



FABLAB
UNIVERSITY OF TEXAS
AT ARLINGTON

SHOPBOT
DESIGN CONSTRAINTS/
MATERIAL SAMPLE

S.A.C.K. CONSULTATION

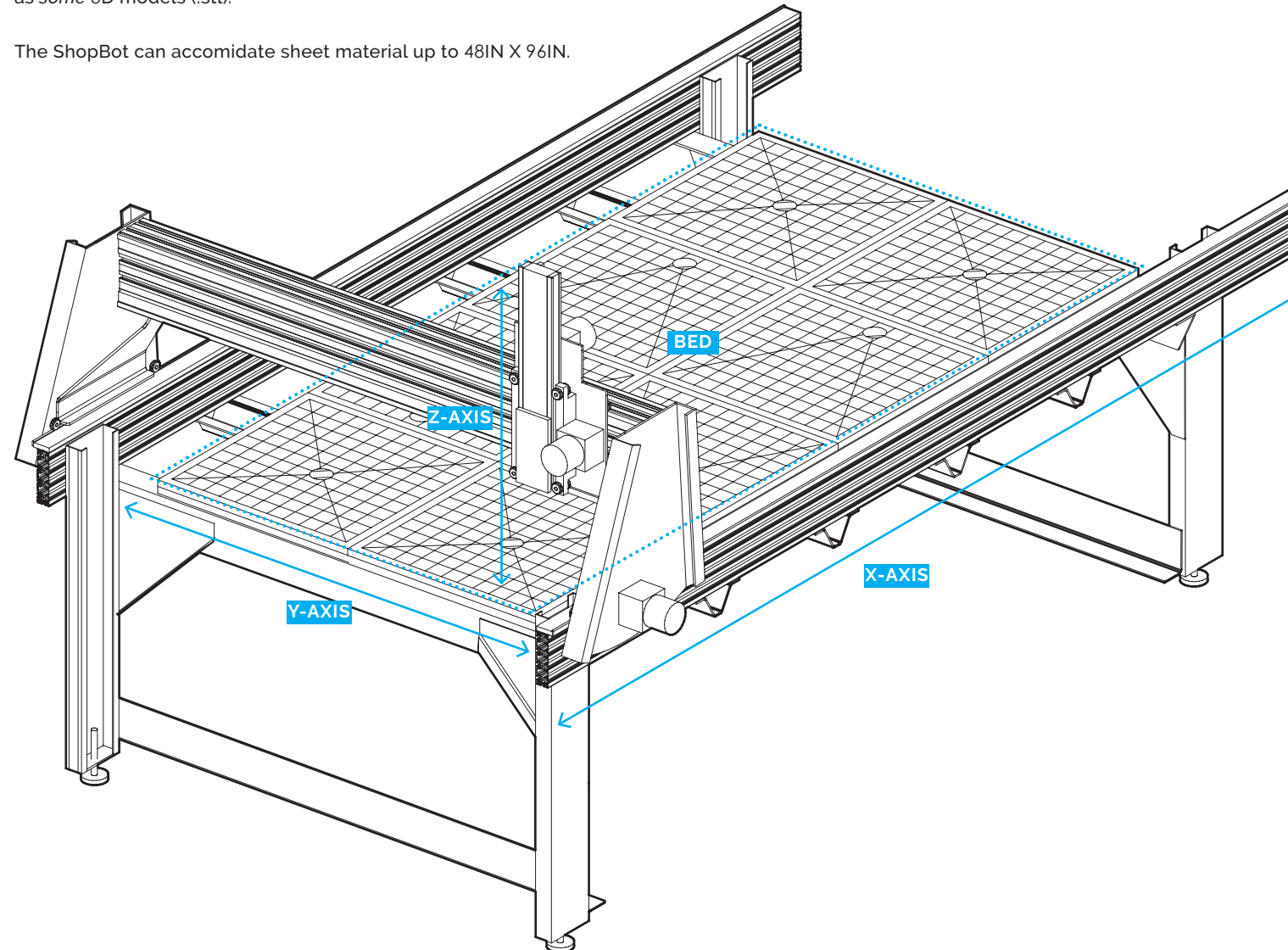
SHOPBOT

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OVERVIEW

The ShopBot is a 3-axis CNC router which uses a rotating bit/endmill to cut or carve through sheet material along set tool paths. During CNC routing, the workpiece is stationary (secured to the bed) and material is removed from the workpiece by the rotating bit/endmill which travels along a 3 linear axis (X,Y,Z) coordinate system. The ShopBot can cut vector designs as well as *some* 3D models (.stl).

The ShopBot can accomodate sheet material up to 48IN X 96IN.





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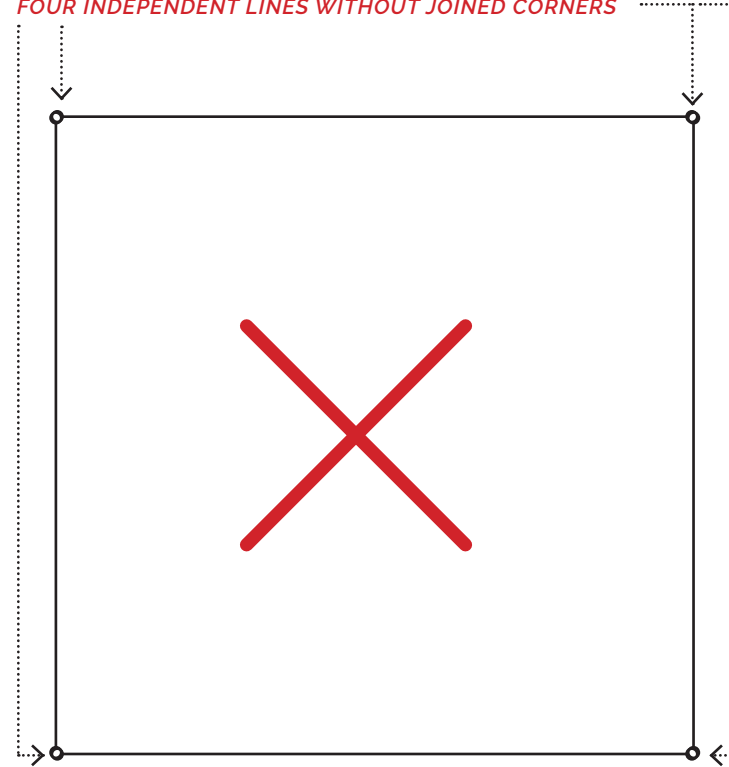
DESIGN CONSTRAINTS

CLOSED VECTORS SHAPES

All vectors must be "closed" shapes to create tool paths. For example, a square with four lines joined at the corners can be cut. A square comprised of four independent lines that intersect yet are not joined at the corners can not be cut. Be sure all shapes are "closed" - all intersecting lines are joined, creating a continuous vector line.

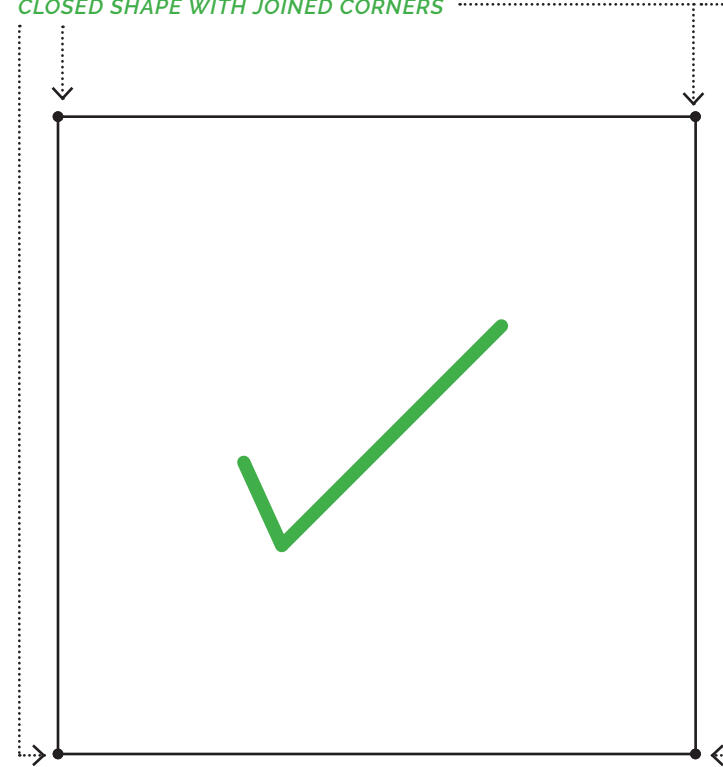
OPEN VECTOR

FOUR INDEPENDENT LINES WITHOUT JOINED CORNERS



CLOSED VECTOR

CLOSED SHAPE WITH JOINED CORNERS



IMPORTANT NOTE

The dots on all four corners are for visual reference to indicate un-joined vs. joined corners. Your design file does not need dots on the corners to verify that it is a closed shape.



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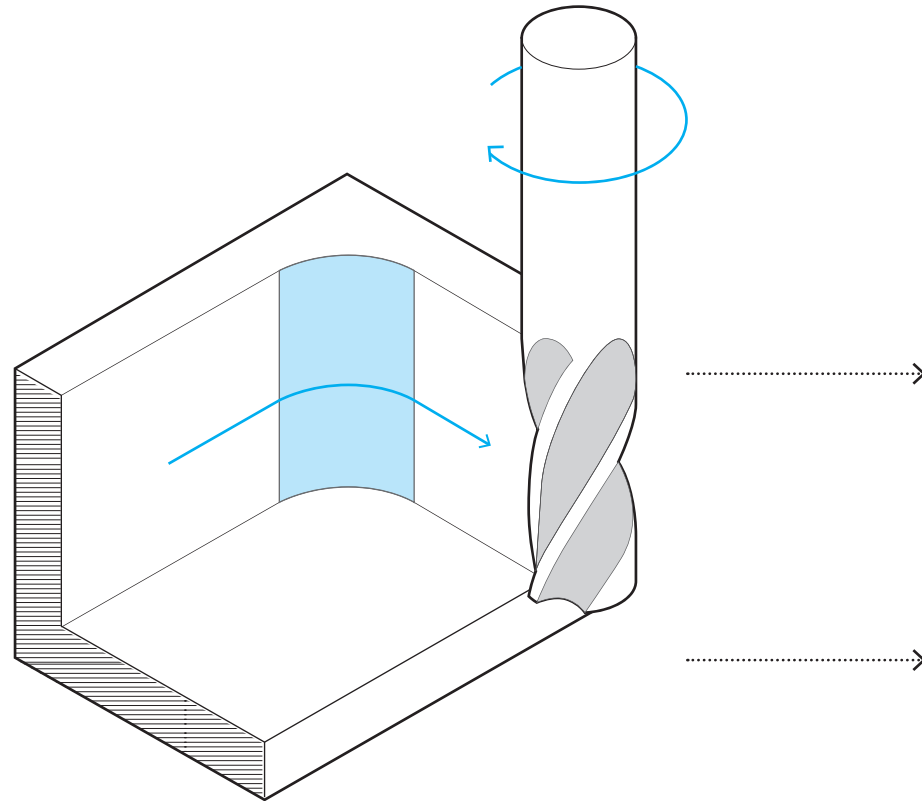
SHOPBOT

DESIGN CONSTRAINTS

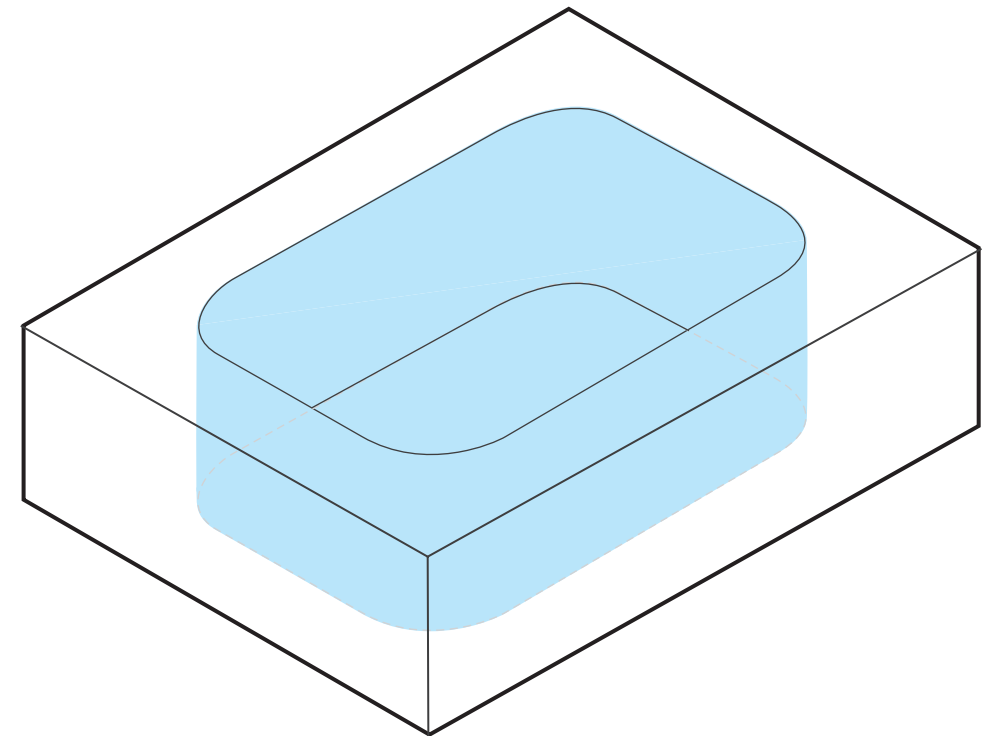
TOOL GEOMETRY - INSIDE (FEMALE) CUTS

A female or inside cut removes material from the piece to reveal a cavity or pocket. Like most CNC routers, the ShopBot uses cylindrical shape endmills. The result is that the internal vertical corners of a female or inside cut will always have a radius, no matter how small a cutting tool is used. Female cuts can be set to various depths - either partially or completely through the material.

INSIDE CUTS - CAVITIES AND POCKET



PART GEOMETRY



IMPORTANT NOTE - CORNER RADIUS

The FabLab typically uses .25IN endmills.



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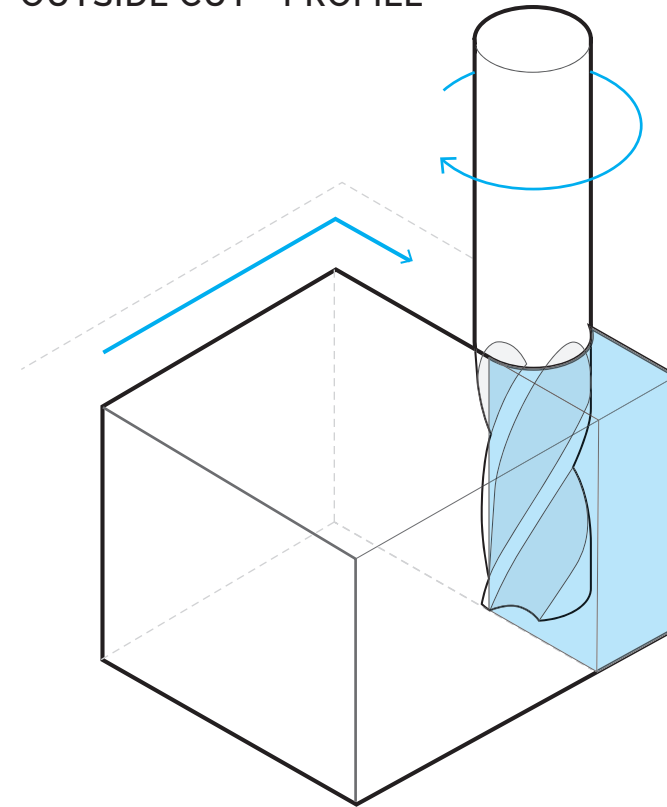
SHOPBOT

DESIGN CONSTRAINTS

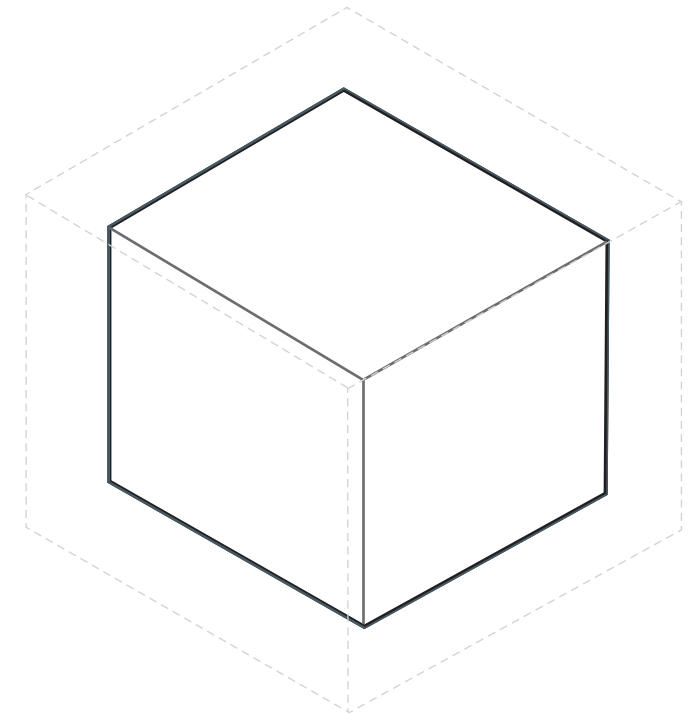
TOOL GEOMETRY - OUTSIDE (MALE) CUTS

Male cuts are outside cuts of a piece or the final cut to remove the piece from the material. Creating sharp inside corners is impossible because of the cylindrical geometry of the endmill. Please consider this when designing male pieces with inside corners.

OUTSIDE CUT - PROFILE



PART GEOMETRY



IMPORTANT NOTE - CORNER RADIUS

The FabLab typically uses .25IN endmills.



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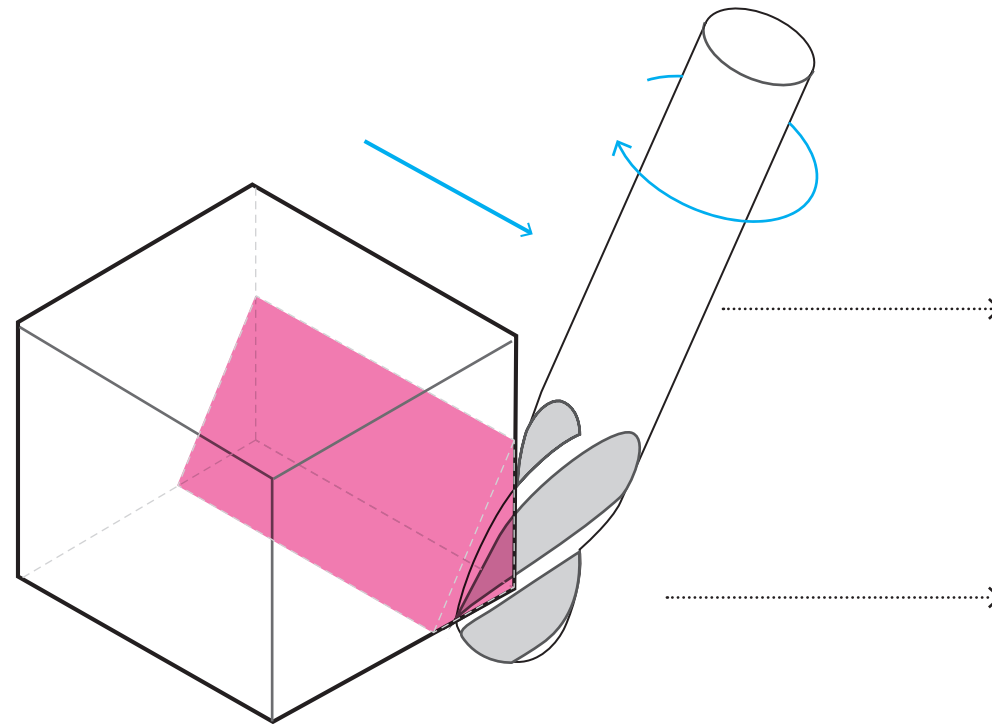
SHOPBOT

DESIGN CONSTRAINTS

TOOL ACCESS - UNDERCUT

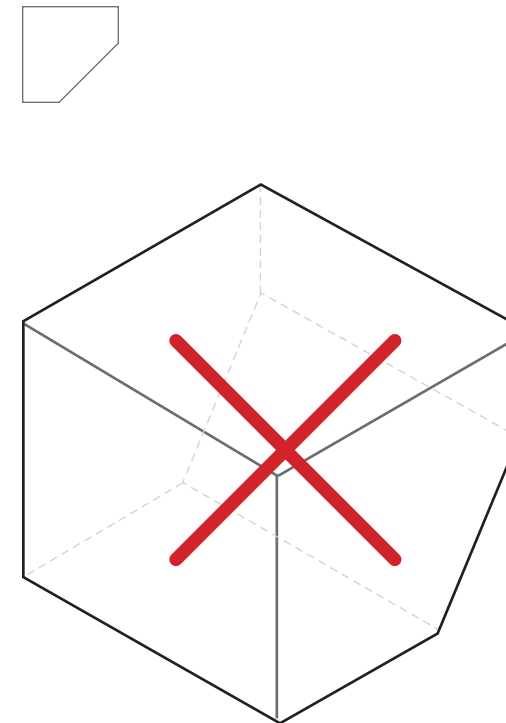
The ShopBot can only travel vertically along the z-axis and the FabLab currently uses non-undercutting endmills. This prohibits cutting parts with undercut or hidden geometries.

OUTSIDE CUT - UNDERCUT



PART GEOMETRY

SIDE VIEW



IMPORTANT NOTE - TAPERS WITH POSITIVE DRAFT

Reorienting the part might allow for the undercut to be cut as a taper with a positive draft angle.



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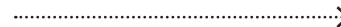
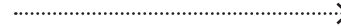
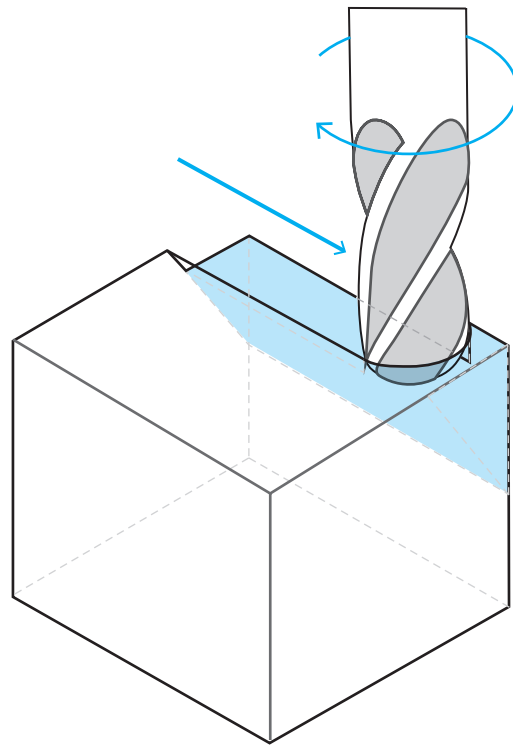
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DESIGN CONSTRAINTS

TOOL ACCESS - OUTSIDE TAPER

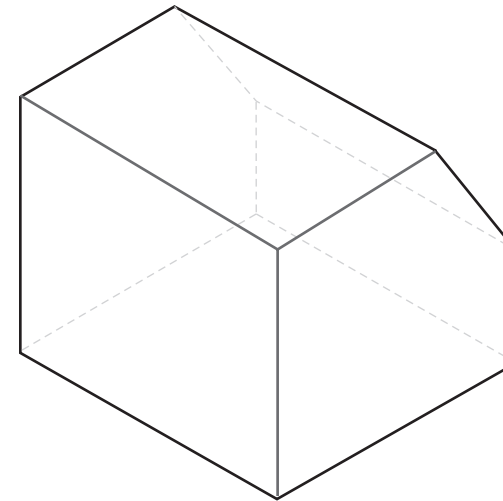
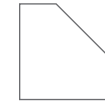
A taper is a difference between the size of the top and bottom surfaces of a part. This gives the part a slanted (non-vertical) wall. It is measured in terms of length. Draft is the measured angle of taper. Tapered geometries with a positive draft angle can be performed as an outside cut.

OUTSIDE CUT - POSITIVE DRAFT ANGLE



PART GEOMETRY

SIDE VIEW



IMPORTANT NOTE - DRAFTS AND TAPERS

For Outside profile cuts, positive angle draft and tapers can be cut. Orient your part so that if it is an outside cut



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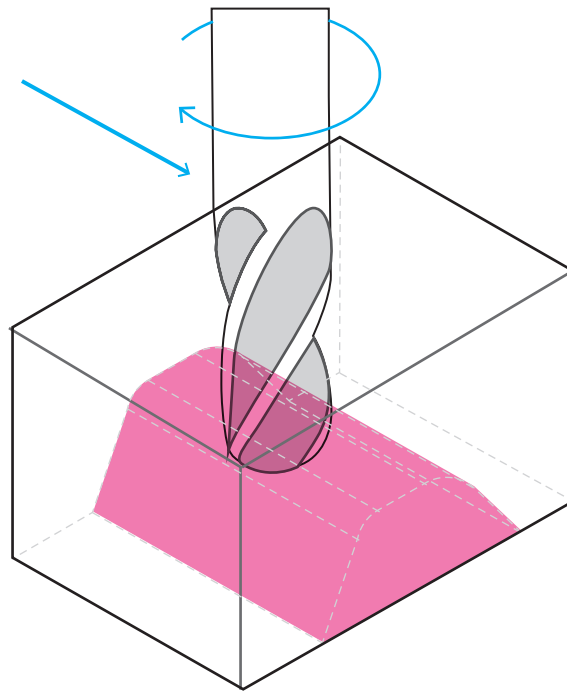
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DESIGN CONSTRAINTS

TOOL ACCESS - INSIDE TAPER

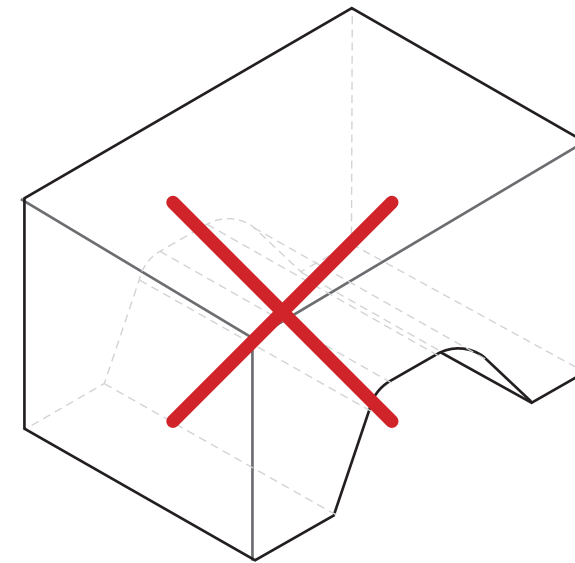
Inside tapers should have a negative draft angle which means that inside cuts should be wider at the top than at the bottom. This gives the part a slanted (non-vertical) walls.

INSIDE CUT - NEGATIVE DRAFT ANGLE



PART GEOMETRY

SIDE VIEW



IMPORTANT NOTE - DRAFTS AND TAPERS

For Inside cuts, negative draft angles and tapers can be cut. Orient your part so that the widest part of the taper is on the top surface being cut.



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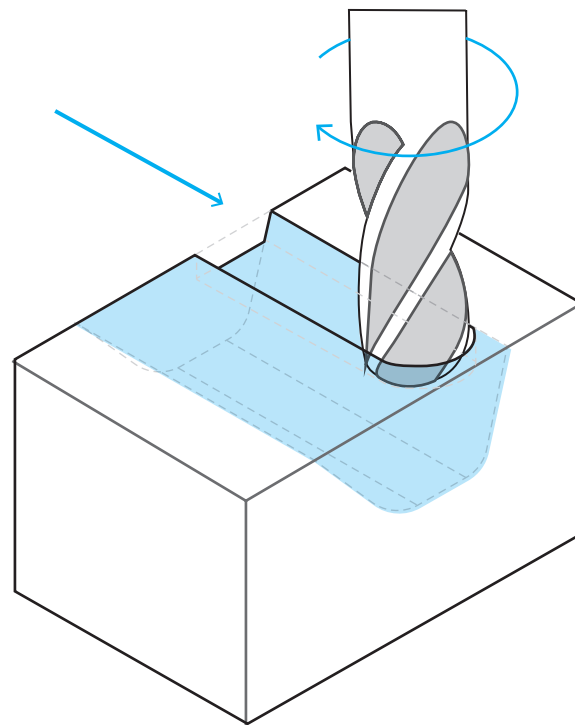
SHOPBOT

DESIGN CONSTRAINTS

TOOL ACCESS - INSIDE TAPER

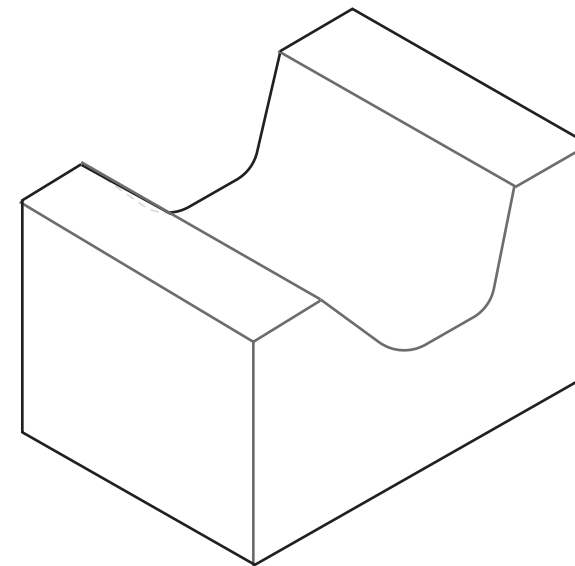
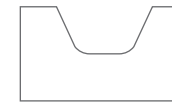
Inside tapers should have a negative draft angle which means that inside cuts should be wider at the top than at the bottom. This gives the part a slanted (non-vertical) walls.

INSIDE CUT - NEGATIVE DRAFT ANGLE



PART GEOMETRY

SIDE VIEW



IMPORTANT NOTE - DRAFTS AND TAPERS

For inside cuts, negative draft angles and tapers can be cut. Orient your part so that the widest part of the taper is on the top surface being cut.



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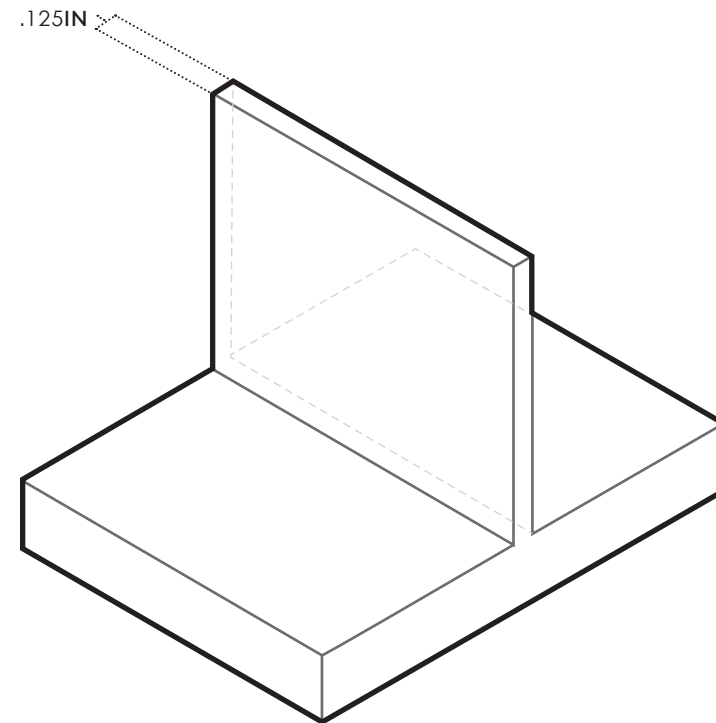
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DESIGN CONSTRAINTS

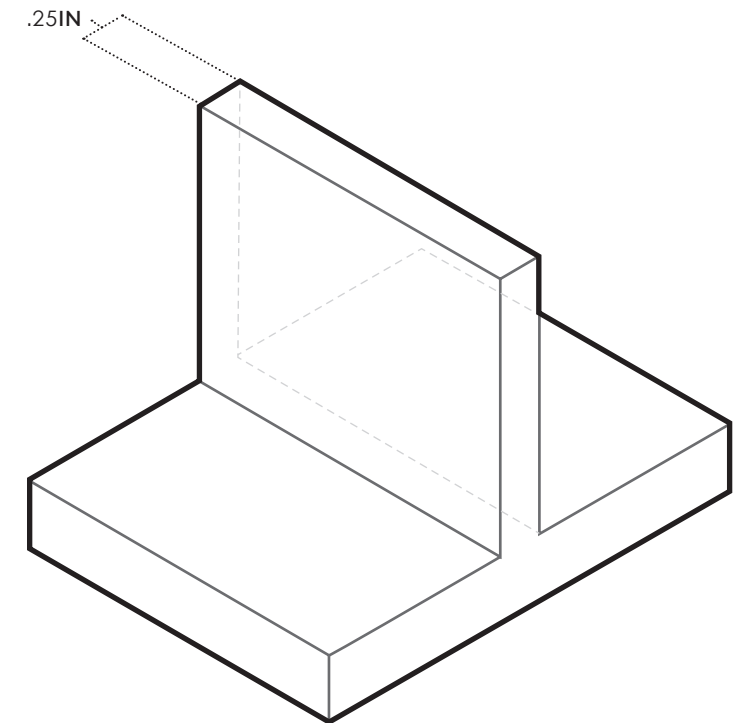
TOOL GEOMETRY - MINIMUM WALL THICKNESS

The forces produced by cutting can be significant and therefore can cause thin sections of material to deform or break off. We ask that designs have no less than a .25IN wall thickness for any part.

< .25IN OFFSET



≥ .25IN OFFSET



IMPORTANT NOTE - WALL THICKNESS

Depending on your part's complexity, a .25IN minimum wall thickness still might not yield the desired results. Please discuss your design intent with us, and we'll advise you on ways to adjust your file.



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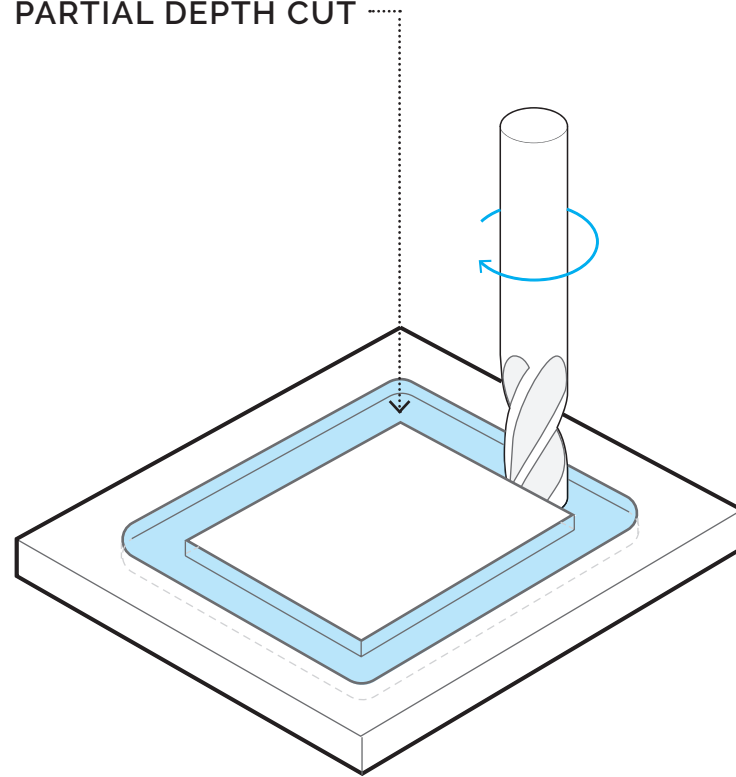
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SHOPBOT CUT DEPTH

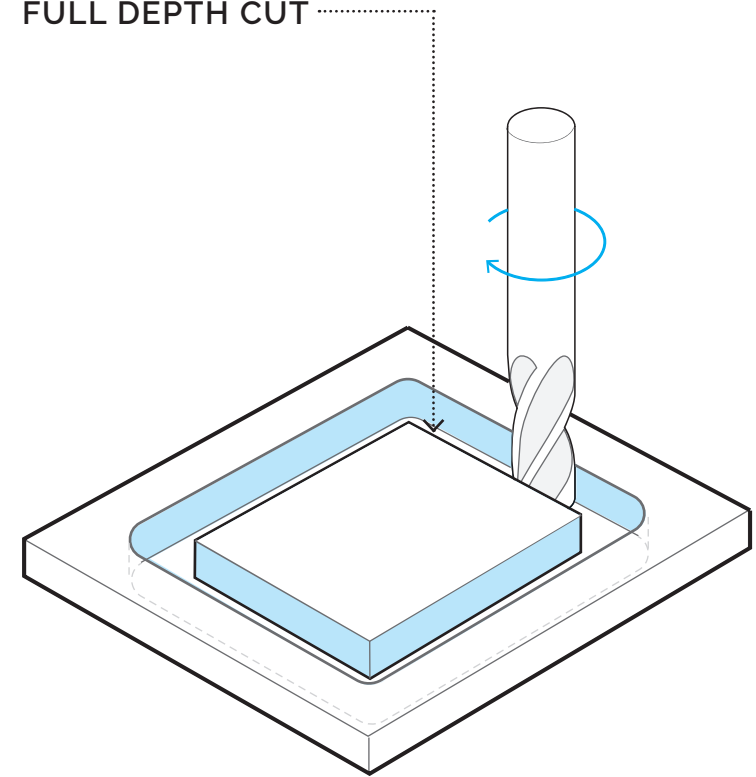
PARTIAL AND FULL DEPTH CUTS

Cuts can be set to a desired depth. This is especially important for milling out cavities or pocket cuts. Cuts can also be set to go completely through the material - allowing the part to be removable from the original sheet material.

PARTIAL DEPTH CUT



FULL DEPTH CUT



IMPORTANT NOTE - PARTIAL DEPTH CUT

If needing multiple partial depth cut, please organize each on thier own layer and specify the depth of the cut and in the layer name.



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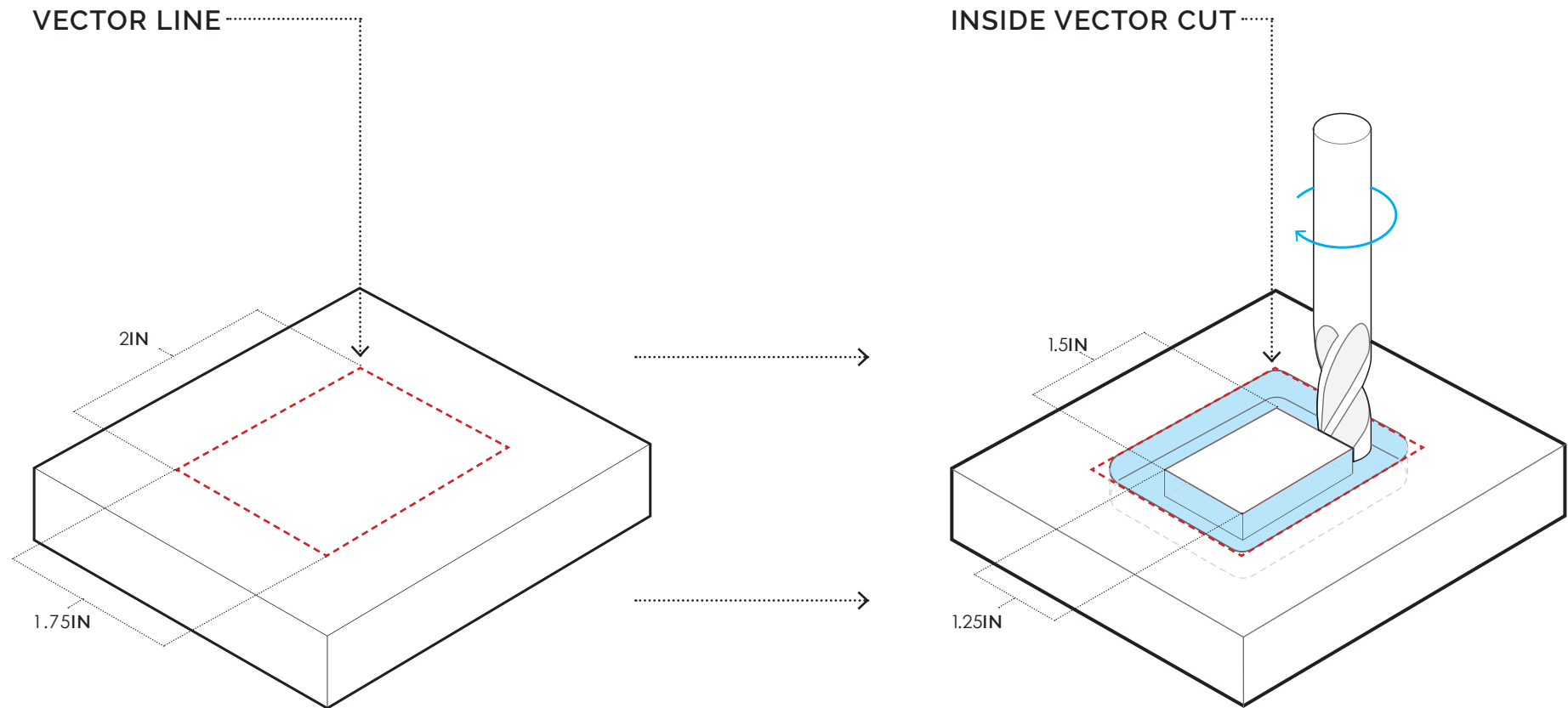
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VECTOR FILE PREP

VECTOR CUTTING - INSIDE VECTOR

For inside vector cuts, the endmill will remove material from the inside of the vector line. With a .25IN endmill, .25IN will be removed from the inside of the vector line on all sides.



IMPORTANT NOTE - INSIDE VECTOR CUT

The vector line for all three slides are exactly the same. The only difference is where the endmill will cut - inside the vector, on the vector, or outside the vector line.



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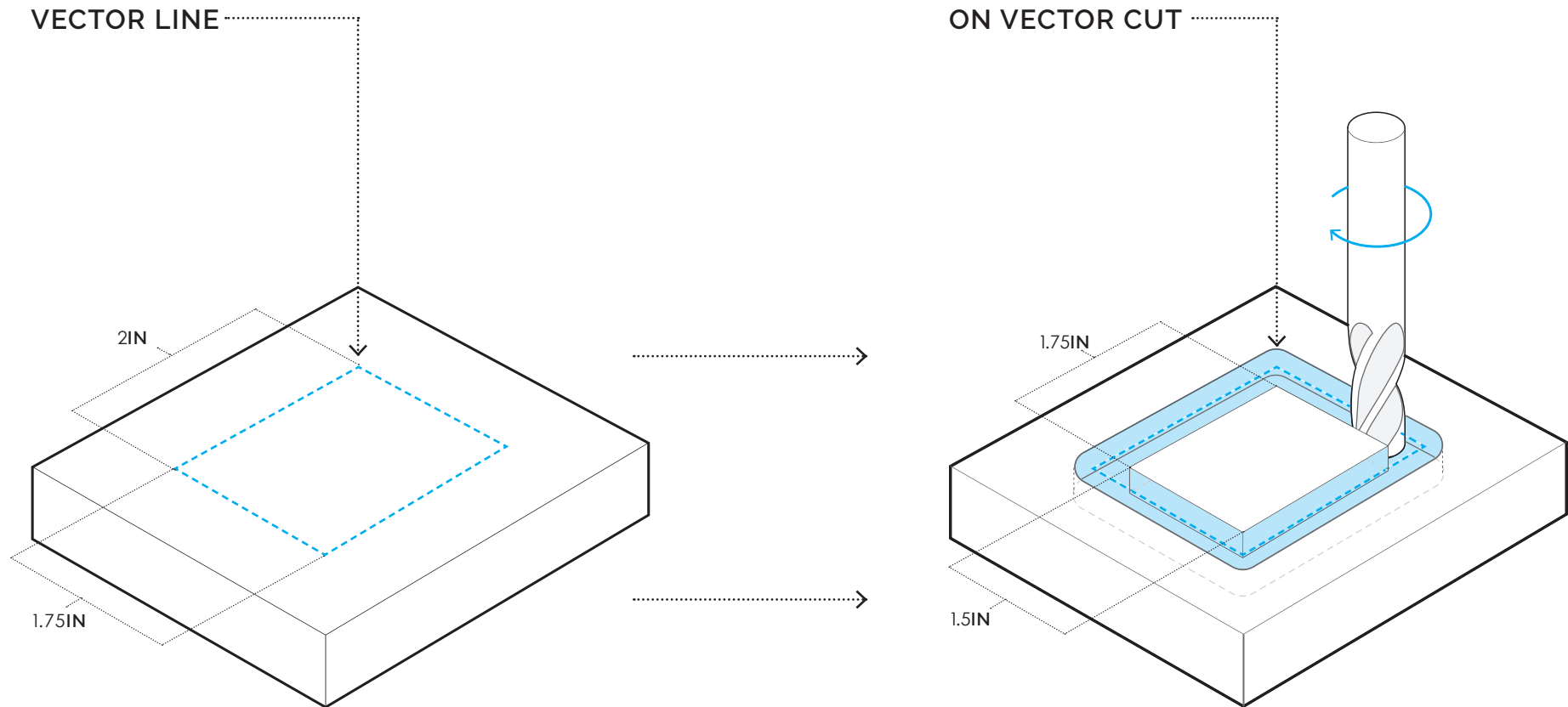
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VECTOR FILE PREP

VECTOR CUTTING - ON VECTOR

For on vector cuts, the endmill will remove material along the vector line. With a .25IN endmill, .125IN will be removed from the inside of the vector line on all sides.



IMPORTANT NOTE - ON VECTOR CUT

The vector line for all three slides are exactly the same. The only difference is where the endmill will cut - inside the vector, on the vector, or outside the vector line.



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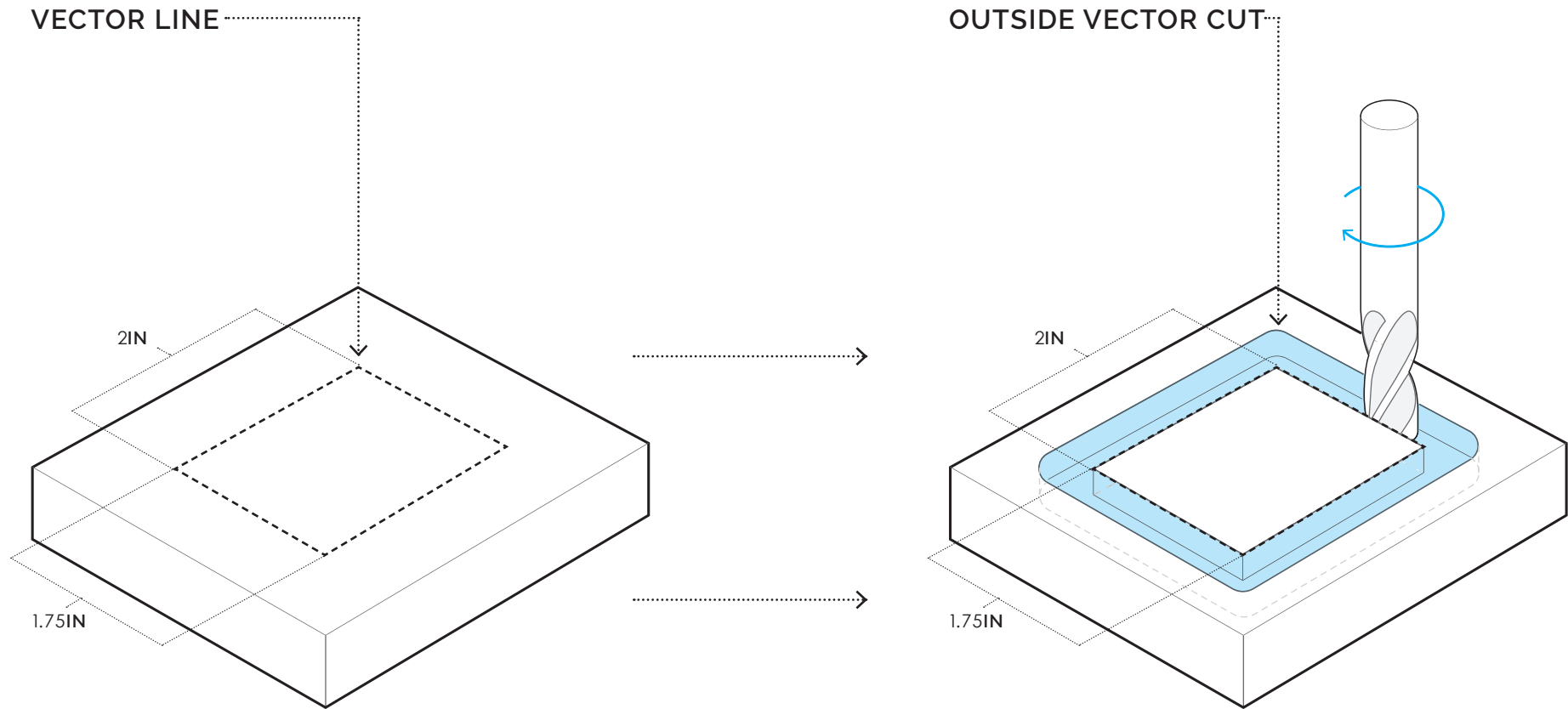
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VECTOR FILE PREP

VECTOR CUTTING - OUTSIDE VECTOR

For outside vector cuts, the endmill will remove material from the outside of the vector line. With a .25IN endmill traveling along the outside of the vector, material will be removed up to the outside of the vector line but not within the vector line itself.



IMPORTANT NOTE - OUTSIDE VECTOR CUT

The vector line for all three slides are exactly the same. The only difference is where the endmill will cut - inside the vector, on the vector, or outside the vector line.



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VECTOR FILE PREP

COLOR MAPPING

Assign red line color to all vectors you intend to be Inside Vector Cuts, blue line color to all vectors you intend to be On Vector Cuts, and black line all vectors you intend to be Outside Vector Cuts.

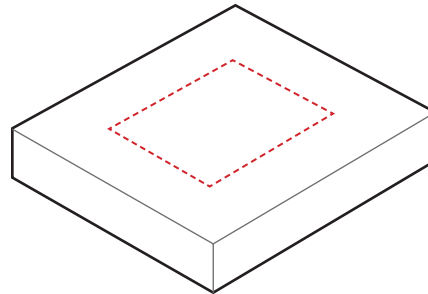
This concept is known as Color Mapping and allows the FabLab staff to ensure your project is completed as intended. Please use the following Color Map settings:

- ALL INSIDE VECTOR CUT LINES ARE CLOSED SHAPES AND WITH A RED LINE COLOR - NO FILL
- ALL ON VECTOR CUT LINES ARE CLOSED SHAPES AND WITH A BLUE LINE COLOR - NO FILL
- ALL OUTSIDE VECTOR LINES ARE CLOSED SHAPES AND WITH A BLACK LINE COLOR - NO FILL

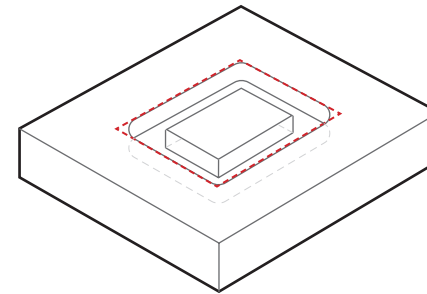
INSIDE VECTOR



VECTOR DESIGN

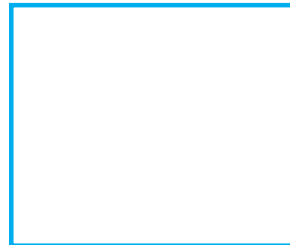


VECTOR ON MATERIAL

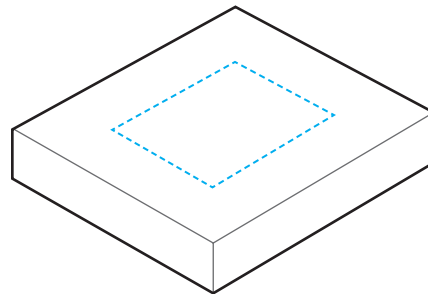


MATERIAL RESULT

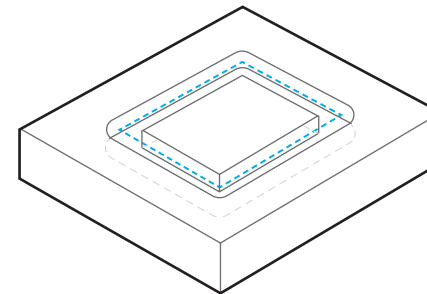
ON VECTOR



VECTOR DESIGN



VECTOR ON MATERIAL

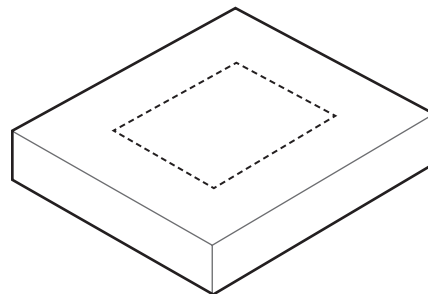


MATERIAL RESULT

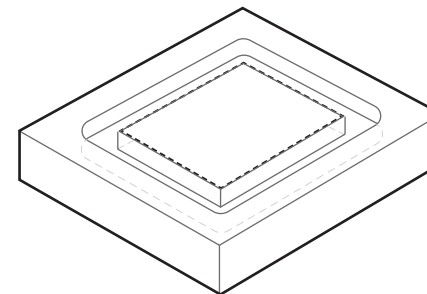
OUTSIDE VECTOR



VECTOR DESIGN



VECTOR ON MATERIAL



MATERIAL RESULT



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VECTOR FILE PREP

REFERENCE BORDER

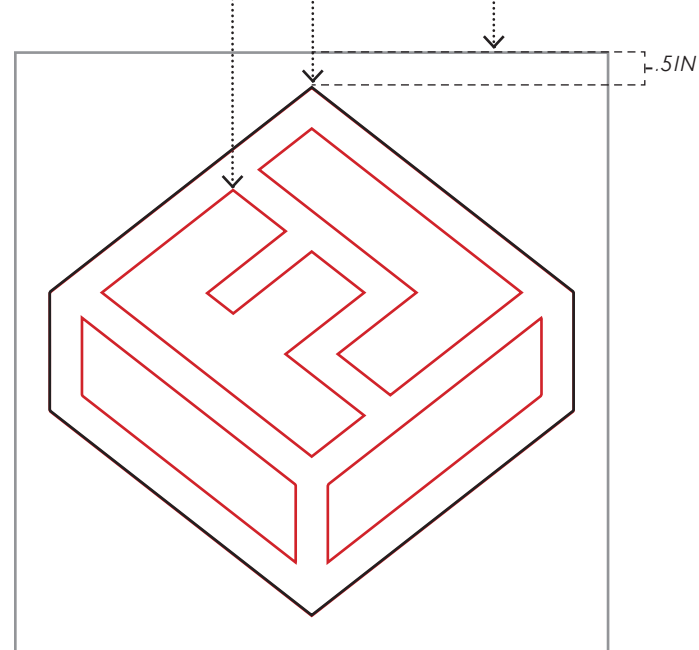
To ensure import of you file is scaled properly, include a reference border around your design. The reference border line must be black and outset by at least .5IN from the design and multiple part be at least .75IN spaces apart.

REFERENCE BORDER - SINGLE PART

REFERENCE BORDER (50% GREY LINE COLOR)

OUTSIDE CUT

INSIDE CUT

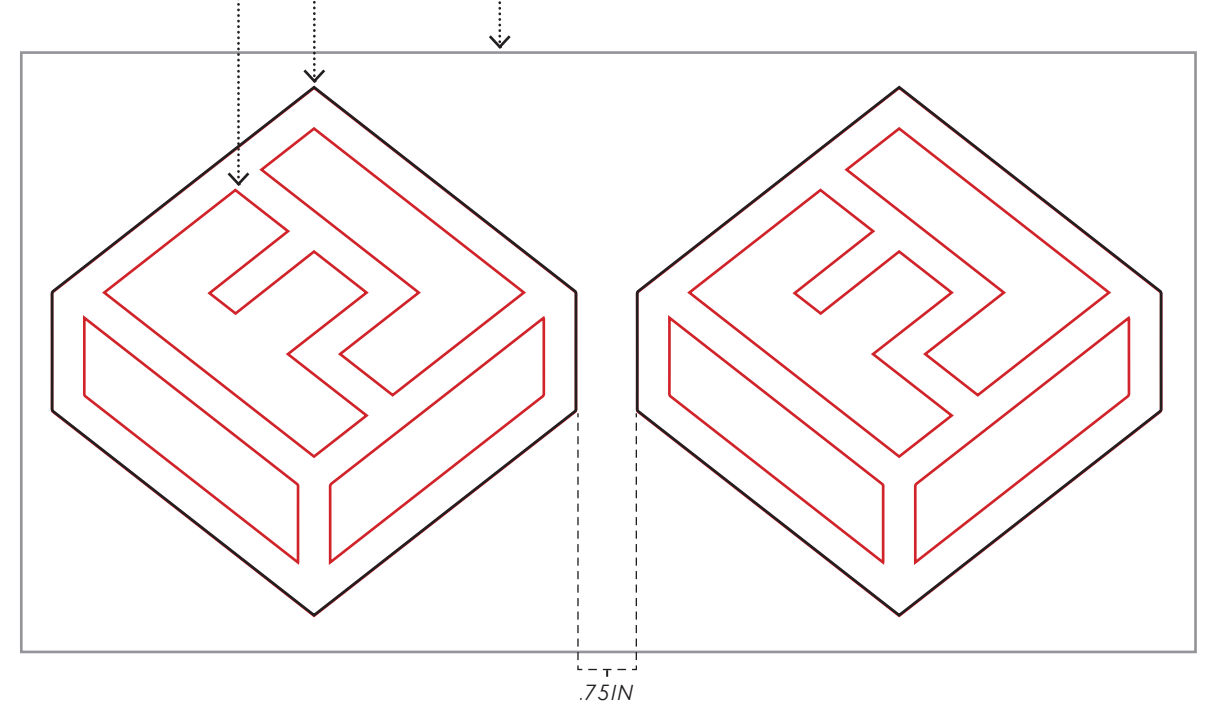


REFERENCE BORDER - NESTED PARTS

REFERENCE BORDER (50% GREY LINE COLOR)

OUTSIDE CUT

INSIDE CUT



IMPORTANT NOTE - NESTING PARTS

Multiple parts should be nested together but with at least a .75IN offset distance between each vector.



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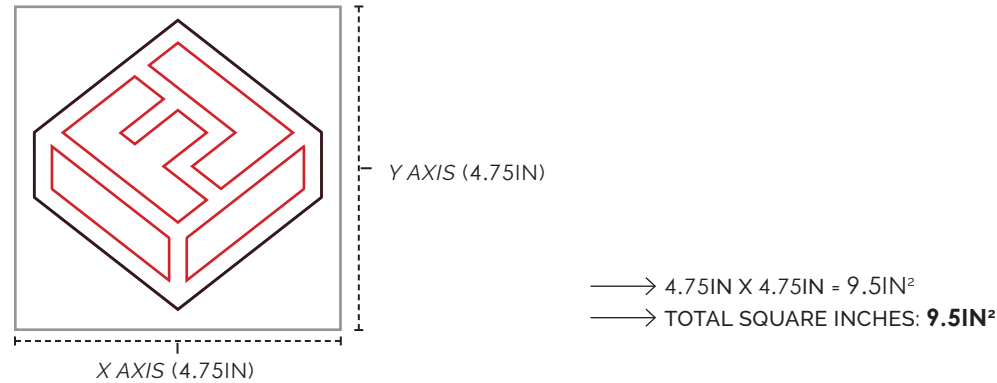
SHOPBOT

VECTOR FILE PREP

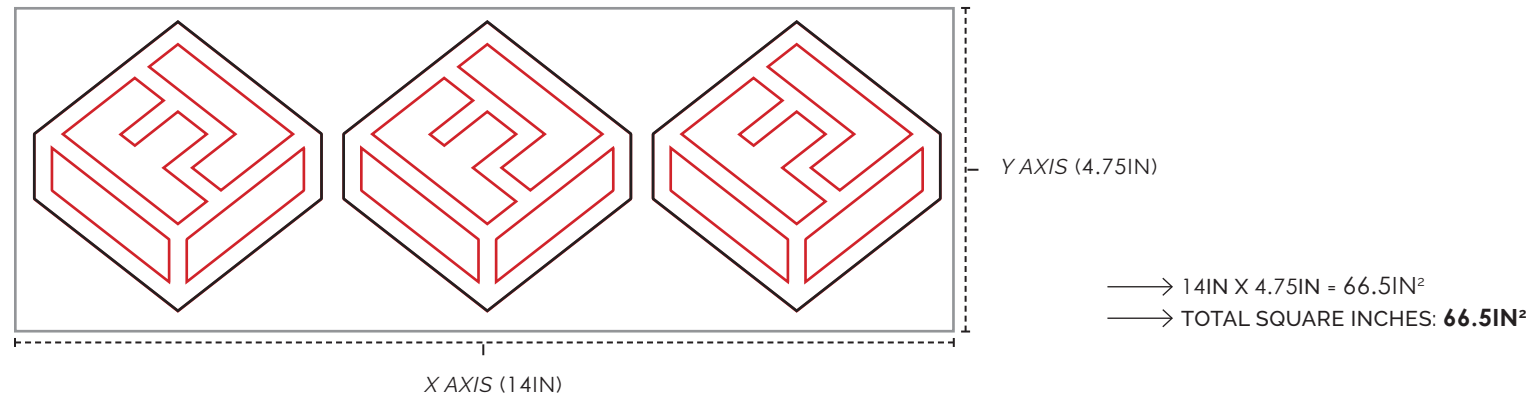
CALCULATING PER IN²

The FabLab charges ShopBot material by square inches based on the reference border in your file. The reference border line must be black and off-set by at least .5IN from the design. For example, if your project is 4.25IN X 4.25IN, your border must be 4.75IN X 4.75IN.

REFERENCE BORDER - SINGLE PART



REFERENCE BORDER - NESTED PARTS



CALCULATING TOTAL AMOUNT

To accommodate the issue of charging a fraction non-whole number square inches, we round up the total price to the nearest whole penny. For example, a project that is 66.5IN² of 16 Gauge Sheet Steel will be rounded from \$3.325 to \$3.33..



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VECTOR FILE PREP

VECTOR FILE TYPES

The FabLab Shop Room can accommodate for the following vector file types:

- .AI - ADOBE ILLUSTRATOR
- .DXF - DRAWING EXCHANGE FORMAT
- .DWG - DRAWING FORMAT
- .SVG - SCALABLE VECTOR GRAPHICS

VECTOR EXPORT

The FabLab Shop Room can accommodate for the following vector file types:

- ENSURE ALL SHAPES ARE "CLOSED"
- CONVERT ALL JPEGS, PNGS, TIFFS, AND TEXT TO VECTOR BASED GRAPHICS
- FOR SCALING PURPOSES, INCLUDE A SQUARE/RECTANGLE REFERENCE BORDER AROUND YOUR DESIGN
- X,Y DIMENSIONS OF THE REFERENCE BORDER MUST BE IN INCHES AND WHOLE NUMBERS.
- CLEAR ALL CONSTRUCTION GEOMETRY/GUIDES
- DELETE ALL EXTEMPORANEOUS ANCHOR POINTS IN YOUR FILE
- ENSURE VECTOR LINEWORK IS "NORMAL TO" OR PERPENDICULAR TO VIEW WINDOW BEFORE EXPORT



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SHOPBOT MATERIAL SAMPLES

RUSSIAN BIRCH PLYWOOD - 12MM / 18MM

SPECIFICATIONS

- MATERIAL GRADE - B/BB
- MATERIAL COST - \$0.03 SQ/IN (12MM) / \$0.04 SQ/IN (18MM)
- MATERIAL THICKNESS - .472IN OR 12MM / .708IN OR 18MM
- MATERIAL DIMENSIONS - 48IN X 96IN

DESCRIPTION

B/BB Grade Russian Birch Plywood - Single piece face and back veneer. Face veneers are considered clear and free of defects with a light-uniform color. The back allows 3-6 color-matched patches, which are oval in shape and egg-sized. Inner cores are solid birch single piece veneers.

SURFACE



END GRAIN



MATERIAL SAMPLE (W/PAINT)





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SHOPBOT MATERIAL SAMPLES

MEDIUM-DENSITY FIBREBOARD (MDF) - .5IN / .75IN

SPECIFICATIONS

- MATERIAL GRADE - MEDIUM DENSITY
- MATERIAL COST - \$0.01 SQ/IN (.5IN) / \$0.02 SQ/IN (.75IN)
- MATERIAL THICKNESS - .5IN OR 12.7MM / .75IN OR 19MM
- MATERIAL DIMENSIONS - 48IN X 96IN

DESCRIPTION

Medium-density fibreboard (MDF) - is an engineered wood product composed of hardwood or softwood wood fibres combining it with wax and a resin binder, and forming it into panels by applying high temperature and pressure. MDF is generally more dense than plywood and can be milled/cut with less grain texture.

SURFACE



END GRAIN



MATERIAL SAMPLE (W/PAINT)





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SHOPBOT MATERIAL SAMPLES

PINK FORMULA 150 SHEET FOAM - 2IN

SPECIFICATIONS

- MATERIAL GRADE - FORMULA 150
- MATERIAL COST - \$0.03 SQ/IN
- MATERIAL THICKNESS - 2IN OR 12.7MM / .75IN OR 19MM
- MATERIAL DIMENSIONS - 48IN X 96IN

DESCRIPTION

Pink Formula 150 Sheet Foam - is a lightweight rigid extruded polystyrene sheet (XPS) foam used primarily for insulation sheathing. Conventional direction routing yields a smooth edge whereas climb direction routing typically leaves a rough texture.

SURFACE



END GRAIN



MATERIAL SAMPLE (W/PAINT)

