Laser / CNC Related Concepts

A printable reference collection of vector explainers for design, setup, cutting, engraving, assembly, and production workflows.

How to use this PDF

- Use the index to find a concept quickly.
- Each concept fills one page for easy teaching or reference.
- The diagrams are static final states of the SVG animations.
- Use the HTML page when you want the animated version.

Precision - Creativity - Excellence

Introduction

Vector Concepts

Clean paths, exact geometry, offsets, layers, and readable construction lines help convert digital drawings into reliable machine work.

Machine Setup

Origin, focus, airflow, workholding, preview framing, and cut order are practical setup details that protect material and improve results.

Testing

Material tests, fit tests, engraving samples, and recorded settings turn guesswork into repeatable production knowledge.

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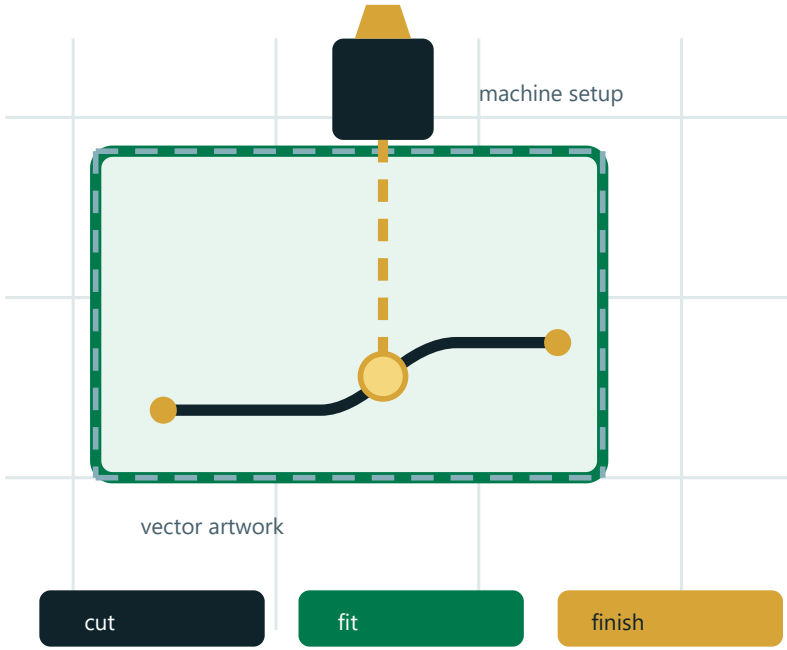
Start here: how to use this page

Laser / CNC related concepts

A browsable library of short animated explainers for design, setup, cutting, engraving, and production.



What this page does

- Shows one concept at a time
- Keeps each animation linkable
- Groups topics by workflow

`learn - test - make`

Choose a topic, then view, loop, expand, or download the concept.

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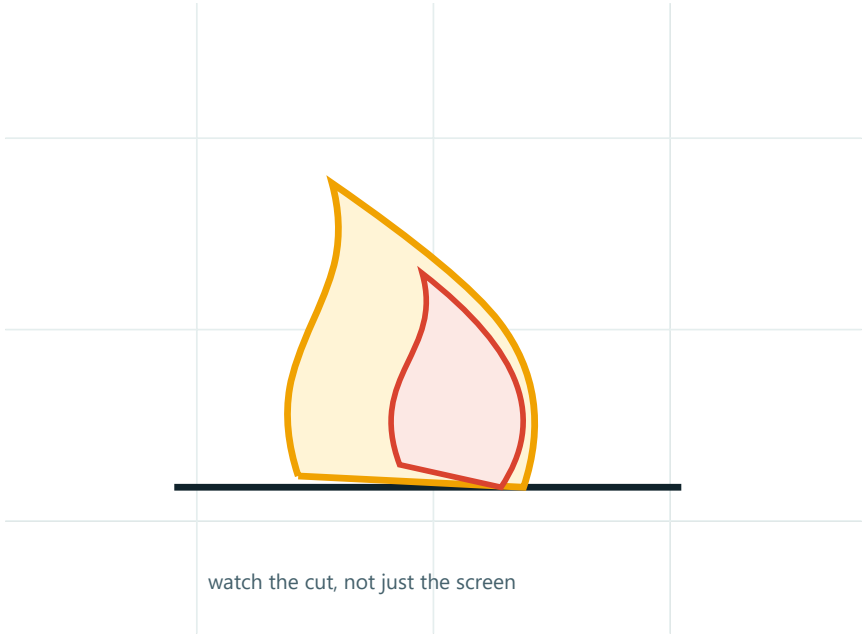
Fire risk and flare-ups

Fire risk and flare-ups

Thin, oily, dusty, or resin-rich materials can ignite quickly.



watch the cut, not just the screen

Fire watch

flame can spread

air can feed fire

pause if needed

keep extinguisher near

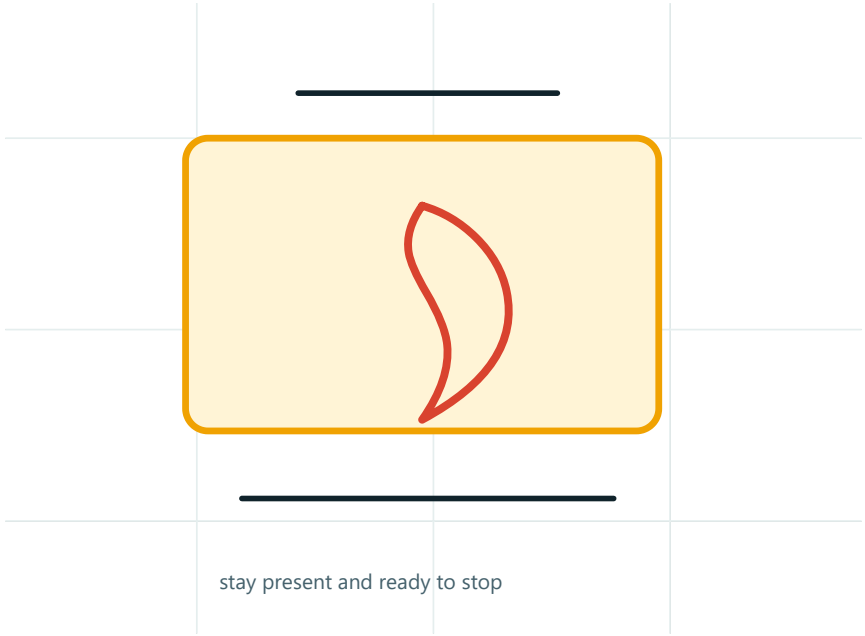
Flare-ups need immediate attention.

Clean beds and correct settings reduce risk.

Laser safety basics

Laser safety basics

Fire watch, eye safety, and supervision are part of every job.



Safety rule

never leave machine

watch for flame

protect eyes

know emergency stop

Safety checks happen before every cut.

A small job can still create fire or fumes.

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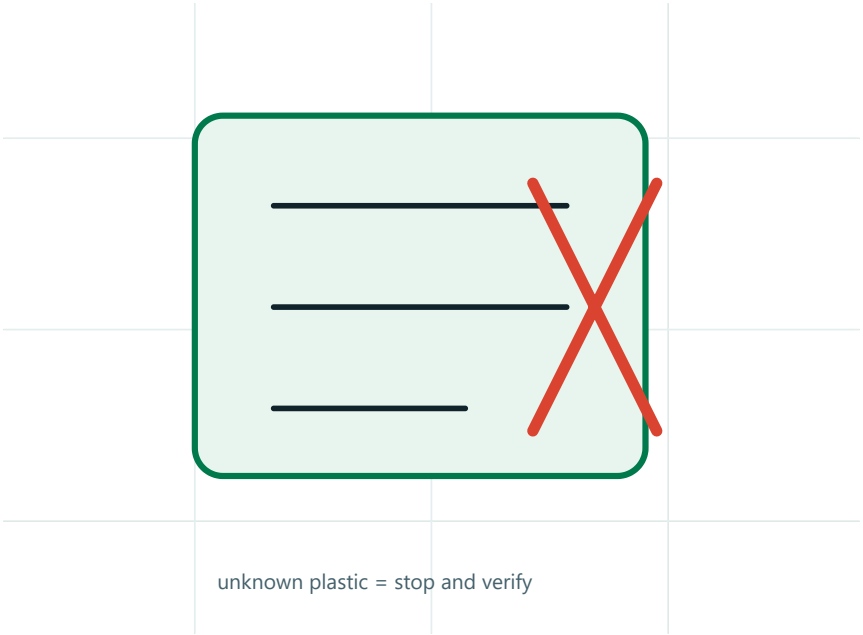
Material compatibility and toxic fumes

Material compatibility and toxic fumes

Some materials are unsafe to cut or engrave.



unknown plastic = stop and verify

Material check

identify material first

avoid unknown plastics

PVC is dangerous

check safety data

Never cut unknown or unsafe material.

Toxic fumes can damage people and machines.

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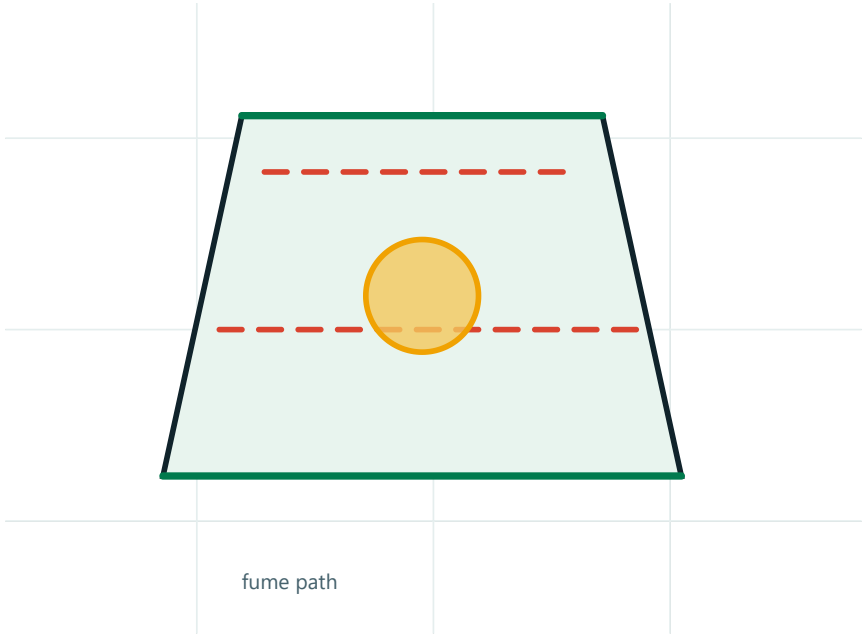
Ventilation and fume path

Ventilation and fume path

Air extraction moves fumes away from the material.



Ventilation

fumes follow airflow

strong flow clears smoke

blocked flow stains

keep filters clear

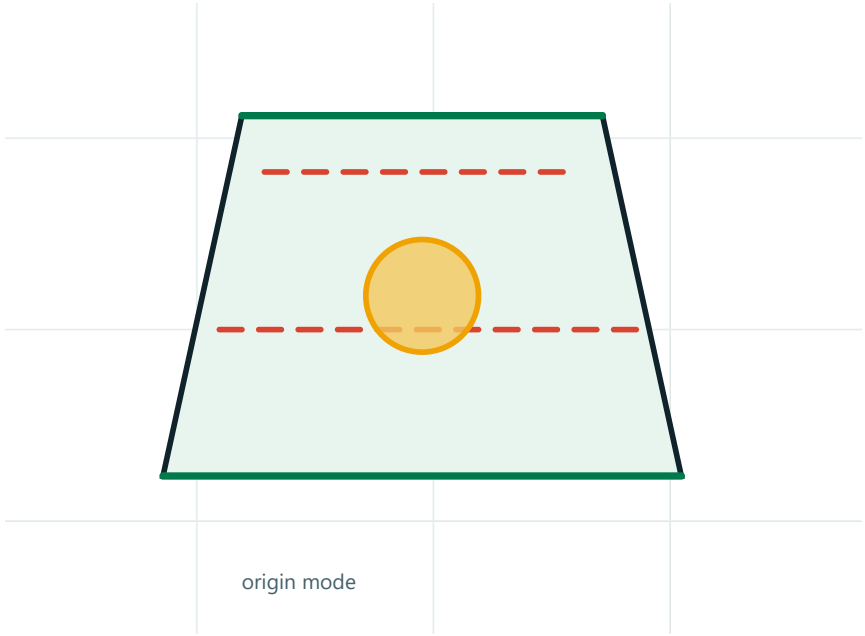
Good ventilation improves cut quality.

Fume direction can change surface staining.

Absolute vs user origin

Absolute vs user origin

Different origin modes change how coordinates are interpreted.



origin mode

Origin modes

absolute uses machine bed

user origin uses set point

current position can shift

preview first

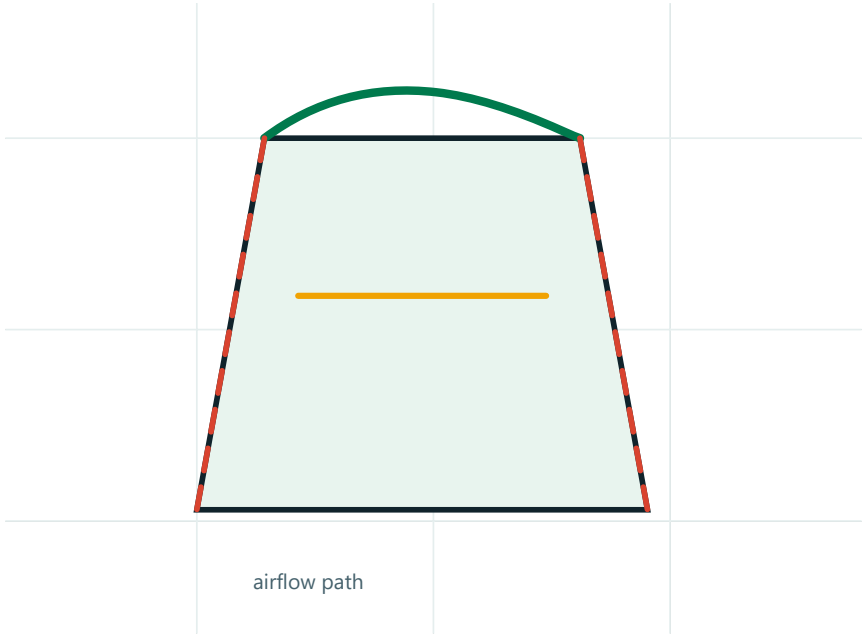
Origin mode can move the entire job.

Use preview framing before firing.

Air assist and smoke direction

Air assist and smoke direction

Airflow clears smoke so the beam cuts cleaner.



Air assist

air pushes smoke away

less scorching

cleaner edge

check nozzle height

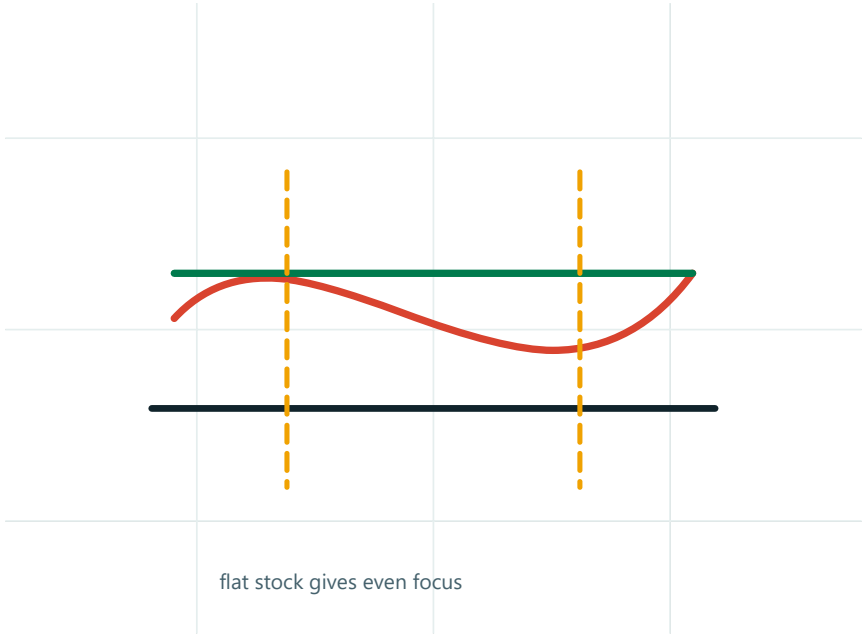
Air assist improves cut quality and visibility.

Smoke direction affects staining near the cut.

Bed levelling and flatness

Bed levelling and flatness

Uneven material changes focus across the job.



flat stock gives even focus

Flatness

flat sheet keeps focus

warps change cut

bed level matters

hold material down

Flat material keeps the beam focused.

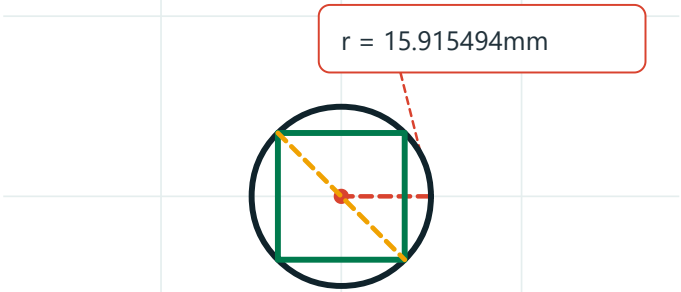
Uneven beds create uneven cut quality.

Circle circumference 100mm with an inscribed square

Circle circumference 100mm with an inscribed square

Animated construction with exact vector geometry and readable calculations.

1. Draw the exact circle
2. Draw a centered square



C: Circumference r: Radius d: Diameter

square diagonal = circle diameter

Final: C = 100.000000000mm.

Square corners touch the circle.

Calculations

Given: `C = 100mm`

Circle radius:

```
r = C / (2*pi)
r = 100 / (2*pi)
r = 15.9154943092mm
```

Circle diameter:

```
d = 2r
d = 31.8309886184mm
```

Inscribed square:

```
diagonal = d
side = d / sqrt(2)
side = 22.507907894mm
```

`Check: side * sqrt(2) = d`

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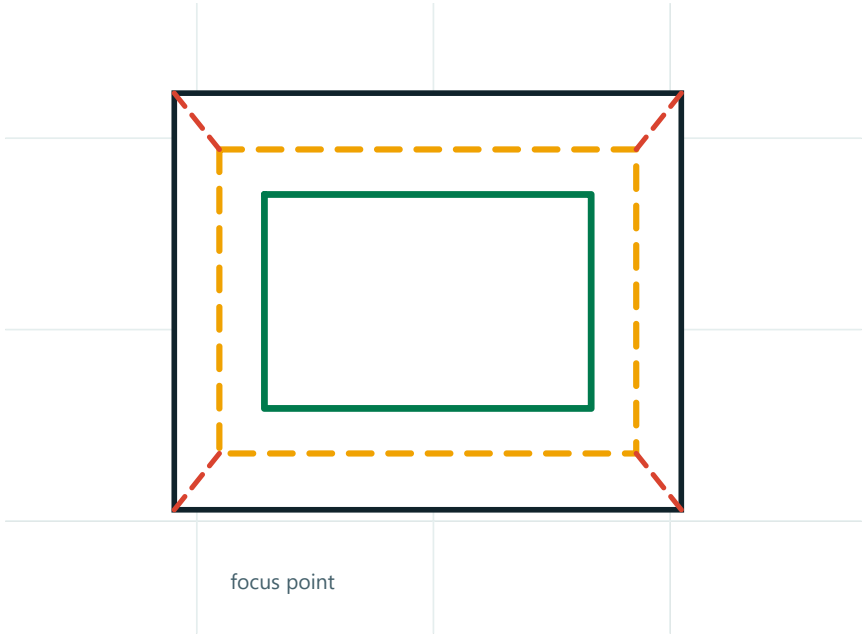
Focus height and beam waist

Focus height and beam waist

The narrowest part of the beam should sit at the right depth.



Focus

beam narrows at focus

wrong height widens kerf

material thickness matters

test before production

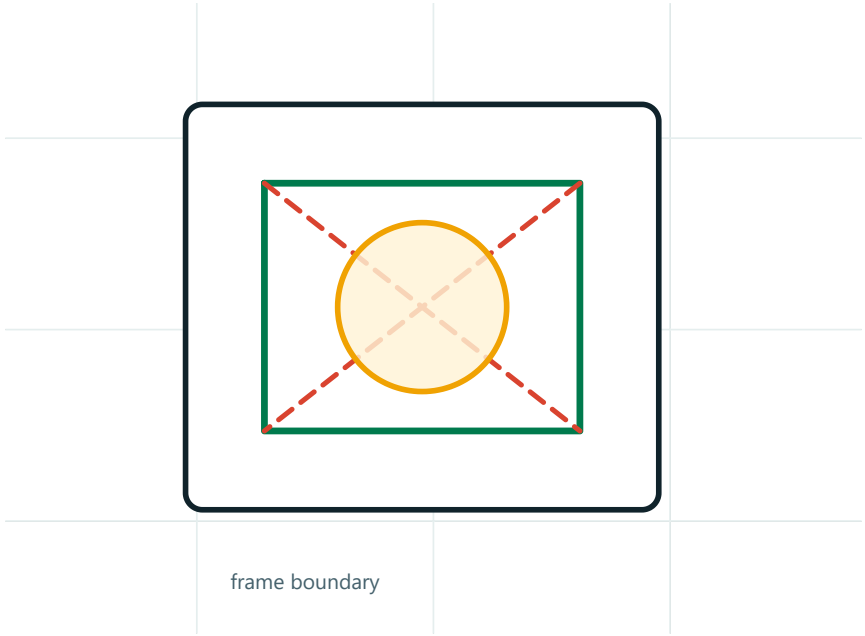
Focus height changes the cut width.

A focused beam gives cleaner, sharper cuts.

Frame preview before cutting

Frame preview before cutting

Framing traces the job boundary before the laser fires.



Frame check

- preview job extents
- catch bad placement
- avoid clamps
- confirm material fit

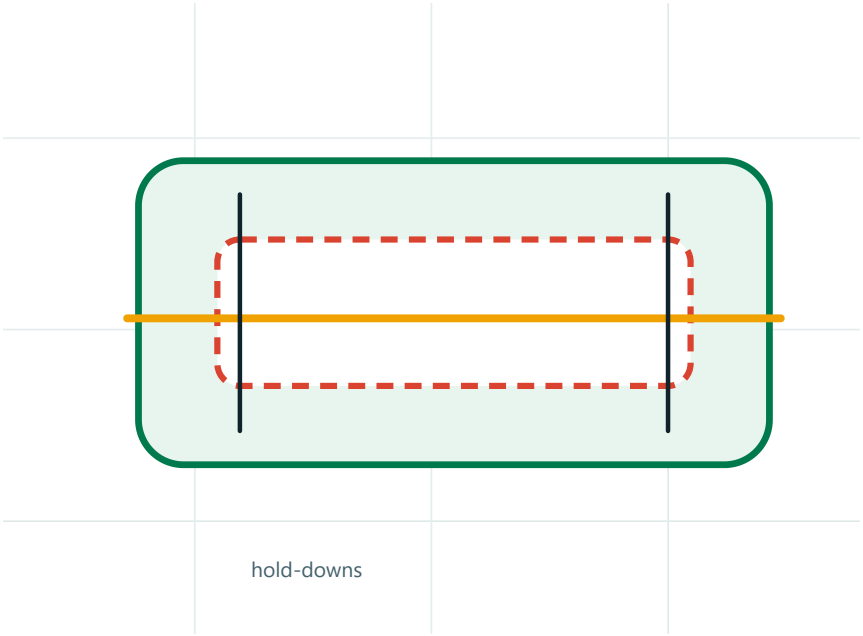
Framing catches placement errors early.

Run it before cutting valuable material.

Hold-down pin placement

Hold-down pin placement

Pins or magnets should hold sheets without blocking the cut.



Workholding

- hold corners flat
- avoid tool path
- leave head clearance
- secure warped stock

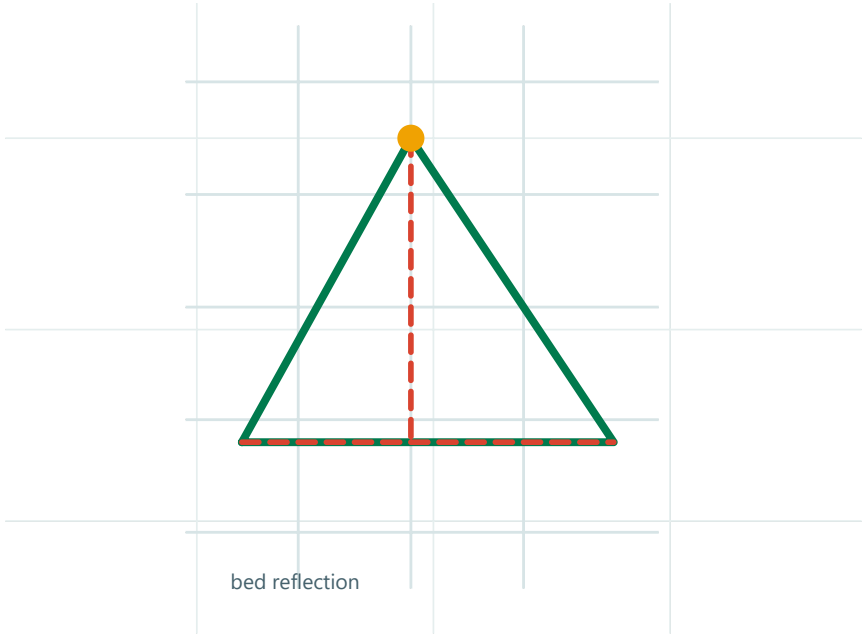
Hold-downs keep material flat and stable.

Place them outside the cutting path.

Honeycomb bed reflection

Honeycomb bed reflection

Bed reflections can mark the underside of material.



Bed marks

beam reflects upward

marks underside

raise or mask part

clean honeycomb

The cutting bed can affect the bottom face.

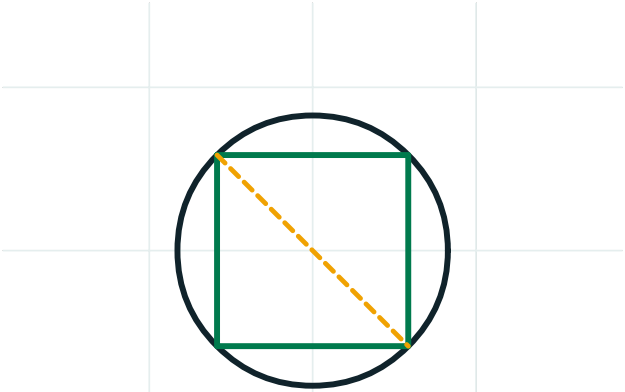
Clean supports reduce back-side marks.

Inscribed vs circumscribed: square and circle

Inscribed vs circumscribed: square and circle

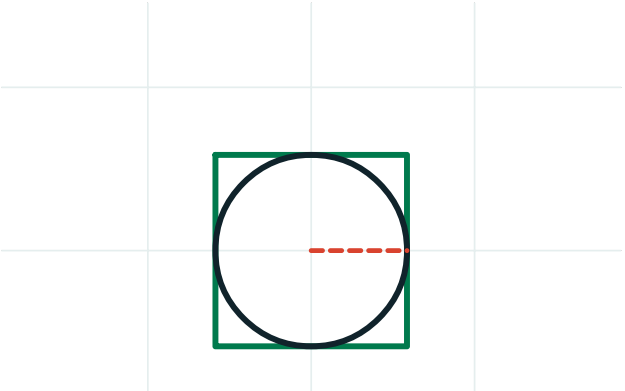
A shape is inscribed when it fits inside and touches; circumscribed when it surrounds and touches.

A. Square inside a circle



Square diagonal = circle diameter

B. Circle inside a square



Circle diameter = square side

```
A: square side = circle diameter / sqrt(2)
B: circle radius = square side / 2
```

```
Inscribed: inside + touching
Circumscribed: outside + touching
```

Both drawings are pure editable vector geometry.

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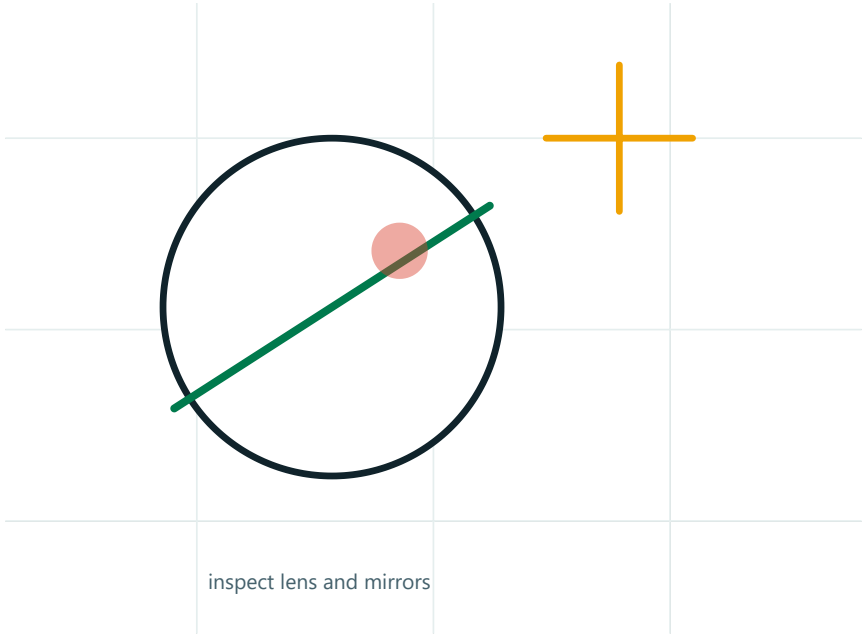
Lens and mirror maintenance

Lens and mirror maintenance

Dirty optics reduce power and can spoil the cut.



inspect lens and mirrors

Optics

- dust blocks power
- smoke coats lens
- clean carefully
- inspect regularly

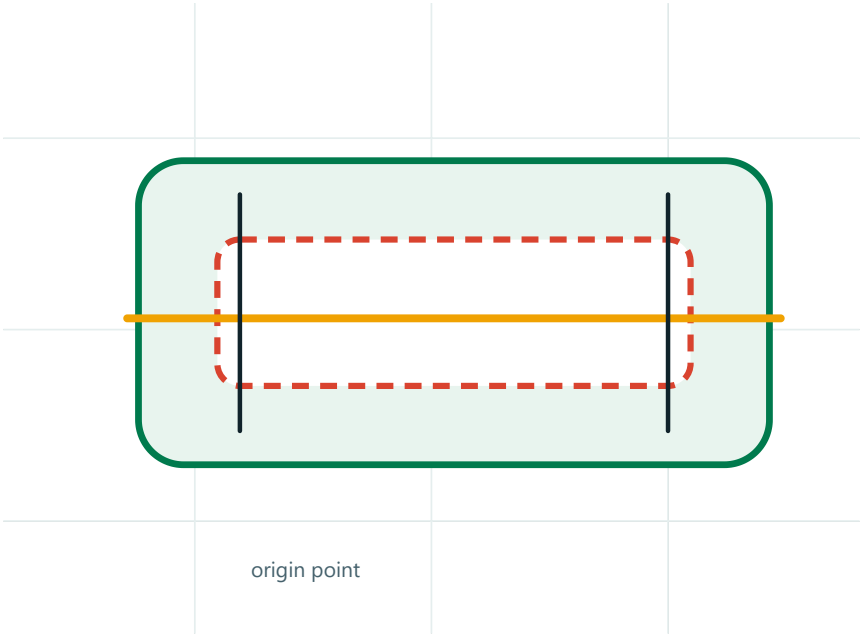
Clean optics keep power consistent.

Dirty lenses can overheat or crack.

Machine origin and job origin

Machine origin and job origin

Machine origin and artwork origin are not always the same.



Origin

machine has home

job has start point

set origin carefully

avoid shifted cuts

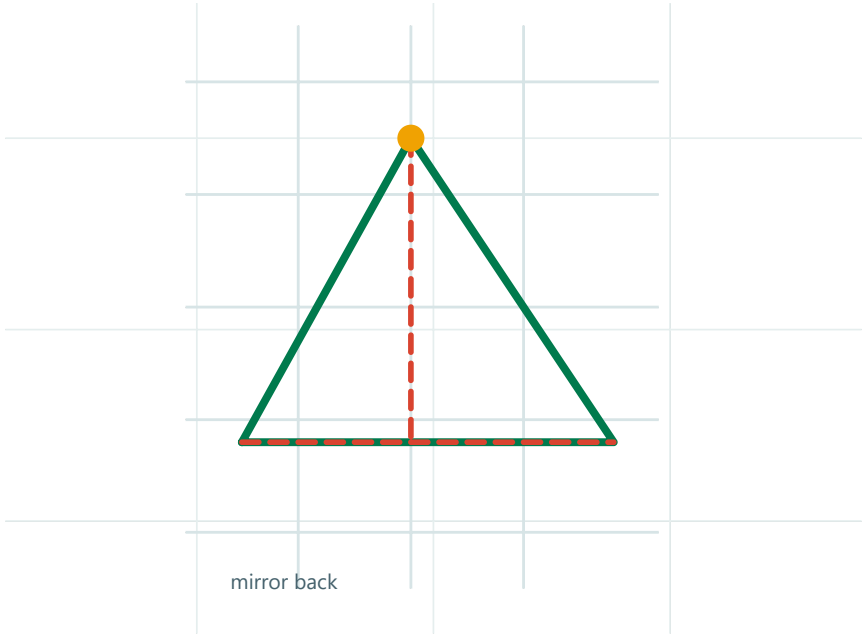
Origin choice controls where the job lands.

Confirm it before starting the cut.

Mirroring for back engraving

Mirroring for back engraving

Back-side engraving often needs mirrored artwork.



Back engraving

- flip artwork for back
- align to front features
- use registration pins
- test orientation

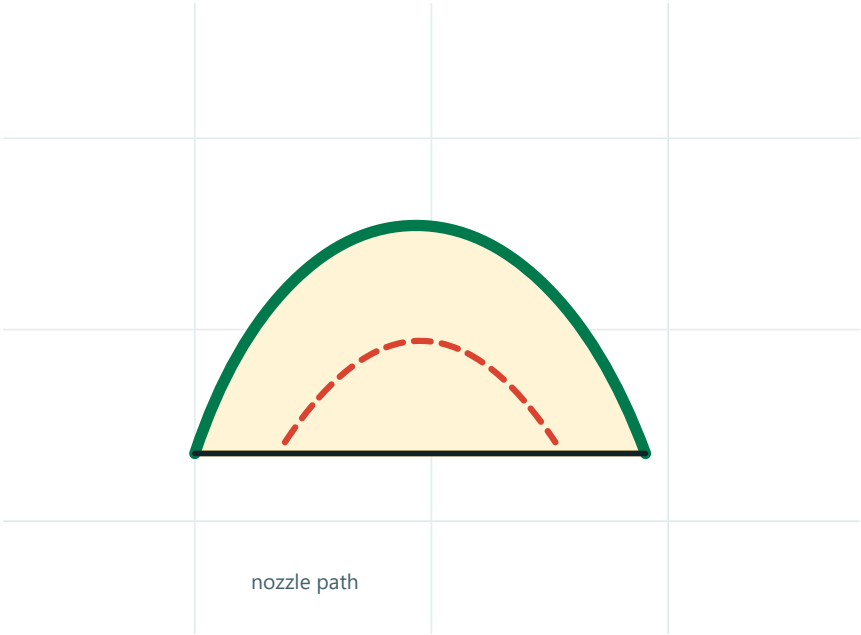
Back engraving needs mirrored thinking.

Registration keeps front and back aligned.

Nozzle clearance check

Nozzle clearance check

The laser head needs room around raised material.



Clearance

warped sheets can lift

head may collide

use hold-downs

check before running

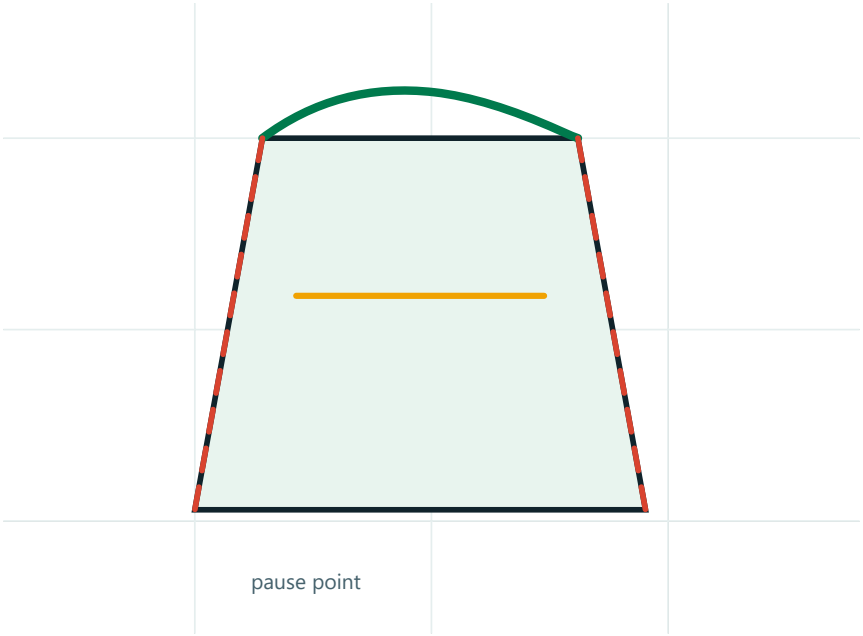
Mechanical clearance protects the job.

Flat material reduces collision risk.

Pause for magnet removal

Pause for magnet removal

A planned pause can let you remove magnets before a cut reaches them.



Planned pause

- pause before danger area
- remove hold-down
- resume safely
- document the step

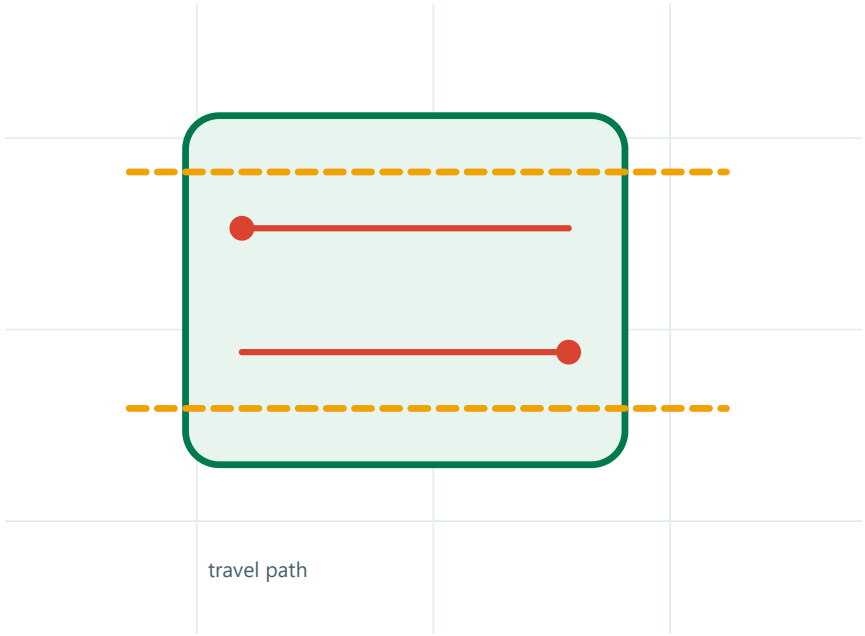
Planned pauses make tricky jobs safer.

Use them when hold-downs block later paths.

Safe Z and travel moves

Safe Z and travel moves

Travel moves need clearance above clamps and stock.



Travel safety

- head moves between cuts
- raised parts can collide
- safe height matters
- watch clamps

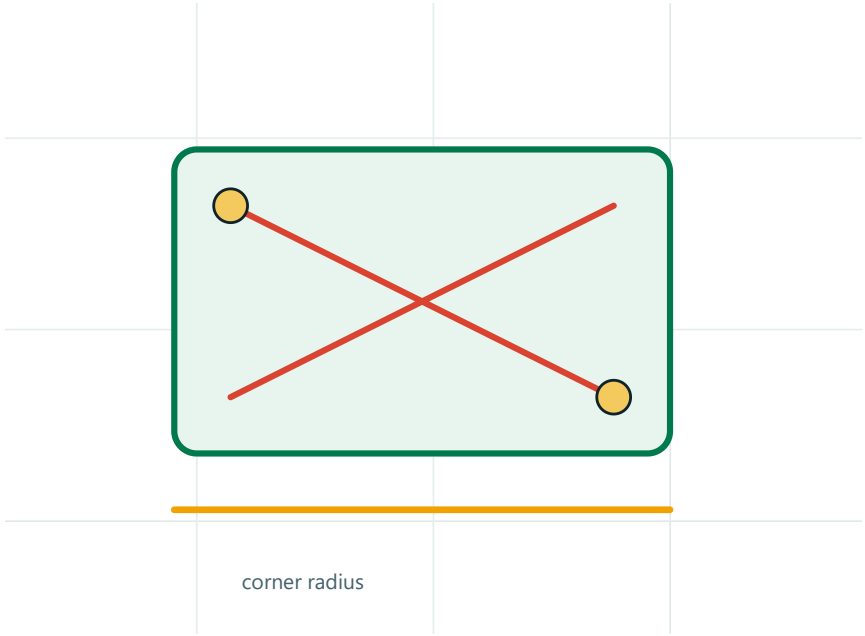
Travel clearance prevents collisions.

Keep the path clear between cuts.

Corner radius for cut parts

Corner radius for cut parts

Rounded corners are stronger and often cut cleaner.



Radius

sharp corners stress

radius spreads force

cuts flow smoother

looks more finished

Corner radius improves strength and finish.

Small radii can reduce chipping and stress.

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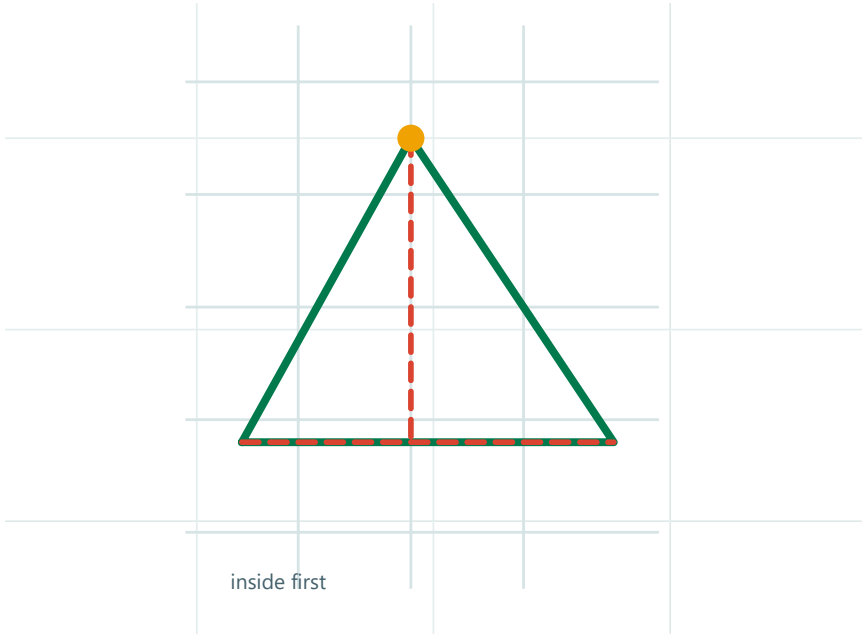
Cut order inside before outside

Cut order inside before outside

Internal details should cut before the outer profile releases.



Cut order

holes cut first

outside cuts last

keeps part stable

reduces movement

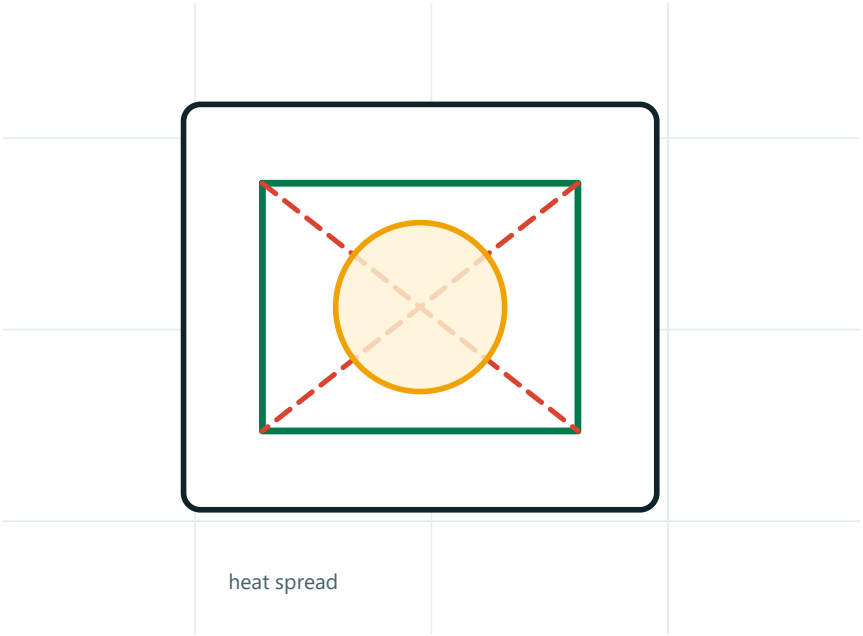
Cut inside features before releasing the part.

Good order keeps small parts from shifting.

Cut sequencing heat spread

Cut sequencing heat spread

Alternating areas helps spread heat across the sheet.



Heat sequence

avoid local heat buildup

space cuts apart

let areas cool

reduce warping

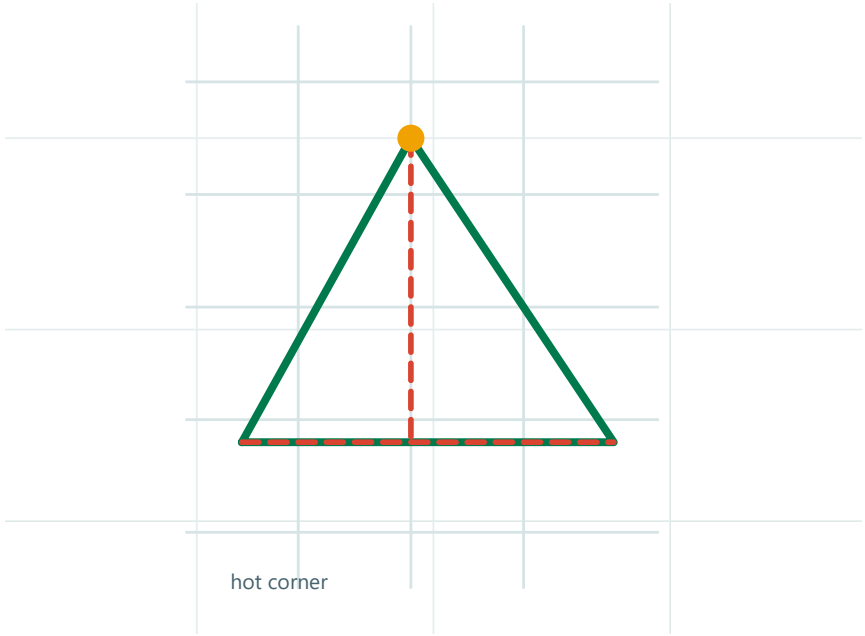
Cut order can manage heat.

Spread nearby cuts across the job timeline.

Inside corner overburn

Inside corner overburn

Corners can receive extra heat as motion changes direction.



Corner heat

slowdown adds heat

corners may darken

reduce power or pause

test sharp details

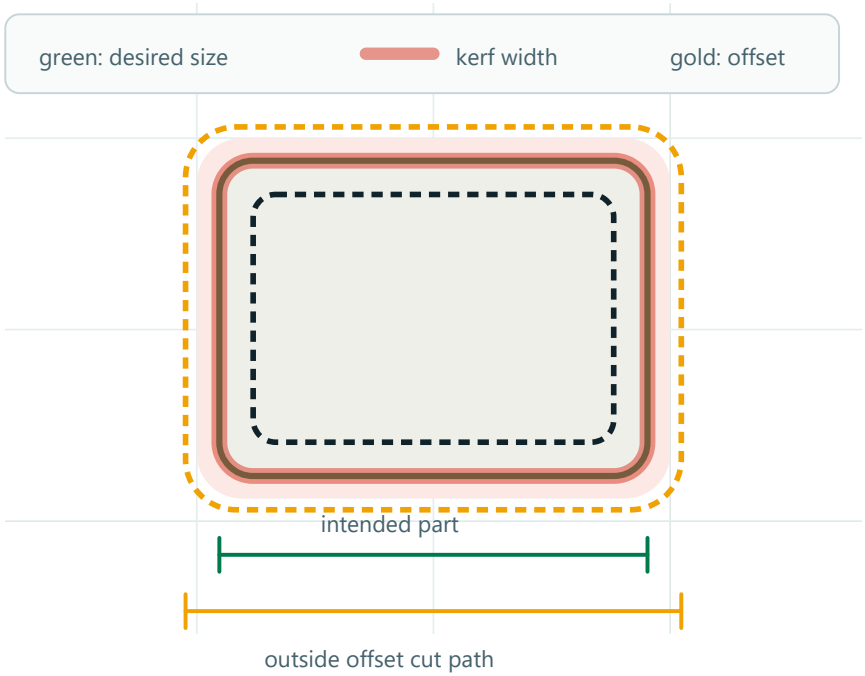
Sharp corners can burn more than straight lines.

Settings and corner style help reduce marks.

Laser/CNC kerf offset explained

Laser/CNC kerf offset explained

The cutter removes material. Offset the cut path so the finished part lands on size.



Kerf idea

Kerf is the cut width.

For an outside cut:

```
offset = kerf / 2
path moves outward
```

For an inside hole:

```
path moves inward
```

Always test kerf on the real material and machine.

Kerf compensation shifts the tool path.

That helps the finished part match the design size.

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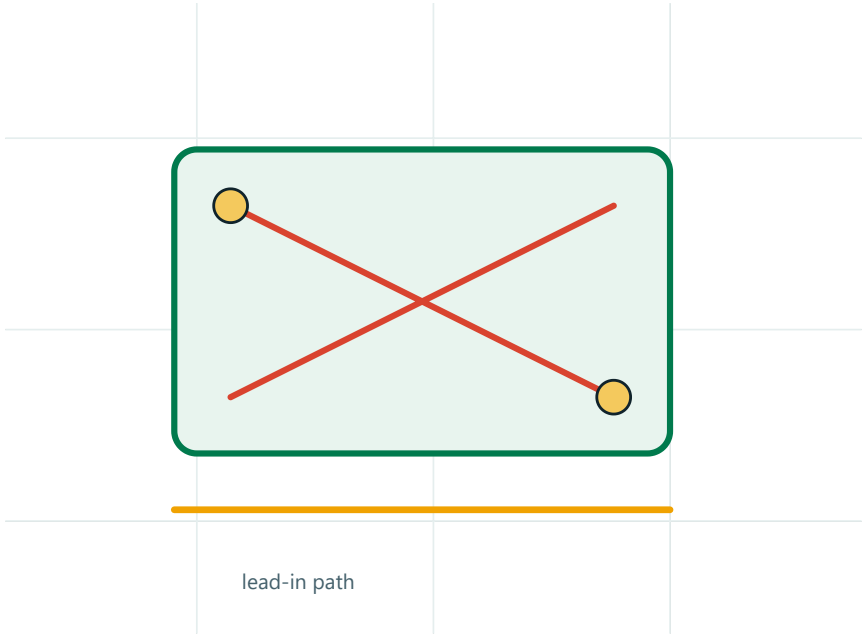
Lead-in and lead-out cuts

Lead-in and lead-out cuts

A lead-in starts the cut away from the final edge.



Lead cuts

start mark moves away

edge stays cleaner

pierce outside profile

use for thick cuts

Lead-ins protect the finished edge.

They are useful on thicker or sensitive material.

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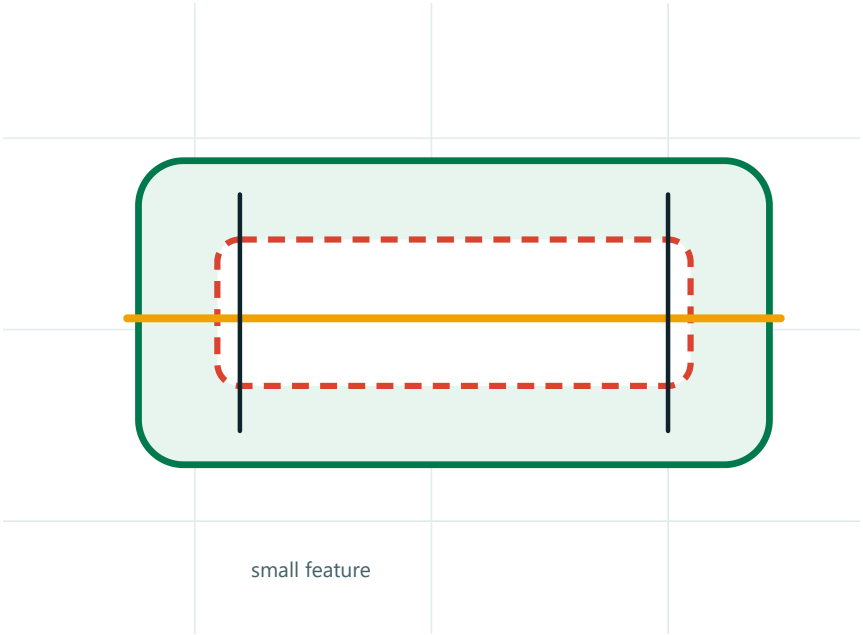
Minimum feature size

Minimum feature size

Small details must be large enough to survive cutting.



Feature size

thin bridges break

tiny holes char

material sets limit

scale details up

Minimum size depends on material and kerf.

Avoid details smaller than the process can hold.

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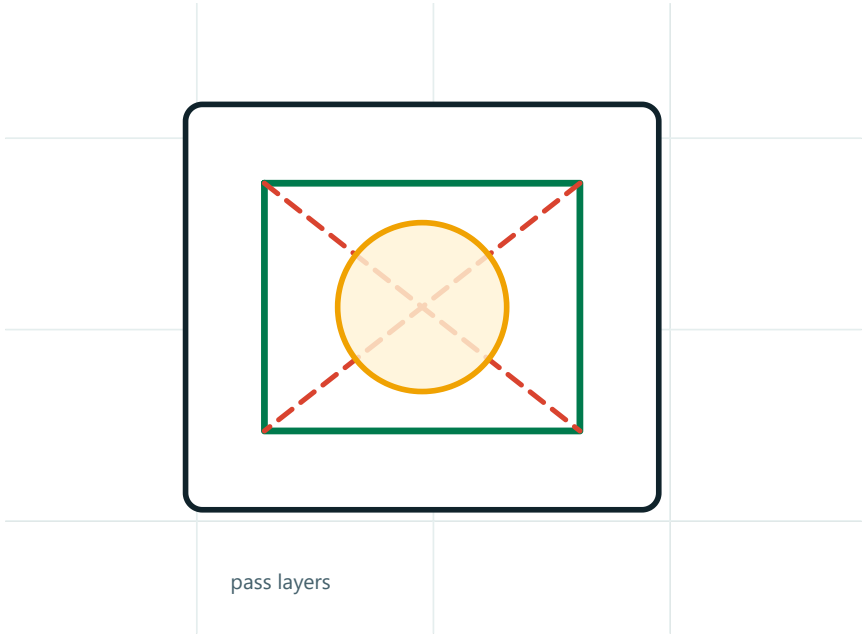
Multiple passes on thick material

Multiple passes on thick material

Several light passes can cut cleaner than one heavy pass.



pass layers

Pass count

pass one starts groove

later passes deepen

less flame risk

watch alignment

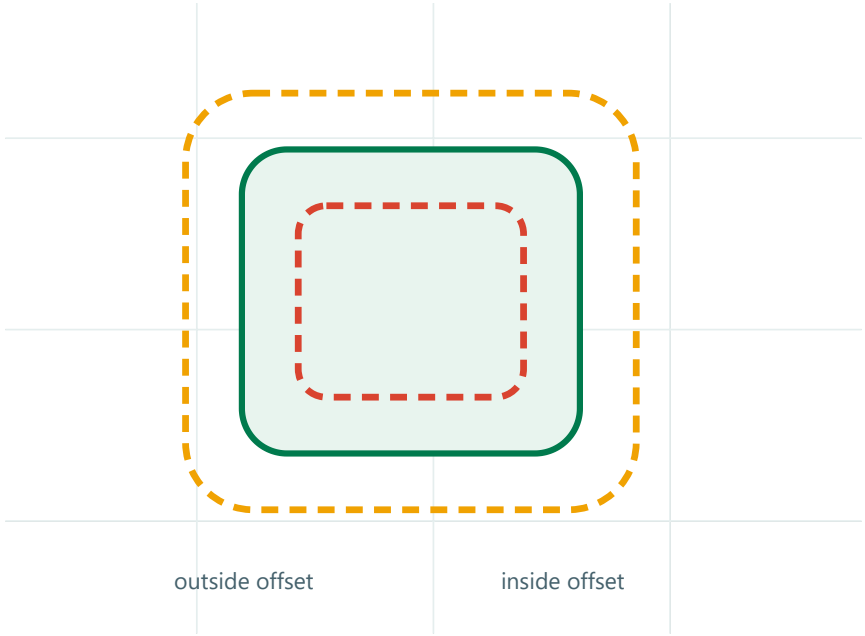
Multiple passes can reduce burning.

The path must stay aligned between passes.

Path offset basics

Path offset basics

Offsetting creates a parallel path inside or outside the original.



Offset path

outside offset expands

inside offset contracts

corner style affects

the new path

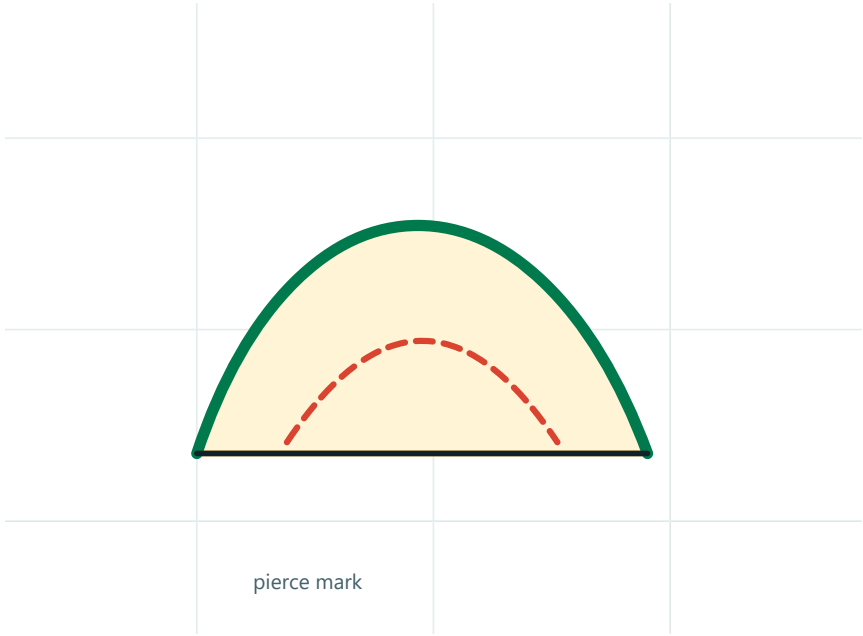
Offsets are useful for outlines, borders, and cuts.

Check corners after offsetting.

Pierce point placement

Pierce point placement

The beam pierces before moving, so its start point matters.



Piercing

pierce can leave a mark

move mark to waste

avoid visible corners

set start points

Start points can affect the final edge.

Put pierce marks where they matter least.

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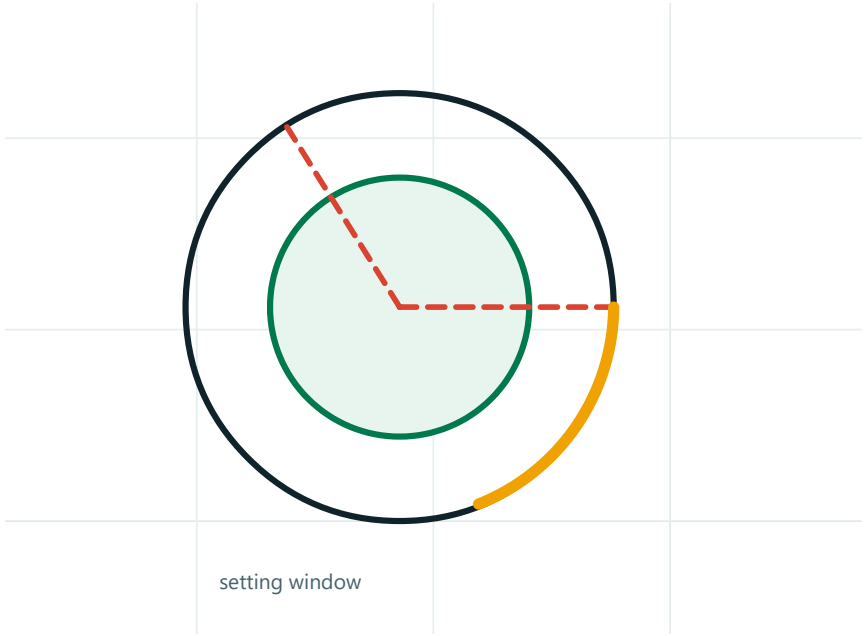
Power and speed balance

Power and speed balance

Power and speed work together to control cut depth.



Settings

more power cuts deeper

slower speed burns more

balance avoids charring

record working settings

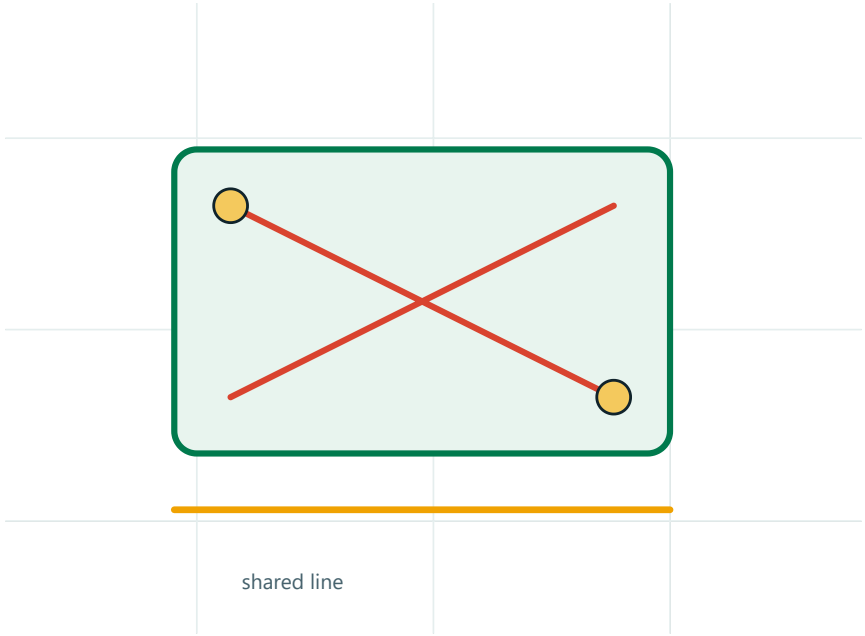
Cut quality depends on both power and speed.

Changing only one setting can mislead tests.

Shared-line cutting

Shared-line cutting

Two parts can share one cut line to save time and material.



Shared cuts

one line cuts two edges

saves material

requires exact geometry

watch heat buildup

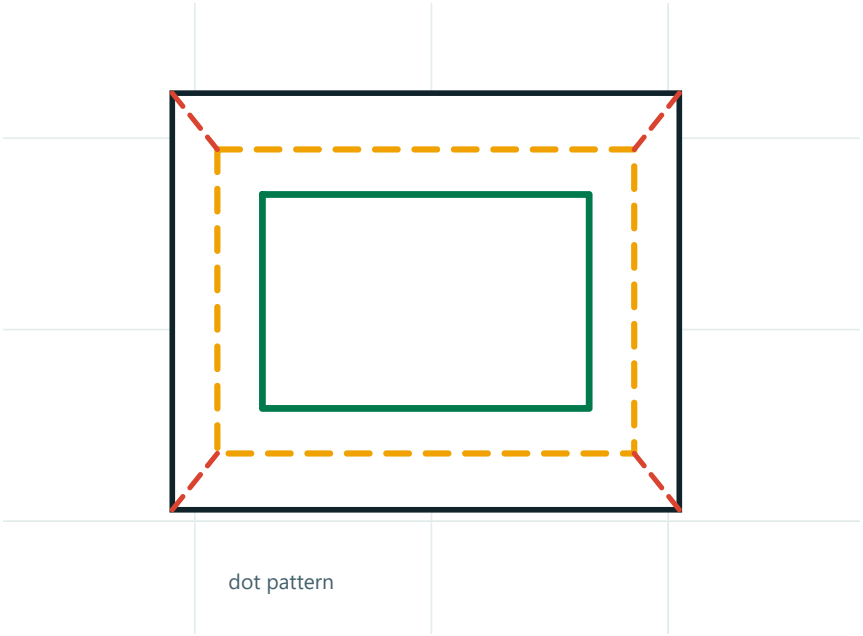
Shared-line cutting can be efficient.

Only use it when both parts tolerate the same edge.

Dither pattern comparison

Dither pattern comparison

Different dithers create different engraving textures.



dot pattern

Dither

dots simulate tone

pattern affects texture

photos need tests

preview before cutting

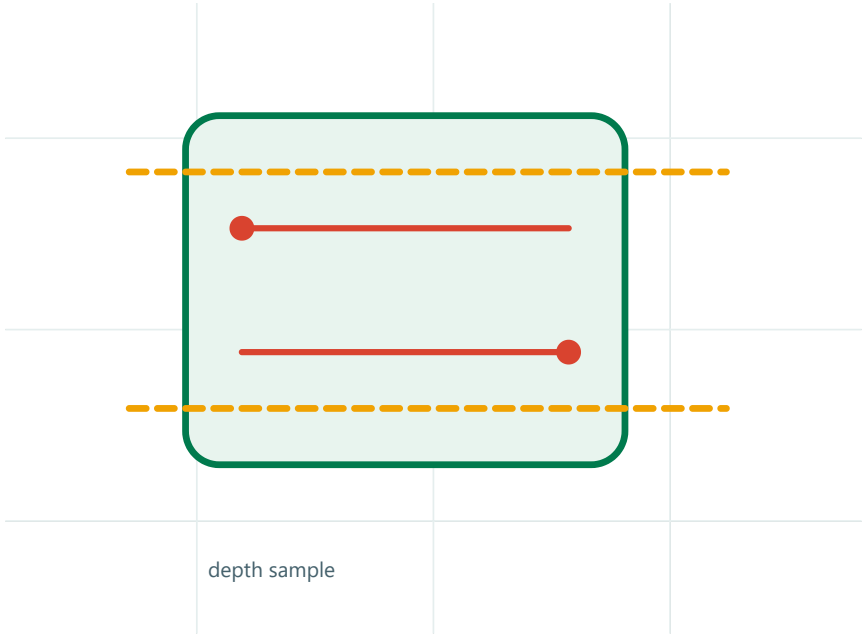
Dither changes how tones become dots.

The best pattern depends on the image and material.

Engrave depth calibration

Engrave depth calibration

Depth tests show how many passes or power settings to use.



Depth

measure engraved depth

increase gradually

avoid excess heat

record results

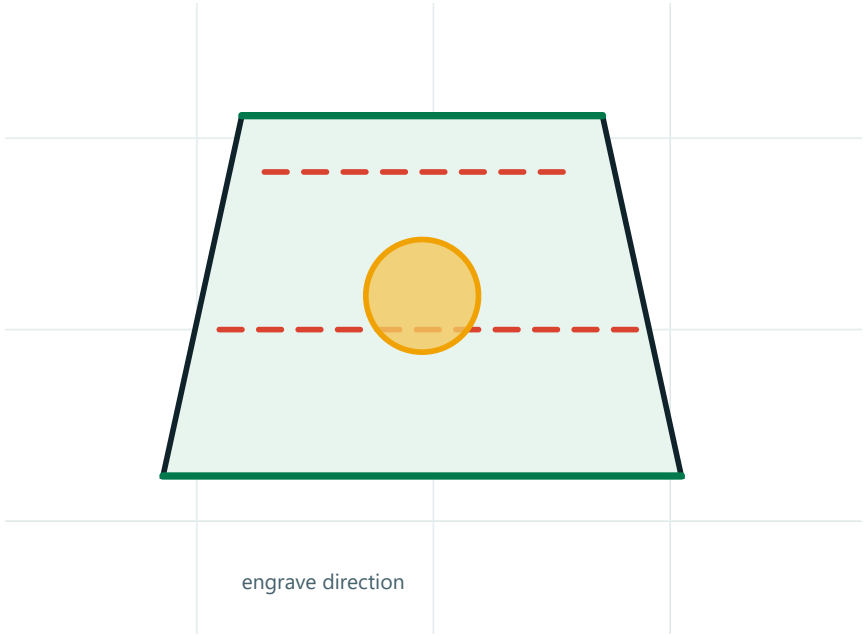
Engraving depth should be tested, not guessed.

Small samples prevent wasted material.

Engrave direction grain

Engrave direction grain

Engraving direction can interact with wood grain.



Grain engraving

- scan direction matters
- grain changes darkness
- rotate sample tests
- choose even result

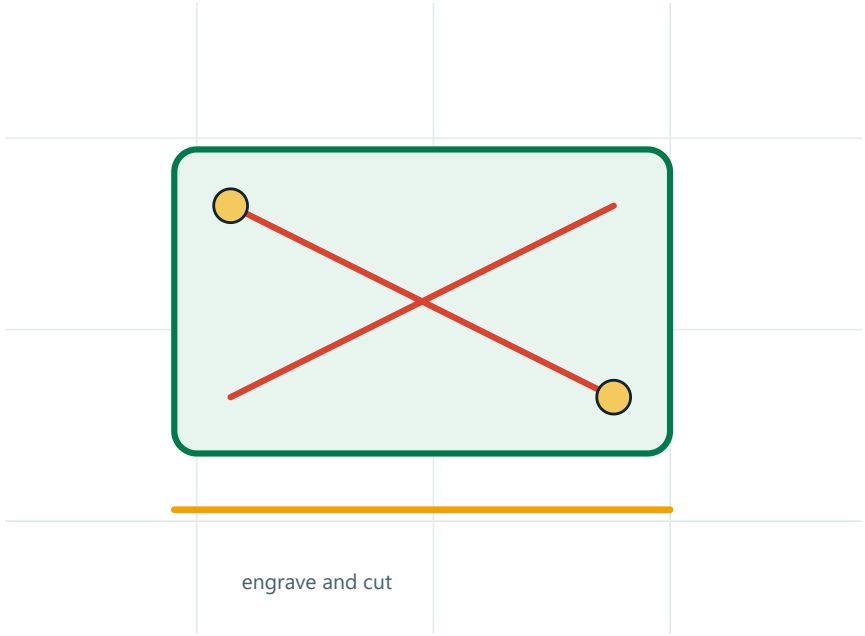
Grain can affect engraved tone.

Test direction on the same material.

Engrave fill vs vector cut

Engrave fill vs vector cut

Filled engraving scans an area; vector cutting follows a path.



Process type

- engrave fills shapes
- cut follows outlines
- order matters
- use separate colours

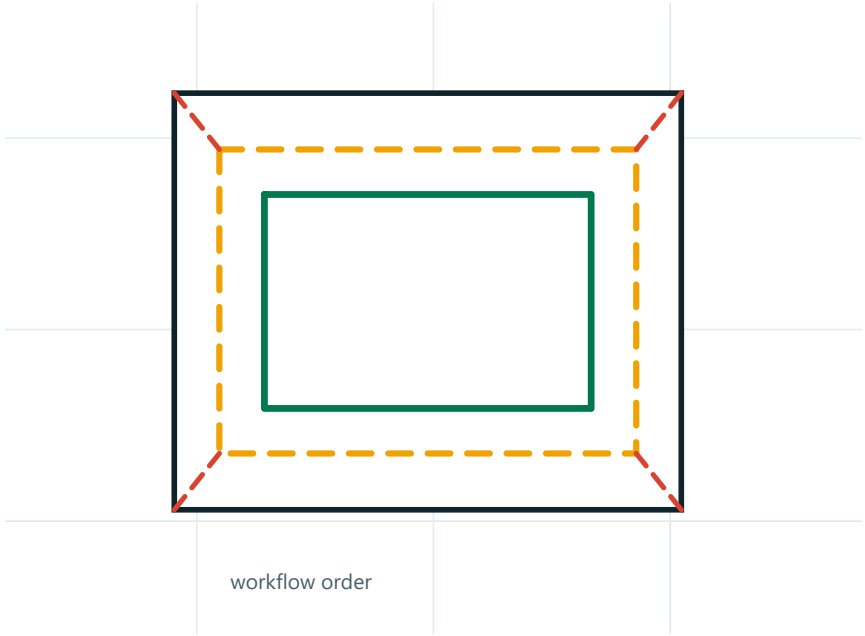
Engraving and cutting are different operations.

Separate layers help the machine know what to do.

Engrave then cut workflow

Engrave then cut workflow

Engraving first keeps the sheet stable until final cutting.



workflow order

Workflow

engrave while stable

score next

cut outside last

less movement

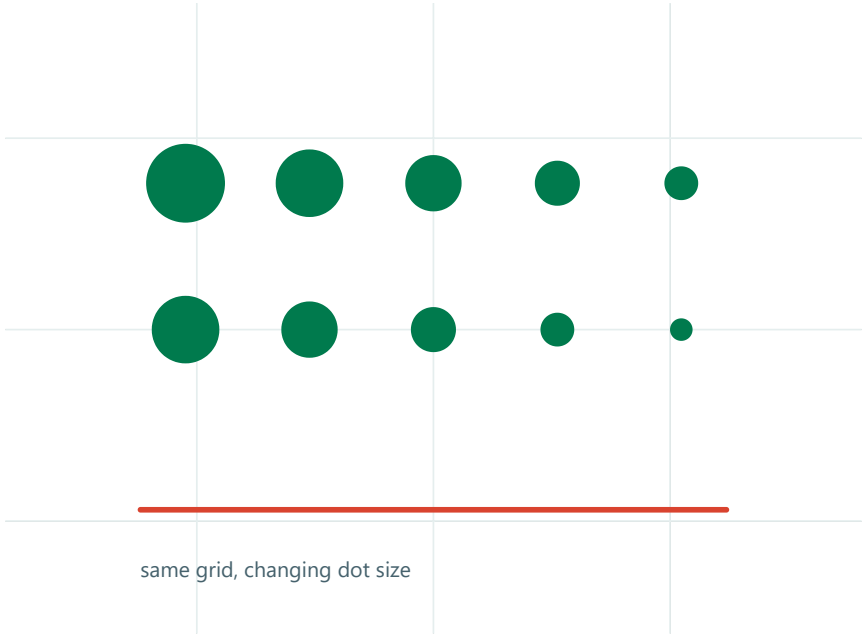
Process order affects accuracy.

Engrave before releasing the part.

Halftone dot gradient

Halftone dot gradient

Dots can simulate tone using only solid shapes.



same grid, changing dot size

Halftone

larger dots look dark

smaller dots look light

spacing stays regular

all shapes stay vector

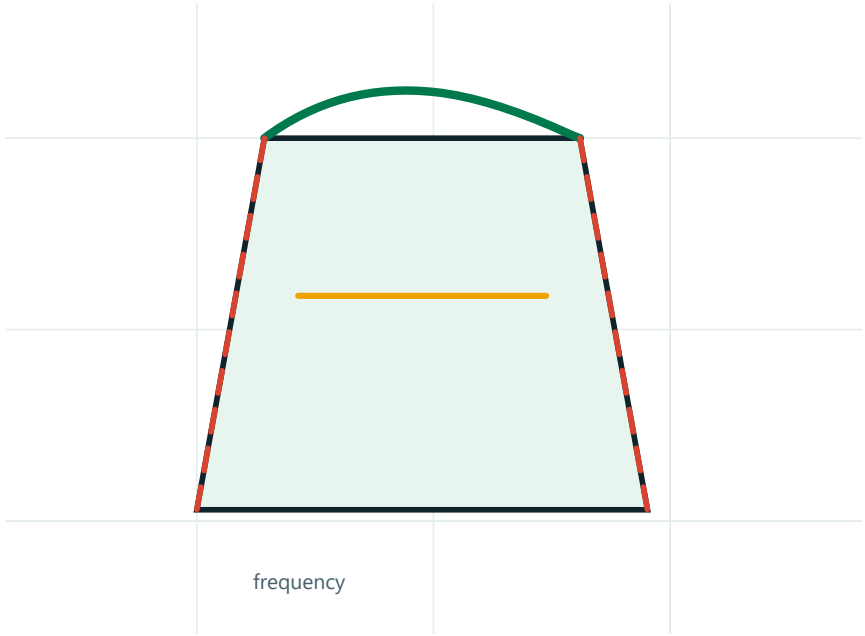
Halftones turn shading into editable dots.

Useful for print, vinyl, and engraving.

Line frequency for engraving

Line frequency for engraving

Frequency affects dot spacing and edge texture.



Frequency

higher can darken

lower can texture

material reacts differently

test before final

Line frequency changes engraving character.

Choose settings for the material, not by habit.

Photo engraving contrast

Photo engraving contrast

Images often need contrast adjustment before engraving.

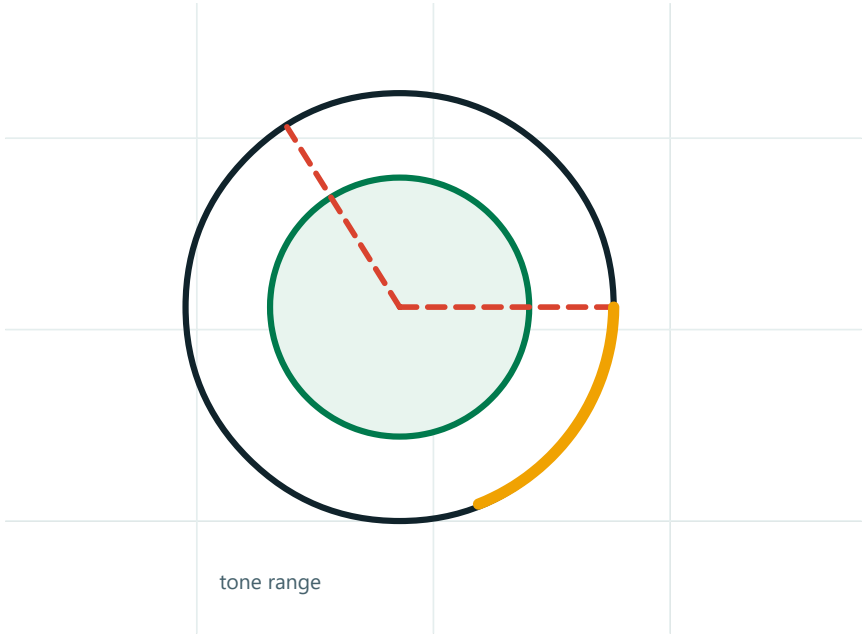


Photo prep

- boost useful contrast
- avoid crushed shadows
- test small crop
- material changes tone

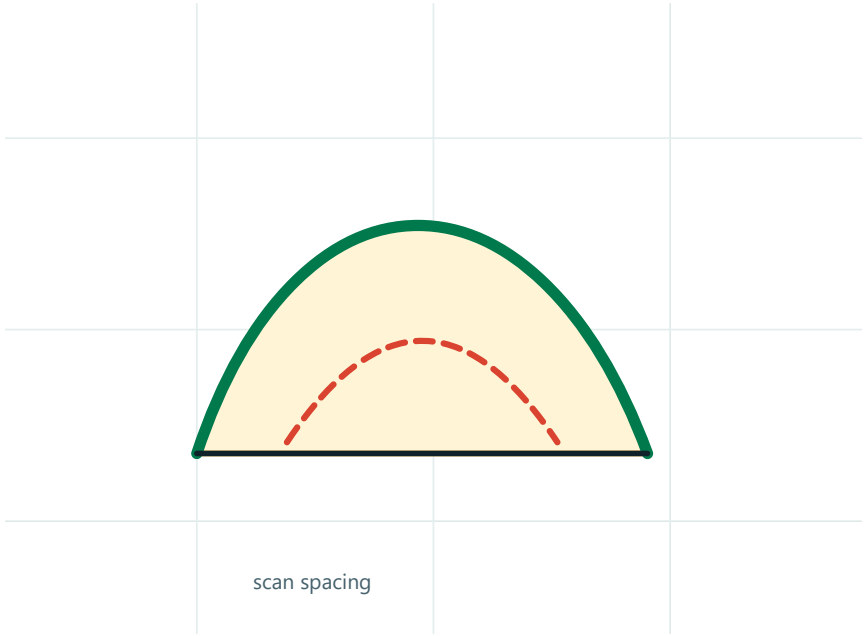
Photo engraving starts with image preparation.

A small crop test saves time and material.

Raster engraving line interval

Raster engraving line interval

Line interval controls how closely engraving scan lines sit.



Engraving

smaller interval = dense

larger interval = faster

too dense may burn

match material

Line interval changes engraving texture.

Use tests to find the cleanest density.

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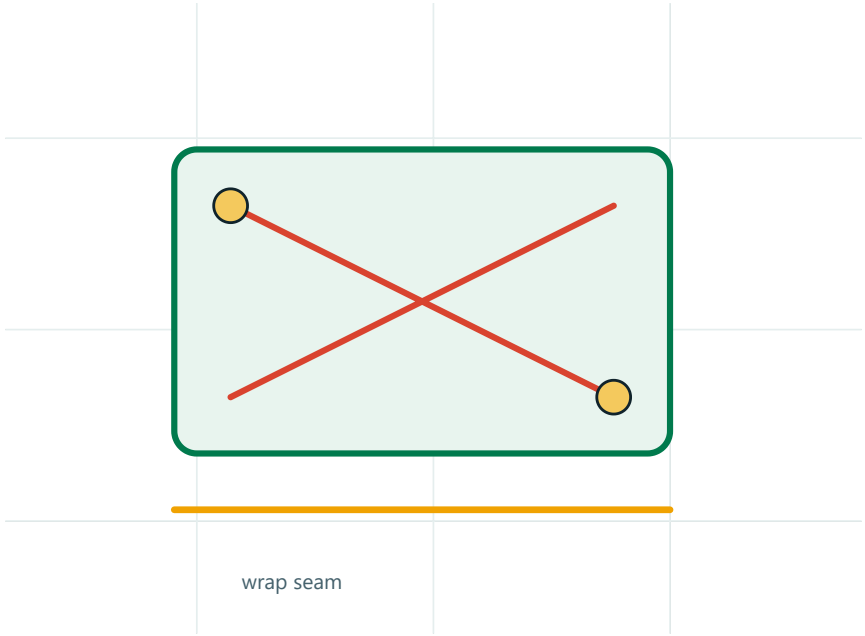
Rotary engraving wrap

Rotary engraving wrap

A rotary axis maps flat art around a cylinder.



Rotary work

- flat width wraps around
- diameter sets scale
- origin matters
- test seam position

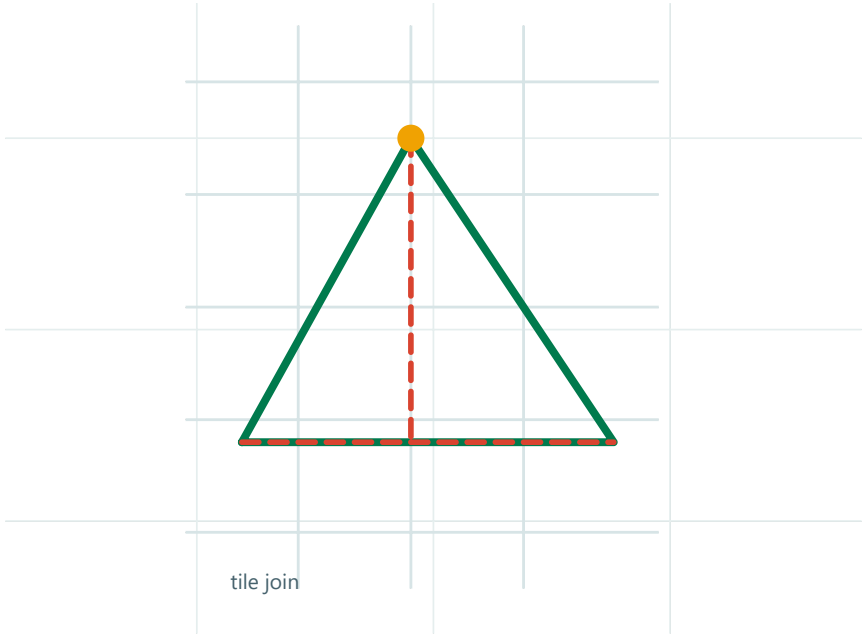
Rotary engraving turns flat layout into a wrap.

Cylinder size controls the artwork scale.

Tile engraving large panels

Tile engraving large panels

Large jobs can be split into aligned tiles.



Tiling

split large artwork

overlap or register

align each tile

check visible joins

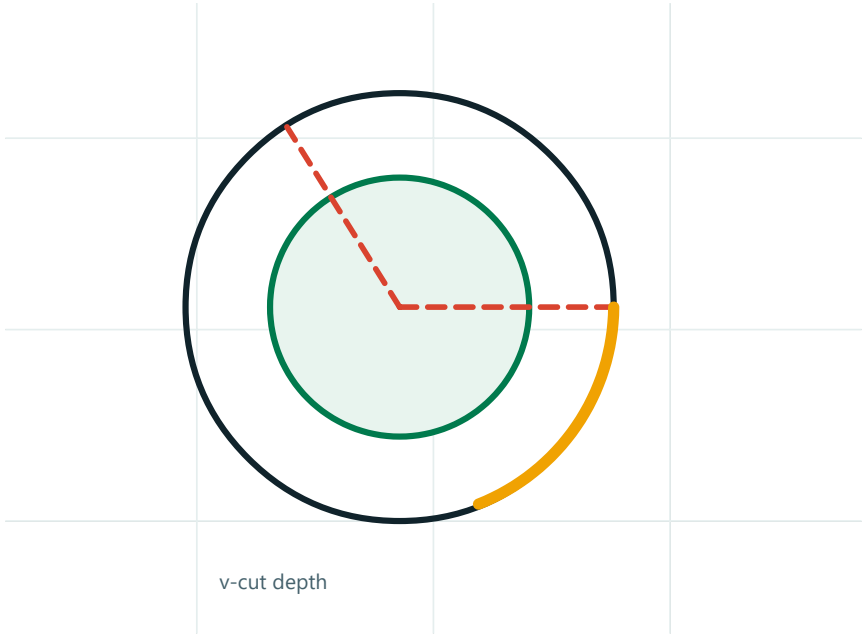
Tiling lets oversized work fit the machine.

Registration keeps the pieces aligned.

V-carve style engraving concept

V-carve style engraving concept

A V-shaped cut changes width with depth.



V engraving

deeper cuts wider

sharp point creates detail

depth controls weight

preview tool path

V-style engraving turns depth into line weight.

Tool shape affects the final mark.

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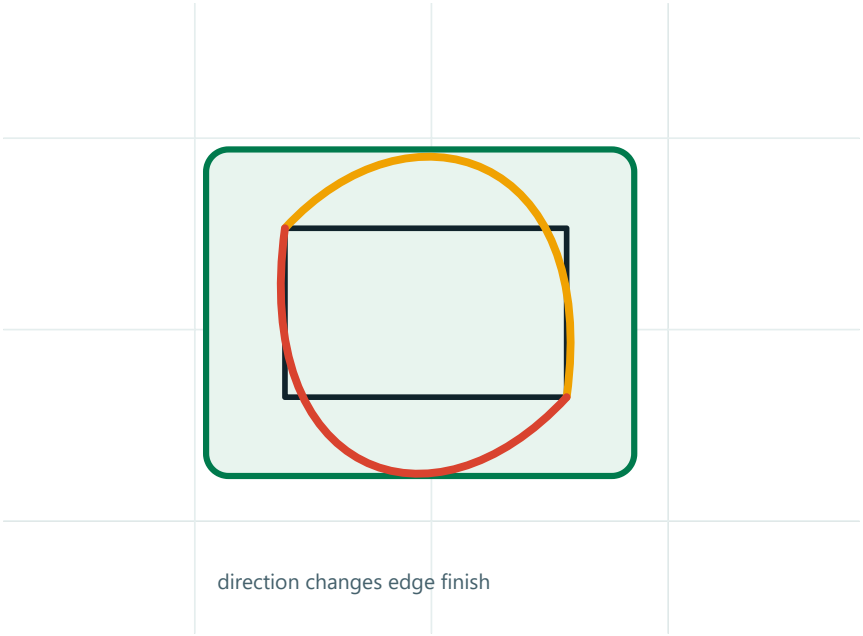
CNC climb vs conventional cutting

CNC climb vs conventional cutting

Cut direction changes edge quality and tool load.



Cut direction

climb pulls tool in

conventional pushes back

grain affects result

test edge quality

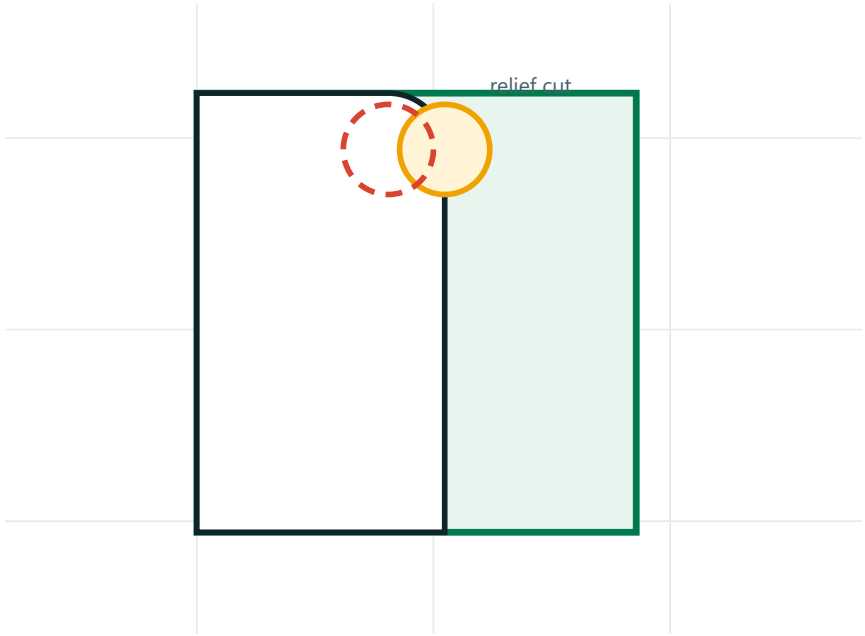
Direction affects finish and control.

Choose direction for tool and material.

CNC dogbone fillet

CNC dogbone fillet

Dogbones let a round cutter clear a square inside corner.



Dogbone

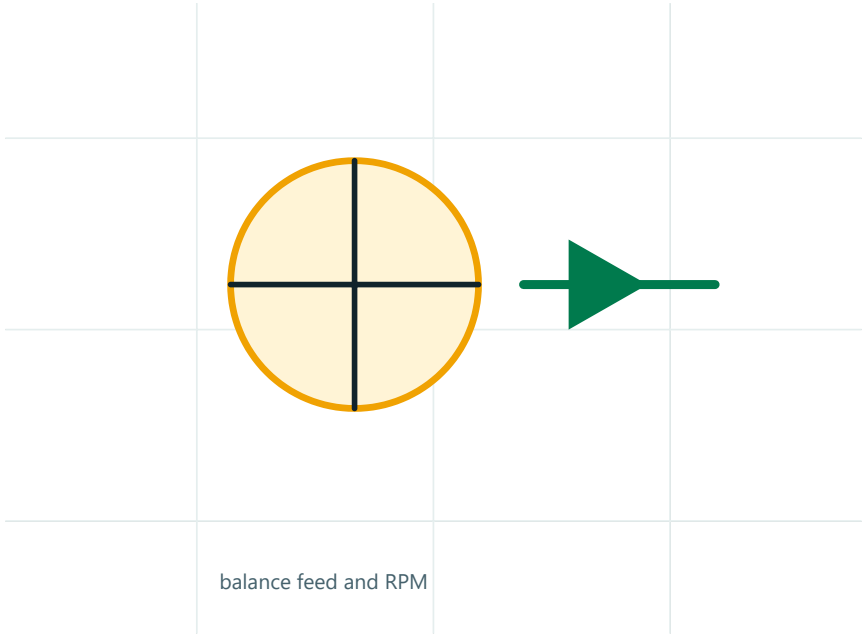
round cutter cannot
make a sharp inside
extra relief clears
square tabs fit

Dogbones solve square-fit CNC corners.
The relief matches the cutter radius.

CNC feeds and speeds

CNC feeds and speeds

Feed rate and spindle speed control chip size.



Chip load

feed = movement speed

RPM = spindle speed

chips carry heat

dust means rubbing

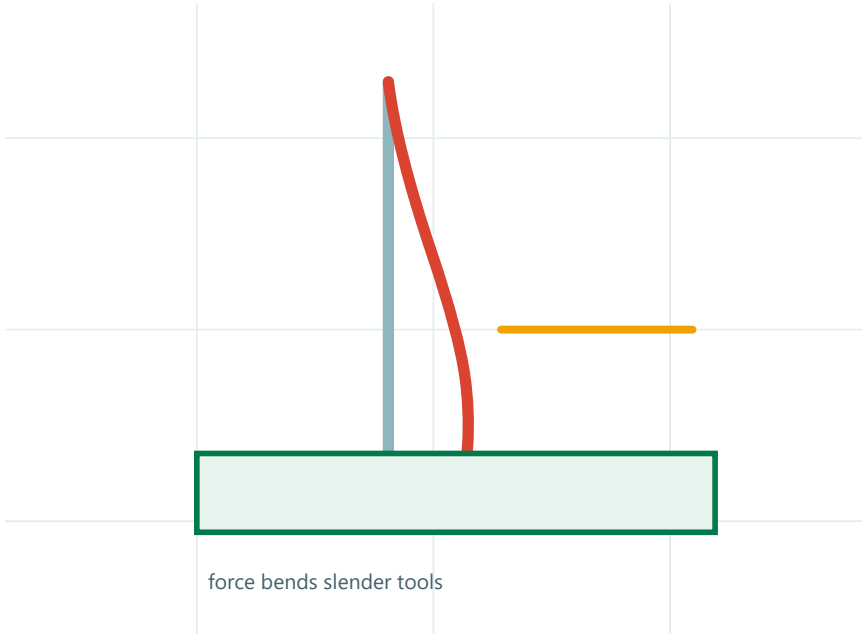
Good feeds and speeds make chips, not dust.

Wrong settings heat the tool and material.

CNC tool deflection

CNC tool deflection

Thin tools can bend under cutting force.



Deflection

long tools bend more

deep cuts add load

use multiple passes

reduce side force

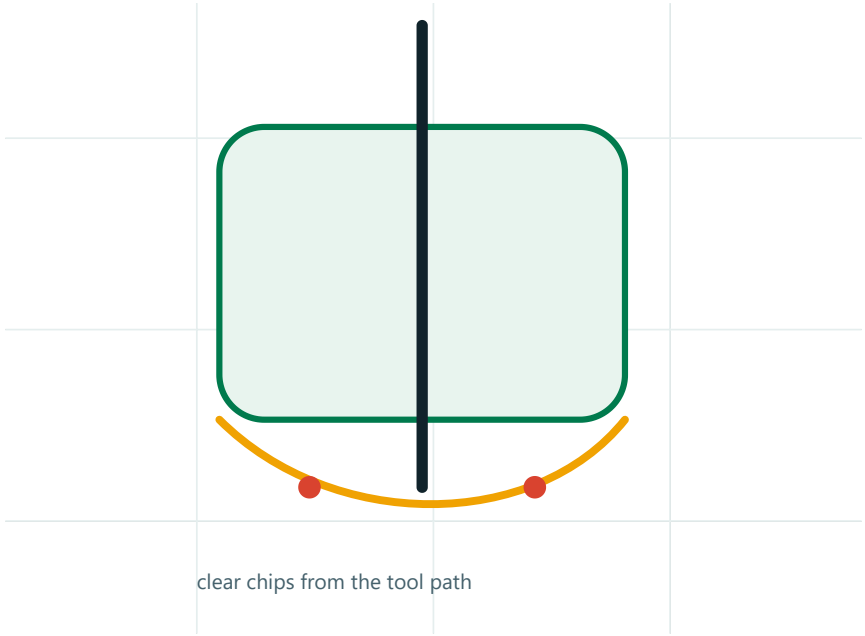
Tool bending changes the real cut path.

Shallow passes improve accuracy.

Dust shoe and chip evacuation

Dust shoe and chip evacuation

Removing chips keeps CNC cuts cooler and cleaner.



Chip removal

chips hold heat

dust shoe clears path

vacuum improves view

avoid recutting chips

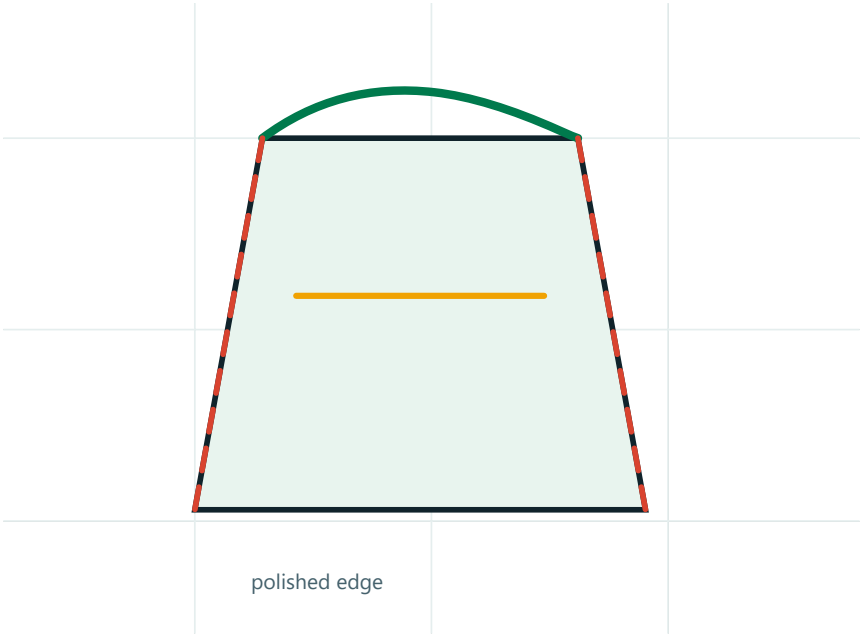
Chip evacuation protects the tool.

Clean cuts need chips removed quickly.

Acrylic flame polishing edge

Acrylic flame polishing edge

A clean laser edge can look polished on acrylic.



Acrylic edge

- speed affects edge
- air can cool surface
- protective film matters
- test for bubbles

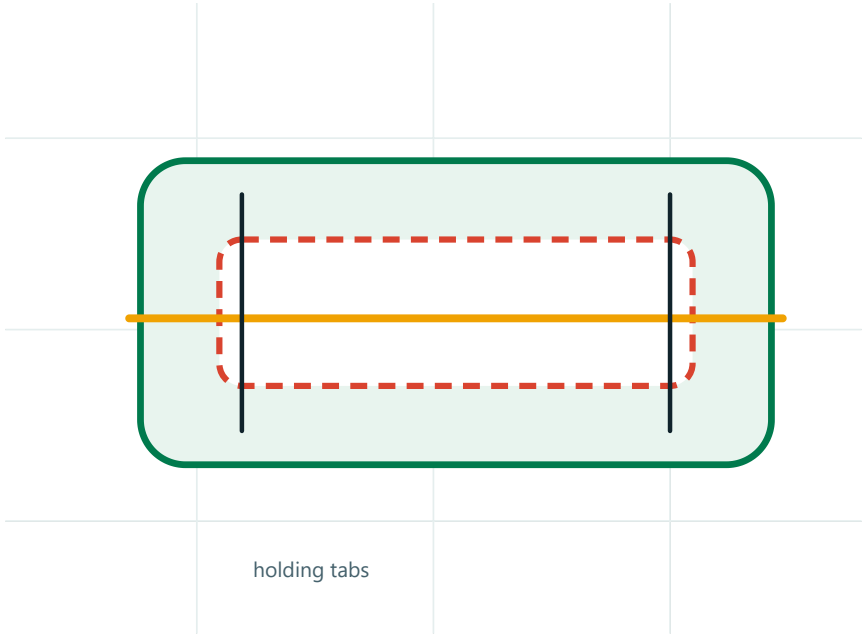
Acrylic edge quality depends on heat balance.

A clean cut can create a polished edge.

Bridge tabs for small parts

Bridge tabs for small parts

Tiny bridges keep parts attached until the job is finished.



Holding tabs

- tabs prevent dropouts
- small gaps remain uncut
- sand or trim later
- use only where needed

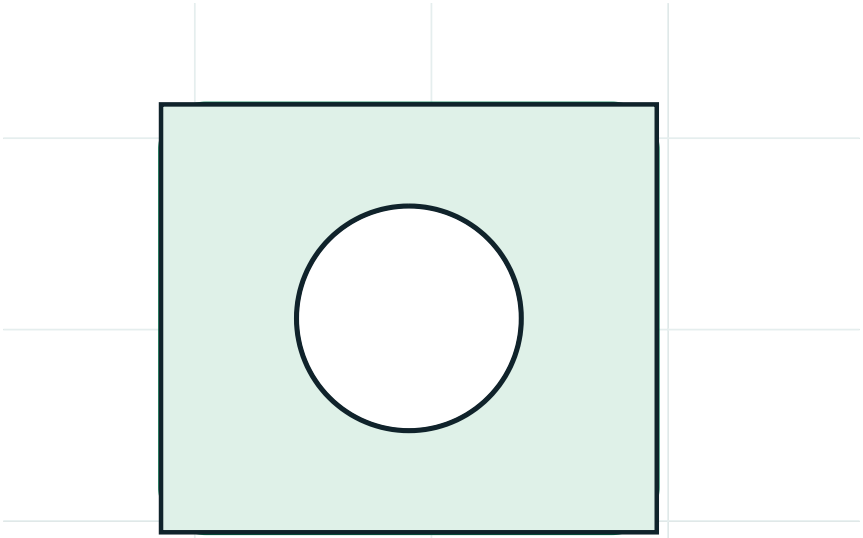
Bridge tabs stop small pieces from moving.

Place tabs where cleanup will be easy.

Compound path and holes

Compound path and holes

A compound path can contain both an outer edge and an inner hole.



outer path + inner path = hole

Compound path

outer path defines edge

inner path cuts hole

fill rule controls

what is solid

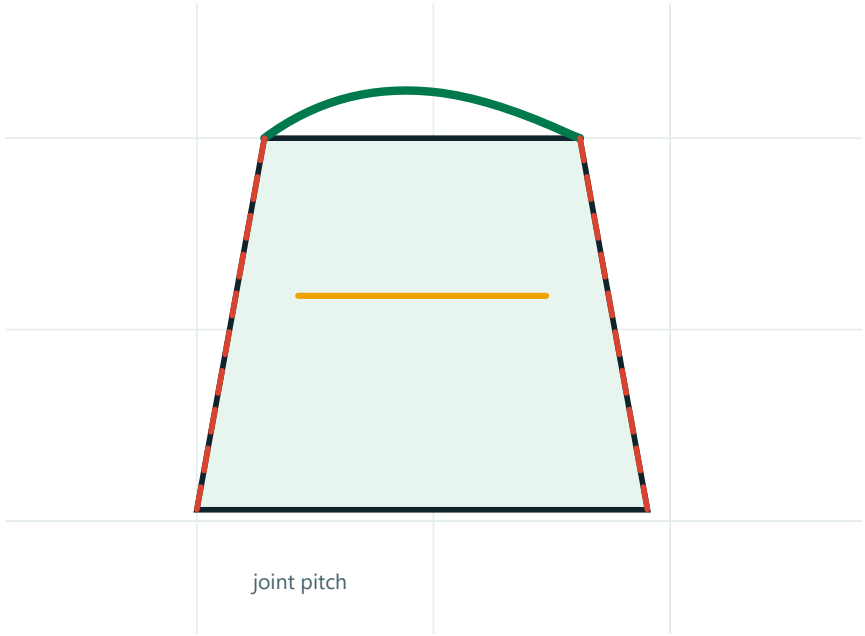
Compound paths are useful for letters and cutouts.

The inner path becomes a real hole.

Finger joint allowance

Finger joint allowance

Finger joints need kerf-aware width and clearance.



Finger joints

tab and slot repeat

clearance controls fit

kerf changes width

test before cutting

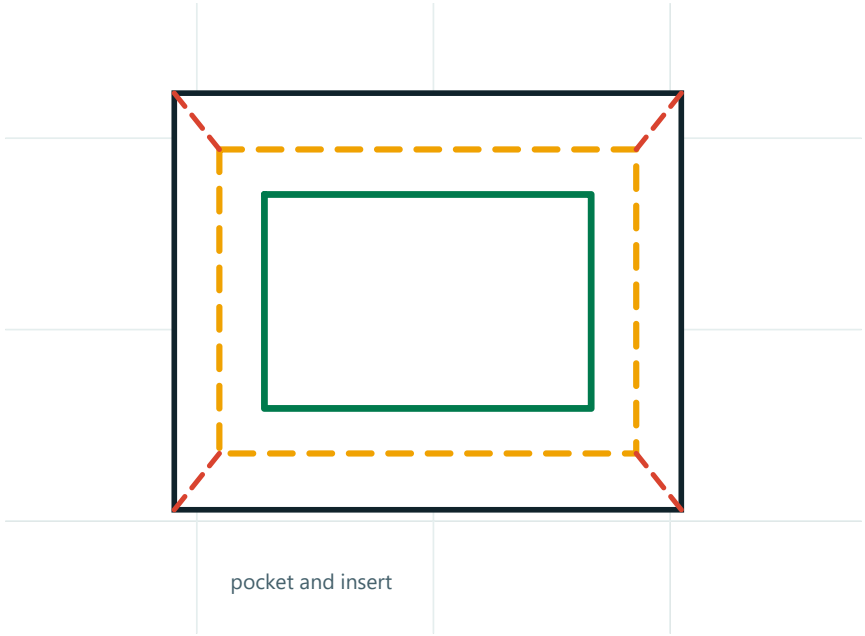
Finger joints depend on accurate allowances.

Good tests prevent loose or impossible joints.

Inlay pocket and insert

Inlay pocket and insert

Inlays need a pocket and matching insert with clearance.



pocket and insert

Inlay fit

pocket cuts inside

insert cuts outside

kerf affects both

test small sample

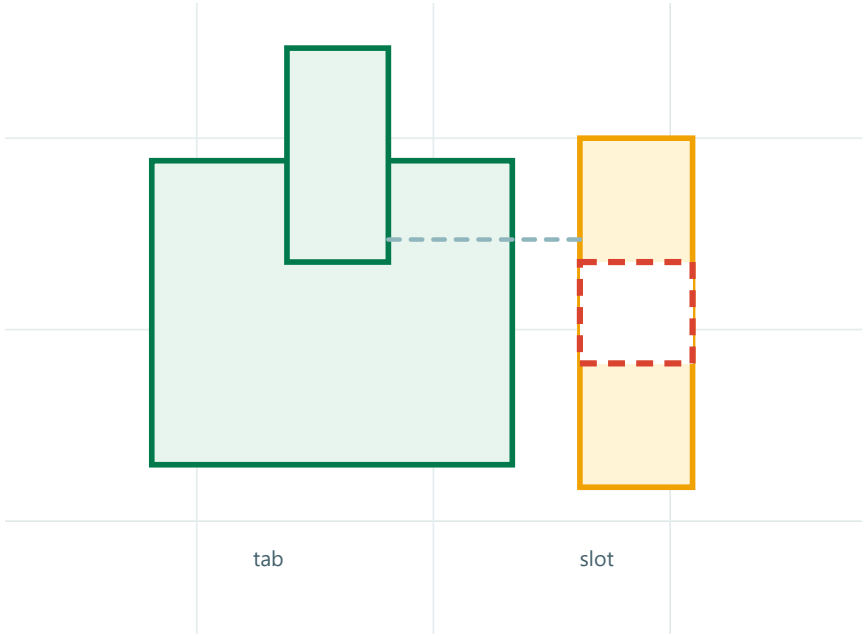
Inlay work needs two matched tool paths.

Clearance controls whether the insert fits.

Laser tab and slot fit

Laser tab and slot fit

Tabs and slots need clearance so parts assemble cleanly.



Fit rule

tab width

slot width

clearance adds room

kerf affects fit

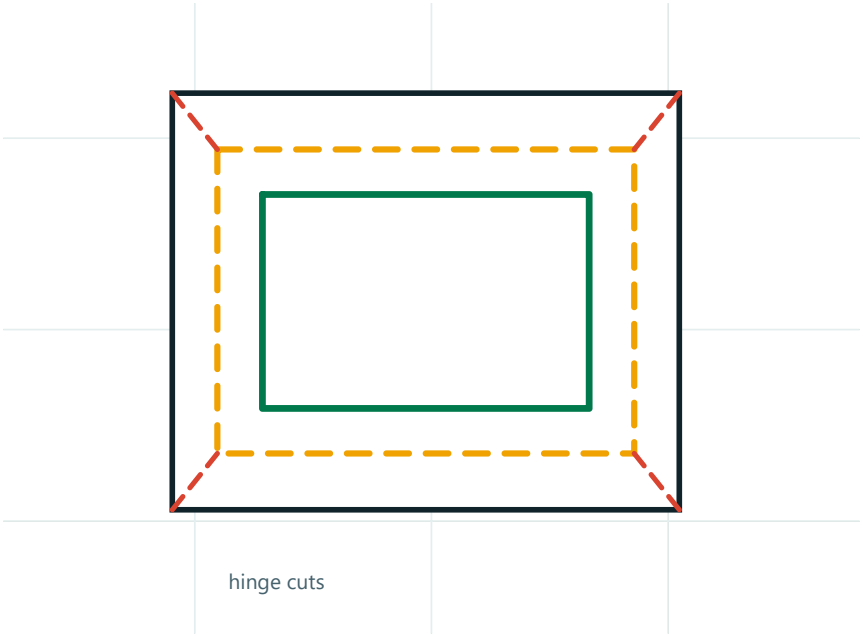
Slots are usually slightly wider than tabs.

Material tests find the best clearance.

Living hinge spacing

Living hinge spacing

Repeated cuts let a rigid sheet bend like a hinge.



Living hinge

cuts create flexibility

spacing controls bend

keep ends strong

test bend radius

Living hinges trade material for flexibility.

Spacing and length set how easily it bends.

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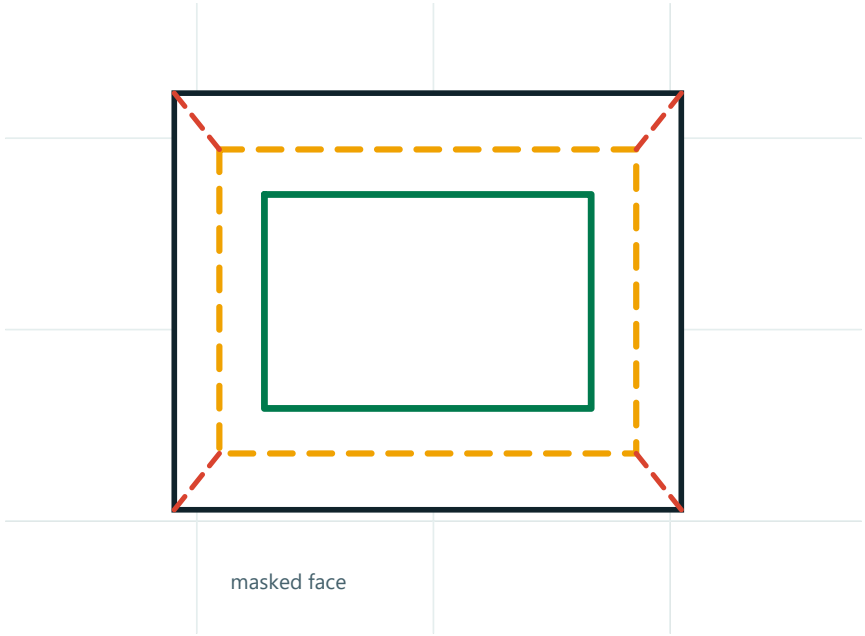
Masking tape scorch control

Masking tape scorch control

Masking can reduce surface smoke staining.



Masking

mask protects face

remove after cutting

watch adhesive residue

test before production

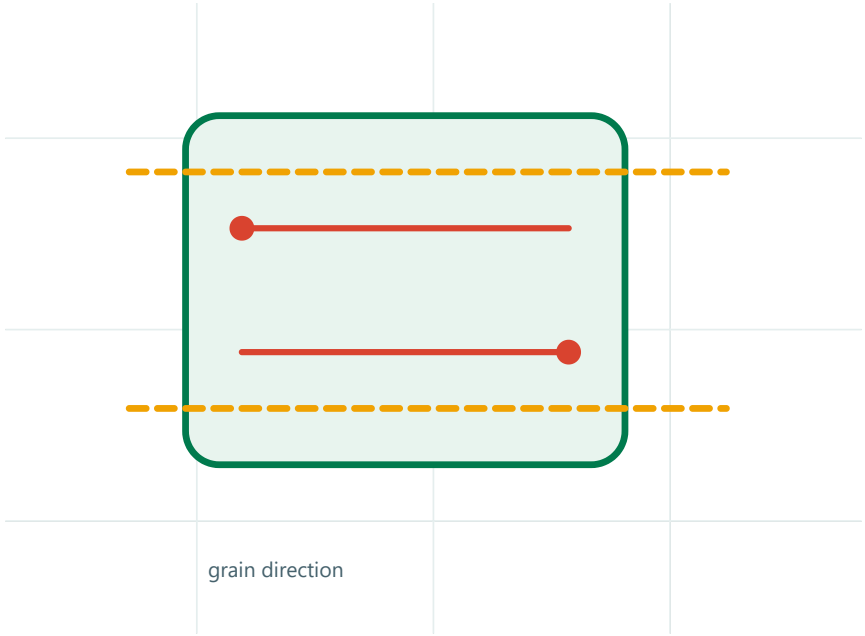
Masking protects visible surfaces.

It can reduce cleanup after cutting.

Material grain direction

Material grain direction

Mark grain before nesting so visible parts face the right way.



Material

- grain can affect look
- rotate parts with care
- keep visible faces matched
- label sheet direction

Grain direction changes the final appearance.

Nest parts without losing material orientation.

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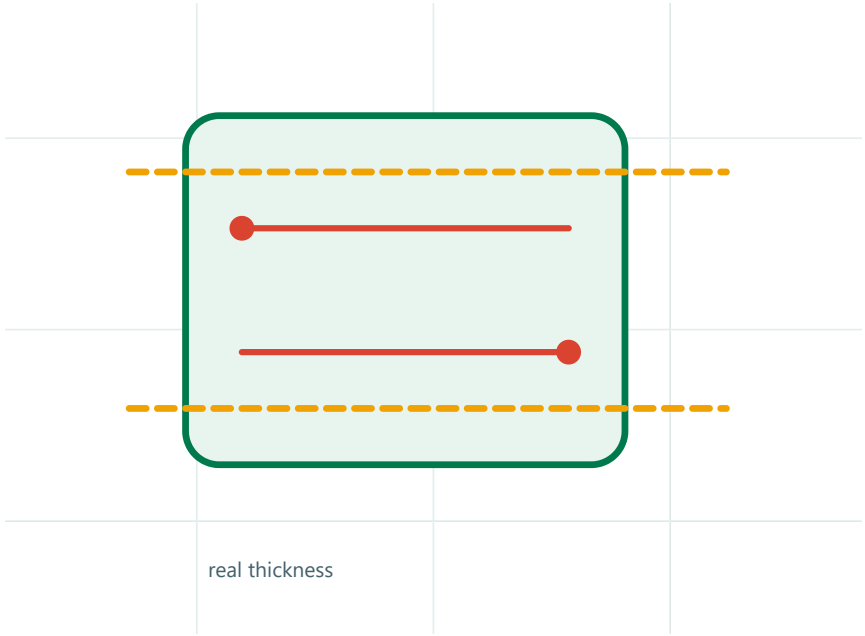
Plywood thickness variation

Plywood thickness variation

Nominal plywood thickness is rarely exact.



Thickness

measure every batch

slots need real size

sheets can vary

calipers beat labels

Plywood thickness changes from sheet to sheet.

Measure the actual material before designing slots.

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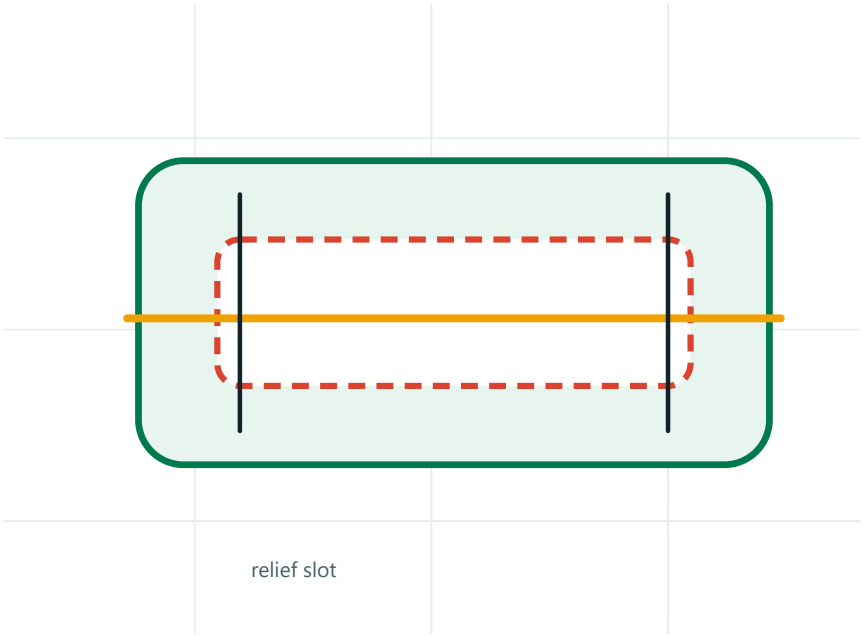
Press-fit stress relief

Press-fit stress relief

Relief cuts help press-fit parts flex without cracking.



Stress relief

press fit adds force

relief lets part flex

avoid sharp notches

test material spring

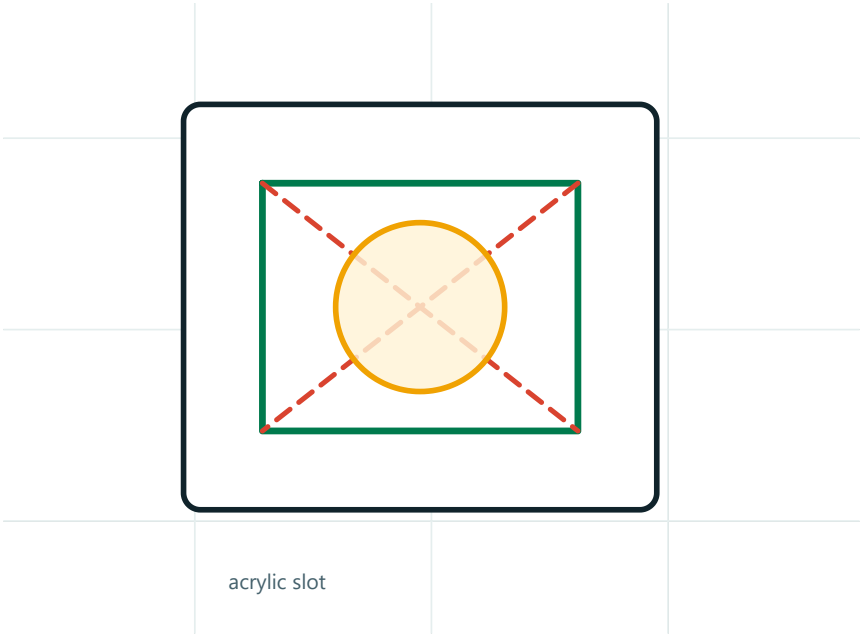
Stress relief makes tight fits safer.

It helps stiff materials assemble cleanly.

Slot clearance for acrylic

Slot clearance for acrylic

Acrylic slots often need more clearance than plywood.



acrylic slot

Acrylic fit

acrylic is rigid

too tight can crack

allow assembly room

polish affects edges

Rigid material needs a gentler fit.

Clearance avoids stress cracking.

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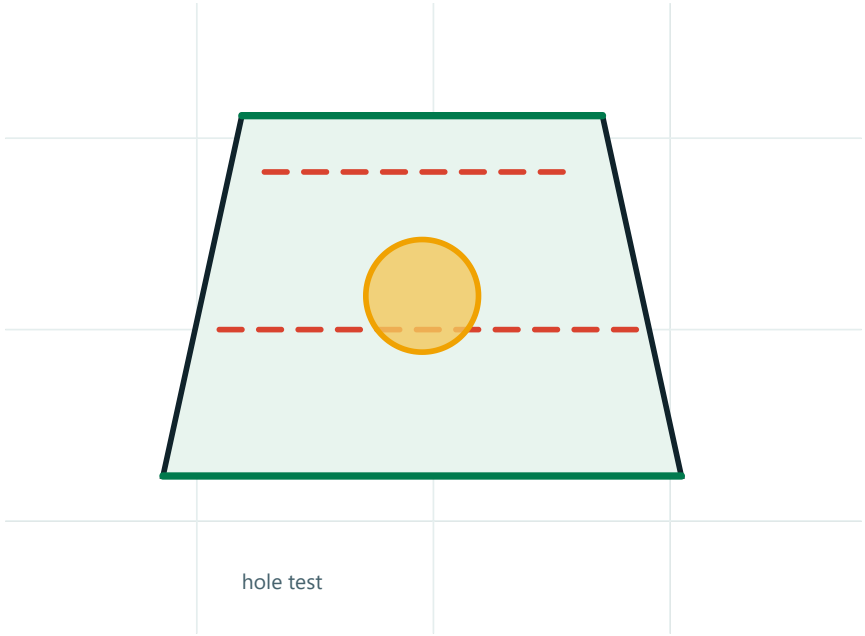
Small hole compensation

Small hole compensation

Tiny holes often cut smaller than expected.



Hole size

kerf changes diameter

heat closes small holes

oversize in design

test actual drill fit

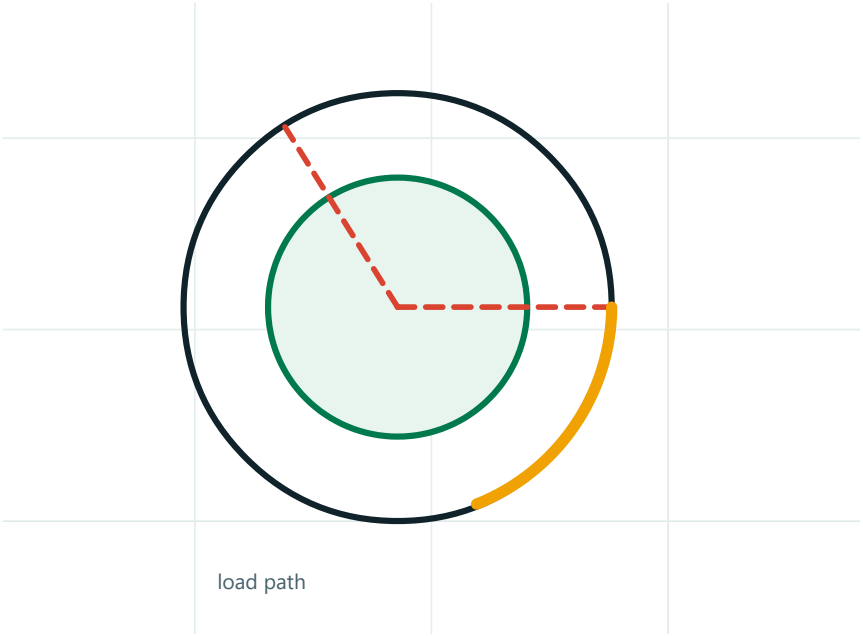
Small holes need extra allowance.

Use a test strip for screw and pin sizes.

Tab orientation for strength

Tab orientation for strength

The strongest direction depends on material and load.



Strength

tabs carry force

grain may weaken parts

wide tabs resist twist

avoid fragile corners

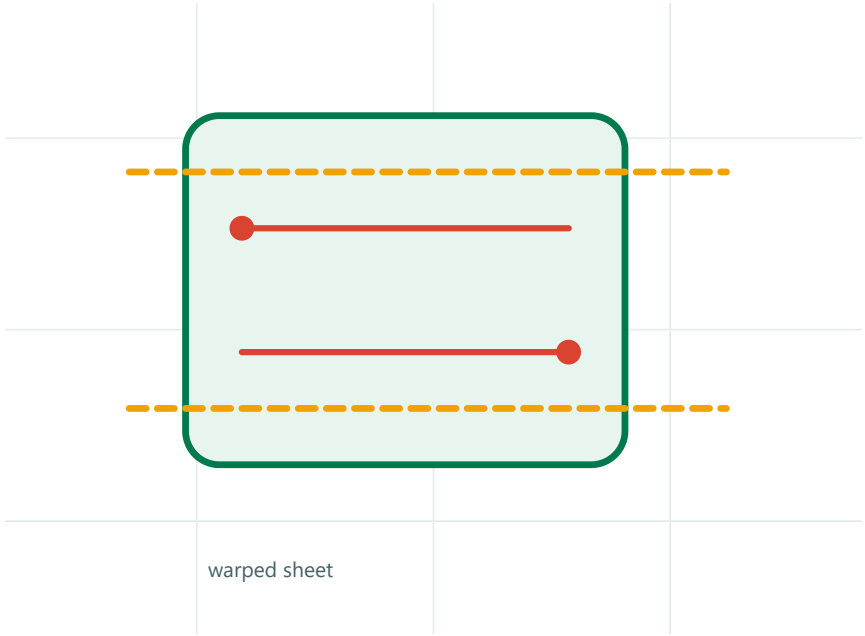
Part strength depends on tab direction.

Orient joints around the load path.

Thin material warping

Thin material warping

Heat can curl thin sheets during cutting.



Warping

thin stock moves

heat causes curl

hold material flat

use lower heat

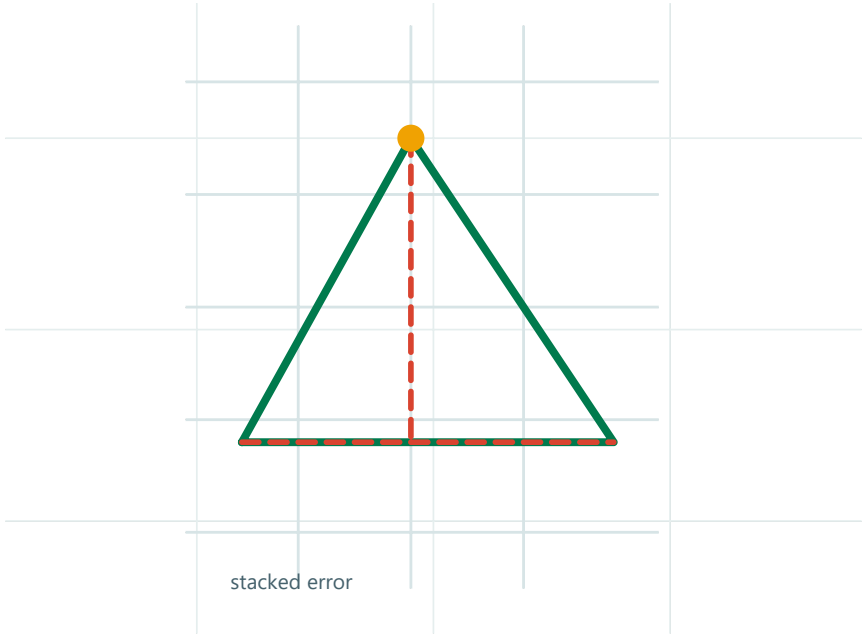
Warping changes focus and cut accuracy.

Flat sheets cut more predictably.

Tolerance stack-up

Tolerance stack-up

Small errors add up across repeated parts.



Tolerance

each joint has error

many joints add up

measure assemblies

design adjustment room

Repeated tolerances can accumulate.

Leave adjustment where assemblies need precision.

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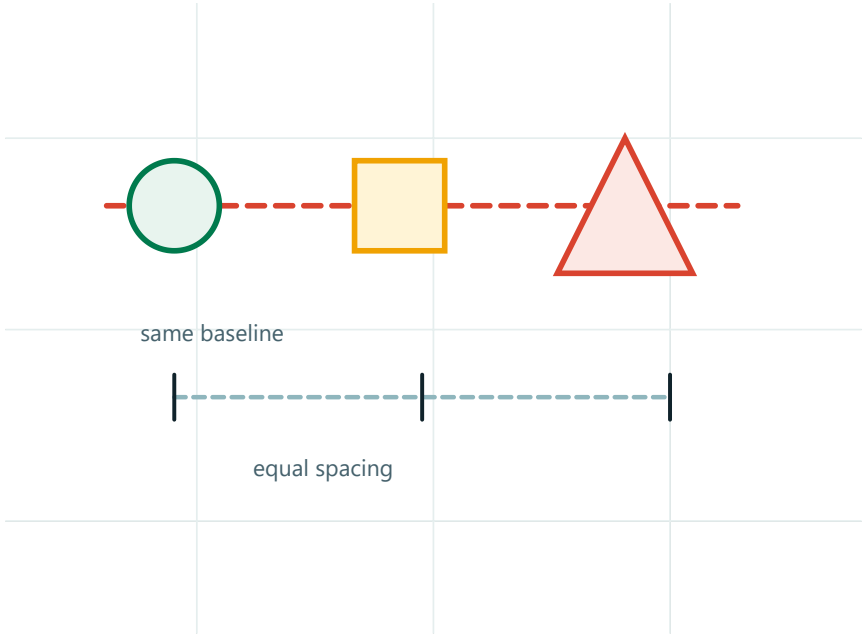
Align and distribute

Align and distribute

Alignment lines objects up; distribution spaces them evenly.



Layout tools

align: share an edge

or center line

distribute: equal gaps

between objects

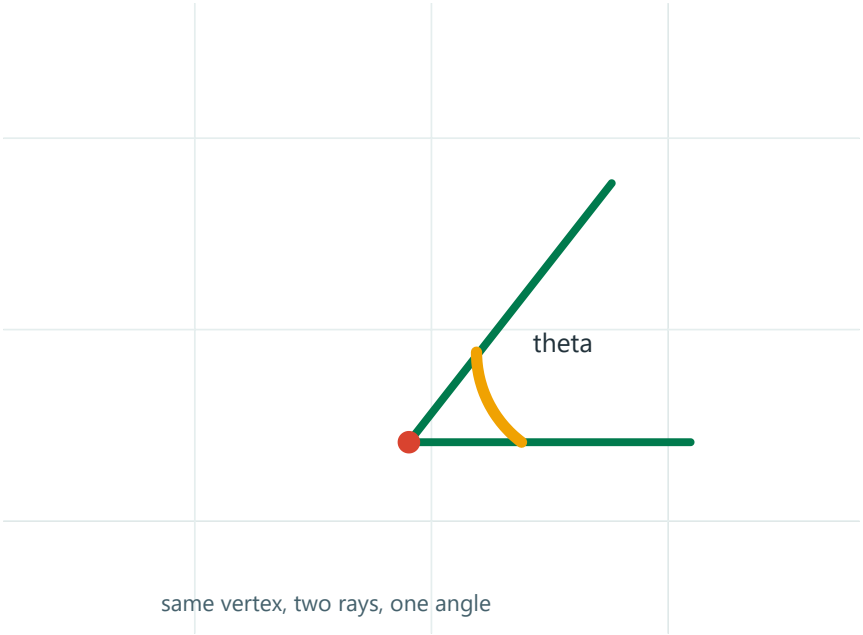
Alignment creates clean visual order.

Distribution keeps repeated items evenly spaced.

Angle measurement

Angle measurement

Angles measure rotation between two rays from the same point.



same vertex, two rays, one angle

Formula idea

full turn = 360 degrees

straight line = 180 degrees

right angle = 90 degrees

`radians: full turn = 2*pi`

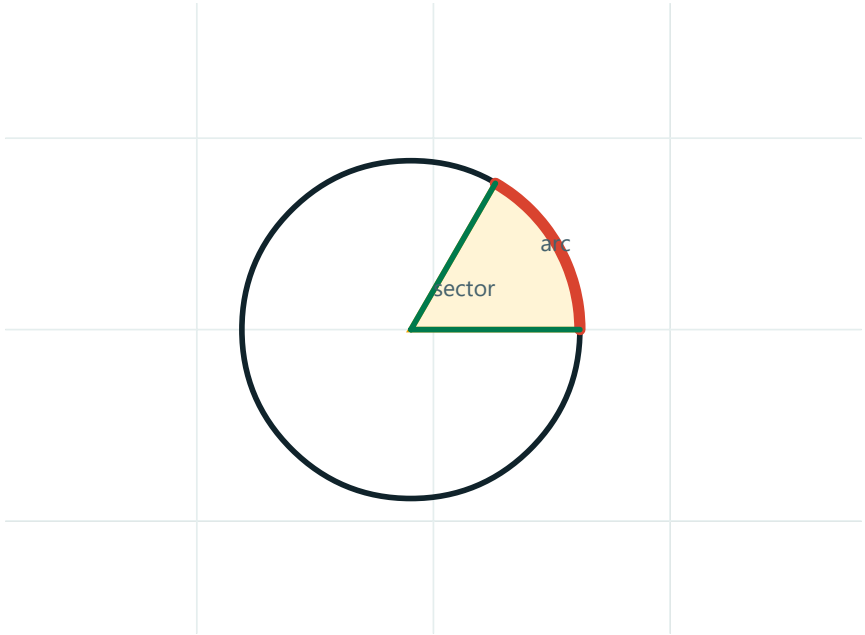
Angles describe rotation from one ray to another.

Degrees and radians are two ways to measure it.

Arc length and sector area

Arc length and sector area

A sector is a slice of a circle controlled by its central angle.



Using angle

`arc = (angle/360)*C`

`sector = (angle/360)*A`

larger angle means

larger arc and area

The angle controls the arc length.

The same fraction controls the sector area.

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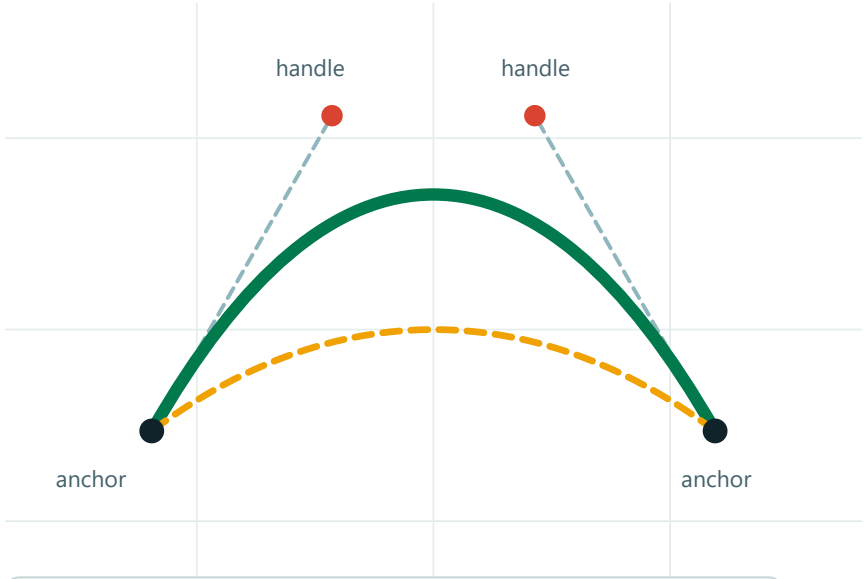
Bezier curves explained

Bezier curves explained

Anchor points set the ends of a curve. Handles control its direction and strength.



black: anchor red: handle green: curve

Bezier idea

Anchors:

`start and end points`

Handles:

`pull curve direction`

`and curve strength`

Shorter handles:

`flatter curve`

The dashed gold curve shows a weaker handle pull.

Move handles to reshape the curve.
The anchors can stay in place.

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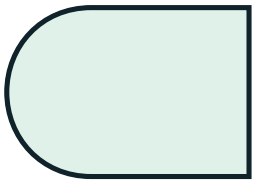
Boolean path operations

Boolean path operations

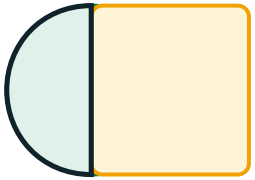
Combine overlapping vector shapes using union, difference, intersection, or exclusion.

Union



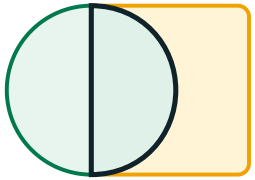
one merged shape

Difference



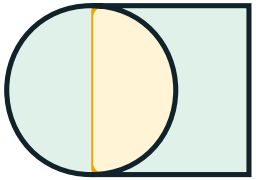
front removes area

Intersection



only overlap remains

Exclusion



overlap becomes hole

green: circle gold: square dark: result

What changes?

Union:

`add shapes together`

Difference:

`subtract front shape`

Intersection:

`keep only overlap`

Exclusion:

`remove overlap area`

Boolean operations create new vector geometry.

Object order matters for difference operations.

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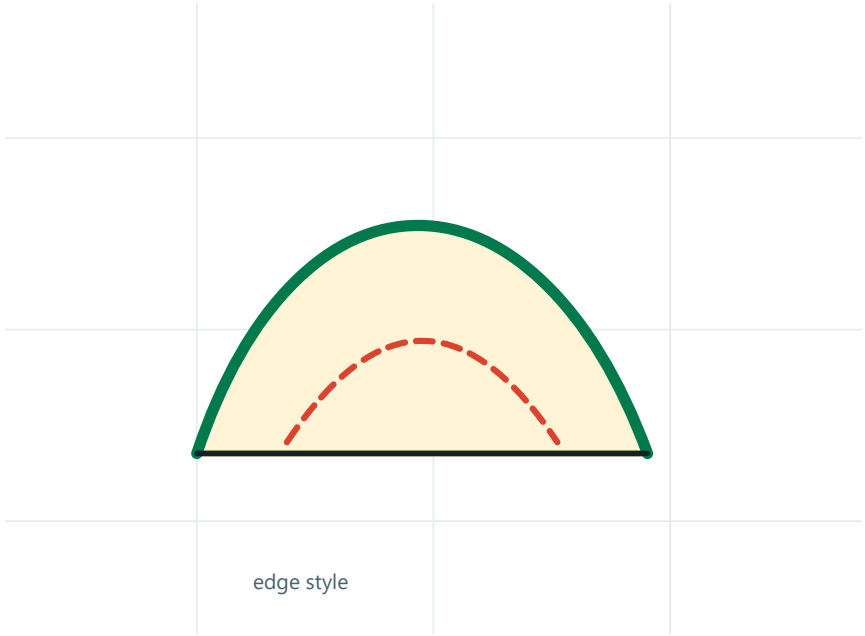
Chamfer vs fillet edges

Chamfer vs fillet edges

Chamfers and fillets change fit, look, and stress points.



Edge style

chamfer is straight

fillet is rounded

both soften corners

choose by purpose

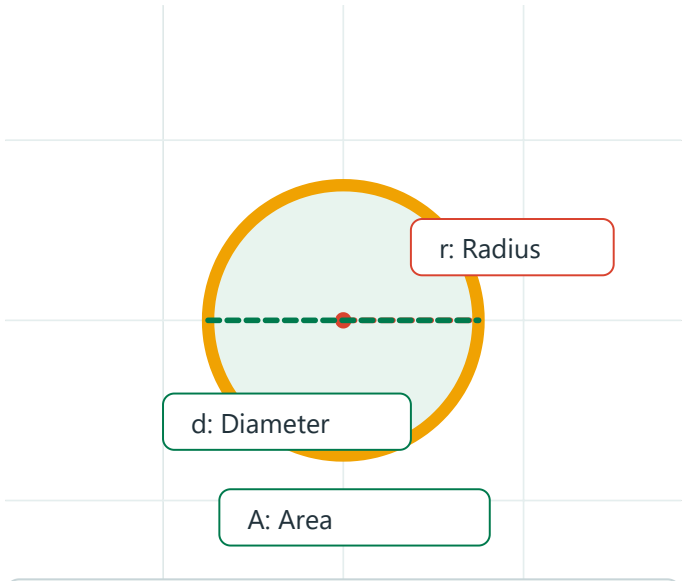
Edge style changes both appearance and fit.

Use the style that suits the material.

Circle Basics: radius, diameter, circumference, and area

Circle Basics: radius, diameter, circumference, and area

A simple animated geometry reference built from editable SVG vector shapes.



Formulas

Diameter

```
d = 2r
```

Circumference

```
C = 2*pi*r
```

```
C = pi*d
```

Area

```
A = pi*r^2
```

pi is the constant ratio of circumference to diameter.

A circle is defined by its radius.

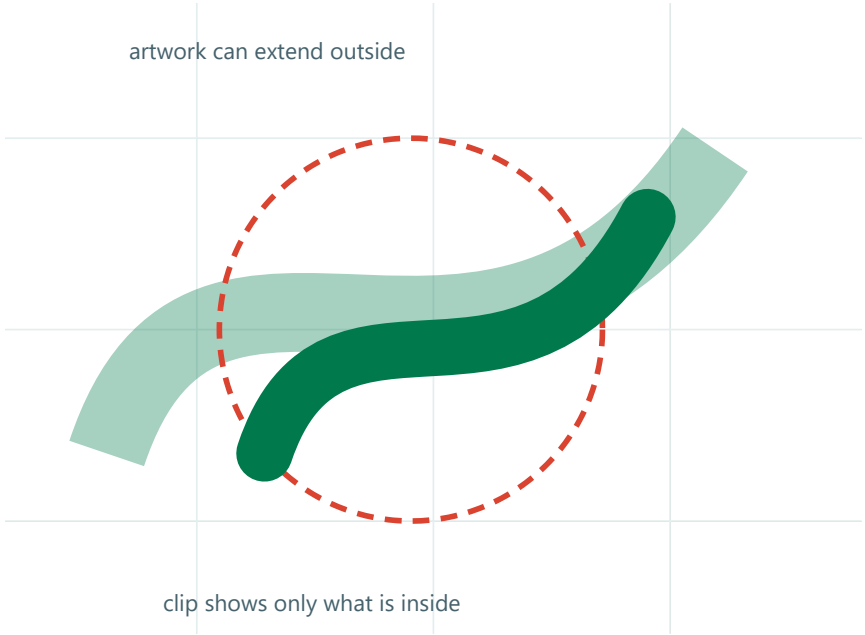
From radius, you can calculate d, C, and A.

DesignAlign.co.za

Clipping mask

Clipping mask

A clipping shape hides anything outside its boundary.



Clipping

clip path = visible window

outside area is hidden

original artwork can

remain editable

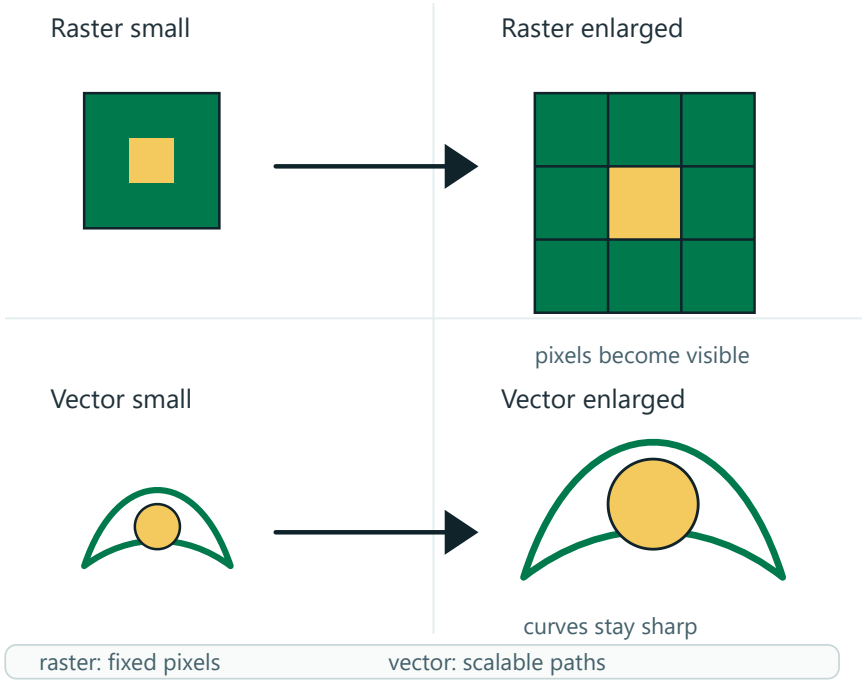
Clipping is non-destructive in editable artwork.

It changes visibility, not the source shape.

DPI vs vector scaling

DPI vs vector scaling

Raster artwork is made of pixels. Vector artwork is made of editable geometry.



Scaling idea

Raster:

`pixels get larger`

`when scaled up`

Vector:

`geometry is recalculated`

`at any size`

DPI matters for raster.

Vectors export cleanly at the size you choose.

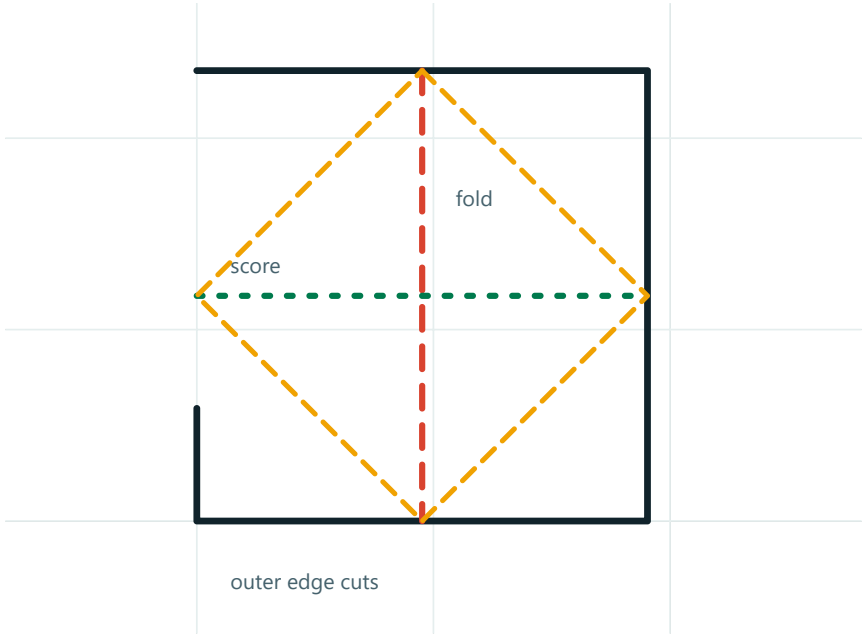
Use vectors when artwork must scale.

Use enough pixels for large raster output.

Fold, score, and cut lines

Fold, score, and cut lines

Different line styles tell production how to finish a flat design.



Line meaning

solid = cut

dashed = fold

dotted = score

labels prevent errors

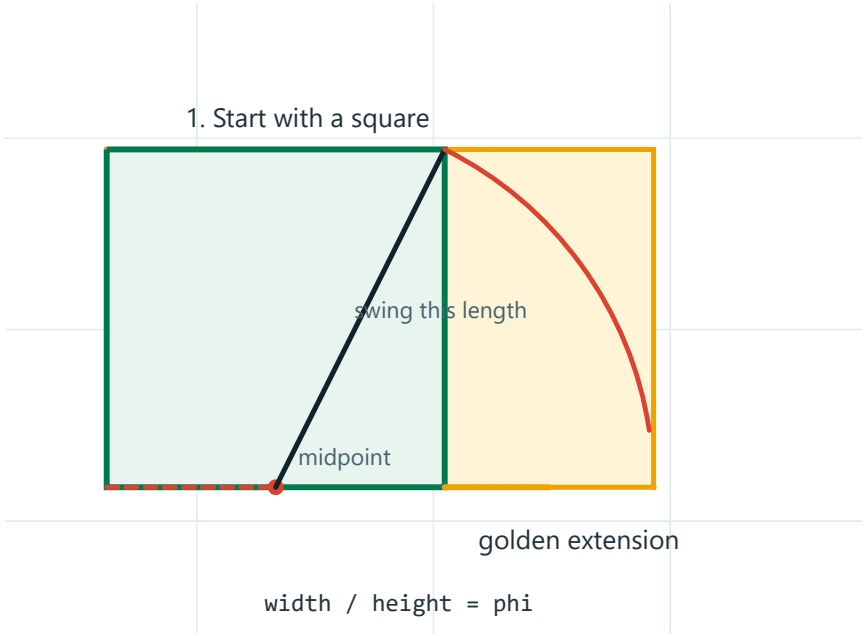
Line styles turn artwork into instructions.

Keep cut, fold, and score clearly separate.

Golden Ratio construction: from square to golden rectangle

Golden Ratio construction: from square to golden rectangle

A compass-style vector construction: square, midpoint, diagonal swing, extension, rectangle.



Golden ratio

Symbol:

```
phi = 1.618033988...
```

Formula:

```
phi = (1 + sqrt(5)) / 2
```

For this rectangle:

```
width = height * phi
97.082... = 60 * phi
```

A golden rectangle can be split into a square plus a smaller golden rectangle.

The diagonal from midpoint to corner sets the extension.

That creates a rectangle in the golden ratio.

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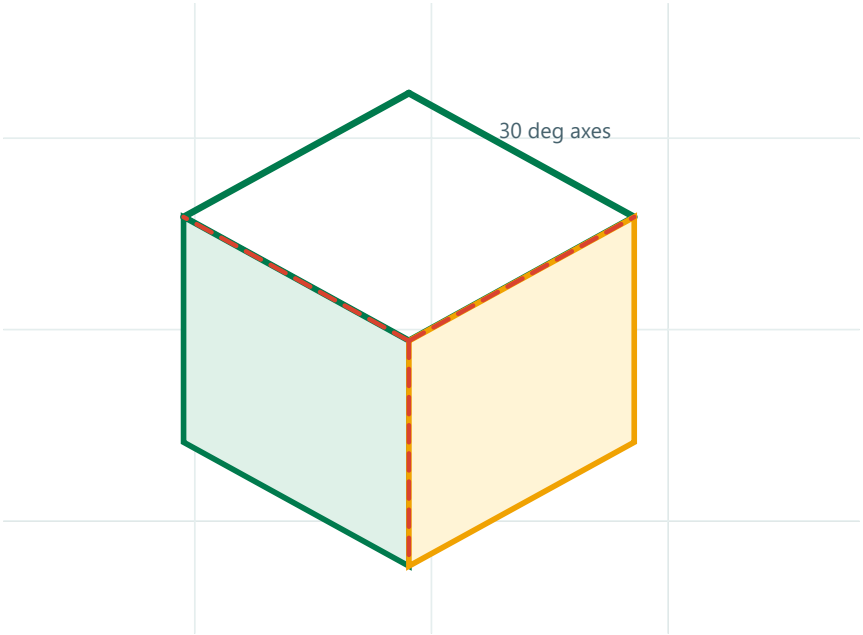
Isometric cube construction

Isometric cube construction

Isometric drawing keeps three axes equally spaced.



Isometric

vertical axis

30 degree left axis

30 degree right axis

no convergence

Isometric objects keep parallel edges parallel.

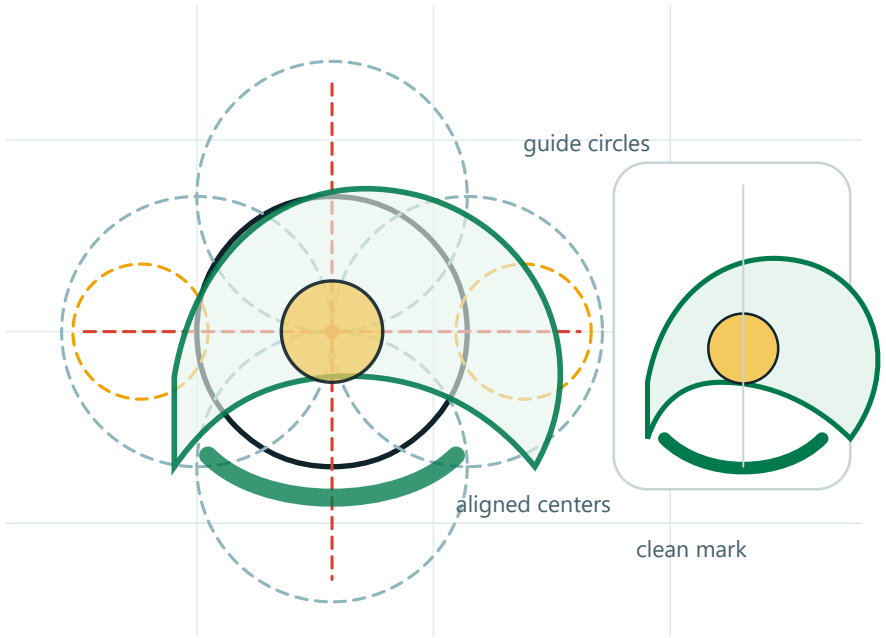
It suggests depth without perspective.

DesignAlign.co.za

Logo grid from circles

Logo grid from circles

Use repeated circles and alignment guides to create a balanced vector mark.



Logo grid idea

Use circles to set:

- curves
- spacing
- symmetry

Then trace the final mark with clean vector paths.

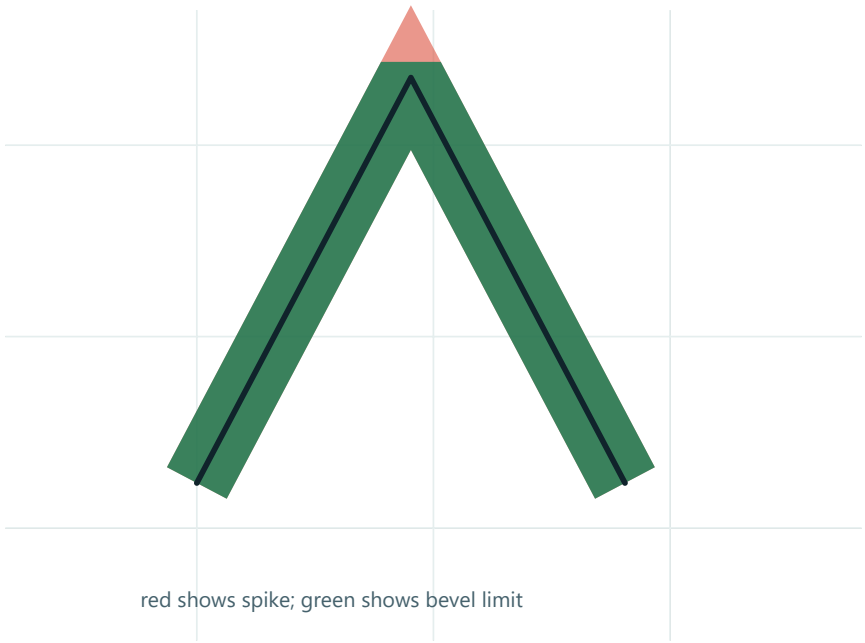
The grid is a design aid, not always part of the final logo.

Circle grids help logos feel balanced and intentional.
Keep the final mark simpler than the construction.

Miter limit on sharp corners

Miter limit on sharp corners

A miter limit prevents extreme spikes at narrow angles.



red shows spike; green shows bevel limit

Miter limit

sharp joins can spike

limit clips the spike

bevel is safer

check acute corners

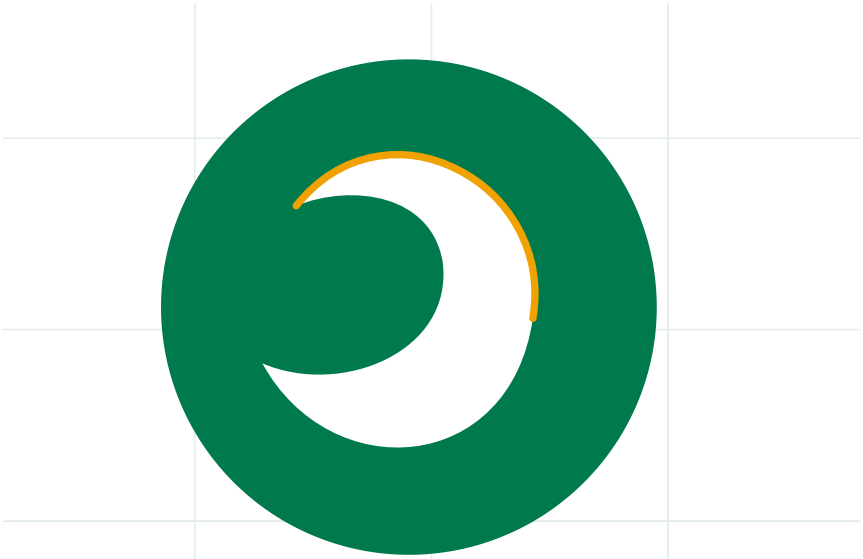
Miter limits keep corners under control.

Very sharp angles may need bevel joins.

Negative space logo

Negative space logo

The empty area can form a second readable shape.



white area becomes the hidden shape

Negative space

solid shape attracts

empty shape reads

contrast defines both

simpler is stronger

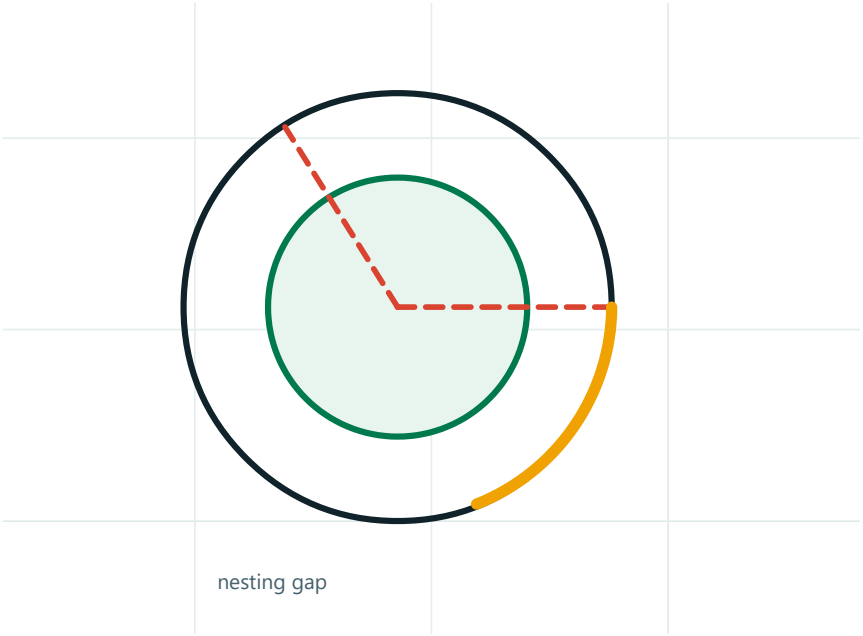
Negative space turns absence into shape.

Good marks are clear in one colour.

Nested parts and spacing

Nested parts and spacing

Parts need enough gap so cuts do not weaken neighbours.



Nesting

spacing saves material

too close overheats

kerf removes material

leave safe gaps

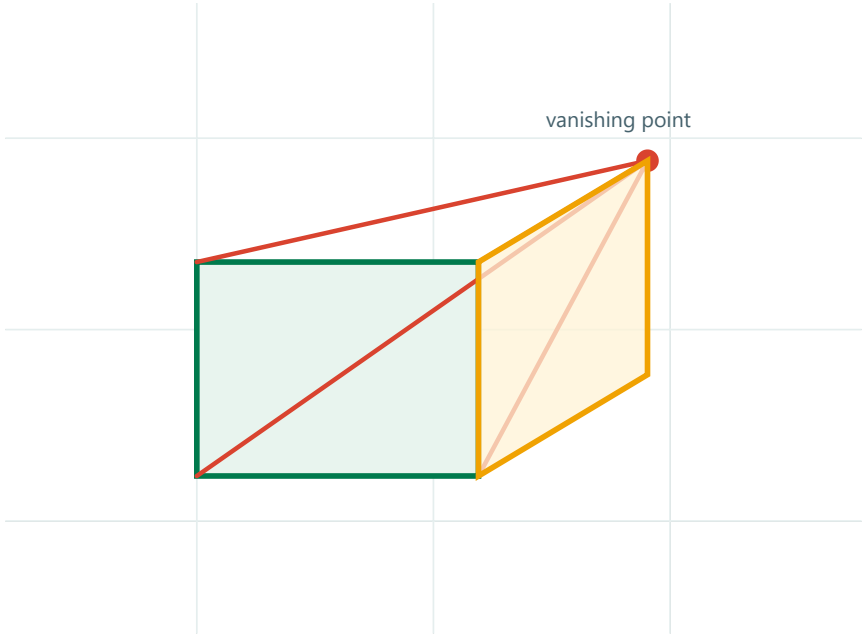
Good nesting saves material without damage.

Spacing must respect heat and kerf.

One-point perspective

One-point perspective

Parallel depth lines meet at one vanishing point.



Perspective

front face stays flat

depth lines converge

vanishing point

sets direction

Perspective turns flat shapes into depth.

All depth edges aim at the same point.

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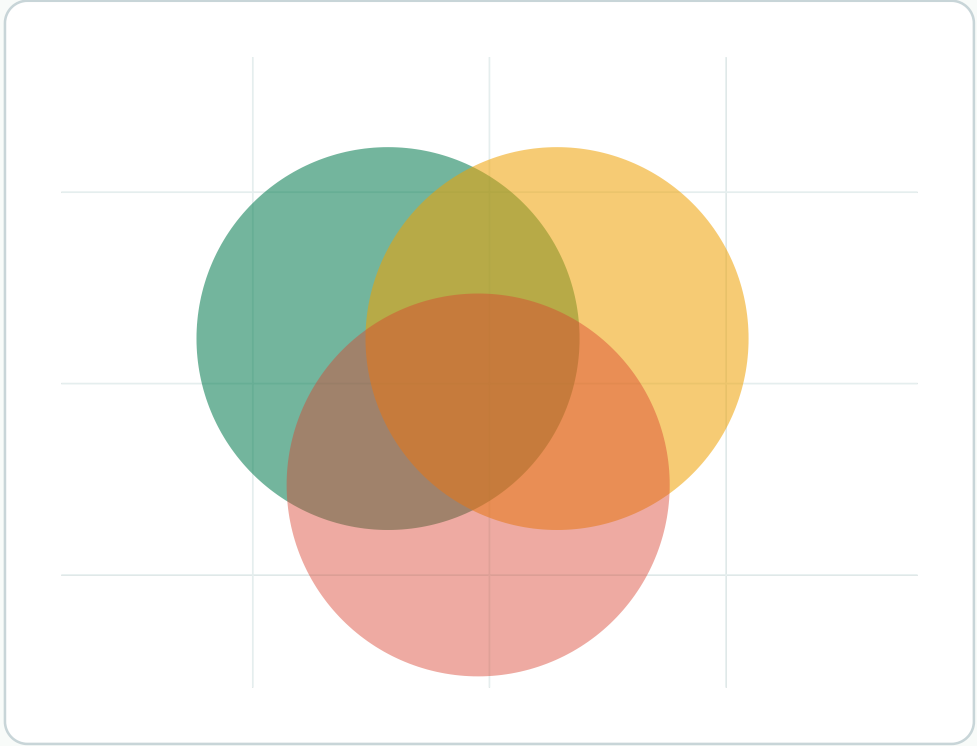
Opacity and blending

Opacity and blending

Transparent colours reveal overlaps and mixed regions.



Opacity

100% hides behind

lower opacity shows

overlap creates mix

use with intention

Opacity lets construction lines stay visible.

It is ideal for layered explanations.

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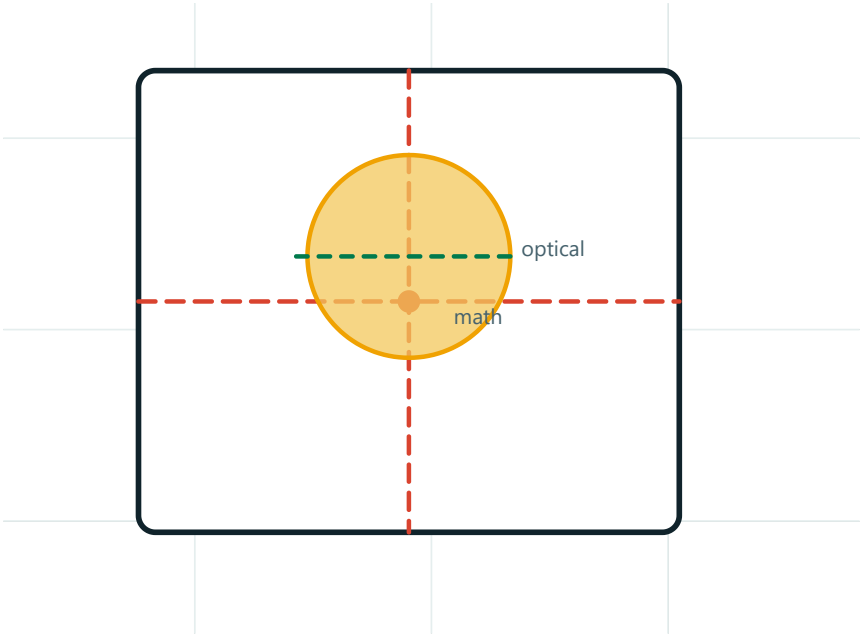
Optical vs geometric center

Optical vs geometric center

A visually centered object can sit slightly above mathematical center.



Centering

geometric center

is exact math

optical center

feels balanced

Visual balance is sometimes not pure math.

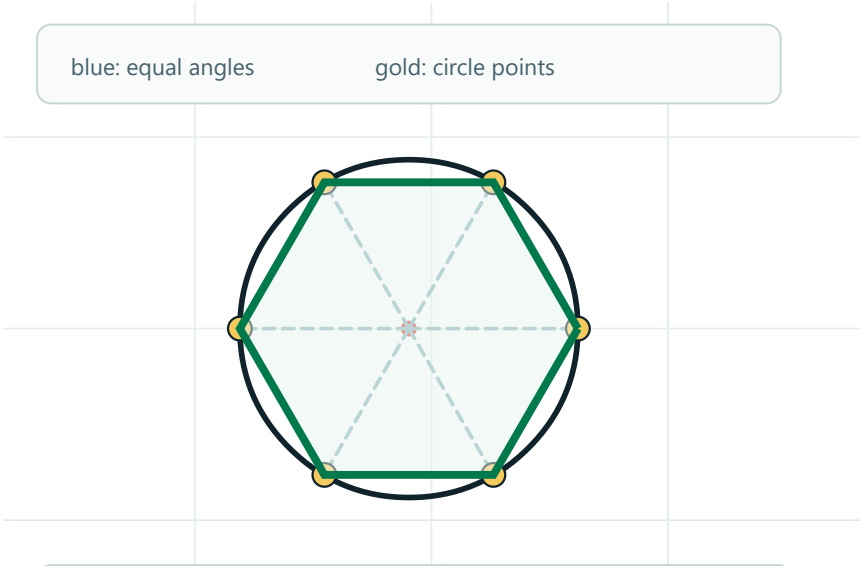
Designers adjust until it looks centered.

DesignAlign.co.za

Polygon from a circle

Polygon from a circle

Divide a circle into equal angles, then connect the points to make a regular polygon.



Hexagon central angle = 60 degrees.

Regular polygon

Choose side count:

```
n = 6
```

Central angle:

```
angle = 360 / n
angle = 60 degrees
```

Hexagon shortcut:

```
side = radius
```

Connect the points in order.

Equal angle divisions create regular polygons.

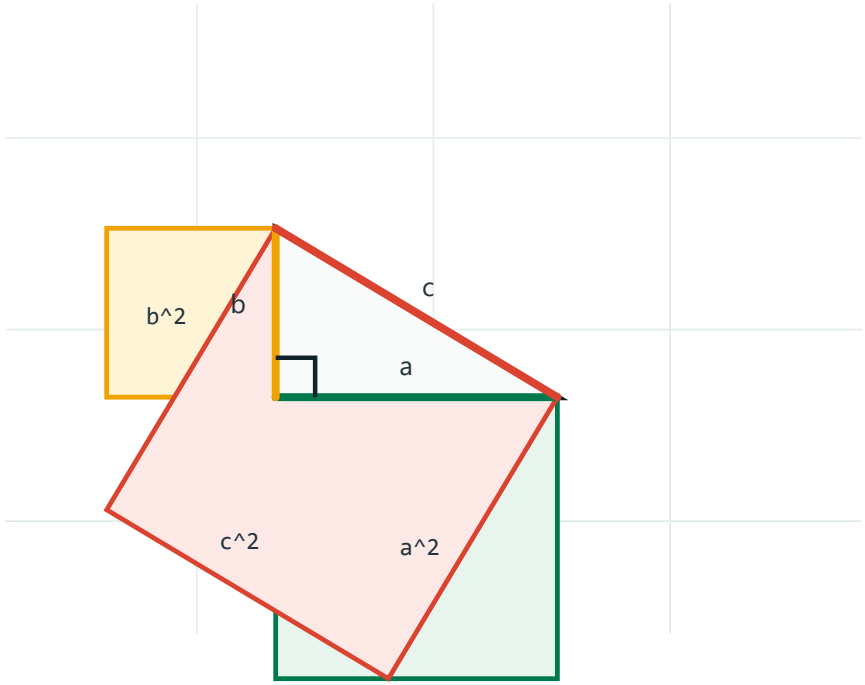
More divisions create more sides.

DesignAlign.co.za

Pythagoras visually: a^2 + b^2 = c^2

Pythagoras visually: $a^2 + b^2 = c^2$

For a right triangle, the areas of the two smaller side-squares equal the area of the hypotenuse-square.



The relationship

Right triangle:

```
a^2 + b^2 = c^2
```

Example shown:

```
a = 50
b = 30
c = sqrt(50^2 + 30^2)
c = sqrt(3400)
```

The c-square area equals the sum of the a-square and b-square areas.

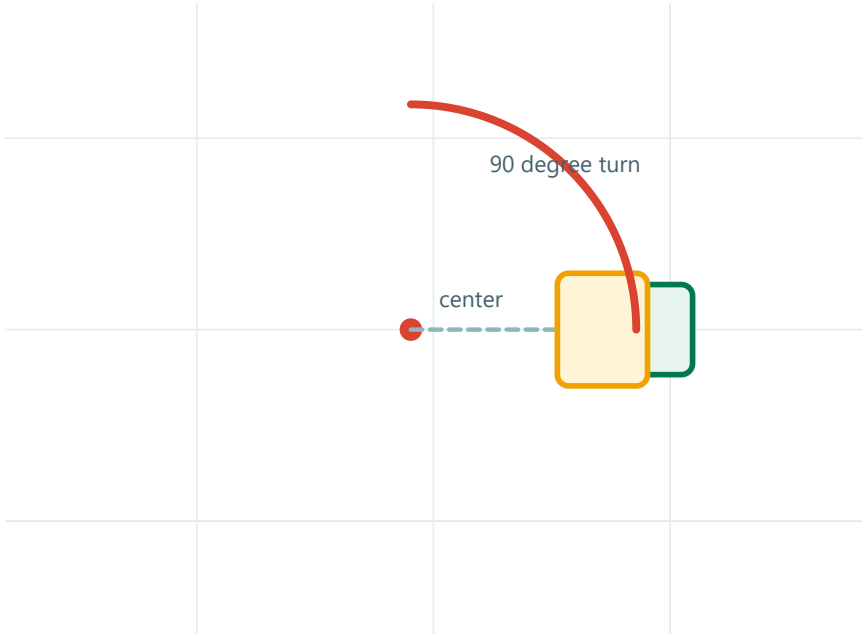
The theorem is about areas, not just side lengths.

The largest square sits on the hypotenuse.

Rotation around a center

Rotation around a center

Rotation turns a shape around a fixed point.



Rotation

center point stays fixed

distance from center

stays the same

angle sets the turn

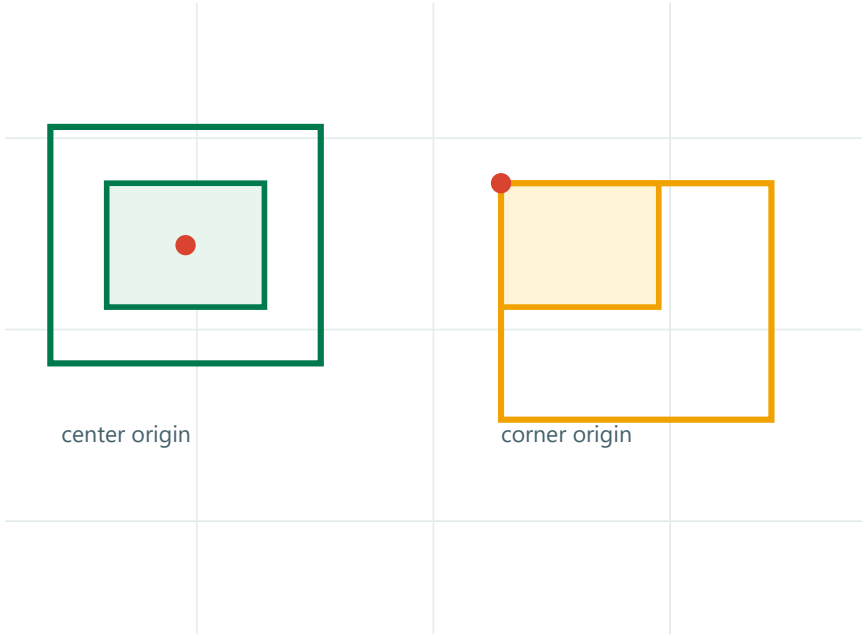
Rotated objects keep their distance from center.

Only their angle changes.

Scale from center vs corner

Scale from center vs corner

The scale origin changes where the object grows.



Scale origin

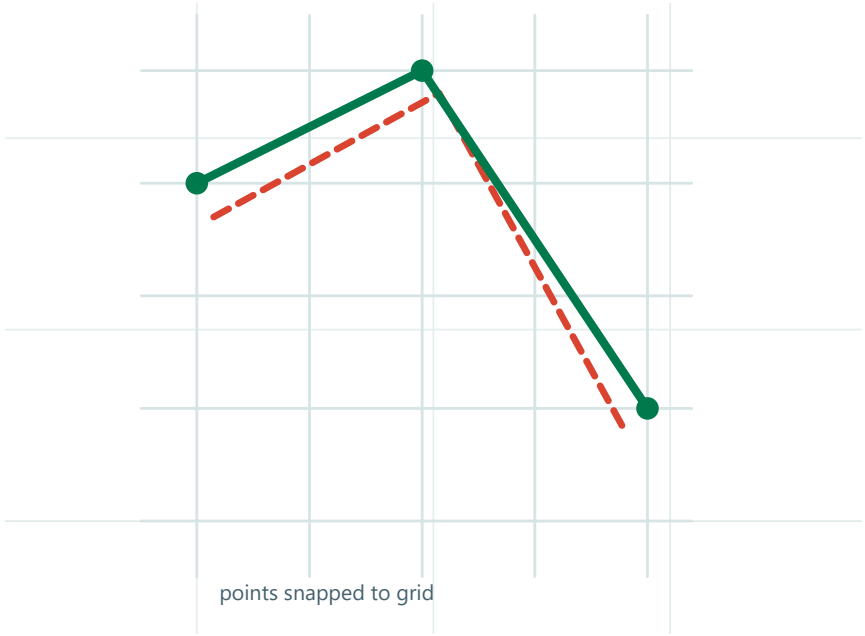
center scaling grows
equally outward
corner scaling keeps
one corner fixed

Scaling changes size relative to an origin point.
Choose the origin before resizing.

Snap to grid

Snap to grid

Snapping pulls points onto regular guide positions.



points snapped to grid

Snapping

grid gives targets

points move to grid

spacing becomes exact

editing is faster

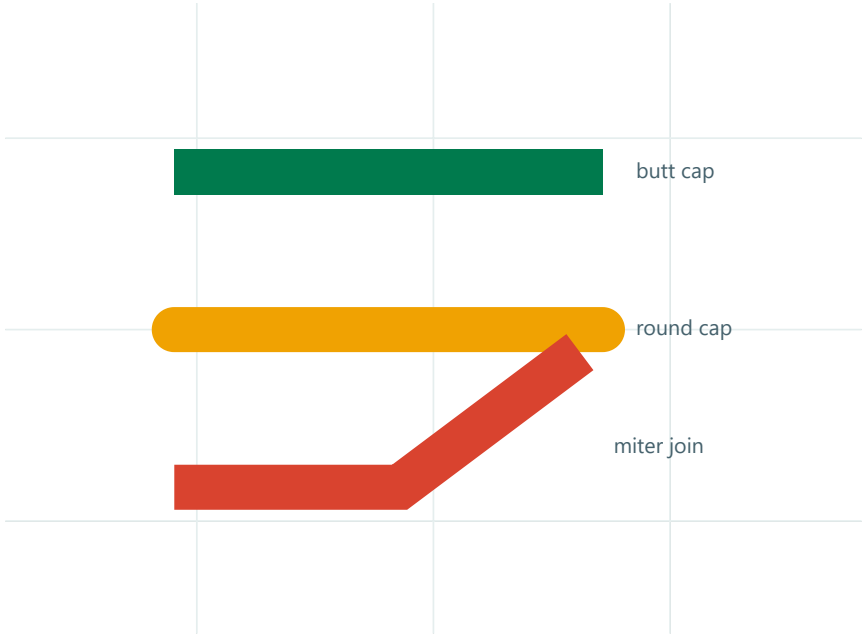
Snapping removes tiny alignment errors.

Use it when precision matters.

Stroke caps and joins

Stroke caps and joins

Caps and joins change the ends and corners of strokes.



Stroke style

cap affects ends

join affects corners

round feels softer

miter feels sharper

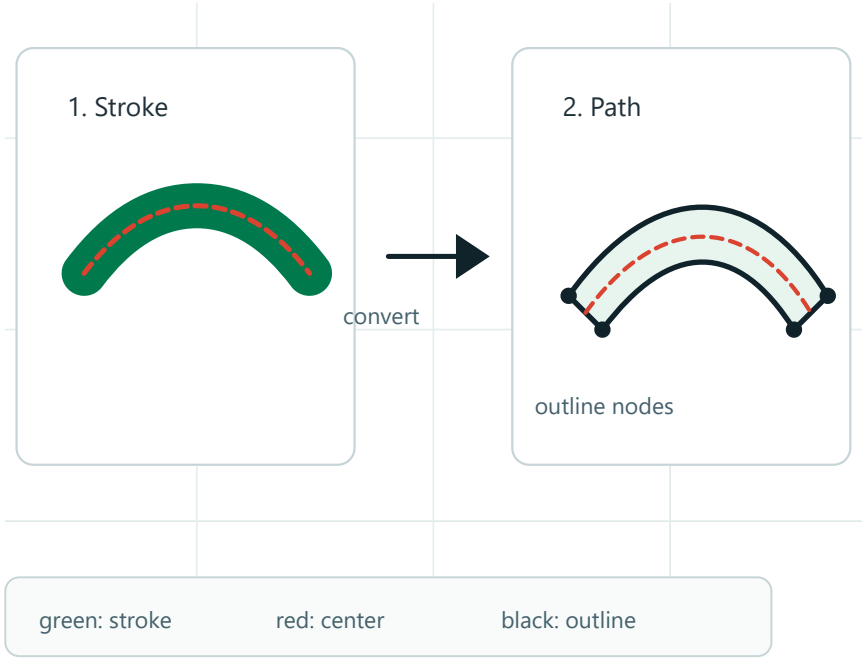
Stroke styling changes the look of paths.

Caps and joins matter for icons and cuts.

Stroke to path

Stroke to path

A visual stroke is converted into real filled outline geometry.



Why convert?

A stroke has width,
but it is not geometry.

Stroke to path:

`turns width into a shape`

Useful for:

`laser cutting`

`vinyl / CNC`

Keep an editable copy first.

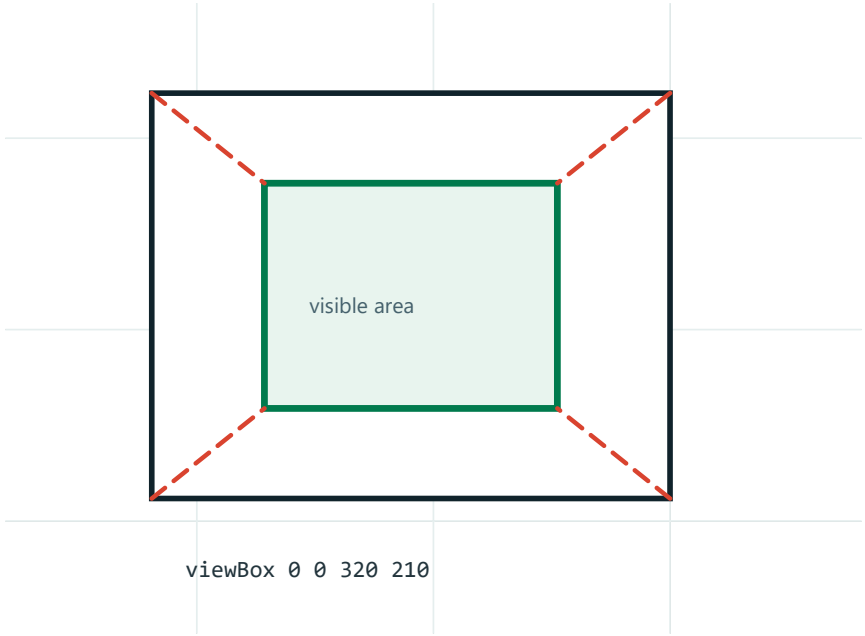
After conversion, the stroke becomes a filled path.
Cutting software can follow the real edges.

DesignAlign.co.za

SVG viewBox mapping

SVG viewBox mapping

The viewBox maps drawing coordinates into the visible frame.



ViewBox

viewBox = coordinate window for artwork

scale can change

geometry stays same

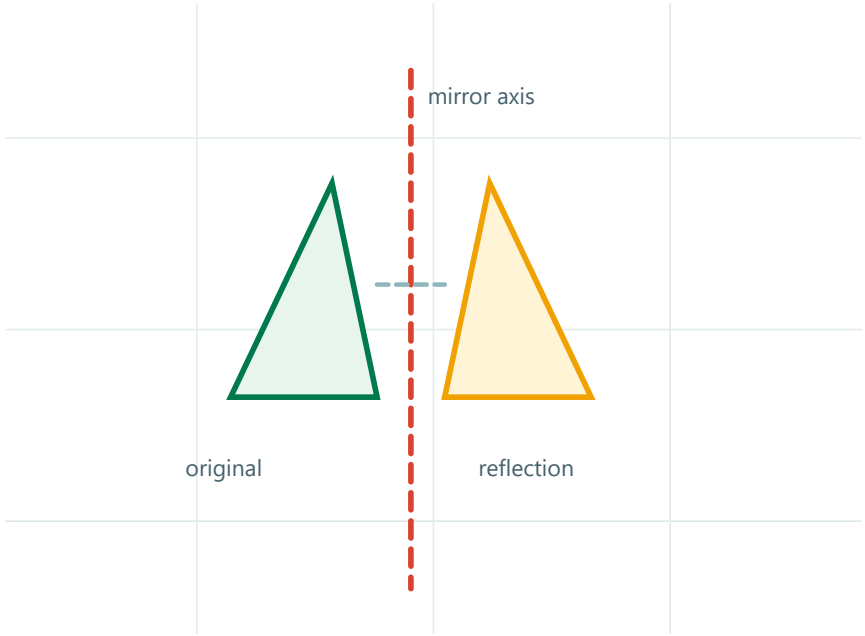
The viewBox controls what part is visible.

It scales the coordinate space to the frame.

Symmetry and reflection

Symmetry and reflection

Reflection mirrors a shape across an axis.



Reflection

shape flips across axis

distance to axis

stays equal

orientation reverses

Symmetry means both sides match across an axis.

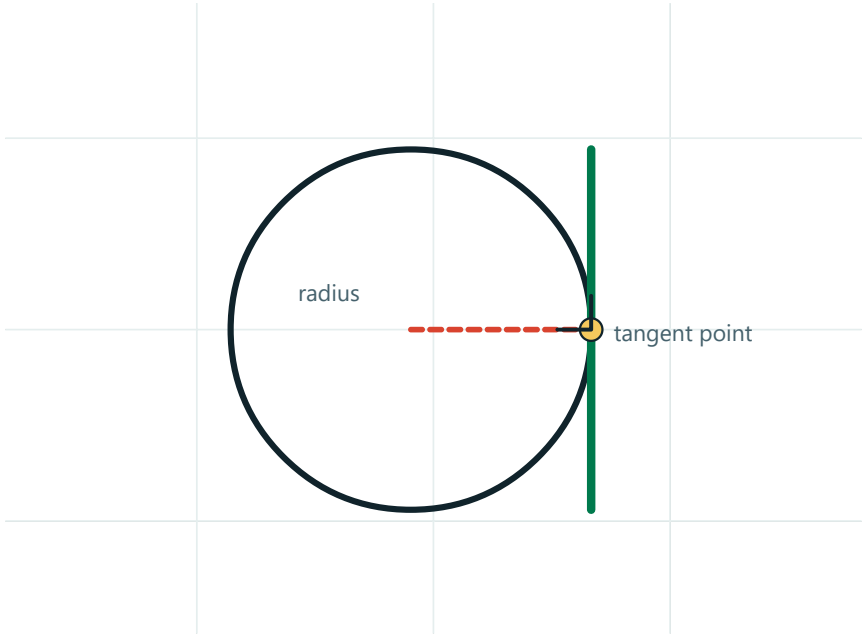
Reflection keeps distance from the mirror line.

DesignAlign.co.za

Tangent to a circle

Tangent to a circle

A tangent touches a circle at exactly one point.



Key rule

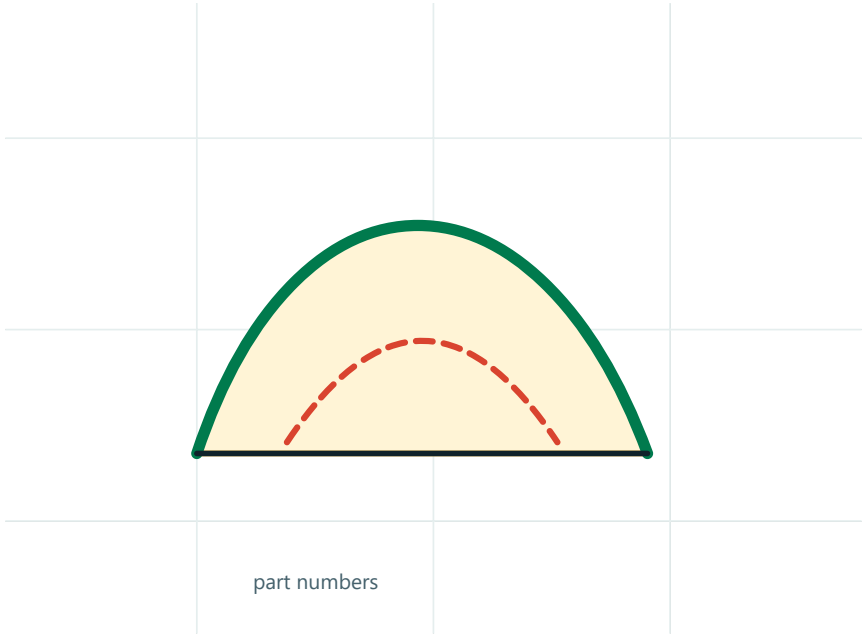
radius is perpendicular
to the tangent line
at the contact point
one touch point only

The tangent just touches the circle.
The radius meets it at 90 degrees.

Batch layout numbering

Batch layout numbering

Numbered parts make assembly easier after cutting.



Part numbers

- engrave small numbers
- keep near each part
- match assembly plan
- avoid visible faces

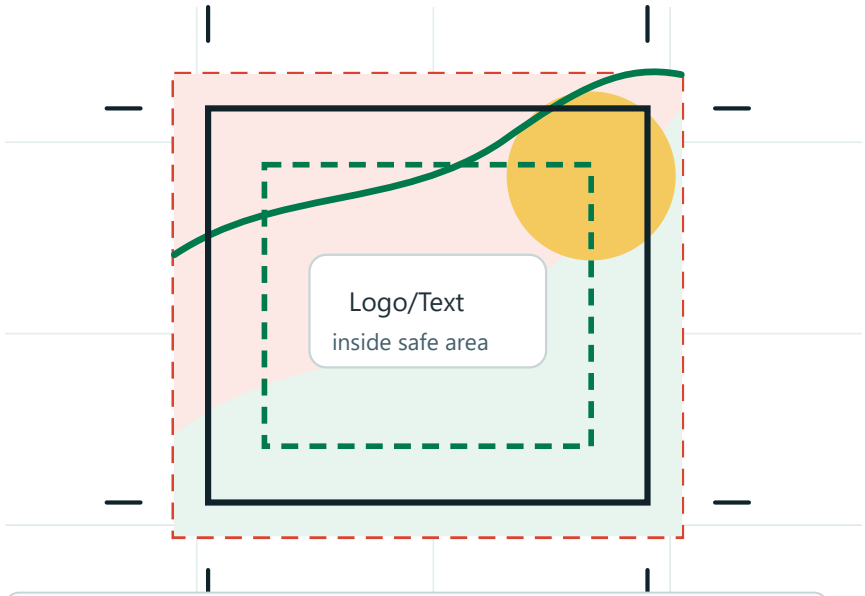
Batch layouts need clear part identity.

Small hidden labels speed assembly.

Bleed, trim, and safe area

Bleed, trim, and safe area

Print artwork should extend to bleed, be cut at trim, and keep important content inside the safe area.



Print layout idea

Bleed:

`art extends past cut`

Trim:

`where the page is cut`

Safe area:

`important content stays in`

Common bleed: 3mm.
Always check the printer's spec.

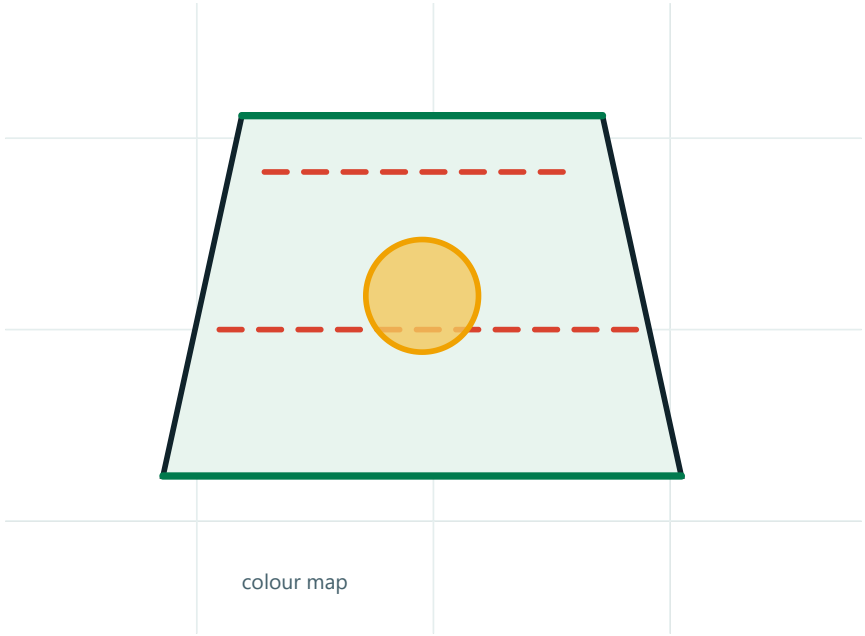
Bleed prevents white edges after cutting.
Safe area protects text and logos.

DesignAlign.co.za

Common line colour mapping

Common line colour mapping

Laser software often maps colours to different operations.



colour map

Layer colours

red can mean cut

blue can mean score

black can engrave

confirm in software

Colour layers help organise laser operations.

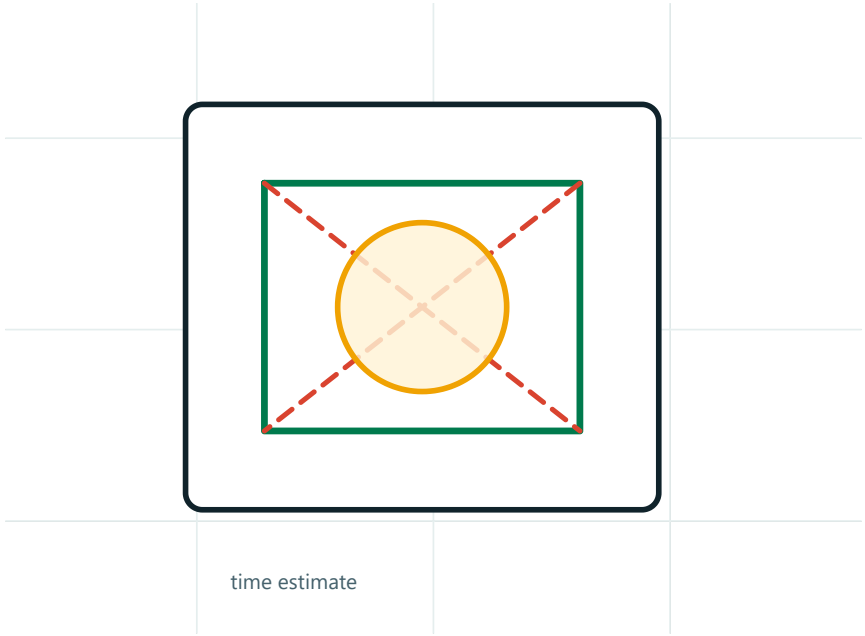
Always verify the colour map before running.

DesignAlign.co.za

Costing by cut time

Costing by cut time

Machine time is often a major part of job cost.



Costing

cut length affects time

engraving area adds time

setup time matters

quote from tests

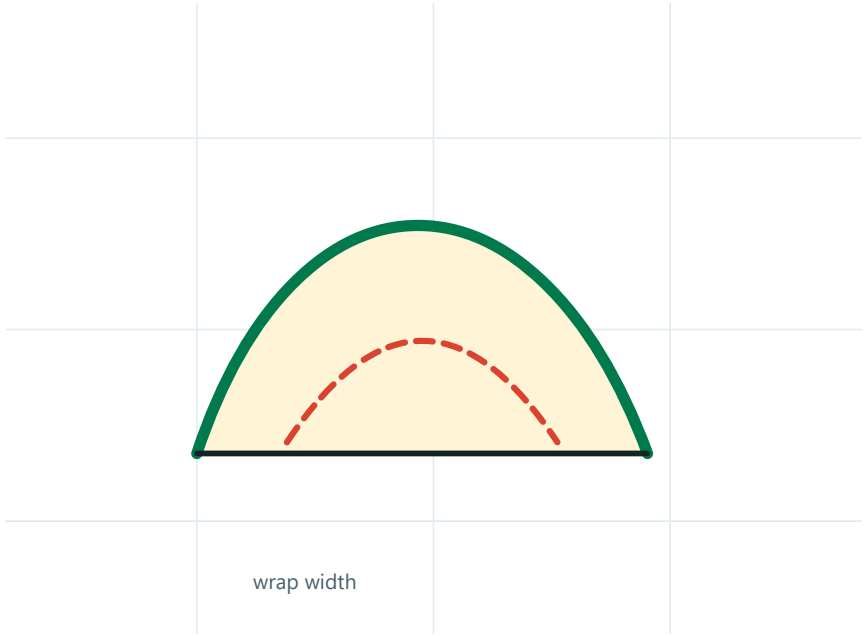
Cut time helps estimate job cost.

Engraving usually dominates long jobs.

Cylinder circumference layout

Cylinder circumference layout

Wrap artwork width should match circumference.



Cylinder math

C = pi * diameter

art width equals C

height stays vertical

leave seam allowance

Cylinder artwork depends on circumference.

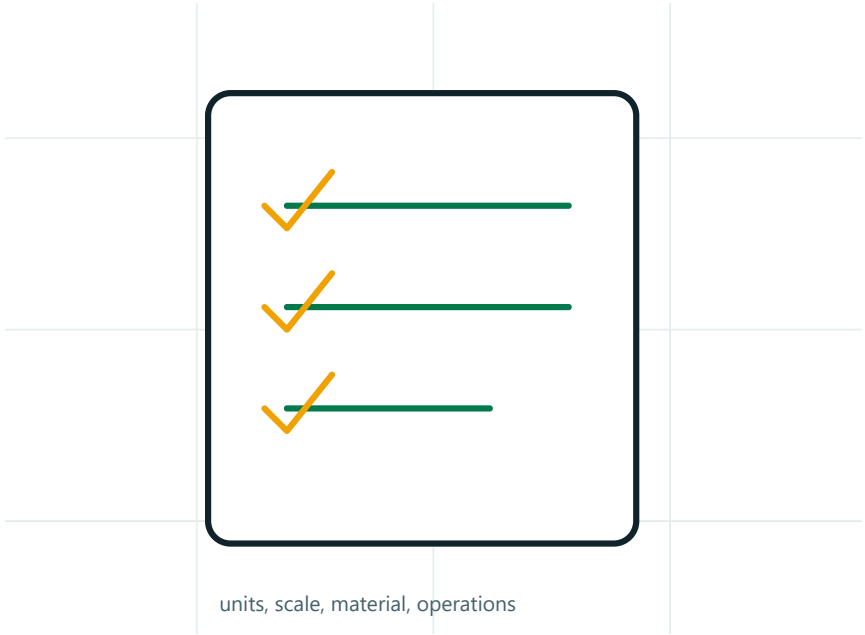
Measure diameter before setting the layout width.

DesignAlign.co.za

File handoff checklist

File handoff checklist

Good handoff files include scale, units, material, and operations.



units, scale, material, operations

Handoff

include units

state material

name operations

attach reference PDF

A complete handoff prevents mistakes.

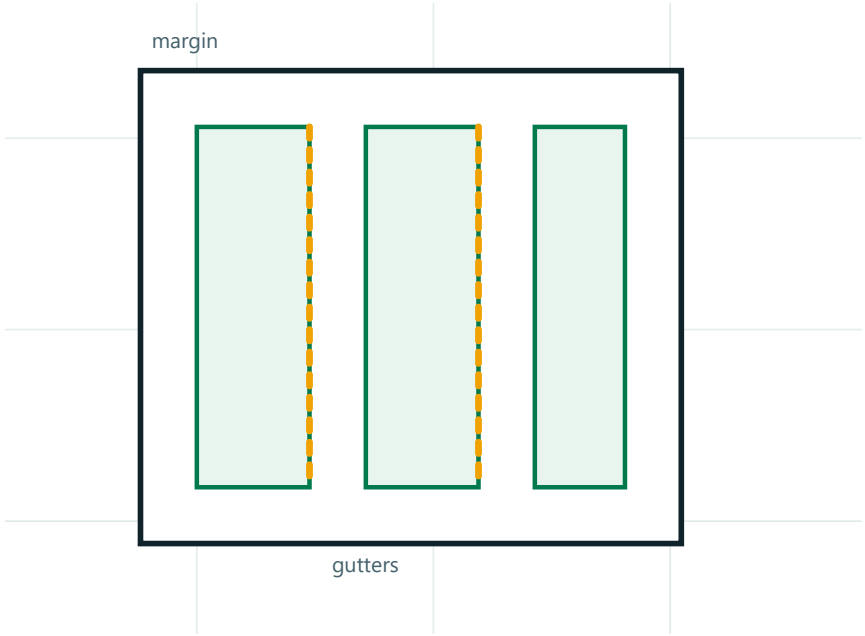
Operators need more than just artwork.

DesignAlign.co.za

Grid gutters and margins

Grid gutters and margins

Columns, gutters, and margins organise page layouts.



Page grid

margin = outer space

column = content lane

gutter = gap

grid keeps order

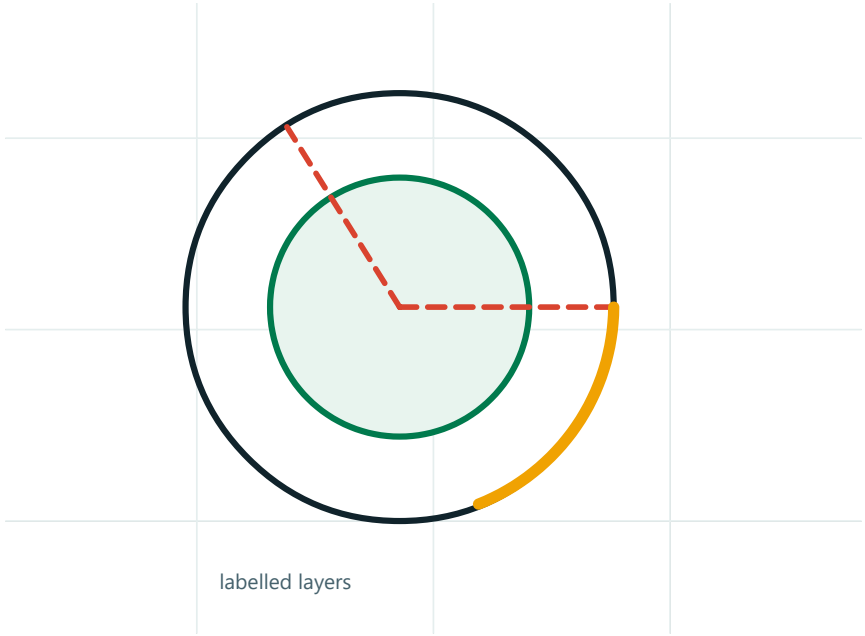
A layout grid makes spacing repeatable.

Gutters separate columns cleanly.

Labeling cut files

Labeling cut files

Clear labels help future you understand layers and settings.



labelled layers

File labels

name each layer

include material

record thickness

save settings notes

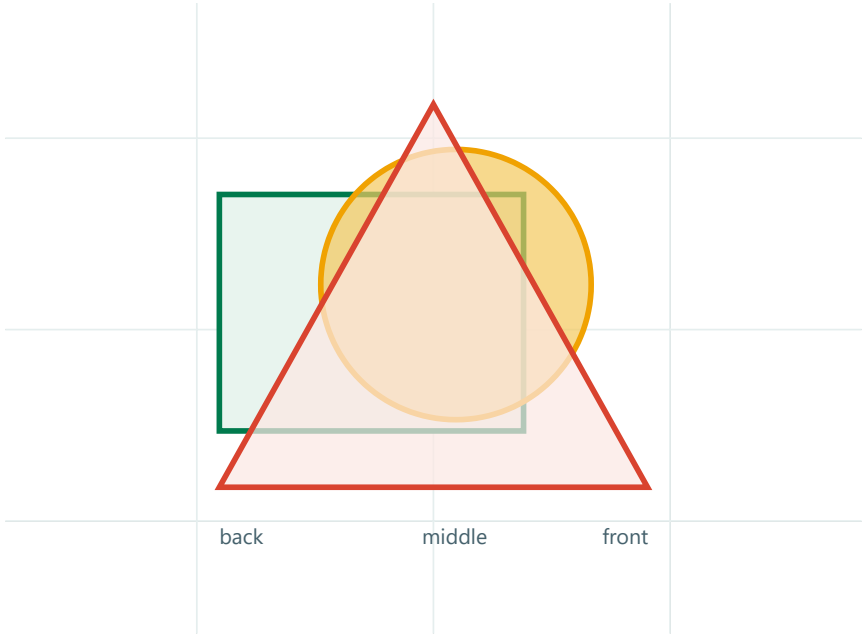
Good labels prevent production mistakes.

Make files understandable after months away.

Layer order and stacking

Layer order and stacking

Objects drawn later appear in front of earlier objects.



Stacking

bottom layer first

top layer last

front can hide back

opacity reveals order

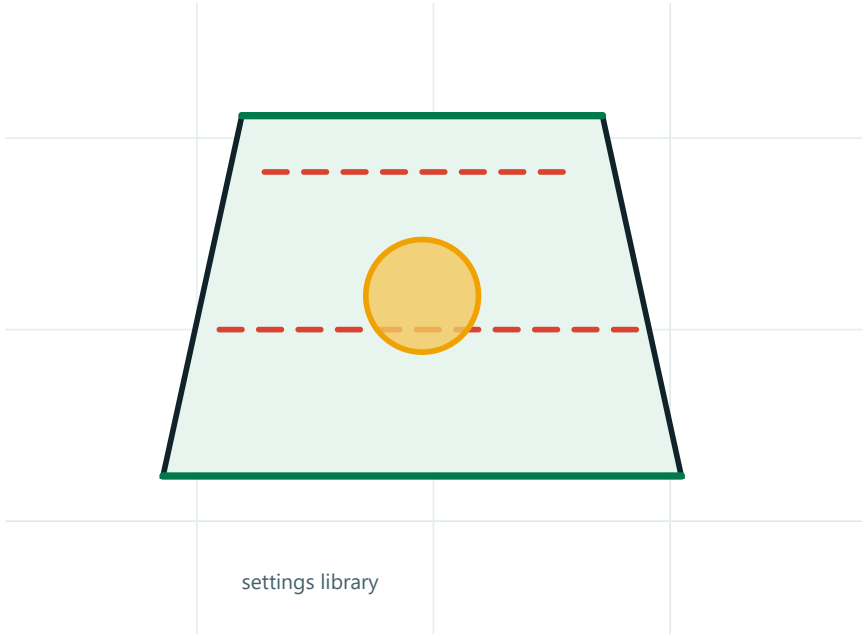
Layer order controls which object is visible.

Transparency helps explain overlapping parts.

Material library settings

Material library settings

A settings library stores proven values by material.



Library

save material name

record thickness

store power and speed

update after tests

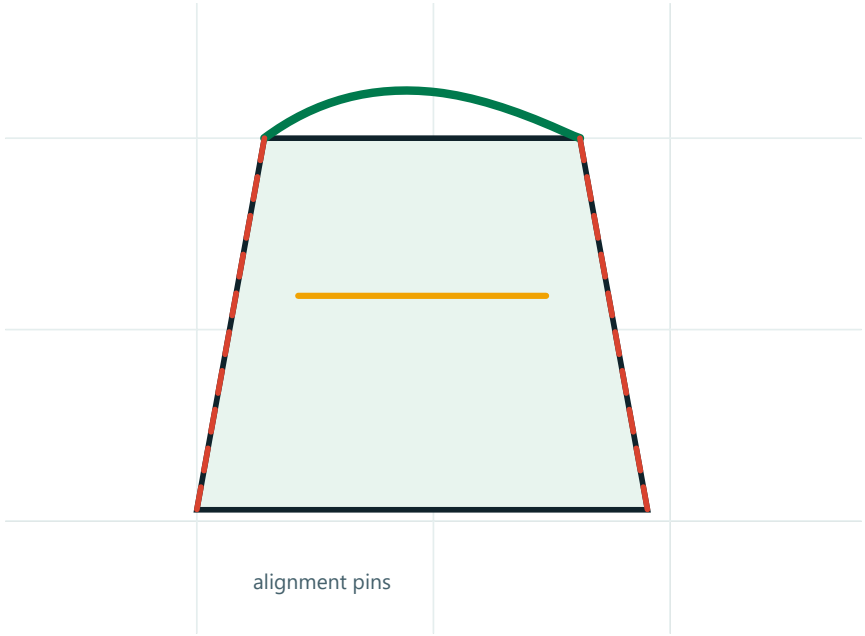
A material library makes repeat jobs faster.

Keep it based on real tested samples.

Multi-layer lamination alignment

Multi-layer lamination alignment

Stacked layers need registration marks or pins.



Lamination

layers must align

pins control position

marks guide assembly

glue before clamping

Layered projects need reliable alignment.

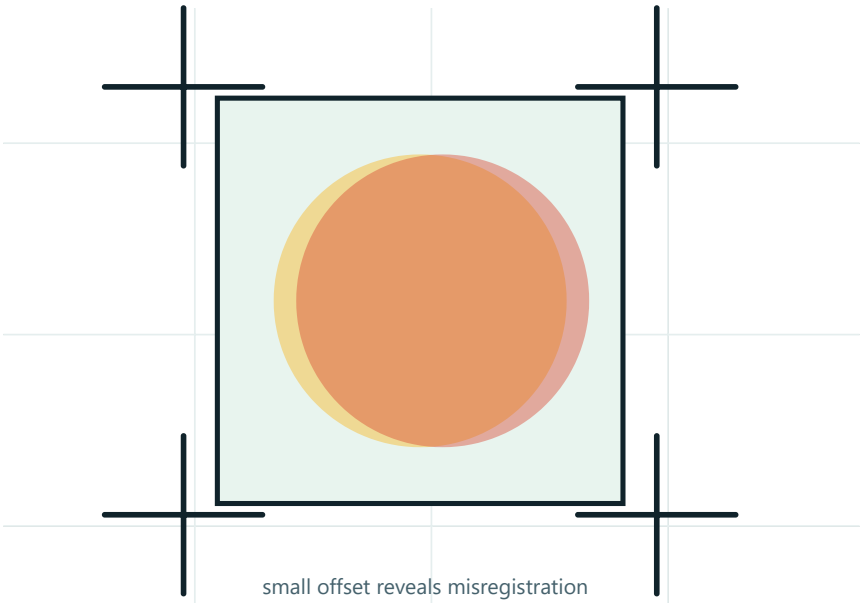
Pins or marks keep the stack accurate.

DesignAlign.co.za

Print registration marks

Print registration marks

Registration marks help separate colour plates line up.



small offset reveals misregistration

Registration

each colour prints

from its own plate

marks must overlap

misfit shows drift

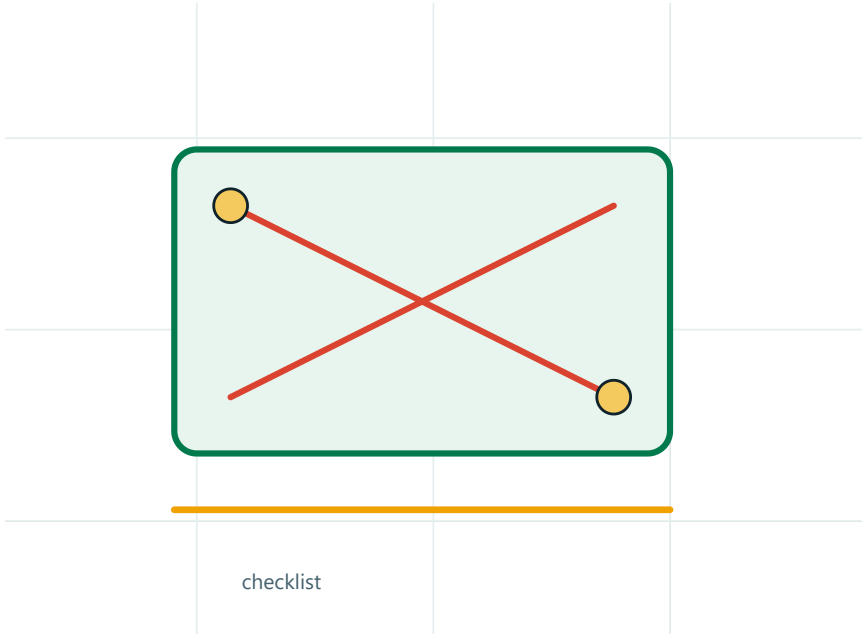
Aligned marks mean the print plates match.

Bad registration creates colour shadows.

Production checklist

Production checklist

A checklist catches simple mistakes before the machine runs.



Checklist

material measured

focus checked

air and vent on

preview framed

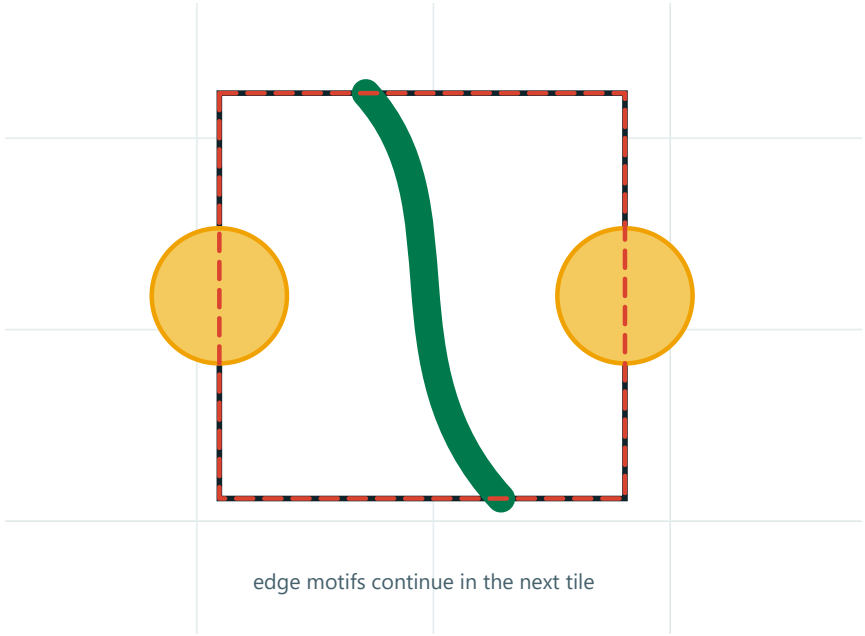
A short checklist prevents expensive errors.

Repeat it before every important job.

Seamless pattern tile

Seamless pattern tile

Edges of a tile must match for a repeat to look continuous.



edge motifs continue in the next tile

Repeat tile

left edge matches right

top matches bottom

motifs can cross edges

repeat hides seams

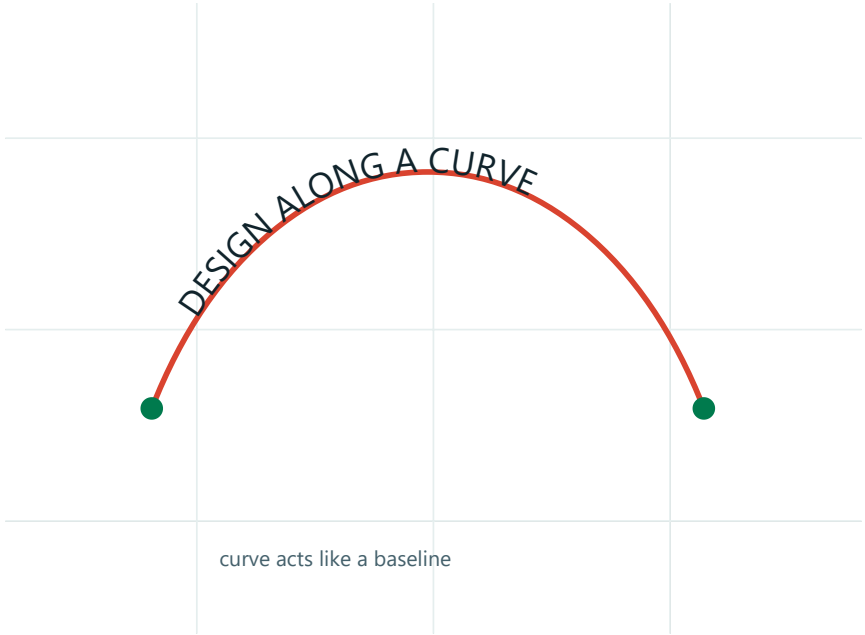
A seamless pattern continues past the tile.

Anything crossing one edge repeats opposite.

Text on a path

Text on a path

Text can follow a curve while staying editable.



Path text

- curve sets baseline
- letters follow path
- spacing can adjust
- text remains editable

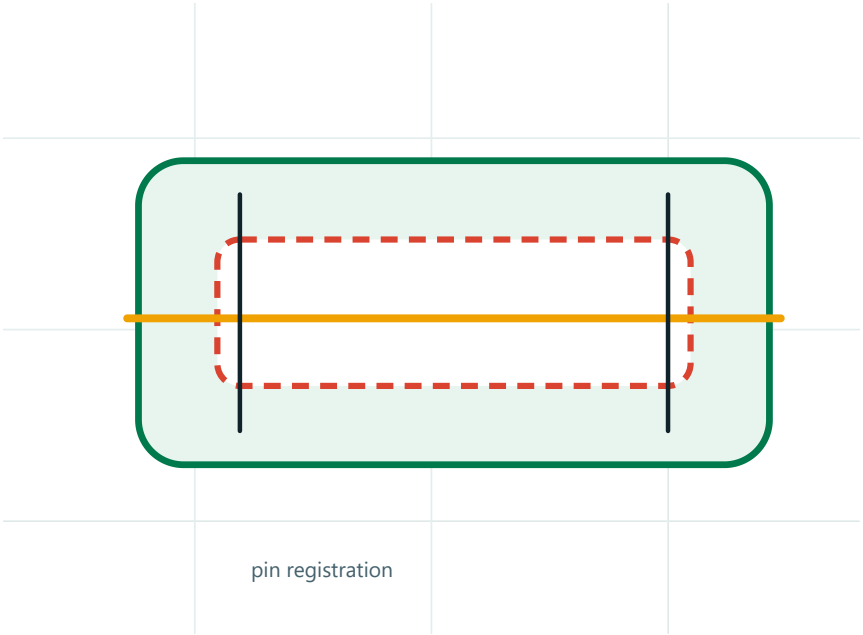
Path text is useful for badges and seals.

Keep a copy before converting to outlines.

Two-sided registration pins

Two-sided registration pins

Pins help flip material and keep the second side aligned.



pin registration

Two-sided work

pin holes locate sheet

flip around known edge

same origin both sides

test with scrap

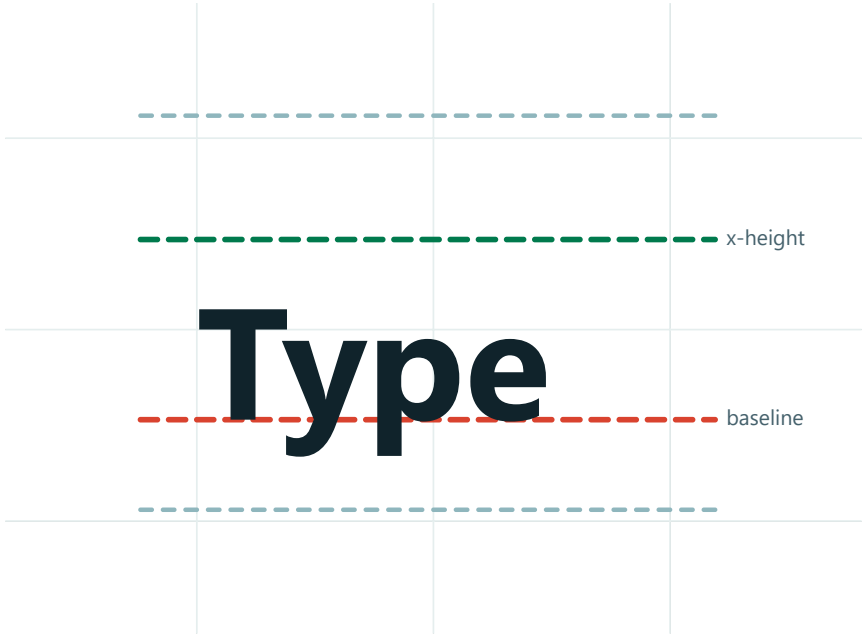
Two-sided jobs need physical registration.

Pins reduce guesswork after flipping.

Typography baseline and x-height

Typography baseline and x-height

Letters align to invisible measurement lines.



Type metrics

baseline holds letters

x-height sets body

ascenders rise above

descenders drop below

Type looks orderly because it follows guides.

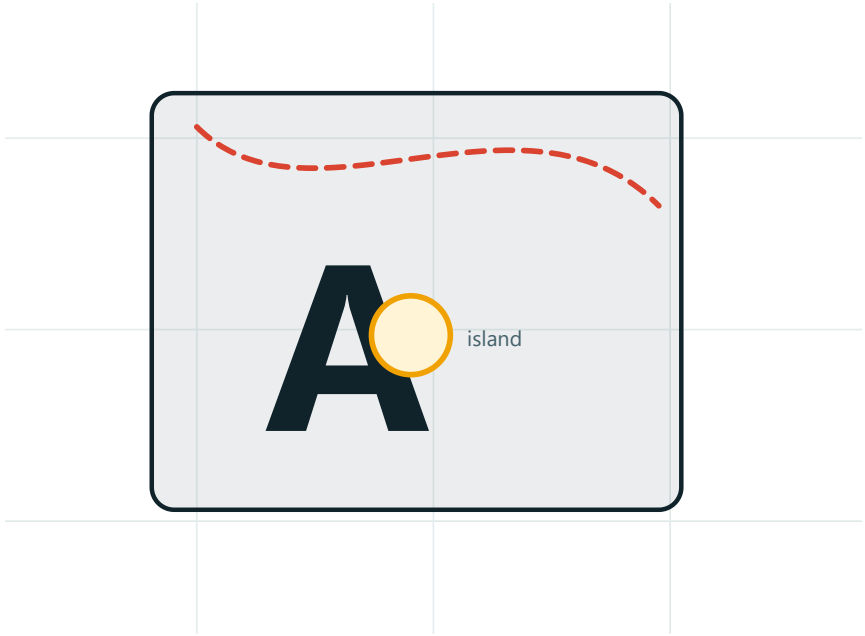
Baseline and x-height control rhythm.

DesignAlign.co.za

Vinyl weeding islands

Vinyl weeding islands

Small islands and bridges affect how vinyl can be weeded.



Weeding

outer vinyl lifts away

letters may contain

small islands

bridges can help

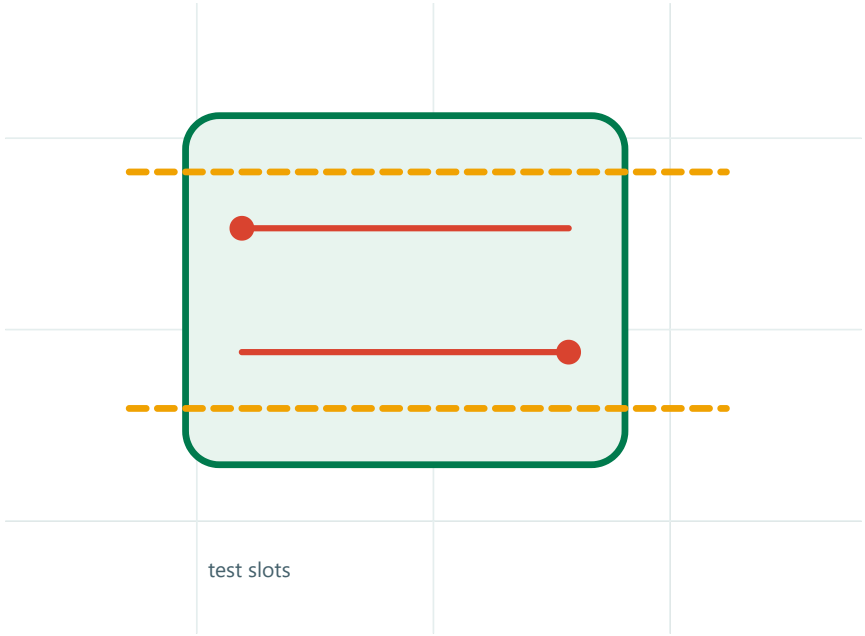
Weeding is easier when islands are obvious.

Tiny floating pieces can be fragile.

Kerf test comb

Kerf test comb

A comb test reveals which slot size fits the material.



Fit testing

- slots vary by step
- try real material
- note best fit
- save the result

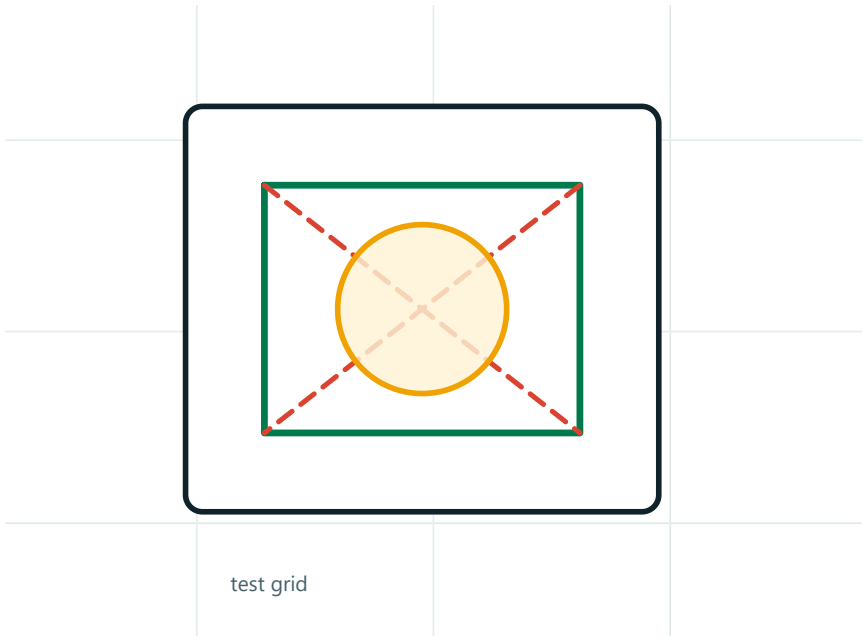
A comb test turns guessing into measurement.

Use the chosen slot for the final design.

Material test matrix

Material test matrix

A test matrix compares power and speed on one sample.



test grid

Test matrix

rows change power

columns change speed

label each cell

save best result

A test matrix makes settings visible.

Keep labelled samples for future jobs.