GETTING STARTED GUIDE v.02
Welcome to Project Memento!

OVERVIEW
Project Memento is an Autodesk Labs preview of an end-to-end solution for converting any reality capture input (photos, scans) into high quality 3D mesh, that can be cleaned up, fixed for errors, and optimized for further digital use or for fabrication.

Project Memento has two goals:
First, to streamline current tedious workflows for creating high quality digital replicas from reality capture sensors, that involve multiple tools which are often very complex and expensive, and require high expertise.
Second, to solve a big, rarely solved technological challenge: the ability to visualize, handle, analyze, fix and optimize very large meshes. Such meshes are a usual result when converting reality data when a highest quality professional result is demanded, but can also come from modeling applications.

Memento offers a focused toolset in a fun, clean, modern UI that enables unprecedented ease of use, which we hope will democratize all things reality computing and increase adoption among a wide audience of users.

WHAT IT DOES - WORKFLOWS

There are two main workflows in the current version of Memento:

A. **Clean up, Fix and optimize an existing mesh** for digital publishing or for 3D printing. This is for use cases where you have an existing mesh that has been generated in other apps, converted from reality capture sensors (photos or scans) or modeled, and you wish to work easily with it, clean it up, fix holes, spikes, cut a part of it or optimize it for various types of downstream use, digital or 3d print

B. **CREATE mesh** from photos and prepare for digital publishing or 3D printing. This is for use cases where you wish to make high quality digital replica of a real life object. In this workflow, you first take photos of the object in question, import them in Memento, process them into a 3D mesh model, and when the model is generated, clean it up, find errors, fix them, and optimize the model for digital publishing or 3d printing.
FUNCTIONALITY LIST (version 10.7.0)

- **Mesh creation:**
  - From Photos to 3D mesh, first iteration *(New)*

- **Import formats:**
  - Supported import file formats: native .RCM, .OBJ, and .STL *(New)*

- **Mesh clean up, fixing and handling:**
  - Fast loading of large meshes (tested with 400 million+ poly)
  - Visualization of large mesh geometry + texture (wireframe, solid, textured mode)
  - Clean up of unnecessary noise or busy surroundings
  - Cutting edge mesh analysis/diagnostic and fixing tools that work on large meshes
  - Smart cleanup tools
  - Semi-automated and manual mesh fix tools for fixing holes, spikes and particles
  - New bridging technique for fixing large holes
  - Fixing in Isolation Mode to easier work with isolated parts of the bigger mesh
  - 10 level undo-redo

- **Export formats:**
  - Export to .OBJ or .STL or save as .RCM

- **Mesh preparation for downstream use:**
  - Decimation tools during export (1-99% decimation range)

- **3D Printing support**
  - Prepare the mesh for 3D printing
  - Save as printable .STL
  - Direct connection to a variety of 3D printers

- **In-product Live update** for all upcoming Memento updates *(New)*
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**INSTALL MEMENTO**

Memento is a desktop application that connects to cloud services for various operations. If you are using Memento solely to clean up and fix meshes, you will not need any Internet connectivity and you can fully use the product offline. However, if you would like to use the newly introduced capability to create a 3D mesh model from photos within Memento, you will need Internet connectivity, both to login to your Autodesk account as well as to access our photo-to-mesh service that requires cloud processing. Memento currently runs on Windows OS only.

If you are reading this manual, you have probably already installed Memento. It is however still useful to check on the system requirements, as Memento’s sweet spot in creating and handling huge datasets can make some intense operations. For optimal experience, these are the minimal hardware requirements.

- 64-bit Windows® 8 or 64-bit Windows® 7 Professional/Enterprise/Ultimate edition
- 64-bit Intel or AMD multi-core processor, 2.0 GHz or faster
- 8 GB of system RAM minimum
- NVIDIA or AMD graphics card with 1GB or above RAM; graphics card to support OpenGL 3.2 or newer and DirectX10 or newer
- 1 GB of free disk space for installation, SSD storage recommended
- 3-button mouse
- Internet connection for creating an Autodesk A360 account or log-in in the account that is need in order to be able to access the photo-to-mesh service as well as for actually accessing the photo to mesh service that uses cloud processing.

**OPENING MEMENTO FOR THE FIRST TIME**

The first time you start Memento, you will see a start screen with 4 discs:
We tried to gather all the information necessary to start with Memento in one place accessible at any time during working in Memento.
Brief description of the content in the discs:

- **LEARN:** Here you can find all available learning material in the form of videos, this getting started guide and a sample project that contains set of photos, for making a 3D model as well as already generated models
- **OPEN:** This is where you start to use Memento, either to open an already processed Memento project (RCM file), or open a mesh created in other applications (.OBJ, .STL) or to create a new mesh from photos
- **ENGAGE:** Under this disc you will find links to the Memento forum where you can ask questions, learn from others or show what you are doing. There is also a direct Feedback link, where you can send us a description of a problem or a feature request, should you prefer to do it privately.
- **ABOUT:** Here you find the version/build number of the software which is often useful in case of technical support, so we know with which build you experience the problem.

The start screen with the four discs appears upon application start and will disappear after opening of the first model. You can come back to it at any time, by clicking on the Autodesk logo located on the top left corner of the application. This corner menu will always be there when you work in a model in collapsed state, and will expand when you hover with a mouse over it, showing the logo and all other options.
GETTING AROUND – UI Overview

The User interface (UI) in Memento is, as you will notice, quite minimal. There are really only three main UI pieces:

1. **Not expanded**
   - Located in the top left of the application frame when a mesh model is open

2. **Visualization modes**, **Selection tools**, **Action tools**
   - Radial bar
     - This bar shows upon when you right click in the main window. *(note: the Action tools will only show when something is selected in the model)*

3. **Before mesh analysis**, **After mesh analysis**
   - Mesh analysis and diagnostic tool
     - Top middle in the application frame

There are a few additional tools that are contextual - they appear only in certain situations or in certain selections - and will be covered in the Workflow section of this guide.

Before we take a deeper dive in the options of these menus, let us quickly cover how to navigate in Memento.
NAVIGATION

**ORBIT**
To orbit the 3D model, hold mouse right-button + move (right click drag)

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<thead>
<tr>
<th>Image 1</th>
<th>Image 2</th>
<th>Image 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>[Image]</td>
<td>[Mouse]</td>
<td>[Rose]</td>
</tr>
<tr>
<td>Hold right mouse + drag</td>
<td></td>
<td></td>
</tr>
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</table>

Additional orbiting controls that can be very useful:

- **ALT + Orbit**
  - Pressing the ALT key during orbiting will ‘tilt’ the scene

- **Ctrl + Orbit**
  - Pressing Ctrl during orbiting will ‘change the center of orbiting’ to the center of the object

Default behavior is that the center of rotation is there where the mouse click is.

There are two scenarios in orbiting:

- When entire model is within the current view: Constraint Orbit happens around entire model’s Center of Gravity. In this mode CTRL + Orbit will freely rotate the model
- When you zoom in and only a part of the model is in view: Free Orbit happens wherever you right clicks. In this mode CTRL + Orbit has no effect

The transition between the modes is seamless and happens without any explicit action by the user

**PAN**
To pan the 3D model or the image cluster in the 2D canvas, hold the mouse wheel + move

<table>
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<td>[Image]</td>
<td>[Mouse]</td>
<td>[Rose]</td>
</tr>
<tr>
<td>Hold middle mouse +move</td>
<td></td>
<td></td>
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</tbody>
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**ZOOM**
To zoom in/out, rotate the mouse wheel up or down
TIP:
**HOME key:** If you moved and zoomed the model in a manner that you feel lost in space and can’t find or position you model correctly, hit the Home key on your keyboard – this will bring you back to the start position of the model.

**Working without a mouse (tablet etc.)**
Ideally you really need to have a mouse to navigate and work with Memento in most pleasant way. However, if you happen not to have one around or are on tablet, here the keys that you need to know:

- Z – zoom
- Spacebar - pan
- X – orbit (same as right click orbit)
- N – twist

These require holding the key (and are active while holding down the key only) and either clicking a trackpad, stylus on screen, or left mouse button

**MESH DISPLAY CONTROL**

Memento offers three different ways to display/visualize the mesh: **Wireframe, Solid** and **Textured** mode. Upon right click in the main UI window, select the appropriate option from the radial menu.
Solid displays monochromatic render of model without texture

Textured displays fully rendered model with texture

***Note: Don’t let the switch to Wireframe display mode not confuse you when you see beautifully shaded grey surface instead of triangulated mesh. This display is well a wireframe display; but in very dense meshes when viewed from far away the wires look like a shaded surface. If you get closer to the model, you will see the wires (the mesh triangles).

Ambient occlusion
We have ambient occlusion turned ON by default, as it makes for more beautiful viewing of the models. However, this sometimes causes performance issues on weaker machines. If you experience performance issues, try toggling it OFF by using the ‘a’ key.
SELECTION METHODS

There are three main ways to make selection of a mesh or parts of mesh: marquee, boundary and brush. Right click in the main window and select an option from the radial menu. The mouse pointer will also change, helping you remember in which selection mode you currently are in.

VERY IMPORTANT NOTE:

Changing of brush size: for many operations you will have to often change the brush size – make it smaller for precise selections or making it bigger - when you want to paint strokes to select. As we currently have not exposed the brush size tool, please note that you will need to use the keyboard keys ] and [ for making the brush smaller or bigger.
**Brush selection**
(change the size of brush using the keyboard keys ] and [

Adding or removing from selection
By holding the **Shift key**, you can add more selections to an already made selection.
By holding the **Alt key**, you can remove from an already made selection.
The brush selection is the only one that selects only visible faces. If you inadvertently selected a portion of a mesh that you didn’t want to, hold the **Alt key** and reselect to undo that selection.

**ACTIONS MENU**

This submenu contains various tools to help work with the mesh: You can refine a mesh by subdividing or smoothing, fill a hole in flat or smooth manner, delete a portion of a selected mesh, delete inverse to a selection, cut and fill selected mesh (for closing bases of statues for example). The isolate tools to help you isolate a part of a complex mesh in order to work with a smaller part of the mesh, access details and edit, without being obstructed by the surrounding mesh. There is a lot more to come here in upcoming releases - stay tuned!

**Refine selected mesh**
Smooth or subdivide the selected mesh
**Fill selected mesh**
Smooth or flat fill the selected mesh

**Delete selected mesh**
Remove the current selection from the model

**Delete unselected mesh**
Remove everything except the current selection (invert and delete)
**Cut and fill selected mesh**
Straight cut, remove and flat fill current selection

**Isolate selected mesh**
Everything outside the selected mesh will be hidden temporarily

**Hide selected mesh**
The current selection will be hidden temporarily
Given that we work with really big and complex meshes (if you ever get a chance to work with mesh created from CT scans, you will feel the pain), isolation is a very useful way to work on a part of a mesh, view and fix it while not bothered by the rest of the mesh. You can not only View a part of the model in isolation but you can actually analyze it, running the mesh detection tool and fix it.

**MESH ANALYSIS and DIAGNOSTIC**

The core value of Memento, in addition to creating high quality meshes from reality capture sensors is to clean up, fix and prepare those large meshes (or any imported meshes) for various downstream workflows. For that, Memento has a unique, state-of-the-art mesh analysis and diagnostic tool, that first analyses the imported mesh or the mesh generated from photos and then guides the user as to where the issues are and how to fix them. The tool looks for particles, holes, spikes, tunnels etc. and displays back to the user the analyzed information, in form of a report that lists the types and numbers of issues, so that the user is aware of the issues found and can start fixing them.

The mesh diagnostic tool can be found on the top middle of the work area, displaying a little lightning bolt icon.

After generating or loading a mesh, a simple click on the icon will start the analysis on the mesh. Memento will start analyzing the entire mesh (or its isolated part), looking for holes, spikes, particles and tunnels. Depending on the size of the mesh, this can take few minutes, but they are well worth it! After finishing the analysis, the little thunderstorm icon turns into a new mesh analysis wheel and when you hover over it, you can see a report of the analysis, informing you how many issues have been found on the mesh, grouped in categories.

From then on, by clicking the **Next** button on the wheel, the tool will help you cycle from one error to the next; Memento will locate the issue, automatically orient the model and zoom into the found problem, so that you are quite clear what needs to be fixed. Further to it, each time you click the ‘Next’ button and a problem is displayed, you will be offered a **Fix** option (also in the wheel). The Fix tool behaves the following way:
- If the detected issue is a **hole** – it will fill it (either using the ‘flat’ or ‘smooth’ option that you can pick within the Fix tool)
- If the detected issue is a **spike**, it will remove it, and fill the remaining hole
- If the detected issue is a floating **particle**, it will delete it

**TIP:**  
**Visualization of the errors**
To assure best visual understanding of the detected problems on the mesh, we recommend that you switch to the Wireframe visualization mode when using the Detect issues tool. If so, the resulting errors will be colored as follows:

**Color Legend**

<table>
<thead>
<tr>
<th>Color</th>
<th>Description</th>
<th>Image</th>
</tr>
</thead>
<tbody>
<tr>
<td>RED</td>
<td>Detected error</td>
<td><img src="example.png" alt="RED Error Image" /></td>
</tr>
<tr>
<td>CYAN</td>
<td>Actively selected error to fix</td>
<td><img src="example.png" alt="CYAN Error Image" /></td>
</tr>
<tr>
<td>BROWN</td>
<td>Backside of a mesh (as seen through a hole on the surface)</td>
<td><img src="example.png" alt="BROWN Error Image" /></td>
</tr>
</tbody>
</table>

**Note:** our selection tools currently do not allow for selection of mesh from the inside/from its backside.
Fixing holes

Holes are usually easy to fill/close using the Fix tool from the mesh error detection menu. After the detection tool finishes the analysis and you start cycling from one error to another using the Next button on the mesh analysis menu, you will be zoomed in into the errors. If the error is a hole, it will be represented with a cyan highlight around a hole, which usually will show dark brown as it’s actually displaying the back of the mesh from the other side of the object. Select the Fill tool and in 99% of the cases, the hole will be filled.

Also, be aware that you can fix a hole using the ‘Smooth’ or the ‘Flat’ option, depending on the results you want to get.

Note that big holes might not be able to be fixed automatically in one go. If that happens to you that are two solutions for it:

1. Set the brush selection tool to be wider than the currently red selection covers (use the ‘]’ or the ‘[’ key to increase or decrease the size of the brush), and after expanding the selection to more triangles around the hole, the hole might be able to close.

2. There can be holes that are so big that no trick will help you fill them in one go. The strategy with such holes is to first create a ‘bridge’ to split the hole in two or more smaller holes, and then fill them with the fill tool. Step-by-step instructions:
   • Select a small area on one side of the hole (you can use the brush tool so select multiple triangles on the opposite side of the hole or the ‘F’ key to select individual triangles).
   • Holding the Shift key, select small area on the opposite side of the first selection.
   • Right click and from the Actions menu, select Fill (flat or smooth, depending on the topology where the hole is). This will create a bridge between the two selections and will split the hole into two smaller holes.
   • Using the brush selection, paint the boundary on the smaller hole, and select again the Fill tool to close it.
   • Repeat for the other hole.
Note: if, using the Flat option of filling filled the hole with a geometry that is too flat, try again with Smooth fill and vice versa.

Big mesh holes stretching across multiple planes are easily closed with the ‘bridge’ technic

subdivide a complex hole into smaller sections that can then be filled with the Fill tool.

Fixing spikes
Spikes are often first deleted by the fix/fill tool, and then the remaining hole it automatically closed.

1. Detected Spike
2. Using the Fix tool, smooth option,
3. Fixed Spike
Don’t forget that in certain situation, the isolate tool might help a lot in editing and fixing in a much easier way, by removing all the noise of the surrounding mesh temporarily, so to work in the focus area easier.

Note:
You can always come back to a hole or spike, to fix it manually, using the selection tools and using the various action tools from the right click context menu. The tools are very similar to what the mesh diagnostic tool would offer, but you will have to find and select them manually.

**IMPORT/OPEN**

This labs release of Memento (10.7.0) reads large meshes in .OBJ, .STL and .RCM file format. They all ‘open’ in Memento, so don’t look for an ‘import’ option.
You can Open a project from the Open disc in the startup screen, or from the corner menu available at all times in the UI when you work on a mesh.

**.OBJ**

Obj is probably the most popular exchange mesh file format that almost any 3D modeling application can make. Additionally, and very relevant to Memento, OBJ files can be files generated by ReCap Photo, 123D Catch, any photo to 3D software (image based modeling solution), or any scan to 3D software. These reality capture solutions, when set to maximum quality, usually generate huge .OBJ files that are quite a challenge to edit and fix in downstream applications. This is the problem that Memento is trying to offer a solution to.

. OBJ are imported along with their texture, if the .mtl file is in the same folder.

**Example file: Mount Rushmore**

Mesh model made from laser scanned input, imported in Memento (Thanks to CYARK [http://archive.cyark.org/](http://archive.cyark.org/) and the National park services for allowing us to show the mesh of a beautiful laser scan capture from Mount Rushmore)
.OBJ generated from a scan and imported in Memento (created by CYARK http://archive.cyark.org/)

IMPORTANT NOTES:
1. Memento instantly and silently generates a native .RCM file when importing an OBJ. That is the format in which Memento will also save the work, unless explicit export to is actioned by the user. This is the main reason why it might take a bit of time during importing an OBJ file, as the conversion happens at opening. After that, Memento excels with unseen performance, given the file sizes that it can handle.

2. It is very important to understand that, if you have already opened an OBJ, worked on fixing it, have saved the work that work is saved in a RCM file. The next time you want to work the file, you should proceed opening the generated RCM file, not the OBJ.
If you mistakenly open the OBJ file again and you have the RCM file with the same name in the same folder and you try to open an OBJ again for which RCM is already generated, you will see a dialog which will give options to save-as or overwrite.

.RCM
RCM is a new file format Reality Capture Mesh. Aside from Memento, currently only Photo on ReCap360 (our Photo to mesh online service app) https://recap360.autodesk.com/#home can generate/export this file format. If you are making 3D models using Photo on ReCap360, you will need to check the RCM export prior to submitting the photos. Once the reconstruction is done, Photo generates a rcm.zip folder that you would need to unzip after downloading. When unzipped, this folder will contain a .RCM file, an image used for a thumbnail and the texture files.
Starting this release of Memento (March 2014), you can also make meshes from photos within Memento. This, however is the very first implementation of this service, and is limited to automatic photo to mesh. There is no image management, manual stitch, survey points or distance tools. That will come later. More on how to create meshes from photos in Memento, see later in the guide, under Workflow 1:

**SAVE/EXPORT**

**Save**
Memento saves a native format as RCM. This is Reality Capture Mesh. Currently it will contain the imported texture information for displaying each time you reopen the RCM file.

**Export**
Memento can currently export to .OBJ or .STL file.
OBJ will also contain texture information while .STL is monochromatic, given that that format does not carry texture information in itself and is mainly used as exchange format for 3D printing.

The export dialog does two things:
- Exports to .OBJ or .STL
- Gives you the option to decimate/simplify the model so that it can be exported in various levels of detail and sizes. You will often need to do this as Memento will generate or handle meshes that can into half million polygons that very few modeling or machine software such as 3D printers are able to read.
Note: While simplification will certainly make the file sizes much smaller, in some cases it might introduce additional artifacts, so please check your model after simplification and before using it downstream. The good news is that from first tests on some of our models, even strong simplification resulted in almost none loss of detail and beautiful 3D prints.
WORKFLOWS

There are two main workflows in Memento:

- **Create mesh** from photos as a digital master replica, and clean, fix/prepare it for downstream use.
- **Open existing mesh** made in another application from photos or scans, or modeled then clean, fix and prepare it for downstream use.

**WORKFLOW 1 - Create a high quality 3D mesh from photos**

Autodesk has one of the most powerful professional-grade photo-to-mesh engines as recognized by many users. It allows users to create high quality 3D models from simple photos. This engine is behind our consumer-grade photo-to-mesh app, 123D Catch and the professional-grade app, Photo on ReCap360 (target professional quality output). With the goal to both simplify workflows and the need for multiple solutions to arrive to a high quality digital replica prepared for downstream, we are implementing full photo-to-mesh service within Memento as a first starting point for making meshes out of reality sensor data. What you see in this release is just the first iteration of that integration effort. It does not yet have stitching tools, survey points, set distance, or all the tools that 123D Catch and Photo have. But if you are good at taking photos for photogrammetry (image based modeling) you will get good end results even with this first release.

**Note for first time users of photo-to-mesh tools**

The process of converting photos into a 3D digital model is called ‘image based modeling’ or ‘photogrammetry’.

All that a user is required to do is to pick a real object, take enough photos from all sides of that object (or scene) to make for good coverage, make sure the photos are taken in a specific way (see link to best practices at the very end of this document) and that’s it. The rest will be taken care by our photo-to-mesh create tool (in the Open disc - Create) that processes those photos into mesh - leveraging our engine on the cloud - then returns back to you a high quality 3D mesh model.

Here are a few examples of 3D models made with Autodesk’s photo-to-mesh service.
Our algorithms are very strong and make for beautiful 3D models from photos. The only really important requirement is to take the photos in a specific way – you will find a list of really good tips as to ‘How to take photos for photogrammetry’ at the end of this document. Remember – you learn how to take best photos – you will get best possible digital replicas from them!

**Note for our Photo on reCap360 users:**
As you are guessing, in Memento we leverage the same cloud engine for creating 3D mesh models from photos as used by Photo on ReCap360. You will notice that this first implementation provides only automatic workflow, with no image managing tools, survey points, manual stitch, or distance tools, and without Ultra quality. This will come later. For the moment we would love you to test the functionality but if you are using Photo on reCap360 in your production, you definitely should continue to do so until we have implemented the full functionality in Memento. Note, the quality level at which we process the meshes in Memento is something between Preview and Ultra.
STEP by STEP – Create a mesh from photos

1. From the start screen, go to the Open disc and click on the Create button.

You will be prompted to login with your Autodesk ID. If you don’t have one, you can quickly create one on the fly. Its easy and free.

Once you are logged in, your name will appear at the top right of the application.

2. Back to the Create button, click on it. A new window opens and it will prompt you to drag and drop or open photos you have made of the object that needs to be digitized.
3. Locate your photos on your computer and drag and drop them in the window.

4. The photos get previewed as they open. Once all of them are open, you will be prompted to name the project.
5. from that moment on what will be happening is that your photos will be sent to the cloud, so that our photo-to-mesh engine can process them in a 3D model. This might take from one to a couple of hours, depending on the number of the images you uploaded and their resolution.

Note that we can currently process maximum 250 images in one reconstruction. An approximate remaining time for your reconstruction will be displayed on the screen. You don’t have to sit and wait. You can continue working on another mesh in Memento - see the link ‘work while you wait’ down right on the screen or close the app. Note: while you can work in parallel on another existing mesh, you will not be able to create a new project before the calculation of the first one is finished.

The moment your 3D model is ready, you will receive an email informing you that your reconstruction is ready, asking you to launch Memento (if it was not open) and find your generated mesh ready in your Create disc.
If Memento was already open, you would see the following message, click on download. This will download the generated .RCM file on your computer and will automatically open the file in Memento.

From then on, you are dealing with a mesh that will need to be cleaned up, fixed up and prepped for digital use or for 3D printing. That will be the same as the process explained in the following chapter, Workflow 2

WORKFLOW 2 – Clean up, Fix and optimize an existing mesh (.RCM, .OBJ, .STL)
This second workflow is the same both for continuation of Workflow 1 and when you start fresh by importing a mesh file (.OBJ, .STL or .RCM). If you are importing a mesh generated somewhere else, you will start with the Open disc and import the file; if however you continue from Workflow 1, go directly to step 2 of this workflow step-by-step explanation

1. Open .OBJ, .STL or .RCM
From the Open disc on the home screen or selecting Open in the corner start menu, click on Open and select an .OBJ, .STL or .RCM from your desktop. If the .OBJ is in the same folder as its associated .mtl file, the mesh will be imported along with its texture. RCM files are also always imported with the texture. .STL’s don’t have textures and will be monochromatic.

2. Set upright the scene
Meshes imported in Memento can come from anywhere. If they come from a photogrammetry (the image based solutions described in Workflow 1, or other image based solutions such as ReCap Photo,123D Catch) they will most probably not be oriented in the way the object was oriented in real life. At the same time, modeling applications often have different coordinates systems (in some the Z axis is ‘UP” in other, the ‘Y’).
To reorient any scene so that you can work in most natural way, wit the ‘sky up’ there is a ‘Set upright scene tool’ that shows up immediately after a mesh is loaded for the first time and that lets you set where the sky points to, which assures natural way of orbiting later in the project. **DO not skip this step!** It’s very useful for the further editing in Memento!
This is how the UI looks like when opening a new scene:

In the bottom left corner, you will notice a wizard like dialog, that informs you of various ways to orbit, asks you to orbit the scene and confirm if the scene ‘feels ‘off’ when doing so. The purpose of this is to see if the scene is already in correct direction and you feel comfortable orienting and orbiting, or its tilted or upside down which results in uncontrolled orbiting. **Best practice** is to always pick ‘feels off’ - a little blue arrow will be displayed on the cursor and you can position it on a surface that represents the axis point up to the sky. Click on it, the scene will automatically orbit to a good position and from now on, the navigation experience is guaranteed going to be good.
Do not forget to click on ‘Yes, better’ to end the process.

If you ran too quickly through this and are, later in the process, noticing that you have real troubles orbiting the scene, you can always call back this tool by clicking Alt+C which will again let you set the upright tool.

As mentioned above, if you cannot orient the model exactly as you desire, you will, after setting the upright tool, need to reach to additional keys to ‘fine tune’ the orbit:

• Pressing the ALT key during orbiting will ‘tilt’ the scene
• Pressing Ctrl during orbiting will allow for an unconstrained orbit, meaning the object can be oriented in any direction and is not kept “upright”.
• Default behavior is a constrained orbit, in which the ‘Z’ axis is always up and the center of rotation is there where the mouse click is.

3. **Clean up the surrounding**

If your mesh was generated from photos, it will most probably be ‘dirty’ meaning that the object that you captured might be ‘lost’ in the bigger context of the surrounding scene that got also captured. (This btw confuses many novice users of any photo-to-mesh sowftare, as they don’t quite understand at first glance what is it they are looking at. **Nothing to worry about!** Your object is somewhere inside that scene, you just need to orbit and zoom a bit to find it!)

1. Meshes made from photos can look quite incomprehensible (upside down and slightly confusing)

2. The same mesh after being orbited upside down, now shows an understandable scene of a temple and statue that was ‘hidden’ in the scene
4. **Slice and cap the base**

Statues or building like models made with photogrammetry often have an open base as the photos have only covered what is above ground. You can use the Cut and Fill tool from the Actions menu to slice the base in clean way and automatically close it.

The trick here is to position the object to be in an almost ortho position and level it (use Alt key during orbiting to achieve this) and then using the tool, make a window selection up to the level you wish to slice the model.
5. **Run the mesh analysis tool – detect errors**

From the middle top of the screen, click on the ‘detect errors’ button which will start the mesh analysis process. This is the most important tool in Memento, don’t miss it! After a while, the analysis will be done and hovering over the new menu that opens at the top of the screen will disclose an error detection report, showing the number of total errors and then grouped into classes: holes, spikes, particles and tunnels. Select the Next button to start cycling through different issues and using the fix button, fix as many issues as you can automatically. See above in this document, how to fix holes and spikes semi-automatically or manually.

6. **Additional editing**

Once you have filled all holes, and spikes, the model is all nicely closed up. The last thing you may have, depending on the model, is to do some cosmetic clean ups such as for example the spaces between the fingers on the example of Rodin’s sculpture, or the sides of the arms on the Warrior statue example.

To do that, you will mainly be using the brush tool (changing its size using the [ and ] keys). Note that in this release, you might not be able to succeed with all the desired edits. There are more editing tools that are needed, that we will be added in future releases.

In this example, there is more work after cleaning the holes and spikes. Due to bad lighting, the spaces between the fingers have been filled and we need to remove the mesh there. While we cannot fully process such an example with the current tools we have, this is a good example for a type of editing that you might need to do after fixing spikes and holes.
Export and decimating the model
You can export your fixed mesh in .OBJ or .STL file. If you don’t make any changes in the export dialog box, it will export with 0% decimation – this means at Maximum possible resolution. You do however have the opportunity to select a level of decimation that will reduce the size of the mesh while not losing too much detail. You can do it by sliding the decimation slider in the export dialog box. The name of the exported mesh with decimation will contain the decimation percentage as suffix to the file name. Note that .OBJ will be exported with its texture, while .STL will have no texture. STL file format does not support texture!

And, that is it.... That is, if your goal was to get a high quality digital model for publishing online, using further in games, movies etc... But, once digital, this replica has a longer life.. It can become physical again! Lets take the next steps!
Now that you have generated a 3D mesh from photos, cleaned it up and fixed the mesh from holes, spikes and other beasts, you will probably want to make it real - RIP MIX BURN (3D PRINT)!

In this March 2014 update of Memento (10.7.0) we introduce our first efforts for supporting 3D printing workflow. Much more interesting stuff is yet to come, stay tuned!

To 3D print a mesh that you fixed or generated from photos in Memento, you can one of the following two:

a. Print using the Autodesk 3D print utility
b. Save as .STL to send it for printing

**a. Print using a 3D printing utility:**
To do this, select the 3D print icon from the top left menu.

This will either prompt you to install the Autodesk 3D printing utility (if you don’t yet have it on your machine) or open the Autodesk 3D printing utility (if it was previously installed on your machine). The utility will open a new window and will help you do the following:

- an automatic background repair on remaining issues on the mesh, issues relative to 3D printing
• Let you select the 3D printer that you want to print on (if you have one or know which printer you will be using) and the material you want to print in. The the material selection list is printer specific
• Minimize the support material (printer dependent)
• Define the size/scale you wish to print
• Hollow the model with a desired thickness for the walls (default is 6mm which is good for printing on majority of the printers)
• Thicken the model in cases of thin shells
• Select numbers of copies to print and arrange them on the printer bed
• And finally, either directly print (if you have a connected 3D printer) or
• Save the .STL file that you can send to any printer, or save Objet or Makerbot project files, (.OBJZF and .THING) so that you can print with the same settings again.

The utility works really well, it offers a list of 10+ different 3D printers from the small scale, consumer grade printers (Makerbot, uPrint, Mojo, Type A, Fortus..) to various models of the best-in-class professional grade 3D printers Objet/Strattasys). By selecting a 3D printer, the utility is informed of the printer size and other printer specific capabilities and limitations and both resizes the model accordingly as well as offers only options and materials, specific to that printer.

If you do not see the printer that you own or have access to in this list, don’t worry, select on that is at least similar in bed size and generate an STL by clicking the SAVE button. The generated .STL file will be readable in any other printer. What you can do to get closer to what you need is to select one that has same or similar print bed so you know the scale is correct.

One disadvantage of this approach of 3D printing or creating a STL for 3D printing using the Autodesk print utility in Memento is that this utility heavily decimates the mesh as it was written for consumer grade usage. As we generate top quality dense digital masters that correspond as close as possible to the look of the real life object, we also want to make sure that the STL’s we create are decimated minimally as possible (as to what the 3D printer has as a limit size), so that the resulting print is best possible quality.

This is why, we work on fully implemented native 3D print preparation tools within Memento, so that we can print meshes that are decimated only minimally, to accommodate the limitations of what printers can read today, in terms of size of models, but not dumb down the beautiful high quality meshes that Memento generates.

For that reason, you might prefer the second approach, which is to clean up and fix up the model in Memento and save as .STL or .OBJ and then send it to a 3D printing software.

b. Export to .STL
The workflow would be to fix your mesh in Memento, using the above described tools, and then use the Export functionality (top left menu) and save the fixed mesh in .STL file format. You would decimate the mesh to accommodate what the resolution limits of the printer you are using would be, but that means, your resulting STL will be much higher resolution and thus quality than the one exported with the 3D printing utility.
Note: This can be already a fully printable model, but in some cases might still have some issues that the native printing software of a professional grade 3D printer will detect and let you fix. Also note, many 3D
printing software that come with the 3D printers also read .OBJ files. (MCOR is a color printer and reads .OBJ’s along with their texture)

Here an example of a beautiful 3D print, made by Cosmo Wenman who took the photos, prepared the mesh and printed it on Objet Connex 500.

and few more things to finish with:

**LIVE UPDATE**
Starting this March 2014 release, you will be notified each time we have a new update. This comes handy as you don’t have to check on the Beta portal to see if there is a new release, and also because we plan to start posting updates a bit more often!

**PERFORMANCE**
Loading OBJ files in Memento is significantly faster since our December release. We continue optimizing our engine and making it even more powerful to read and fix big meshes. With this release, the loading time for opening meshes has been dramatically improved, making an even bigger gap between Memento and other older, existing tools used for the purpose.
# MEMENTO SHORT KEY TABLE

**File Menu:**

<table>
<thead>
<tr>
<th>shortcut</th>
<th>action</th>
</tr>
</thead>
<tbody>
<tr>
<td>ctrl + o</td>
<td>open file</td>
</tr>
<tr>
<td>ctrl + s</td>
<td>save</td>
</tr>
<tr>
<td>ctrl + shift + s</td>
<td>save as</td>
</tr>
<tr>
<td>ctrl + w</td>
<td>close</td>
</tr>
<tr>
<td>ctrl + z</td>
<td>undo</td>
</tr>
<tr>
<td>ctrl + y</td>
<td>redo</td>
</tr>
<tr>
<td>shift + e</td>
<td>export</td>
</tr>
</tbody>
</table>

**Right Click: (Selection Tools, Display and Actions)**

<table>
<thead>
<tr>
<th>shortcut</th>
<th>action</th>
</tr>
</thead>
<tbody>
<tr>
<td>ctrl + f</td>
<td>last used fill method – requires active selection</td>
</tr>
<tr>
<td>ctrl + r</td>
<td>last used refine method – requires active selection</td>
</tr>
<tr>
<td>del</td>
<td>delete selected</td>
</tr>
<tr>
<td>shift + del</td>
<td>delete unselected</td>
</tr>
<tr>
<td>ctrl + shift + del</td>
<td>cut and fill selected (only available in marquee selection)</td>
</tr>
<tr>
<td>I</td>
<td>isolate selected</td>
</tr>
<tr>
<td>shift + I</td>
<td>hide selected</td>
</tr>
<tr>
<td>ctrl + I</td>
<td>show all</td>
</tr>
<tr>
<td>\</td>
<td>toggle between display modes</td>
</tr>
<tr>
<td>[ , ]</td>
<td>increase decrease brush size</td>
</tr>
<tr>
<td>TAB</td>
<td>toggle between selection modes</td>
</tr>
<tr>
<td>ctrl + P</td>
<td>print</td>
</tr>
<tr>
<td>Ctrl + P</td>
<td>print</td>
</tr>
</tbody>
</table>
### Navigation, selection and everything else....

<table>
<thead>
<tr>
<th>shortcut</th>
<th>action</th>
</tr>
</thead>
<tbody>
<tr>
<td>selection</td>
<td></td>
</tr>
<tr>
<td>alt + select</td>
<td>remove from selection</td>
</tr>
<tr>
<td>shift + select</td>
<td>add to selection</td>
</tr>
<tr>
<td>f + select</td>
<td>select face</td>
</tr>
<tr>
<td>ESC</td>
<td>clear selection</td>
</tr>
<tr>
<td><strong>boundary selection</strong></td>
<td></td>
</tr>
<tr>
<td>ctrl + z</td>
<td>remove previous point in fence mode</td>
</tr>
<tr>
<td>ESC</td>
<td>clear boundary in fence mode</td>
</tr>
<tr>
<td>Enter/right click</td>
<td>complete boundary with current mouse position in fence mode</td>
</tr>
<tr>
<td><strong>calibration</strong></td>
<td></td>
</tr>
<tr>
<td>alt + c</td>
<td>enter calibration mode</td>
</tr>
<tr>
<td><strong>navigation</strong></td>
<td></td>
</tr>
<tr>
<td>left &amp; right arrow</td>
<td>navigate defect list</td>
</tr>
<tr>
<td>Enter</td>
<td>zoom in on current mesh issue</td>
</tr>
<tr>
<td>Home</td>
<td>reset view</td>
</tr>
<tr>
<td>F5</td>
<td>refresh issue list</td>
</tr>
<tr>
<td>alt + orbit</td>
<td>rotate about axis perpendicular to view</td>
</tr>
<tr>
<td><strong>miscellaneous</strong></td>
<td></td>
</tr>
<tr>
<td>d</td>
<td>toggle HUD display</td>
</tr>
<tr>
<td>a</td>
<td>toggle ambient occlusion in solid and wireframe rendering modes</td>
</tr>
<tr>
<td>Ctrl + p</td>
<td>3D print</td>
</tr>
</tbody>
</table>
Navigation without a mouse (when using Tablet, Trackpad, Stylus)
These require holding the key (and are active while holding down the key only) and either clicking a trackpad, stylus on screen, or left mouse button

<table>
<thead>
<tr>
<th>shortcut</th>
<th>action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z</td>
<td>zoom</td>
</tr>
<tr>
<td>Spacebar</td>
<td>pan</td>
</tr>
<tr>
<td>X</td>
<td>Orbit (same as right click orbit)</td>
</tr>
<tr>
<td>N</td>
<td>twist</td>
</tr>
</tbody>
</table>

SYSTEM REQUIREMENTS

- 64-bit Windows® 8 or 64-bit Windows® 7 Professional/Enterprise/Ultimate edition
- 64-bit Intel or AMD multi-core processor, 2.0 GHz or faster
- 8 GB of system RAM minimum
- NVIDIA or AMD graphics card with 1GB or above RAM; graphics card to support OpenGL 3.2 or newer and DirectX10 or newer
- 1 GB of free disk space for installation, SSD storage recommended
- 3-button mouse
- internet connection for log-in in with your ADSK account as well as for using the photo to mesh service

KNOWN ISSUES

- Memento crashed when one user signed-out & signed in same session when job in progress.
- Defect detection on modeled meshes (typically imported STLs that are generated in solid modeling applications) detects false positives (tunnels)
- Occasional widgets random placement issues
- Memento job status is not updated when job is cancelled from different machine or on ReCap Photo
- Mac OS is not yet supported, neither natively nor is virtual environment
- Back side/interior side of mesh (colored brown) cannot be selected. You will always need to select a mesh from its outside (white color)
- We have ambient occlusion turned ON by default, as it makes for more beautiful model view/render. But this sometimes causes performance issues on weaker machines. If you experience performance issues, try toggling it OFF by using the ‘a’ key.

Want to know more about Photo on Autodesk® RECAP™ 360?
Click here: https://recap360.autodesk.com

For any questions or suggestions for improvement of the tutorial, please contact labs.Memento@autodesk.com or Tatjana.dzambazova@autodesk.com
ADDENDUM - How to take photos that are good for photogrammetry

What makes photos good for photogrammetry?
The photogrammetry process looks at series of photos and reconstructs the camera location, orientation, lens type and lens distortion. It does that by comparing and matching pixels/points across photos in the Entire Scene and match/ triangulate on visual features. This means that you should follow the following guidelines:

ENVIRONMENT (Lighting conditions)
You should avoid any environment in which the light creates strong contrast shadows over the object you shoot. Shadows are enemy to the photo-to-mesh reconstruction process.
• If you shoot in interior
  o The object must be shot under diffuse light that does not produce contrast light or shadow.
  o Never use the flash
• If you shoot outside
  o Avoid shooting at midday under strong sun. Best times are early in the morning or later in the afternoon

EQUIPMENT
• You can get good results with any camera. However, plastic lenses only go so far in terms of sharpness. If you are serious about this process and expect top quality results, a good lens makes a difference.
• Try to shoot the photos with a fixed lens. Fixed lens have no focal change, which is good for the photogrammetry process. A 50mm lens is great.
• Whenever possible, shoot with a tripod and if possible a clicker. You need this because in order to make the entire photo sharp, you will have to set a wide depth of field. This means that a very small amount of light will be coming in the camera so you will need to set your shutter speed long. This makes even a tiniest of shake of the camera result blurry photos. The tripod and a clicker will assure sharp photos.

PHOTO QUALITY
• The photos must be in focus SHARP and CRISP throughout the entire scene (not just the object of desire) as we compare pixels from the entire photo. If you happen to have few blurry photos among the entire set, remove them before making the reconstruction.
• Avoid blurriness in any part of the photos (ah, that beloved Depth of field effect). That will not work very well for photogrammetry. Do not assume that all is well if the object you try to shoot is sharp. We calculate the entire scene, not just the target object and any blurriness will confuse the algorithm.
• Do not change the zoom if you don’t have a fixed lens. Rather move towards and away from the object.
• Do not change exposure during the same acquisition.
• Set ISO to 100, it works on pretty much any reconstruction. Or simply keep the ISO low. High iso brings noise, which should be avoided.
• The ReCap Photo service currently accepts JPEG format only. However, if you shoot in RAW, you will have the ability to do some changes in the RAW images that WILL affect the quality of the 3D model. You can always re-export JPEG’s from the Raw images using photo editing software such as Adobe Photoshop or Bridge.

SHOOTING STRATEGIES – SCENE SET UP
• Make sure that he object you shoot is always in the middle of the photo and fills most of the frame (75-80% of the photo should be covered by the object you are digitizing)
• Use rich background. If you shoot a single object, avoid placing them on a monochromatic surface. If the surface is monochromatic, add many other smaller objects around the target object. The algorithms need as many different references in the space to do better calculation.
• Avoid green photographers screens (ChromaKey). Photogrammetry doesn’t do well with them.
• Don’t move any of the surrounding objects during the shoot and don’t have people walk around. Movements in the photos create uncertainty in the reconstruction.
• Shoot all around the object to cover each aspect of it with multiple overlapping photos. Shooting each 5-15 degrees on the same height of the object is a good practice. If you want to have a good level of detail, you should shoot at 2-3 different heights of the object, ending up with 70-100 photos for a small to medium object and 180-200 photos for a building.

• Take enough photos. It is not enough to have many photos, but they must also have a good overlap between them. If the overlap is too small or non-existent, the software might not take an entire cluster of photos in account for the reconstruction, and the reconstruction will be inferior to its potential.
• When shooting Interiors, follow the directions on the diagram below. Instead of standing in the middle of the room and rotating around your own axis to shoot the photos, move along the walls to shoot in the other direction.
• When shooting Exteriors, again, avoid standing in one spot and shooting ‘panorama like’ spherical photos but move along the façade with the camera.

• Don’t have people walking cross the scene while the photos are taken. Anything that makes a movement in the scene makes it hard for the algorithm to compare pixels between the photos.

KNOWN TECHNOLOGICAL LIMITATIONS OF PHOTOGRAMMETRY

The photogrammetry process does not work on shiny, transparent or highly glossy objects. This is due to the fact that these reflect the surrounding which makes the same point on one photo to be in a different color on another photo, making it impossible for the algorithms to calculate the scene.

For any questions or suggestions for improvement of the tutorial, please contact labs.Memento@autodesk.com or Tatjana.dzambazova@autodesk.com