Untold Byte – GAINS (Generative AI Novelty Software)

Introduction

GAINS is a collection of tools that enables rapid asset development by leveraging Stable Diffusion (generative image AI) and ControlNet. Currently the package comes with two tools Symbol Creator and Entity Painter and as you read this, we are working on expanding this set further. We are thrilled to share with you what we have created so far.

Requirements

- Unity version 2019.4 and up on Windows (not tested but may work on Mac OS or Linux)
    - SharpZipLib (com.unity.sharp-zip-lib:1.3.4-preview)
    - Newtonsoft Json (com.unity.nuget.newtonsoft-json:3.2.1)
- Stable Diffusion Web UI – link (v1.6.0 - earlier versions may work too; installation is not necessarily on local machine)
    - 4GB video card support (also reports of 2GB working)
    - Works best with nVidia graphics cards (xformers library)
- ControlNet for Stable Diffusion Web UI (v1.1.420 – earlier versions may work) – link
- Rembg extension for Stable Diffusion Web UI – link (for removing background)
- Lots of GBs of free space (for Stable Diffusion Web UI installation)

Tools

Symbol Creator,

Is a tool that helps create symbols and icons using ControlNet guided image generation, AI image upscaling and AI background removal.

Entity Painter,

Tool that uses ControlNet guided image generation and texture projection for generating object textures.

Installation

- Prerequisites (per machine install)
    - Install Stable Diffusion Web UI - https://github.com/AUTOMATIC1111/stable-diffusion-webui#installation-and-running (please follow the links for installations for AMD or nVidia GPUs)
    - Install ControlNet for Stable Diffusion Web UI - https://github.com/Mikubill/sd-webui-controlnet#installation
    - Install Rembg extension for Stable Diffusion Web UI - https://github.com/AUTOMATIC1111/stable-diffusion-webui-rembg#installation
    - Enable API in Stable Diffusion Web UI - in your "webui-user.bat" add --api parameter: *set COMMANDLINE_ARGS=--api*
    - For convenience check “Do not append detectmap to output” in Stable Diffusion Web UI > Settings > ControlNet (to stop it from returning depth map as a result in Entity Painter)
- Install Untold Byte GAINS package from Unity Asset Store

Settings

Adjust settings to be able to use Stable Diffusion Web UI API from Symbol Creator and Entity Painte r – settings file is named SDSettings and is located in projects Assets\UntoldByte\GAINS\Settings folder.

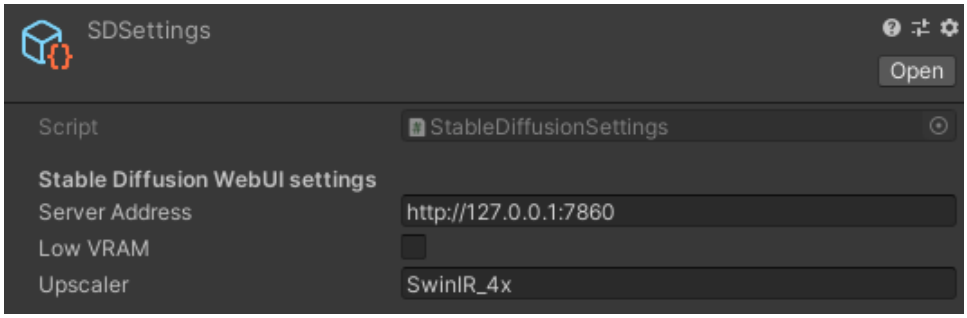
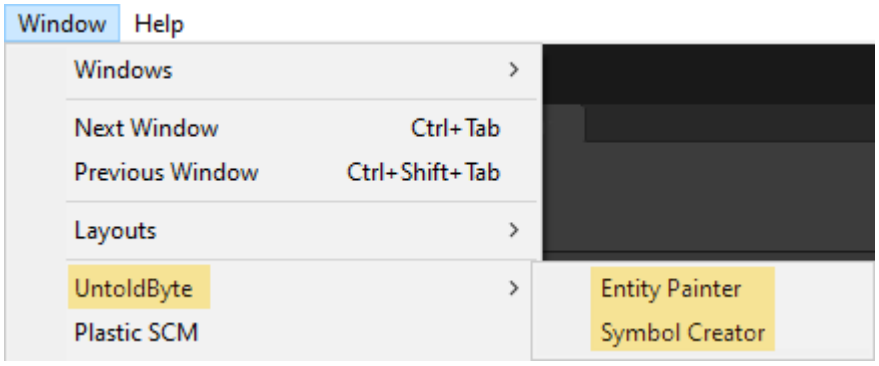


Figure 1Stable Diffusion Web UI settings

- Server Address – http address of Stable Diffusion Web UI (default: http://localhost:7860/)
- Low VRAM – check if VRAM <= 4GB (default: unchecked) documentation
- Upscaler – upscaler used when upscaling images – every time you change upscaler when upscaling this settings value will be updated (default: SwinIR_4x)

Where do I begin with?

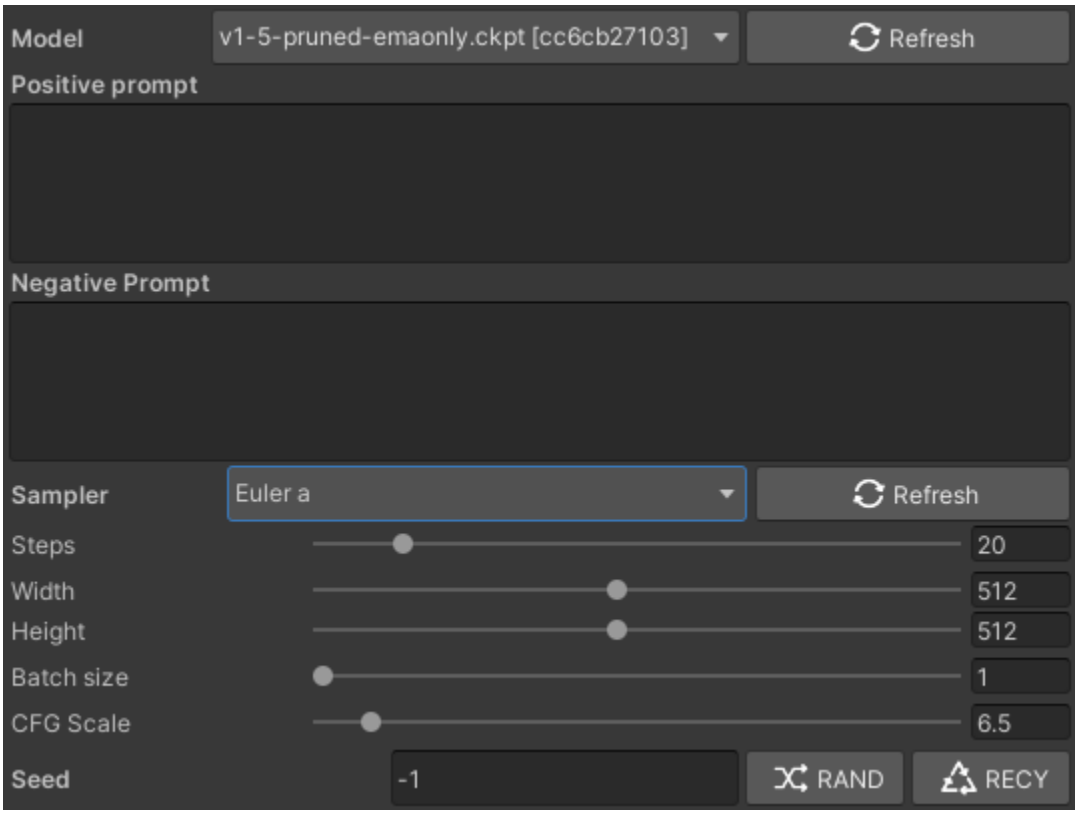
To open either Symbol Creator or Entity Painter in Unity menu bar pick Window/UntoldByte and then pick Symbol Creator or Entity Painter.



How to open Entity Painter or Symbol Creator

Both windows have common Stable Diffusion options which are found in Generate tab in Symbol Creator and Entity Painter windows.

Stable Diffusion options



Stable Diffusion options

Model – dropdown for selecting stable diffusion model

- Refresh button refreshes model options from Stable Diffusion Web UI

Positive prompt – prompt for all the things stable diffusion should consider including when generating

Negative prompt – prompt for all the things stable diffusion should avoid including when generating

Sampler – diffusion sampling method to use

- Refresh button refreshes sampler options from Stable Diffusion Web UI

Steps – number of steps to take in creating image(s): less steps – faster likely not detailed or as sharp, more steps - slower likely more detailed and sharper image

Width, Height – for the generated image – currently both best set to 512 and used with Stable Diffusion 1.5 based models (or other models that generate 512x512 images), 768x768 or 1024x1024 (SDXL) have been tested to work (please pick square resolution, non-square resolutions have not been tested and behavior is unknown)

Batch size – number of images to generate in one go (larger batch sizes require more GPU memory)

CFG Scale – how imaginative Stable Diffusion should be in generating windows (smaller values – AI will try to stick to prompt strictly, larger values – AI will feel free to experiment and express, they advise using values from 6 to 12)

Seed – a random value to start the generation process off with (same input including same seed number should generate same output)

- RAND button resets the seed (to use random seed)
- RECY button to recycle last seed that was used in generating

ControlNet options

ControlNet options

Preprocessor – preprocessor to prepare input image(s) for use in ControlNet

- Refresh button refreshes preprocessor options from Stable Diffusion Web UI

Model – ControlNet model to use

- Refresh button to refresh ControlNet models from Stable Diffusion Web UI

Weight – how much weight should be given to ControlNet image during image generation

Guidance Start - progress value (in 0 – 1 range) that indicates when to begin guiding image generation using ControlNet

Guidance End – progress value (in 0 – 1 range) that indicates when to stop guiding image generation using ControlNet

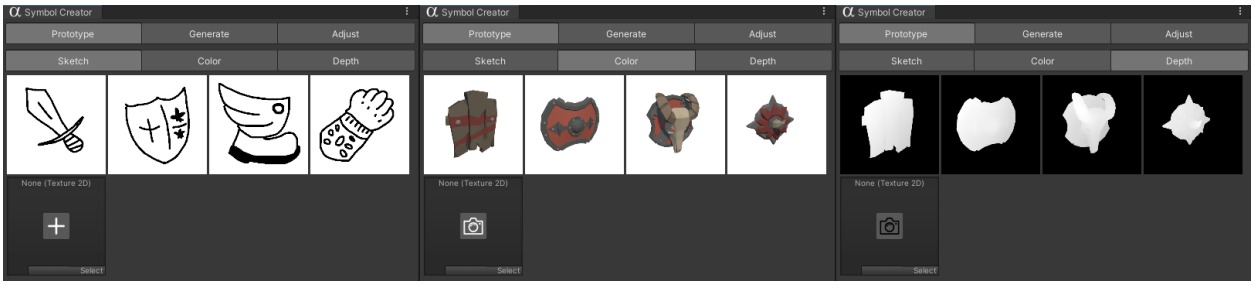
Additional parameters specifically related to selected preprocessor (please look at Stable Diffusion Web UI documentation for more details). In example on the picture above for *canny* preprocessor we have three additional parameters (Preprocessor Resolution, Canny Low Threshold and Canny High Threshold)

Symbol Creator

The process (in short):

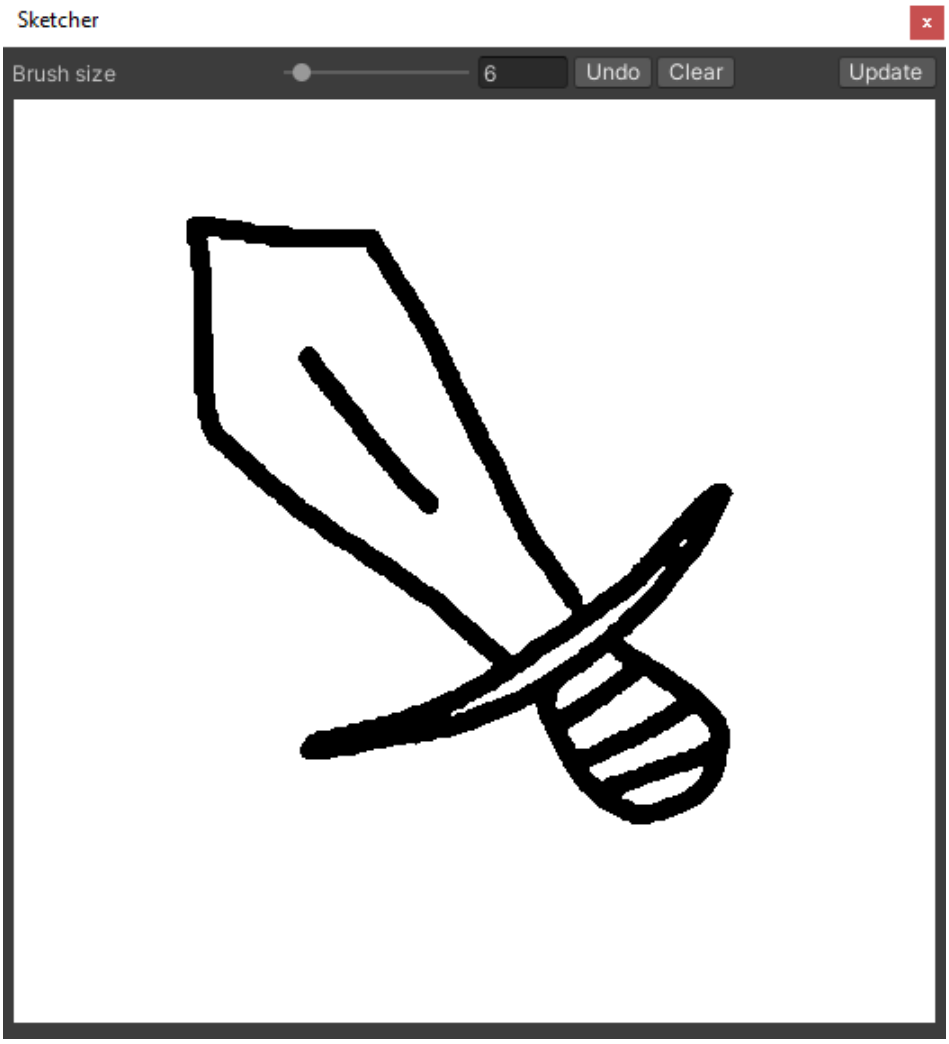
- Create prototype(s)
- Generate symbols
- Save

Process in details:



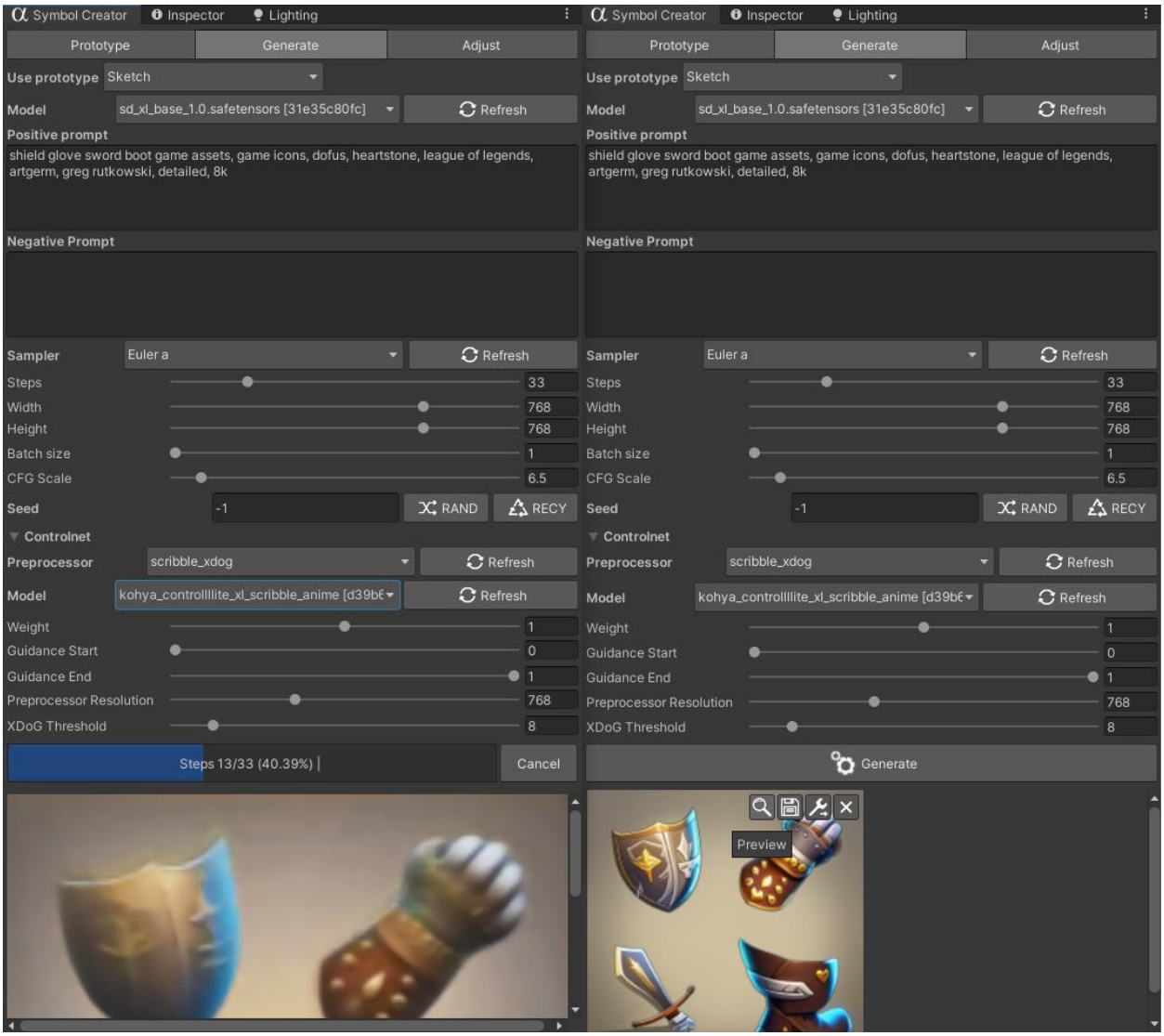
Symbol Creator Prototype tab with Sketch Color and Depth tabs open

- Create prototype(s):
  - Select Prototype tab in Symbol Creator window
  - Choose one from 3 different types of prototypes to create yours by selecting appropriate tab



Sketcher window to quickly create sketch prototypes

- Sketch prototype – clicking on  button opens Sketcher window to sketch out roughly what your symbols should look like (you can also drag and drop existing sketches or click on “select” button to select them)
- Color prototype – clicking on  button to take a color snap of your object in Scene window (you can also drag and drop existing color snaps or click on “select” button to select them)
- Depth prototype – clicking on  button to take a depth snap of your object in Scene window (you can also drag and drop existing depth snaps or click on “select” button to select them)



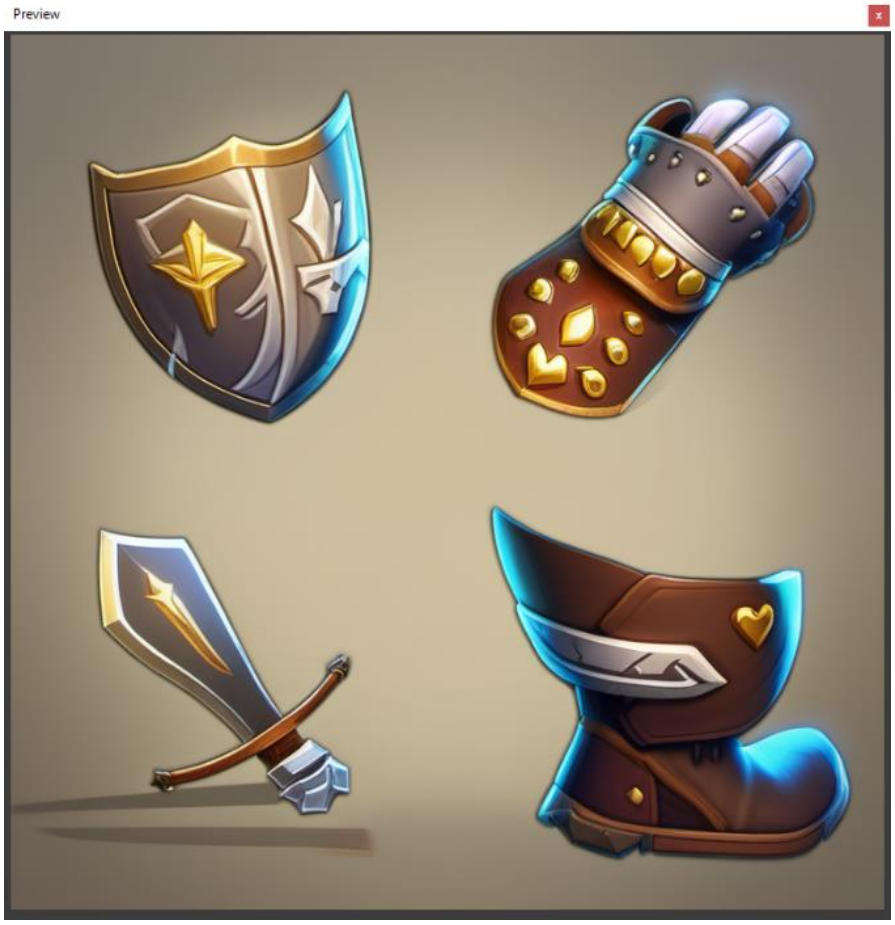
Symbol Creator waiting for image to be generated (left) and after image has been generated (right)

- Generate symbols:
  - In Generate tab's Use prototype dropdown and if not already please select prototypes that should be used to generate symbols
  - In Model dropdown select the model to use (e.g., "v1-5-pruned-emaonly.ckpt [cc6cb27103]")
    - Refresh button is used to refresh list of available models from Stable Diffusion Web UI
  - Specify Stable Diffusion options
  - Specify ControlNet options
    - Symbol Creator will try to select the first suitable option for ControlNet Preprocessor and Model, but it is possible that it will fail so please select appropriate:
      - For Sketch prototypes if ControlNet preprocessor is set to none it will invert image (to black with white lines) – useful for generating

sketches, or you can use scribble preprocessors with a scribble model

- For Color prototypes canny ControlNet preprocessor in combination with canny ControlNet model gives decent results
- For Depth prototypes as input, ControlNet expects that preprocessor is set to “none” as the images are already in correct depth format and Model to be set to ControlNet depth model)

- Press Generate button and wait for Stable Diffusion to finish generating



Preview of the generated image

Symbol Creator Adjust tab processing adjustments (left) and finished removing background (right)

- Save:
    - Hover over one of the generated images and buttons will appear:
        - Preview generated image by clicking on preview button
        - Save the image by clicking on save button (saves the image to Assets\UntoldByte\GAINSExports\Generated folder)
        - Upscale/remove background by clicking on adjust button (selects the image and moves you to Adjust tab for further adjustment – upscaling and/or background removal)
        - Remove generated image from the list by clicking on remove button (by generating again previously generated ones will be removed)

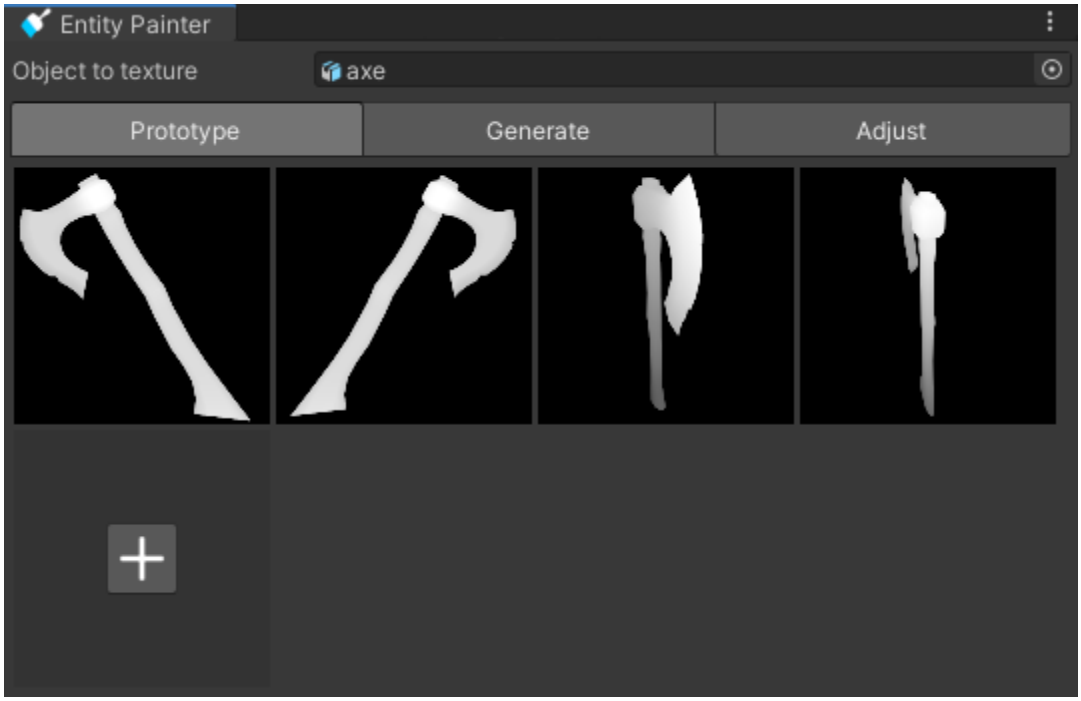
Entity Painter

The only additional requirement for Entity Painter to work properly is to have a mesh with unwrapped UVs in 0-1 square – values in [(0, 0), (1, 1)] to be able to create (render) the texture correctly.

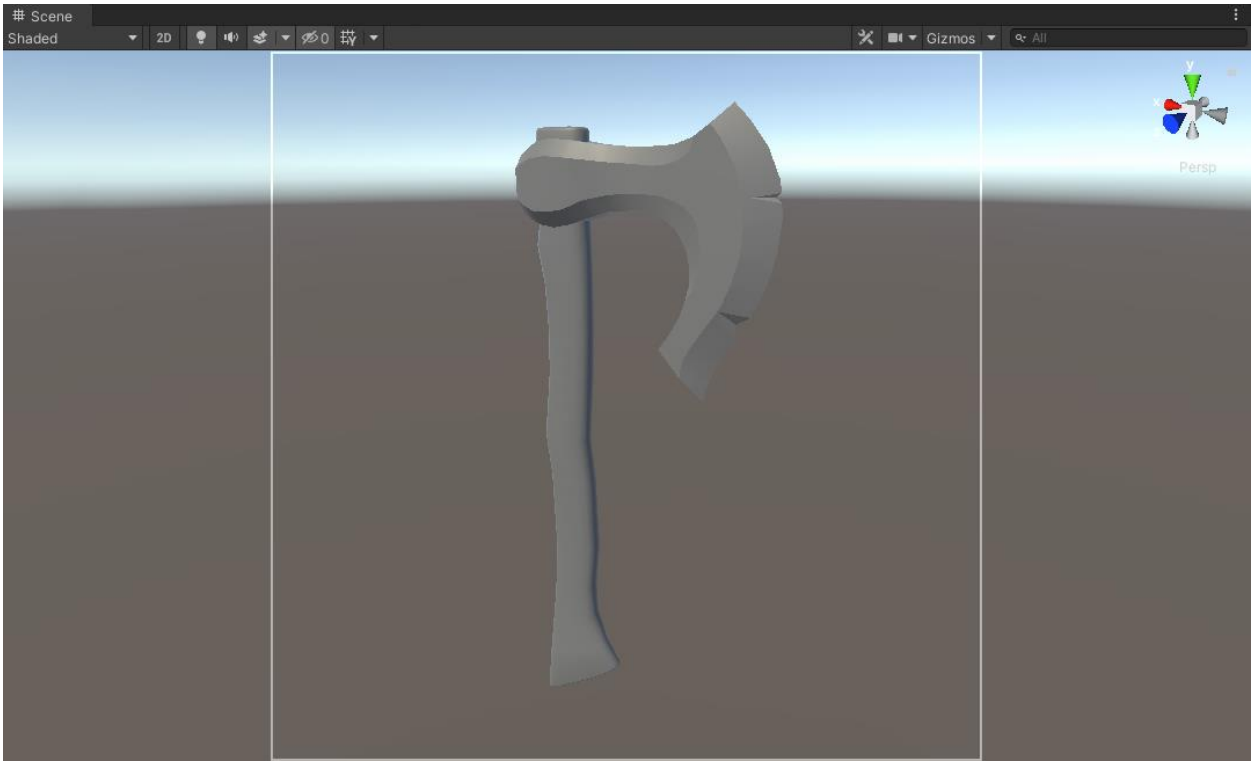
The process is simple and straightforward:

- Take snap(s)
- Generate projection texture(s)
- Test generated texture(s)
- Bake and save texture(s)

Process in details:



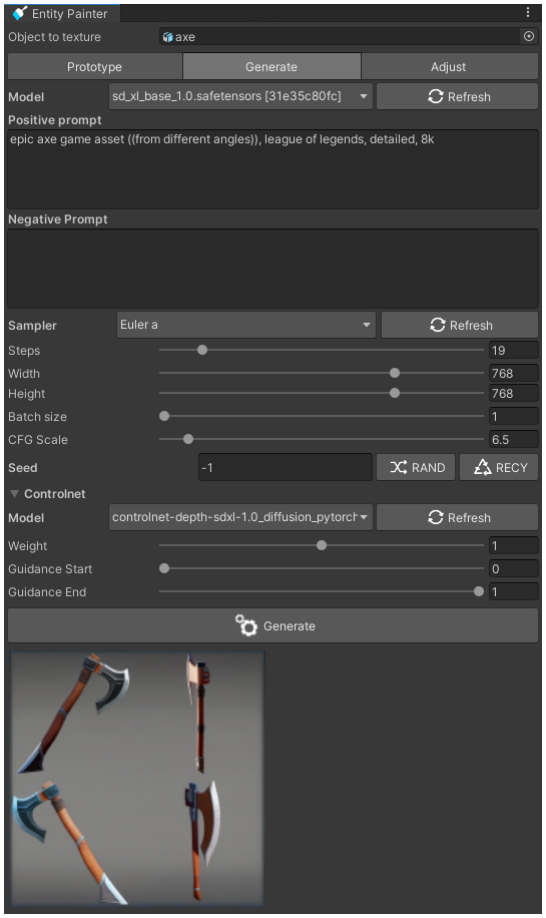
Entity Painter Prototype tab with captured axe snaps



Scene with white viewfinder for taking snaps in Entity Painter

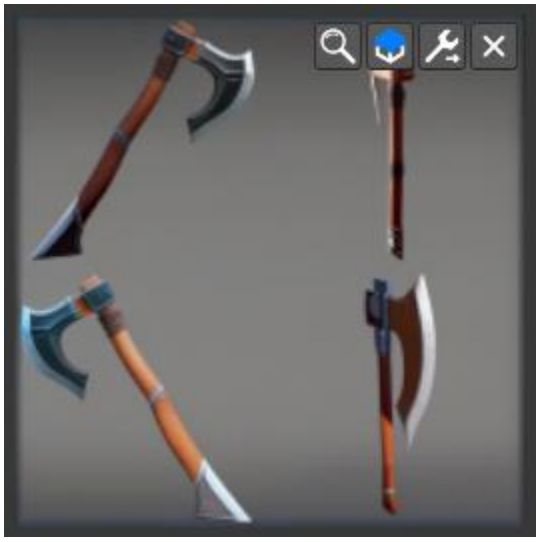
- Take snap(s):

- From Hierarchy window drag the mesh to Entity Painter window's Object to texture field (at the very top of the window)
- select Prototype tab (Scene windows will display white square – represents viewfinder to take prototype snapshots – active Scene window will be used)
- position your object (mesh) from first step in desired position to take prototype snapshot (if you need to texture the object from all sides take multiple snapshots to cover the mesh in entirety – because of packing it advisable to use to the power of 2 number of snapshots e.g., 4 or 9)
- take snap by clicking the  button



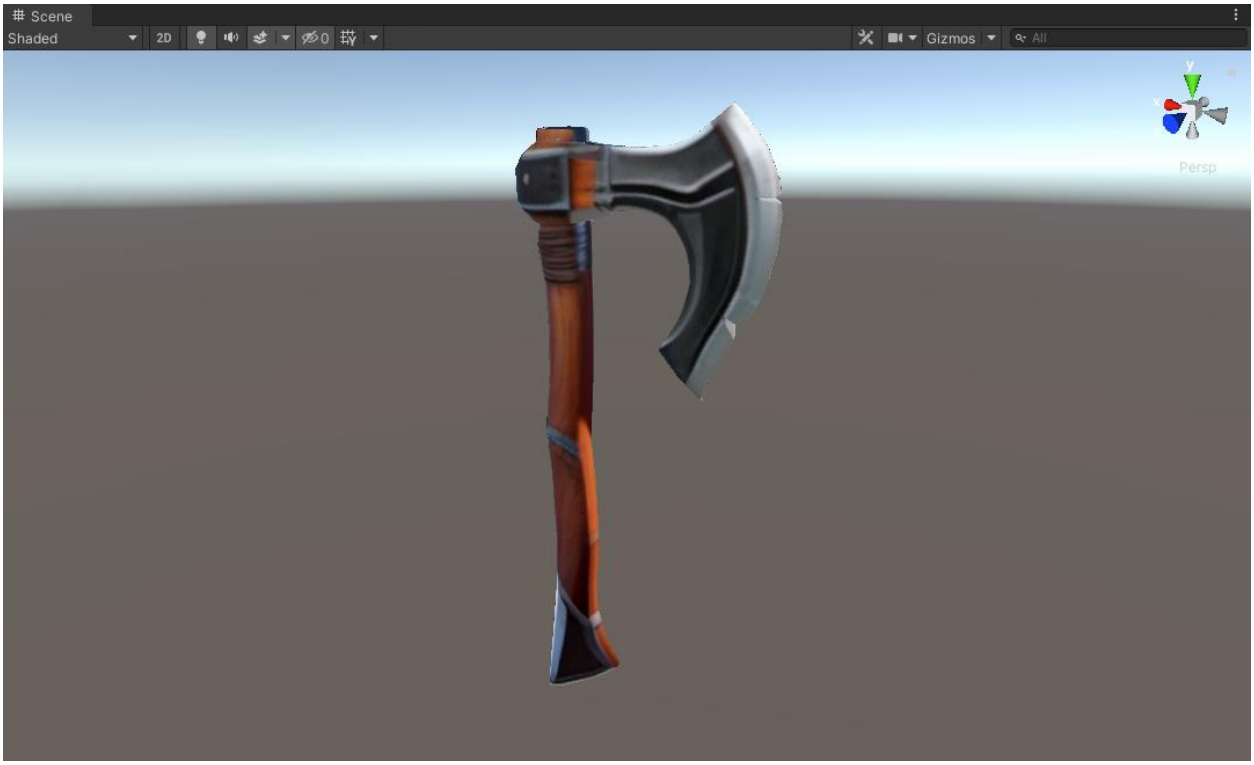
Entity Painter Generate tab after generating 1 image

- Generate projection texture(s):
  - Go to Generate tab in Entity Painter window
  - setup stable diffusion and ControlNet parameters and click on Generate button (wait for it to finish)



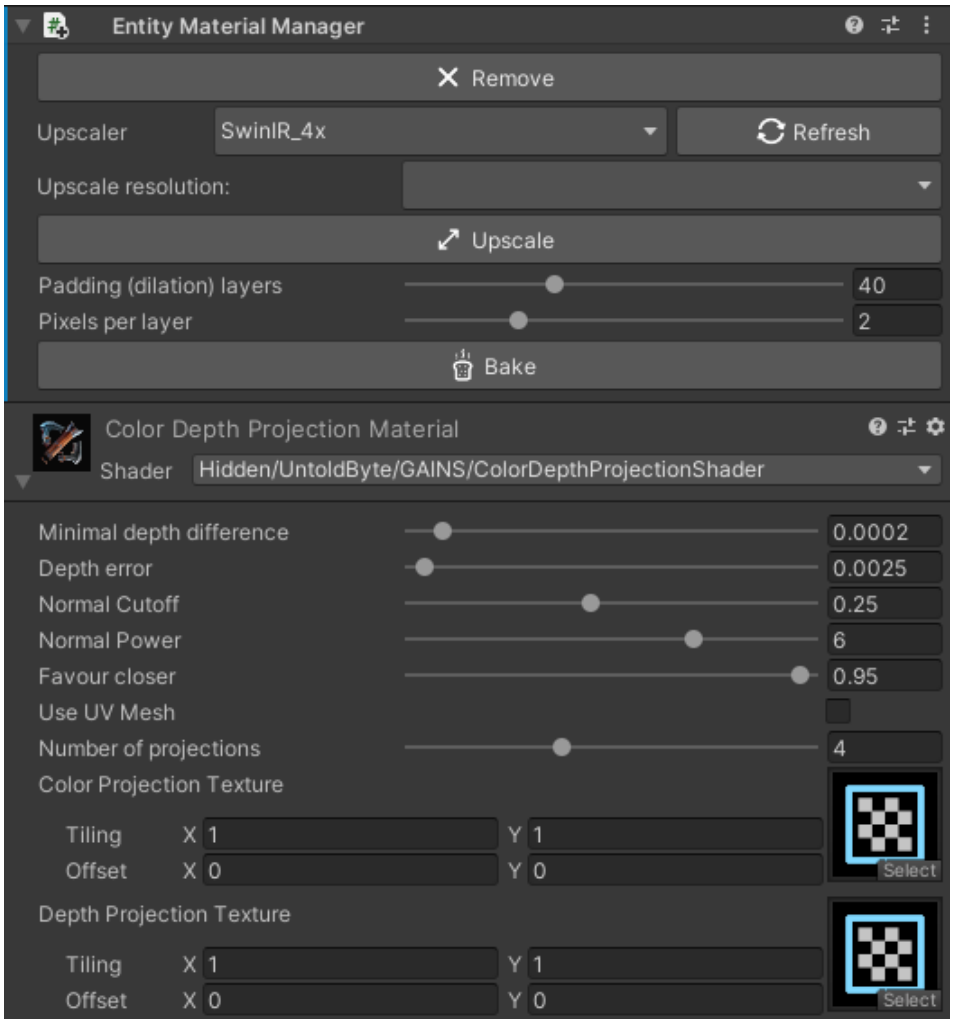
Hovering over generated image displays action buttons

- Test generated texture(s):
    - Preview generated image by clicking on preview button



Testing generated texture on axe 3d object in Scene view

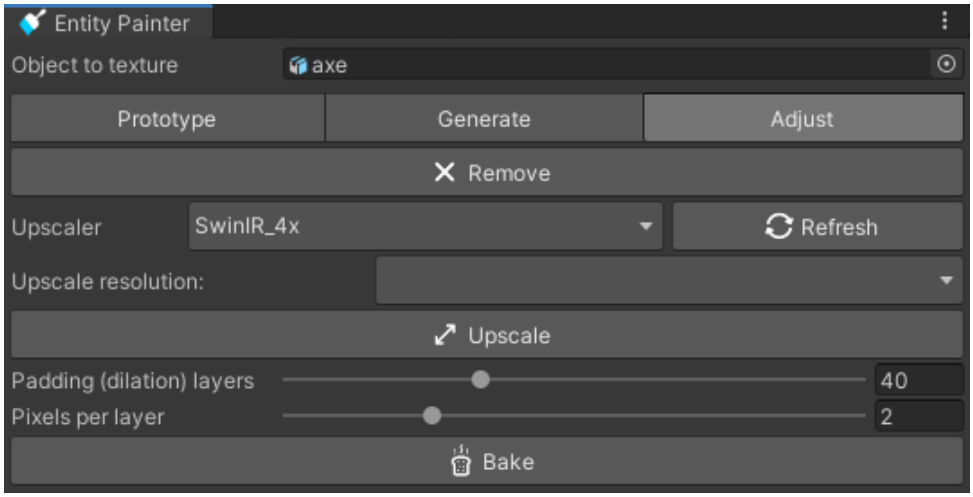
    - Test generated texture on the object click on test button to project generated textures onto selected mesh



Axe 3D object inspector with new component and test projection material

- You can select your mesh and adjust parameters on the newly added material to make projections blend better
    - Minimal depth difference – difference between two different ways the depth is measured (increasing value can sometimes help cover more of the object with texture; value is in world units)
    - Depth error – in order to texture only visible surface and allow some error in depth recorded in depth image (sudden changes in geometry depth) this value is used to adjust this tolerance value (increasing value a bit can help in some cases; value is in world units)
    - Normal Cutoff – cosine of texture projection angle at which or above the texture is not projected (lower values covers pixels whose normal is pointing further away from projection direction and higher values covers pixels whose normal is pointing toward projection direction)

- Normal Power – how strongly should surface normal influence object surface color from each projection (lower values allow color from side projections to come through, higher values favour color from direct projections)
- Favour closer – favours color from projections that are closer to object surface – which should give more detail (this is a percentage value expressed as a factor from 0-1, lower value does not favour closer projections higher does)
- Use UV Mesh – * *used internally* for baking the texture – can be used for testing (if you are curious, otherwise please leave as is)
- Number of projections – * *used internally*, number of projections applied to the object (in our case axe), again if curious to see how each projection is applied cumulatively (in order in which projections were snapped in Prototype)
- Color Projection Texture - * *used internally*, texture array with color textures for each prototype (projection) snap from generated image
- Depth Projection Texture - * *used internally*, texture array with depth difference values (between visible and current surface) for each prototype (projection) snap

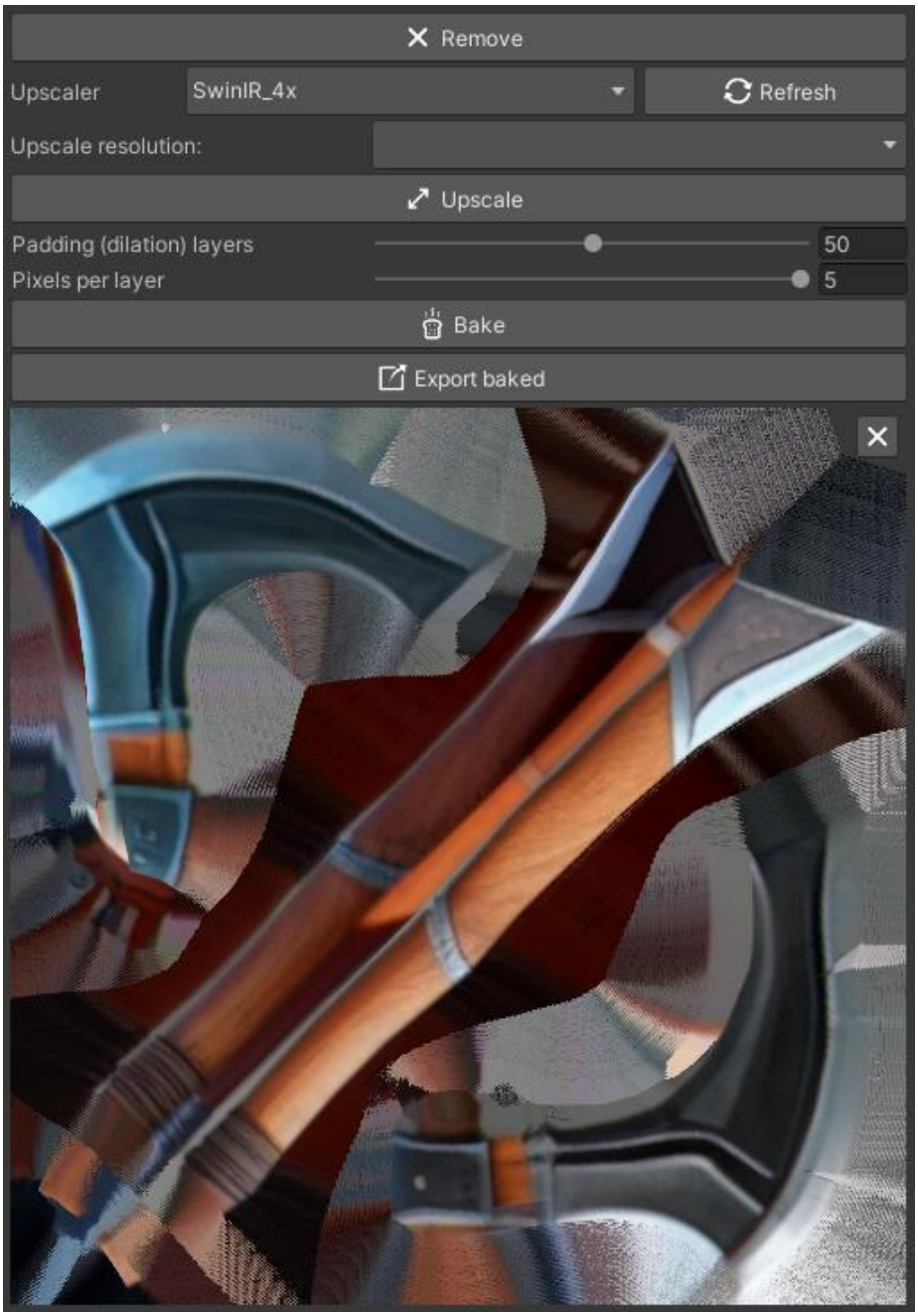


Entity Painter Adjust tab with same functionality as in new component on Axe object

- Adjust by clicking on adjust button  (selects the image and moves you to Adjust tab for further adjustment)
- Remove generated image from the list by clicking on remove button 

- Bake and save texture(s):
  - In Inspector window for your mesh from step 1 or Adjust tab of Entity painter. You fill find new component that has buttons to bake and save baked textures
    - Remove button removes Entity Material Manager component and projection material from object (axe in our case) and removes object from Object to texture field at the top of the Entity Painter

- Upscale resolution – used for selecting the resolution to upscale new texture to
- Upscale – button used to upscaling to selected upscale resolution
- Padding (dilation) layers – used for baking texture to configure how many layers to use to cover the area around UV coordinates in baked texture (to avoid artefact when texture is used – to allow filtering to work correctly)
- Pixels per layer – how far away from previous layer should next layer of padding be painted
- Bake button used to create/bake texture



Entity Material Manager with baked texture and visible Export baked button

- Baked texture is displayed bellow buttons
- When Export baked button is pressed baked textures and simple materials are created and stored in Assets\UntoldByte\GAINSExports\Materials and Assets\UntoldByte\GAINSExports\Textures folders
    - Note: Created materials are basic Unlit materials just so that you can have something to quickly test (to have it working across multiple render pipelines)

Additionally Adjust tab of Entity Painter window is used the same way as new component in Inspector window on selected “Object to texture” as it contains the same functionality (Bake and Save).

Stable Diffusion models

If you have not already found some awesome custom Stable Diffusion models and loras you can find them on Civit.ai

Prompting

If you are new to Stable Diffusion and would like to get decent results quickly, go to one of the web sites with collections of prompts (e.g., https://openart.ai/discovery?searchType=both&searchModel=sd) and search for what you are trying to create.

Entity Painter use case overview

Texture untextured 3D object:

- Make sure Entity Painter window is open
- Use 3D object from scene and drag it in Object to texture field of Entity Painter
- Position scene camera so that it captures above selected object from angle you wish to texture and in Prototype tab press the  button (repeat for up to 4 – 9 different angles/captures – don’t delete captures after generating images if you want to use them to texture the object)
- Go to Generate tab, fill out Stable Diffusion query parameters and click Generate button
- In generated image(s) (when hovering over) find and click on test butto  to preview what generated texture would look like on the object
- Select the object with preview texture and adjust parameters on its new material
- In inspector you will find new component that allows you to bake and then save the texture (because the preview material/shader is not optimized for real-time rendering).

Some Symbol Creator use cases overview

Generate images using Sketch prototypes:

- Make sure Symbol Creator window is open
- Make sure you have sketches in Prototype Sketch tab and/or add some
- Go to Generate tab
- Make sure Sketch option is selected in Use prototype dropdown
- Fill out Stable Diffusion query parameters and click Generate button
- After generating click on adjust button (wrench with right arrow) and optionally upscale and/or remove background (make it transparent)

Generate images based on captured Color prototypes:

- Make sure Symbol Creator window is open

- Make sure you have color prototypes in Prototype Color tab and/or add some
- Go to Generate tab
- Make sure Color option is selected in Use prototype dropdown
- Fill out Stable Diffusion query parameters and click Generate button
- After generating click on adjust button  and optionally upscale and/or remove background (make it transparent)

Generate images based on captured Depth prototypes:

- Make sure Symbol Creator window is open
- Make sure you have depth prototypes in Prototype Depth tab and/or add some
- Go to Generate tab
- Make sure Depth option is selected in Use prototype dropdown
- Fill out Stable Diffusion query parameters and click Generate button
- After generating click on adjust button  and optionally upscale and/or remove background (make it transparent)

Generate images with Stable Diffusion within Unity:

- Make sure Symbol Creator window is open
- Go to Generate tab
- Select None in Use prototype dropdown
- Fill out Stable Diffusion query parameters and click Generate button
- After generating click on adjust button  and optionally upscale and/or remove background (make it transparent)