THIS TUTORIAL EXPLAINS HOW TO CONFORM YOUR 3D DATA TO VIRTUAL & AUGMENTED REALITY APPLICATIONS, PHYSIC & FLUID SIMULATIONS, 3D PRINTING... THANKS TO PiXYZ STUDIO

Following items are described:
- GUI presentation
- Import Wizard
- Tessellation
- Remove Holes
- Hidden Removal
- Decimation

Definitions of words followed by * are given at the end of this tutorial.
PiXYZ Studio comes in two different offers: PiXYZ Studio and PiXYZ Studio.batch.

### PiXYZ Studio

<table>
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<th>Functionality</th>
<th>PiXYZ Studio.batch</th>
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<tr>
<td>All Input Formats</td>
<td>✓</td>
</tr>
<tr>
<td>PiXYZ Core Algorithms for CAD Data Preparation</td>
<td>✓</td>
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<tr>
<td>PiXYZ Core Algorithms for Data Optimization</td>
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<tr>
<td>Python Scripting Editor Capability</td>
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</tr>
<tr>
<td>Additional Import/Export Python Functions for Automatic Batch Processing</td>
<td>✓</td>
</tr>
</tbody>
</table>

### PiXYZ Studio.batch

**Recommended for Optimal Data Preparation**

- **Processor**
  - Intel core i7 2 GHz or more
- **RAM**
  - 16 GB or more
- **Graphics Hardware**
  - nVidia GeForce GTX 980 Ti or more
- **Disk Space**
  - 1 GB or more (with dynamic swap)
- **Operating System**
  - Windows 10, 64-bit

**Minimum**

- **Processor**
  - 86 dual-core 2 GHz
- **RAM**
  - 4 GB
- **Graphics Hardware**
  - OpenGL 4 compatible
- **Disk Space**
  - 200 MB
- **Operating System**
  - Windows XP, Seven, 10 64-bit
<table>
<thead>
<tr>
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<th>PIXYZ STUDIO</th>
<th>DETAILS</th>
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<tr>
<td>ACIS</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>AutoCAD 3D</td>
<td>✓</td>
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<tr>
<td>Autodesk Alias</td>
<td>✓</td>
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<tr>
<td>Autodesk FBX</td>
<td>✓</td>
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<tr>
<td>Autodesk Inventor</td>
<td>✓</td>
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<tr>
<td>CATIA V4 – V5</td>
<td>✓</td>
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<tr>
<td>CATIA V5 [3DXML]</td>
<td>✓</td>
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<tr>
<td>CATIA V6 [3DXML]</td>
<td>✓</td>
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<tr>
<td>Creo - Pro/E</td>
<td>✓</td>
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<tr>
<td>COLLADA</td>
<td>✓</td>
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<td>CSB Deltagen</td>
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<td>IFC</td>
<td>✓</td>
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<td>IGES</td>
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<tr>
<td>JT</td>
<td>✓</td>
<td>Mesh + NURBS</td>
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<tr>
<td>OBJ</td>
<td>✓</td>
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<tr>
<td>Parasolid</td>
<td>✓</td>
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<tr>
<td>PDF</td>
<td>✓</td>
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<tr>
<td>PLM XML</td>
<td>✓</td>
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<tr>
<td>PLY</td>
<td>✓</td>
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<tr>
<td>Point Cloud</td>
<td>✓</td>
<td>ES7, PTS, PTX, XYZ</td>
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<tr>
<td>PRC</td>
<td>✓</td>
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<tr>
<td>Revit</td>
<td>✓</td>
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<tr>
<td>Rhino3D</td>
<td>✓</td>
<td></td>
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<tr>
<td>SketchUp</td>
<td>✓</td>
<td></td>
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<tr>
<td>Solid Edge</td>
<td>✓</td>
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<tr>
<td>SolidWorks</td>
<td>✓</td>
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<tr>
<td>STEP</td>
<td>✓</td>
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</tr>
<tr>
<td>Stereo Lithography (STL)</td>
<td>✓</td>
<td></td>
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<tr>
<td>U3D</td>
<td>✓</td>
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</tbody>
</table>
The entire user interface is customizable. The position and the size of each window can be adjusted and clipped on each corner of the interface. The menu that appears by right-clicking on the toolbar or by pushing on the tab «Windows» allows to manage the windows visibility, create custom GUI, reset default settings,...

The viewer displays information regarding the loaded model: occurrences (parts) and triangles (polygons) number.
FILE management system
- Open Project: Open .pxz project file
- Save Project: Save current project
- Save Project As: Save as new *.pxz project
- Import Wizard: Opens the Import Wizard window
- Import Model: Import CAD file (all formats)
- Export Model: Export geometry
- Export Selection: Export selected geometry
- Recent Project: List of the projects recently open
- Reset Project: Reset PiXYZ scene
- Exit: Quit PiXYZ STUDIO

EDIT
- Fit: Fit camera-view to selection
- Show Hidden: Switch to no-show (hidden parts)
- Take Screenshot: Save current viewer as an image
- Select All: Select all occurrences (parts)
- Invert Selection: Switch selection
- Find Selection In Tree: Identify selection in product hierarchy
- Show B-Reps: Display native CAD representation
- Show Wireframe: Display polygons
- Show Shaded: Display shaded mesh
- Show Outlines: Display lines and patches information
- Show Points: Display Point Cloud
- Function List: Open PiXYZ Core Function List
- Install Plugin: Install a PiXYZ STUDIO plugin (contact PiXYZ)
- Plugin List: Manage installed plugins (contact PiXYZ)
- Preferences: Open PiXYZ STUDIO settings
Details regarding the Menu bar and settings:

**SELECTION**
- **Select All**: Select all occurrences (parts)
- **Invert Selection**: Switch selection
- **Find Selection In Tree**: Identify selection in product hierarchy

Advanced selection tools
- **Select Small Parts**: Automatically select parts based on geometrical property: bounding box max diagonal distance
- **Select Part from No Show**: Automatically select parts with «Visibility» attribute set to false.
- **Identify Multiple Occurrences**: Select parts with numerous identical entities (= occurrences = instances)
- **Select Identical**: Automatically scan the entire scene to identify similar part to current selection. Please select a part before using.

**NOTE**: Following tools require tessellated models
- **Select Duplicated Parts**: Automatically select parts with similar size, polygon count, position and orientation.
- **Hidden Selection**: Automatically select parts, patches or polygons not viewed from a sphere around the scene.
- **Smart Hidden Selection**: Select parts, patches or polygons not viewed from a set of camera automatically generated. Allow to consider empty cavities (cockpit, engine area,...)

These advanced selection tools will definitely ease and accelerate your data preparation processes into PiXYZ STUDIO. Other «smart» selection can be achieved through python scripting. Please contact PiXYZ Software for more information.
**Details regarding the Menu bar and settings:**

<table>
<thead>
<tr>
<th>SCENE management</th>
<th>MATERIALS</th>
<th>CAD data preparation dedicated features</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Merge Final Assemblies: Convert final assemblies (assemblies with only parts as children) into parts by merging their children</td>
<td>• Handle all materials contained in the scene</td>
<td>• Repair CAD: Start an automatic reparation of native CAD assemblies (Nurbs/B-REP files): CAD patches combining, faces automatic orient; ...</td>
</tr>
<tr>
<td>• Merge Assemblies By Tree Level: Reduce the Tree depth by merging together all parts located beyond the specified level</td>
<td>• Material Library: Open Material Library</td>
<td>• Assemble CAD: Combine disconnected CAD patches</td>
</tr>
<tr>
<td>• Merge Parts: Combine selected geometries</td>
<td>• Texture Library: Open the Texture Library, containing all textures used in the current scene</td>
<td>• Orient: Check patches orientation consistency</td>
</tr>
<tr>
<td>• Merge Parts By Material: Combine selected geometries with one part by existing material</td>
<td>• Merge Materials: Merge all equivalent materials (i.e. with same visual appearance)</td>
<td>• Explode Bodies: Explode part by bodies (see glossary)</td>
</tr>
<tr>
<td>• Compress Tree: Compress a sub-tree by removing assembly containing only one SceneNode or empty, and by removing useless instances</td>
<td>• Clean Unused Materials: Remove unused materials in the scene from the Material Library</td>
<td>• Tessellate: Generate a perfect an efficient mesh representation of your CAD file</td>
</tr>
<tr>
<td>• Rake Tree: Destroy hierarchy and flatten all transforms</td>
<td>• Replace Material: Replace a material by another everywhere it is used in the scene</td>
<td></td>
</tr>
<tr>
<td>• Apply Transformation: Change transformation matrix</td>
<td>• Select By Materials: Select all occurrences with a given material on scene node or occurrence property</td>
<td></td>
</tr>
<tr>
<td>• Create symmetry: Create planar symmetry from selection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Make instance unique: Destroy connection between instances</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Reset Transform: Set all transformation matrices to identity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Delete Empty Parts: Delete parts with deactivate “Visibility” attribute</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Delete Empty Assemblies: Delete assemblies without children</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Rename Long Part Name: Automatically reduce long character chains in assembly and part name attribute.</td>
<td></td>
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</tr>
</tbody>
</table>

PiXYZ tessellation algorithm has been proven to be the most efficient and performant algorithm available in CAD data preparation software.
Details regarding the Menu bar and settings:

**MESH – Mesh optimization features**
- **Repair Mesh**: Start an automatic reparation of the existing mesh: connected meshes fusion, face automatic orientation...
- **Create Normals**: Create normals on polygons
- **Orient Faces**: Check faces and normals orientation consistency
- **Invert Orientation**: Invert selection orientation
- **Triangulate**: Convert the entire mesh selection into triangles
- **Equilateralize**: Force use of equilateral triangles
- **Quadify**: Force use of quads when possible
- **Identify Patches**: Only for tessellated models: start identification of former CAD information
- **Explode Patches**: Split geometry at patches level
- **Explode Part y Materials**: Create one part out of the selected part(s) by material applied on the patches
- **Delete Patches**: Remove all CAD information
- **Create Lines**: Convert CAD information in free edges
- **Delete Lines**: Delete free edges. Improve FBX export.
- **Explode Connected Meshes**: Split combined geometries in multiple unconnected entities

**OPTIMIZE MESH – Polygon optimization/reduction algorithms**
- **Decimate**: Process existing mesh and reduce polygon count
- **Remove Holes**: Remove holes features from geometry
- **Hidden Removal**: Automatically delete parts, patches or polygons not viewed from a sphere around the scene
- **Smart Hidden Removal**: Delete parts, patches or polygons not viewed from a set of cameras automatically generated. Allow to consider empty cavities (cockpit, engine area,...)
- **Replace By Box**: Replace selected parts by their Bounding Box (Axis-Aligned BB or Oriented BB)
- **Bake Texture Maps**: Create texture maps (Diffuse, Normal, MaterialID, PartID) out of the selected parts, providing they have UVs.

**UV – Manage texture coordinates**
- **Generate UV by Projection**: Automatically create texture coordinates by projection (cubic, BB, custom)
- **Generate UV by Unwrapping**: Automatically generate UV fit by unwrapping
- **Repack UV**: Automatically fit all UV islands to the [0,1] UV space
- **Normalize UV**: Automatically scale UV to the [0,1] UV space
- **Swap UV Channel**: Invert UV from one channel to another, when multiple UV channels exist on the selected part(s)
- **Remove UV**: Clean UV from selected channel
- **UV Viewer**: Open UV 2D representation
Details regarding the Menu bar and settings:

**SCENARIOS – Apply high-end optimization processes**

- **Run Generic Process:**
  Automatically create optimized meshes out of any 3D model (mesh or CAD).
  Check the API documentation for more information (HELP menu > API Documentation)

- **Generate LOD Chain:**
  Automatically generate 3 LODs for the current selection.
  Check the API documentation for more information (HELP menu > API Documentation)

- **Generate Phantom Mesh:**
  Automatically generate one unique optimized mesh out of the models in the scene, with material(s).
  Check the API documentation for more information (HELP menu > API Documentation)

- **Generate Proxy Mesh:**
  Automatically generate a proxy mesh out of the current selection, with optional automatic texture maps generation.
  Check the API documentation for more information (HELP menu > API Documentation)

**WINDOWS – Manage PiXYZ STUDIO GUI**

- **Workspace:** Customize and arrange your workspace (windows layout). Manage keyboard shortcuts.

- **Show tabs:** Set the windows to be displayed on the GUI, amongst: Product Structure, Properties, Modifiers, Visualization, Measurement, Script, Output, Material On Patches

**HELP menu**

- **Open Documentation:** You are there!
- **API Documentation:** Open embedded API documentation for python scripting purposes and algorithms technical details
- **Open Sample Scripts Directory:** Start using python scripting in STUDIO using reference scripts
- **Download 3D Model Samples:** from PiXYZ website
- **License Manager:** Manage your license: license request, license installation, connection to your PiXYZ account...
- **Export log file:** Access the log file automatically saved for each session of PiXYZ STUDIO launched
- **Release Note:** Access the release note for the current version of PiXYZ STUDIO
- **Check For Update:** Automatically check available update for PiXYZ STUDIO
PiXYZ STUDIO already exposes most powerful features in the standard GUI. However, more than 120 functions are available in the PiXYZ API for python scripting but also interactive Data Preparation.
Go to menu EDIT > Preferences to access the full functions list (or press F12).
Go to the API Documentation for more information regarding algorithms in PiXYZ STUDIO.

Custom menus allow users to create bespoke list of functions and make easily accessible most used functions, for a specific workflow.

1. Right-click on the toolbar and choose « Add a custom menu/toolbar ».
2. Name your custom toolbar and menu.
3. A new menu has been added. Push on « Manage » to add new functions shortcuts.
4. A window opens. Click on the « +add » button.
5. Select the function to add in the toolbar/menu.
6. Validate by clicking on « Ok ».
7. The function is now accessible through a new menu and a new toolbar. You can manage the toolbar visibility like any toolbar.

By pushing on « Go to Documentation », you can get more information on a function.
To manipulate the camera position and orientation in the viewer, use the following key combinations:

- **Mouse Left Click**: Select / Replace selection
- **Shift Key + Mouse Left Click**: Remove from Selection
- **Ctrl Key + Mouse Left Click**: Add/remove from selection
- **Alt Key + Left Click**: Rotate
- **Alt Key + Middle Click**: Pan
- **Alt Key + Right Click (or Mouse wheel)**: Zoom
- **Mouse Middle Click**: Change rotation center (camera pivot point)
- **Mouse Right Click**: Show contextual menu (only on selection)
- **Mouse Left Key + Selection area**: Select parts inside the selection
- **Mouse Right Click + Selection area**: Select all parts inside the selection (depth-selection)
To manipulate the camera position and orientation in the viewer, use the following key combinations:

- **Mouse Left Click**: Select / Replace selection
- **Shift Key + Mouse Left Click**: Remove from Selection
- **Ctrl Key + Mouse Left Click**: Add/remove from selection
- **Center Click + Left Click**: Rotate
- **Center Click + Middle Click**: Pan
- **Center Click + Right Click (or Mouse wheel)**: Zoom
- **Mouse Middle Click**: Change rotation center
- **Mouse Right Click**: Show contextual menu (only with selection)
- **Mouse Left Click + Selection area**: Select visible parts inside the selection
- **Mouse Right Click + Selection area**: Select all parts inside the selection (depth-selection)

By default, PiXYZ STUDIO is set to STANDARD (DCC-like navigation). You can also set a "CATIA-like navigation" mode (mouse only).

3D Viewer navigation settings can be adjusted through menu **EDIT > Preferences > Viewer > Navigation > CatiaLikeNavigation**.
PiXYZ Studio Documentation

Functionalities & GUI
The Main Toolbar contains shortcuts to main functionalities of PiXYZ STUDIO:

1. **IMPORT WIZARD**: Import wizard for easy 3D file import in PiXYZ STUDIO
2. **IMPORT SCENE**: Import file in PiXYZ (CATIA, 3DXML, NX, FBX, ...)
3. **EXPORT SCENE**: Export the complete geometry in various file formats (FBX, 3DXML, ...)
4. **SAVE PROJECT**: Save the scene to a *.pxz project
5. **RESET**: Clean and reset the scene (new project)
6. **MATERIALS**: Open Material Editor
7. **CHECKER**: Visual override of all materials visible in the scene using predefined shaders
8. **FIT TO VIEW**: Fit camera view to selected objects
9. **RENDERING MODE**: Backface culling rendering modes
10. **SHOW / NO SHOW**: Switch between shown/hidden occurrences & parts
11. **FULLSCREEN**: Switch to full screen (viewer only)
12. **SCREENSHOT**: Take a screenshot of the camera view
13. **VIEWCUBE**: Predefined camera views. Perspective & orthographic camera modes
14. **TRANSPARENCY**: Adjust global transparency rendering setting
15. **RENDER MODE**: Visualization mode (B-REP, Wireframe, Shaded, Patches/lines, points)
The viewer can be customized from the « PREFERENCES » menu (F9). Background, lights, lines colors, FOV... can be adjusted to your needs.
PiXYZ STUDIO preserves your CAD model hierarchy, organization and naming, when available. The elements that compose a scene tree, are represented as following:

- Assembly *
- Instance *
- Part *

Once a part is selected, the highest - not unfolded - node of the scene hierarchy is colored in orange. The surface of this part is also colored in orange to indicate the selection.

By default, actions will affect only selected elements. But you can always change the selection in the function dialog box. A SELECT menu is available to help selecting specific parts.

For a selected part, position in the scene tree can be shown through the FIND IN TREE function in the contextual menu (RIGHT click).

Multi-selection is available by pushing CTRL key while selecting elements in the viewer or in the scene tree.
The “Properties” window displays a selected element details. In the case of a selection of several elements, some fields are not filled.

From this window, you can also:

- show/hide selected element(s) by checking/unchecking the « Visible » box in the « Occurrence » section
- show/hide all occurrences* of selected element(s) by checking/unchecking the « Visible » box in the element section
- affect a material to a mesh

Pressing the button in the material field opens a « Material selector » window that allows to affect another material to a mesh. If the list is empty, add a new material thank to the material editor tool.

*One element All occurrences

Properties of one selected element.

Properties of 33 selected elements.

The same icon allows to show either hidden elements or visible ones.
The PROPERTIES window displays all available information regarding the selected element(s). Informations are originally contained directly in the CAD file (CATProduct, CATPart, STEP, JT, FBX, ...).

Following metadata might be found, depending on the CAD model and its origin:

- PartNumber
- PartName
- AssemblyName
- Definition
- Nomenclature
- Source
- Revision
- Author
- Description
- ID PiXYZ
- ...

Other PROPERTIES are displayed and modifiable within PiXYZ, such as:

- Occurrence Material
- Part Material
- Transformation Matrix
- Occurrence Visibility
- Part Visibility
PIXYZ STUDIO allows to manage materials: creation, update... Also, you can affect a material to a mesh when missing.

The material editor is accessible from the « MATERIALS » menu or by pushing on the following button (1): 

- Click on the button « + Add » (2). A window opens. Choose a material pattern (3) and define the new material (4).
- Push on « edit properties » allows you to access to the shader code.

This material will be available in the Material Selector window accessible from the properties window (5).
It is possible to modify actions done on a model. Indeed, all modifications can be saved to let you update or delete a process step. Yet modifiers history is not enabled by default. You need to activate the « KeepShapeHistory » option in the PREFERENCES (F9), « Algo » section of the parameters.

Also, any parameter can be modified and any process can be updated by pushing on the « Apply » button. The button will appear after changing a value parameter.

Any action can be cancelled by pushing the white cross:

A removal can’t be reverted.

Updating first steps of the history can impact last steps

The use of modifier history may cause an overload of memory
PiXYZ STUDIO 2018.2 release introduces a new feature: the IMPORT WIZARD.

The purpose of this wizard is to help the user obtaining, quickly and easily, ready-to-use tessellated models (meshes) out of almost any CAD model. The resulting meshes are delivered in the PiXYZ STUDIO interface, and can be furtherly optimized using all available algorithms, or directly exported (through FBX, OBJ ...).

There are 2 ways to open the Import Wizard:

1) Go to menu FILE > Import Wizard:

2) Click on the icon from the Toolbar

The Wizard comes as a window combining all the necessary setting for a 1-click import process. Please read the information thereafter for information about each exposed setting, or use the "Go to documentation" link.

💡 All the settings exposed in the window are also available in PiXYZ STUDIO as preferences settings, or as functions accessible from the Menu bar.
**SETTINGS INFORMATION**

- **PRESETS**
  A combination of settings can be saved under a preset, using the “Preset” bar. Use the “Default” preset to restore PiXYZ default settings. Use the available buttons to manage user presets.

- **FILE NAME**
  Use the browser to select the CAD file you wish to import in PiXYZ STUDIO through the Wizard.

Only one CAD file can be imported at once using the Import Wizard. Anyway, a master assembly file (like *.CATProduct files for example) will load all the other CAD files it references.

- **COORDINATE SYSTEM**
  Use the Coordinate System settings to adapt the imported model’s units/transformation to PiXYZ STUDIO units/coordinate system (Millimeters / Right-handed / Z-up axis). Default settings change a millimeters/Z-up axis scene to PiXYZ STUDIO configuration.

  **Scale**: Set the scale of the imported model.

  **Right Handed**: Uncheck this setting to mirror model from a left-handed coordinate system to a right-handed one.

  **Y-up**: Use this setting to rotate model from Z-up axis to Y-up axis.
**SETTINGS INFORMATION**

- **IMPORT OPTIONS**

The Import Options control which data must be imported from the original CAD file, and how the hierarchy is being processed.

**Load Hidden Parts:** If checked, the parts that are as set as hidden (not visible) in the imported CAD file are also imported, and their visibility set to hidden (use the No-Show view to display them).

**Load PMI:** If checked, the PMI potentially present in the imported CAD file will be imported too.

**Hierarchy Mode:** From the "Hierarchy Mode" drop-down list, choose one of the available modes to optimize the imported model's hierarchy (also called "Product Structure" in CAD vocabulary):

- **Full** (default setting): No modification of the hierarchy
- **Compress:** Compresses the hierarchy by removing empty nodes, or any node containing only one sub-node.
- **Rake:** Simplifies the hierarchy by transferring all parts present in the imported CAD model under the root node of the imported model.
- **Merge All:** All parts contained in the original CAD model will be merged together, as one single part.
- **Merge Final Assemblies:** Convert final assemblies (assemblies with only parts as children) into parts by merging their children.
**SETTINGS INFORMATION**

- **TESSELLATION SETTINGS**

  Tessellation Settings define the way CAD surfaces inherited from the imported CAD file are processed to create beautiful optimized meshes.

  **Repair CAD:** Before creating a mesh out of the imported CAD surfaces, it can be useful to perform some preparatory work on these surfaces. The Repair CAD removes possible gaps between CAD faces, removes overlapping faces, and tries to orient CAD faces consistently (check the API documentation for more information).

  **Tessellation Quality:** Define the density/visual quality of the mesh that PiXYZ STUDIO delivers. Exposed settings are the most important ones from the Tessellate algorithm.

  ![Image of Import Wizard settings](image)

  Check the ABOUT TESSELLATION & DECIMATION page of this documentation to learn more about tessellation settings, or refer to the API documentation (Tessellate algorithm).
In a CAD file (coming from CATIA, NX, CREO...), materials (or colors) can be assigned to the CAD parts in many different and complex ways. Material Assignment section defines how materials will be assigned to the imported CAD model.

A CAD model is made of parts (also called occurrences) and a hierarchy (sometimes called Product Structure in CAD vocabulary).

A Part can have a material assigned in many different ways:
- On the Part itself through its Material Property
- On a parent of the Part, in which case the Part inherits its parent’s Material Property
- Directly on the CAD surfaces of the Part (surfaces all also called patches, see the Glossary)

Using one of the following settings, choose how to deal with material assignment when importing a CAD file:

**Keep As Assigned In The Original CAD file:** Using this setting preserves the material assignment how it was defined in the CAD software delivering the imported CAD file.

**Transfer CAD Materials On Parts** (default setting): All materials inherited from a parent node or from the CAD surfaces of a Part are transferred to the Material Property of this Part. This action is executed for each Part of the hierarchy. This makes the material management easier in PiXYZ STUDIO.
PiXYZ STUDIO offers several visualization tools for CAD project review and analysis.

MEASUREMENT TOOLS
Measurement system is available to measure any type of entity: distance, radius, angle, center distance, plane inclination, ... STUDIO uses a «primitive» recognition feature (circle, polylines, points) to ease and accelerate the measurement process. Here are the steps to perform quick measurements:

1. SELECT the type of primitive/element you are willing to measure: POLYLINE (patch boundary), CIRCLE or POINT.
2. Perform «FLY-OVER» PRIMITVE RECOGNITION directly in the 3D Viewer to identify, select and measure elements
3. Use or re-use primitives from the «Measurement» tab to CALCULATE distances, radius, ... or convert point to primitives (circle center,...)

SNAPPING FUNCTIONALITY

- SNAPPING ON LINES
  proximity conception line
  Measure point will snap on eventual (green dot)
  Orange dot
- STANDARD PICKING
  Line snapping
  No snapping
CUTTING PLANE

The cutting plane feature allows to visualize inside a model. Check the « Enabled » option for activation and choose the cutting axis. Slide the translation cursor to move the cutting plane.

Optional visualization parameters

- Select plane axis (XYZ or camera axis)
- Translate cutting plane
- SHOW PLANE : identify* filled or hollow volumes *can take few seconds to calculate
- Invert visibility
- Lock (camera axis only)
- Edges color *use after « Show Plane »
- Edges thickness *use after « Show Plane »
- ALIGN CAMERA : align camera with sectional drawing *use after « Show Plane ». Consider switching to orthographic camera

SHOW PLANE : visualize solids and hollow volumes
Sectional view : SHOW PLANE + ALIGN CAMERA + Orthographic view setting
Sectional drawing or « footprint » : SHOW PLANE + ALIGN CAMERA + Orthographic view setting + HIDE « Product » motion group + EDGE COLORS red
EXPLODED VIEW
The «Exploded View» feature spreads outward all the model parts, according to a defined axis (XYZ, planar or single-axis). This tool allows to visualize all components inside an element.

All axis

Z-axis explode only

Slide the factor cursor to amplify the explode effect
FTA or PMI VISUALIZATION AND HANDLING

Visualize and manage FTA (Functional and Tolerancing Annotations) or PMI (Product and Manufacturing Information) directly in PiXYZ STUDIO. Annotations are available directly from the Product Tree structure. Look for “Annotation Set” in the first listed nodes, then double-click on the annotation you wish to display (a “eye” icon appears before the Annotation name):

- Captures
- Datums
- Dimensions
- Tolerances
- Notes
- Views
- Sectional views

FTA sample visualization

FTA with annotations and predefined sectional view

Product Structure with FTA
Some actions manually applied to a model can be automatically scripted in Python. From the MODIFIERS window, push on the «Generate script» button. The corresponding script is written in the script editor.

Specific workshops and training regarding python scripting in PixYZ can be delivered through "remote engineering hours" or on-site training sessions. Please contact PixYZ.

PixYZ STUDIO batch is a premium version including additional Import/Export functions to the Python scripting capacities, for automatic batch processing of CAD files.
OBJECTIVE  Obtain a high quality tessellation from a native CAD file while respecting original geometry (see page #42 for more information regarding differences between native CAD files and Tessellated files).

PiXYZ STUDIO creates high quality and low density meshes from almost any CAD model. It provides efficient and very fast tessellation*, thanks to a smarter organization of vertices. The part 1 of the tutorial explains how to get a high quality 3D object for a rendering usage.

STEP 1- CAD file import

PiXYZ STUDIO supports both tessellated (mesh) and native CAD (exact geometry) formats. To import your model:

- Go to the « File » menu and choose « Import Model » or press the following button from the Main Toolbar;
- Select the file to import. Multiple files (several formats) can be imported at the same time.

PiXYZ STUDIO also handles drag & drop loading directly in the viewport:

![Drag & drop CAD file](image)

![Processing](image)

![File imported in PiXYZ](image)

Supported file formats  See slide #6 for a detailed overview
STEP 2 – Tessellation – See page #43 for more information

Parameters
CAD models are not tessellated, they contain exact mathematical surfaces. To create meshes, or polygonal surfaces:

- Go to the « CAD » menu and choose the « Tessellate» function or click the button from the Essential toolbar
- Set the following parameters for a high quality tessellation*:
  - Max Sag*: 0.2 mm
  - Max Angle: 10°
- Click on « Execute » (do not select anything or select the Root node to execute the algorithm on the whole scene)

3 basic parameters are usually defined for a surface mesh generation:

- **Max Sag** - the maximum distance between the geometry and the tessellation*. This parameter ensures that mesh is similar enough to the original analytical surface. A low value means that a very fine mesh is used to render surfaces.
- **Max Length** - the maximum allowed length of polygons sides.
- **Max Angle** - the maximum allowed angle between normals of two adjacent polygons (on a same face). It allows to add more precision in short radius fillet.

Parameters examples:
1. Good tessellation quality for high End visualization application:
   - Max Sag: 0.2
   - Max Angle: NO
2. Extreme accuracy tessellation for physics engine:
   - Max SAG: 0.1
   - Max Angle: 20°

Before tessellating, use the function « Repair CAD » or « Assemble CAD » to prevent non-assembled CAD elements (patches) or faces orientation issues.
STEP 3 – Model Repair

The original model might have some default: misoriented faces, missing faces/gaps.

PiXYZ STUDIO offers mesh repair features, such as polygons reconnection, normals/faces orientation unification, topology correction.

The « Repair Mesh » function can automatically correct the model’s defaults.

To repair your model:

• Go to the « Optimize mesh » menu and choose «Repair Mesh» option or press the following button from the Essential toolbar:
• Set 0.1 millimeter as tolerance value
• Click on « Execute » (do not select anything or select the Root node to execute the algorithm on the whole scene)

The « Orient » and « Invert Orientation » functions are also available, but they only correct orientation issues on selected surfaces.

Crack non-manifold
Uncheck this option to keep the non-manifold edges *

Orient
Use this option to orient all the polygons/faces of the model in the same direction
The first part of this tutorial is now finished. The model has been processed and optimized for a photo-realistic rendering usage. A fine mesh has been created to get a geometry similar enough to the original surface.

However the model may still have a too high number of polygons for some real-time applications. The part 2 will explain how to reduce polygons count.
OBJECTIVE Reduce the polygons count of a high quality tessellated model by keeping a nice visual quality. This part of the tutorial explains how to get a nice low-poly model for a Virtual Reality usage.

STEP 1 - Remove holes
Once tessellated and repaired, the original model contains around 12M triangles. This amount can be optimized. PiXYZ can remove specific features on a CAD model, such as holes.

To reduce the triangles count, let’s start by removing through holes with a diameter lower than 10 mm:

- Go to « Reduce mesh » menu and choose « Remove holes » option
- Check « Through Holes » option
- Set the Maximum Diameter to 10 millimeters
- Click on « Execute » (do not select anything or select the Root node to execute the algorithm on the whole scene)

From 12M to 560K polygons

« Max Diameter » is the maximum diameter of holes to be removed

Checking “surfacing holes” may reseal holes due to a tessellation failure
STEP 2 – Hidden Removal

The original model contains hidden patches*, parts* and polygons which are not necessary for the visualization.

To remove automatically all hidden parts*, patches* or polygons not visible from a sphere around the scene:

- Go to the « Optimize » menu and choose « Hidden removal » function
- Choose to remove patches (for instance)
- Click on « Execute » (do not select anything or select the Root node to execute the algorithm on the whole scene)

3 parameters can be adjusted:
  - Resolution of the visibility viewer
  - Sphere count : segmentation of the sphere
  - Fov X : horizontal field of view
  - Screen Size Per View

You can choose to remove parts*, patches* or polygons.

If a portion of a patch* or a part* is visible, this patch or this part won’t be removed.

For further reduction of the number of polygons, choose « polygons ». Thus the portion of the patch*/part* not visible will be removed.

Smart Hidden Removal — A similar function is available in PiXYZ STUDIO and apply the same process yet it uses multiple cameras in all closed volumes higher than a specified value (ideal for car interior, engine compartment...).
STEP 3 – Remove the link with CAD patches

Before reducing the triangles count with the decimation* function, we need to delete the CAD patches* to allow the remeshing over patches* boundaries.

Go to « Optimize mesh » menu and choose « Delete Patches» function:
STEP 4 – Decimation – See page #44 for more information

For a lower-memory usage, the model needs to be transformed to a low-poly object. PiXYZ STUDIO reduces the polygon density of a mesh by deleting vertices. It allows precise control, preserving normal distortion and texture coordinates.

To remove vertices:
- Go to the « Reduce mesh » menu and choose the « Decimate » function, or push on the following button from the Essential toolbar.
- Use the default parameters.
- Click on « Execute » (do not select anything or select the Root node to execute the algorithm on the whole scene).

The best way to decimate a model is to combine the 3 following parameters to obtain the lighter model while keeping an acceptable quality:

- **Surfacic tolerance**: the maximum distance between vertices of the original model and resulting simplified surfaces.
- **Lineic tolerance**: the maximum distance between vertices of the original model and resulting simplified lines.
- **Normal tolerance**: the maximum angle between original normals and those interpolated on the simplified surface.
Thanks to the normal distortion control of PiXYZ, the visual appearance has not changed despite the significant polygons reduction.

Before DECIMATION process (env. 450k polygons)

After DECIMATION (env. 76k polygons),
6 times polygons reduction
STEP 5 – Export the model

The model has been reduced from 1M to 76k triangles, almost 95% reduction and the visual aspect remains the same as the original. The model has been optimized for a real-time usage, such as Virtual or Augmented Reality.

It can now be exported in one of the supported formats. To do so, go to the « File » menu and choose « Export Model » or click on the following button to open the export window.

The format *.pxz has been created to let you save your scene. To save your project click the following button or go to the « File » menu.

This format keeps the original CAD shapes and history Modifiers to allow modifications in a second phase.

Supported export formats: FBX, glTF, JT, 3DXML, COLLADA, Stereolithography, OBJ, 3DS, PRC, PDF
INFORMATION DIFFERENCES BETWEEN CAD MODELS AND MESH MODELS

CAD models inherited from CAD software (CATIA, NX, SolidWorks, Alias, STEP..) are not tessellated. They contain exact parametric/mathematical surfaces.

A CAD body (closed volume) or CAD surface (open shell surface) is composed of CAD faces (or patches), delimited by boundaries (see Glossary). To be displayed in a 3D application, these CAD faces need to be translated into meshes. A mesh is composed of multiple connected polygons, or triangles (1 polygon = 2 coplanar triangles), forming a mesh surface that is understandable by a Graphic Card, to be rendered in a 3D application.

Moreover, CAD models can contain additional engineering and design data (metadata, PMI,..), that can be very useful to perform a targeted Data Preparation process based on targeted properties.

DCC software (Maya, 3DSMax, Blender,..) natively create tessellated geometries, or meshes, than can be exported as FBX files (for example) to be re-imported in Unity3D using PiXYZ PLUGIN. Note that these meshes often come with UVs (1st channel and/or 2nd channel), that can either be kept at import, or overridden using the "Generate UVs" setting (1st channel only).

Already tessellated meshes are meant to be optimized to create LODs by performing efficient and conservative decimation on them.

<table>
<thead>
<tr>
<th>CAD</th>
<th>MESH</th>
</tr>
</thead>
<tbody>
<tr>
<td>(patches/faces, boundaries) BREP</td>
<td>MESHER (polygons, edges, vertices)</td>
</tr>
<tr>
<td>PARAMETRIC EXACT GEOMETRIES</td>
<td>« DEAD » DATA</td>
</tr>
<tr>
<td>DESIGN PRODUCT STRUCTURE (PMI, manufacturing info, properties...)</td>
<td>SIMPLE HIERARCHY</td>
</tr>
<tr>
<td>METADATA (visualization) SURFACE COLORS</td>
<td>NO METADATA</td>
</tr>
<tr>
<td>(physical properties for simulation) MATERIALS</td>
<td>MATERIALS (visualization)</td>
</tr>
<tr>
<td>UVs (texture coordinates)</td>
<td></td>
</tr>
</tbody>
</table>
**TESELLATION** - When creating a mesh out of a CAD model, PiXYZ PLUGIN uses this algorithm to create a surface mesh.

2 main parameters are defined for a surface mesh generation:

- **MAX SAG**: The maximum distance between the geometry and the tessellation. This parameter ensures that mesh is similar enough to the original analytical surface (exact geometry).

A low value means that a very fine mesh is created. The distance values are expressed in millimeter.

- **MAX ANGLE**: The maximum allowed angle between normals of two adjacent polygons (on a same face). It allows to add more precision on short radius fillets.

Adjust the « Max angle » parameter to keep enough polygons in high curvature areas whose radius is lower than the « Max sag » value: fillets and chamfers for example.

Other parameter possible – not used in PiXYZ PLUGIN

- **MAX LENGTH**: Used to control the length of a polygon (edge).

For a rendering usage, it is often not recommended to use the « max Length » parameter. It increases the polygons count without significant improvement on the visual aspect. But in case of very long objects (a plane body, a train cabin...), this setting can avoid lighting artefacts caused by too long polygons.

Ex. with Max Sag = 0.2 mm
Ex. with Max Sag = 0.1 mm
Ex. with Max Sag = 0.2 mm - Max Angle = 20°

In the above example, the « Max angle » parameter has improved fillets precision by adding a row of elements without increasing polygons number of the yellow piece contour.
DECIMATION - When optimizing a tessellated model, PiXYZ PLUGIN uses this algorithm to reduce the mesh polygon density by smartly deleting vertices. It allows precise control, preserving from bad smoothing and topological irregularities.

The algorithm uses a combination of the 3 following parameters to obtain the lighter model possible while keeping an acceptable quality:

- **SURFACIC TOLERANCE**: the maximum distance between vertices of the original model and resulting simplified surfaces.

- **LINEIC TOLERANCE**: the maximum distance between lineic vertices of the original model and resulting simplified lines.

- **NORMAL TOLERANCE**: the maximum angle between original normals and those interpolated on the simplified surface.

The Normal Tolerance setting preserves the quality of how the light reacts on a surface/mesh. Combined with the Surface Tolerance setting, it will act as a quality controller, keeping polygons where the surface curvature is important, preserving the visual quality of the model.

The Lineic Tolerance is meant to preserve the boundaries of the original surface (where the edges are "sharp").

Other parameter possible:

- **TEXTURE COORDINATES TOLERANCE**: this setting is meant to preserve the UV (or Texture Coordinates) while decimating a mesh (0.01 is a good value).
Assembly  a scene node that contains components. It permits to hierarchize the product structure

Brep  Boundary Representation. Method for representing shapes using the limits. Boundary representation models are composed of two parts: topology and geometry (surfaces, curves and points). The main topological items are: faces, edges and vertices. A face is a bounded portion of a surface; an edge is a bounded piece of a curve and a vertex lies at a point.

Component  part or assembly

Chamfer  a transitional edge between two faces of an object.

Decimation  polygons diminution by removing vertices

Defeaturing  Details removal (holes,...)

Fillet  a rounding of an interior or exterior corner of a part design.

Instance  scene node used to instantiate a component.

Occurrence  As parts and assemblies can be instantiated, an occurrence is the instantiated occurrence of a component. For example, if a wheel part is instantiated 4 times, there will be 1 part but 4 occurrence of the wheel.

Non-manifold edges  Edges of polysurfaces or meshes that have more than two faces joined

Patch  CAD face or surface limited by spline curves

Part  scene node representing a single object.

Sag  The sag value defines the chordal deviation for curves and surfaces. The "curve chordal deviation" represents the maximum distance between a polyline ("chord") whose end points lie on a curve and a point on this curve.

Tessellation  in surface modeling and solid modeling, the method used to represent 3D objects as a collection of triangles or other polygons. All surfaces, both curved and straight, are turned into triangles either at the time they are first created or in real time when they are rendered. The more triangles used to represent a surface, the more realistic the rendering, but the more computation is required.