

Shadow Baker 3D Manual

~ Fine-Tuning 3D Shading Designs and Baking Seamless Action Sequences ~

This document is the official manual for "Shadow Baker 3D", a 3D shading and bake pipeline utility designed for Moho Pro 14 or later.

*Note: While primarily verified on Windows, the internal architecture (Python engine and path resolution) is designed cross-platform and **may also run on macOS** (experimental support).*

Part 1: What is Shadow Baker 3D? (Core Essence & Design Philosophy)

1. Core Essence: A Tool for Fine-Tuning Shading Designs

Shadow Baker 3D is **NOT a software that allows arbitrary repositioning of 3D spatial lights**.

In Moho Pro's 3D environment, the lighting position has historically been permanently fixed (facing from the bottom-right). Shadow Baker 3D overcomes this constraint using a mathematical approach: by applying micro-orbit rotations (spherical camera orbits) around the 3D model, it serves as a specialized utility to **fine-tune, design, and direct the shading and shadows of 3D models**.

- **Why not move the light directly?:**

Under Moho's internal engine specifications, the lighting coordinates for 3D objects are hardcoded and cannot be modified via scripting APIs.

- **Shading Design via Orbit Camera:**

By subtly orbiting a virtual camera around the target 3D model without altering a single pixel of your original 3D rotations, animation keyframes, or material properties, Shadow Baker 3D creates the visual effect of customized lighting and shadows.

2. The Critical Importance of Previews (Preview Angle)

In this tool, **it is absolutely vital to verify your results using "Preview Angle" before initiating a full bake**.

Because 3D models differ widely in their geometric topology (depth, thickness, surface bevels), placement orientation, and camera perspective, the resulting shadows generated by camera orbit will vary significantly. Determining whether shadows fall exactly where you envision, or if the contrast is well-balanced, requires visual confirmation.

The newly introduced **[Preview Angle (Test Start Frame)]** feature enables you to iterate and experiment on single frames without polluting your timeline or layer hierarchy.

3. The Golden Rule to Minimize Distortion: 3D Origin Alignment

For 3D objects with noticeable physical depth, orbiting the camera induces perspective parallax between foreground and background surfaces, which can be perceived as mesh distortion or outline offset.

[!IMPORTANT] Essential Technique to Minimize Mesh Distortion

If you wish to minimize perspective distortion and outline drift, **make sure to align your 3D model to the 3D world origin before executing a preview or bake.**

- **Why this works:** When the 3D object's pivot/origin is precisely located at the spatial coordinates $(0, 0, 0)$, the virtual camera's orbit axis perfectly coincides with the model's geometric center. This eliminates eccentric parallax drift and preserves maximum silhouette integrity.
- **Procedure:**
 1. Select the target 3D layer on your timeline.
 2. **Align to 3D Origin $(0, 0, 0)$:**
 - **If `we_foldweaver_origin_tool` is installed:** Press the shortcut key **Shift + O** (this is the dedicated shortcut for this tool) to instantly snap the mesh origin to $(0, 0, 0)$.
 - **If the tool is NOT installed:** Use Moho's Transform Layer tool or Layer Properties to manually set the layer's 3D position coordinates (Position X, Y, Z) to $(0, 0, 0)$.
 3. Execute Shadow Baker's preview or bake in this aligned state.

4. Summary of Latest Feature Upgrades

Incorporating direct feedback from production studios, usability and data safety have been substantially upgraded:

1. Preview Angle (Safe & Rapid Preview):

- Renders a single test frame at the Start frame (or current frame) directly into the viewport for immediate visual evaluation.
- Repeated previewing with different directions or intensities merely overwrites a temporary preview layer (`_Shadow_Preview`), keeping the timeline and layer hierarchy 100% clean.

2. Start / End Frames Auto-Initialized to Current Frame (Accident Prevention):

- Automatically initializes Start and End inputs to the current timeline playhead position upon opening the dialog.
- Eliminates the risk of accidentally rendering hundreds of frames across the entire project duration.

3. Frame-Range-Specific Directory Isolation & Auto Clean Reuse:

- Output images are neatly organized into dedicated folders named `[Project]_[Layer]_shadow_[Start]_[End]` (or `..._shadow_preview`).
- When re-baking the same frame range, old images (`*.png`, `*.json`) within that folder are automatically deleted before rendering, preventing stale files and disk clutter.

4. Automatic Source Visibility Restoration & Unhide Button:

- When re-baking or previewing a range previously hidden by an earlier bake, the tool automatically restores source visibility prior to rendering, completely solving the issue of transparent/empty output renders.
- Features a dedicated `[ Unhide 3D Source (Restore Frame Range) ]` button on the floating panel to manually restore original visibility at any time.

5. High-Contrast Warning Banner:

- Prominently displays `>>> [!] SAVE (Ctrl+S) FIRST TO INCLUDE EDITS! <<<` directly above action buttons to prevent unsaved data discrepancies.

5. The Hidden Superpower: Full Group Layer Support & Partial Pre-Rendering ("Pure 3D Bake")

Shadow Baker 3D is far more than just a shading tool. In professional animation production, it functions as an indispensable **"Timeline Optimization & Partial Pre-Rendering Pipeline"**:

-  **Full Group Layer Hierarchy Support:**
You don't need to bake models layer by layer. You can select an entire **Group Layer or Bone Layer** containing multiple 3D props, accessories, and sub-layers. The internal background engine automatically traverses and preserves all child descendants (`collect_descendants`), baking complex assembled scenes in a single pass without unlinking hierarchies.
-  **"Pure 3D Bake" (0° Orbit) for Instant 3D Proxy Caching:**
When working with heavy 3D meshes or multiple complex props in Moho, timeline playback often lags, making frame-by-frame synchronization with 2D character animation frustrating.
By selecting **Pure 3D Bake (0 deg Orbit / Moho Default)**, the tool applies **zero camera rotation (0° orbit)**. It captures the exact 3D model posture, keyframes, and Moho default lighting with **0% geometric distortion**, converting heavy 3D calculations into a lightweight, transparent PNG Switch sequence.
This acts like an **instant, pinpoint pre-render cache for the selected 3D prop**, dramatically accelerating timeline playback performance!

Part 2: Installation and Setup

Shadow Baker 3D can be configured either as **"Menu Mode (Scripts Menu)"** or **"Icon Mode (Tools Palette)"**, or both, depending on your preferred working style.

1. File Structure

The tool consists of the following three core files:

Filename	Role
<code>we_shadow_baker_menu.lua</code>	Floating control panel launched from the top menu bar
<code>we_shadow_baker_tool.lua</code>	Floating control panel launched from the Tools palette
<code>we_shadow_baker_engine.py</code>	High-speed, headless background rendering engine for transparent sequences

2. Installation Steps

[Mode A] Menu Mode (Recommended / Quickest Setup)

Ideal if you prefer keeping your tool palette clean and launching via the top menu bar.

- Navigate to your Moho Custom Content folder and open `scripts/menu/`. Create a subfolder named **3D** (or **Weaver**).
 - Example path: `[Moho Custom Content Folder]/scripts/menu/3D/`

2. Copy the following two files into this folder:

- `we_shadow_baker_menu.lua`
- `we_shadow_baker_engine.py`

3. Launch Moho (or press `Ctrl+Shift+Alt+L` to reload scripts). The tool will appear under **Scripts > 3D > Shadow Baker**.

[Mode B] Icon Mode (Tools Palette Integration)

Ideal if you prefer a dedicated tool button on the left Tools palette.

1. In your Moho Custom Content folder, open `scripts/tool/` and copy the following files:

- `we_shadow_baker_tool.lua`
- `we_shadow_baker_tool.png` (Button icon)
- `we_shadow_baker_engine.py`

2. Open `_tool_list.txt` located inside `scripts/tool/` with any text editor, and append the following lines at the end:

```
group Weaver
button we_shadow_baker_tool ...
```

3. Restart Moho. The dedicated icon will now appear in your Tools palette.

3. Python Environment (Zero Setup Required)

- Shadow Baker 3D's background rendering engine (`we_shadow_baker_engine.py`) automatically detects Moho Pro 14's built-in official Python binary (or the system Python 3 on Windows and macOS).
- You do not need to perform command-line setups or install third-party libraries.

Part 3: UI Reference and Basic Operations

Launching the script opens a **modeless floating control panel** that does not block viewport interaction.

```
+-----+
|           Shadow Baker (Floating)           |
+-----+
| Target: FoldWeaver_Prop                     |
| Frame: 10                                  |
+-----+
| Select Shadow Direction (Camera Angle):    |
| ( ) Pure 3D Bake (0 deg Orbit / Moho Default) |
| ( ) Bottom (90 deg)                        |
| ( ) Bottom-Left (135 deg)                  |
| ( ) Left (180 deg)                         |
| ( ) Top-Left (225 deg)                     |
| (•) Top (270 deg / Upward Shadow) *Default |
+-----+
```

```
| ( ) Top-Right (315 deg) |
| ( ) Right (0 deg) |
+-----+
| Select Orbit Intensity (Tilt Angle): |
| (•) Light (8 deg - Safe Silhouette) *Default |
| ( ) Medium (15 deg - Balanced Contrast) |
| ( ) Strong (20 deg - Max 2D Match Limit) |
| ( ) Heavy (30 deg - Plane / Centered Only) |
+-----+
| Action Bake: Frame Range: |
| Start: [ 10 ] End: [ 10 ] |
| * Automatically saves project (Ctrl+S) on execution |
| |
| [ Save & Preview Angle (Test Start Frame) ] |
| [ Save & Bake Range (Render Action Sequence) ] |
| [ Unhide 3D Source (Restore Frame Range) ] |
+-----+
| Status / Warning: Ready. |
| Source camera & layers are 100% protected. |
+-----+
```

Feature Breakdown

1. Target / Frame (Live Tracking)

- **Target:** Displays the currently selected layer in the Layers palette in real time.
- **Frame:** Automatically tracks the current timeline frame number.

2. Select Shadow Direction (8-Direction Presets)

Select the desired shadow projection angle via radio buttons (defaults to **Top: 270 deg / Upward Shadow**).

Preset	Angle	Artistic Intent
Top (270 deg)	270°	[Standard / Recommended] Natural overhead drop shadow. Accentuates form and character volume.
Bottom (90 deg)	90°	Downward shadow. Upward stage lighting or dramatic, eerie mood.
Left (180 deg)	180°	Shadow cast to the left (strong key light from the right).
Right (0 deg)	0°	Shadow cast to the right (strong key light from the left).
Top-Left (225 deg)	225°	Dramatic diagonal shadow to the upper-left.
Top-Right (315 deg)	315°	Diagonal shadow to the upper-right.
Bottom-Left (135 deg)	135°	Diagonal shadow to the lower-left.

Preset	Angle	Artistic Intent
Pure 3D Bake (0° Orbit / Moho Default)	0° / 45°	[Exact Silhouette / Partial Pre-Render Proxy] 0° camera orbit. Bakes exact 3D posture, keyframes, and Moho lighting into transparent PNG Switch layers with 0% distortion. Acts as an instant local cache to massively accelerate timeline playback.

3. Select Orbit Intensity (Tilt Angle)

Select the camera orbit depth across four calibrated tiers. Your last chosen intensity is remembered across sessions.

Preset	Single / Diagonal	Outline Match	Characteristics & Best Usage
Light (8°)	8.0° / 6.0°	96.0%	[Standard / Recommended] Outline drift approx. 11px. Safe silhouette with no noticeable double-contours when overlaid on 2D artwork.
Medium (15°)	15.0° / 11.0°	93.2%	[Balanced] Deeper shading contrast while maintaining good edge alignment.
Strong (20°)	20.0° / 14.5°	89.3%	[2D Edge Limit] The physical upper threshold before double-lines (~38px) become visible. For deep architectural shadows.
Heavy (30°)	30.0° / 21.5°	85.8%	[Flat Planes / Texture Extraction Only] Powerful contrast. Noticeable perspective drift on volumetric meshes triggers an English warning.

[!WARNING] **Understanding the Heavy (30°) Warning**

Solid 3D objects possess depth (Z). Orbiting the camera by 30° creates significant foreground-background parallax ($\approx D \cdot \sin(30^\circ) = 0.5D$).

Selecting Heavy (30°) displays the following warning:

WARNING: 30° causes severe parallax drift on 3D meshes! Recommended only for flat planes or centered origins.

Best utilized on planar surfaces (signs, walls, cards) or when extracting shadow maps as raw texture assets.

4. Action Bake: Frame Range (Execution Controls)

- Start / End Frame Inputs (Accident Prevention):**
Both fields automatically populate with the current timeline playhead frame when the dialog opens, preventing unwanted full-project renders.
- Automatic Pre-Render Project Save:**
Clicking either action button automatically saves your active project (`moho:FileSave()`) before isolated

background rendering starts, ensuring all latest timeline keyframes, layer postures, and camera adjustments are 100% written to disk.

- **[Save & Preview Angle (Test Start Frame)] Button:**
Saves the project and renders the Start frame (or current frame) as a temporary layer (`_Shadow_Preview`). You can re-test angles and intensities repeatedly without cluttering your timeline or layer hierarchy.
- **[Save & Bake Range (Render Action Sequence)] Button:**
Saves the project and bakes the designated frame range into a clean sequence of transparent PNGs, instantiating a fully synced Switch layer. Previously hidden source keyframes in the same range are automatically restored prior to baking.
- **[Unhide 3D Source (Restore Frame Range)] Button:**
Instantly clears visibility mute keyframes on the original 3D layer across the specified range, restoring it to visible state (`visible: true`).

Part 4: Practical Workflows (Tutorial)

[Pro Tips] The Golden Angle Rules for Maximum Shading Impact

To achieve the best possible results in real-world production, keep these three fundamental rules in mind:

- **1. Maximum Effect is Achieved When the "Left Side" of the Model is Visible:**
Because Moho's fixed 3D light source is positioned on the right (front-right), the **left side of your 3D prop acts as the natural "terminator line" (the boundary between light and shadow)**. Positioning your model so that its left side is visible allows subtle micro-orbits (8° to 15°) to dynamically shift shadow patterns across the surface, delivering maximum visual impact.
(Conversely, surfaces facing directly toward the right light source remain fully lit, showing much less dramatic shading movement.)
- **2. OBJ Models Only: The "Flip Bake" Technique for Right-Side Shading:**
While Moho's procedural vector 3D layers ignore layer-level flipping by design, **pure OBJ 3D layers fully support standard layer flipping (Flip Horizontally / Flip H)**.
If you want dramatic shading on the right side of an OBJ model, use this pro workaround:
 1. Turn ON **Flip Layer Horizontally (Flip H)** on the OBJ layer using the Transform Layer tool (temporarily exposing that side to the left).
 2. Run Shadow Baker preview or full bake.
 3. Turn ON **Flip H** on the resulting Switch layer (or preview layer) to restore the original facing direction.
 4. Turn OFF **Flip H** on the source OBJ layer.
-> This successfully bakes rich, dynamic shading onto the right-facing surfaces that would otherwise remain static!
- **3. The Golden Rule for Rotating Animations: "If Horizontal, Orbit Vertical (Top/Bottom)":**
When an object undergoes horizontal rotation (Y-axis spin / turn), orbiting the camera horizontally (Left/Right) mathematically creates a **pure rotational phase delay (lag)**. In motion playback, this merely looks like the rotation angle has been slightly delayed by a couple of frames rather than receiving dynamic lighting.

[The Secret to Volumetric Depth] Orbit on the perpendicular axis — use vertical tilt (Top 270° or Bottom 90°)!

- For horizontal turns, applying **Top (270°)** prevents rotational lag and produces authentic volumetric illumination: **as the object spins horizontally, top surfaces consistently catch overhead light while undersides cast grounded shadows.**
- Conversely, for vertical tumbling or nodding actions (X-axis pitch), horizontal orbits (Left/Right) provide the ideal cross-axis contrast.

[Step 0] Origin Alignment to Minimize Parallax Distortion (Preparatory / Recommended)

For volumetric 3D models where you want the cleanest possible silhouette match with minimal perspective drift:

[Origin Alignment Steps]

1. Select the target 3D layer on the timeline.
2. Align coordinates to (0, 0, 0):
 - If `we_foldweaver_origin_tool` is installed:
Press [Shift + 0] (or click its icon) -> Snaps origin to (0, 0, 0).
 - If the tool is NOT installed:
Manually reset the layer's 3D Position coordinates (X, Y, Z) to (0, 0, 0).

Aligning the mesh center to the world origin ensures that the camera orbit axis aligns perfectly with the model, minimizing geometric distortion.

[Step 1] Angle Validation via Preview Angle (Iterative, Clean Testing)

Shading varies dynamically depending on mesh geometry and orientation. Test your lighting angle cleanly before full baking:

[Preview Validation Steps]

1. Select: Highlight the 3D layer.
2. Save: Press `Ctrl+S` to save project state.
3. Frame: Move the timeline playhead to the frame you wish to evaluate.
4. Setup: Choose Direction (e.g., Top) and Intensity (e.g., Light).
5. Test: Click [Preview Angle (Test Start Frame)]!
-> Evaluates lighting directly in the viewport without polluting the timeline!

1. Select & Save:

Select the 3D layer and press **Ctrl+S**.

2. Execute Preview:

Select desired direction and intensity, then click **[Preview Angle (Test Start Frame)]**. Within seconds, a temporary preview layer (`_Shadow_Preview`) appears in the viewport.

3. Iterate:

Adjust direction or intensity and click **[Preview Angle]** again. The preview layer is cleanly overwritten with zero clutter.

[Step 2] Action Sequence Baking (Frame Range to Switch Layer)

Once satisfied with your previewed shading:

[Action Sequence Baking Steps]

1. Set Range: Enter Start and End frames in Action Bake (e.g., 0 to 24).
 2. Save: Press Ctrl+S.
 3. Bake: Click [Bake Frame Range]!
- > Preview layer clears automatically, producing a fully synchronized Switch layer!

1. **Set Range:** Specify Start and End frame numbers (e.g., 0 and 24).
2. **Save (Ctrl+S):** Ensure all timeline keyframes are saved to disk.
3. **Bake Sequence:** Click **[Bake Frame Range (Render Action Sequence)]**. Background rendering outputs the full sequence.
4. **Playback:**
A new Switch layer named **[LayerName]_shadow_0_24** is placed above your 3D model. Press Spacebar to play back the smoothly shaded animation.

[Step 3] Multi-Range Baking & Clean Pinpoint Replacement

- **Multiple Distinct Action Ranges:**
Baking range 1–10 and later baking 20–30 preserves both shadow sequences in their respective dedicated folders, while automatically hiding the source 3D layer only during active baked spans.
- **Pinpoint Re-Baking:**
Re-baking the same frame range automatically purges old PNGs and JSON files from that specific folder and cleanly replaces the existing Switch layer, avoiding duplicate layers and orphaned disk assets.

[Step 4] Supercharging Timeline Speed via Partial Pre-Rendering ("Pure 3D Bake")

When complex 3D objects, polyhedral environments, or multi-part props slow down your Moho timeline playback, you can utilize Shadow Baker 3D as a dedicated **"Partial Pre-Rendering Engine"**:

[Partial Pre-Rendering Steps]

1. Select: Highlight the heavy 3D layer or the parent Group Layer containing all sub-parts.
2. Direction: Select [Pure 3D Bake (0 deg Orbit / Moho Default)].
3. Range: Enter the action span you want to cache (e.g., frames 1 to 100).
4. Bake: Click [Save & Bake Range]!

-> Instantly converts the 3D calculation into a lightweight 2D Switch layer with 0% distortion!

- **Effortless Non-Destructive Re-Editing:**

Whenever you need to adjust keyframes on the original 3D object, simply click [**Unhide 3D Source (Restore Frame Range)**] to bring the source layer back. After modifying, click Bake Range again to automatically update the proxy cache.

Part 5: Professional Technical Specifications & Fail-Safe Architecture

Shadow Baker 3D is engineered under strict "**Non-Destructive Data Integrity**" principles for production studios.

1. 100% Non-Destructive Source Protection

- **No doc:Save Calls:** The script never writes directly to or overwrites your active **.moho** workfile.
- **Sandboxed Safe Copy:**
Baking executes inside a detached duplicate (**_temp_shadow_bake.moho**) created within the isolated output folder.
- **Forced Visibility Channel Reset:**
Inside the sandbox copy, the engine resets all visibility channels (**layer_effects.visibility**, etc.) to visible (**True**), ensuring reliable output regardless of prior mute states.

2. Object-Centered Orbit Mathematics

- Rather than orbiting around absolute world (**0, 0, 0**), the engine tracks the 3D layer's animated spatial coordinates (**obj_x, obj_y, obj_z**) with sub-frame interpolation and orbits directly around the object's center.
- Prevents off-screen drift even if objects are positioned away from canvas center.

3. 1:1 Viewport Alignment & Double-Offset Prevention

- Rendered transparent PNGs match your project render canvas (e.g., 1920x1080) at a 1:1 pixel ratio.
- Switch layers sit at canvas origin (**0, 0, 0**) without translational offsets, ensuring exact registration with original 3D silhouettes.

Part 6: Troubleshooting (Q&A)

Q1: Clicking [Bake] or [Preview Angle] exits immediately without changes.

- **Cause:** The project has not been saved to disk.
- **Solution:** Shadow Baker operates in Fail-Fast mode to protect unsaved work. Press **Ctrl+S** to save your document, then run the command again.

Q2: Shading direction does not match my expectations.

- **Explanation:** Mesh curvature, bevels, and viewing angles influence how orbit lighting interacts with surfaces.
- **Solution:** Always use **[Preview Angle]** to test different directions and intensities before committing to a full bake.
 - **Pro Advice:** Because Moho's light comes from the right, **positioning your prop so that its left side is visible** yields the most dynamic shading movement (see Part 4 "Pro Tips").
 - **For OBJ Models:** If you need dramatic shading on the right-facing surfaces, you can temporarily Flip H the OBJ layer, bake, and flip the result back (Part 4 Rule 2).

Q3: The 3D model appears slightly distorted after baking.

- **Cause:** Volumetric depth creates perspective parallax during camera orbit.
- **Solution:**
 1. Align your 3D model to world origin before baking:
 - With `we_foldweaver_origin_tool`: Press **Shift + 0**.
 - Without the tool: Manually set 3D Position (X, Y, Z) to **(0, 0, 0)**.
 2. Reduce orbit intensity to **Light (8°)** or **Medium (15°)**.

Q4: Can this be used on standard 2D vector layers?

- **Answer:** No. This tool is purpose-built for Moho's 3D shading pipeline (OBJ models, extruded vector meshes). Standard 2D vector layers do not have Moho 3D shading channels.

Q5: Where are baked image sequences stored?

- **Answer:** Inside dedicated subfolders alongside your `.moho` project file, formatted as `[Project]_[Layer]_shadow_[Start]_[End]` (or `..._shadow_preview`). Re-baking the same span automatically purges old images to conserve disk space.

Q6: How do I re-edit or check the original 3D model after baking?

- **Answer:**
 - Click the **[Unhide 3D Source (Restore Frame Range)]** button on the control panel to instantly clear visibility mute keys.
 - Alternatively, toggle the eyeball visibility icon of the generated Switch layer.

Q7: Is it safe to use Heavy (30°) despite the warning?

- **Answer:** Yes, for appropriate use cases. Heavy (30°) provides bold contrast ideal for planar 3D surfaces (cards, signage, walls) or for extracting shadow maps as raw texture assets. The warning exists to alert animators against unexpected silhouette drift on volumetric characters.