Arma Automotive Inc.

CNC Tube Notcher Kit

Installation and Operation Manual

http://armaautomotive.com

Revision 1.0

Draft: January 21 2022
Latest update: March 23, 2022

Introduction

The Arma CNC Tube Notcher kit contains hardware components, electronics and software to be used with a customer fabricated steel rail and frame made along with a customer supplied computer, plasma torch, air compressor and water trough.

The assembled CNC Tube notcher automates fabrication of metal tubing and pipe with coping for joints, tabs and slots for alignment and is compatible with the Arma Tube Bender allowing for notched, tabbed and slotted bent tubing fabrication from CAD models.

The CAD CAM software Arma Design Studio (ADS) has support for modelling tubing, auto notching intersections, auto tab slots and bending with GCode export and machine control. ADS also has import functions to take geometric cad models from other software and generate GCode notching instructions.

The tube notcher kit requires the purchase of additional metal and a fabricator to assemble a frame and rail for the kit to attach onto. The kit also requires a computer to operate the machine, a plasma torch and air compressor.

The Arma Tube Notcher is ideal for fabricators building round tube structures such as vehicle chassis, roll cages, bumper cages, truck racks, etc.
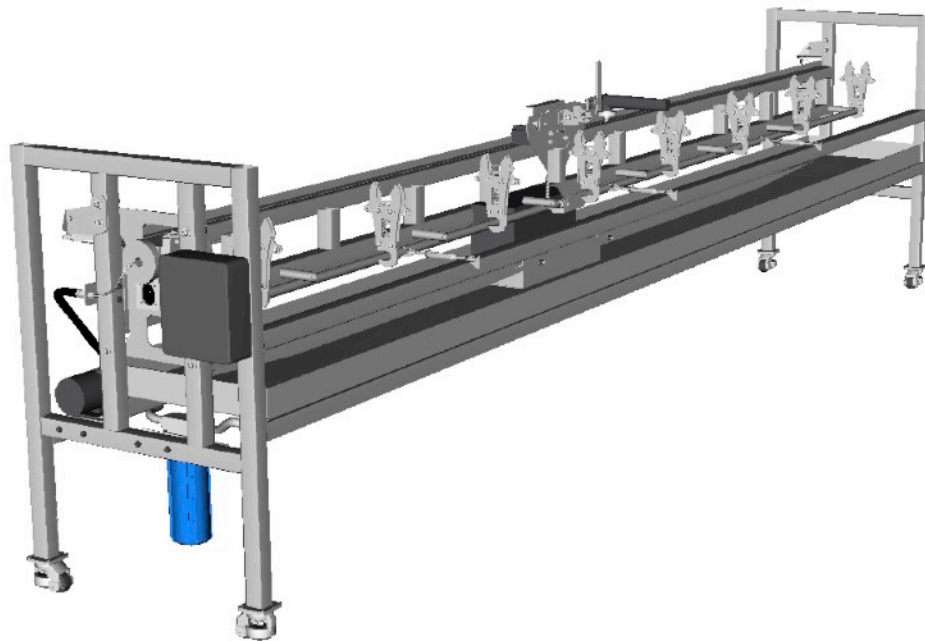

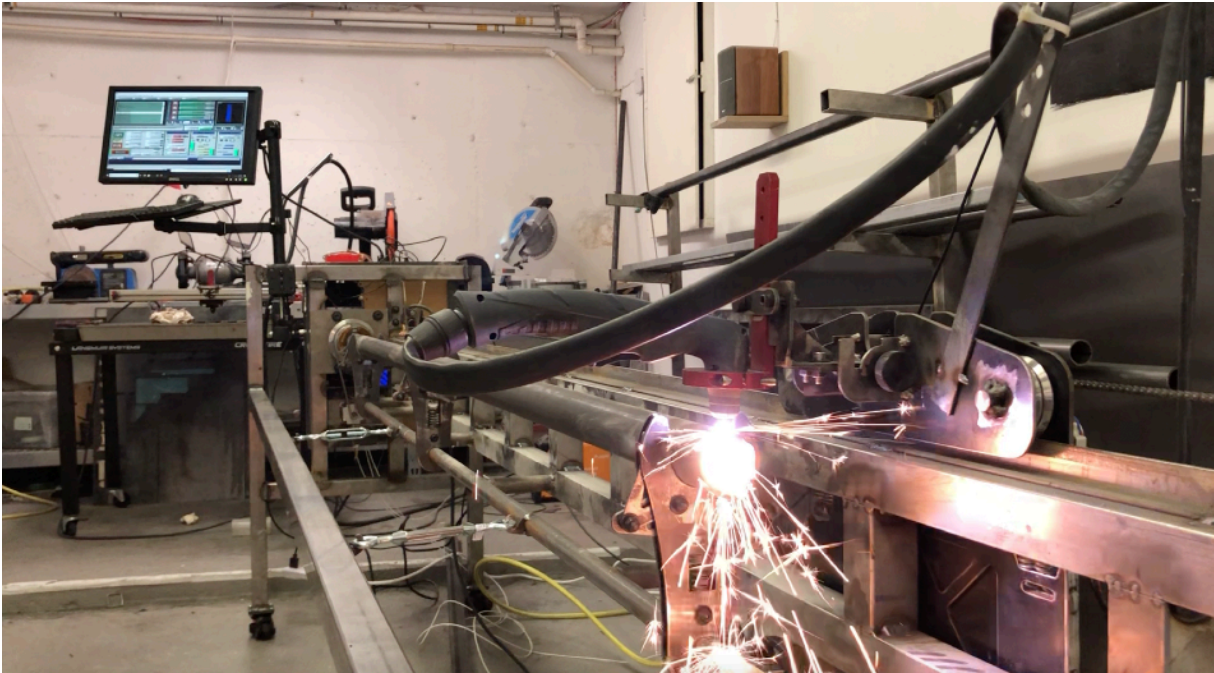*Illustration: Assembled Arma CNC Tube Notcher Kit Fully Assembled.*

Illustration: Prototype development cutting test tube parts. The kit parts are different.

Illustration: Early prototype test parts. Calibrated notches and cuts are cleaner.

Specifications

The tube notcher supports the cutting of Steel and Aluminum round tubing and pipe with an outer diameter between 1" and 2".

Wall thickness up to 3/8th inch is supported.

Square tubing is not supported by this product.

Two axis positioning and cutting is supported. The torch cutter is always positioned perpendicular to the tube surface as the tube rotates and the torch travels along the length. This means that there may be a wedge shape that needs to be welded on coped joints especially for tubing with a thick wall.

The maximum supported length of tube and pipe is flexible as the length of the frame and rail can be customized during assembly. The reference notcher is 14' wide supporting tubing with a maximum length of 12'. The notcher can be made smaller to accommodate confined workspaces and lengthened to cut full length tubes 24' long.

Control software in the Arma Design Studio application supports fabrication with new model designs or existing third parts cad models imported.

Optionally a Mach3 compatible controller solution can be provided for customers wishing to use Mach3.

Environment

A dry workspace is required with a floor space area of 4 feet by 14 feet and optionally up to 26 feet for extended models.

Power outlets of 220 volts with 40 Amps are required for the plasma torch and a 110v receptacle is required for the control electronics and operating computer.

Adequate ventilation is required near the plasma torch as fumes are produced during cutting.

Target Applications

The Arma CNC Tube Notcher is intended to be an affordable automation tool for individual builders, medium sized business and industrial manufacturers.

Complex tube structures can be modelled in CAD software and fabricated in an efficient, accurate and repeatable manner.

Tube structures can be cut with coping edges for accurate fitment to connecting tube where it can be welded in place.

The Arma Design Studio CAD/CAM software can generate notch profiles for intersecting tubes with tabs in one part and corresponding slots in the connecting part. This aids in verifying alignment as tubes can only fit together in the correct location as well aiding in assembly where the tabs hold parts in place more easily resulting in less jig scaffolding for complex projects.
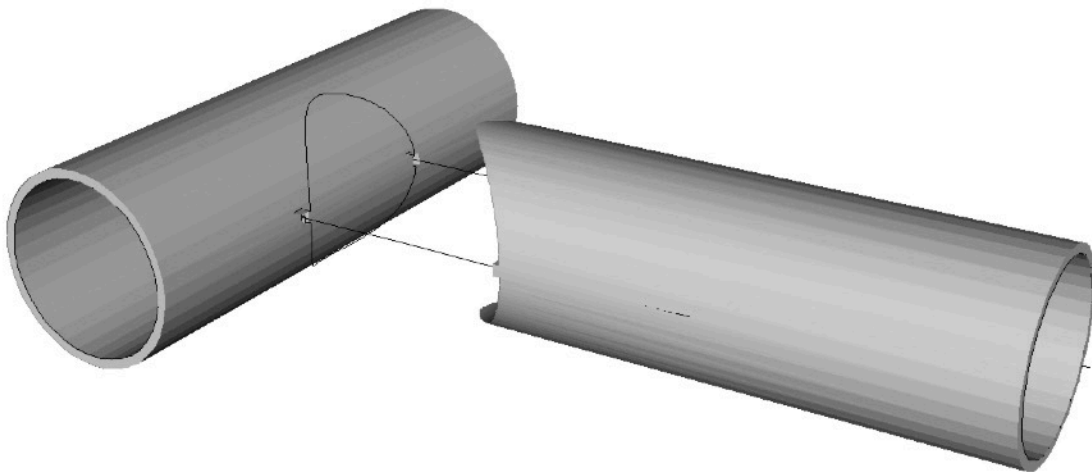

Illustration: Example notch with tabs and corresponding alignment slots.

The CNC Tube Bender was designed for projects like the Arma vehicle chassis made from a space frame tube structure using notches, tabs and slots to reduce the alignment jig structure requirements and complex bends for better space constraints as well as appearance.
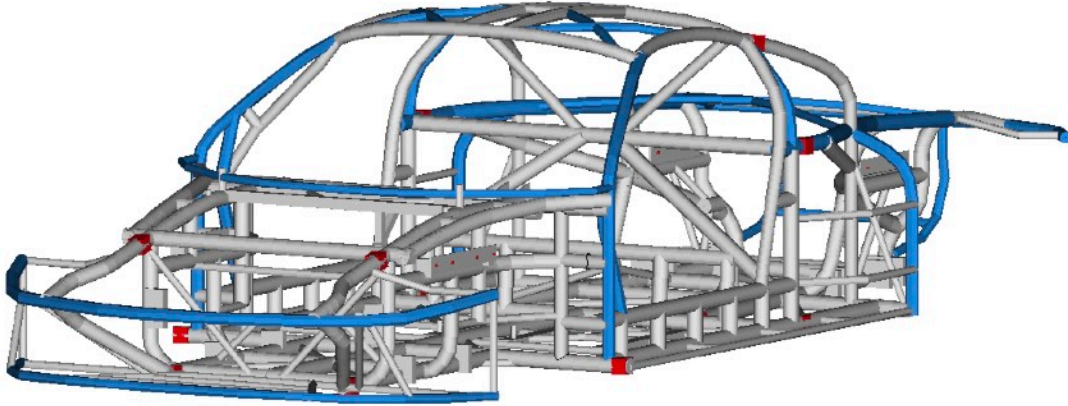

Illustration: Example project - The Arma vehicle chassis.

Notched parts are compatible with the Arma CNC Tube Bender allowing CAD models of tube structures with bends to be cut using the Arma CNC Tube Notcher and then placed in the bender to produce complete parts ready for assembly.

Illustration: Optional Product - Arma CNC Tube Bender is compatible with the CNC Tube Notcher.

The acquisition cost for a complete bender system:

Component	Price	Reference
Notcher Kit	$5,000.00 CAD	armaautomotive.com/tools/tubenotcher/
Plasma Torch	$1,000.00 CAD est.	CNC compatible
Metal Frame & Rail	$1,000.00 CAD est.	Local sourced material cost
Assembly & Welding	$1,000.00 CAD est.	Local contractor cost
Air Compressor	$600.00 CAD est.	Local purchase
Computer	$500.00 CAD est.	Windows XP, Mac OSX, Linux with USB
Total	$9,100.00 CAD est.	

Operational cost projections:

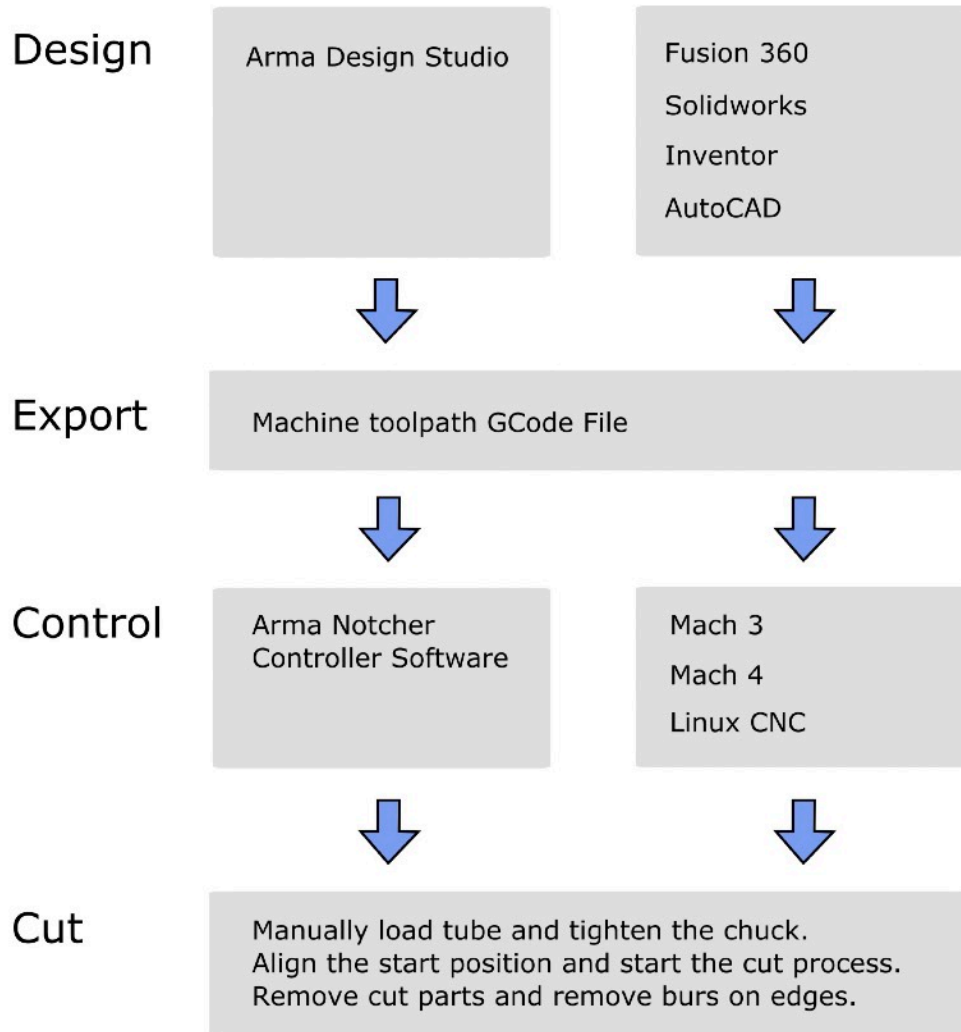| Operation	Time	Cost
Single notch - Human operator: measure + notch + fitment check	8 Minutes est.	1 Notch = $3.33 @ $25/hr
One year human operator	7 hours per day.	12,600 notches = $42,000 / year
Single notch - Arma CNC Tube Notcher: load material + monitor operation.	2 Minutes est.	1 Notch = $0.83 @$25/hr
One year Arma CNC Tube Notcher - Time savings.	1.75 hours per day	12,600 notches = $11,200 / year
One year Arma CNC Tube Notcher - Increased production.	7 hours per day.	50,400 notches = $42,000 / year
Yearly productivity comparison.	4X Gain.	$30,800 Savings or 37,800 more notches per year.
Return of capital @1 hour per day	45 minutes per day saved	2 Years to return.
Return of capital @2 hours per day	1.5 hours per day saved	1 year to return.
Return of capital @3 hours per day	2.25 hours per day saved	8.6 Months to return.
Return of capital @4 hours per day	3 hours per day saved	3.1 Months to return.

Workflow

Design	Arma Design Studio	Fusion 360 Solidworks Inventor AutoCAD
	⬇	⬇
Export	Machine toolpath GCode File	
	⬇	⬇
Control	Arma Notcher Controller Software	Mach 3 Mach 4 Linux CNC
	⬇	⬇
Cut	Manually load tube and tighten the chuck. Align the start position and start the cut process. Remove cut parts and remove burs on edges.	

Illustration: Options for software compatible with the notcher workflow.

The Arma CNC Tube Notcher can be used with a wide variety of control hardware and design and manufacturing software.

Some hardware options available to control the notcher are software specific and need to be ordered or configured based on your preferred software.

If you do not already have CAD and control software licenses you can use the Arma ADS and control software as they are designed to work in a streamlined workflow.

Kit Contents

Gantry trolly: 1 Piece

The gantry holds the plasma torch head and rolls along the rail length. The torch has a cable that needs to be suspended so that it doesn't catch. A ventilation duct should be added to the torch head to pull out smoke when cutting.
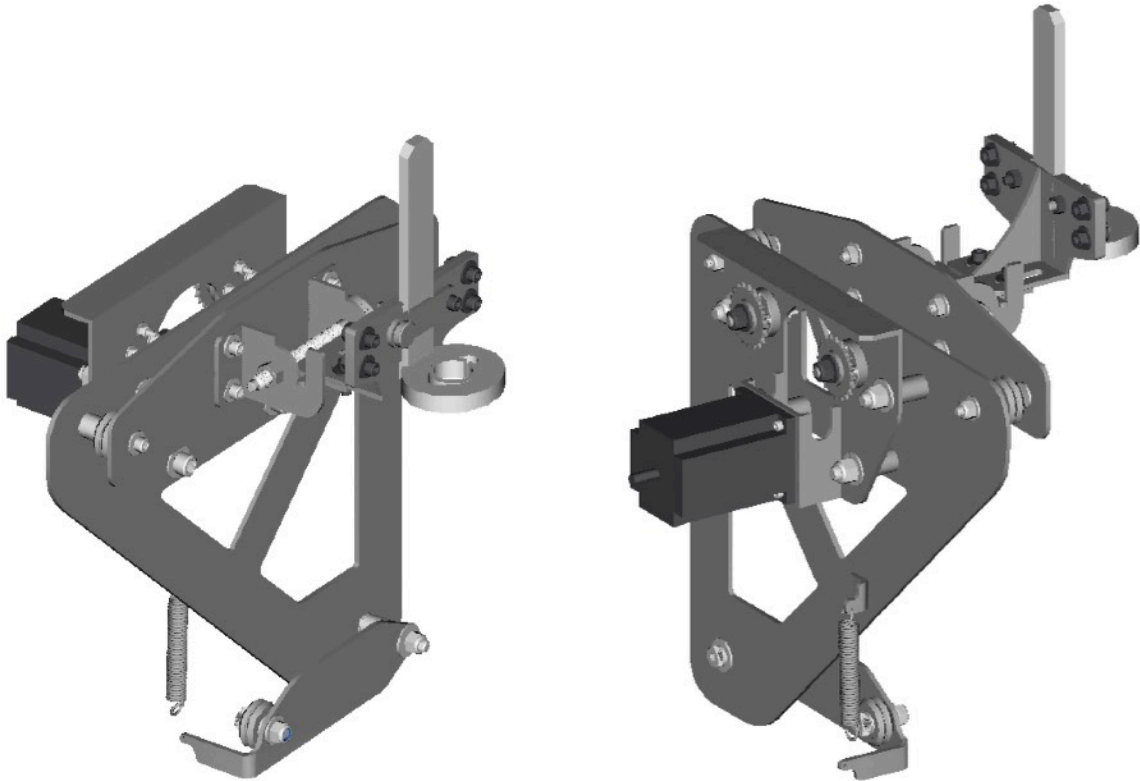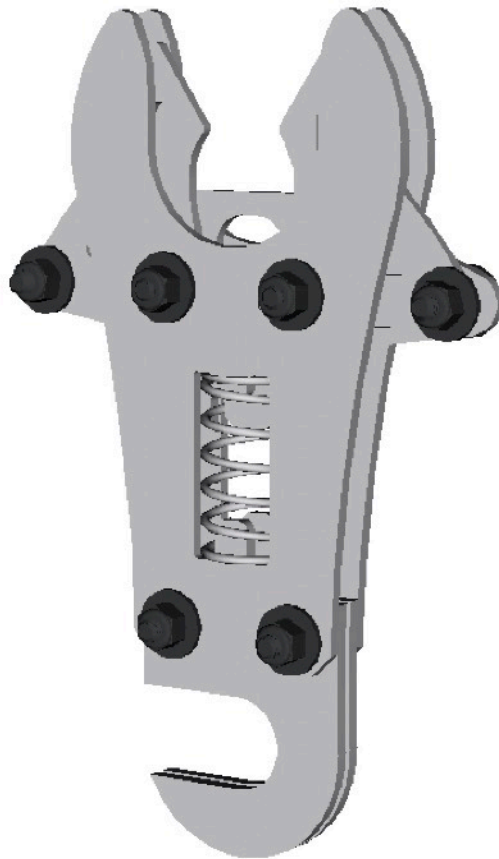
Chuck Assembly: 1 Piece

The chuck assembly bolts to the frame and holds the loaded tubing to be cut as it rotates.
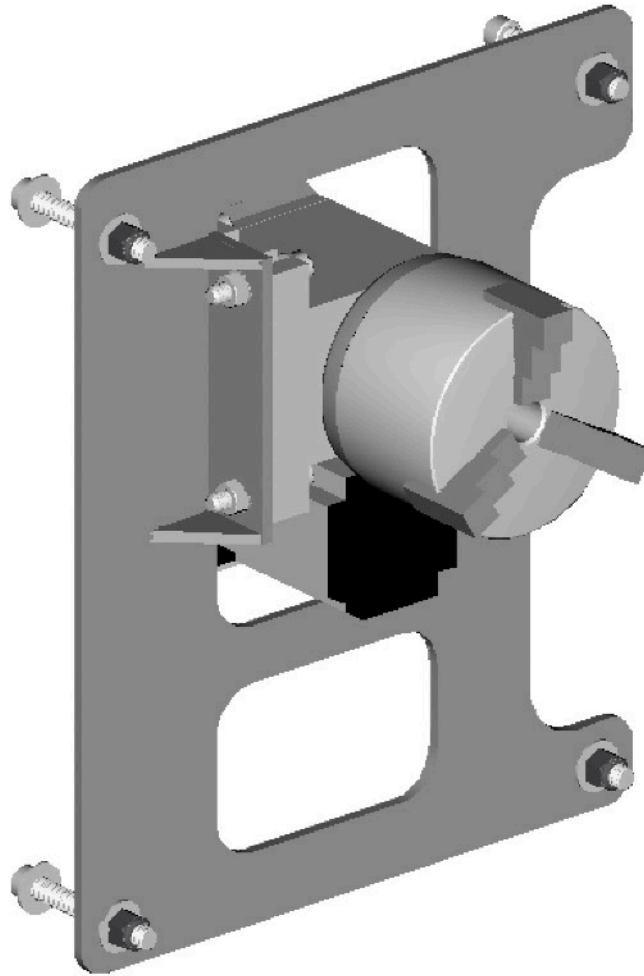
Tube Stays: 8 Pieces

The tube stays hold loaded tubes centred with the chuck so that they can be rotated. The arms can carry a 1" diameter tube up to 2" in diameter. The base should be tack welded to the rail and the upper portion can be replaced or upgraded.

Chain Stay: 2 Pieces

The chain stays hold the chain in place for the gantry trolly to pull against as well as limit switches that shut off the machine before the trolly moves into one of the ends on the machine.
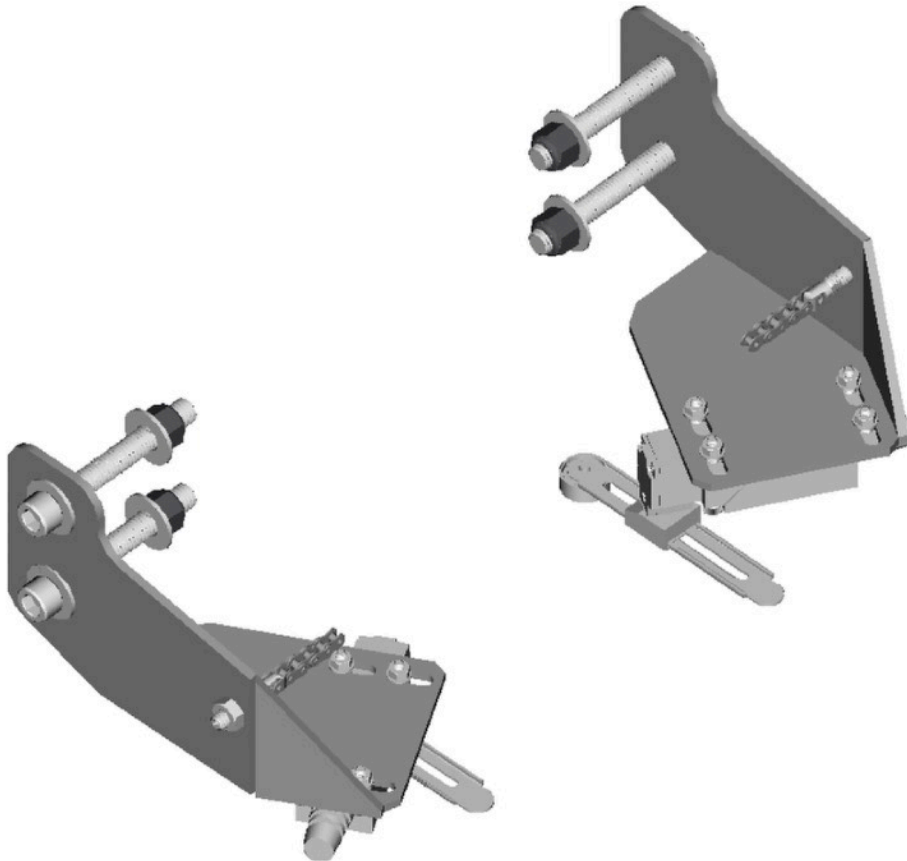
Gantry Tensioner: 3 parts

The gantry tensioner adds stability to the gantry rail and allows for alignment adjustability in case the gantry needs to be straightened.
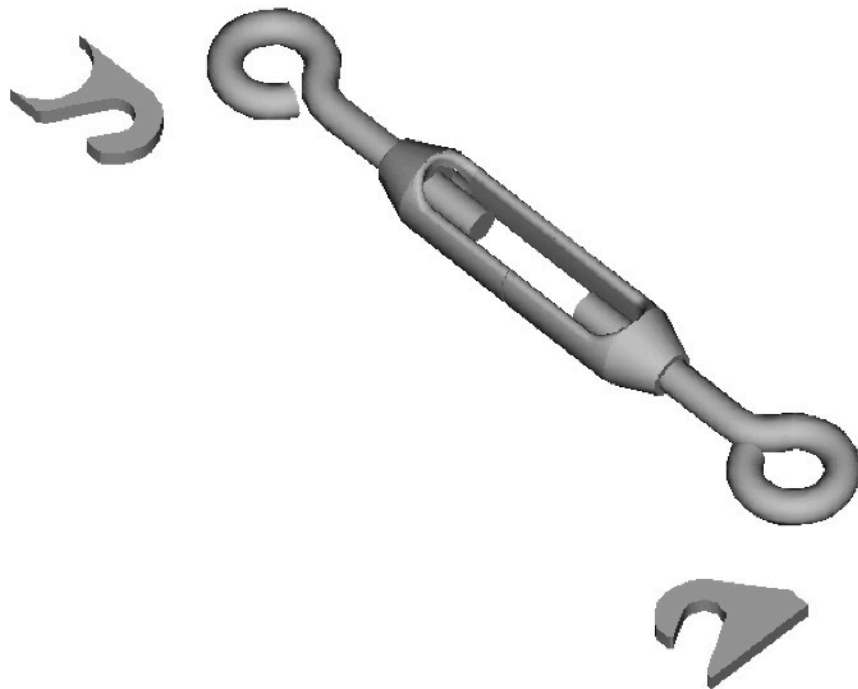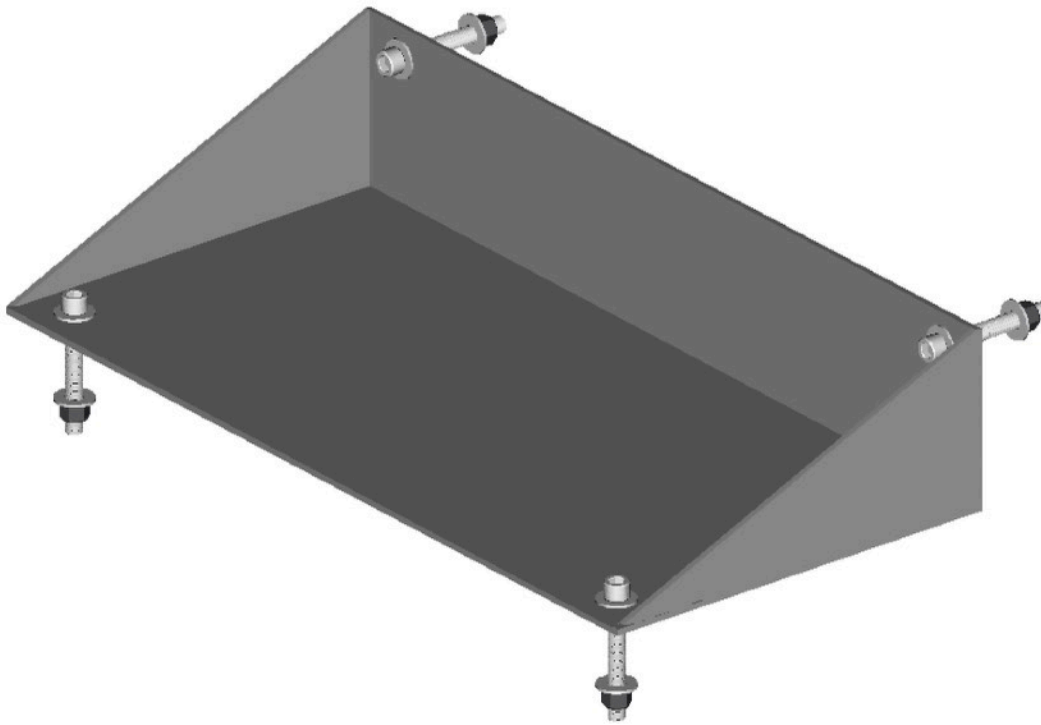
Casters: 4 Pieces

Plates are to be welded to the frame and caster wheels bolted on. Casters allow the notcher to be moved and each leg height adjusted in a fixed position for stable operation.
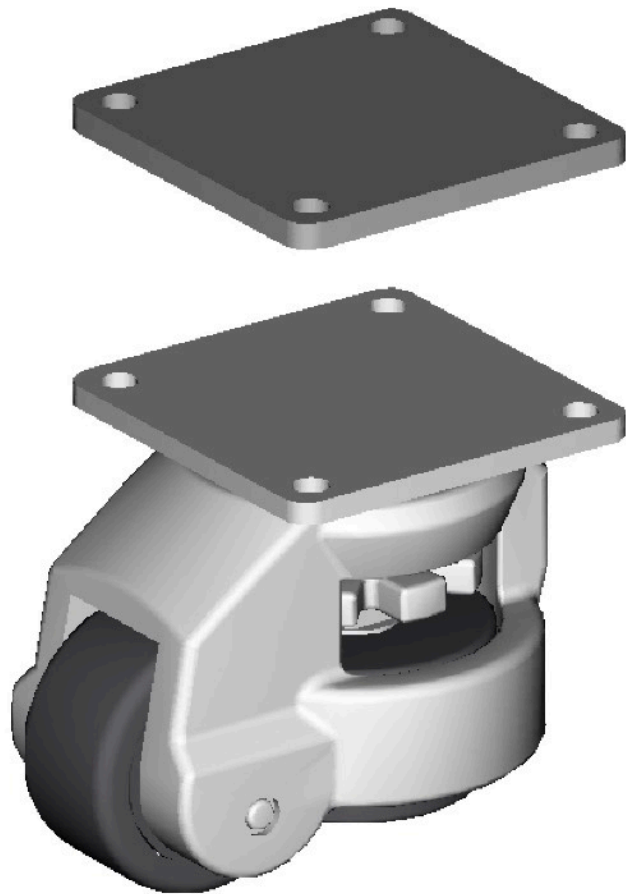
Plasma Torch Tray: 1 Piece

The torch tray mounts to the frame and holds the plasma torch off of the ground so that the torch cable can reach from side to side.

Water System: 1 Set

The water system pumps water from the catch tray through a filter and between the chuck so that it flows through the tube. Water flowing through the tube as it is being cut prevents cut through and material from sticking to the inside of the tube.
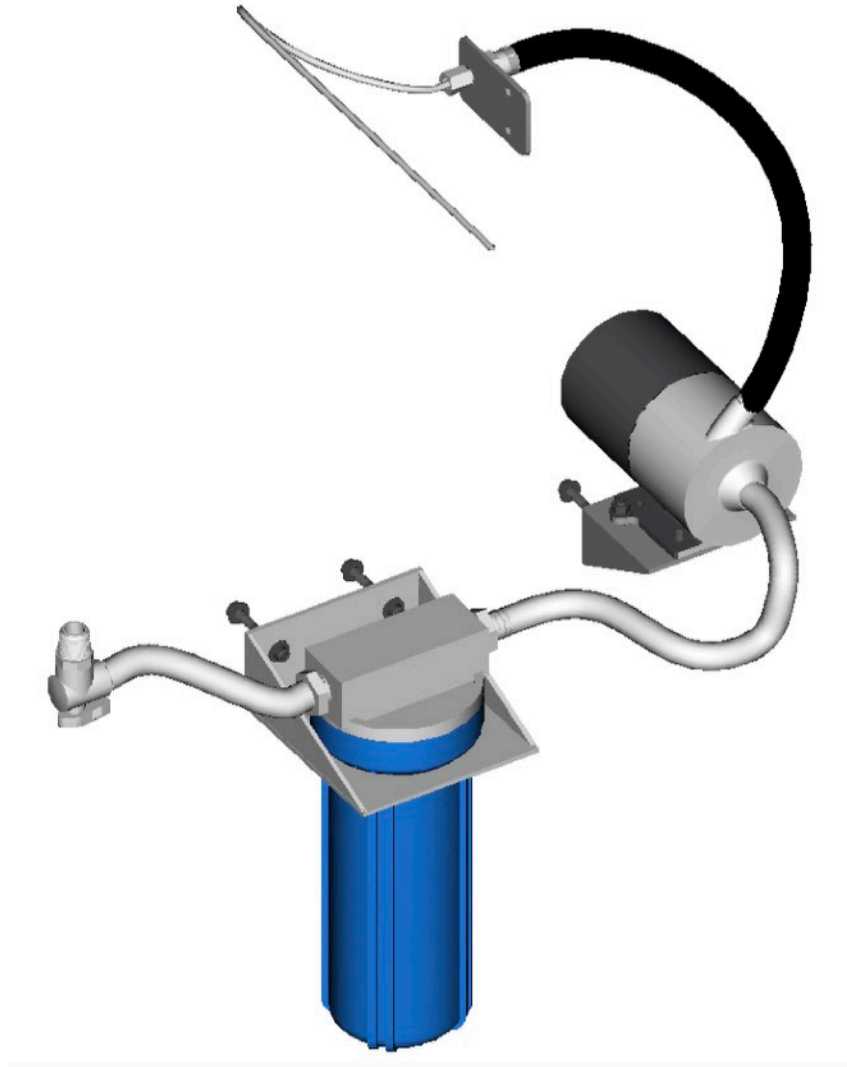
Controller Box: 1 Piece

The control box connects a computer with CAD / CAM instructions and drives the stepper motors, limit switches and torch connectors. The controller is available based on two different hardware options, one with a Mach3 compatible version that works with the Mach3 control software and the other with the Arma Controller compatible system.

Wiring harness: 1 Piece

The wiring connects the control box to two stepper motors and the plasma torch activation signal and limit switches. Optional connectors for a tube sensor and hood vent switch are available on the Arma Controller currently under development.

Chain: 1 Piece.

The chain spans the length of the rail and allows the gantry trolly to advance. The chain needs to be ordered with a length long enough to span the rail which can be longer or shorter than the reference fourteen feet.

Software: ADS (CAD/CAM/Control) Website download.

A copy of ADS and an accompanying hardware controller program is provided for modelling or importing CAD models to generate GCode files which instruct the notcher how to cut parts.

Updates to the software will be available from the Arma Automotive Inc. website.

Additional Required Hardware

Steel Tubing:
6X 168 Inch length 1.75" x 1.75" 0.064" wall thickness square tubing.
4X 36 inch length 1.75" x 1.75" 0.064" wall thickness square tubing.
3X 22 inch length 1.75" x 1.75" 0.064" wall thickness square tubing.
4X 28 inch length 1.75" x 1.75" 0.064" wall thickness square tubing.
12X 4.125 inch length 1.75" x 1.75" 0.064" wall thickness square tubing.
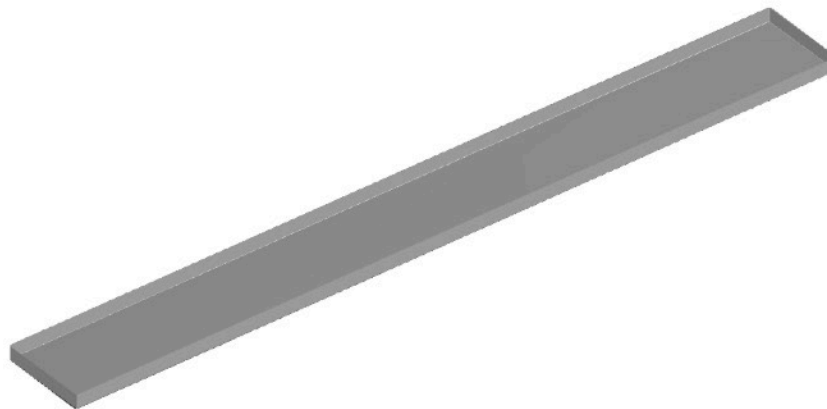2 Pieces 14 feet length 1" x 1" L channel mild steel.
8x 5 inch 1" OD 0.095 Wall mild steel tubing.
1x 156" Length 1" OD 0.095" Wall mild steel tubing.

Water Trough:

A water trough catches water as it runs out the end of the tube so that it can be collected and pumped again.

Plasma Torch:

A customer supplied plasma torch is required for cutting. A torch with a remote activation switch is recommended so that the control electronics can start and stop cuts during operation. If your plasma torch does not have a remote activation switch a relay circuit will be required.
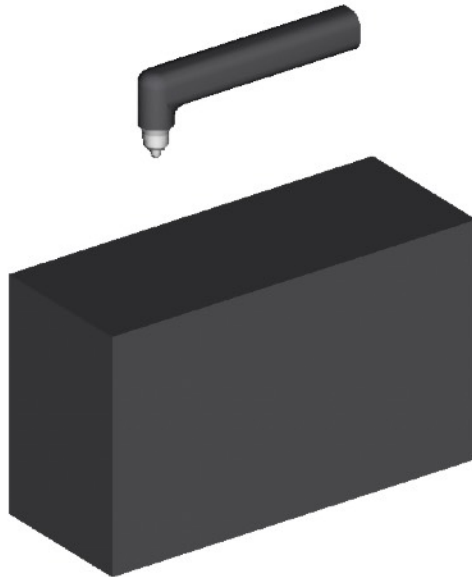
Air Compressor: The plasma torch will require a source of compressed air. The torch will have a minimum requirement.

Power Outlets: The plasma torch will require a 220v receptacle with enough capacity to operate the torch. 40 Amps is the reference value. The control electronics require a 110v receptacle with a maximum draw of 150 watts.

Computer: Capable of running Windows XP, Mac OSX, Linux with a USB port.

Ventilation: Adequate ventilation is required near the plasma torch as fumes are produced during cutting.

Welder: A welder is required for the assembly stage of the installation.

Safety Warning

Eye Protection

When operating the CNC Tube Notcher ensure that anyone in line of sight to the plasma torch arc wear protective eye wear. The bright light and flying ambers can cause eye damage without adequate protection.

Gloves

When loading and unloading metal tubing and piping from the notcher wear protective gloves, shoes and clothing as metals can be heavy with sharp edges and can cause injury if handled improperly.
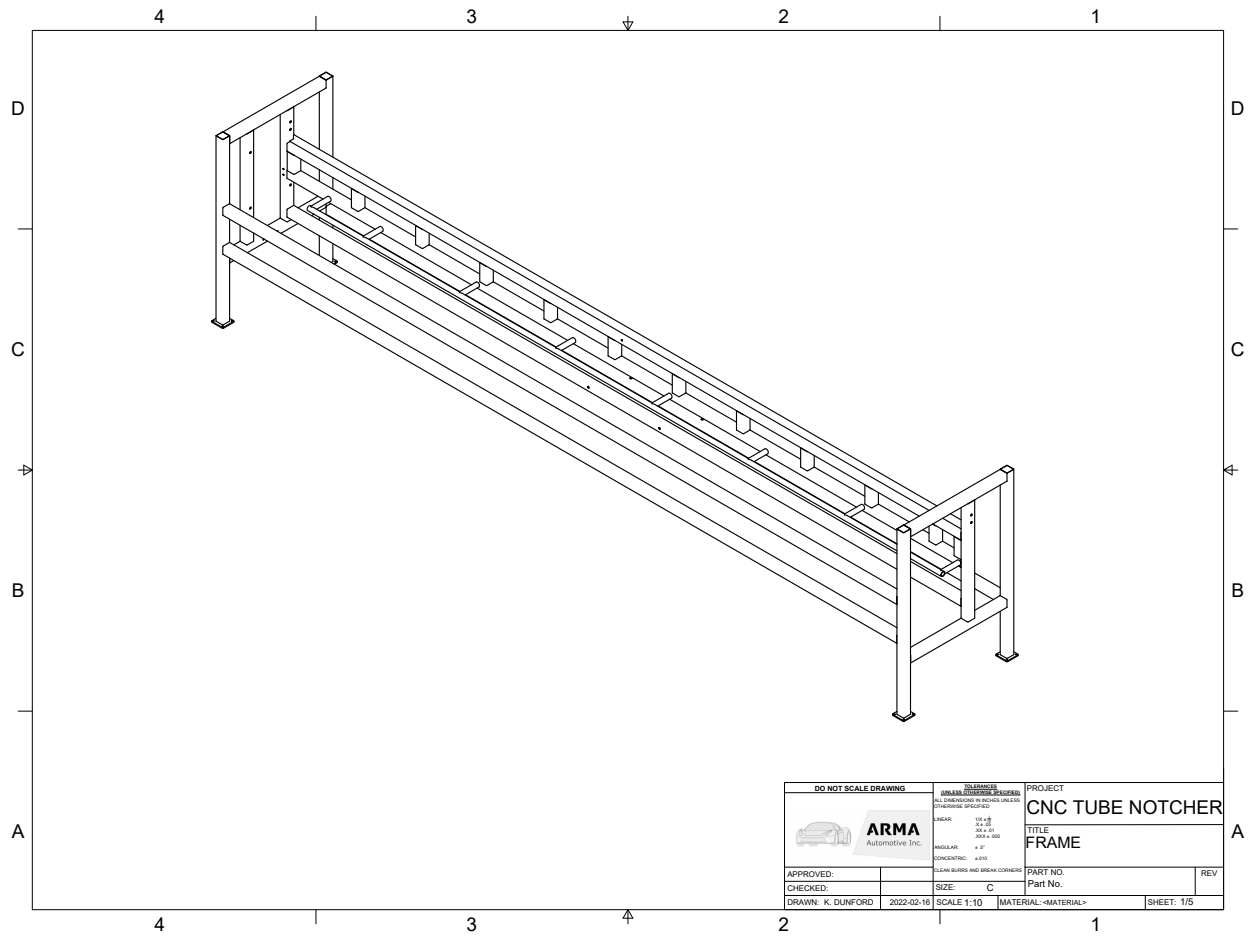
Electrical

Ensure that adequate power is available to the plasma torch and that the working environment is dry with adequate ventilation free from flammable gasses and fumes.
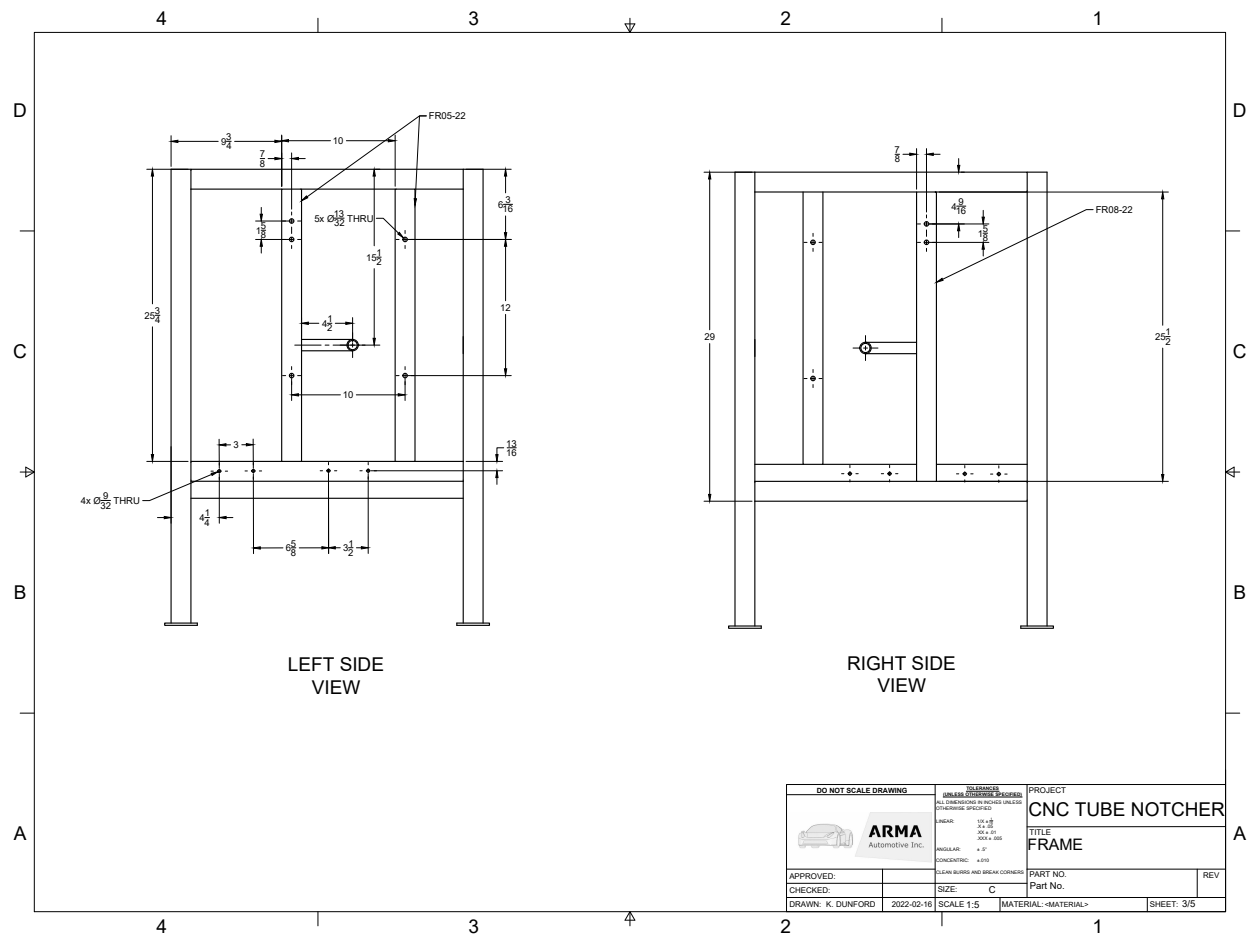
Water

The Arma Tube Notcher uses circulating water pumped through the length of tubing to be cut to cool and prevent cut through on the opposite side. Ensure that there are no water leaks or electrical wires in the water system.
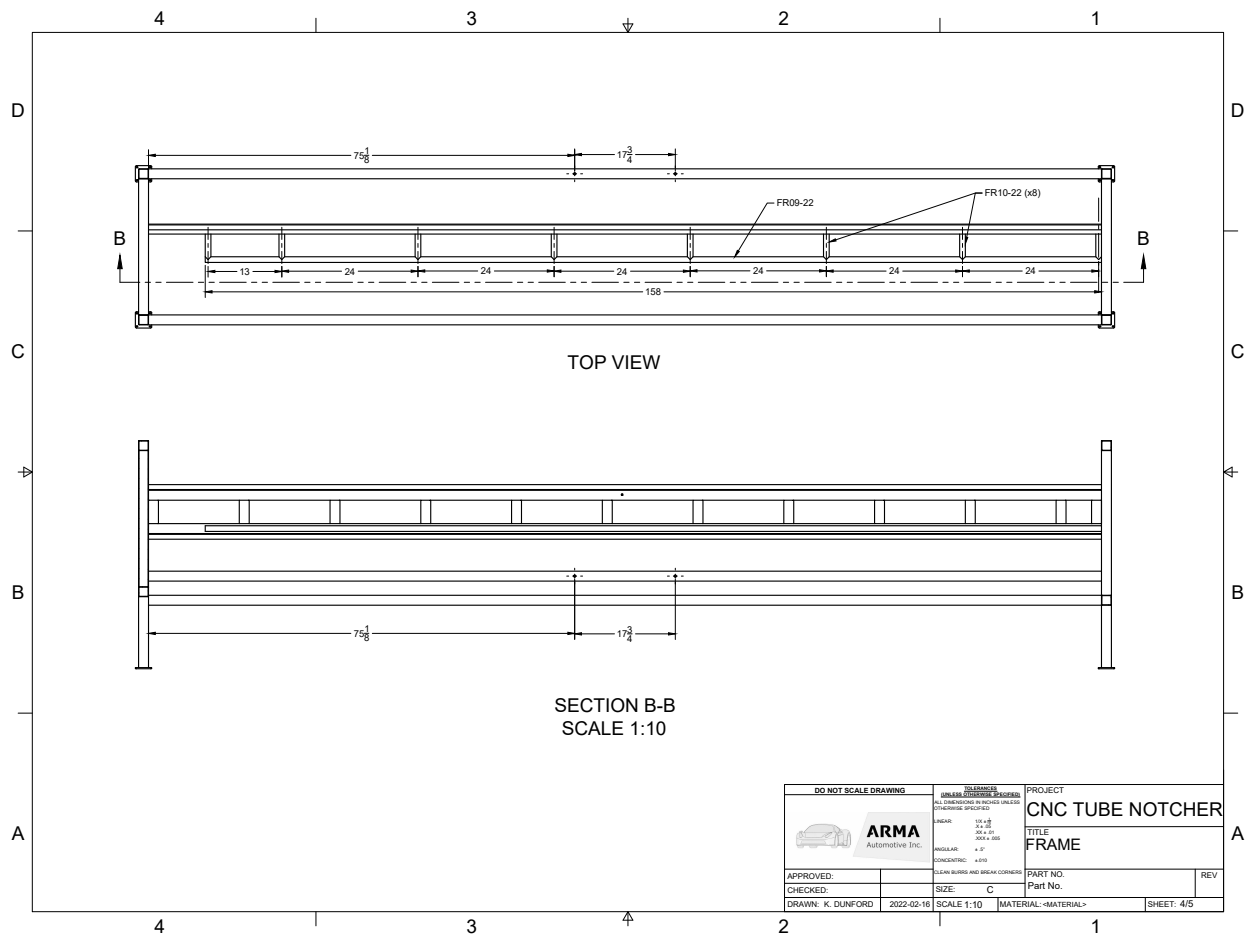
Assembly Instructions

Cut the mild steel square tube with a size of 1.75" x 1.75" to the dimensions illustrated in the following drawings. Larger scale versions are available on request.


DO NOT SCALE DRAWING		TOLERANCES (UNLESS OTHERWISE SPECIFIED) ALL DIMENSIONS IN INCHES UNLESS OTHERWISE SPECIFIED	PROJECT CNC TUBE NOTCHER	
	ARMA Automotive Inc.	LINEAR: 1/X ± 1/8 .X ± .03 .XX ± .01 .XXX ± .005 ANGULAR: ± .5° CONCENTRIC: ± .010	TITLE FRAME	
APPROVED:		CLEAN BURRS AND BREAK CORNERS	PART NO.	REV
CHECKED:			Part No.	
DRAWN: K. DUNFORD	2022-02-16	SIZE: C SCALE 1:10 MATERIAL:<MATERIAL>		SHEET: 1/5

FRONT VIEW

SECTION C-C
SCALE 1:15

DETAIL A
SCALE 1" = 0'-6"

FR01-22 (x4)
FR04-22 (x4)
FR13-22
FR03-22
FR12-22
FR02-22 (x12)
FR02-22

$4\frac{1}{2}$
8
(168)
$171\frac{1}{2}$
$7\frac{3}{4}$
$17\frac{3}{8}$
23
$27\frac{1}{4}$
10X $14\frac{7}{16}$
$(4\frac{1}{8})$
$(9\frac{5}{8})$

REVISIONS

REV	DESCRIPTION	NAME	DATE

DO NOT SCALE DRAWING

TOLERANCES
(UNLESS OTHERWISE SPECIFIED)
ALL DIMENSIONS IN INCHES UNLESS
OTHERWISE SPECIFIED:

LINEAR:
1/X ± $\frac{1}{8}$
.X ± .03
.XX ± .01
.XXX ± .005

ANGULAR: ± .5°

CONCENTRIC: ±.010

CLEAN BURRS AND BREAK CORNERS

ARMA
Automotive Inc.

PROJECT
CNC TUBE NOTCHER

TITLE
FRAME

PART NO.
Part No.

REV

APPROVED:		PART NO. Part No.	REV
CHECKED:		SIZE: C	
DRAWN: K. DUNFORD	2022-02-16	SCALE 1:30	MATERIAL:<MATERIAL>	SHEET: 2/5

LEFT SIDE
VIEW

RIGHT SIDE
VIEW

FR05-22

5x Ø13/32 THRU

4x Ø9/32 THRU

FR08-22

DO NOT SCALE DRAWING

TOLERANCES
(UNLESS OTHERWISE SPECIFIED)
ALL DIMENSIONS IN INCHES UNLESS
OTHERWISE SPECIFIED:

LINEAR: 1/X x .1/8
            .X x .03
            .XX x .01
            .XXX x .005
ANGULAR: ± .5°
CONCENTRIC: ±.010
CLEAN BURRS AND BREAK CORNERS

PROJECT
CNC TUBE NOTCHER

TITLE
FRAME

ARMA
Automotive Inc.

APPROVED:

CHECKED:

DRAWN: K. DUNFORD   2022-02-16

PART NO.
Part No.

REV

SIZE: C

SCALE 1:5   MATERIAL:<MATERIAL>   SHEET: 3/5

TOP VIEW

$75\frac{1}{8}$ $17\frac{3}{4}$

FR09-22 FR10-22 (x8)

13 24 24 24 24 24 24

158

B B

SECTION B-B
SCALE 1:10

$75\frac{1}{8}$ $17\frac{3}{4}$

PROJECT
CNC TUBE NOTCHER

TITLE
FRAME

ARMA
Automotive Inc.

APPROVED:
CHECKED:
DRAWN: K. DUNFORD | 2022-02-16

PART NO.
Part No.

REV

SIZE: C

SCALE 1:10 | MATERIAL:<MATERIAL> | SHEET: 4/5

D   D

4x

C   C

FR11-22 (x4)

B   B

$\frac{9}{16}$ $\frac{9}{16}$

DETAIL D
SCALE 1:2

DO NOT SCALE DRAWING	TOLERANCES (UNLESS OTHERWISE SPECIFIED)	PROJECT	
	ALL DIMENSIONS IN INCHES UNLESS OTHERWISE SPECIFIED	CNC TUBE NOTCHER	
ARMA Automotive Inc.	LINEAR: 1/X ± 1/8 .X ± .03 .XX ± .01 .XXX ± .005	TITLE FRAME	
	ANGULAR: ± .5° CONCENTRIC: ±.010		
APPROVED:	CLEAN BURRS AND BREAK CORNERS	PART NO.	REV
CHECKED:		Part No.	
DRAWN: K. DUNFORD 2022-02-16	SIZE: C SCALE 1:30	MATERIAL:<MATERIAL>	SHEET: 5/5

A   A

Casters

Weld each of the four caster plates to the frame and assemble the casters with pictured bolts, washers and nuts.
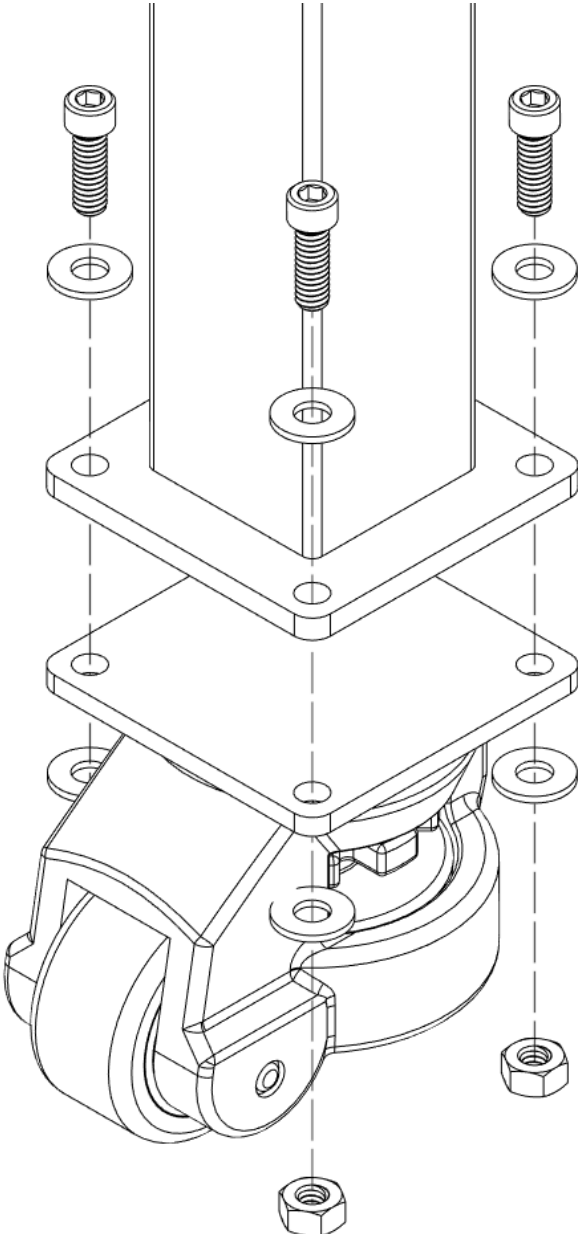
Chuck Assembly

Drill holes through the frame at locations matching the chuck assembly mount holes.

Install the chuck assembly to the frame using bolts, washers and nuts as shown.

Lock washers between the frame and the chuck assembly can be used to align the chuck so that the axis of rotation matches the frame stays.
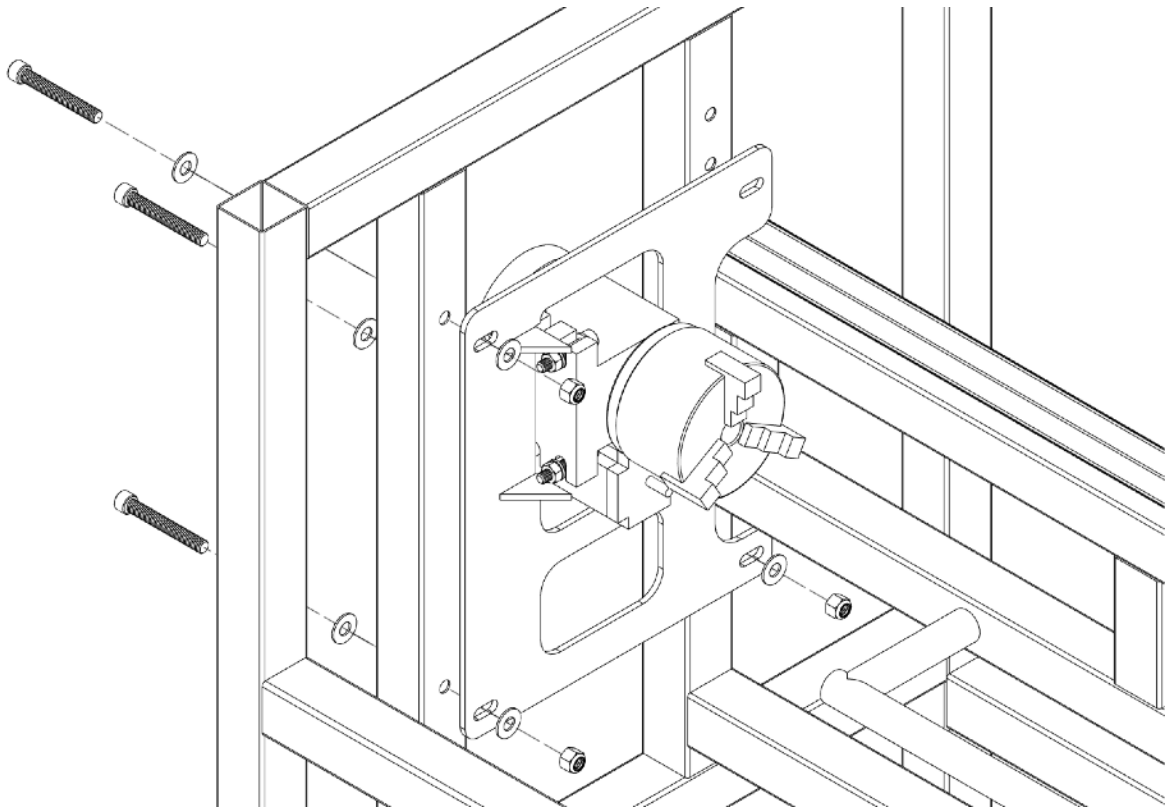
Gantry

Install the gantry to the frame rail and feed the drive chain through the sprockets
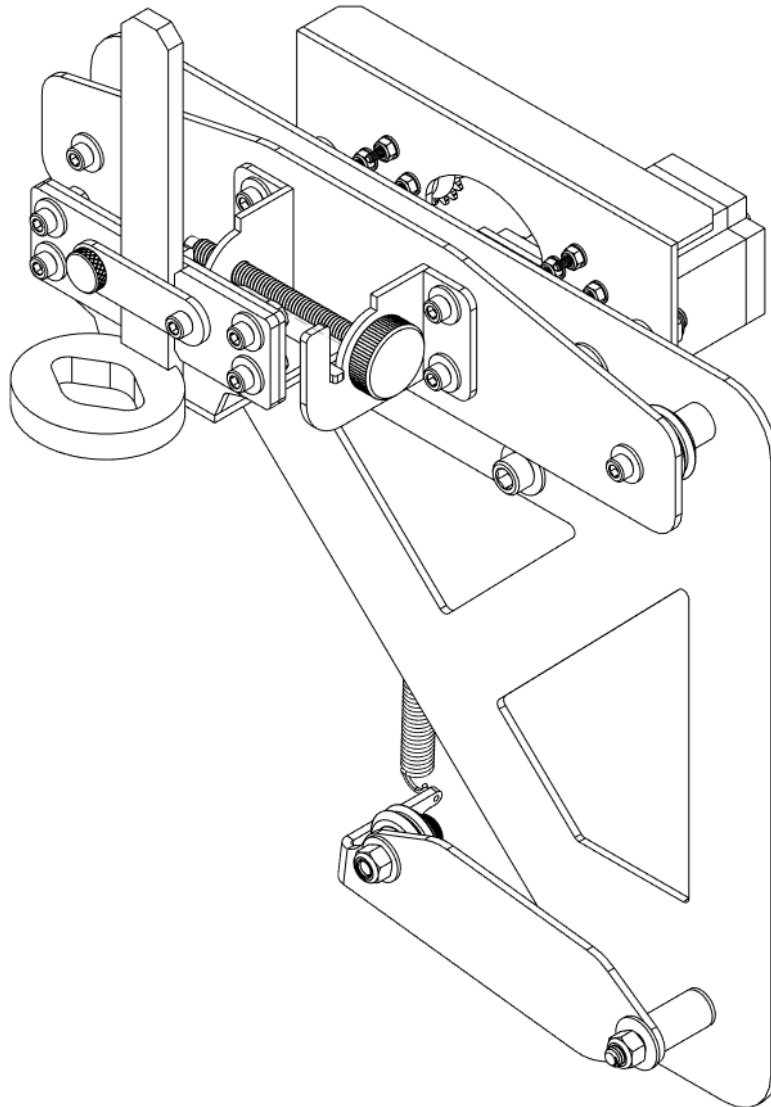
Illustration: Gantry assembly front view.

The gantry sits behind the frame rail resting on two roller bearings on top and one spring loaded bearing on the bottom. The lower bearing arm will need to be pulled down for assembly.
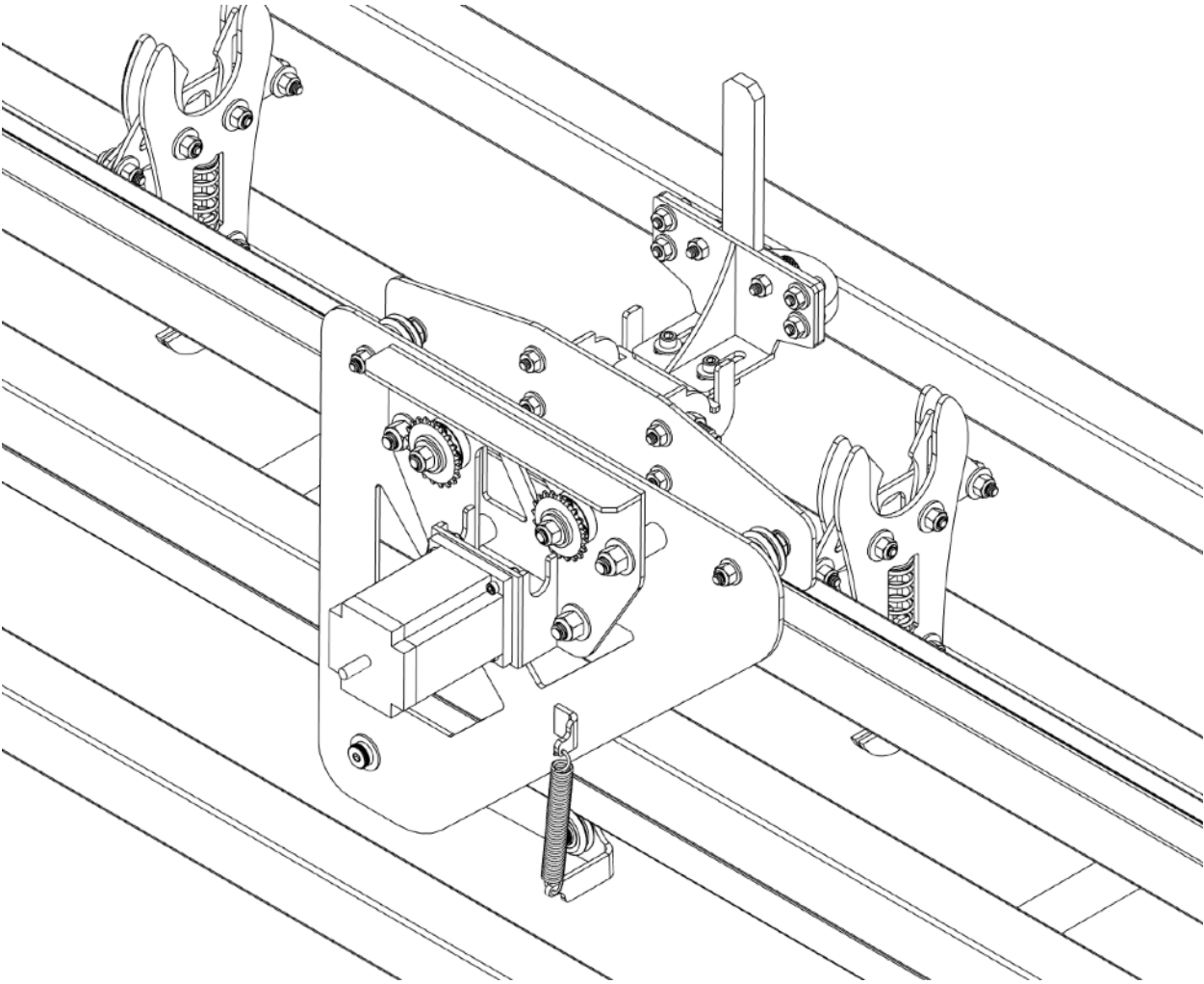
Illustration: Gantry on frame rail rear view.

A spring holds the lower rail bearing against the rail.
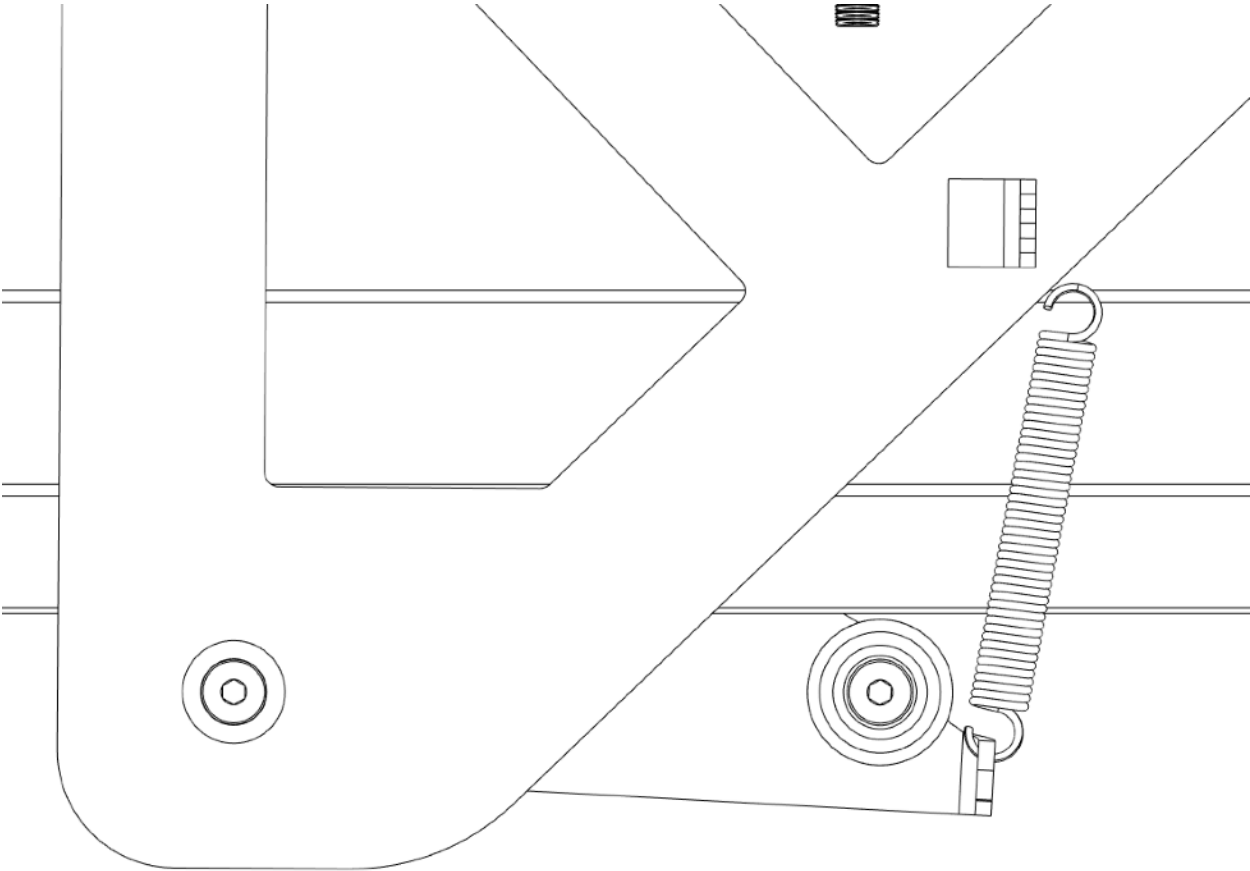
Illustration: Gantry lower bearing arm and spring.

Chain Stays

Drill and assemble the left chain stay and gantry limit switch using the illustrated bolts, washers and nuts to the main frame.
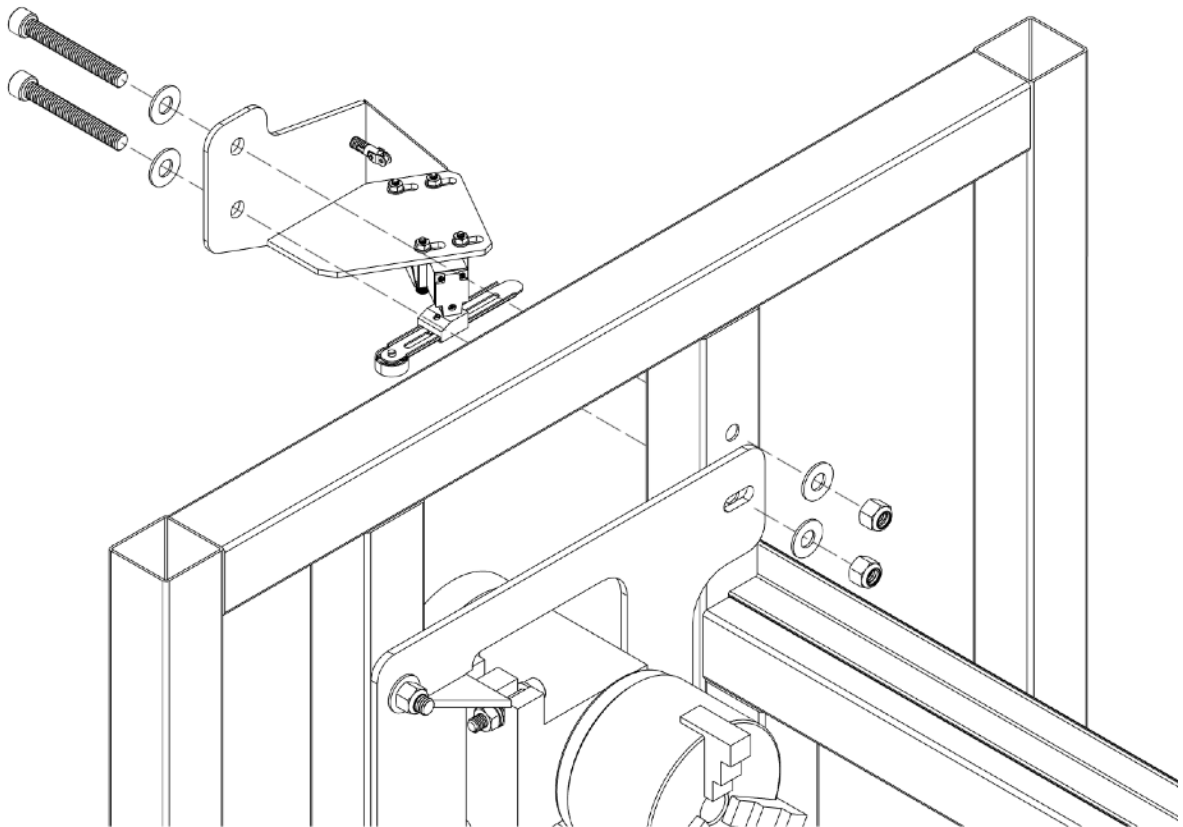
Illustration: Left chain stay bolted to the main frame on the outside.

Drill and assemble the right side chain stay and gantry limit switch using the illustrated bolts, washers and nuts to the main frame.
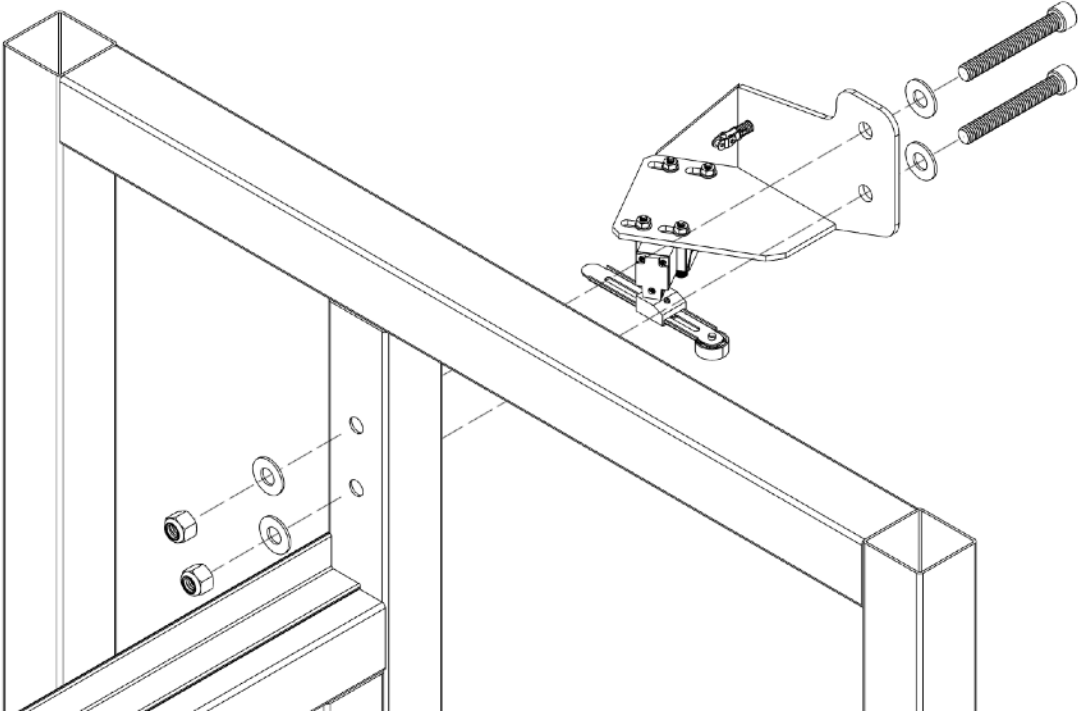
Illustration: Right chain stay bolted to the main frame on the outside.

Steady Rests

Slide on the steady rests to the one inch tube on the main frame. Space the stays equal distance apart from each other and align angles and centre line so they are all positioned along a straight line. Tack weld one or two spots to hold the base of the stays positioned.
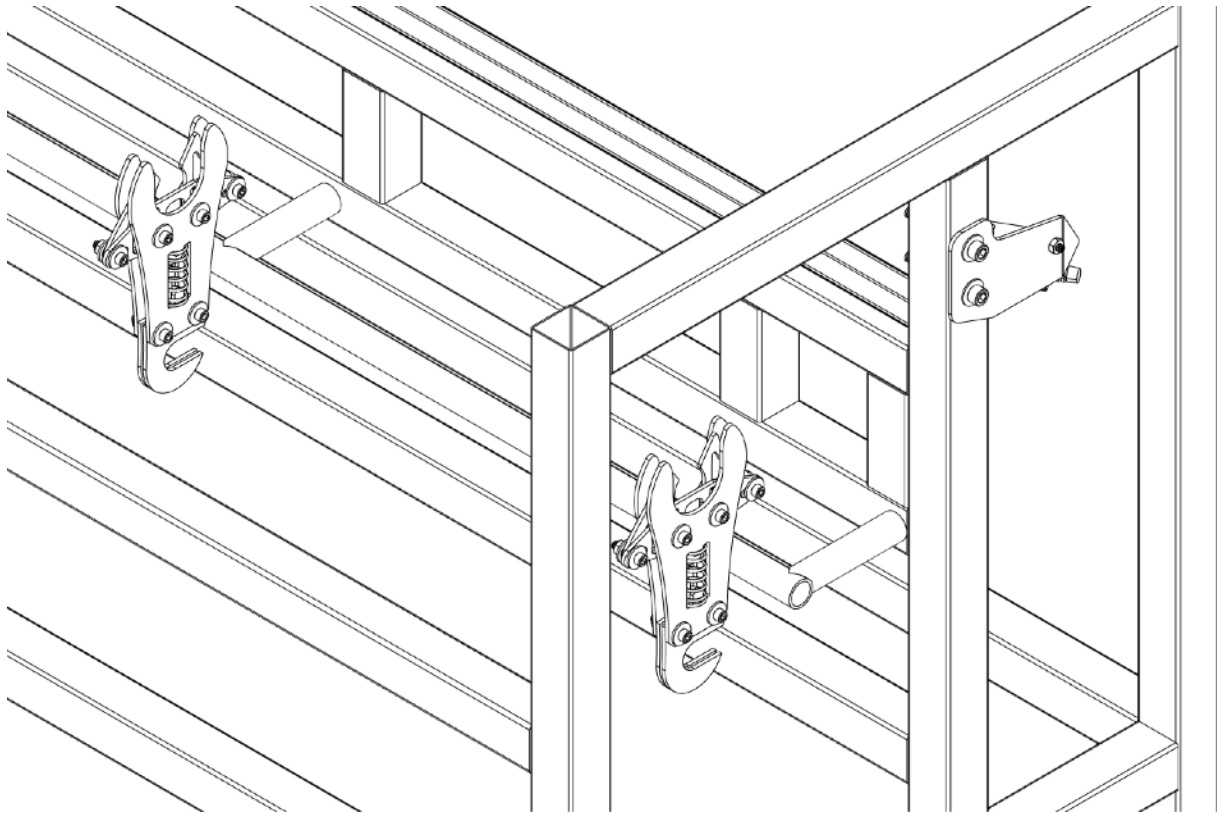
Illustration: Install the stays onto the main frame.
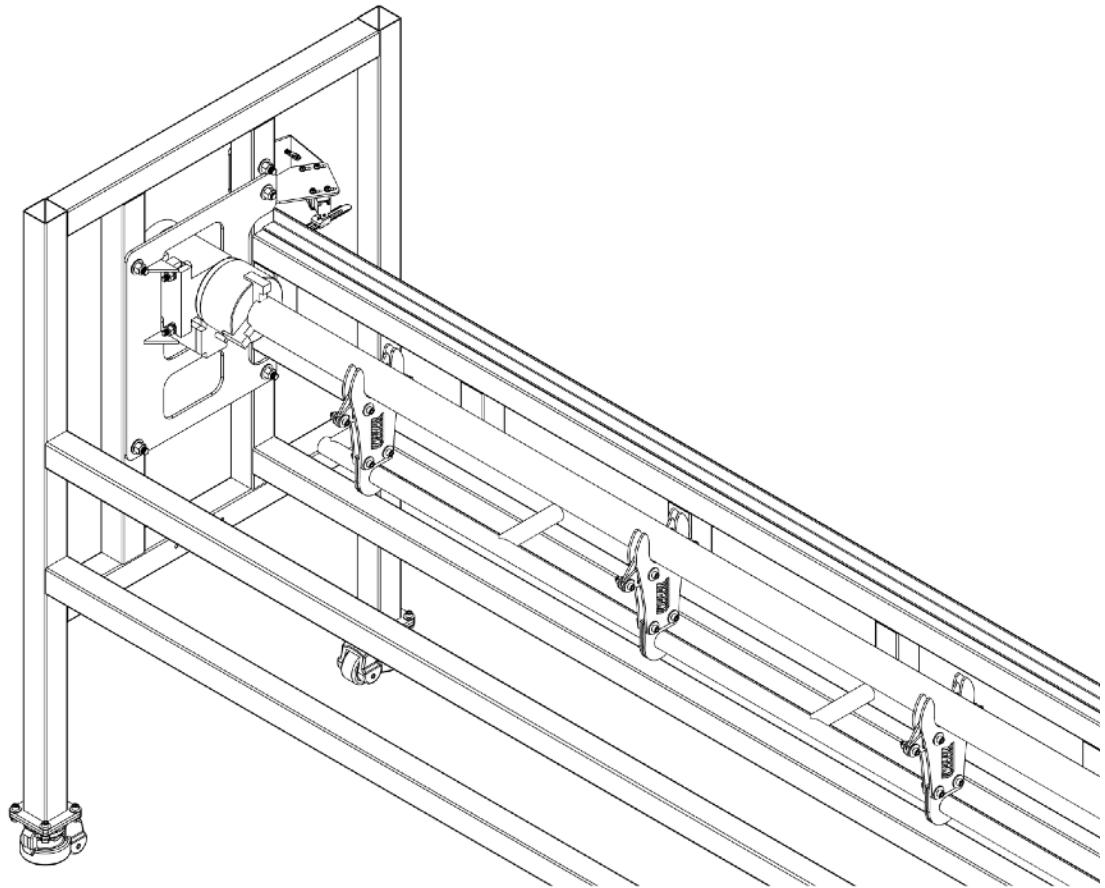
Illustration: Place a tube in the chuck to align the stay angles and positions before welding.

Electrical

Electronics are used to connect a computer to stepper motor drivers which operate the machine as well as activate and deactivate the plasma torch. Several options for electronics are available including widely available Mach 3 control boards that works with the Mach 3 control software.

Arma Controller

Arma Automotive Inc. Is working on control software and hardware for operating the CNC tube notcher with features for operating hood fans and reporting on machine status remotely however this product is currently not finalized and we recommend using Mach 3 as the control software and electronics at this time.

Mach 3 Controller

Mach 3 controllers and stepper motor drivers can be used to operate the Arma CNC Tube Notcher to cut tubes and pipe from GCode generated from ADS or other Cad and Cam software.

The Mach 3 controller connects to a computer through a usb cable, 24v power, torch trigger and ground to the plasma torch, two input switches for the gantry limits and seven wires to each of the two stepper motor drivers.

Mach 3 Stepper driver wiring:
Mach 3 controller: X Pulse -> Stepper driver 1 Signal PUL +.
Mach 3 controller: Ground -> Stepper driver 1 Signal PUL -.
Mach 3 controller: X Dir -> Stepper driver 1 Signal DIR +.
Mach 3 controller: Ground -> Stepper driver 1 Signal Dir DIR -.
Mach 3 controller: 5v -> Stepper driver 1 Signal ENA +.
Mach 3 controller: Ground -> Stepper driver 1 Signal ENA -.

Mach 3 controller: Z Pulse -> Stepper driver 2 Signal PUL +.
Mach 3 controller: Ground -> Stepper driver 2 Signal PUL -.
Mach 3 controller: Z Dir -> Stepper driver 2 Signal DIR +.
Mach 3 controller: Ground -> Stepper driver 2 Signal Dir DIR -.
Mach 3 controller: 5v -> Stepper driver 2 Signal ENA +.
Mach 3 controller: Ground -> Stepper driver 2 Signal ENA -.

Stepper motor wiring:
B- -> Black stepper motor wire.
B+ -> Green stepper motor wire
A- -> Red stepper motor wire.
A+ -> Blue stepper motor wire.
VCC -> 24 V power supply.
GND -> Power supply ground.

Torch Wiring:
Mach 3 controller: OUT 1 terminal to the torch trigger signal pin.
Mach 3 controller: GND terminal to the torch trigger ground pin.

Limit switch Wiring:
Mach 3 controller: IN 1 to the right hand side limit switch pin 1.
Mach 3 controller: 5v to the right hand side limit switch pin 2.
Mach 3 controller: IN 2 to the left hand side limit switch pin 1.
Mach 3 controller: 5v to the left hand side limit switch pin 2.

Notcher Setup

Power

The CNC Tube Notcher requires power to operate the electronics and stepper motors as well as a V220 receptacle for the plasma torch.

Water

Water is used in the tray and pumped through the tube to prevent accumulation of splatter. Be sure that water does not leak near electrical power.

Torch tip replacement

The torch tip will require replacement after use.

Cut tubes to length

If tubes are longer than the maximum supported length of the notcher they will first need to be cut.

Load tubes in machine

Tubes should be placed in the frame stays and chuck before being tightened securely.

Remove cut parts and clean up edges.

After parts are cut they will fall into the water tray. Wait for the machine to stop and carefully remove cut parts with safety gloves.

CAD Modelling with Arma Design Studio
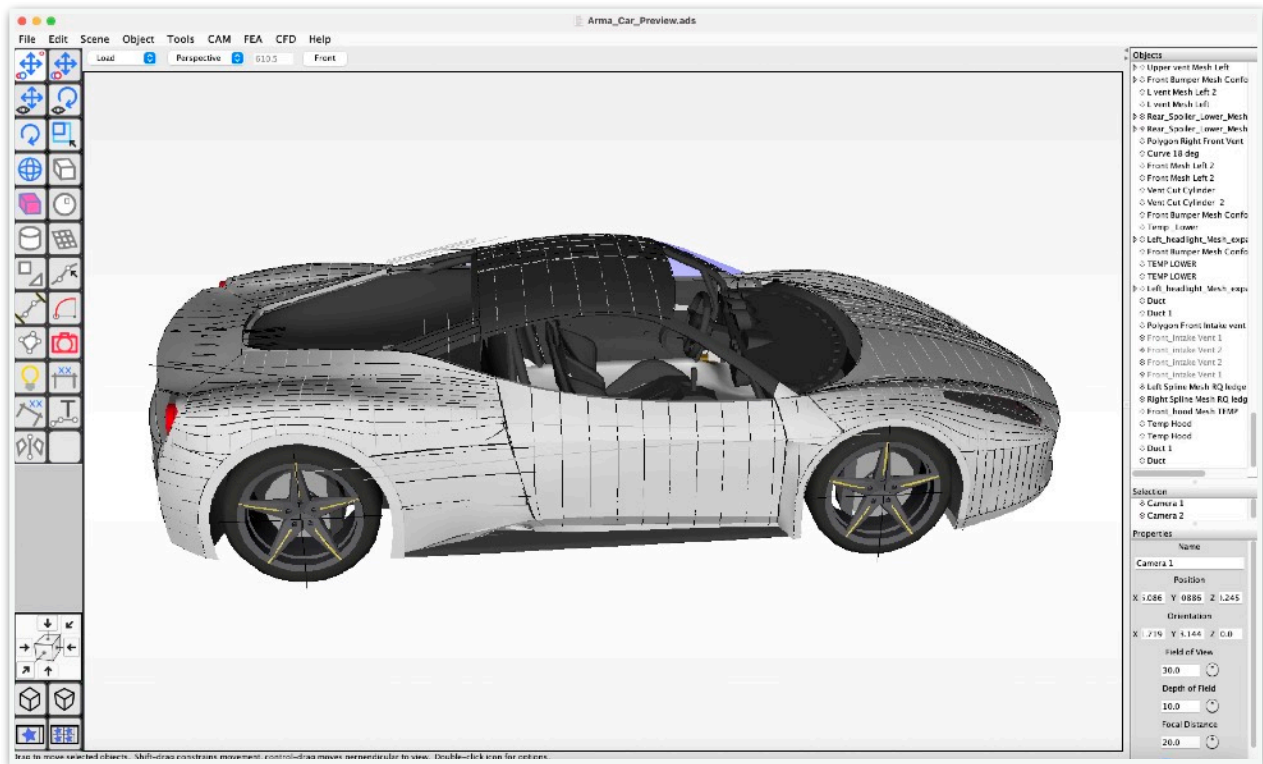
Illustration 6: Arma Design Studio CAD/CAM software application.

Getting started with Arma Design Studio

ADS runs on Windows, Mac OSX and Linux.

Download from: http://armaautomotive.com/build/ads.php

There are download links for Windows and Cross Platform that will run on Windows, MacOSX and Linux with Java.

See the appendix for a tutorial on the basic navigation and operations of ADS.

The version of ADS documented in this manual is 1.1.37 Released Marc 23, 2022.

Windows
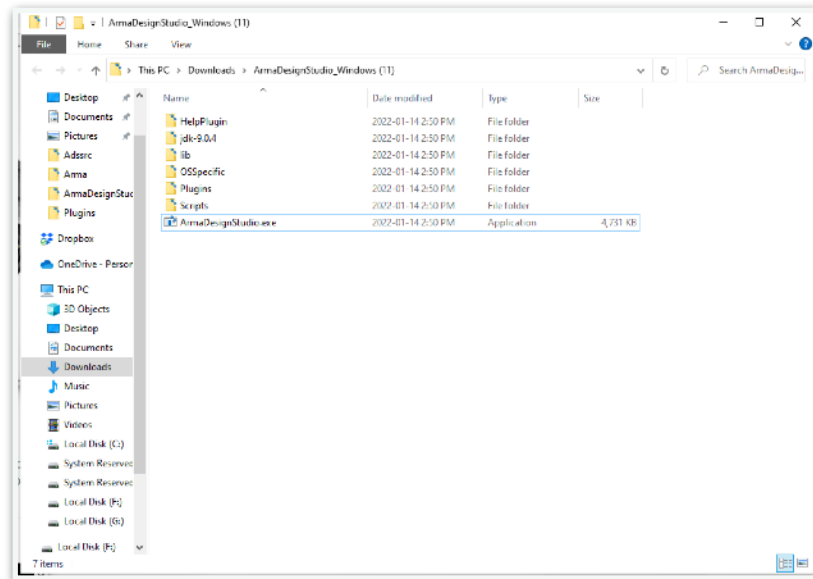
Extract the file contents and double click the ArmaDesignStudio.exe application.
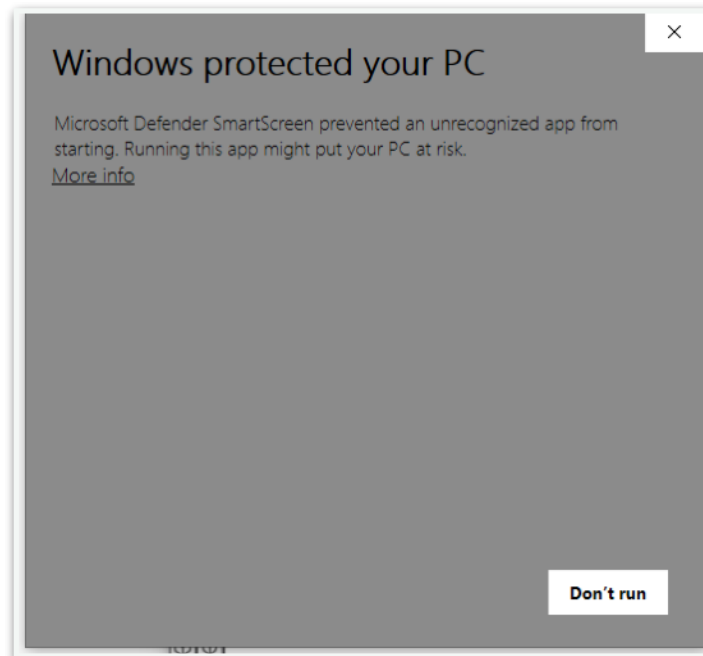
The Windows version is currently not signed so a dialog will appear. Click on the More info link.
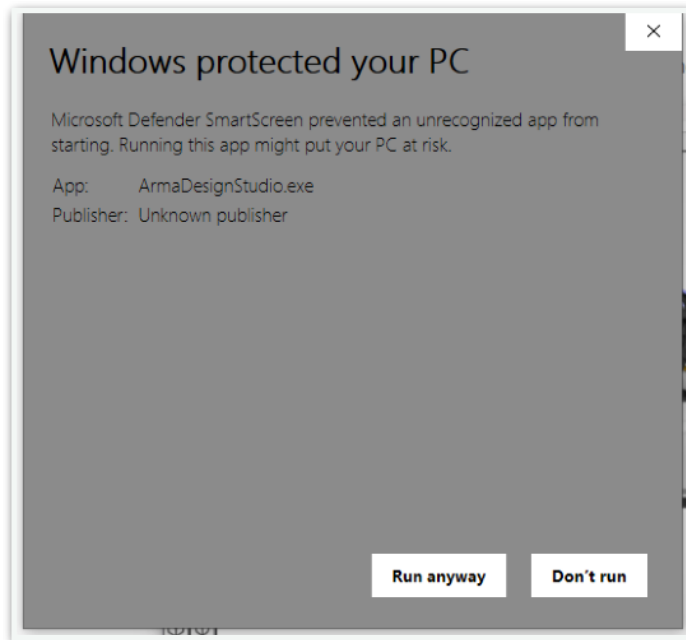
Click on the Run anyway button.

Cross Platform

Download a Java Runtime.
- Oracle links https://www.java.com/en/download/manual.jsp
- Mac M1 based Macs will run with the runtime from Azul: https://www.azul.com/

Extract the zip file and ArmaDesignStudio.jar

In a terminal window navigate to the extracted files Adssrc directory and type the command:

> run.sh

Notch Cut Profile Modelling

Tubes are modelled in Arma Design Studio using the ArcObject which has attributes for tube diameter and wall thickness. Geometric polygonal tubes can also be used but lack certain features.

Notch cuts are modelled on tubes using either a polygon or curve object placed as a children in the object tree list.
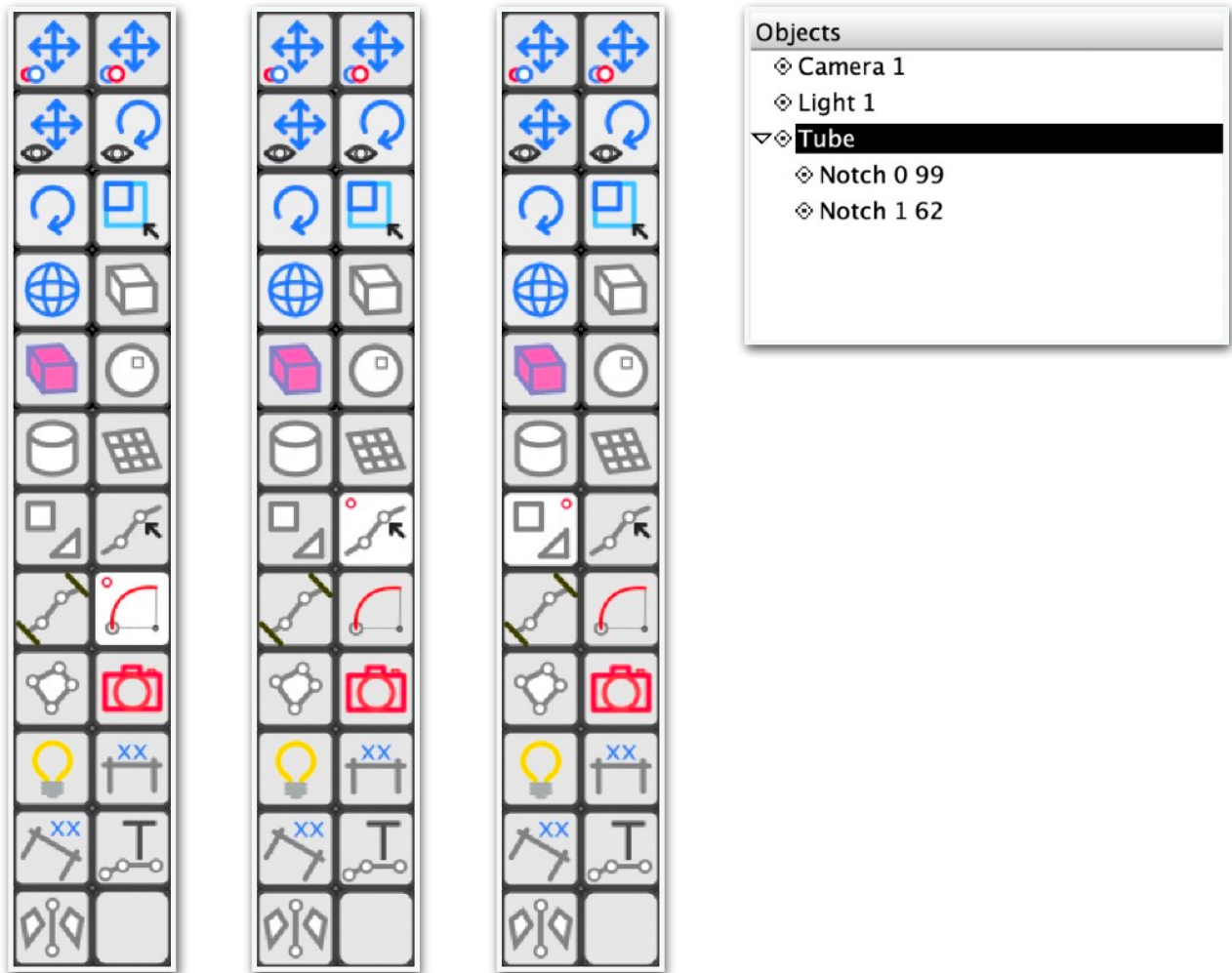
Modelling Tube Structures

To add a tube structure to a project click to select the ArcObject from the tool menu then click on the scene points for the start location and double click to add the end location.

With the arc object selected update the properties Tube Diameter and Tube Wall. The Bend Radius and Min Bend Span apply to parts intended for the Arma CNC Tube Bender and are modelled with arc tube objects with more than two points.
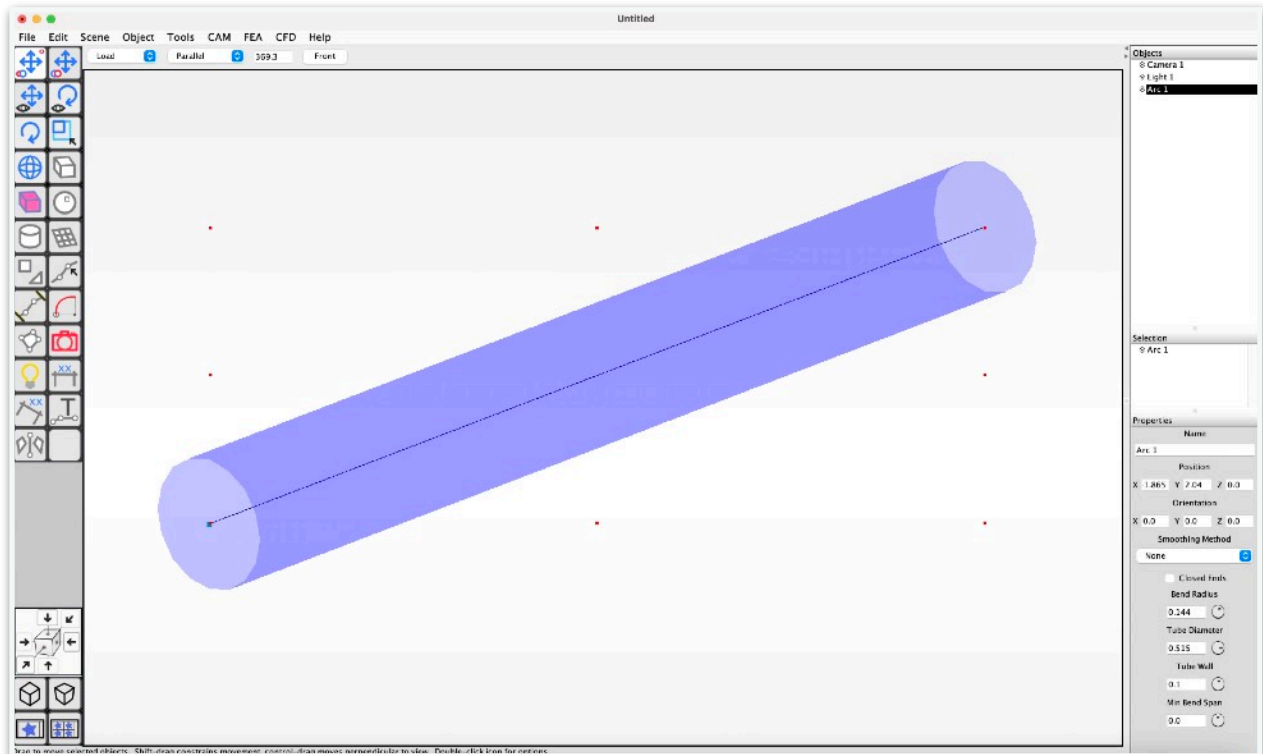
Manual Notch

Manually add notch cut profiles by selecting the curve tool or polygon tool and clicking points on the scene double clicking to end a curve. Selected curve objects can be edited to add / remove and reposition points to the desired location around the tube. In the object tree list drag the notch into the arc tube object as a child. This will cause the notch to be applied to the tube when exporting GCode.

For a detailed explanation of how to add and edit arc objects polygon and curves to the scene see the appendix section on getting started with Arma Design Studio.
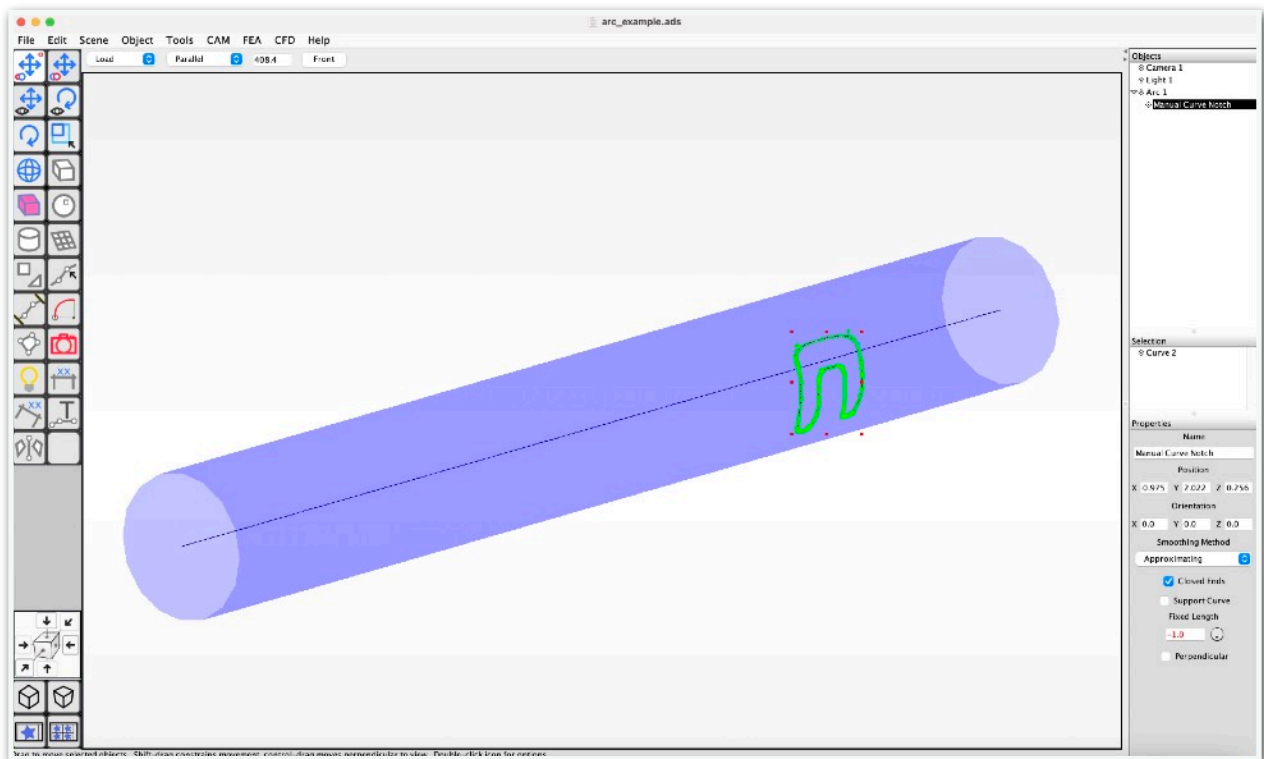
Notch Intersections

Intersecting notch cut profiles can be added by selecting the Auto Notch Tube Intersections under the Tools menu.
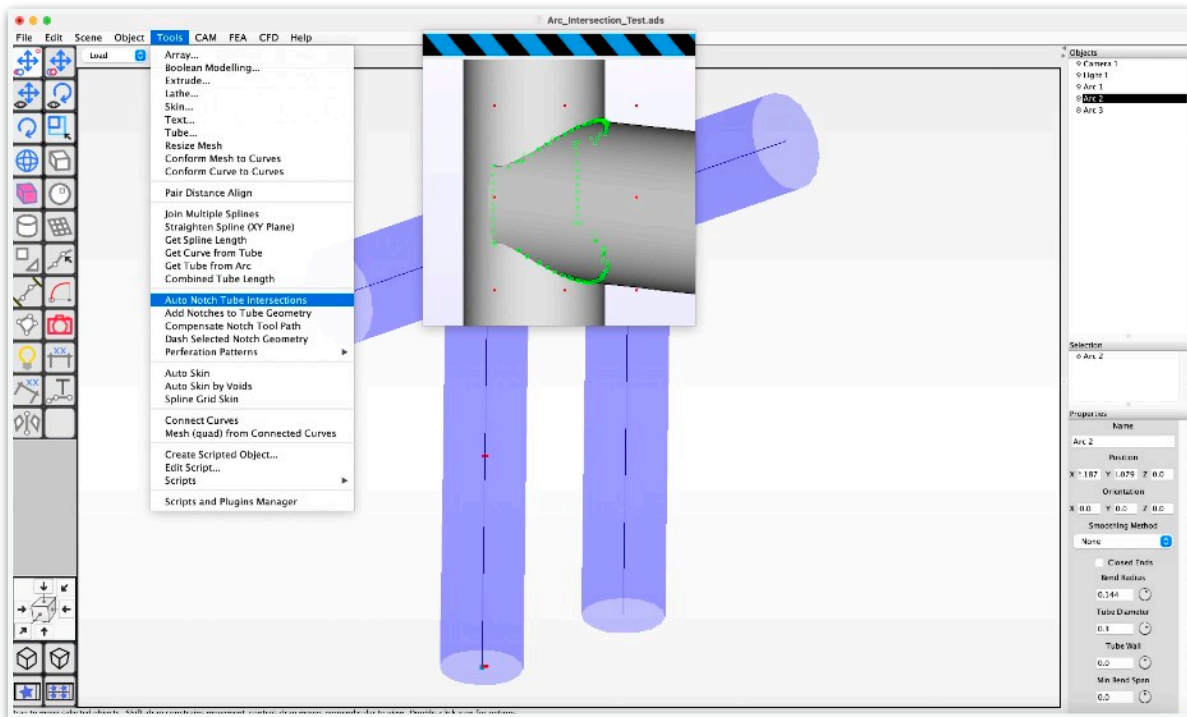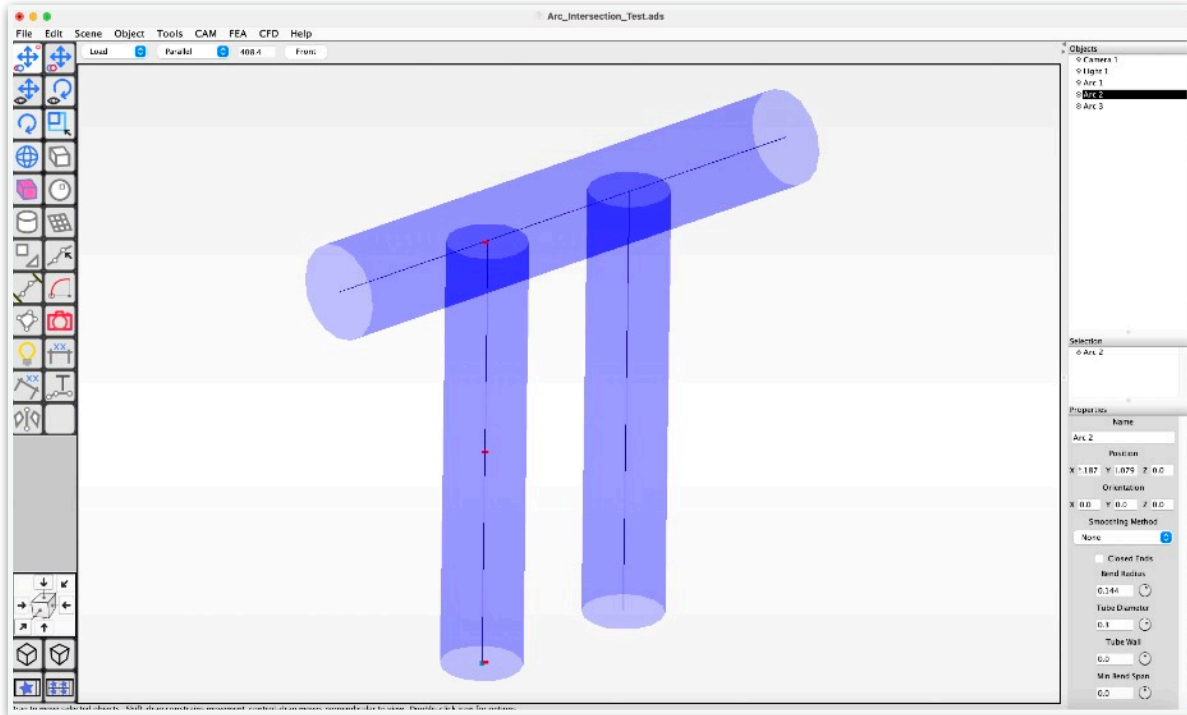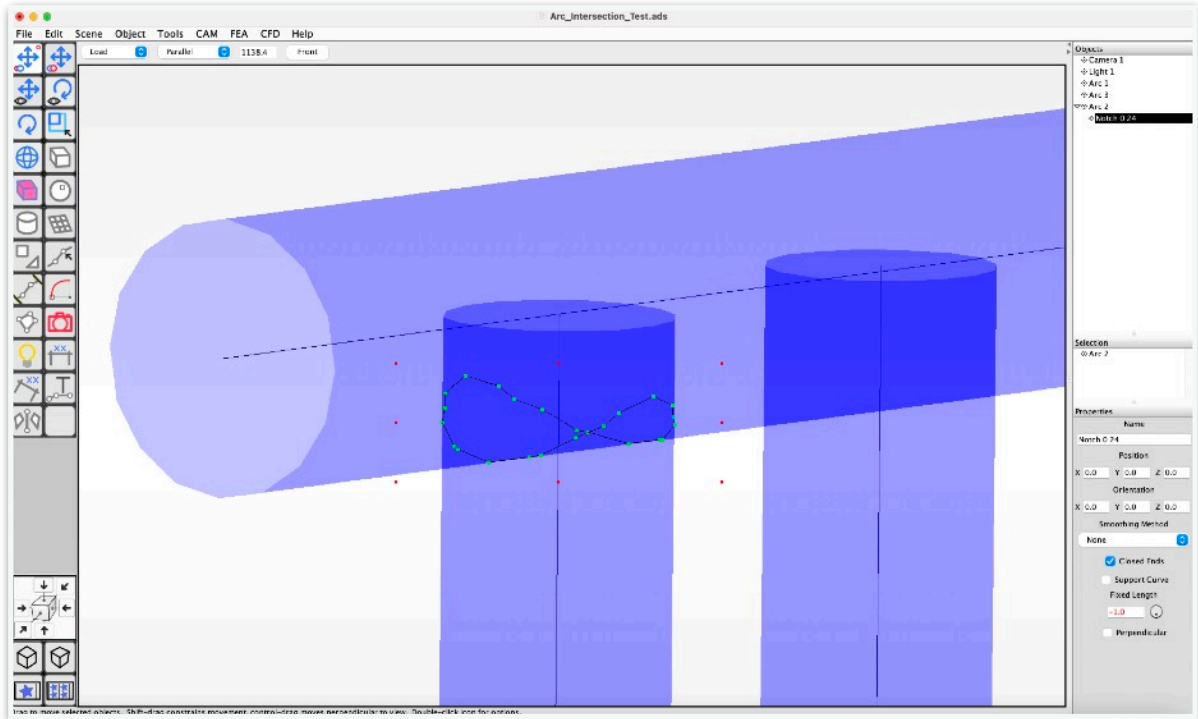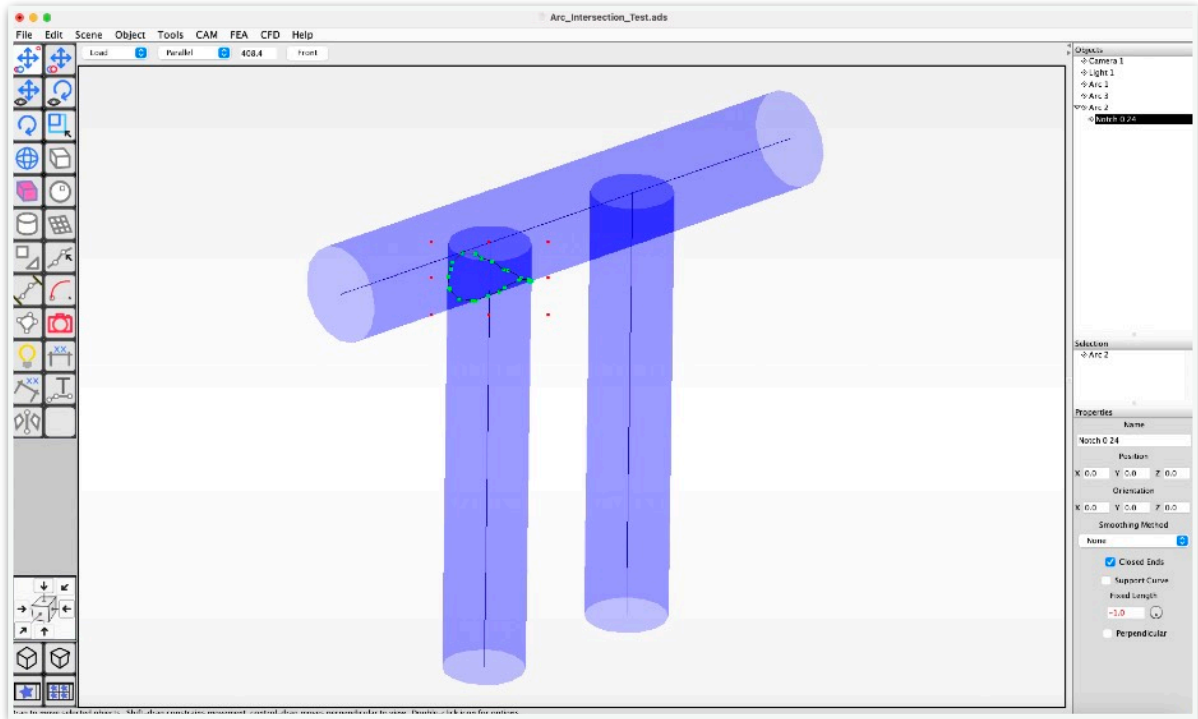
Tabs and Slots

Select a notch curve and select the Tools menu, Tube Notching, Add Tabs to Notch item. This will add tabs to the notch and add slots to the intersecting arc tube. Currently the slots need to be checked for possible adjustment as the tube wall thickness is not factored into the size of the slot yet.
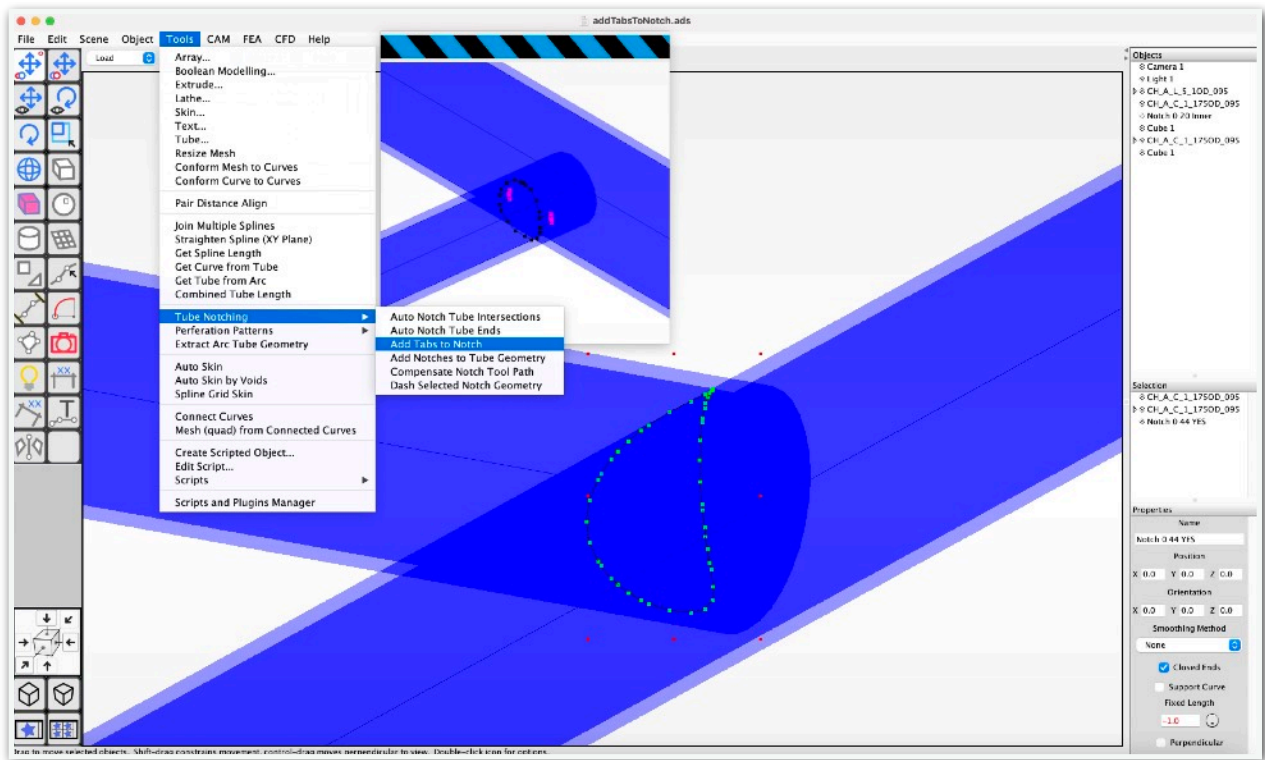

Illustration: Selected notch profile and menu item for adding tabs and slots selected.

The notch object will be modified to add tabs and slots will be added to the intersecting arc tube object. This way the cut tubes will fit together but only in the correct location modelled in the CAD application.
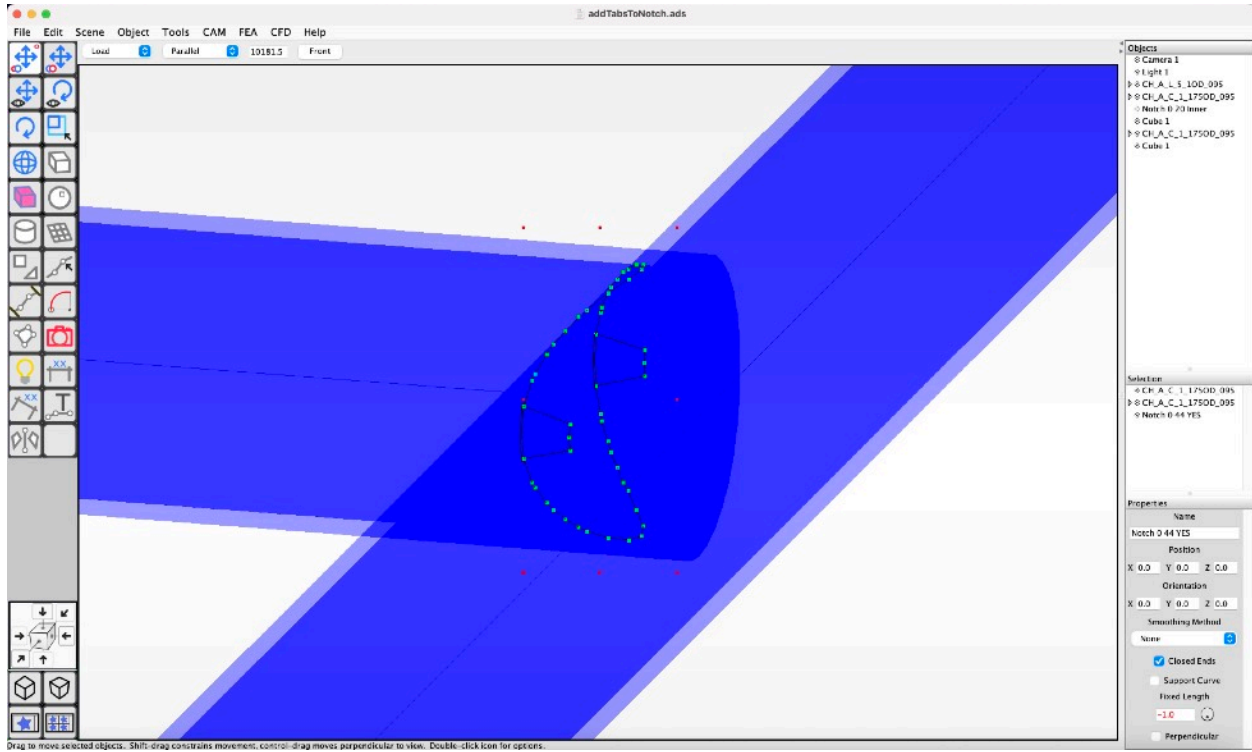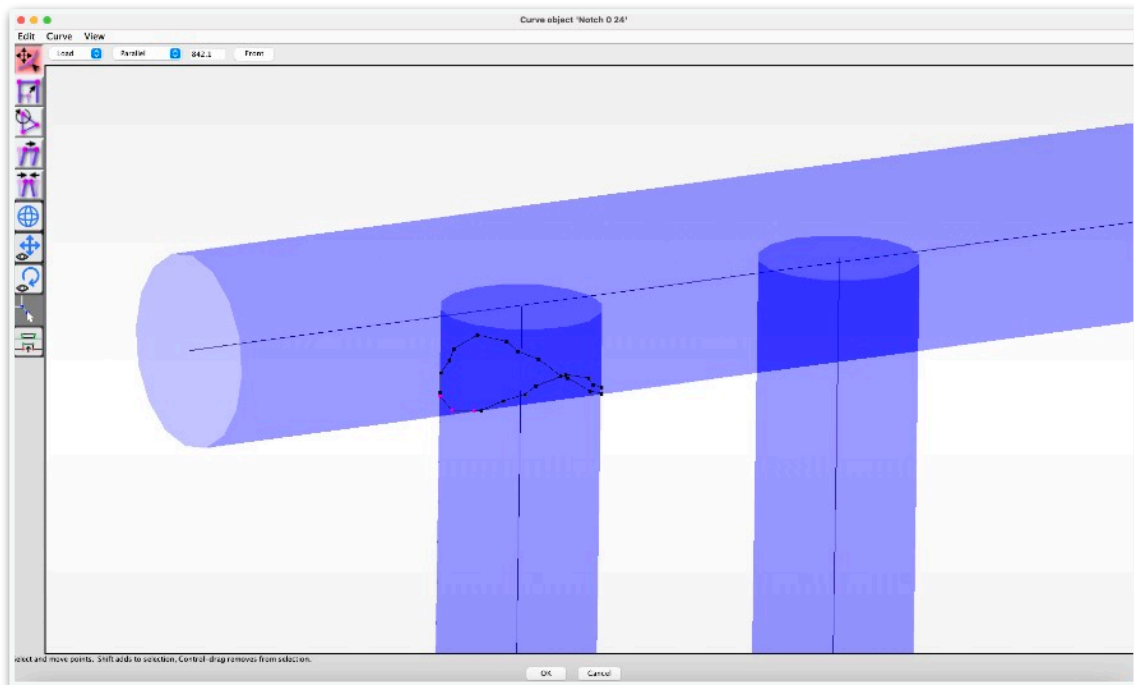

Illustration: Notch modified with slots and intersecting slots.

Add or modify tab and slot manually by editing a notch profile, adding points and moving them using the Tab Slot Tool into the space of an intersecting tube. This will create a slot curve cut profile in the intersecting arc tube.
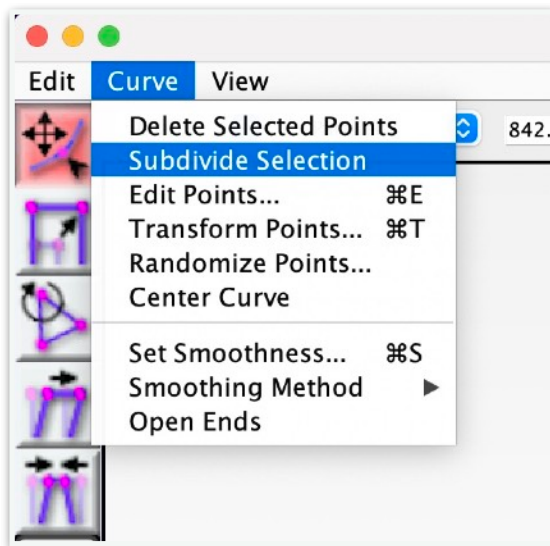
Add points as needed to create your tab. Select the tab slot tool at the bottom of the curve editor window and use the mouse or keyboard to move a selected set of points into the intersecting tube area.
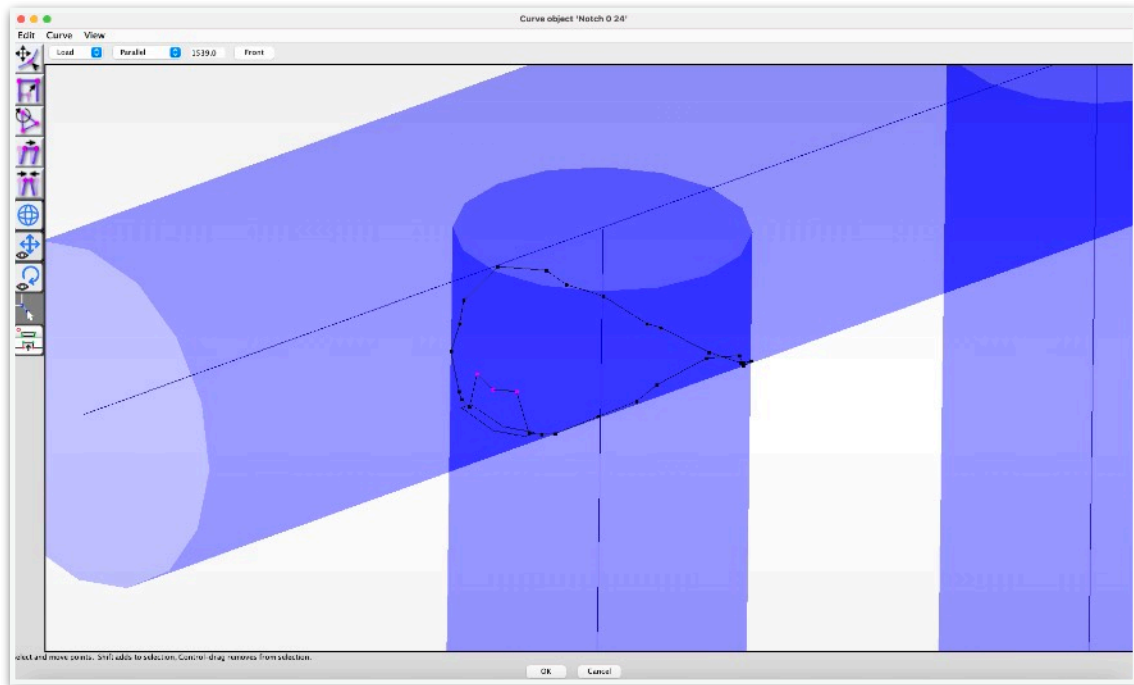
Slot cut profiles are added to the intersecting tube.
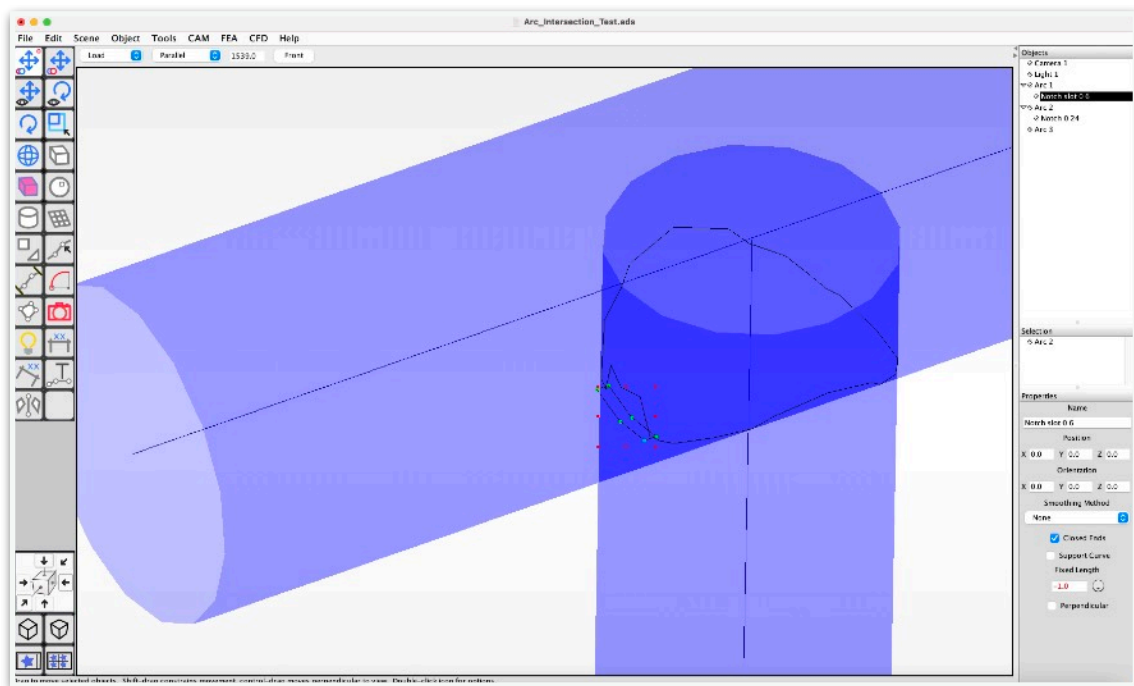
Mirror Planes

Adding a mirror plane object to an arc centre point will cause any notch profiles to be duplicated on the opposite side. This is useful on projects that are symmetrical left to right as it ensures that the notch and tab slot profiles are the same.

Add an Arc tube to the scene oriented along the X axis and add a centre point that is positioned where you want the mirror duplication to be based from. As a child of the arc tube object add a Mirror Plane object so that the start and end points span the Arc centre point.

Add and edit notch profiles on the arc tube and observe that new notch profiles are added on the opposite side. Edits to the duplicated profile geometry will be overwritten if the original object is moved or edited.
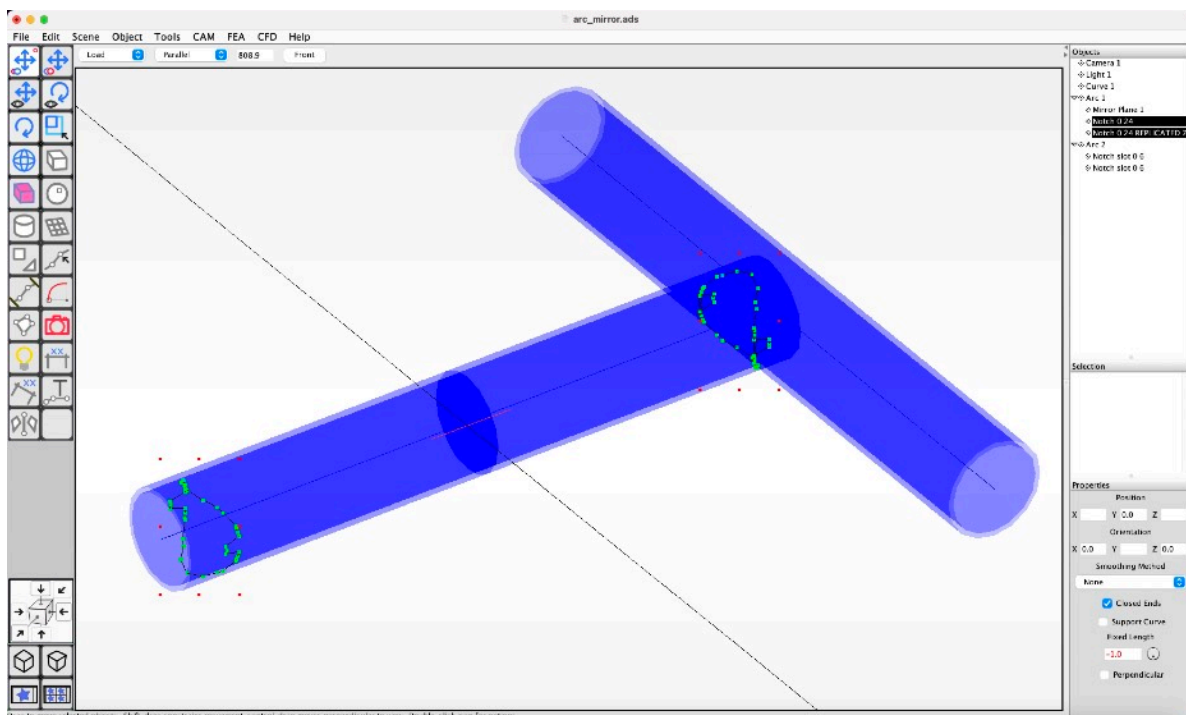
Arc objects with a mirror plane object in the centre point will also conform to modifications to points on the left hand side such that moving, adding or deleting points will be mirrored across the other side.

Cut Order

Notch cut profiles need to be ordered so that notches farthest from the chuck are cut first. This ensures that all cuts are completed on the tube when it is still attached.
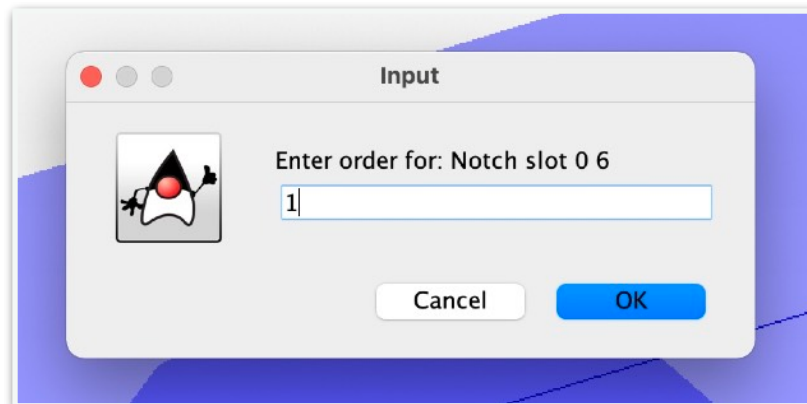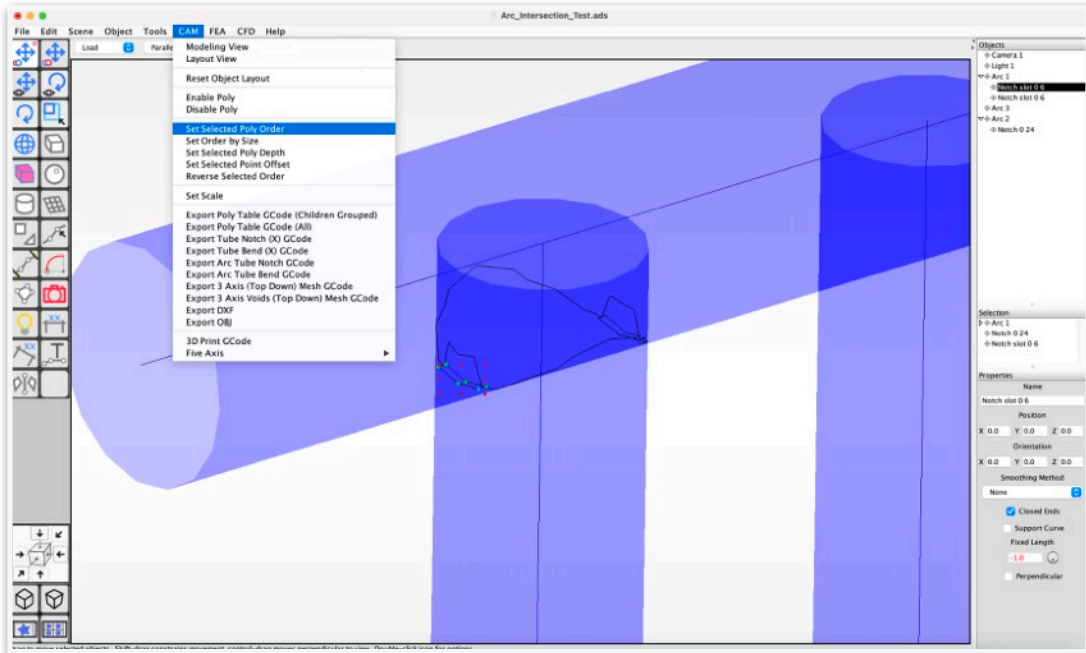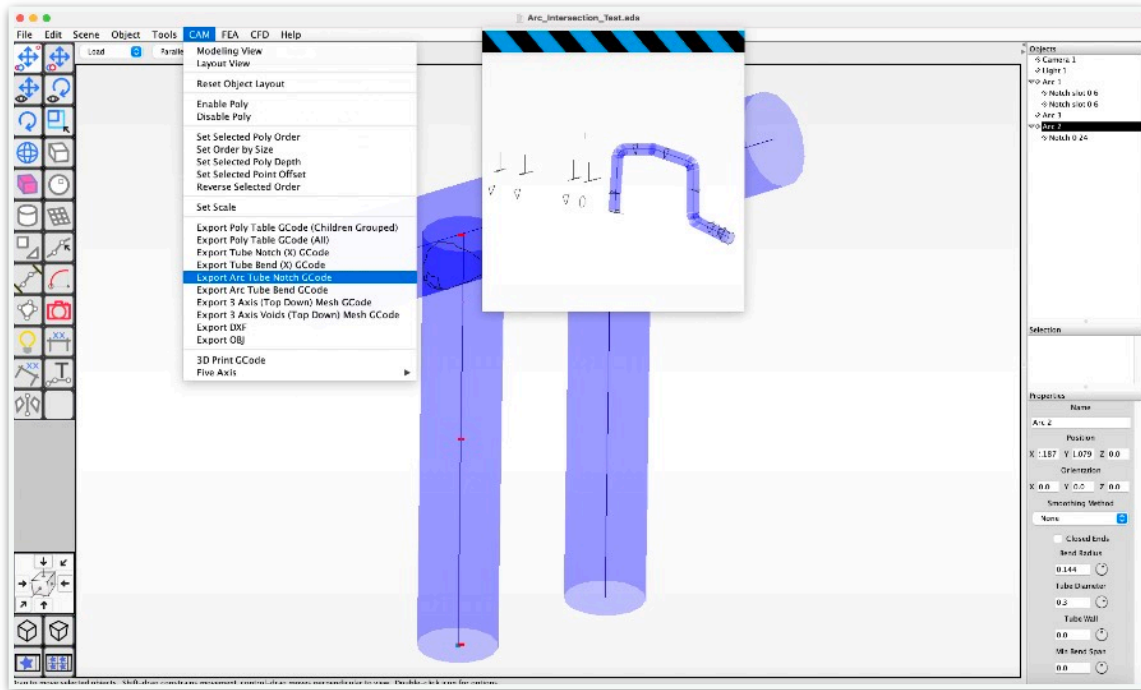
Scale

An export scale factor can be set for a file to change the exported units. The default value is 1.
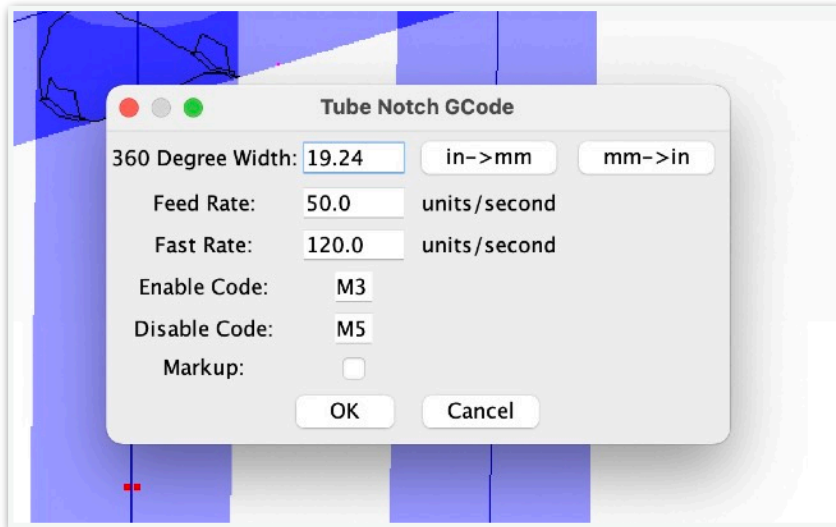
Units in the scene will need to be defined in the control software to map to real world units typically inches or cm.
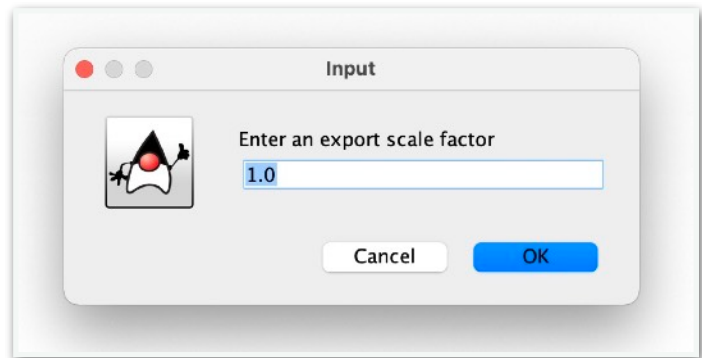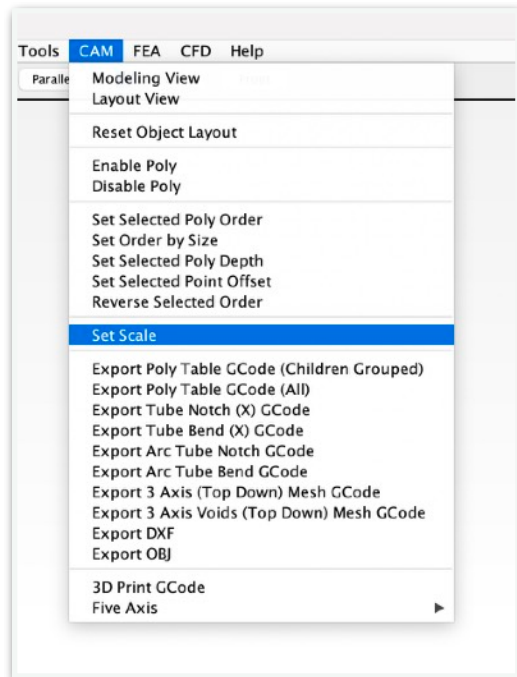
Export Arc Notch Cut Profile GCode

Select an arc object with notch cut profiles and select Export Arc Tube Notch GCode under the CAM menu.
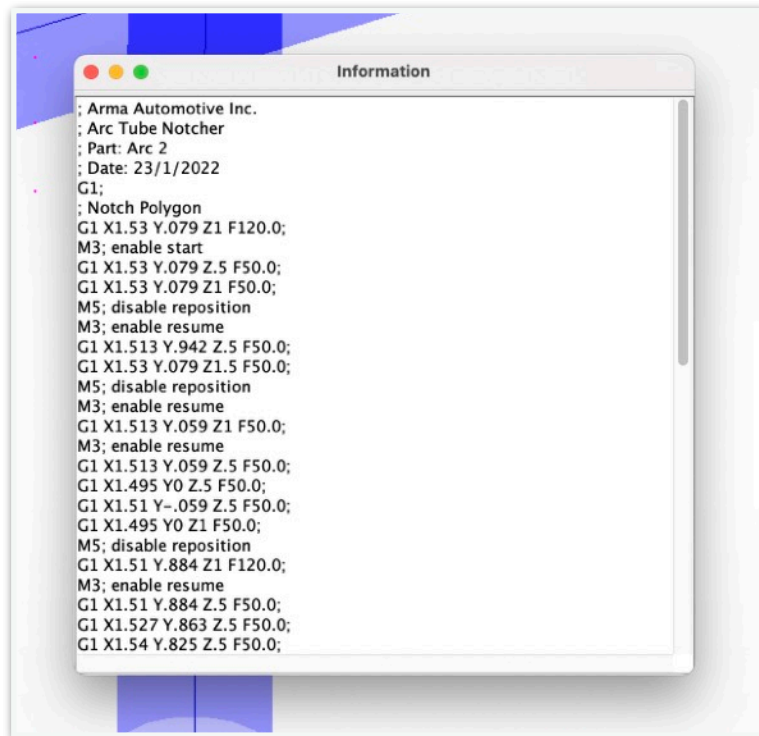
Export tube notch GCode file dialog.

The 360 Degree Width is a notcher machine specific value that maps the radial geometry of a CAD model around a tube to a linear value the chuck needs to move so that the notch profile spans 360 degrees to complete the notch profile so the end point connects to the start.

The Feed Rate specifies how fast the cutter head is moved when cutting. This value will vary depending on the material thickness and composition. Too fast and the torch may not cut through the material and too slow might cause warping and larger cut paths.

The Fast Rate specifies how fast the part is moved when not cutting. This can be faster than when cutting. The maximum moving speed depends on the amount of energy available to drive the motors and the mass of the moving parts. Too fast an acceleration can cause the stepper motors to stall and loose track of the correct positioning.

Before cutting parts check the exported GCode part order is correct by reviewing the part order section.

GCode files will be written in the project folder for each part. If a single part is selected the GCode will be displayed in a dialog. These GCode files need to be loaded into a controller program that will operate the CNC Notcher.

```
; Arma Automotive Inc.
; Arc Tube Notcher
; Part: Arc 2
; Date: 23/1/2022
G1;
; Notch Polygon
G1 X1.53 Y.079 Z1 F120.0;
M3; enable start
G1 X1.53 Y.079 Z.5 F50.0;
G1 X1.53 Y.079 Z1 F50.0;
M5; disable reposition
M3; enable resume
G1 X1.513 Y.942 Z.5 F50.0;
G1 X1.53 Y.079 Z1.5 F50.0;
M5; disable reposition
M3; enable resume
G1 X1.513 Y.059 Z1 F50.0;
M3; enable resume
G1 X1.513 Y.059 Z.5 F50.0;
G1 X1.495 Y0 Z.5 F50.0;
G1 X1.51 Y-.059 Z.5 F50.0;
G1 X1.495 Y0 Z1 F50.0;
M5; disable reposition
G1 X1.51 Y.884 Z1 F120.0;
M3; enable resume
G1 X1.51 Y.884 Z.5 F50.0;
G1 X1.527 Y.863 Z.5 F50.0;
G1 X1.54 Y.825 Z.5 F50.0;
```

Importing Geometric Models from Other CAD Applications

If you use third party CAD applications to model your tube projects you can export models in OBJ format and import them into Arma Design Studio and use tools to add notch profiles that will be used to generate GCode for the notcher.

If your CAD application can export tube notch profile GCode directly then you do not need to use ADS.

Note: If you don't already have geometric models in another CAD application the recommended method for modelling tube based projects in ADS is described in the next section.
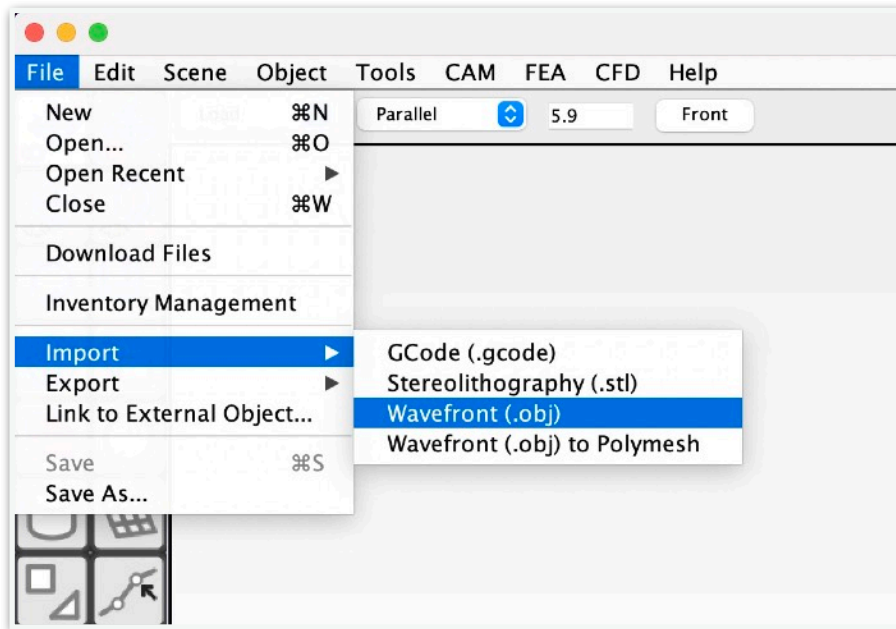
Import geometric object files in OBJ or STL file format.

Select the imported object and click Add Notches to Tube Geometry under the Tools menu. This will add notch profile curves as children of the object.
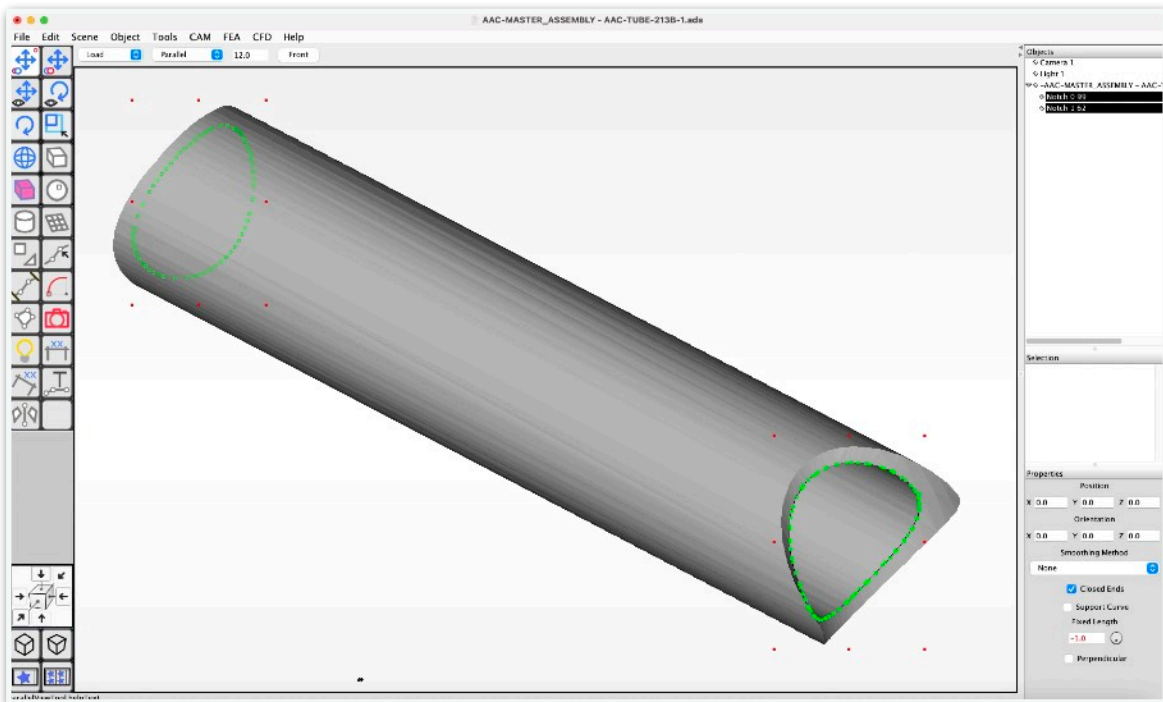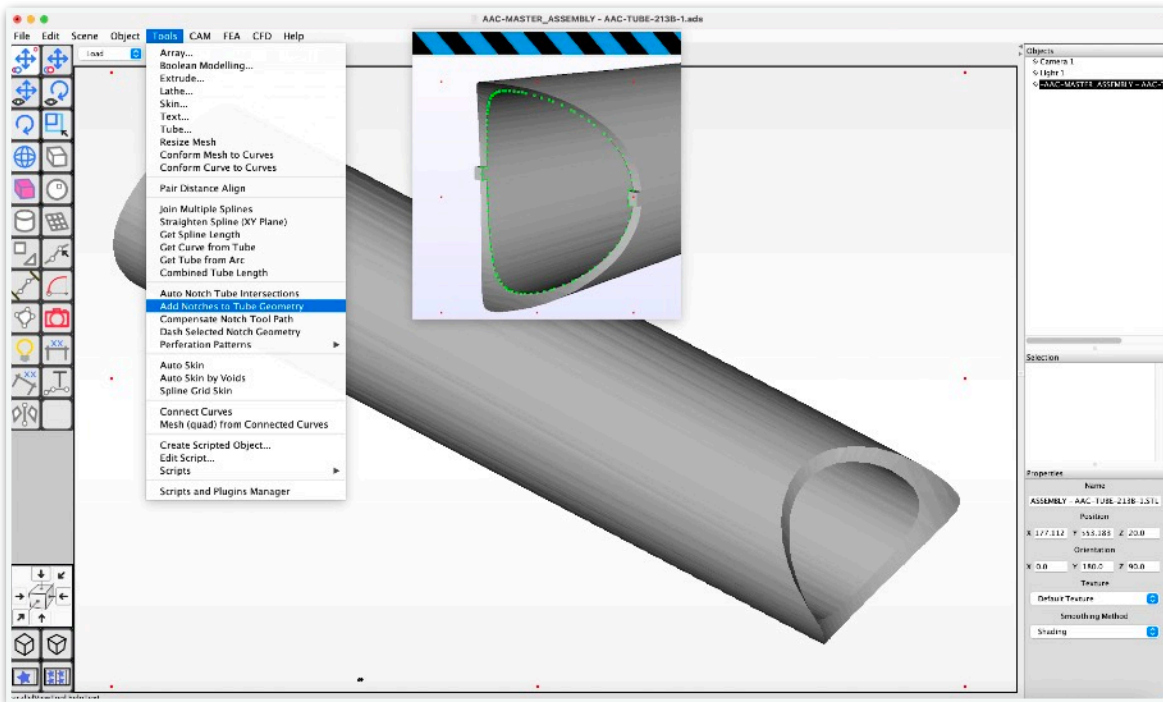
Currently the Tube functions only export parts when oriented along the X axis. Tubes modelled with the Arc Object to not need to be oriented along any axis and are recommended for new designs.
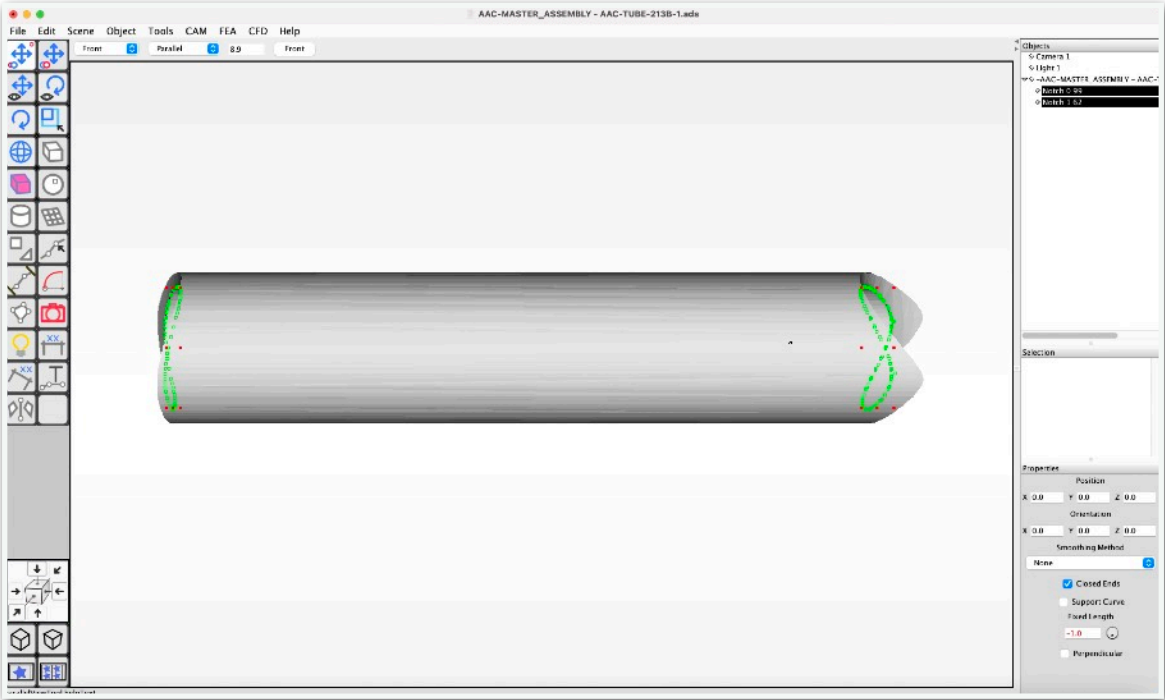
Cut Order

Notch cut profiles need to be ordered so that notches farthest from the chuck are cut first. This ensures that all cuts are completed on the tube when it is still attached to the chuck.
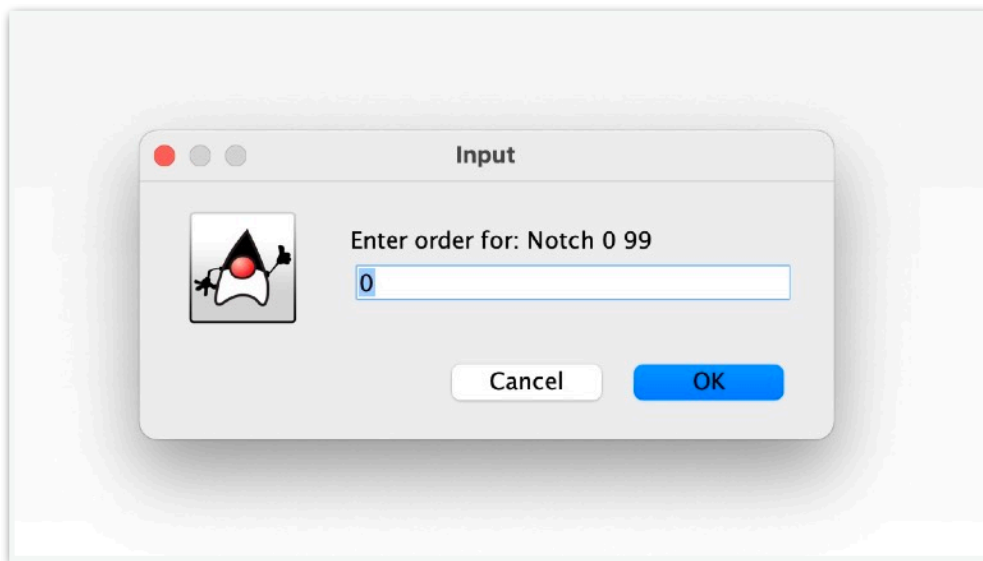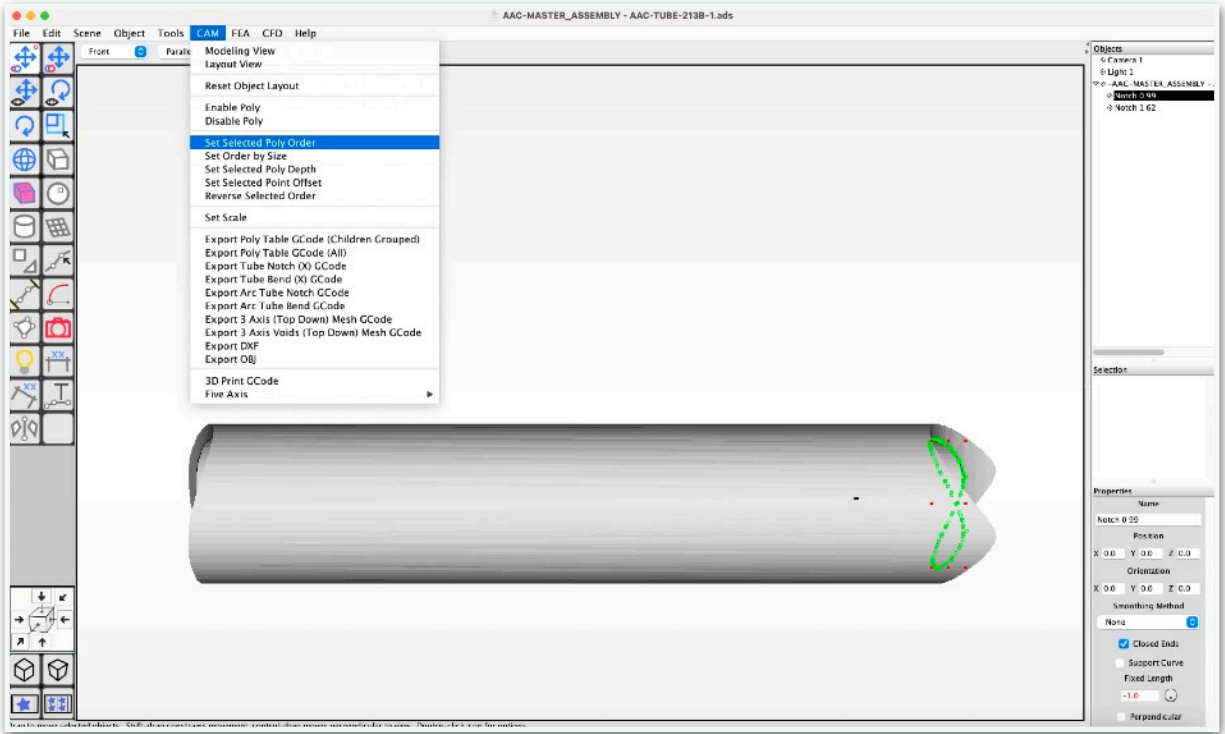
Notches are cut in ascending order, so lower numbers should start farthest from the chuck.

Export from the CAM menu.

Export tube notch GCode file dialog.

The 360 Degree Width is a notcher machine specific value that maps the radial geometry of a CAD model around a tube to a linear value the chuck needs to move so that the notch profile spans 360 degrees to complete the notch profile so the end point connects to the start.
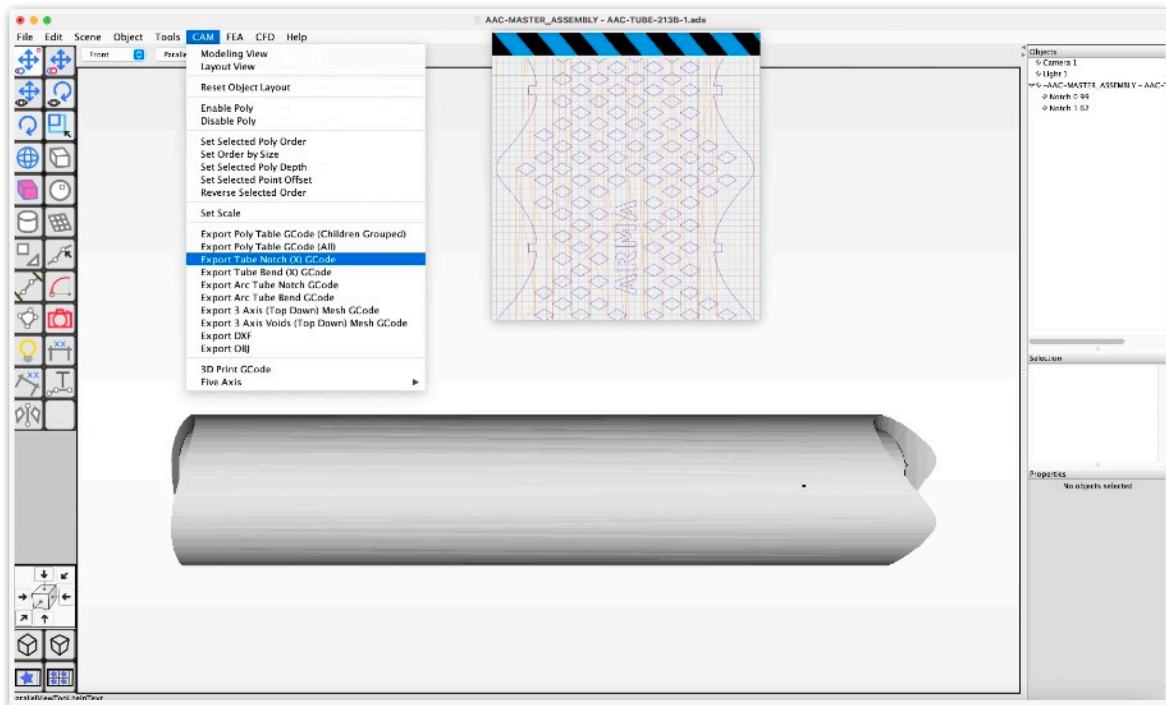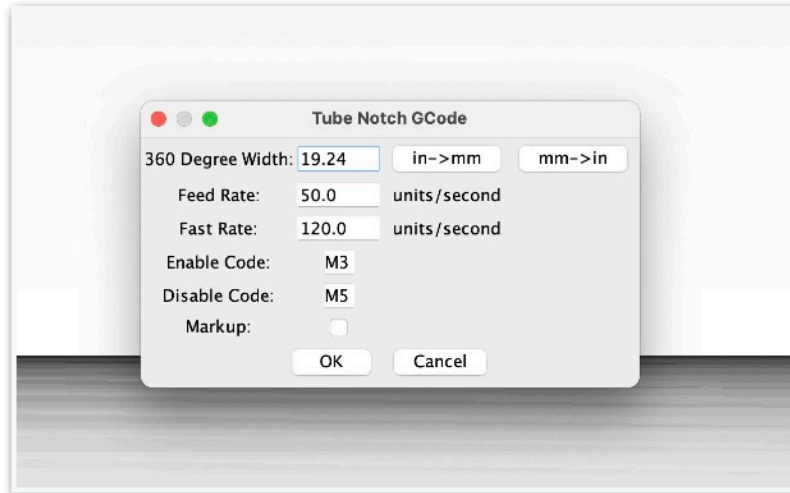
The Feed Rate specifies how fast the cutter head is moved when cutting. This value will vary depending on the material thickness and composition. Too fast and the torch may not cut through the material and too slow might cause warping and larger cut paths.

The Fast Rate specifies how fast the part is moved when not cutting. This can be faster than when cutting. The maximum moving speed depends on the amount of energy available to drive the motors and the mass of the moving parts. Too fast an acceleration can cause the stepper motors to stall and loose track of the correct positioning.

Before cutting parts check the exported GCode part order is correct by reviewing the part order section.

Control Software

Control software takes GCode files exported from CAD software and operates the CNC Tube Notcher. Arma Design Studio has a control program that works with the Plasma Notcher but you can use any control software you like provided you have the hardware that drives the stepper motors, activating the torch and input for limit switches.

Arma CNC Notcher Control Software

To launch the Arma Control Program select the CAM menu item and CNC Machine Control menu item.
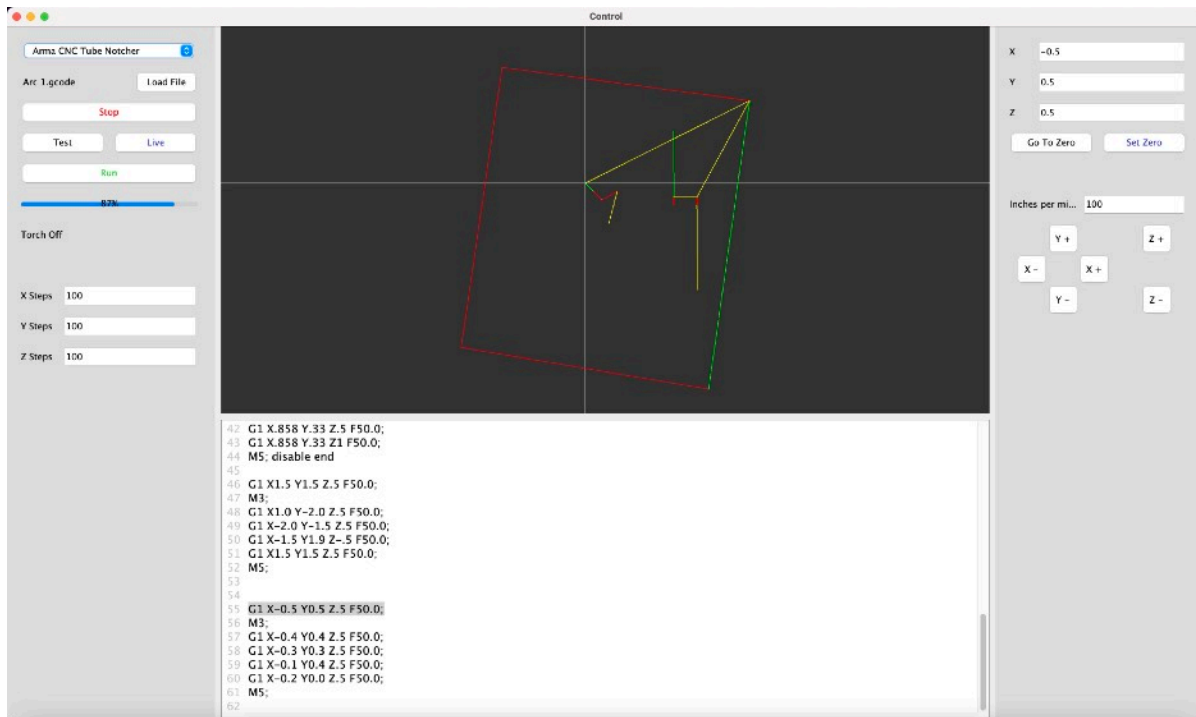
In the top left of the window is a drop down that lists the connected hardware devices.

Load File will prompt for a GCode file for processing. ADS generates folders with GCode files in the same directory the project file resides when running exporting Tube Notch and Arc Tube Notch functions.

Stop will halt the torch and any movement of the gantry and chuck as a cut profile is being run.

Test activates a mode where by running the GCode profile will move the gantry and chuck as if a notch is being cut but the torch will not activate. This is a good way to check that the start and end points line up with the loaded tube and that the order of the notches is correct so that no features are missed. Be sure that the notches are cut first from the furthest and away from the chuck.

Live disables the test mode. Running the GCode cut program will move the gantry and chuck rotation and activate the torch for cuts.

Run will start the program from the current selected GCode line.

Progress indicates how far into the GCode file is currently being viewed in the editor or run.

X Y Z Steps are machine specific values and calibrate the number of pulses to be sent to each stepper motor to move a unit of distance, typically one inch. X moves the gantry torch head left and right along the rail. Y moves the chuck rotation and units are translated in the GCode to unroll to 360 degrees. Z is not currently used in the Tube Notcher.

The top centre window displays a preview of the GCode cut profiles. This is used to show the progress through cuts and to verify patters are correct before cutting material.

The bottom centre window displays the GCode file contents. Running the program will step line by line through the program. Selecting a line will display in the preview where the torch head will move too.

In the top right window are X Y and Z values that indicated the numerical unit position of each axis the machine is being instructed to move too. The X axis is the gantry width and the Y axis is the chuck rotation movement. Z is currently not used in the notcher.

Go To will cause the machine to move the torch head to the input value coordinates.

Set Zero will set the control program coordinates to zero so that the loaded program will start from that location.

Movement Buttons jog the torch head left or right and rotation forward and backward manually for positioning.

Mach 3

The Mach 3 control software can be found on the website ArtSoft.

https://www.machsupport.com/software/mach3/
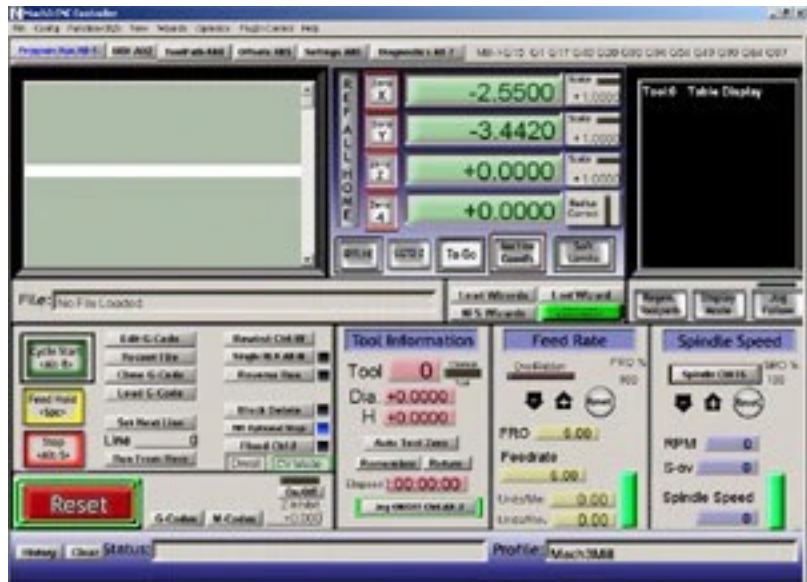
Appendix

Getting started with Arma Design Studio

Loading files

ADS files have the file extension .ads. Open existing files by clicking Open or Open Recent from the File menu.
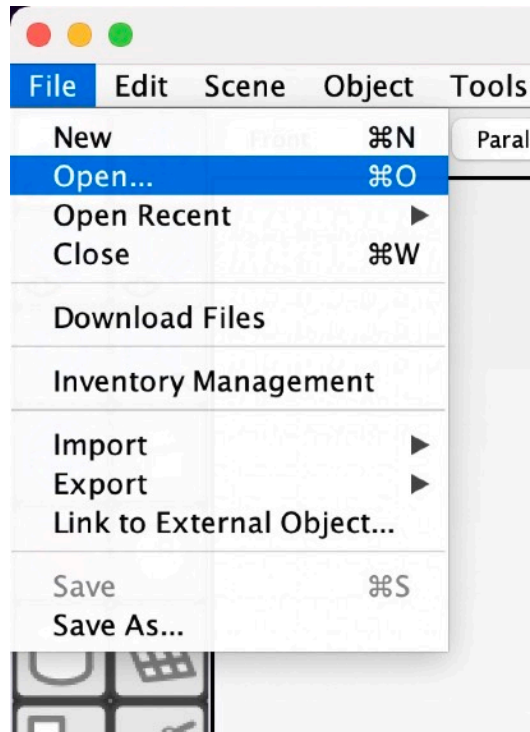
Download Files will show a few sample model files for demonstration.
Import STL and OBJ file models into the scene using the appropriate Import menu item.

Zooming

Zoom in and out of the scene by moving the mouse cursor over the view scene window and use the mouse scroll wheel or two fingers on a track pad.

Panning

Hold the command keyboard key down and left click with the mouse to drag the scene viewer area.

Rotating

Hold the option keyboard key down and left click with the mouse to drag the scene viewer area.

Selecting Objects

Objects in a scene can be selected by clicking on them or clicking on the object list in the right side pane.

When clicking on a scene with many objects overlapping the smallest object will be selected by default. If this is not the desired object the desired object can be selected by name as listed in the selection window on the right hand side under the object list.

Adding Primitives

Adding Curves

Click on the Create Curve or Create Arc Curve toolbar buttons and then click on the viewer canvas for each point in the curve. Double click to end the curve object. Curve points can be modified after creation.

Adding Meshes

Double click on the Create Spline Mesh toolbar item to specify the mesh size and other properties. Then single click the Create Spline Mesh toolbar item and click and drag on the view window to add a mesh to the scene. Mesh points can be modified in edit mode, as well columns and rows can be added and removed after creation.

Spline mesh objects can also be conformed to curve object profiles using the conform menu items in the Tools menu.

Editing Objects

Double clicking on an object will open an editor window for objects. Double clicking an object from the right hand object list pane to edit or right click and choose the edit menu item.

Hiding Objects
Right click to hide or show objects in the object list pane on the right side of the window.

Nesting Children

In the scene object list items can be selected and dragged into other objects to become a child. Nesting can be used for organization and some special objects apply properties to their parent object for example the mirror plane object will mirror parent curve and mesh objects.

Searching for Objects

The Object Menu, Find Object menu brings up a dialog for searching for objects by name. Results will be displayed in the selection list on the right hand pane. Selecting items from the selection list will highlight them.

Saving and Exporting

Saving native ADS files can be done from the file menu and exporting to some supported file formats are available.

GCode Reference

GCode is a machine instruction file format many CNC machines use for control including the Arma CNC Tube Notcher. There are many instructions but a subset used by the notcher are detailed here.

G1 - Linear interpolation. Instructs the control software to move in straight lines.

X - Specifies position values along the X axis used by the Gantry.

Y - Specifies position values along the Y axis not used by the Arma Tube Notcher.

Z - Specifies position values along the Z axis used by the check rotation.

M3 - Start the plasma torch.

M5 - Stop the plasma torch.

F - Specifies the motion speed.

Trouble shooting

Torch is not activating

Check that power is supplied and the connections are secure.

Torch is not cutting consistently

Check that the metal being cut is clean.

The cut parts are not the correct size.

Calibrate the control software configuration on X and Z steps per inch. Move the gantry the full length to verify the movement is expected.