



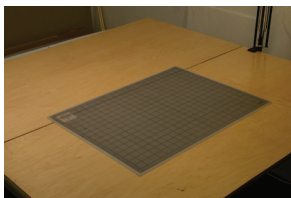
WORK SURFACE

Find a sturdy table that is in a well-lit area. Ideally you'll be working with 40" x 30" sheets, so a suitably sized surface will help.



RAZOR KNIFE

I highly recommend getting an Olfa knife. It is difficult to cut 1/2" foamcore with just an Exacto.



CUTTING MAT

A large piece of cardboard will do, but I would highly recommend a cutting mat. Mine is 18"x24" and made by Artool.



WIRE CUTTERS

These will be important for cutting thin steel cable and stripping the stepper motor wires.



MARKING TOOLS

I use an ultra fine point black Sharpie, but if you'd prefer, a pencil and eraser will work as well.



PLIERS

A needle-nose or any other variety will work well.



CIRCLE STENCIL

The two hole diameters which you'll need to mark are 5/8" and 1-1/8". A compass will work just as well.



SMALL WOOD SAW

If you want to save money and use wooden dowels, you'll need this to cut them to length. A real saw works even better.



COMPASS

A substitute for the circle stencil.



12" METAL RULER*

I cut everything freehand, but if you're bad at cutting straight lines or want to better protect your fingers, grab one of these.



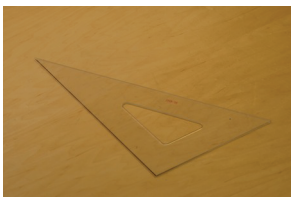
> 16" RULER

Highly recommended. A 24" C-Thru ruler will make your life much easier. Make sure that it has 1/16" markings throughout.



HOT GLUE GUN

Mine is made by Surebonder and has both a high and low temperature setting. I run it at high.



RIGHT TRIANGLE

These instructions are designed to take advantage of the factory-square edges of the foamcore. This tool is optional.



SCREWDRIVER

You'll need a medium sized flat head screwdriver.

**ALUMINUM SHAFTS**

These shafts are made to be very straight with highly accurate diameters. They are responsible for both moving and guiding the toolhead and the Z axis table. 1/2" diameter x 15" long.

QTY: 3 \$9.00 EA, \$27.00 TOTAL
McMaster-Carr P/N 1031K14

**WIRE ROPE**

The motion system of the machine relies on what is called the "capstan effect." This fine braided steel cable will prevent the aluminum shafts from spinning without also rolling.

QTY: 25 FT \$0.41/FT, \$10.25 TOTAL
McMaster-Carr P/N 8930T22

**NYLON BUSHINGS**

Molded plastic sleeves which are designed to slide on precision shafts. They provide a low-friction bearing for the moving parts of the machine. 1/2" inner diameter.

QTY: 2 PACKS \$3.15 /PK, \$6.30 TOTAL
McMaster-Carr P/N 6389K623

**DOUBLE-STICK TAPE**

An adhesive-paper-adhesive sandwich. Double-stick tape is used to laminate the delrin strips to the foamcore, as well as generally to stick things together.

QTY: 1 ROLL \$7.93 /ROLL, \$7.93 TOTAL
McMaster-Carr P/N 76405A13

**CONSTANT-FORCE SPRING**

This tape-measure-like spring unravels with consistent force, making it ideal to counter the weight of the Z-axis table and to reduce the load on the Z-axis stepper motor.

QTY: 1 \$5.17 EA, \$5.17 TOTAL
McMaster-Carr P/N 9293K44

**ELECTRICAL TAPE***

Any color will do. This flexible and somewhat stretchy tape will be used to couple the motors to the aluminum shafts, as well as to insulate wiring connections.

Local Hardware Store

**DELRIN STRIP**

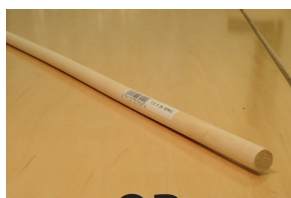
Thin strips of delrin, an engineering-grade plastic, are used to reinforce the foamcore in places where it might dent or wear.

QTY: 20 FT \$0.39 /FT, \$7.80 TOTAL
McMaster-Carr P/N 2638T11

**POLYESTER TAPE**

I really like this plastic-backed adhesive tape, but you could get by with masking tape or clear tape. It is used as a general tape wherever necessary.

QTY: 1 ROLL \$6.81 /ROLL, \$6.81 TOTAL
McMaster-Carr P/N 7630A42

**WOODEN DOWELS**

If you have the ability to cut them, wooden dowels are a cheap and effective alternative to steel dowel pins. **Purchase at least 18" of both 1/4" and 1/2" diameter wooden dowel.**

~\$3.00 TOTAL

Local Art Supply Store

**FOAMCORE!**

You'll need a 40" x 30" sheet of 1/2" thick foamcore, and a 30" x 20" sheet of 1/4" thick foamcore. Several smaller sheets can be used instead of a big sheet - check the cut patterns.

~\$13.00

Local Art Store

OR

**STUBBY STEEL DOWEL PINS***

These pins will get the job done, but are expensive so search for alternatives first. If you can't use wooden dowels, you'll need to find or create cylinders which are 1/2" dia. and 1" long.

QTY: 2 PACKS (20) \$6.65/PK, \$13.30 TOTAL
McMaster-Carr P/N 98381A710

**ALUMINUM SPACER**

These spacers coincidentally have the right inner and outer diameters to adapt the 5mm motor shaft to the 1/2" aluminum shafts.

QTY: 3 \$1.54 EA, \$4.62 TOTAL
McMaster-Carr P/N 92510A745

+

**SLENDER STEEL DOWEL PINS***

These pins will get the job done, but are expensive so search for alternatives first. If you can't use wooden dowels, you'll need to find or create cylinders which are 1/4" dia. and 2" long.

QTY: 1 PACK \$8.85/PK, \$8.85 TOTAL
McMaster-Carr P/N 90145A549

**SUPERGLUE***

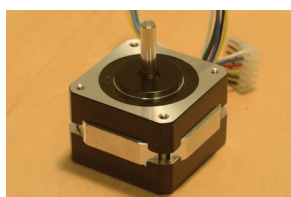
Any super glue will do, although the thinner the better. I use this awesome 5cP glue, but 100cP would be OK too. (cP is a measure of fluid viscosity.)

Local Hardware Store

**HOSE CLAMPS**

Typically used to secure hoses to fittings, we will use hose clamps as simple tensioning mechanisms for the steel cables.

QTY: 1 PK \$7.01/PK, \$7.01 TOTAL
McMaster-Carr P/N 5388K22

**STEPPER MOTORS**

These easily controlled motors will move the toolhead around with some degree of precision. The type depends on your controller, but I will be using unipolar motors with a step angle of 0.9°.

QTY: 3 \$6.95 EA, \$20.85 TOTAL
Alltronics P/N 28M053

TOTAL MATERIAL COST: \$119.74

* These are either household items or alternative parts and are not included in the calculated parts price.



Date March 20, 2011
 Purchase order
 Order created by Ilan Moyer (imoyer@mit.edu)

Ship to
 3 Ames Street
 East Campus, #358
 Cambridge, MA 02142

Send invoice to
 imoyer@mit.edu

Payment method

Attention: Ilan Moyer

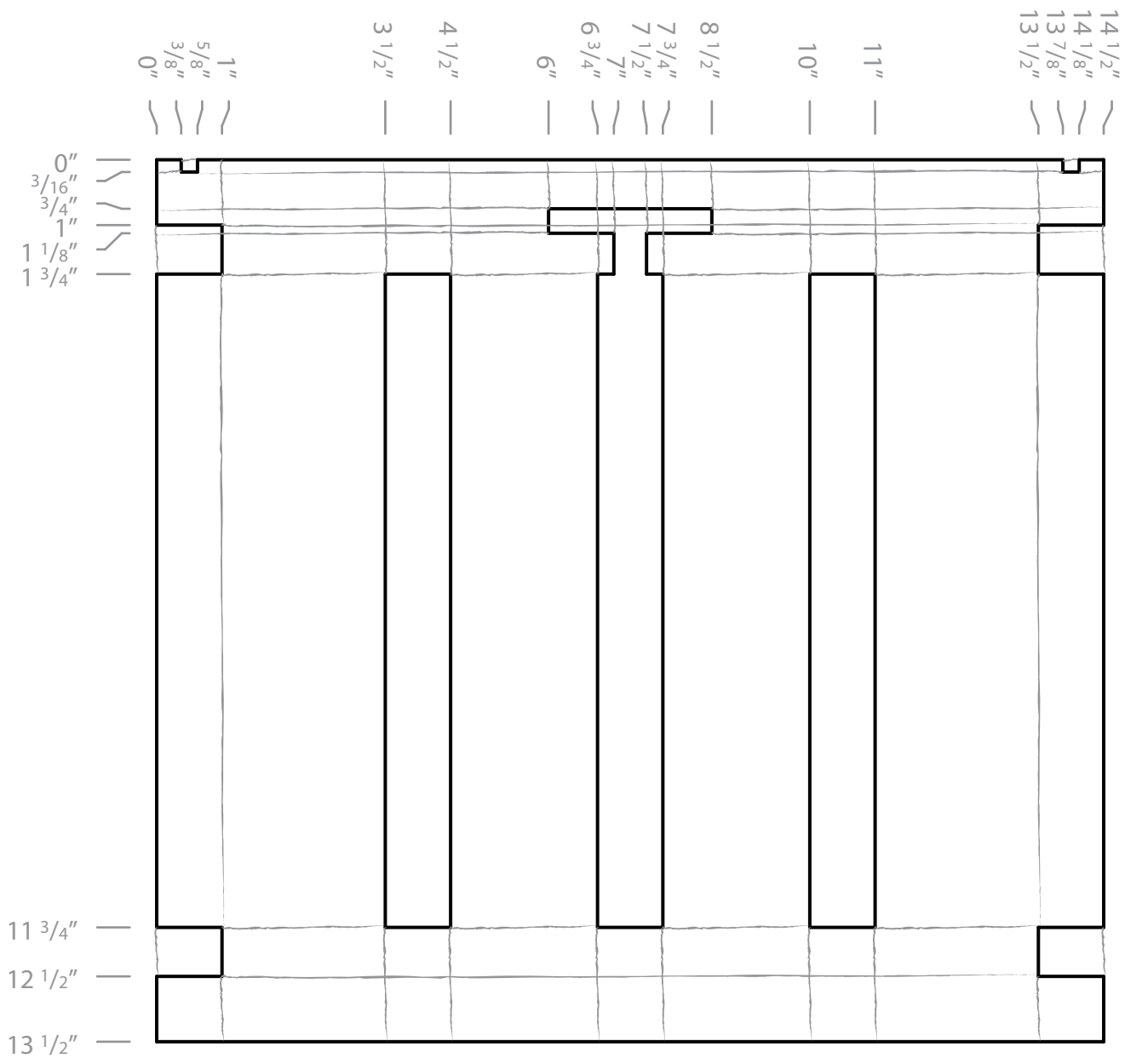
Shipping method
 Ground

Line	Quantity	Item		Ships	Unit price	Total
1	3 each	1031K14	Precision Ceramic-Coated Aluminum Shaft 1/2" Diameter, 15" Length	Monday morning	\$9.00 each	27.00
2	2 packs	6389K623	Nylon Bearing Flanged, for 1/2" Shaft Dia, 5/8" OD, 1/2" Length, packs of 5	Monday morning	\$3.15 pack	6.30
3	1 each	9293K44	Stainless Steel Constant-Force Spring 4000 Cycle Life, .005" Thick, 17" L, .312" Wide	Monday morning	\$5.17 each	5.17
4	20 ft.	2638T11	Black Delrin Strip .020" Thick, 1" Width	Monday morning	\$.39 ft.	7.80
5	2 packs	98381A710	Alloy Steel Dowel Pin 1/2" Diameter, 3/4" Length, packs of 10	Monday morning	\$6.65 pack	13.30
6	1 pack	5388K22	Worm-Drive Hose Clamp W/Zinc Pltd Steel Screw 11/16" to 1-1/4" Clamp Dia Range, 5/16" Band Width, packs of 10	Monday morning	\$7.01 pack	7.01
7	25 ft.	8930T22	Commercial Grade Nylon-Coated SS Wire Rope 7X7 Strand Core, .018" - .024", 40# Break Strg	Monday morning	\$.41 ft.	10.25
8	1 roll	76405A13	Masking Tape - Adhesive on Both Sides for General Purpose, 1" Wide X 36 Yards Long	Monday morning	\$7.93 roll	7.93
9	1 roll	7630A42	High-Temp Polyester Masking Tape 1" Wide X 18 Yards Long	Monday morning	\$6.81 roll	6.81
10	3 each	92510A745	Aluminum Unthreaded Round Spacer 1/2" OD, 1/2" Length, #10 Screw Size	Monday morning	\$1.54 each	4.62
11	1 pack	90145A549	18-8 Stainless Steel Dowel Pin 1/4" Diameter, 2" Length, packs of 10	Monday morning	\$8.85 pack	8.85

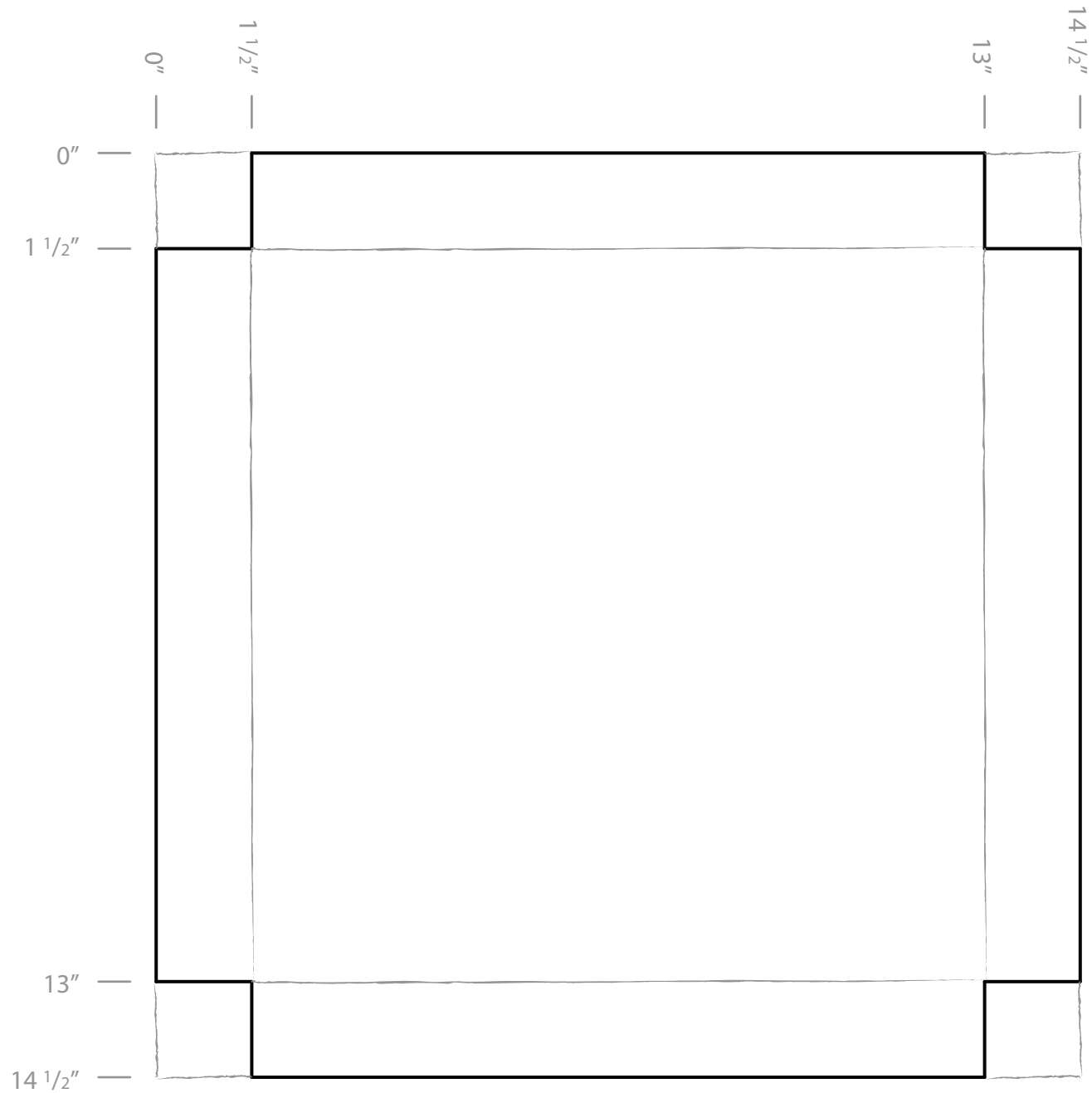
Merchandise total \$105.04

Applicable shipping charges and tax will be added.

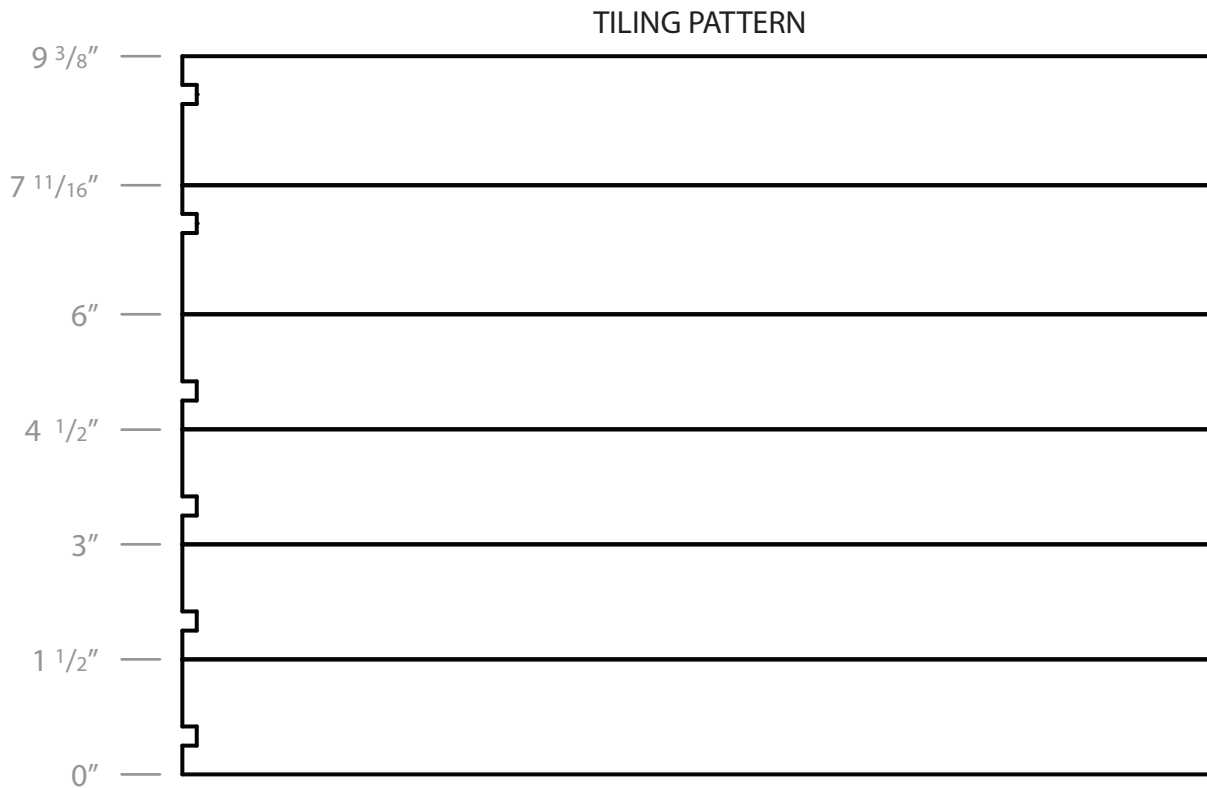
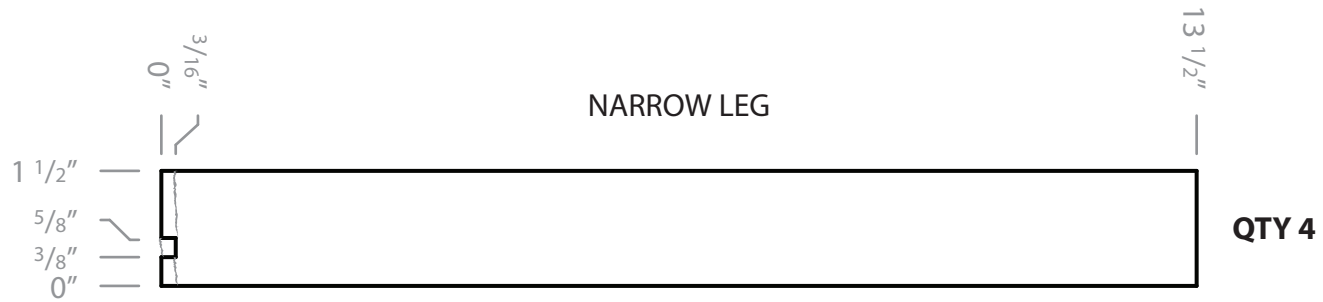
Phone (609) 689-3000 Fax (609) 259-3575 Internet www.mcmaster.com Email nj.sales@mcmaster.com



— SKETCH LINE
— CUT LINE



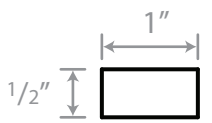
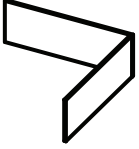
— SKETCH LINE
— CUT LINE



— SKETCH LINE
 — CUT LINE



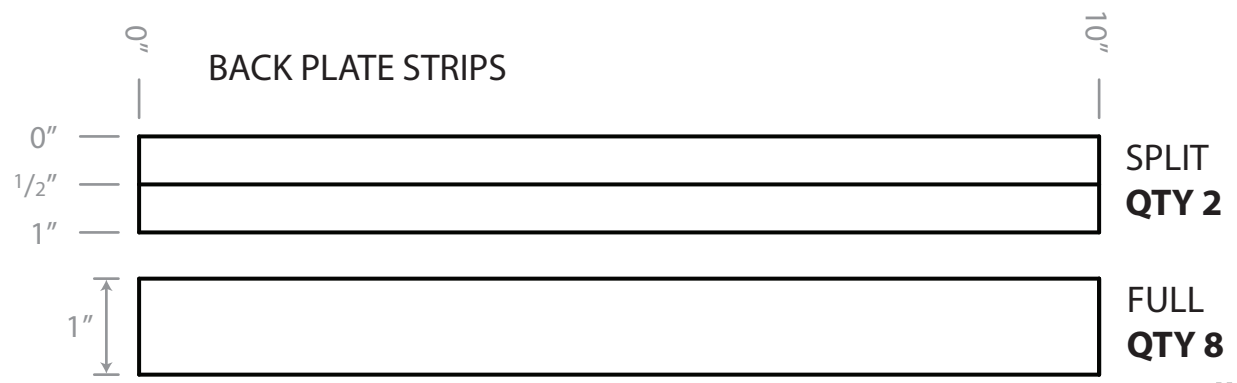
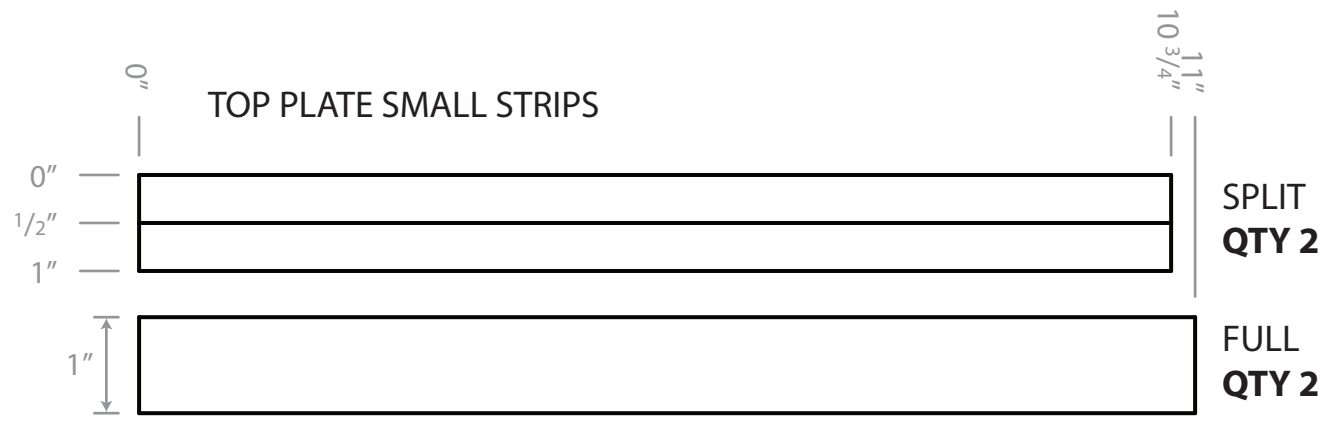
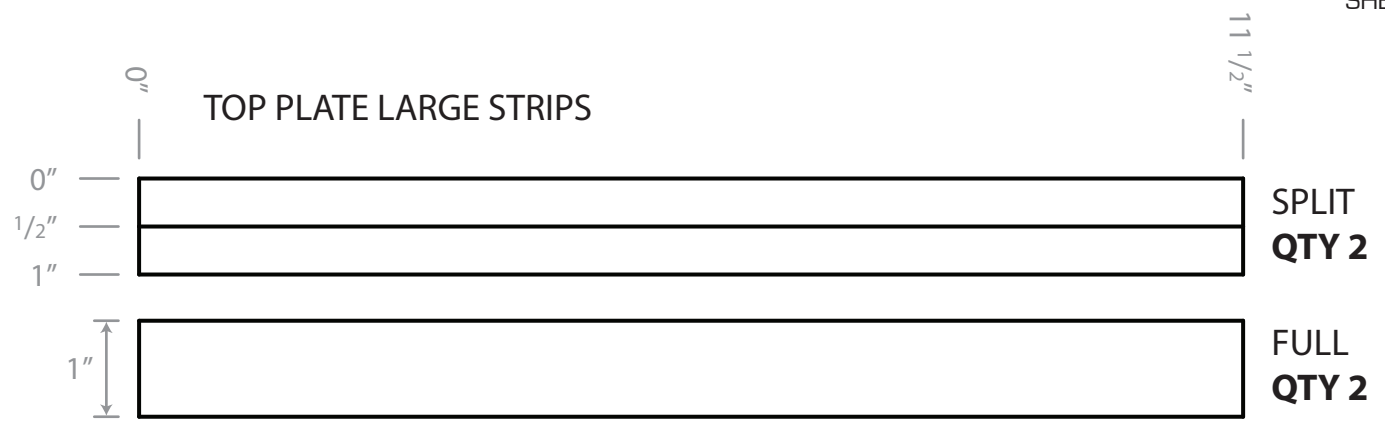
TOP PLATE
EDGE STRIPS
QTY 4



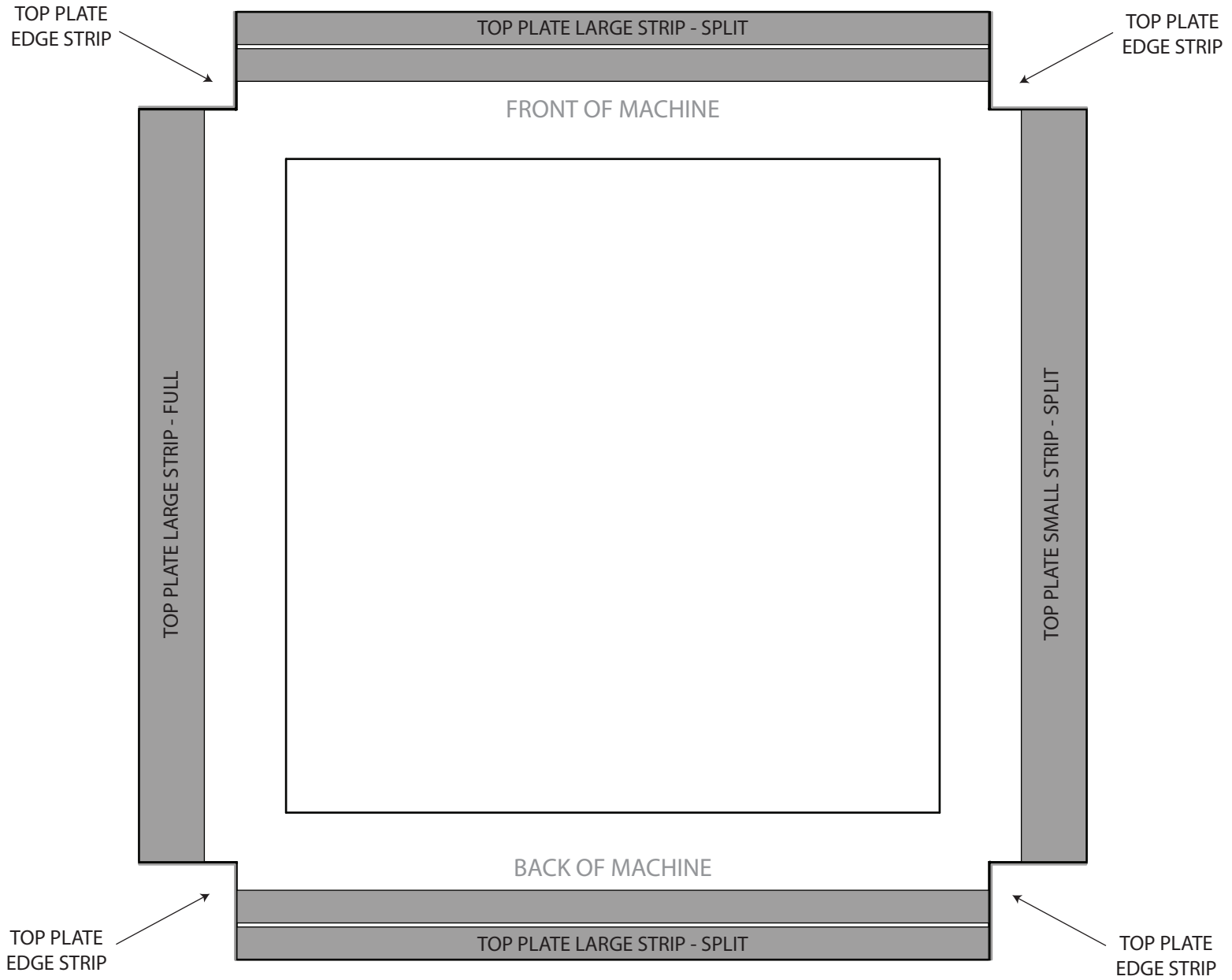
BACK PLATE
EDGE STRIPS
QTY 6

TOTAL SPLIT LENGTH: 73.5"
TOTAL FULL LENGTH: 125"
OVERALL LENGTH: 198.5"

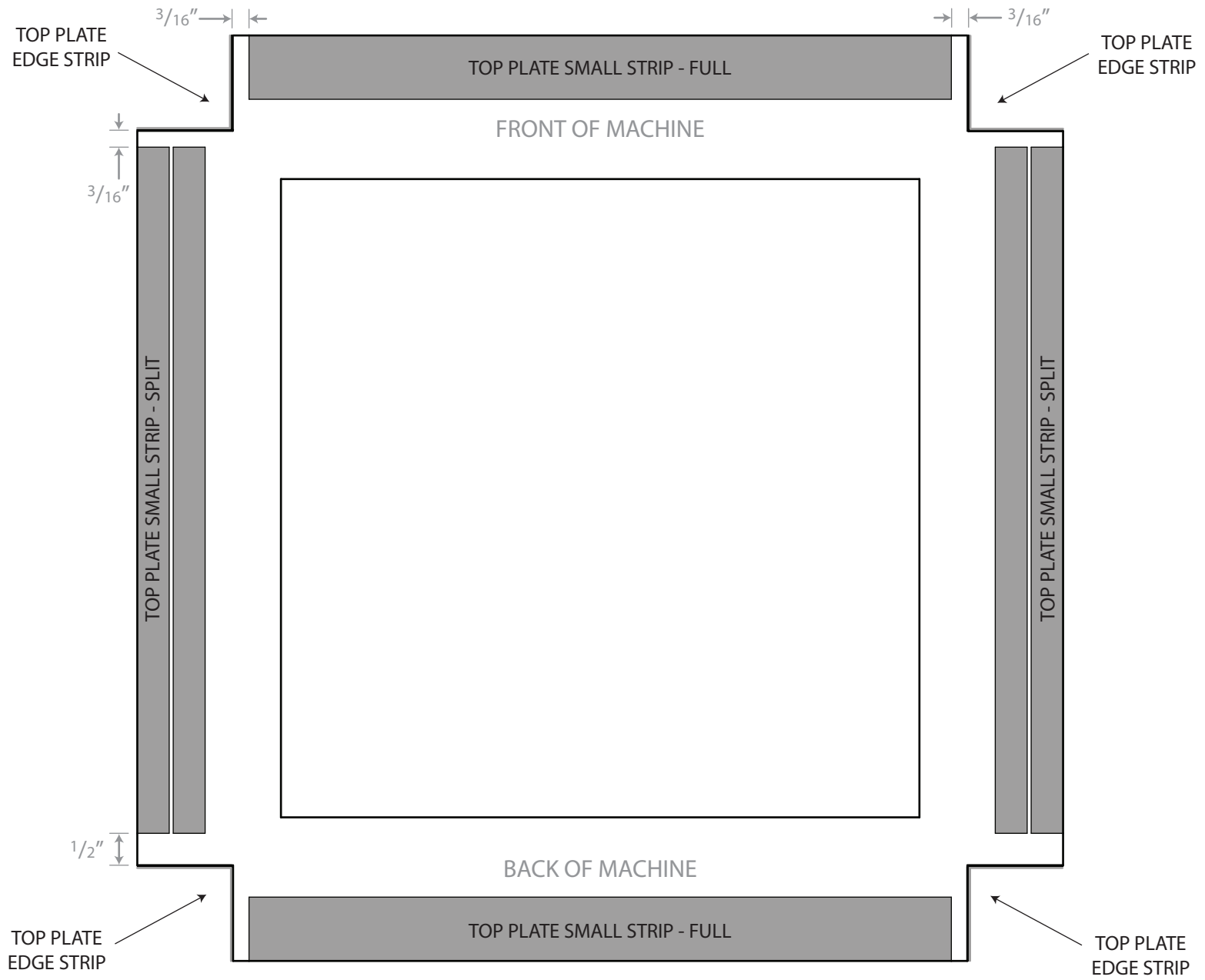
Total split length is the total length of 1" wide delrin strip which needs to be halved along its length. Total full length is the total length of delrin strip which will retain its original width of 1".



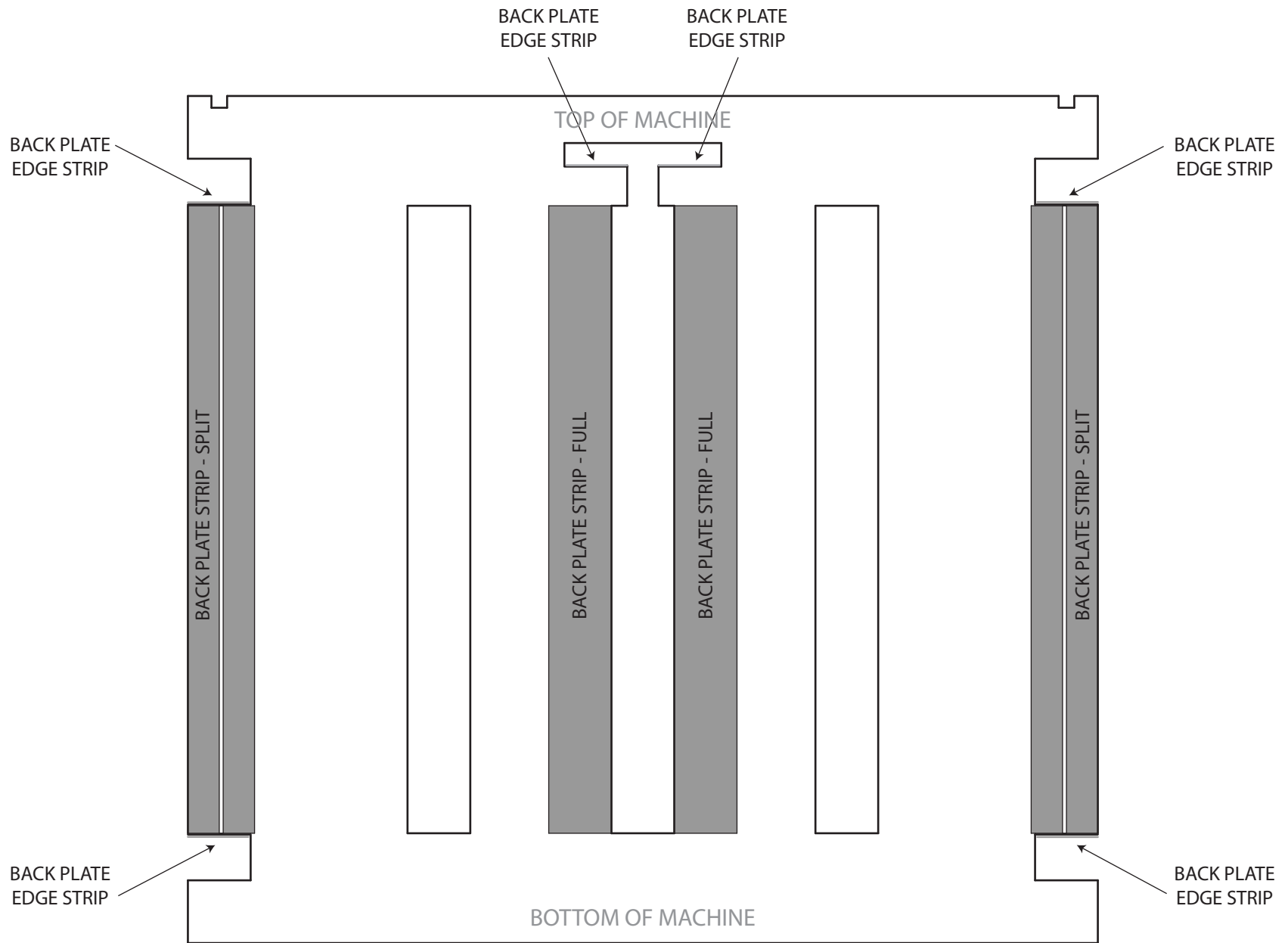
----- SCORE LINE
——— CUT LINE



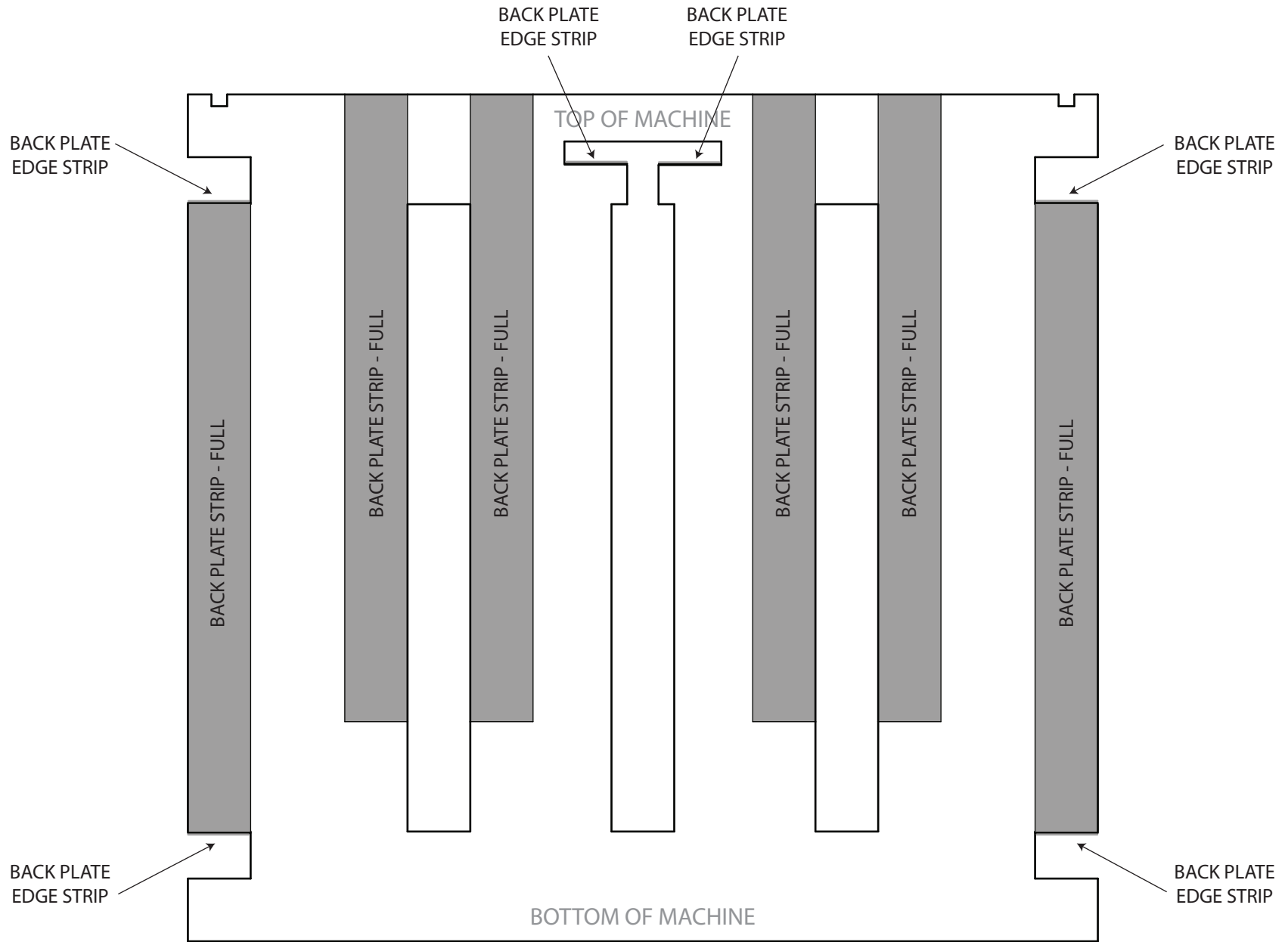
NOTE: GAP BETWEEN HALVES OF SPLIT STRIPS SHOULD BE CONSISTENT AND APPROXIMATELY 1/16".

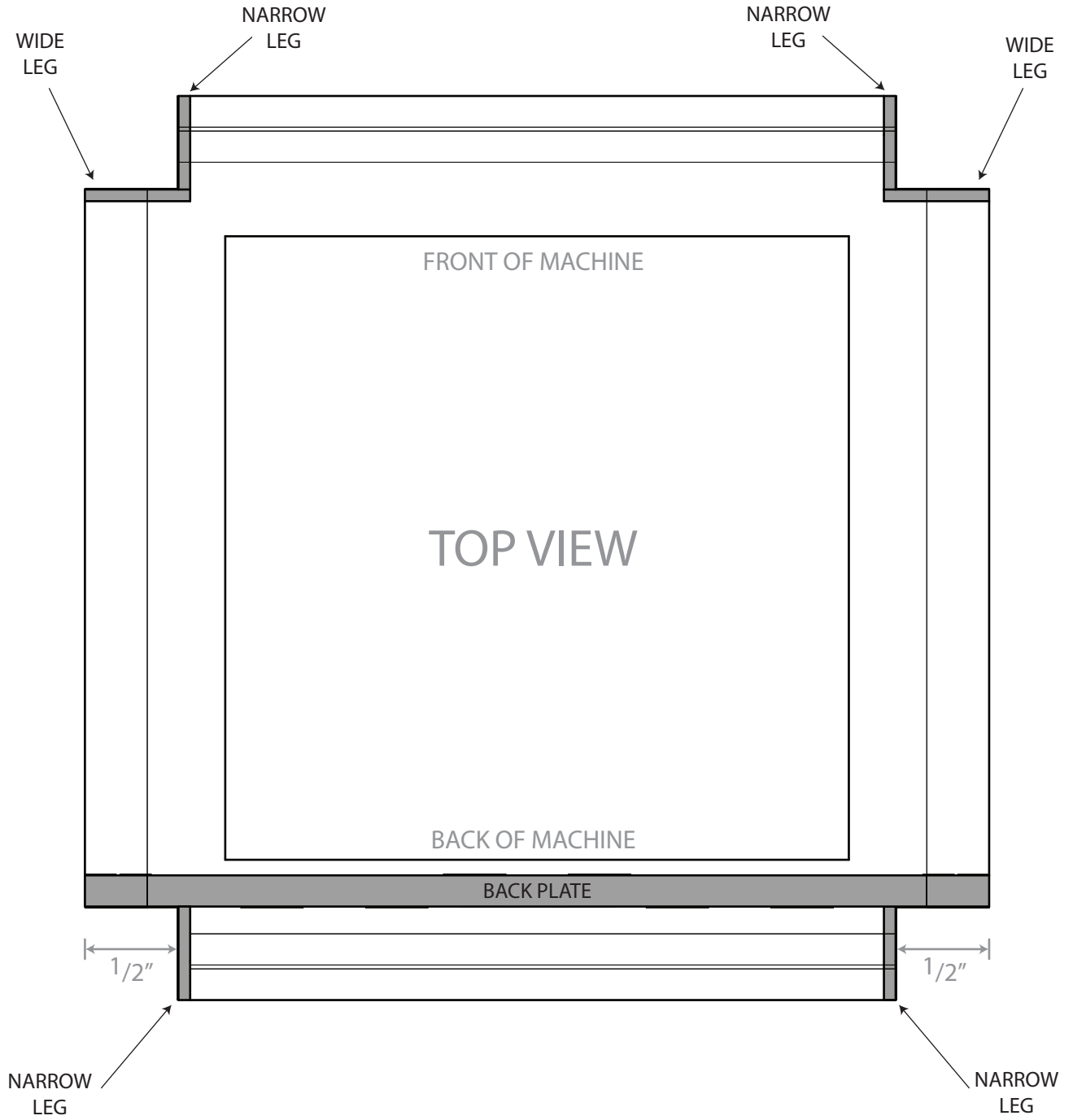
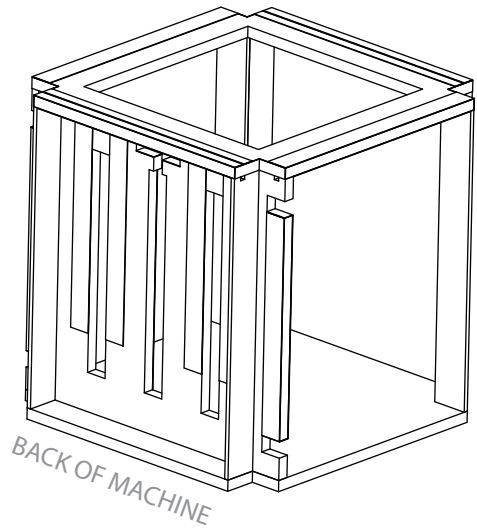
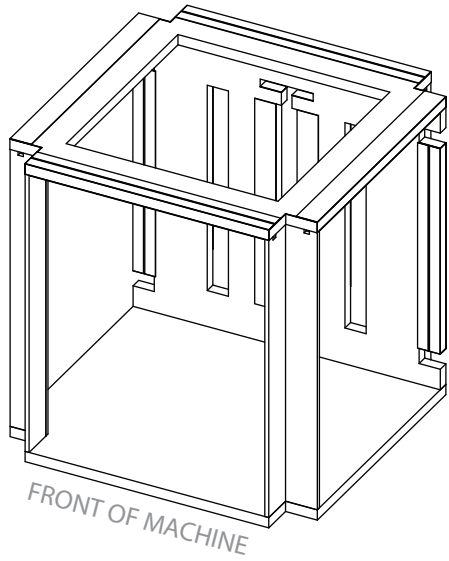


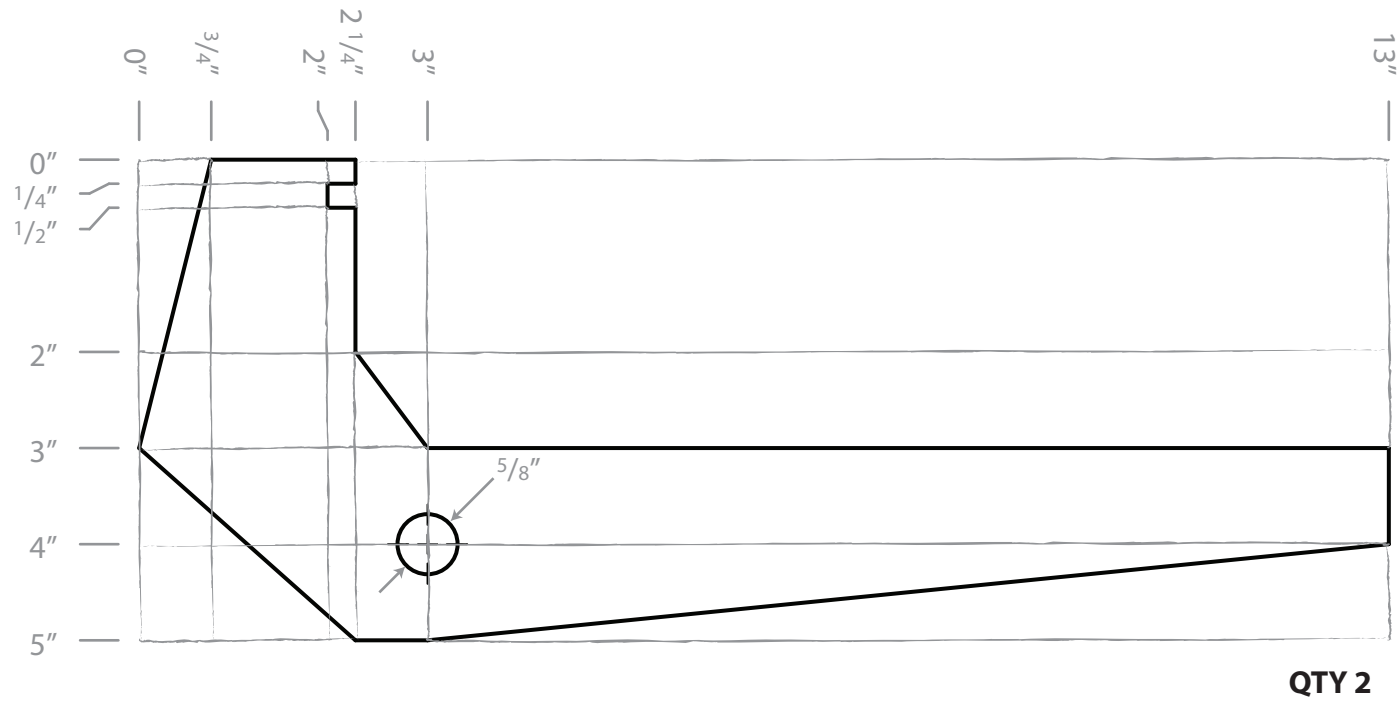
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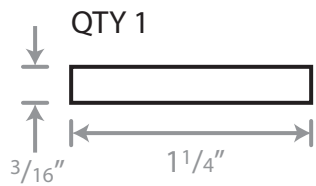
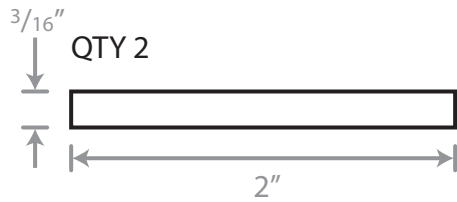
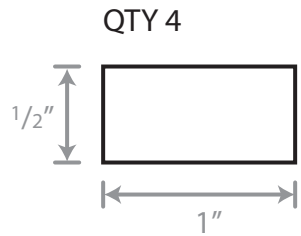
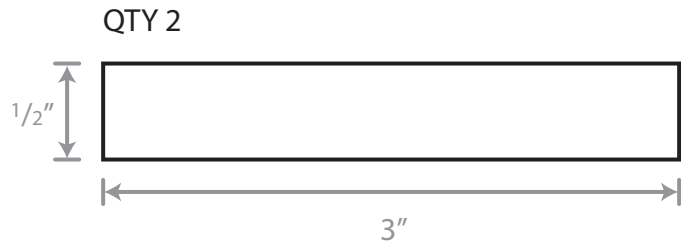




SKETCH LINE
CUT LINE

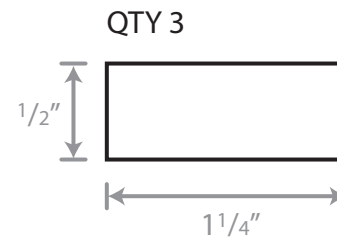
MADE FROM DELRIN STRIP

MADE FROM 3/16" FOAMCORE

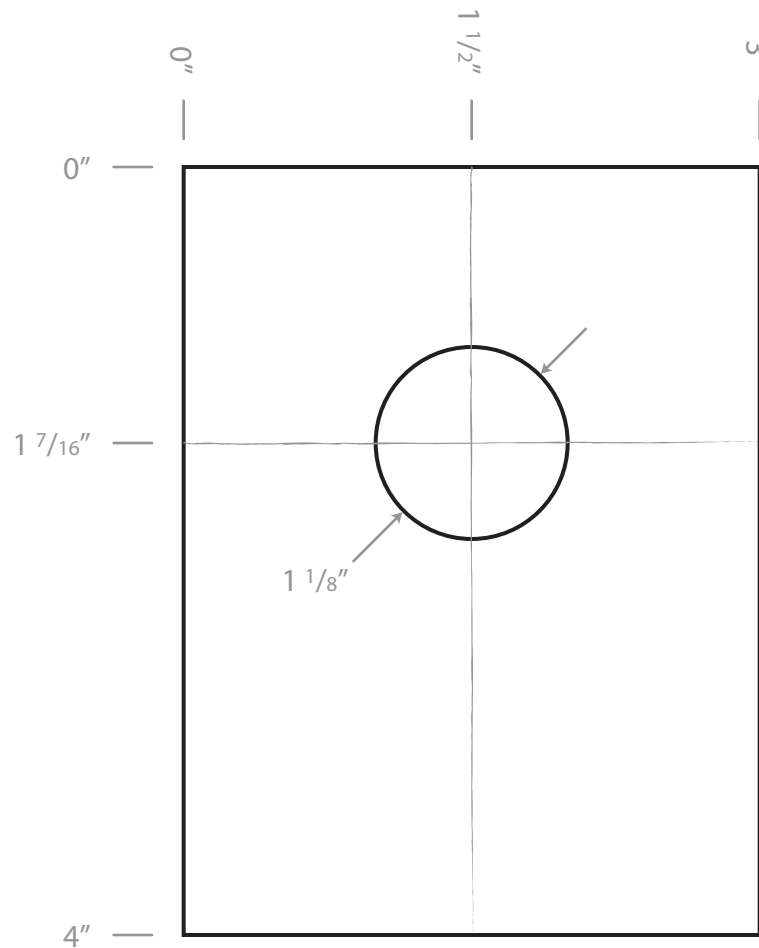


LAMINATED WITH ADHESIVE

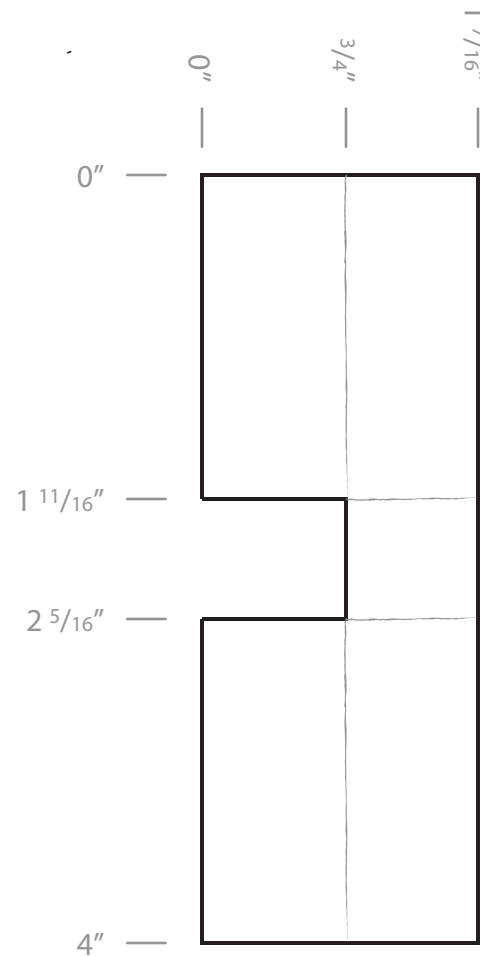
UNLAMINATED



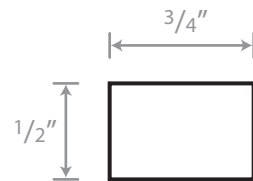
— CUT LINE



BACK PLATE
 MATERIAL: 3/16" FOAMCORE
QTY 3



SIDE PLATE
 MATERIAL: 1/2" FOAMCORE
QTY 6



BEARING STRIPS
 MATERIAL: DELRIN STRIP, LAMINATED WITH ADHESIVE
QTY 12

NOTE: IF POSSIBLE USE A FACTORY-CUT EDGE OF THE FOAMCORE SHEET FOR THIS SURFACE.

— SKETCH LINE
 — CUT LINE