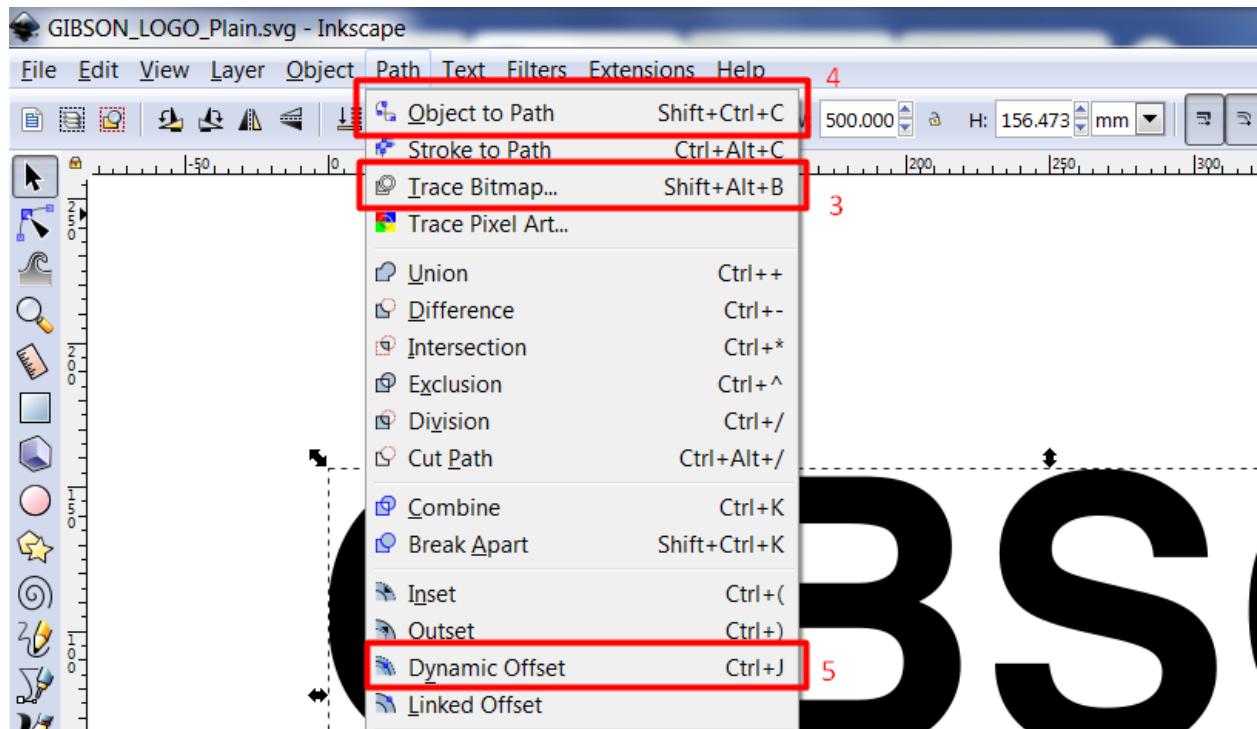


Instructions below detail how to trace an image using an AUBO robot. If you already have a list of XYZ coordinates in a CSV and want to trace that path, skip to Part 5: Importing XYZ Coordinates onto the AUBO.

Part 1: Inkscape

- This will prepare your image for cutting. IF you have a DXF file, you should be able to save it as an SVG and skip to Part 2.

1. Open your image (jpeg, png, svg, etc.) in Inkscape.
2. Select your image.
3. Path → Trace Bitmap
 - a. Adjust the settings as needed to create the best image. Eyeballing usually works fine.
4. Path → Object to Path
5. Path → Dynamic Offset
6. Export as an SVG.



Part 2: MakerCAM

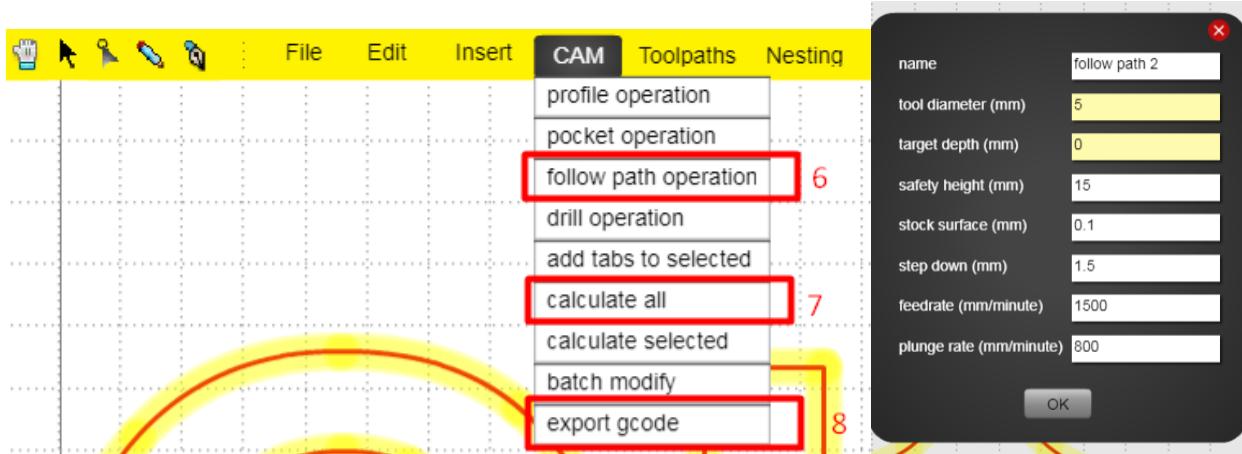
1. Go to <https://partkam.com/>
2. File → Open SVG File
 - a. Select the SVG file you saved in the last part.
3. Edit → Edit Preferences
 - a. SVG Default Resolution → Set to 90 since you used Inkscape → OK
4. In the top righthand corner, adjust the units as necessary (inch or cm).
5. Make sure your image is selected (it will be in RED)
6. CAM → Follow Path Operation → Adjust settings as needed → OK
 - a. Target Depth = 0

- i. This is the height at which you will be drawing the image. I make it 0 so that it is easier to track and I can set relative offsets later.
- b. Safety Height = 15mm
 - i. This is the height the robot raises up before moving to another location to avoid hitting the assembly.
- c. Stock Surface = 0.1
 - i. This shouldn't matter as long as it is larger than the Target Depth. If you are unsure, 0.1 typically works.
- d. Step Down = 1.5mm
- e. Note: Any combination of numbers should work as long as Target Depth = 0, Safety Height > Target Depth, and Step Down > (Safety Height – Target Depth)

7. CAM → Calculate All

8. CAM → Export G-Code

- a. Select the tool path you created for the image.
- b. Note: It will export as an *.NC file



Part 3: NCViewer (Optional)

- I like to do this step to make sure the G-Code came out as intended.

1. Open the G-Code file and make sure everything looks right

Part 4: Excel

Section Summary

- Get rid of all cells that DO NOT contain X#, Y#, or Z#
- Move the Z moves to their own column
- Fill in the empty spaces (in the X and Y column) left over from moving the Z# with the value in the cell above
- Eliminate the letters in front of the numbers
- End with 3 columns of X, Y, and Z points

There is probably an easier way to simply parse this into the final format.

1. Open the G-Code in Notepad.
2. Ctrl + A
3. Open Excel
4. Home → Paste → Paste Options → Use Text Wizard
 - a. Choose File Type = Delimited, Next
 - b. Delimiters = Space, Next

- c. Column Data Format = General for the 2nd and 3rd columns
 - i. Everything else → Do not import (skip)
- d. Finish

5. Delete all ROWS containing values that do not begin with X, Y, or Z.

- a. Your screen should look something like this:

	A	B	C
1	Z15		
2	X67.53136906273812	Y124.36093472186944	
3	Z0	F200	
4	X65.9486918973838	Y128.93065786131572	
5	X63.70078740157481	Y132.51714503429008	
6	X60.65532131064262	Y135.44323088646178	
7	X56.65735331470663	Y137.7774955549911	
8	X51.70942341884683	Y139.31673863347729	
9	X45.910591821183644	Y139.8755397510795	
i. 10	X40.375920751841505	Y139.30657861315723	

- i. 10
- 6. Copy columns A and B to columns D and E
- 7. In columns D and E, delete any cell values that begin with Z or F.
 - a. Since my Z height is always either 0 or 15, delete all Z0 and Z15. Since my feed rate is 200, I delete the cells with F200.
 - b. In D1 and E1, enter arbitrary X and Y coordinates for a starting point with letters in front of the number (I chose F0, and F0)
 - c. Home → Find & Select → Go to Special → Blanks
 - d. Select cell D3 and press F2 on your keyboard to edit. Type in the cell block: = D2
 - e. Ctrl + Enter
 - f. Note: Any line that includes only a Z value (and possibly an F value) is a pure linear move, so the X and Y coordinates stay the same.
- 8. In cell I2, copy and paste this (replace 15 with safety height as needed):
 - a. =IF(OR(ISNUMBER(SEARCH("Z15",A2)), ISNUMBER(SEARCH("Z15",B2))), "15", IF(OR(ISNUMBER(SEARCH("Z15",A1)), ISNUMBER(SEARCH("Z15",B1))), "15", "0"))
 - b. Apply to all the cells in column I except I1
 - c. Note: This is supposed to create Z coordinates that are at the correct Z height. When G code is generated, if there is only a Z move, the G-Code will only produce Z#. We need a complete XYZ array so that we have a complete table to give to the Auto.
- 9. In G1 enter: =RIGHT(A1, LEN(A1)-1)
 - a. Apply to the rest of the column and then column H.
- 10. By now all of your XYZ coordinates should be in G, H, and I. Like below
 - a.

A	B	C	D	E	F	G	H	I
1 Z15		F0	F0	0	0	0		
2 X67.53136906273812	Y124.36093472186944	X67.53136906273812	Y124.36093472186944	67.53136906273812	124.36093472186944	67.53136906273812	124.36093472186944	15
3 Z0	F200	X67.53136906273812	Y124.36093472186944	67.53136906273812	124.36093472186944	67.53136906273812	124.36093472186944	0
4 X65.9486918973838	Y128.93065786131572	X65.9486918973838	Y128.93065786131572	65.9486918973838	128.93065786131572	65.9486918973838	128.93065786131572	0
5 X63.70078740157481	Y132.51714503429008	X63.70078740157481	Y132.51714503429008	63.70078740157481	132.51714503429008	63.70078740157481	132.51714503429008	0
6 X60.65532131064262	Y135.44323088646178	X60.65532131064262	Y135.44323088646178	60.65532131064262	135.44323088646178	60.65532131064262	135.44323088646178	0
7 X56.65735331470663	Y137.774955549911	X56.65735331470663	Y137.774955549911	56.65735331470663	137.774955549911	56.65735331470663	137.774955549911	0
8 X51.70942341884683	Y139.31673863347729	X51.70942341884683	Y139.31673863347729	51.70942341884683	139.31673863347729	51.70942341884683	139.31673863347729	0
9 X45.910591821183644	Y140.8755397510795	X45.910591821183644	Y140.8755397510795	45.910591821183644	140.8755397510795	45.910591821183644	140.8755397510795	0
10 X40.375920751841505	Y139.30657861315723	X40.375920751841505	Y139.30657861315723	40.375920751841505	139.30657861315723	40.375920751841505	139.30657861315723	0
11 X35.59309118618237	Y137.72923545847092	X35.59309118618237	Y137.72923545847092	35.59309118618237	137.72923545847092	35.59309118618237	137.72923545847092	0
12 X31.287782575565153	Y135.11811023622047	X31.287782575565153	Y135.11811023622047	31.287782575565153	135.11811023622047	31.287782575565153	135.11811023622047	0
13 X27.27965455930912	Y131.29286258572517	X27.27965455930912	Y131.29286258572517	27.27965455930912	131.29286258572517	27.27965455930912	131.29286258572517	0
14 X24.234188468376935	Y126.7233934467869	X24.234188468376935	Y126.7233934467869	24.234188468376935	126.7233934467869	24.234188468376935	126.7233934467869	0
15 X21.844043688087375	Y120.60960121920245	X21.844043688087375	Y120.60960121920245	21.844043688087375	120.60960121920245	21.844043688087375	120.60960121920245	0
16 X20.54356108712217	Y114.11480822961647	X20.54356108712217	Y114.11480822961647	20.54356108712217	114.11480822961647	20.54356108712217	114.11480822961647	0
17 X20.030480060960123	Y105.6032512065024	X20.030480060960123	Y105.6032512065024	20.030480060960123	105.6032512065024	20.030480060960123	105.6032512065024	0
18 X20.599441198882396	Y97.04343408686817	X20.599441198882396	Y97.04343408686817	20.599441198882396	97.04343408686817	20.599441198882396	97.04343408686817	0
19 X22.001524003048004	Y90.83312166624333	X22.001524003048004	Y90.83312166624333	22.001524003048004	90.83312166624333	22.001524003048004	90.83312166624333	0

11. Save as a CSV
12. Open the CSV and delete all columns except for G, H, and I (the columns that have no blanks and are filled only with numbers for your coordinates).
13. Save to the flash drive with the other files for Trace_Path

Part 5: Tracing the Path with the Aubo

The following instructions are also in the README file of the Path Following Tools Folder. Follow the instructions for placing files and creating a project with the scripts.

READ ME

File Locations

1. fromcsv.lua goes in the Home directory of the computer
2. find_csv.aubo goes in Scripts folder for AuboWorkspace
3. trace_path.aubo goes in Scripts folder for AuboWorkspace
4. The CSV goes in the Documents folder of the computer

When Making a Project:

- make sure your coordinates are in METERS (adjust as needed)
- make sure you can move to your first point (this should be automatic in trace_path)
- you might have to include offsets as robot could hit itself (ex: (0,0,0) in Base = robot base)

1. Run find_csv (make sure you've indicated the location of the CSV here)
2. Run trace_path (adjust the number of points as needed)

Common Errors and/or FAQs

Q1. Script runtime error: ...eachpendant/share/teachpendant/project/project_name/main.aubo:19: attempt to perform arithmetic on a nil value

A1. Try taking out the last number and adding it manually via another method.

Q2. Call service interface failed! Return value 21300 or 21301

A2. Something in the path making failed. Try doing splitting the path into parts or using B-Spline.

Q3. Why does it look like the robot is trying to a) crash into itself or b) flip around and try to follow the path from underneath?

A3. Probably something wrong with the motion planning. Try decreasing the Z coordinate of your tracing so that it is negative.

Last Updated: 8/9/2019

- Isabelle Chan

- The bulk of the code can be found in trace_path.aubo
- o The points are assumed to be in millimeters and are converted to meters via scaling
- Always try to use moveP first as it creates the best image, however it does not always work use
 - B- Spline but add more points.
 - o moveP works best for images with lots of right angles and straight lines
 - o B-Spline works best for images with lots of curves or images with MANY points.