

Mesh & Pin Weaver 3D Manual

~ Automatic Projection & Baking of Camera-Facing 2D Smart Warp & Pin Bone Rigs onto 3D Props ~

This document is the official manual for "MeshWeaver 3D" and "PinWeaver 3D", professional-grade 3D geometric projection and camera-facing 2D rigging engines designed for Moho Pro 12 or later (Compatible with Moho 12 / 13 / 14).

Part 1: What is Mesh & Pin Weaver 3D?

Mesh & Pin Weaver 3D is a dual projection engine that extracts 3D coordinates from moving 3D props (props, background objects, complex compound parts assembled with FoldWeaver, etc.) in Moho Pro's 3D space, and mathematically projects and bakes them onto camera-facing (2D screen plane) Smart Warp meshes and Pin Bone rigs.

Without relying on image-based motion tracking, it calculates Moho's complete transformation matrix to directly convert and project 3D vertex coordinates into 2D screen coordinates, achieving 100% mathematically exact geometric synchronization with zero drift or jitter.

1.1 Differences from Traditional Image-Based Motion Tracking

Comparison Item	Traditional Image-Based Motion Tracking	Mesh & Pin Weaver 3D (Geometric Projection Baking)
Tracking Accuracy	Prone to frequent drift, jitter, and lost tracking on perspective distortion, lighting changes, or flat solid colors.	Zero Error (100% Perfect Sync). Calculated directly from vertex geometry; drift and jitter are fundamentally impossible.
Workflow & Steps	Complex multi-stage workflow: Rendering → Tracker placement → Analysis → Baking.	One-Click (~1 Second). Simply select guide points/layer and press shortcut (Shift+W / Shift+P).
Drawing & Painting Usability	Requires drawing at tilted oblique angles, making brush strokes and Bezier control axes prone to distortion.	Camera-Facing (2D Frontal Plane). Draw, paint shadows, and adjust points intuitively just like drawing on a flat sheet of paper.
Modifications & Iterations	Requires re-rendering and re-analyzing tracking data whenever the 3D animation is modified.	Non-Destructive Overwriting. Preserves 100% of your hand-drawn artwork while instantly re-syncing to the latest animation with a single button press.

1.2 Two Major Projection Engines: Smart Warp vs. Pin Bones

The Weaver pipeline offers two powerful engines tailored to your specific use cases and rig structures:

Engine	Execution Command	Output Rig Structure	Best Use Cases
MeshWeaver (Mesh Warp)	<code>we_meshweaver_tool</code> (Shift+W)	<pre>Auto_Warp_Rig ├── Mesh_Warp (4-point Smart Warp) └── Paint_Canvas (Auto-bound)</pre>	Curved Surface Texture & Wrapping: Cylinders, pipes, signboards, box surfaces, perspective deformation of full 4-corner planes, and adjusting elliptical bulges.
PinWeaver (Pin Bones)	<code>we_pinweaver_menu</code> (Shift+P)	<pre>Auto_Pin_Rig ├── Pin_1 .. Pin_N (Pin Bones) └── Paint_Canvas (Flexi-bound)</pre>	Freeform Shapes & Part Pinning: Arbitrary points (1–10 points), character accessories, fluttering ribbons/sashes, joint-following badges, and organic multi-point deformation.

1.3 Why "Camera-Facing (2D Screen Space)"?

Attempting to draw textures directly onto 3D parts rotating and deforming in 3D space causes severe distortion of brush and Bezier handle control axes due to surface tilt and perspective.

In Mesh & Pin Weaver 3D:

- **MeshWeaver:** The outer 4-point Smart Warp mesh (`Mesh_Warp`) handles 3D rotation and perspective tracking, providing a flat drawing plane (`Paint_Canvas`).
- **PinWeaver:** Camera-facing pin bones (`Pin_1` .. `Pin_N`) track 3D space vertices on the screen, deforming the canvas smoothly without tilting it in 3D space.

This allows animators to freely draw and adjust **beautiful vector linework, cel-style shading, and highlights with the intuitive feel of drawing on paper**, completely free from the complexities of 3D coordinates and UV unwrapping.

Part 2: Installation and Setup (Icon Mode vs. Menu Mode)

Just like FoldWeaver 3D, both MeshWeaver 3D and PinWeaver 3D scripts can be installed as "**Icon Mode (Tools Palette)**" or "**Menu Mode (Scripts Menu)**", or both simultaneously depending on your preferred workflow.

2.1 Fundamental Difference Between Tools and Buttons

Moho scripts are broadly classified into "tools" (interactive selection/adjustment tools) and "buttons" (one-shot instant execution buttons).

- **Tool:**
 - Clicking it activates the tool into a selected state, allowing you to drag in the viewport and adjust parameters in the top options bar.
 - **Button:**
 - Clicking it (or pressing its shortcut) triggers an **instant, one-shot execution without switching your active tool**.
 - **Your currently selected tool (Point Transform, Add Point, Freehand/Brush, etc.) remains active**, allowing you to execute projection and baking instantly without interrupting your drawing or editing workflow.
 - **Both MeshWeaver 3D and PinWeaver 3D are engineered as ultra-fast "Button" scripts.**
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2.2 Choosing Your Installation Mode

[Mode A] Icon Mode (Placing in the Tools Palette)

Choose this mode if you want dedicated icons always visible in Moho's Tools palette for quick clicking.

- **Target Folder:**

[Moho Custom Content Folder]/scripts/tool/

- **Files to Install:**

- **MeshWeaver:** `we_meshweaver_tool.lua` and `we_meshweaver_tool.png`
- **PinWeaver:** `we_pinweaver_tool.lua` and `we_pinweaver_tool.png`

- **Editing `_tool_list.txt` (Required):**

To display the icons in the Tools palette, open `_tool_list.txt` (located inside the same `scripts/tool/` folder) with a text editor and add the following lines under `group Weaver` (or your preferred group):

```
group Weaver
button we_meshweaver_tool    ...
button we_pinweaver_tool     ...
```

Note

Example of `_tool_list.txt` when installing the complete Weaver Series:

```
group Weaver
button we_foldweaver_add_marker_tool    ...
button we_foldweaver_align_tool    ...
button we_foldweaver_clear_tool    ...
button we_foldweaver_origin_tool    ...
button we_meshweaver_tool    ...
button we_pinweaver_tool     ...
```

Each line must start with `button` , followed by a tab (or space), and the script filename without the `.lua` extension. The trailing `...` serves as a placeholder for keyboard shortcuts.

[Mode B] Menu Mode (Placing in the Scripts Menu)

Choose this mode if you prefer keeping your Tools palette clean and executing scripts from the top menu bar (Scripts menu).

- **Target Folder:**

[Moho Custom Content Folder]/scripts/menu/Weaver/ (Create the `Weaver` subfolder if it does not exist)

- **Files to Install:**

- Copy `we_meshweaver_menu.lua` and `we_pinweaver_menu.lua` into this folder.

- **Features:**

- Scripts appear cleanly structured in the top menu hierarchy:
 - **Scripts > Weaver > MeshWeaver: Project & Bake**

▪ **Scripts > Weaver > PinWeaver: Project & Bake**

- No need to edit `_tool_list.txt` . Moho detects them automatically upon launch.
- When assigned keyboard shortcuts, they execute with the exact same lightning-fast speed as the icon version.

2.3 Assigning Keyboard Shortcuts (`Shift+W` and `Shift+P`)

To unlock the full potential of the Weaver pipeline, assigning dedicated keyboard shortcuts is essential. We strongly recommend `Shift+W` (Mesh/Warp) and `Shift+P` (Pin), which integrate seamlessly into the Weaver series ecosystem.

Script	Recommended Shortcut	Initial / Role	Weaver Ecosystem Synergy
MeshWeaver	<code>Shift+W</code>	Warp (4-point Smart Warp)	Naturally connects with <code>Shift+M</code> (Marker), <code>Shift+A</code> (Align), <code>Shift+C</code> (Clear), and <code>Shift+O</code> (Origin).
PinWeaver	<code>Shift+P</code>	Pin (Pin Bone Projection)	Intuitively calls the multi-point pin bone rig without key conflicts.

Shortcut Setup Steps:

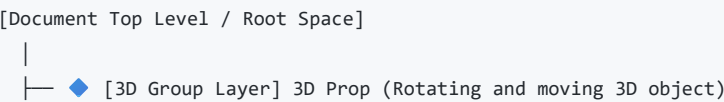
1. From Moho's top menu bar, open **Edit > Keyboard Shortcuts**.
2. Type `weaver` or the script name in the search box at the top left:
 - For MeshWeaver: Search `MeshWeaver` → Assign `Shift+W`
 - For PinWeaver: Search `PinWeaver` → Assign `Shift+P`
3. Click **OK** to save your settings.

Part 3: System Architecture and Layer Hierarchy

Based on the guide information placed inside the 3D prop, both MeshWeaver 3D and PinWeaver 3D automatically build a dedicated camera-facing rig structure at the top level (root space) of your document.

3.1 Layer Hierarchy Trees for the Two Projection Rigs

[Structure A] MeshWeaver Rig Hierarchy (`Auto_Warp_Rig`)



- | └─ [3D Object / Parts] 3D parts (Extrusions, FoldWeaver assembled parts, etc.)
- | └─ [Vector Layer] 4 point (4-point Guide)
 - * Nested inside 3D group (Rotates together with 3D prop)
- | └─ [Group Layer] Auto_Warp_Rig (★ Auto-generated at root by script)
 - └─ [Vector Layer] Mesh_Warp (Smart Warp Mesh)
 - * Projected screen coordinates of "4 point" are baked to 4 corners for all frames
 - └─ [Vector Layer] Paint_Canvas (Canvas for drawing, shadows, and details)
 - * Smart Warp Layer setting is automatically assigned to "Mesh_Warp"

[Structure B] PinWeaver Rig Hierarchy (Auto_Pin_Rig)

[Document Top Level / Root Space]

- | └─ [3D Group Layer] 3D Prop / Character (Rotating and moving object)
 - | └─ [3D Object / Parts] 3D parts
 - | └─ [Vector Layer] Guide Vertices (1-10 points)
 - * Selected vertices inside 3D group, or active vector layer
 - | └─ [Bone Layer] Auto_Pin_Rig (★ Auto-generated at root by script)
 - └─ [Pin Bone] Pin_1, Pin_2 ... Pin_N (Zero-length pin bones)
 - * Screen projection coordinates of 3D guide points are baked to each pin bone
 - └─ [Vector Layer] Paint_Canvas (Canvas for attachments, badges, and free drawing)
 - * Nested inside bone hierarchy, deforming smoothly under pin bone influence

3.2 Layer Roles and Automatic Configuration Specifications

Engine	Component Name	Type	Source	Role & Behavioral Specification
MeshWeaver	4 point (Guide)	Vector	User-Created	[3D Geometric Guide] A 4-vertex rectangular layer placed inside the 3D group. Defines the 4 corners of the surface to be textured; MeshWeaver computes its screen projection coordinates across all frames.
MeshWeaver	Auto_Warp_Rig	Group	Auto-Generated	[Camera-Facing Rig Container] Generated at document root. Independent of parent 3D rotation, providing a flat drawing environment that strictly faces the camera (2D screen plane).
MeshWeaver	Mesh_Warp	Vector	Auto-Generated	[Smart Warp Mesh] A sharp-cornered quad mesh (MOHO.PEAKED). Receives projected 2D

Engine	Component Name	Type	Source	Role & Behavioral Specification
				screen coordinates from the 4-point guide for all frames and distorts accurately.
MeshWeaver	Paint_Canvas	Vector	Auto-Generated	[Drawing / Texture Canvas] Canvas for drawing illustrations, cel-style cast shadows, highlights, and linework. ★ Auto-Bound: In Layer Settings (Vectors tab), "Select warp layer" is automatically assigned to Mesh_Warp .
PinWeaver	Guide Vertices	Vector Points	User-Created	[3D Guide Vertices] 1 to 10 selected vertices on moving 3D structures (or all vertices in the selected vector layer).
PinWeaver	Auto_Pin_Rig	Bone	Auto-Generated	[Camera-Facing Pin Bone Container] Top-level bone group generated at root level. Encloses generated pin bones and drawing canvas.
PinWeaver	Pin_1 .. Pin_N	Pin Bone	Auto-Generated	[Projected Pin Bones] Zero-length pin bones (<code>fLength = 0</code> , <code>fStrength = 6.0</code> , <code>fIsPin = true</code>). Each bone position is locked and baked to corresponding 3D guide vertex screen coordinates.
PinWeaver	Paint_Canvas	Vector	Auto-Generated	[Attachment Canvas] Placed inside <code>Auto_Pin_Rig</code> . Artwork drawn here smoothly deforms and tracks moving pin bones.

Part 4: Basic Operating Procedures & Workflow (One-Click Projection Baking Tutorial)

Both engines share an ultra-fast **one-click (~1 second)** execution workflow. You can intuitively choose between 4-corner surface warping (MeshWeaver) or multi-point pinning and attaching (PinWeaver) depending on your production goals.

4.1 Workflow A: 4-Point Quad Surface Projection (MeshWeaver / `Shift+W`)

Used for applying textures, labels, and shading to cylinders, pipes, signboards, box surfaces, and curved 3D props.

【MeshWeaver Workflow (~1 Second)】

- ① [Place Guide] : Create a 4-point rectangular vector layer (e.g., "4 point") inside the 3D group.
- ② [Select] : Click to select the guide layer (make it active).
- ③ [Bake] : Press shortcut Shift+W (or click the MeshWeaver button).
- ④ [Draw] : Start drawing directly on the automatically selected Paint_Canvas!

Step 1: Place 4-Point Guide in 3D Space

1. Create and finalize the animation of your 3D prop (rotating cylinder, box, etc.) using 3D layers or FoldWeaver.

[!TIP]

【FoldWeaver Integration: Origin Reset & Depth Calculation via Shift+O】

Before placing your guide, select the prop parent group and press **FoldWeaver's Shift+O (Origin Reset)** to snap the group origin exactly to the world origin (0, 0, 0).

(Selecting a bottom vertex or center vertex and pressing Shift+O snaps the origin to its precise center of gravity).

For instance, if a cylinder radius is 0.5, simply enter 0.5 into the guide layer's "Position Z" field to place the guide flush against the curved surface without manual subtraction math!

2. Inside the 3D group, create a new vector layer (name it anything, e.g., 4 point).
 - *Placing it inside the 3D group ensures it follows all 3D rotations and translations of the prop.*
3. Using the Rectangle tool or Add Point tool, draw a **rectangle with exactly 4 points** covering the target texture area.

Step 2: One-Click Projection Baking (Shift+W)

1. Ensure the created guide layer (4 point) is selected.
2. Press **Shift+W** (or click the MeshWeaver button).
3. **【Automatic Background Processing (~1 Second)】** :
 - Auto-generates Auto_Warp_Rig at document root.
 - Generates Mesh_Warp and Paint_Canvas inside, automatically binding the Smart Warp mesh layer.
 - Scans all frames from start to end, projecting 3D guide coordinates to screen space and baking keyframes onto the 4 sharp corners of Mesh_Warp .
 - **Automatically switches the active layer to Paint_Canvas and stands by for drawing.**

Step 3: Drawing Textures & Shadows

1. Move the timeline playhead to **"Frame 0"**.
2. On Paint_Canvas , draw your artwork, illustrations, textures, or cast shadows using standard Moho brushes, fills, and gradient tools.

3. Play the timeline: your flat 2D artwork deforms and tracks the rotating 3D prop with 100% geometric synchronization!

4.2 Workflow B: Multi-Point / Pin Bone Projection (PinWeaver / Shift+P)

Used for character accessories, fluttering ribbons/sashes, mechanical joint pivots, and organic multi-point surface pinning.

[PinWeaver Workflow (~1 Second)]

- ① [Select Points] : Select 1 to 10 vertices on a 3D vector layer (or select guide layer).
- ② [Bake] : Press shortcut Shift+P (or run Scripts > Weaver > PinWeaver).
- ③ [Draw/Paste] : Draw or paste artwork on Paint_Canvas inside Auto_Pin_Rig!

Step 1: Select Guide Points in 3D Space

1. Create your 3D character, mecha, or animated prop.
2. Select a vector layer inside the 3D structure:
 - **Specifying Specific Points:** Use Moho's Select Points tool (`G`) to highlight 1 to 10 vertices you want to pin.
 - **Using Entire Layer:** If no individual points are selected, PinWeaver automatically collects all vertices (up to 10) in the currently selected vector layer.

Step 2: One-Click Projection Baking (Shift+P)

1. Press `Shift+P` (or run from menu).
2. **[Automatic Background Processing (~1 Second)] :**
 - Auto-generates `Auto_Pin_Rig` (Bone Layer) at document root.
 - Generates zero-length pin bones (`Pin_1` .. `Pin_N` , wide influence `fStrength = 6.0`) corresponding to guide points.
 - Auto-generates `Paint_Canvas` (Vector Layer) inside `Auto_Pin_Rig` .
 - Scans the entire timeline and bakes screen-projected coordinates to each pin bone at high speed.
 - **Automatically switches the active layer to `Paint_Canvas` and stands by.**

Step 3: Creating Pin-Deformed Artwork

1. Move to "Frame 0".
2. Draw badges, ribbons, mecha dials, or accessories onto `Paint_Canvas` .
3. Play the timeline: the pin bones drive smoothly in sync with the parent 3D object, and the hand-drawn artwork deforms and tracks naturally.

4.3 Timeline Roles & Recommended Workflow

MeshWeaver and PinWeaver utilize an intuitive timeline workflow:

Timeline State	Behavior / Role	Recommended Work
During Script Execution	Can be run on ANY frame	Whether executed on Frame 0, Frame 1, or mid-timeline, the script scans the entire project range (Frame 0 and Start–End frames) in memory and batch-bakes all keyframes.
Frame 0 (Setup Pose)	[Drawing & Artwork Adjustments]	Base pose and initial bone positions are baked here. Following Moho's standard conventions, always draw vector art and adjust curves on Frame 0.
Frame 1 to End Frame	[Animation Playback Verification]	3D tracking keyframes are baked across all frames. Play the timeline to verify smooth, synchronized deformation.

Part 5: Practical Styling & Drawing Techniques (Cylinders, Curved Surfaces, and Cel-Style Shadows)

The greatest strength of Mesh & Pin Weaver 3D lies in its clear division of labor: **"Mathematical projection perfectly handles underlying 3D tracking and perspective distortion, while curved surface rendering, organic decoration, and expressive styling can be freely drawn in native 2D."**

[Golden Rule of Division of Labor]

- Mesh_Warp / Pin Bones (Baking Layer) : Foundation that automatically handles 3D rotation, translation, and perspective
- Paint_Canvas (Drawing & Expression) : Craft Bezier handles, point deformations, badge attachments, and shadows in

5.1 Techniques for Curved Surfaces & Elliptical Edges on Cylinders and Pipes (MeshWeaver)

Procedures for rendering rounded edges and cylindrical wrapping on objects like cylinders, pipes, cans, bottles, and character limbs:

1. Draw the Base Rectangle (Frame 0):
- On Paint_Canvas , draw a rectangle (Fill or Stroke) aligned with the 4 corners of the guide.
2. Shape the Curves Using the Point Transform Tool (T):
- Drag near the center of the top and bottom horizontal edges to create **elliptical curves (bulges)** matching the tilt and curvature of the cylinder rim.

◦ Fine-tune the curves using Bezier handles or the Curvature Tool (c) to perfectly match the cylinder's thickness and perspective.
3. Play Back to Verify Tracking:

- When playing the timeline, the outer `Mesh_Warp` stretches and tilts in sync with the 3D prop's rotation. **The artwork smoothly rotates through 3D space while flawlessly preserving the beautiful elliptical curvature crafted on Frame 0!**
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5.2 Organic Decoration & Part Pinning Techniques (PinWeaver)

PinWeaver excels at pinning 2D vector elements onto arbitrary locations of moving 3D objects:

- **Floating Badges, Chest Emblems & Shoulder Armor:**
 - Bake 1 or 2 guide vertices on the chest or shoulder of a 3D character.
 - Draw the badge on `Paint_Canvas`. It follows the exact 3D position and tilt without complex 3D bone rigging.
 - **Fluttering Ribbons, Sashes & Scarves (Multi-Point Pin Deformation):**
 - Select and bake 3 to 5 guide vertices along a moving 3D curve or edge.
 - Draw a flexible ribbon connecting each pin. Under the spatial movement of the pin bones (with smooth bone weight interpolation via `fStrength = 6.0`), the ribbon organically stretches, twists, and flexes.
 - **Mecha Dials, Screws & HUD Overlays:**
 - Pin gauges, screws, and HUD displays directly onto rotating machine parts or cockpit panels.
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5.3 Expressing Anime-Style "Cast Shadows", "Highlights", and "Variable Line Widths"

Relying solely on 3D CG automated lighting makes it difficult to achieve the crisp, stylized shadows characteristic of traditional Japanese animation. The Weaver pipeline allows you to cast beautiful shadows onto 3D forms using standard 2D animation methods:

- **Cel-Style Vertical Shadows (Cylinder Shading):**
 - Draw shadow-tone polygons (Multiply fill or semi-transparent color) along the cylinder surface on `Paint_Canvas`.
 - As the object rotates in 3D, the shadow's width automatically compresses and expands along the perspective via Smart Warp or Pin Bones.
 - **Hand-Drawn Style Contours (Variable Line Width):**
 - Using Moho's Line Width tool (`w`), freely vary stroke thickness (e.g., thicker at corners, thinner at the center) to add the subtle nuance of hand-drawn animation.
 - **Gradients & Textured Brushes:**
 - Linear/radial gradient fills and organic vector brush styles can be applied 100% natively on `Paint_Canvas`.
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5.4 Production Technique: Eliminating Unwanted Internal Artifact Lines on Moho 3D Extruded Layers for a Pure Cel Look

Moho Pro's native vector 3D feature (3D Extrusion / Inflation) has a long-standing issue: **"The original center vector line remains embedded inside the 3D mesh, exposing unsightly intersecting artifact lines, seam edges, and see-through glitches on top, side, and bottom surfaces."**

Mesh & Pin Weaver 3D serves as a definitive solution to overcome these 3D line artifacts, transforming them into a pure, clean 2D cel look.

■ Core Philosophy: Use 3D as a "Kinematic Anchor" Rather than the "Final Render"

Instead of rendering the raw 3D extruded mesh as the final screen output, shift your mindset: **"Use the 3D layer strictly as an anchor for accurate motion and perspective, while painting over and covering all visible surfaces and lines on Weaver's 2D canvas."**

[Artifact Line Elimination & Pure Cel-Look Workflow]

- ① Select corners/vertices on the Moho 3D object.
- ② Execute Weaver projection bake (Shift+W / Shift+P).
- ③ A camera-facing 2D canvas (Paint_Canvas) is automatically generated.
- ④ Draw clean solid fills and outer contour lines (100% occluding and concealing unwanted internal artifact lines).
- ⑤ [Complete] A pristine, artifact-free cel-look prop with hand-drawn warmth!

■ Specific Techniques and Use Cases

1. Cleaning Entire Surfaces (MeshWeaver / Shift+W):

- Select the 4 vertices of a book cover, box face, or smartphone screen, and press Shift+W to bake a 4-point mesh.
- Drawing clean surface fills and crisp outer borders on `Paint_Canvas` **completely hides and occludes all see-through center lines and intersecting internal edges**, producing a flawless, pristine surface.

2. Concealing Corner Glitches / Adding Accents (PinWeaver / Shift+P):

- Select corner vertices or points where you want to place decorations, and press Shift+P to bake pin bones.
- Draw concealing patch shapes or hand-drawn details (clasps, buttons, logos, fasteners) on `Paint_Canvas` to mask unnatural 3D thickness seams while infusing hand-crafted charm.

Part 6: Non-Destructive Iteration During 3D Animation Revisions (Re-Baking Procedures)

In animation production, revisions frequently occur—such as "changing the 3D prop's rotation timing," "modifying camera work," or "adjusting character pose timings."

In traditional image motion tracking, every revision required a painful and time-consuming loop of "Re-rendering → Re-analyzing tracking → Re-baking & re-aligning." With Mesh & Pin Weaver 3D, you can

instantly re-synchronize to the latest animation with a single click while preserving 100% of your hand-drawn artwork.

[Re-Baking Steps Upon Animation Revisions (No Need to Delete Layers!)]

- ① Modify rotation, translation, or camera timing on your 3D prop or character.
- ② Select the guide layer (or guide vertices) inside the 3D structure.
- ③ Press Shift+W (Mesh) or Shift+P (Pin) again (Overwrites and updates to latest data in ~1 second!).

6.1 No Need to Delete Existing Layers or Drawn Artwork

- **Complete Protection of Drawn Artwork (`Paint_Canvas`):**
 - All fills, linework, curved elliptical edges, badges, textures, and cast shadows drawn on `Paint_Canvas` are **completely preserved and never deleted or reset**.
- **High-Speed Overwriting of Keyframes Only:**
 - **MeshWeaver:** Automatically detects existing `Auto_Warp_Rig` and `Mesh_Warp` , and **overwrites (re-bakes) only the 4-corner keyframe coordinates to match the updated 3D animation**.
 - **PinWeaver:** Automatically detects existing `Auto_Pin_Rig` and `Pin_1 .. Pin_N` bones, updating only the position keyframes across all frames at high speed while preserving all drawn vector art and bone influences.

6.2 Production Pipeline Benefits

1. Zero Stress During Retakes:

When directors or clients request sudden retakes (e.g., "halve the prop's rotation speed," "tilt it forward more," or "shift the motion timing"), simply adjust the 3D animation and hit `Shift+W` or `Shift+P` once—your textured artwork and badges follow flawlessly.

2. Artwork-First Workflow:

Even before 3D motion or camera work is completely locked down, artists can start detailing and painting on `Paint_Canvas` in advance.

3. Multi-Pass Polishing:

You can seamlessly alternate between fine-tuning 3D motion and refining 2D vector styling nuances at any stage of production.

6.3 [Pro Must-Read] Moho Smart Warp Evaluation Specifications & Viewport Display Behavior

When drawing or switching actions in MeshWeaver, understanding **Moho's internal Smart Warp (Mesh Warp) rendering pipeline** is crucial:

① Smart Warp Deformation Principle (Frame 0 = Rest Pose)

- Moho's Smart Warp treats the **mesh geometry at Frame 0 (Setup Pose)** as the baseline **Rest Pose**, computing the delta deformation on Frame 1+ to warp the vector drawing on `Paint_Canvas`.
- Therefore, the golden rule is: **Always draw textures on Frame 0, and verify animated deformation results on Frame 1 or later.**

② Why Artwork Appears "Left Behind" When Paused or Switching Actions

- **Mesh (`Mesh_Warp`)**: Contains actual vector vertex data, so its boundary lines snap immediately to new positions when switching actions or moving points.
- **Paint Curves (`Paint_Canvas`)**: Point coordinates do not move directly; instead, the **GPU / rendering engine warps and projects the visual output in real time based on parent mesh deformation (post-effect projection)**.
- **Moho Internal Cache Behavior**: Moho's viewport optimizes performance by deferring warp recalculations during static editing or immediately after switching actions. **Warp deformation is evaluated in batch the moment timeline playback (frame scrubbing or stepping) occurs.** Consequently, it may sometimes appear as though only the mesh frame moved while the artwork was left behind until playback starts.

③ Instant Snap Fix (One-Touch Resynchronization)

- If artwork tracking lags after switching actions or adjusting guides, simply **press Spacebar (Play) or step 1 frame forward and back with Left/Right Arrow keys**. This forces Moho to trigger warp re-evaluation, immediately snapping the paint curves to the latest mesh geometry.

Part 7: Technical Specifications & Error Handling (Fail-Fast Architecture)

Mesh & Pin Weaver 3D features strict safety checks, Fail-Fast (immediate abort) data validation, and a high-precision geometric calculation engine to guarantee absolute stability in professional animation production pipelines.

7.1 Fail-Fast Validation & Safe Error Notifications

Before modifying any project data, both scripts immediately validate the integrity of the selected data. If prerequisites are not met, the script does not attempt guesswork fallback and **aborts execution immediately (Fail-Fast)**, notifying the user via clear dialogs:

[MeshWeaver Validation Rules]

- **Vector Layer Type Check:**
 - If the active layer is not a Vector Layer, aborts immediately without executing and alerts:
`"Please select a 4-point Vector Guide Layer."`

- **Vertex Count Check (Strict 4-Point Enforcement):**
 - If the selected guide layer contains anything other than exactly 4 points (3 or fewer, or 5 or more), the script **aborts immediately (Fail-Fast)** without guesswork interpolation and alerts:
`"The selected Guide Layer must contain exactly 4 points."`

[PinWeaver Validation Rules]

- **Guide Point Presence Check:**
 - If no points are selected in the document and no valid vector layer is selected, aborts and alerts: `"PinWeaver Error: No guide points found in selection or document."`
 - **Safety Limit of 10 Points (MAX_POINTS = 10):**
 - If detected guide points exceed 10, aborts to prevent bone hierarchy bloat and performance degradation: `"PinWeaver Error: Too many points found (%d). Please limit guide points to 10 or fewer."`
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7.2 Full Transformation Matrix Geometric Projection Engine

- **Complete Multi-Tier 3D Transform & Camera Perspective Interpretation:**
 - Regardless of parent group nesting depth, uses Moho's `layer:GetFullTransform(frame, layerMat, doc)` to obtain the **complete composite transformation matrix**, accurately integrating parent 3D translation, X/Y/Z rotation, scale, flipping, and document camera perspective across all frames.
 - **Elimination of Double-Perspective Distortion:**
 - Direct matrix transformation to screen 2D coordinates (`layerMat:Transform(screenPos)`) ensures zero perspective drift or magnification errors, achieving 100% exact alignment with 3D guide vertices.
 - **Maintaining Sharp Quad Edges (MeshWeaver):**
 - Applies the official Moho API `M_Point:SetCurvature(MOHO.PEAKED, f)` across all frames to ensure sharp, linear quad edges without unwanted curve rounding.
 - **Pin Bone Field of Influence Setup (PinWeaver):**
 - Generates zero-length pin bones (`fLength = 0` , `fStrength = 6.0` , `fIsPin = true`) to provide smooth bone weight interpolation and precise screen binding.
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7.3 Version Compatibility & Undo Protection

- **Full Moho Pro 12 / 13 / 14 Compatibility:**
 - Dynamically and safely detects version-specific Smart Warp binding properties (`fMeshLayer` / `fWarpLayer`), ensuring `Mesh_Warp` binds correctly across all Moho versions.
 - Safely configures pin bone properties across different Moho releases using protected function calls (`pcall`).
- **Complete Undo Protection (PrepUndo):**

- Calls `doc:PrepUndo(nil, "...")` at initialization, allowing a complete one-step rollback (`Ctrl+Z` / macOS: `Cmd+Z`) to the pre-execution state.
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■ Supplementary & Important: Deformation Precision & Choosing Between MeshWeaver and PinWeaver

1. MeshWeaver 3D (Smart Mesh)

- **100% Geometric Quad Surface Accuracy:** Artwork inside the 4-point quad is warped with **mathematical precision without strength falloff**. Best suited for rigid surface labels, signboards, cylindrical cans, pipes, and box faces.

2. PinWeaver 3D (Pin Bones)

- **Flexible Bone-Strength-Based Deformation:** Deformation smoothly follows the configured **Bone Strength (radius of influence)**.
 - **Curved Surface & Organic Tracking via Hierarchy:** By parenting intermediate control bones to the 4-corner 3D guide bones and adjusting Bone Strength, smoothly deform artwork along bending cylinders (arms, legs, organic bodies).
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■ Expanding Your Pipeline: For Users Seeking 3D Polyhedrons & Origami Unfolding

Mesh & Pin Weaver 3D specializes in fast, lightweight 3D projection of hand-drawn textures and 2D artwork.

For automated **3D Polyhedron Construction, Origami 3D Rigging, and Automatic Face Masking**, explore the advanced companion tool [FoldWeaver 3D](#) (featuring universal centroid snap `Shift+0` and hinge connect `Shift+C`)!