a line, circle, or arc entity to display a measurement.

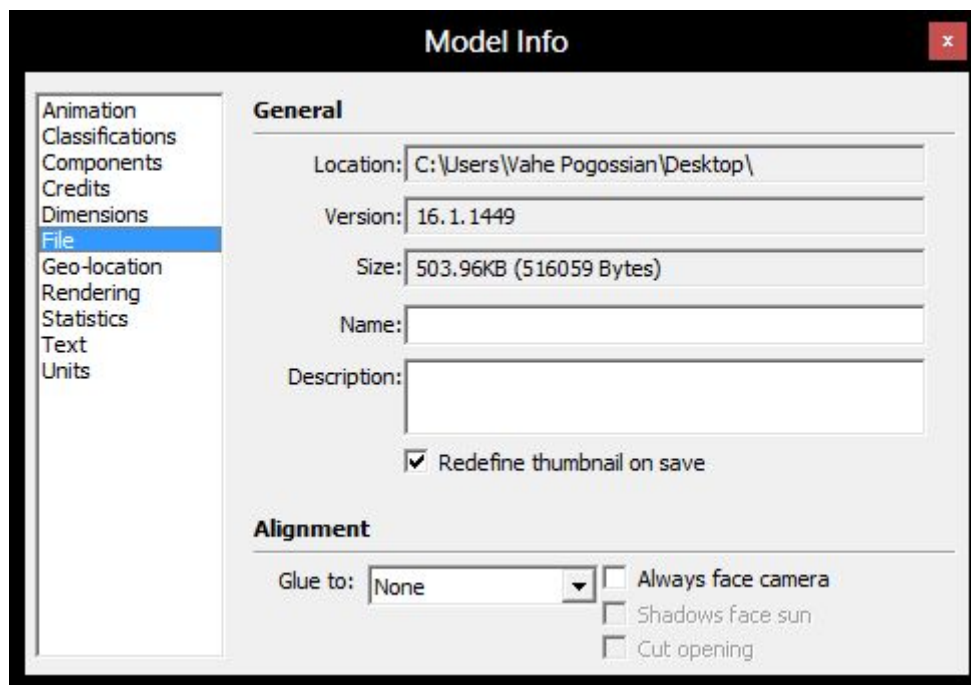
A Guide Line entity is a temporary line used as a drawing guide.



Text types and dimensions © Trimble

4.2.10. Metadata

File properties and statistics can be read from the Model Info option in SketchUp. The Statistics panel displays information about the type and number of drawing elements in a model and allows performing verifications on the model.

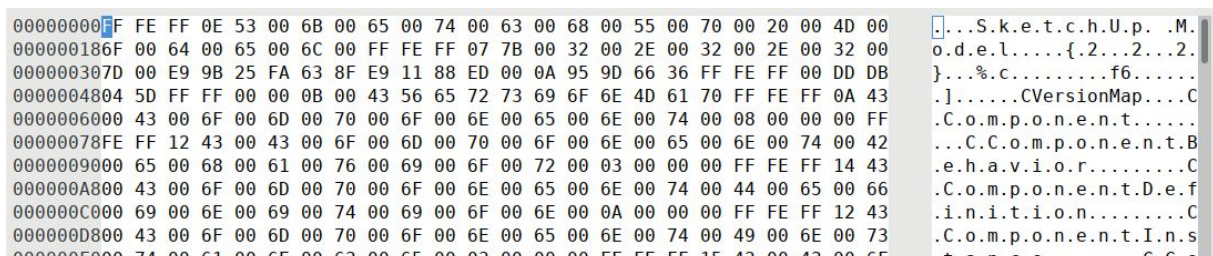


4.3. SketchUp file format structure

The SketchUp format is the native format used by Trimble's SketchUp Pro and SketchUp Viewer 3D modeling packages. Every major version of SketchUp has a unique version of the SketchUp file format. A SketchUp file consists of one single file, that contains all components and entities used inside a SketchUp model. The format is binary, but some components are stored as plain text (ASCII) characters. Like the software, the file structure is licensed and not disclosed. As a consequence, analyzing and documenting the internal file format structure is quite a complex task.^{46, 47}

4.3.1. Internal structure

The structure of a SketchUp model can be derived from the API documentation, but it gives no indication on how the file itself is organized. Some clues may come from the bits of ASCII text that are found in the file. Inspection with a hex- or text editor shows that SketchUp files have a directory-like structure in which entities of the file are named and probably indexed. The directory is marked by start- and end markers CVersionMap and End-Of-Version-Map.

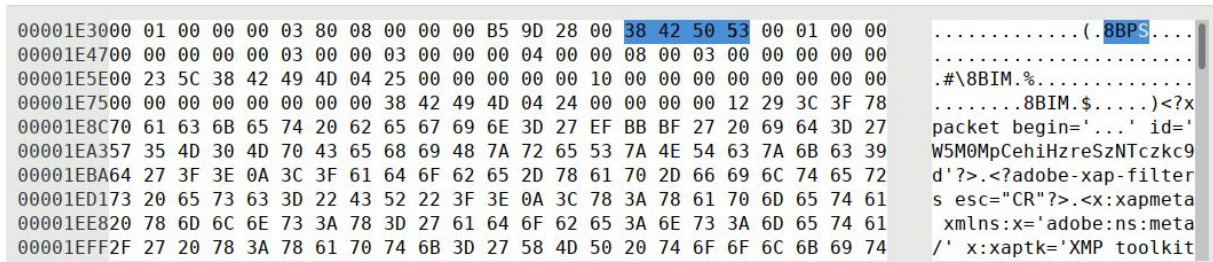


Beginning of a SketchUp file in a Hex-viewer, with the beginning of a versionmap in the left pane.

⁴⁶ <https://forums.sketchup.com/t/is-there-any-documentation-of-the-skp-file-format/62269/3>

⁴⁷ http://extensions.sketchup.com/developer_center/sketchup_c_api/sketchup/index.html

The format can contain other files e.g. for textures. The presence of these files can be detected by the occurrence of strings that give an indication of the format of the embedded file (e.g. JFIF, illustration) or file signatures (e.g. 8BPS for Photoshop documents).



Hex view of a SketchUp file (fragment) with start of an embedded Photoshop document file (with file signature 8BPS)

From this it can be deduced that SketchUp is a container format. As entities are organized in a tree-like format, it is also likely that the format is structured similar to a Windows binary file with and OLE data structure.⁴⁸

4.3.2. SketchUp file identification and signature

SketchUp files can be identified by its extension (.skp or .skb for backup files), which is used on a Windows operating system. A more reliable and specific identification method is based on the file signature or magic number located in the header of the file. Magic numbers can be used to identify the format, as well as the software version and even the build number. This identification method is used on most *nix based operating systems (Linux, macOS).⁴⁹

SketchUp magic numbers nor extensions are registered in the default registries of current Windows or macOS versions. The SketchUp file format has an entry in the National Archives for inclusion in the PRONOM registry, but consecutive versions are not identified.^{50,51} For a further analysis of the magic number we collected SketchUp files from different resources, such as the Sketchup Warehouse (versions 2017 and later), GitHub and the archive of Christian Kieckens architects, held by the Flanders Architecture Institute.^{52, 53} The Flanders Architecture Institute also invited architects to send SketchUp files for our analysis. Lastly, we used an older version of SketchUp (v. 8.0) to *downsave* SketchUp files to earlier versions (up to version 2.0).

These samples revealed a consistent pattern of the signature that represents the file format, version and build number, e.g.: SketchUp Model {8.0.3117}

In HEX and ISO 8859-1 encoding (with unprintable characters represented as '.'):

```
fffe ff0e 5300 6b00 6500 7400 6300 6800 ....S.k.e.t.c.h.
5500 7000 2000 4d00 6f00 6400 6500 6c00 U.p. .M.o.d.e.l.
fffe ff0a 7b00 3800 2e00 3000 2e00 3300 ....{.8...0...3.
```

⁴⁸ https://olefile.readthedocs.io/en/latest/OLE_Overview.html

⁴⁹ Underwood, 2009

⁵⁰ In PRONOM database: id = PUID: x-fmt/451

<https://www.nationalarchives.gov.uk/pronom/x-fmt/451>

⁵¹ Smith, 2009

⁵² Van Impe & Serulus, 2018

⁵³ Dhaese, n.d.

```
3100 3100 3700 7d00 2c60 ad08 3a31 d446 1.1.7.},`:1.F
```

There are different builds for the Mac and Windows operating systems, so with the build number it is possible to determine the OS that was used. However, when a file is downsaved to an earlier format version, the signature is saved without a build number, e.g.: SketchUp Model {17.0.1}.

A listing of the file signatures can be found in the Addenda.⁵⁴

4.3.3. External References

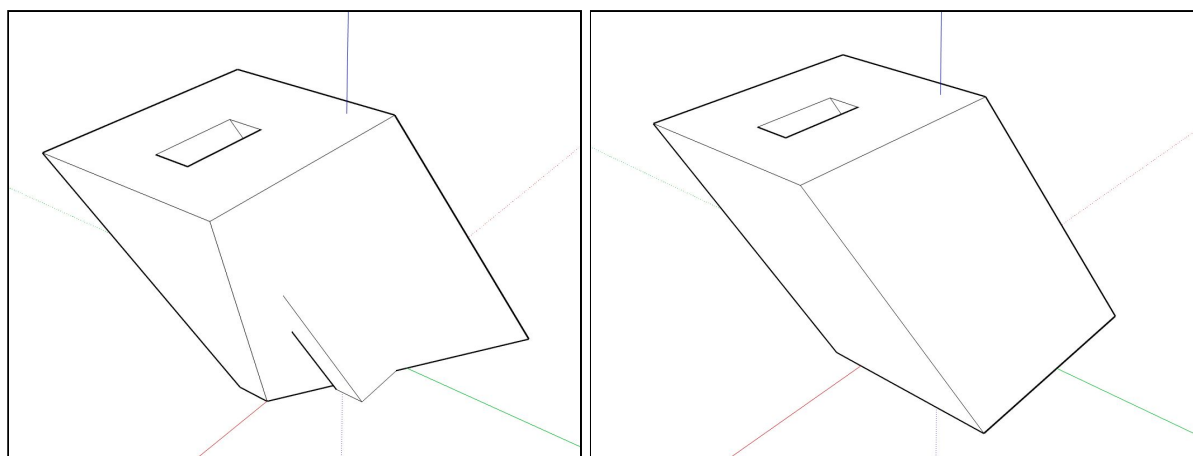
When a model is imported to another ‘master’ model, the imported object is treated as a component and copied entirely in the master model. The reference to the original object is stored in the master model as well, which allows a user to update the master after the component has been changed. Since the 2016 version, references can also be stored on the web (e.g. Dropbox).⁵⁵

Note that files imported into SketchUp behave differently than XREFS in AutoCAD: in SketchUp, a copy of the imported file is placed into the SketchUp model. In AutoCAD, the XREF isn’t copied into the master drawing, it’s just linked to it.

4.3.4. Bitrot vulnerability

Bitrot is the corruption of files as a consequence of disappearing bits or unwanted bit flipping, i.e. one or more bits switched from 1 to 0 or vice versa. Bitrot often results in damaged or unreadable files. The impact of bitrot may also depend on the part of the file which is affected. Bitrot in the header of a file will generally have a higher impact than a bit flipping in the body of the file. The risk of bitrot is also said to be higher with binary files, although there is no general agreement with this.⁵⁶

As a preliminary test, we investigated the effect of bitrot on Sketchup files by manually flipping one or more bits.⁵⁷ It turned out that SketchUp is very vulnerable to bitrot: even one bit flip in the body of a Sketchup file changed the geometry of the model significantly (see screenshot).



File with 1 bit flipped

Original file

⁵⁴ A request was sent to the National Archives to incorporate this information in the PRONOM database.

⁵⁵ <https://help.sketchup.com/en/working-components-sketchup>

⁵⁶ McGrath, 2016

⁵⁷ Gattuso, 2013

SketchUp does not give a warning that the file is damaged or has been inadvertently changed. So it seems that SketchUp has no mechanism for checking file integrity. It is clear that the possible risks and consequences of bitrot for SketchUp files need to be further investigated.

4.4. Supported export formats

The Pro and Shop versions of the SketchUp application natively support importing and exporting to different file formats. The SketchUp Ruby API has also several exporter plugins.⁵⁸ Below is a list of natively supported export formats and some of their limitations.⁵⁹ Apart from these, third party applications or plugins are available in the Extensions Warehouse.

4.4.1. 3D Studio

3DS (extension .3ds) is one of the file formats used by the Autodesk 3ds Max 3D modeling, animation and rendering software. Along with the OBJ file format, it is a de facto industry standard for transferring models between 3D programs. 3DS is a binary format.⁶⁰

3DS preserves material assignments, texture mapping, and camera position, and therefore 3DS can often transfer models with greater fidelity than CAD formats can. It has some limitations:⁶¹

- The 3DS format does not support layers;
- Length of filenames of objects are restricted (e.g. texture filenames are limited to the 8.3 DOS format);
- The number of vertices and polygons per mesh is limited to 65536;
- All meshes are triangulated;
- Directional light sources are not supported.

4.4.2. AutoCAD files

DWG and DXF (extension .dwg, .dxf) are well known and widely adopted file formats for 2D and 3D architectural drawings. The DWG specification is owned by AutoDesk and proprietary, but has been made available (including open software libraries) by reverse engineering by the Open Design Alliance.⁶² The DXF format is Autodesk's text based, open version of the format.⁶³ SketchUp supports export up to version 2014 of the DWG file format.⁶⁴

SketchUp faces are exported as a triangulated polyface mesh. SketchUp uses the current units set in the Units pane of the Model Info dialog box as a reference for translation to a .dwg or .dxf file.⁶⁵

4.4.3. COLLADA

COLLADA (extension .dae) is an XML-based schema that enables transferring data among 3D digital content creation tools, such as SketchUp, Maya, 3ds Max, and Rhino. COLLADA is an open file format, maintained by the Khronos group.⁶⁶ SketchUp supports the COLLADA 1.4 specification and schema, while the latest version of Collada is 1.5.

⁵⁸ http://ruby.sketchup.com/file.exporter_options.html

⁵⁹ <https://help.sketchup.com/en/sketchup/using-sketchup-data-other-modeling-programs-or-tools>

⁶⁰ <https://en.wikipedia.org/wiki/.3ds>

⁶¹ <https://help.sketchup.com/en/sketchup/importing-and-exporting-3ds-files#export-3ds>

⁶² https://www.opendesign.com/files/guestdownloads/OpenDesign_Specification_for_.dwg_files.pdf

⁶³ https://images.autodesk.com/adsk/files/autocad_2012_pdf_dxf-reference_enu.pdf

⁶⁴ http://ruby.sketchup.com/file.exporter_options.html

⁶⁵ <https://help.sketchup.com/en/sketchup/importing-and-exporting-cad-files>

⁶⁶ <https://www.khronos.org/collada/>

COLLADA doesn't support all features of a SketchUp file: coordinate lines, dimensions, guidelines and guide points, matched photos, material pushpin locations, rendering options, scenes, section planes, section cuts, shadows and text are not supported.⁶⁷

Exporting to COLLADA is also available in the free SketchUp for Web application.

4.4.4. FBX

FBX (Filmbox, extension .fbx) is a proprietary and binary file format (.fbx) owned by Autodesk. It is used to provide interoperability between applications to create film, game, or similar 3D content. According to the SketchUp documentation, all features of a SketchUp model are preserved when exporting an FBX file.⁶⁸ It is possible to break down multi sided faces into triangles. Two-sided faces are exported twice: once for the front and once for the back.

4.4.5. IFC

IFC (Industry Foundation Classes, extension .ifc) is an open file format for the description of architectural, building and construction industry data. The format is used as the collaboration format in Building information modeling (BIM) projects.

SketchUp models with classified objects can be exported as an IFC file or a CSV table.⁶⁹ 'Classification' means that every component must be tagged with a classification that is part of the SketchUp file (see above under 3.5.8 BIM support). The exporter supports the IFC2x3 format only and several issues with the support of the IFC format have been reported.^{70, 71}

4.4.6. KMZ Google Earth

The KMZ format (extension .kmz) is a zipped form of Google Earth's proprietary Keyhole Markup Language (KML). It is mainly used to represent an SketchUp model in context of its intended surroundings. Exporting to KMZ is also available in the free SketchUp for Web application. A KMZ can contain location data (latitude and longitude) along with other information, including limited SketchUp geometry.⁷²

4.4.7. OBJ

The OBJ file format (extension .obj) was developed by Wavefront Technologies and has been widely adopted by other developers as a de facto standard. OBJ files are text-based, but there's also a binary version available. Both free-form and polygonal geometry is supported. When a SketchUp file is exported to OBJ, an additional .mtl file is created, which describes materials defined in the .obj file.⁷³ Geometrical entities are structured in a flat set membership hierarchy. The multilevel hierarchies (tree format) from SketchUp are not supported.

4.4.8. PDF and EPS

Export of vector images as PDF or EPS is supported as 2D format. Some features may get lost however: graphic features that rely on raster images, such as textures, shadows, smooth shading, backgrounds, and transparency, can't be exported to PDF and EPS vector files. When other geometry hides text and dimensions, the text and dimensions appear on top of the geometry in the exported

⁶⁷ <https://help.sketchup.com/en/sketchup/importing-and-exporting-collada-files>

⁶⁸ <https://help.sketchup.com/en/sketchup/exporting-fbx-files>

⁶⁹ <https://help.sketchup.com/en/sketchup/classifying-objects>

⁷⁰ <https://forums.sketchup.com/t/export-to-ifc-how-to-export-lines-and-edit-component-info/50351/7>

⁷¹ <https://forums.sketchup.com/t/ifc-import-to-export-from-sketchup-pro/46139/5>

⁷² <https://help.sketchup.com/en/sketchup/exporting-kmz-files-google-earth>

⁷³ <https://help.sketchup.com/en/sketchup/exporting-obj-files>

file. When edges of the SketchUp drawing area clip part of a text or dimension entity, it's not exported at all. Some text may appear in a slightly different font in the exported file.⁷⁴

4.4.9. STL

STereoLithography with extension .stl is an open and widely supported file format mainly intended for 3D printing. The format can be both in ASCII and binary format. An STL file describes a raw, unstructured triangulated surface. STL files describe only the surface geometry of a three-dimensional object without any representation of color, texture or other common CAD model attributes. However, for the binary format, there are some non-standard ways of supporting color information.⁷⁵

For a SketchUp model to become a successful 3D printout, the model needs to meet certain criteria, such as having a base and a volume and being a solid.⁷⁶ Exporting to STL is also available in the free SketchUp for Web application.

4.4.10. VRML

VRML (Virtual Reality Modeling Language, extension .wrl) is a standard file format for representing 3-dimensional interactive vector graphics. The format is text based and has been accepted as an ISO standard.⁷⁷ VRML is still supported and used as a format to exchange data between 3D applications and to publish 3D information online. However, it has been superseded by X3D. The latest version was issued in 1997 as ISO/IEC 14772-1:1997.⁷⁸

A VRML file references to the textures as separate files. VRML doesn't support all features of a SketchUp model, but it is claimed that basic entities such as: camera views, edges, faces, groups, lights, materials, textures and transparency are supported.⁷⁹ VRML's successor X3D added shaders, geolocation and other features to support use in specific domains such as CAD, GIS and AR/VR, but an X3D export isn't supported by SketchUp.⁸⁰

4.4.11. XSI

XSI (extension .xsi) is a proprietary format used with Autodesk Softimage, an application used to create 3D content in film and video gaming industry. The software has been discontinued by Autodesk in 2015.⁸¹

When exporting to XSI, multi sided faces can optionally be triangulated. Two-sided faces are exported twice: once for the front and once for the back.⁸²

4.4.12. Export formats supported by plugins

Via the Extension Warehouse, third party developers such as Simlab and Okino offer extensions that allow the export to some additional file formats, such as DWF, 3D PDF, GLTF, STL and IGES:^{83, 84}

⁷⁴ <https://help.sketchup.com/en/sketchup/importing-and-exporting-image-files>

⁷⁵ [https://en.wikipedia.org/wiki/STL_\(file_format\)#Use_in_other_fields](https://en.wikipedia.org/wiki/STL_(file_format)#Use_in_other_fields)

⁷⁶ <https://help.sketchup.com/en/sketchup/3d-printing-model>

⁷⁷ <http://www.web3d.org/standards>

⁷⁸ <https://www.iso.org/standard/25508.html>

⁷⁹ <https://help.sketchup.com/en/sketchup/exporting-vrml-files>

⁸⁰ <https://www.web3d.org/x3d-vrml-most-widely-used-3d-formats>

⁸¹ https://en.wikipedia.org/wiki/Autodesk_Softimage

⁸² <https://help.sketchup.com/en/sketchup/exporting-xsi-files>

⁸³ https://www.okino.com/conv/imp_sketchup.htm

⁸⁴ https://www.simlab-soft.com/3d-plugins/SketchUp_Plugins.aspx

- (1) AutoCAD Design Web Format (DWF) is a proprietary, compressed file format, intended to publish and communicate AutoCAD DWG files in a lightweight form. This compression is achieved by omitting the 'overhead' in complex CAD files.
- (2) 3D PDF is a PDF file with 3D geometry inside. The geometry is encoded in an embedded file, e.g. U3D.
- (3) WebGL is a JavaScript API for real-time rendering of 3D and 2D graphics within a browser. It is accompanied by the GLTF file format. glTF is a file format for 3D scenes and models using the JSON standard.
- (4) IGES is an open, ASCII based file format for the representation of geometric objects, with limited capability of representing more complex features, metadata etc.

4.4.13. Export as 2D graphic files

SketchUp supports the export of 2D raster or vector images. Supported vector based formats are the aforementioned formats DWG, DXF, PDF and EPS. Visualizations can be exported to raster images in JPEG, TIFF, PNG, PSD or BMP format.⁸⁵

4.5. Importing SketchUp files in third party applications

Some other CAD applications can import SketchUp files as well, often with the help of a plugin. As the SketchUp file format is undisclosed, these import functions probably use software libraries provided by Trimble in the SDK. Some examples are:

- VectorWorks: supports the import of SketchUp files, but the after importing, the design may need redesign using Vectorworks editing tools.⁸⁶
- AutoCAD: provides a plugin to import SketchUp files⁸⁷ Only recent versions of the SketchUp file format are supported.
- Rhino: supports import and export natively.⁸⁸
- 3ds Max: can import SketchUp files from version 6 through SketchUp 2014. When bringing a SketchUp file into 3ds Max, all objects are imported except (optionally) hidden objects.⁸⁹
- Blender: can import SketchUp files via an older plugin.⁹⁰
- DesignSpark: supports the import of SketchUp files up to version 2018.⁹¹

Other applications don't support Sketchup files import directly, but advise to use an intermediate format such as DXF (LibreCAD)⁹² STL (SolidWorks) or COLLADA (Blender)⁹³ etc.

⁸⁵ <https://help.sketchup.com/en/sketchup/importing-and-exporting-image-files>

⁸⁶ http://app-help.vectorworks.net/2016/eng/VW2016_Guide/ImportExport/Importing_in_Sketchup_Format.htm

⁸⁷ <https://apps.autodesk.com/ACD/en/Detail/Index?id=4545979311403124726>

⁸⁸ <https://www.rhino3d.com/formats/>

⁸⁹ <https://knowledge.autodesk.com/support/3ds-max/learn-explore/caas/CloudHelp/cloudhelp/2019/ENU/3DSMax-Data-Exchange/files/GUID-AD50EB5B-A535-431B-8066-E2F4836E42D3-htm.html>

⁹⁰ <https://www.blender3darchitect.com/blender-3d/how-to-import-sketchup-files-to-blender-2-8/>

⁹¹ <https://designspark.zendesk.com/hc/en-us/articles/211943145-What-are-the-import-and-export-formats-available->

⁹² https://wiki.librecad.org/index.php/LibreCAD_users_Manual#File_formats

⁹³ https://www.freecadweb.org/wiki/Importing_From_Sketchup

4.6. Backward/forward compatibility

Forward compatibility is not supported: formats in a newer version can't be opened in an older software version. The limit doesn't apply to intermediate updates: e.g. if model is saved in 7.1, it will still be able to be read by SketchUp 7.0, but not SketchUp 6.0.⁹⁴ In every SketchUp application it is possible to downsave up to version 3. An example are the Classification features: classification assignments to objects need to be saved within the SketchUp file. Older SketchUp versions would choke and likely crash SketchUp if they encountered this data.⁹⁵ The effect is that downsaving removes the unsupported properties.

The files are backwards compatible to at least version 3. Compatibility with earlier versions is not documented, but we had no problems opening a SketchUp version 2 file in SketchUp version 2019.

4.7. Preservation risks

Based on the analysis of the SketchUp model and format, it is possible to identify preservation risks. To determine these risks, for this we use a list of criteria to determine whether a format is suitable as an archive format:⁹⁶

- (1) Adoption — the extent to which the format is in widespread use, e.g; the availability of software or software libraries;
- (2) Platform independence — the extent to which the format is independent of specific support from hardware and software;
- (3) Disclosure — the extent to which the file format specification is in the public domain;
- (4) Transparency — the readiness with which the file format can be inspected or interrogated to discover its identity and attributes, as against where it is obscured by compression, 'wrapper' data architectures or other techniques;
- (5) Metadata support — the extent to which descriptive information is supported in machine readable form within the format. This includes OAIS⁹⁷ representation information and occasionally how far the file format supports the recording of management processes it has been subject to (e.g. Microsoft Office document properties).

4.7.1. Adoption

Adoption of SketchUp is relatively high: the SketchUp software and file format is used by architects and designers all over the world. There is a global community of developers and designers that share their creations on both Trimble's and others platforms.

A publicly available software library and SDK allows the creation of applications that can read and write SketchUp files, but Trimble is the sole owner and maintainer.

Although different viewers for SketchUp files are available, adoption of the format by other applications is rather low in that the SketchUp file format is only used by SketchUp as a native format. Some applications (Blender, VectorWorks, AutoCAD) do support the import and/or export of

⁹⁴ <https://help.sketchup.com/en/sketchup/older-release-notes>

⁹⁵ <https://forums.sketchup.com/t/sketchup-not-backwards-compatible-why/20913/2>

⁹⁶ Todd, 2009

⁹⁷ OAIS, 1999

SketchUp files, but contrary to formats such as DWG, DXF or STEP, SketchUp is not widely used as an exchange format, nor has it the status of a de facto standard.

4.7.2. Technological dependencies

The file format itself is platform independent in that all SketchUp files can be read by the Windows and macOS versions of the software (Linux is not supported). The license prohibits the use in a virtual server environment, which may complicate emulation as a preservation strategy.

Another possible risk arises because users must log in to the Trimble license server before the software can be activated. This must be repeated every time the software is used on another device. In addition, since 2019 Trimble started to sell licences on a subscription base. Any interruption or permanent failure of the license server can result in the disabling of SketchUp.

Internally the application depends on few other technologies, most of which are open source. The application extension (plugin) development relies heavily on the open Ruby programming language.

SketchUp files can include raster image files (e.g. used as texture). Some embeddable file formats are proprietary (e.g. Photoshop format), which may create an extra preservation risk.

Workflows may rely on relations between a model and other files, e.g. updates in external components that are used in a model, or changes in a model that have an effect on the dependent Layout files. However, the files themselves contain all necessary information and don't rely on these external files. Exceptions may be the use of external location files.

4.7.3. Disclosure

As the file format specifications are not published or available otherwise, disclosure is an important preservation risk. Also, the source code of the application itself is undisclosed. An analysis of the files and the API documentation can give some clues about the way the model and the file format is structured, but Trimble's software license prohibits reverse engineering the software or the format.

4.7.4. Transparency

A SketchUp file can be identified based on the extension .skp or .skb. An analysis of the file header revealed it is also possible to determine the file format, version and build number by its file signature. As the structure of the file is not documented and the file is binary, file contents cannot be checked or analyzed properly. Some information however (e.g. the presence of embedded raster image files) may be derived by inspecting the files in a text editor or hex viewer.

4.7.5. Metadata support

Metadata, such as credits or file properties can only be extracted from the SketchUp files through the SketchUp application or the API, and not directly from the SketchUp file. We found no indication of metadata that document the history of a SketchUp file.

5. Conclusion: towards a preservation policy for SketchUp files

From a digital archivist's perspective, the overall conclusion is that the SketchUp file format can't be used as a preservation format and it is advisable to develop a strategy to preserve the logical and intellectual contents of SketchUp files. This said, this doesn't imply that the SketchUp files are in danger on a short term: the software and the format have been developed continuously by its successive owners since it was created and there are no indications yet that this process will come to an end. The format architecture never radically changed, and backward compatibility is supported from the first version until now. In other words, SketchUp may be regarded as a stable format that is — at this time — not at risk to become obsolete.

Nevertheless, on medium or long term archival institutions will need to take action and have to develop and implement preservation policies for SketchUp files in their archives. Several approaches are available, which can be grouped in either (1) the preservation of the technology or (2) the preservation of the objects.⁹⁸

Preserving technology approaches attempt to keep data in specific logical or physical formats and use technology originally associated with those formats.⁹⁹ This can be achieved by actually preserving the entire environment (hardware, operating system, software, files) to represent the original SketchUp models in an archival context. This 'computer museum' approach may be useful as a first step, but should be considered as a dead end because obsolete technology - especially the hardware - can't be maintained on the long term.¹⁰⁰

Emulation might solve the obsolete technology issue, but may be hindered by the licensing policy of the owners of the software and format. The same licensing policy impedes the possibility of reverse engineering the format in order to create documentation and open software libraries that could guarantee access to SketchUp files in the future. In any case, applying an emulation strategy requires that the legal and technical challenges are addressed in advance.

The *preserving objects* approach attempts to preserve the essential characteristics (the 'significant properties') of digital documents, without relying on specific hard- or software. In practice this often comes down to the migration of files from the original format to a so-called 'archival format' that preserves the essential characteristics as accurately as possible. This archival format is expected to minimize the preservation risks listed above: adoption, platform independence, disclosure, transparency and metadata support.

As described in chapter 4.4 Supported export formats, the file formats that are natively supported by the SketchUp export function may all have their drawbacks, in that they don't support the file properties adequately, and/or imply other preservation risks. A brief overview of the available extensions for export indicate that the same problem occurs: export file formats often lack the intelligence to represent a SketchUp file's properties sufficiently, and/or are in a format that is undisclosed or obsolete.

⁹⁸ Harvey, 2008

⁹⁹ Thibodeau, 2002

¹⁰⁰ Harvey, 2005

Of the formats discussed, some however may be eligible for use as an archive format:

- (1) OBJ, which has limited support for hierarchies;
- (2) IFC: an open files format, but with questionable support by the SketchUp application;
- (3) AutoCAD DWG or DXF: de facto standards, with public documentation and software libraries;
- (4) 3D PDF: PDF is widely regarded as an archival format, but the format for the embedded 3D geometry is undocumented;
- (5) VRML, which is superseded by X3D and probably limited support for SketchUp entities;¹⁰¹
- (6) COLLADA, with known limits in the support of SketchUp model properties.

The development of a migration workflow would require a more thorough investigation of the way these different file formats support the required significant properties, as well as the way the SketchUp export functionalities or plugins comply with the file format definitions.

The preservation policy should also take into account the properties that are effectively applied by SketchUp users: complex SketchUp models that contain dynamic components, advanced lighting settings will be more demanding than a model with uncomplicated geometry. In other words: simple SketchUp models may be migrated to relatively simple, ‘unintelligent’ file formats without loss of information, while more complex models will lose information when the same migration path is used. Therefore, different migration paths may be applied: e.g. models with meaningful visual properties could best be converted to VRML, while models with BIM properties would benefit more from a migration to IFC. But again: the effects of a migration on the eventual loss of significant properties should be thoroughly investigated.

In the event that the current SketchUp supported export formats do not meet the requirements of an archiving format, a choice can be made to develop an extension that can migrate the logical content — or at least the significant properties — of a SketchUp file to an acceptable archiving format. In doing so, account must be taken of the need to adjust this extension with each significant modification of the SketchUp model.

¹⁰¹ X3D could also be considered as a candidate preservation format, but is not natively supported by SketchUp. A migration procedure should still use VRML as an intermediate format.

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7. Addenda

All data in the following tables was built on the basis of the historical data collected during the course of the research. They therefore constitute a reconstruction based on different sources and do not provide a complete picture of all software and file format versions that have existed.

7.1. Sketchup file signatures

Each SketchUp file has a file signature or magic number that defines the file format, the version number and eventually the build number. Every file we analyzed starts with a string (“S.k.e.t.c.h.U.p.
.M.o.d.e.l”) on a 4 byte offset, followed by the version and build number between curly brackets. The table below shows the magic numbers in ISO 8859-1 and HEX encoding. The magic number is based on an actual analysis of the file format, or compiled on the basis of the known structure and the version number. Magic numbers that were thus recomposed are marked with an asterisk (*).

Software version	software maintenance no.	version no.	OS	Magic number HEX	Magic Number (ASCII)
V1 Pre-release		1.0.20		....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{1... 0...2.0.}* 	fffe ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3100 2e00 3000 2e00 3200 3000 7d00 *
SketchUp v.1		1.0.1		....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{1... 0...1.}* 	fffe ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3100 2e00 3000 2e00 3100 7d00 *
SketchUp v.2		2.0.1		....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{2... 0...1.}* 	fffe ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3200 2e00 3000 2e00 3100 7d00 *
SketchUp v.2.2		2.2.2	Mac	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{.2.. .2...2.} 	fffe ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3200 2e00 3200 2e00 3200 7d00 *
SketchUp v.3		3.0.102	Mac	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{.3.. .0...1.0.2.} 	fffe ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3300 2e00 3000 2e00 3100 3000 3200 7d00 *
SketchUp 4		4.0.1	Mac	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{.4.. .0...1.} 	fffe ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3400 2e00 3000 2e00 3100 7d00 *

SketchUp 5		5.0.1		. . . . S . k . e . t . c . h . U . p . . M . o . d . e . l { . 5 . . . 0 . . . 1 . }	f f f e f f 0 e 5 3 0 0 6 b 0 0 6 5 0 0 7 4 0 0 6 3 0 0 6 8 0 0 5 5 0 0 7 0 0 0 2 0 0 0 4 d 0 0 6 f 0 0 6 4 0 0 6 5 0 0 6 c 0 0 f f f e f f 0 7 7 b 0 0 3 5 0 0 2 e 0 0 3 0 0 0 2 e 0 0 3 1 0 0 7 d 0 0 *
SketchUp 5		5.0.260		. . . . S . k . e . t . c . h . U . p . . M . o . d . e . l { . 5 . . . 0 . . . 2 . 6 . 0 . }	f f f e f f 0 e 5 3 0 0 6 b 0 0 6 5 0 0 7 4 0 0 6 3 0 0 6 8 0 0 5 5 0 0 7 0 0 0 2 0 0 0 4 d 0 0 6 f 0 0 6 4 0 0 6 5 0 0 6 c 0 0 f f f e f f 0 7 7 b 0 0 3 5 0 0 2 e 0 0 3 0 0 0 2 e 0 0 3 2 0 0 3 6 0 0 3 0 0 0 7 d 0 0 *
SketchUp 5		5.0.295		. . . . S . k . e . t . c . h . U . p . . M . o . d . e . l { . 5 . . . 0 . . . 2 . 9 . 5 . }	f f f e f f 0 e 5 3 0 0 6 b 0 0 6 5 0 0 7 4 0 0 6 3 0 0 6 8 0 0 5 5 0 0 7 0 0 0 2 0 0 0 4 d 0 0 6 f 0 0 6 4 0 0 6 5 0 0 6 c 0 0 f f f e f f 0 7 7 b 0 0 3 5 0 0 2 e 0 0 3 0 0 0 2 e 0 0 3 2 0 0 3 9 0 0 3 5 0 0 7 d 0 0 *
SketchUp 6	-	6.0.1	Mac	. . . . S . k . e . t . c . h . U . p . . M . o . d . e . l { . 6 . . . 0 . . . 1 . }	f f f e f f 0 e 5 3 0 0 6 b 0 0 6 5 0 0 7 4 0 0 6 3 0 0 6 8 0 0 5 5 0 0 7 0 0 0 2 0 0 0 4 d 0 0 6 f 0 0 6 4 0 0 6 5 0 0 6 c 0 0 f f f e f f 0 7 7 b 0 0 3 6 0 0 2 e 0 0 3 0 0 0 2 e 0 0 3 1 0 0 7 d 0 0 *
SketchUp 6	-	6.0.514	Win	. . . . S . k . e . t . c . h . U . p . . M . o . d . e . l { 6 . . . 0 . . . 5 . 1 . 4 . } *	f f f e f f 0 e 5 3 0 0 6 b 0 0 6 5 0 0 7 4 0 0 6 3 0 0 6 8 0 0 5 5 0 0 7 0 0 0 2 0 0 0 4 d 0 0 6 f 0 0 6 4 0 0 6 5 0 0 6 c 0 0 f f f e f f 0 7 7 b 0 0 3 6 0 0 2 e 0 0 3 0 0 0 2 e 0 0 3 5 0 0 3 1 0 0 3 4 0 0 7 d 0 0 *
SketchUp 6	(?)	6.4.112	Win	. . . . S . k . e . t . c . h . U . p . . M . o . d . e . l { 6 . . . 4 . . . 1 . 1 . 2 . } *	f f f e f f 0 e 5 3 0 0 6 b 0 0 6 5 0 0 7 4 0 0 6 3 0 0 6 8 0 0 5 5 0 0 7 0 0 0 2 0 0 0 4 d 0 0 6 f 0 0 6 4 0 0 6 5 0 0 6 c 0 0 f f f e f f 0 7 7 b 0 0 3 6 0 0 2 e 0 0 3 4 0 0 2 e 0 0 3 1 0 0 3 1 0 0 3 2 0 0 7 d 0 0 *
SketchUp 6	M6	6.4.263	Mac	. . . . S . k . e . t . c . h . U . p . . M . o . d . e . l { 6 . . . 4 . . . 2 . 6 . 3 . } *	f f f e f f 0 e 5 3 0 0 6 b 0 0 6 5 0 0 7 4 0 0 6 3 0 0 6 8 0 0 5 5 0 0 7 0 0 0 2 0 0 0 4 d 0 0 6 f 0 0 6 4 0 0 6 5 0 0 6 c 0 0 f f f e f f 0 7 7 b 0 0 3 6 0 0 2 e 0 0 3 4 0 0 2 e 0 0 3 2 0 0 3 6 0 0 3 3 0 0 7 d 0 0 *
SketchUp 6	M6	6.4.265	Win	. . . . S . k . e . t . c . h . U . p . . M . o . d . e . l { 6 . . . 4 . . . 2 . 6 . 5 . } *	f f f e f f 0 e 5 3 0 0 6 b 0 0 6 5 0 0 7 4 0 0 6 3 0 0 6 8 0 0 5 5 0 0 7 0 0 0 2 0 0 0 4 d 0 0 6 f 0 0 6 4 0 0 6 5 0 0 6 c 0 0 f f f e f f 0 7 7 b 0 0 3 6 0 0 2 e 0 0 3 4 0 0 2 e 0 0 3 2 0 0 3 6 0 0 3 5 0 0 7 d 0 0 *
SketchUp 7	-	7.0.1		. . . . S . k . e . t . c . h . U . p . . M . o . d . e . l { . 7 . . . 0 . . . 1 . }	f f f e f f 0 e 5 3 0 0 6 b 0 0 6 5 0 0 7 4 0 0 6 3 0 0 6 8 0 0 5 5 0 0 7 0 0 0 2 0 0 0 4 d 0 0 6 f 0 0 6 4 0 0 6 5 0 0 6 c 0 0 f f f e f f 0 7 7 b 0 0 3 7 0 0 2 e 0 0 3 0 0 0 2 e 0 0 3 1 0 0 7 d 0 0 *
SketchUp 7.0	-	7.0.8656	Mac	. . . . S . k . e . t . c . h . U . p . . M . o . d . e . l { 7 . . . 0 . . . 8 . 6 . 5 . 6 . } *	f f f e f f 0 e 5 3 0 0 6 b 0 0 6 5 0 0 7 4 0 0 6 3 0 0 6 8 0 0 5 5 0 0 7 0 0 0 2 0 0 0 4 d 0 0 6 f 0 0 6 4 0 0 6 5 0 0 6 c 0 0 f f f e f f 0 7 7 b 0 0 3 7 0 0 2 e 0 0 3 0 0 0 2 e 0 0 3 8 0 0 3 6 0 0 3 5 0 0 3 6 0 0 7 d 0 0 *
SketchUp 7.0	-	7.0.8657	Win	. . . . S . k . e . t . c . h . U . p . . M . o . d . e . l { 7 . . . 0 . . . 8 . 6 . 5 . 7 . } *	f f f e f f 0 e 5 3 0 0 6 b 0 0 6 5 0 0 7 4 0 0 6 3 0 0 6 8 0 0 5 5 0 0 7 0 0 0 2 0 0 0 4 d 0 0 6 f 0 0 6 4 0 0 6 5 0 0 6 c 0 0 f f f e f f 0 7 7 b 0 0 3 7 0 0 2 e 0 0 3 0 0 0 2 e 0 0 3 8 0 0 3 6 0 0 3 5 0 0 3 7 0 0 7 d 0 0 *

SketchUp 7.0	M1	7.0.10246	Mac	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{7... 0...1.0.2.4.6.}* 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3700 2e00 3000 2e00 3100 3000 3200 3400 3600 7d00 *	ffff ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3700 2e00 3000 2e00 3100 3000 3200 3400 3600 7d00 *
SketchUp 7.0	M1	7.0.10247	Win	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{7... .0...1.0.2.4.7.} 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3700 2e00 3000 2e00 3100 3000 3200 3400 3700 7d00 *	ffff ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3700 2e00 3000 2e00 3100 3000 3200 3400 3700 7d00 *
SketchUp 7	M1	7.0.7783		....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{7... .0...7.7.8.3.} 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3700 2e00 3000 2e00 3700 3700 3800 3300 7d00 *	ffff ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3700 2e00 3000 2e00 3700 3700 3800 3300 7d00 *
SketchUp 7.0	M1	7.1.8107		....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{7... .0...8.1.0.7.} 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3700 2e00 3100 2e00 3800 3100 3000 3700 7d00 *	ffff ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3700 2e00 3100 2e00 3800 3100 3000 3700 7d00 *
SketchUp 7.1	M2	7.1.6859	Mac	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{7... 1...6.8.5.9.}* 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3700 2e00 3100 2e00 3600 3800 3500 3900 7d00 *	ffff ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3700 2e00 3100 2e00 3600 3800 3500 3900 7d00 *
SketchUp 7.1	M2	7.1.6860	Win	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{7... .1...6.8.6.0.} 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3700 2e00 3100 2e00 3600 3800 3600 3000 7d00 *	ffff ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3700 2e00 3100 2e00 3600 3800 3600 3000 7d00 *
SketchUp 8	-	8.0.3117	Win	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{8... .0...3.1.1.7.} 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3800 2e00 3000 2e00 3300 3100 3100 3700 7d00 *	ffff ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3800 2e00 3000 2e00 3300 3100 3100 3700 7d00 *
SketchUp 8	-	8.0.4810	Mac	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{8... 0...4.8.1.0.}* 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3800 2e00 3000 2e00 3400 3800 3100 3000 7d00 *	ffff ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3800 2e00 3000 2e00 3400 3800 3100 3000 7d00 *
SketchUp 8	M1	8.0.4810	Mac	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{8... 0...4.8.1.0.}* 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3800 2e00 3000 2e00 3400 3800 3100 3000 7d00 *	ffff ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3800 2e00 3000 2e00 3400 3800 3100 3000 7d00 *
SketchUp 8	M1	8.0.4811	Win	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{8... 0...4.8.1.1.}* 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3800 2e00 3000 2e00 3400 3800 3100 3100 7d00 *	ffff ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3800 2e00 3000 2e00 3400 3800 3100 3100 7d00 *
SketchUp 8	M2	8.0.11751	Mac	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{ .8...0...1.1.7.5.1.} * 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 300 8200 e300 0200 e300 1300 1300 7300 5300 17d00 *	ffff ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 300 8200 e300 0200 e300 1300 1300 7300 5300 17d00 *

SketchUp 8	M2	8.0.11752	Win	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{.8.. .0...1.1.7.5.2.}	fffe ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 300 8200 e300 0200 e300 1300 1300 7300 5300 27d00 *
SketchUp 8	M3 (?)	8.0.14346		....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{.8.. .0...1.4.3.4.6.}	fffe ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3800 2e00 3000 2e00 3100 3400 3300 3400 3600 7d00 *
SketchUp 8	M4	8.0.15157	Mac	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{8... 0...1.5.1.5.7.}* }	fffe ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3800 2e00 3000 2e00 3100 3500 3100 3500 3700 7d00 *
SketchUp 8	M4	8.0.15158	Win	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{8... 0...1.5.1.5.8. . }* }	fffe ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3800 2e00 3000 2e00 3100 3500 3100 3500 3800 7d00 *
SketchUp 8	M5	8.0.16845	Mac	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{8... 0...1.6.8.4.5. .}* }	fffe ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3800 2e00 3000 2e00 3100 3600 3800 3400 3500 7d00 *
SketchUp 8	M5	8.0.16846	Win	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{.8.. .0...1.6.8.4.6.}	fffe ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3800 2e00 3000 2e00 3100 3600 3800 3400 3600 7d00 *
SketchUp 2013	-	13.0.3688	Mac	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{1.3.. ..0...3.6.8.8.}* }	fffe ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3100 3300 2e00 3000 2e00 3300 3600 3800 3800 7d00 *
SketchUp 2013	-	13.0.3689	Win	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{1.3.. ..0...3.6.8.9. .}* }	fffe ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3100 3300 2e00 3000 2e00 3300 3600 3800 3900 7d00 *
SketchUp 2013	M1	13.0.4124	Win	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{1.3.. ..0...4.1.2.4. . }* }	fffe ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3100 3300 2e00 3000 2e00 3400 3100 3200 3400 7d00 *
SketchUp 2013	M1	13.0.4123	Mac	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{.1.3.. ...0...4.1.2.3.}	fffe ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3100 3300 2e00 3000 2e00 3400 3100 3200 3300 7d00 *

SketchUp 2013	M2	13.0.4811	Mac	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{.1.3 ...0...4.8.1.1.}	fffe ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3100 3300 2e00 3000 2e00 3400 3800 3100 3100 7d00 *
SketchUp 2013	M2	13.0.4812	Win	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{.1.3. ..0...4.8.1.2. . }* 7d00 *	fffe ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3100 3300 2e00 3000 2e00 3400 3800 3100 3200 7d00 *
SketchUp 2014	-	14.0.4899	Mac	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{.1.4 ...0...4.8.9.9.}	fffe ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3100 3400 2e00 3000 2e00 3400 3800 3900 3900 7d00 *
SketchUp 2014	-	14.0.4900	Win	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{.1.4. ..0...4.9.0.0. . }* 7d00 *	fffe ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3100 3400 2e00 3000 2e00 3400 3900 3000 3000 7d00 *
SketchUp 2014	M1	14.1.1282	Win	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{.1.4. ..1...1.2.8.2. .}* 7d00 *	fffe ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3100 3400 2e00 3100 2e00 3100 3200 3800 3200 7d00 *
SketchUp 2014	M1	14.1.1283	Mac	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{.1.4 ...1...1.2.8.3.}	fffe ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3100 3400 2e00 3100 2e00 3100 3200 3800 3300 7d00 *
Pro 2015; Make 2015	-	15.0.1	-	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{.1.5 ...0...1.}	fffe ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3100 3500 2e00 3000 2e00 3100 7d00 *
Pro 2015; Make 2015	-	15.0.9349	Mac	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{ 1.5...0...9.3.4.9.}* 7b00 3100 3500 2e00 3000 2e00 3900 3300 3400 3900 7d00 *	fffe ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3100 3500 2e00 3000 2e00 3900 3300 3400 3900 7d00 *
Pro 2015; Make 2015	-	15.0.9350	Win 64-bit	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{.1.5. ..0...9.3.5.0. . }* 7d00 *	fffe ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3100 3500 2e00 3000 2e00 3900 3300 3500 3000 7d00 *
Pro 2015; Make 2015	-	15.0.9351	Win 32-bit	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{.1.5. ..0...9.3.5.1.}* 7d00 *	fffe ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3100 3500 2e00 3000 2e00 3900 3300 3500 3100 7d00 *

Pro 2015; Make 2015	M1	15.1.104	Mac	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{1.5. ..1...1.0.4. }*	fffe ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3100 3500 2e00 3100 2e00 3100 3000 3400 7d00 *
Pro 2015; Make 2015	M1	15.1.105	Win 32-bit	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{1.5. ..1...1.0.5. }*	fffe ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3100 3500 2e00 3100 2e00 3100 3000 3500 7d00 *
Pro 2015; Make 2015	M1	15.1.106	Win 64-bit	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{1.5. ..1...1.0.6. }*	fffe ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3100 3500 2e00 3100 2e00 3100 3000 3600 7d00 *
Pro 2015; Make 2015	M2	15.2.685	Win 64-bit	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{1.5. ..2...6.8.5. }*	fffe ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3100 3500 2e00 3200 2e00 3600 3800 3500 7d00 *
Pro 2015; Make 2015	M2	15.2.686	Mac	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{1.5. ..2...6.8.6. }*	fffe ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3100 3500 2e00 3200 2e00 3600 3800 3600 7d00 *
Pro 2015; Make 2015	M2	15.2.687	Win 32-bit	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{1.5. ..2...6.8.7. }*	fffe ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3100 3500 2e00 3200 2e00 3600 3800 3700 7d00 *
Pro 2015; Make 2015	M3	15.3.329	Mac	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{1.5. ..3...3.2.9. }*	fffe ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3100 3500 2e00 3300 2e00 3300 3200 3900 7d00 *
Pro 2015; Make 2015	M3	15.3.330	Win 32-bit	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{1.5. ..3...3.3.0. }*	fffe ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3100 3500 2e00 3300 2e00 3300 3300 3000 7d00 *
Pro 2015; Make 2015	M3	15.3.331	Win 64-bit	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{1.5. ..3...3.3.1. }*	fffe ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3100 3500 2e00 3300 2e00 3300 3300 3100 7d00 *
Pro 2016; Make 2016	-	16.0.19911	Win 32-bit	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{1.6. ..0...1.9.9.1.1. }*	fffe ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3100 3600 2e00 3000 2e00 3100 3900 3900 3100 3100 7d00 *

Pro 2016; Make 2016	-	16.0.19912	Win 64-bit	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{1.6. ..0...1.9.9.1.2.}* 	ffff ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3100 3600 2e00 3000 2e00 3100 3900 3900 3100 3200 7d00 *
Pro 2016; Make 2016	-	16.0.19913	Mac	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{1.6. ..0...1.9.9.1.3.}* 	ffff ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3100 3600 2e00 3000 2e00 3100 3900 3900 3100 3300 7d00 *
Pro 2016; Make 2016	M1	16.1.1450	Win 32-bit	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{1.6. ..1...1.4.5.0.}* 	ffff ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3100 3600 2e00 3100 2e00 3100 3400 3500 3000 7d00 *
Pro 2016; Make 2016	M1	16.1.1449	Win 64-bit	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{.1.6 ...1...1.4.4.9.} 	ffff ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3100 3600 2e00 3100 2e00 3100 3400 3400 3900 7d00 *
Pro 2016; Make 2016	M1	16.1.1451	Mac	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{1.6. ..1...1.4.5.1.}* 	ffff ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3100 3600 2e00 3100 2e00 3100 3400 3500 3100 7d00 *
Pro 2016; Make 2016	M2	16.1.2418	Mac	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{1.6. ..1...2.4.1.8.}* 	ffff ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3100 3600 2e00 3100 2e00 3200 3400 3100 3800 7d00 *
Pro 2017; Make 2017	-	17.0.1		....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{.1.7 ...0...1.} 	ffff ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3100 3700 2e00 3000 2e00 3100 7d00 *
Pro 2017; Make 2017	-	17.0.18898	Mac	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{1.7. ..0...1.8.8.9.8.}* 	ffff ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3100 3700 2e00 3000 2e00 3100 3800 3800 3900 3800 7d00 *
Pro 2017; Make 2017	-	17.0.18899	Win 64-bit	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{1.7. ..0...1.8.8.9.9.}* 	ffff ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3100 3700 2e00 3000 2e00 3100 3800 3800 3900 3900 7d00 *
Pro 2017; Make 2017	M1	17.1.173	Mac	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{1.7. ..1...1.7.3.}* 	ffff ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3100 3700 2e00 3100 2e00 3100 3700 3300 7d00 *

Pro 2017; Make 2017	M1	17.1.174	Win 64-bit	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{1.7. ..1...1.7.4.}*	fffe ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3100 3700 2e00 3100 2e00 3100 3700 3400 7d00 *
Pro 2017; Make 2017	M2	17.2.2554	Mac	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{1.7. ..2...2.5.5.4.}*	fffe ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3100 3700 2e00 3200 2e00 3200 3500 3500 3400 7d00 *
Pro 2017; Make 2017	M2	17.2.2555	Win 64-bit	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{1.7. ..2...2.5.5.5.}*	fffe ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3100 3700 2e00 3200 2e00 3200 3500 3500 3500 7d00 *
Pro 2017; Make 2017	M3	17.3.116	Mac	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{1.7. ..3...1.1.6.}*	fffe ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3100 3700 2e00 3300 2e00 3100 3100 3600 7d00 *
Pro 2018	-	18.0.0		....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{1.8 ...0...0.}	fffe ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3100 3800 2e00 3000 2e00 3000 7d00 *
Pro 2018	-	18.0.16975	Win 64-bit	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{1.8. ..0...1.6.9.7.5.}*	fffe ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3100 3800 2e00 3000 2e00 3100 3600 3900 3700 3500 7d00 *
Pro 2018	-	18.0.16976	Mac	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{1.8. ..0...1.6.9.7.6.}*	fffe ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3100 3800 2e00 3000 2e00 3100 3600 3900 3700 3600 7d00 *
Pro 2018	M1	18.1.1180	Mac	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{1.8. ..1...1.1.8.0.}*	fffe ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3100 3800 2e00 3100 2e00 3100 3100 3800 3000 7d00 *
SketchUp Desktop 2019	-	19.0.0		....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{1.9 ...0...0.}	fffe ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3100 3900 2e00 3000 2e00 3000 7d00 *
SketchUp Desktop 2018	-	19.0.634	Win	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{1.9. ..0...6.3.4.}*	fffe ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3100 3900 2e00 3000 2e00 3600 3300 3400 7d00 *

SketchUp Desktop 2019	-	19.0.635	Mac	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{1.9. ..0...6.3.5.}* fffe ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3100 3900 2e00 3000 2e00 3600 3300 3500 7d00 *
SketchUp Desktop 2019	-	19.0.684	Mac	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{1.9. ..0...6.8.4.}* fffe ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3100 3900 2e00 3000 2e00 3600 3800 3400 7d00 *
SketchUp Desktop 2019	-	19.0.685	Win	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{1.9. ..0...6.8.5.}* fffe ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3100 3900 2e00 3000 2e00 3600 3800 3500 7d00 *
SketchUp Desktop 2019	M1	19.1.173	Mac	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{1.9. ..1...1.7.3.}* fffe ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3100 3900 2e00 3100 2e00 3100 3700 3300 7d00 *
SketchUp Desktop 2019	M1	19.1.174	Win	....S.k.e.t.c.h.U.p. .M.o.d.e.l.....{1.9. ..1...1.7.4.}* fffe ff0e 5300 6b00 6500 7400 6300 6800 5500 7000 2000 4d00 6f00 6400 6500 6c00 fffe ff07 7b00 3100 3900 2e00 3100 2e00 3100 3700 3400 7d00 *

7.2. Software release and supported OS history

Version	maintenance no	date	Supported OS
1.0.20 (Pre-release)		2000	
1		2000-08-01	
1.2		2001	Windows 95/98/NT/2000; 133MHz Pentium processor; 32MB of RAM; 20MB of disk space
2		2002	Pentium 600 or higher, 64MB of RAM, 20MB of hard disk space, Windows 98, NT4 (SP3), 2000 or XP (3) Mac OS X
3		2003	Pentium II 600MHz, 128Mb of RAM, 20Mb of hard disk space, Windows 98, ME, NT4 (SP3), 2000 and XP, OpenGL graphics card recommended
4		2004	Pentium III 400MHz, 128MB of RAM , 20MB of hard disk space, Windows 98, Me, NT 4 (SP3), 2000 or XP, 1024x768 display, CD-ROM.
5		2004	
6		2007-12-14	
7.0		2008-11-17	Removed support for Windows 2000 and earlier.
7.1		2009-09-22	

7.1	M1	2009-11-17	
7.1	M2	2010-01-13	SketchUp 7.1 M2 Pro now requires Windows XP, SP2 as a minimum operating system version. SketchUp 7.1 M2 Free is not impacted.
8		2010-01-09	removed support for OS X 10.4 (Tiger) and earlier.
8	M1	2011-01-12	
8	M2	2011-01-12	OS X Lion support
8	M3	2012-05-23	
8	M4	2012-08-28	Mac OS X 400 MHz PowerPC™ G4
8	M5	2012-12-19	Microsoft Windows® XP, 7 and Windows 8.;
2013		2013-05-21	Reduced the level of support for Windows XP; Removed support for OS X 10.6 (Snow Leopard) and earlier.
2013	M1	2013-06-12	
2013	M2	2013-08-15	
2014		2014-02-27	No System requirement changes were made.
2014	M1	2014-06-03	
2015		2014-11-03	Removed support for Windows Vista, Windows XP and OS X 10.7 (Lion) and earlier. SketchUp 2015 and earlier isn't supported on Mac OS X Sierra, but is supported on Mac OS X Mountain Lion, Mavericks, and Yosemite. Additionally Microsoft Internet Explorer 9 or greater required.
2015	M1	2014-11-21	
2015	M2	2014-12-18	
2015	M3	2015-02-05	
2016		2015-11-17	Windows 10 and macOS El Capitan supported; Removed support for OS X 10.8 (Mountain Lion) and earlier.
2016	M1		
2016	M2	2016-09-20	Improved support of MacOS Sierra (10.12)
2017		2016-11-07	only 64 bit; Support for macOS Sierra; Removed support for 32-bit operating systems, OpenGL 2.0, and software rendering of models (as opposed to hardware acceleration). Removed support for OS X 10.9 (Mavericks.)
2017	M1	2016-11-17	
2017	M2	2017-02-15	
2017	M3	2017-09-21	
2018		2017-11-14	Mac High Sierra (10.13): official Removed support for Mac OS X 10.10 (Yosemite). There is no longer a SketchUp Make for download, the free version of SketchUp is called SketchUp Free and available in all modern web browsers.

2018	M1	2018-11-12	
2019		2019-02-05	Removed support for Mac OS X 10.11 (El Capitan). Users need to sign in with a Trimble ID to access the SketchUp Pro 2019 subscription or to participate in a Free Trial. SketchUp Desktop 2019 Classic licenses do not require a sign-in.
2019	M1	2019-04-08	

7.3. SketchUp model hierarchy

The API documentation lists the entity classes and subclasses (starting with “--”) that can be used to interact with a model. This gives an insight into the structure and evolution of the SketchUp model.

AttributeDictionaries	a collection of all of the AttributeDictionary objects that are attached to a given Entity object.	6.0
AttributeDictionary	allows you to attach arbitrary collections of attributes to a SketchUp entity. The attributes are defined by key/value pairs where the keys are strings. An Entity or Model object can have any number of AttributeDictionary objects (see the AttributeDictionaries class).	6.0
Axes	SketchUp's drawing axes consist of three colored lines (red, green, blue), usually perpendicular to each other, displayed in the drawing area. The exception is when the user open an instance with a non-orthogonal transformation. The root model transformation is always orthogonal. The drawing axes are used by drawing tools to align the geometry it creates as well as affecting the inference engine.	2016
Behaviour	The Behavior class is used to control the “behavior” of components, which roughly correlates to the series of options that you see in the Components dialog under the “edit” tab, such as whether it casts shadows, glues to walls, etc.	6.0
Curve	The Curve class is used by SketchUp to unite a series of Edge objects into one conceptual entity. Since SketchUp is a surface modeler, all circles, arcs, and arbitrary curves are really just edges that are bound together in sequence.	6.0
--ArcCurve	An ArcCurve is a Curve that makes up part of a circle. This is the underlying class for circles as well. You can think of ArcCurves as entities that were created with SketchUp's Arc or Circle drawing tools and Curves as entities that were created with the Freehand drawing tool. However, keep in mind that all Curves in SketchUp are really edges with some extra data attached to them.	6.0
Drawingelement	Drawingelement is a base class for an item in the model that can be displayed. These items include edges, construction points, construction lines, and images. Arc curves and arcs are not included because they are not drawing elements by themselves, but are a	6.0

	composition of edges.	
--ComponentDefinition	The ComponentDefinition class is used to define the contents for a SketchUp component. Components are a collection of entities that can be instantiated and reused multiple times throughout a model. For example, you could draw a chair once, turn it into a component, and then use 6 instances of it to surround a table. Edits to the original “definition” will then propagate across all of its instances.	6.0
--ComponentInstance	The ComponentInstance class is used to represent component instances of a component definition or components that have been dragged from the Component Browser and placed (thus, instantiated) within the Model. Therefore, the ComponentInstance class contains a reference to a corresponding ComponentDefinition object and a Transformation object (which contains the location of the component in the Drawing Window).	6.0
--ConstructionLine	The ConstructionLine class contains methods for modifying construction lines. Construction lines can be infinite in length, semi-infinite (i.e. infinite in one direction) or finite.	6.0
--ConstructionPoint	A construction point represents a point in the model that can be used to aid in other modeling operations. For example, you may put a construction point at the center of a circle to make it easier to locate that point for performing other operations.	6.0
--Dimension	The Dimension class provides base functionality for classes DimensionLinear and DimensionRadial. It's not instantiable.	2014
DimensionLinear	The DimensionLinear class represents linear dimensions.	2014
DimensionRadial	The DimensionRadial class represents radius and diameter dimensions on arcs and circles.	2014
--Edge	The Edge class contains methods modifying and extracting information for edges.	6.0
--Face	Faces in SketchUp are flat, 2-sided polygons with 3 or more sides.	6.0
--Group	A Group class contains methods for manipulating groups of entities. Groups in SketchUp are very similar to Components, except that there is no instantiating of groups. That means that you always will have one and only one of each of your groups. (In the actual implementation, SketchUp keeps track of groups as a special kind of Component that combines properties of definitions and instances, which is why you will see deprecated methods like Group.make_unique, and the class of observer you attach to Groups are ComponentInstance observers.)	6.0
--Image	An Image object represents a raster image placed in the Model.	6.0
--SectionPlane	The SectionPlane class represents a section plane in a SketchUp model. Note that prior to SketchUp 2014 there was no way to create a SectionPlane object using Ruby. For older versions of SketchUp,	6.0

	you must manually create a section plane with the Section Plane Tool in SketchUp and then query the entities array to find the SectionPlane object.	
--Text	The Text class contains method to manipulate a Text entity object.	6.0
DefinitionList	A DefinitionList object holds a list of all of the ComponentDefinition objects in a model. This class contains methods for adding and retrieving definitions from the list.	6.0
EdgeUse	The EdgeUse class defines how an Edge is used in the definition of a Face.	6.0
Layer	The Layer class contains methods modifying and extracting information for a layer. By default, a SketchUp model has one layer, Layer 0 (zero), which is the base layer. You can't delete or rename Layer 0. Unlike certain other CAD software packages, entities associated with different layers in SketchUp still intersect with each other. (If you want collections of entities to not intersect, place them in Groups instead.) Layers are commonly used to organize your model and control the visibility of related groups and components.	6.0
Layers	The Layers collection allows you to see and manage all of the layers in a model. You get a pointer to the Layers object from within the Model.	6.0
LineStyle	This provides a way for SketchUp to customize a line style and be set on a layer.	2019
LineStyles	Provides access to the different line style objects in the model.	2019
Loop	Loop is a low level topology class that will not need to be used often. A Loop is a chain of Edges that bound a Face.	6.0
Material	The Material class represents a texture or color that can be applied to Drawingelements. It is most often applied to Faces.	6.0
Materials	A collection of Materials objects. Each model contains a Materials collection that can be accessed via Model.materials.	6.0
Page	The Page class contains methods to extract information and modify the properties of an individual page. Note that inside the SketchUp user interface pages are called "Scenes".	6.0
Pages	The Pages class contains methods for manipulating a collection of Pages (scenes) in a model.	6.0
RenderingOptions	The RenderingOptions class contains method to extract the rendering information for a model.	6.0 ... 2019
ShadowInfo	The ShadowInfo class contains method to extract the shadow information for a model. The majority of the shadow information returned exists in the Model Info > Location and Model Info > Shadows dialogs inside SketchUp.	6.0

Style	The Style class contains methods for modifying information about a specific style. Styles are a collection of display settings that tell SketchUp how to draw the model.	6.0
Styles	The Styles class contains methods for manipulating a collection of styles in a model. Typically, you will access this via the <code>active_model</code> :	6.0
Texture	The Texture class contains methods for obtaining information about textures that are part of your materials in your model (within the In-Model section of the Materials Browser). Remember, textures are repeatable images that “tile” when painted on a surface.	6.0
Vertex	A Vertex represents the end of an Edge or a point inside a Face.	6.0

7.4. Other formats used by Sketchup

7.4.1. KML

KML¹⁰² is an Open Geospatial Consortium (OGC) sponsored XML schema file format used to display geographic data in an earth browser, such as Google Earth, Google Maps, and Google Maps for mobile. A KML file is processed in much the same way that HTML (and XML) files are processed by web browsers. Like HTML, KML has a tag-based structure with names and attributes used for specific display purposes. Thus, Google Earth and Maps act as browsers for KML files. Full specifications available at: <http://www.opengeospatial.org/standards/kml> Equivalent to Keyhole Markup Language (KML). KMZ files are zipped .KML files, which make them easier to distribute and share with multiple users.

7.4.2. Sketchup Backup File (SKB)

A SKB file is a backup document created by the Windows version of SketchUp only. SKB files appear as [filename].skb. The macOS version autosaves models with the ".skp" extension as [filename]~.skp. The file structure is not different from that of a regular.skp file, but to open it, it may be necessary to change the extension to .skp.¹⁰³

7.4.3. Sketchup Classification file (SKC)

In SketchUp, the .skc file format stores the classification data used in the Classification tool (see above in the chapter on BIM support). Each .skc file contains XML schema definition files (with extension .xsd) and other files that help define additional schema metadata. All these files are zipped up in one file. Alternatively, a classification can also be defined in a single XSD file.¹⁰⁴

7.4.4. SketchUp Layout file

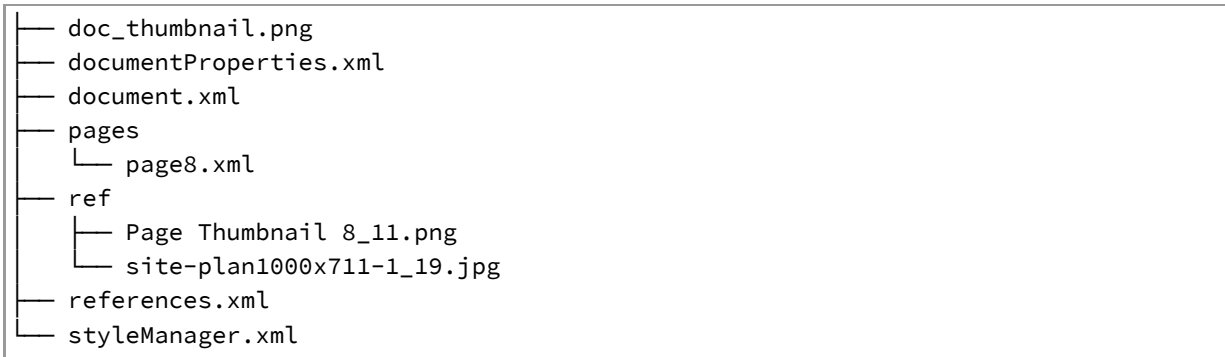
The SketchUp LayOut file structure is much more transparent than SketchUp file. A LayOut file uses the ZIP archive file format.¹⁰⁵ It contains file definitions in XML as well as raster image files for the representation of images.

¹⁰² <https://www.nationalarchives.gov.uk/pronom/fmt/244>

¹⁰³ <https://fileinfo.com/extension/skb>

¹⁰⁴ <https://help.sketchup.com/en/sketchup/classifying-objects>

¹⁰⁵ <https://www.nationalarchives.gov.uk/pronom/x-fmt/263>



Example of the folder structure of a Layout file

Most operating systems and file format identification tools (such as File¹⁰⁶, DROID¹⁰⁷ or Siegfried¹⁰⁸) typically identify a LayOut file as a ZIP-archive, but it can be identified with the .layout extension as well.

7.4.5. SketchUp License File

The license file is created when the license number is entered (see above, chapter Software license). A license file can have a .lc or .lic extension.

7.4.6. SketchUp Material File

Materials can be exported from a model to a separate file, with extension .skm. These .skm files can be used on both macOS and Win platforms.

Materials files have a structure similar to LayOut files: a zip archive containing raster images and xml files (illustration). The thumbnail images are in PNG format, while the referenced images are in the original file format.



Example of the folder structure of a Materials file

7.4.7. SketchUp Custom Location Data

SketchUp 6.0.514 and earlier stored custom locations in the "sketchup.tzl" file. Newer versions of SketchUp (6.4.112 and above) store custom locations in the "locations.dat" file.

7.4.8. Extension definitions

Extensions (plugins) are stored in a separate folder as a subfolder along with an *.rb file. Both the .rb file and the accompanying folder share the same name. In zipped format, a plugin file has the file extension .rbz.

¹⁰⁶ <http://pubs.opengroup.org/onlinepubs/9699919799/utilities/file.html>

¹⁰⁷ <http://www.nationalarchives.gov.uk/information-management/manage-information/preserving-digital-records/droid/>

¹⁰⁸ <https://www.itforarchivists.com/siegfried/>