Marimba CNC Bar And Resonator Build Packet Print Packet

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Packet folder: /mnt/c/Users/Tony/Documents/GitHub/marimba

File Map

File	Purpose
design.md	Project intent, catalog metadata, assumptions, and validation plan.
bom.csv	Starter bill of materials with part categories, quantities, drawing refs, and notes.
sourcing.csv	Supplier/search tracker with specs, price/date fields, lead time, substitutes, and risks.
cut-list.csv	Rough/final stock sizes, material, grain/orientation, operations, yield, and offcuts.
drawing-brief.md	Manufacturing drawing and technical product sketch brief.
assembly-manual.md	Shop-facing sequence, tools, fixtures, safety, tuning, finishing, and maintenance notes.
validation.csv	Target/measured values, tolerance, environment, result, and tuning/build action log.
supplier-rfq.md	Supplier email/request-for-quote starter.
visual-bom-brief.md	Art direction for an image-forward visual BOM.
README.md	Project artifact.
family-spec.csv	Project artifact.
photo-shotlist.md	Project artifact.
risks.md	Project artifact.

design.md

Project intent, catalog metadata, assumptions, and validation plan.

Marimba Design Packet

Project Intent

Build a 37-bar C3-C6 marimba packet from the existing workbook design table. The first build target is a CNC-friendly instrument with African Padauk bars, parabolic underside arch undercuts, drilled node supports, quarter-wave resonators, and a frame layout that can become a SolidWorks master sketch.

The useful boundary for this packet is "build-ready documentation, not finished CAD." Native SolidWorks files do not exist yet. The CAD folder defines the global-variable and design-table contract Tony can use to build the real model.

Design Intake

Field	Value
Instrument	Marimba

Instrument family	Free-free beam idiophone with tuned quarter-wave resonators
Active build range	C3-C6 chromatic, 37 bars
Source workbook	marimba-design-table.xlsx, sheet Marimba, range A1:X106
Primary material	African Padauk bars, workbook K constant 155502
Bar thickness	0.875 in nominal edge thickness
Minimum center thickness	0.250 in after arch undercut
Construction pipeline	CNC surfaced blanks, 3D arch undercut, profile/tabs, node drilling, resonator cutting, frame assembly
Done-bar reference	tongue-drum README and wooden idiophone validation discipline

The guided v4.2 intake artifacts are in data/design-intake.json and data/design-input-row.csv.

Governing Model

Bar Pitch

The marimba bars are treated as free-free beams. The first flexural mode uses:

```
lambda_1 = 4.730
f_1 = (lambda_1^2 / (2piL^2))  sqrt(EI/(rhoA))
```

The workbook uses the practical shop form:

```
f ~= K  t / L^2
L ~= sqrt(K  t / f)
```

where:

- f is target frequency in Hz.
- K is the material-specific free-free bar constant.
- t is nominal bar thickness at the edge.
- L is bar length.

For the active packet:

```
K = 155502
t = 0.875 in
```

The workbook material library derives this free-free K from the beam material properties and the lambda_1 = 4.730 mode shape. Do not apply flute-bore K2 corrections here; those belong to Native American style flute bore correction work, not beam idiophones.

Nodes And Supports

The suspension node locations are:

```
node_1 = 0.224  L
node_2 = 0.776  L
```

Cord holes and rail pins reference these two locations. Holes must be drilled at the nodal line so the support does not damp the main mode.

Arch Undercut

The workbook defines a linear MIDI-scaled arch-depth schedule:

```
arch_depth = (edge_thickness - min_center_thickness)  min(1, (96 - midi)/48)
center_thickness = edge_thickness - arch_depth
```

This makes the low bars carry the deepest undercut and the high bars approach a shallow arch. The current minimum center thickness is 0.250 in, so C3 reaches the minimum while C6 remains about 0.719 in at center.

The arch should be cut as a centered parabolic underside relief over roughly 60 percent of the bar length. Final voicing still requires controlled sanding and tuner checks; the workbook is the first-pass schedule.

Resonators

The resonator tubes are treated as quarter-wave closed pipes:

```
L_res = 13552 / (4  f) - 0.82  bore
```

The sheet currently uses the bar-width column as the resonator bore/end-correction proxy. That is acceptable as a first-pass planning value, but the sourcing pass should decide real tube diameters and update family-spec.csv if the selected bore differs from the workbook proxy.

The distinction is important:

- Bar pitch is tuned by bar length, thickness, arch geometry, and material.
- Resonator length is tuned to reinforce the already-tuned bar frequency.
- A resonator mismatch changes sustain/loudness/color; it does not fix a wrong bar pitch.

Bar Schedule

The full schedule is in family-spec.csv. Representative rows:

Note	MIDI	Target Hz	Length in	Width in	Node 1 in	Node 2 in	Arch in	Center in	Resonator in
C3	48	130.813	32.251	2.000	7.224	25.027	0.625	0.250	24.260
C4	60	261.626	22.805	1.750	5.108	17.697	0.469	0.406	11.515
A4	69	440.000	17.585	1.750	3.939	13.646	0.352	0.523	6.265
C6	84	1046.502	11.403	1.250	2.554	8.848	0.156	0.719	2.212

Resonator Schedule

family-spec.csv includes a first-pass tube length for every note. Treat these as cut-long values until a tube material, bore, cap style, and stopper/trim strategy are selected.

Recommended build behavior:

1. Cut resonators at least 0.5 in long for C5 and above, and at least 1.0 in long below C5.
2. Use adjustable caps or removable plugs for the first build.
3. Tune resonators after the bars are struck and measured in the frame.
4. Record final tube length and cents response in validation.csv.

Hardware Alignment

The support rails follow the node path rather than a fixed straight rail. For each bar:

- Left support: node_1_in.
- Right support: node_2_in.
- Cord/support hole diameter: 0.250 in starting point.
- Frame pin/rubber support must touch at the node, not at the bar end.
- Bar spacing and frame taper are TBD until mallet clearance and resonator tube diameters are chosen.

SolidWorks MasterLayout Plan

The SolidWorks model should be driven from a master sketch and equations:

1. A Master_Bar part with configurations from cad/design-table-inputs.csv.
2. A Master_Resonator part with tube length, bore, cap allowance, and mounting hole variables.
3. A Frame_MasterLayout sketch defining bass and treble rail curves, bar spacing, resonator centerlines, and player-side datum.

Do not model hand-edited dimensions in SolidWorks. Every repeated note configuration should be driven by the variables listed in cad/sw-global-variables.csv.

Open Assumptions

- Active packet uses C3-C6 instead of the workbook’s full C2-F6 or portable C4-F6 variants.
- African Padauk is the workbook-selected material; actual board availability and moisture content are not verified.
- Resonator tube material and exact bore are TBD; current resonator lengths use the workbook width/end-correction proxy.
- Frame geometry, rail spacing, bar spacing, and transport strategy need CAD and ergonomic review.
- CNC feeds/speeds are starting notes only; final CAM must use the actual bit, router, hold-down, stock, and simulation.
- No measured bar data exists yet, so all frequencies are target predictions.

Validation Plan

1. Surface three sacrificial bars first: C3, A4, and C6. These bound the length, arch, and treble-end assumptions.
2. Measure blank thickness, length, density estimate, and moisture content before cutting the arch.
3. Record flat-bar pitch, post-arch pitch, post-sanding pitch, and final assembled pitch.
4. Update validation.csv with measured Hz and cents error:

$$\text{cents} = 1200 \cdot \log_2(\text{measured\_hz} / \text{target\_hz})$$

5. If the C3/A4/C6 pilot set misses by more than +/- 15 cents before final sanding, update the K constant or arch schedule before cutting the remaining 34 bars.
6. Tune resonators only after bars are within the target tuning window.

Provenance

- Source workbook: marimba-design-table.xlsx, generated before this v4.2 packet run.
- Skill workflow: instrument-maker-v4 v4.2.
- Reference family: cantilever-idiophone in repo-relationships.yaml; marimba notes call out bar tuning plus resonator coupling.

bom.csv

Starter bill of materials with part categories, quantities, drawing refs, and notes.

item	subassembly	part_name	qty	unit	material_or_spec	make_buy	status	notes
1	Bar set	C3-C6 tuned bars	37	ea	African Padauk 7/8 in nominal edge thickness	make	workbook-derived	Individual dimensions in family-spec.csv.
2	Resonators	C3-C6 resonator tubes	37	ea	PVC or aluminum tube; bore TBD by sourcing	buy	TBD	Lengths in family-spec.csv are first-pass quarter-wave values using workbook bore proxy.
3	Resonators	Tube caps or adjustable stoppers	37	ea	Matched to selected tube bore	buy	TBD	Use adjustable closure for first validation build.
4	Frame	Bass-side rail	1	ea	Hard maple or laminated hardwood	make	TBD	Final length and curve depend on CAD frame layout.
5	Frame	Treble-side rail	1	ea	Hard maple or laminated hardwood	make	TBD	Must follow support nodes or carry adjustable posts.
6	Frame	Cross members	4	ea	Hardwood or plywood fixture stock	make	TBD	Temporary shop frame acceptable for validation build.
7	Hardware	Support cord	1	roll	Low-stretch braided cord or synthetic marimba cord	buy	TBD	Size to match 1/4 in node holes and rubber isolators.
8	Hardware	Rubber support tubing or grommets	74	ea	Rubber or silicone isolation supports	buy	TBD	Two supports per bar minimum.
9	Hardware	Frame fasteners	1	set	Wood screws | threaded inserts | washers	buy	TBD	Prefer removable fasteners for tuning access.
10	CNC tooling	3/4 in ball-end mill	1	ea	Hardwood-capable ball-end cutter	buy	TBD	Primary arch undercut tool for bass/mid bars.
11	CNC tooling	1/2 in ball-end mill	1	ea	Hardwood-capable ball-end cutter	buy	TBD	Alternative or treble arch finish tool.
12	CNC tooling	1/4 in downcut spiral	1	ea	Hardwood-capable router bit	buy	TBD	Bar profile cleanup and fixture pockets.
13	CNC tooling	1/8 in upcut spiral	1	ea	Hardwood-capable router bit	buy	TBD	Small reliefs | pilot features | or templates.
14	Finish	Sanding and finish consumables	1	set	80-320 grit abrasives plus oil/shellac/lacquer TBD	buy	TBD	Finish must not load bar underside or node areas.
15	Measurement	Tuning and data capture	1	set	Chromatic tuner | microphone			

calipers | scale | buy/owned | TBD | Needed for validation.csv completion. |

 sourcing.csv

Supplier/search tracker with specs, price/date fields, lead time, substitutes, and risks.

item	stable_spec	supplier_candidates	current_price_status	lead_time_status	verification_needed	notes			
African Padauk lumber	Clear straight-grain stock at least 34 in long and 7/8 in final thickness; quartersawn preferred	Local hardwood dealer; Woodcraft; Rockler; specialty tonewood supplier	not verified	not verified	Verify board width/defect-free yield before purchase	Buy enough extra for C3/A4/C6 pilot bars and tuning failures.			
Alternative bar lumber	Hard maple or cherry at 7/8 in final thickness	Local hardwood dealer; Woodcraft; Rockler	not verified	not verified	Verify K constant before substituting	Use only for material study or education build	not direct swap without validation.		
Resonator tube stock	PVC or aluminum tubes in selected bores from about 1.25-2.00 in or revised bore set	McMaster-Carr; local plumbing supplier; OnlineMetals	not verified	not verified	Verify ID/OD	wall thickness	cap availability	and cut length	Current workbook lengths use a bore proxy; update after selecting tube sizes.
Tube caps/stoppers	Adjustable or removable closed end matching tube ID	McMaster-Carr; plumbing supplier; 3D printed plugs	not verified	not verified	Confirm air seal and tuning adjustability	Prototype with removable caps before permanent end caps.			
Frame hardwood	Hard maple or stable hardwood rail stock	Local hardwood dealer	not verified	not verified	Confirm straightness and final rail length	Frame geometry is still CAD-driven TBD.			
Support cord	Low-stretch braided synthetic cord sized for 1/4 in support holes	Music hardware supplier; climbing accessory cord supplier	not verified	not verified	Confirm diameter and stretch	Must not buzz against bar holes.			
Rubber supports	Silicone/rubber tubing or grommets sized to isolate bars	McMaster-Carr; marimba parts supplier	not verified	not verified	Confirm durometer and fit	Two supports per bar minimum.			
CNC ball-end bit	3/4 in carbide ball-end mill suitable for hardwood	Amana; Whiteside; Onsrud; local tooling supplier	not verified	not verified	Verify shank	flute length	machine collet	and feeds/speeds	Use actual bit geometry in CAM.
CNC downcut bit	1/4 in carbide downcut spiral for clean top edges	Amana; Whiteside; Onsrud	not verified	not verified	Verify cut length and chip evacuation	Profile passes need tabs or fixture retention.			
Finish	Thin oil/shellac/lacquer finish compatible with tuned bars	Wood finishing supplier	not verified	not verified	Test on offcuts for pitch shift	Heavy finishes can detune/damp bars.			

 cut-list.csv

Rough/final stock sizes, material, grain/orientation, operations, yield, and offcuts.

| cut_id | subassembly | qty | material | rough_dimension_in |

finished_dimension_or_reference | operation | notes | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| CUT-BAR-BASS | Bars C3-B3 | 12 | African Padauk | 34.0 x 2.25 x 1.00 each max rough blank | See MAR-C3 through MAR-B3 in family-spec.csv | Surface/thickness/profile/arch/drill | Long bars are the stock-yield driver; cut long and tune down. | |
| CUT-BAR-MID | Bars C4-B4 | 12 | African Padauk | 24.0 x 2.00 x 1.00 each max rough blank | See MAR-C4 through MAR-B4 in family-spec.csv | Surface/thickness/profile/arch/drill | Keep grain direction consistent across the octave. | |
| CUT-BAR-TREBLE | Bars C5-B5 | 12 | African Padauk | 17.0 x 1.75 x 1.00 each max rough blank | See MAR-C5 through MAR-B5 in family-spec.csv | Surface/thickness/profile/arch/drill | Smaller arch depths need careful Z-zero discipline. | |
| CUT-BAR-TOP | Bars C6 | 1 | African Padauk | 12.5 x 1.50 x 1.00 rough blank | See MAR-C6 in family-spec.csv | Surface/thickness/profile/arch/drill | High bar is short and sensitive to over-sanding. | |
| CUT-RES-BASS | Resonators C3-B3 | 12 | PVC or aluminum tube | Cut 1.0 in oversize from family-spec.csv lengths | Final trim after bar tuning | Tube cut/deburr/cap/drill | Use selected tube bore | not blindly the workbook bore proxy. |
| CUT-RES-MID | Resonators C4-B4 | 12 | PVC or aluminum tube | Cut 0.75 in oversize from family-spec.csv lengths | Final trim after bar tuning | Tube cut/deburr/cap/drill | Mark each tube with note and target Hz. | |
| CUT-RES-TREBLE | Resonators C5-C6 | 13 | PVC or aluminum tube | Cut 0.5 in oversize from family-spec.csv lengths | Final trim after bar tuning | Tube cut/deburr/cap/drill | Very short tubes may need larger bore or box coupling review. | |
| CUT-RAIL-BASS | Frame bass rail | 1 | Hard maple or laminated hardwood | TBD | Node-following rail curve from CAD | Rip/plane/CNC drill | Do not freeze until bar spacing and tube diameters are selected. | |
| CUT-RAIL-TREBLE | Frame treble rail | 1 | Hard maple or laminated hardwood | TBD | Node-following rail curve from CAD | Rip/plane/CNC drill | Keep removable for tuning access. | |
| CUT-CROSS | Frame cross members | 4 | Hardwood or plywood | TBD | Width set by resonator clearance | Cut/drill/assemble | Prototype frame can be sacrificial. | |
| CUT-JIG | Bar underside arch fixture | 1 | MDF or plywood spoilboard | CNC bed sized | Datum fence and tabs per cnc/setup-sheet.md | CNC fixture | Use repeatable X datum and replaceable spoilboard. | |

 drawing-brief.md

Manufacturing drawing and technical product sketch brief.

 Drawing Brief

 Drawing Set

The current packet requires four build-critical drawing classes:

1. Per-bar SVGs generated from family-spec.csv.
2. arch-undercut-section.svg showing underside relief, edge thickness, center thickness, and tool assumptions.
3. resonator-layout.svg showing first-pass tube lengths and note mapping.
4. frame-overview.svg showing the frame datum plan, rail concept, bar order, and resonator clearance assumptions.

Drawing Standards

- Units: inches.
- Primary datum for each bar: left end and centerline.
- Support holes: show 0.224 L and 0.776 L.
- Bar dimensions: length, width, edge thickness, center thickness, arch depth.
- Resonator dimensions: tube bore, acoustic length, trim allowance, cap style.
- Tolerances:
  - Bar length rough cut: +0.125 in / -0.000 in before tuning.
  - Final length: tune-to-pitch, not dimension-only.
  - Thickness before arch: +/- 0.005 in.
  - Node hole placement: +/- 0.020 in first-pass, improve after pilot data.
- CNC notes: bit diameter, stepover, Z-zero surface, tabs, workholding, and release checks.

Open Drawing Questions

- Final resonator tube bore and cap style.
- Final frame rail curve and cross-member spacing.
- Bar spacing and accidental/natural row layout.
- Whether the first build uses a temporary validation frame or final furniture frame.

Source Files

- family-spec.csv
- design.md
- marimba-design-table.xlsx
- cad/SolidWorks-MasterLayout-Plan.md
- cnc/setup-sheet.md

assembly-manual.md

Shop-facing sequence, tools, fixtures, safety, tuning, finishing, and maintenance notes.

Marimba Assembly Manual

Build Philosophy

Cut three pilot bars before committing the whole set: C3, A4, and C6. They bound the low arch-depth limit, the center of the scale, and the short/high-bar behavior. Use their measured pitch and resonator response to decide whether the workbook K constant, selected wood, and CNC arch path are ready for the full run.

Preflight

- [ ] Confirm active range: C3-C6 chromatic, 37 bars.
- [ ] Confirm selected bar wood and moisture content.
- [ ] Confirm actual resonator tube bore and update family-spec.csv if it differs from the workbook proxy.
- [ ] Confirm CNC bed size, hold-down, bit length, and dust collection.

- [ ] Print or open drawings/arch-undercut-section.svg, drawings/resonator-layout.svg, and cnc/setup-sheet.md.

Bar Workflow

1. Break down rough Padauk stock into oversize blanks using cut-list.csv.
2. Joint one face and edge. Mark grain direction and top face.
3. Plane or sand each blank to 0.875 in nominal edge thickness.
4. Label every blank with member_id, note, target Hz, and top face.
5. CNC profile each bar oversize or leave tabs for final cleanup.
6. Mark node positions from family-spec.csv.
7. Drill support/cord holes at the node line. Start with 0.250 in, then adapt to the actual cord/rubber support system.
8. Cut the underside parabolic arch. Use a conservative Z-zero and leave a sanding/tuning allowance.
9. Deburr and sand without rounding node contact areas excessively.
10. Strike-test on soft supports at the node positions and record measured Hz in validation.csv.

Tuning Direction

- To lower pitch: remove material from the center underside arch region.
- To raise pitch: shorten the bar or reduce mass near the ends; raising pitch after over-cutting is limited, so sneak up slowly.
- Keep both ends visually balanced. Asymmetric mass removal can pull modes sideways or create uneven sustain.
- Tune bars before final resonator matching.

Resonator Workflow

1. Select tube material and bore.
2. Recalculate tube lengths if the selected bore differs from resonator_bore_in.
3. Cut tubes oversize per cut-list.csv.
4. Deburr both ends.
5. Add removable caps or adjustable stoppers.
6. Mount under the matching bar with the opening centered below the vibrating region.
7. Trim or adjust caps after the bar pitch is stable in the frame.
8. Record final resonator length, cap style, and response notes.

Frame Workflow

1. Build a temporary straight or lightly tapered validation frame before the final furniture-grade frame.
2. Lay out rail supports from the node schedule, not from equal bar-end offsets.
3. Keep resonator access open so tubes can be removed and tuned.
4. Add cross members only after checking mallet clearance, tube clearance, and player reach.
5. Use removable fasteners until tuning and buzz checks are done.

Final Checks

- [ ] All bars are labeled and match family-spec.csv.
- [ ] Node supports touch at node positions.

- [ ] No bar contacts the frame except through intended rubber/cord supports.
- [ ] No resonator tube touches a vibrating bar.
- [ ] Every measured pitch has a validation.csv row.
- [ ] Any bar outside +/- 10 cents after final tuning is flagged for rework.

validation.csv

Target/measured values, tolerance, environment, result, and tuning/build action log.

member_id	target_note	target_hz	predicted_length_in	stage	measured_hz	cents_error	tuner	environment	notes			
MAR-C3	C3	130.813	32.251	prebuild					Pilot low bar; record flat blank	post-arch	post-sand	final frame.
MAR-Csharp3	C3	138.591	31.333	prebuild								
MAR-D3	D3	146.832	30.441	prebuild								
MAR-Dsharp3	D3	155.563	29.575	prebuild								
MAR-E3	E3	164.814	28.733	prebuild								
MAR-F3	F3	174.614	27.915	prebuild								
MAR-Fsharp3	F3	184.997	27.120	prebuild								
MAR-G3	G3	195.998	26.348	prebuild								
MAR-Gsharp3	G3	207.652	25.598	prebuild								
MAR-A3	A3	220.000	24.869	prebuild								
MAR-Asharp3	A3	233.082	24.161	prebuild								
MAR-B3	B3	246.942	23.473	prebuild								
MAR-C4	C4	261.626	22.805	prebuild								
MAR-Csharp4	C4	277.183	22.156	prebuild								
MAR-D4	D4	293.665	21.525	prebuild								
MAR-Dsharp4	D4	311.127	20.912	prebuild								
MAR-E4	E4	329.628	20.317	prebuild								
MAR-F4	F4	349.228	19.739	prebuild								
MAR-Fsharp4	F4	369.994	19.177	prebuild								
MAR-G4	G4	391.995	18.631	prebuild								
MAR-Gsharp4	G4	415.305	18.100	prebuild								
MAR-A4	A4	440.000	17.585	prebuild					Pilot reference bar; use to calibrate K and arch schedule.			
MAR-Asharp4	A4	466.164	17.085	prebuild								
MAR-B4	B4	493.883	16.598	prebuild								
MAR-C5	C5	523.251	16.126	prebuild								
MAR-Csharp5	C5	554.365	15.667	prebuild								
MAR-D5	D5	587.330	15.221	prebuild								
MAR-Dsharp5	D5	622.254	14.787	prebuild								
MAR-E5	E5	659.255	14.366	prebuild								
MAR-F5	F5	698.456	13.957	prebuild								
MAR-Fsharp5	F5	739.989	13.560	prebuild								
MAR-G5	G5	783.991	13.174	prebuild								
MAR-Gsharp5	G5	830.609	12.799	prebuild								
MAR-A5	A5	880.000	12.435	prebuild								
MAR-Asharp5	A5	932.328	12.081	prebuild								
MAR-B5	B5	987.767	11.737	prebuild								

| MAR-C6 | C6 | 1046.502 | 11.403 | prebuild | | | | | Pilot high bar; validate shallow arch and short resonator behavior. | | | |

supplier-rfq.md

Supplier email/request-for-quote starter.

Supplier RFQ - Marimba C3-C6 Build

Scope

Request quotes for one 37-bar C3-C6 marimba prototype build. Prices, stock, and lead times are intentionally not assumed in this repo; verify current facts before purchasing.

Bar Lumber

Please quote clear straight-grain African Padauk suitable for tuned percussion bars.

Required:

- Final thickness after surfacing: 0.875 in.
- Longest finished bar: 32.251 in.
- Widest finished bar: 2.000 in.
- Preferred rough allowance: at least 34 in x 2.25 in x 1.00 in for the longest bass blanks.
- Quantity: enough for 37 bars plus at least 3 pilot/scrap bars.
- Grain: straight, stable, no checks through the finished bar area.
- Moisture content: provide measured or estimated value.

Alternates:

- Hard maple for education/prototype comparison.
- Cherry for easier machining comparison.

Do not substitute material directly into the build schedule without updating the K constant and validating pitch.

Resonator Tubes

Please quote PVC or aluminum tube options for 37 quarter-wave resonators.

Required quote data:

- Material.
- Nominal size.
- Actual ID and OD.
- Wall thickness.
- Available lengths.
- Compatible caps, plugs, or stopper hardware.
- Cutting service availability.

The first-pass length range in this packet is about 2.2 in to 24.3 in, before oversize tuning allowance. Actual lengths must be recalculated if bore differs from the workbook proxy.

Hardware

Please quote:

- Low-stretch support cord or equivalent.
- Rubber or silicone tubing/grommets for support isolation.
- Frame fasteners suitable for removable tuning access.
- Optional threaded inserts for rail/cross-member joints.

CNC Tooling

Please quote:

- 3/4 in carbide ball-end mill, hardwood capable.
- 1/2 in carbide ball-end mill, hardwood capable.
- 1/4 in downcut spiral router bit.
- 1/8 in upcut spiral router bit.

Include shank diameter, cut length, recommended feed/speed range, and replacement availability.

Response Format

Please return:

    item
    supplier part number
    material/spec
    actual dimensions
    quantity available
    unit price
    lead time
    shipping estimate
    notes/substitution risks

visual-bom-brief.md

Art direction for an image-forward visual BOM.

Visual BOM Brief

Goal

Create a visual BOM plate that lets another maker understand the marimba build at a glance: bars, resonators, support hardware, frame rails, tooling, and measurement gear.

Required Views

1. Hero view of the assembled C3-C6 marimba on a simple shop frame.
2. Exploded view showing bars above resonator tubes above frame rails.
3. Detail inset for one bar: node holes, underside arch, grain direction.
4. Detail inset for one resonator: tube, cap/stopper, mounting clearance.
5. Material swatches: Padauk bar wood, tube material, rubber supports, frame wood.

BOM Rows To Show

Item	Visual Needed	Source
Tuned Padauk bars	Actual shop photo once cut; concept placeholder acceptable before build	family-spec.csv
Resonator tubes	Supplier image or shop photo	sourcing.csv
Support cord	Supplier image or shop photo	bom.csv
Rubber supports	Supplier image or shop photo	bom.csv
Frame rails	CAD render or shop photo	cad/
CNC bits	Supplier image or shop photo	bom.csv
Tuning tools	Shop photo	validation.csv workflow

Labeling Rules

- Label generated images as concept placeholders.
- Do not use generated images for exact dimensions.
- Every dimension callout must match family-spec.csv or be marked TBD.
- Keep supplier prices out of the visual until current quotes are verified.

First Plate Layout

Top: title, date, range, and material.

Middle left: exploded assembly with numbered callouts.

Middle right: BOM table grouped by bars, resonators, frame, hardware, tooling.

Bottom: assumptions and missing purchase-verification items.

README.md

Project artifact.

Marimba - CNC Bar And Resonator Build Packet

> A workbook-derived 37-bar C3-C6 marimba packet for CNC-cut Padauk bars, 3D arch undercuts, tuned quarter-wave resonators, and a SolidWorks-ready master-layout handoff.

What This Is

This repository is the Mode A v4.2 build packet for a marimba: tuned wooden free-free bars

suspended at their nodes, with a matched resonator under each note. It turns the existing marimba-design-table.xlsx scaffold into a shop-facing documentation set:

1. design.md explains the physics model, build range, assumptions, and validation plan.
2. family-spec.csv is the 37-bar C3-C6 schedule extracted from the workbook formulas.
3. bom.csv, sourcing.csv, and cut-list.csv separate stable specifications from supplier facts that should be verified before buying.
4. drawings/, cad/, cnc/, wolfram/, and site/ carry the technical handoff layers.

Part of the tonykoop/instrument-maker catalog.

Physics In One Minute

A marimba bar is a free-free beam. The first mode uses lambda_1 = 4.730, and the practical workbook model is:

```
f ~= K  t / L^2
L ~= sqrt(K  t / f)
```

Length is the dominant pitch lever. Bar thickness and the underside arch tune the bar; width mostly affects feel, loudness, stiffness distribution, and available resonator bore. The cord/support points land at about 0.224 L and 0.776 L.

The resonator tubes are quarter-wave closed pipes:

```
L_res ~= c / (4  f) - 0.82  bore
```

The resonator reinforces the bar’s target frequency. It does not tune the bar itself.

Build Range

The active packet is a 37-bar chromatic range from C3 to C6, using the workbook’s African Padauk setting:

Note	Frequency	Bar length	Width	Arch depth	Resonator
C3	130.813 Hz	32.251 in	2.000 in	0.625 in	24.260 in
C4	261.626 Hz	22.805 in	1.750 in	0.469 in	11.515 in
A4	440.000 Hz	17.585 in	1.750 in	0.352 in	6.265 in
C6	1046.502 Hz	11.403 in	1.250 in	0.156 in	2.212 in

The workbook also documents two expansion shapes: a full C2-F6 marimba and a portable C4-F6 instrument. Those are not cut lists yet; they are future configurations once the C3-C6 bar and resonator workflow is validated.

Repository Structure

```
marimba/
|-- README.md
|-- design.md
|-- marimba-design-table.xlsx
|-- family-spec.csv
```

```
    |-- bom.csv
    |-- sourcing.csv
    |-- cut-list.csv
    |-- validation.csv
    |-- assembly-manual.md
    |-- supplier-rfq.md
    |-- visual-bom-brief.md
    |-- drawing-brief.md
    |-- risks.md
    |-- photo-shotlist.md
    |-- cad/
    |-- cnc/
    |-- data/
    |-- drawings/
    |-- images/
    |-- site/
    -- wolfram/
```

Status

Area	Status
Workbook scaffold	done, source table in marimba-design-table.xlsx
Guided intake	done, see data/design-intake.json
C3-C6 bar schedule	done, see family-spec.csv
CNC operation plan	generated, pre-CAM only
SolidWorks handoff	prepared as CSV/Markdown contract, no native CAD yet
Wolfram source	prepared as .wl; notebook execution pending local Wolfram
Build photos	pending first shop build
Measured tuning data	pending prototype validation

License

family-spec.csv

Project artifact.

member_id	target_note	midi	target_hz	predicted_length_in	predicted_width_in	predicted_thick_in	node_1_in	node_2_in	arch_depth_in	center_thickness_in	resonator_length_in	resonator_bore_in	material	k_constant	scale_label	notes
MAR-C3	C3	48	130.813	32.251	2.000	0.875	7.224	25.027	0.625	0.250	24.260	2.000	African Padauk	155502	C3-C6 chromatic	Workbook-derived from Marimba sheet; resonator bore currently follows width/end-correction proxy.
MAR-Csharp3	C3	49	138.591	31.333	2.000	0.875	7.019	24.315	0.612	0.263	22.806	2.000	African Padauk	155502	C3-C6 chromatic	Workbook-derived from Marimba sheet; resonator bore currently follows width/end-correction proxy.

MAR-D3	D3	50	146.832	30.441	2.000	0.875	6.819	23.622	0.599	0.276	21.434	2.000	African Padauk	155502	C3-C6 chromatic	Workbook-derived from Marimba sheet; resonator bore currently follows width/end-correction proxy.
MAR-Dsharp3	D3	51	155.563	29.575	2.000	0.875	6.625	22.950	0.586	0.289	20.139	2.000	African Padauk	155502	C3-C6 chromatic	Workbook-derived from Marimba sheet; resonator bore currently follows width/end-correction proxy.
MAR-E3	E3	52	164.814	28.733	2.000	0.875	6.436	22.297	0.573	0.302	18.917	2.000	African Padauk	155502	C3-C6 chromatic	Workbook-derived from Marimba sheet; resonator bore currently follows width/end-correction proxy.
MAR-F3	F3	53	174.614	27.915	2.000	0.875	6.253	21.662	0.560	0.315	17.763	2.000	African Padauk	155502	C3-C6 chromatic	Workbook-derived from Marimba sheet; resonator bore currently follows width/end-correction proxy.
MAR-Fsharp3	F3	54	184.997	27.120	2.000	0.875	6.075	21.045	0.547	0.328	16.674	2.000	African Padauk	155502	C3-C6 chromatic	Workbook-derived from Marimba sheet; resonator bore currently follows width/end-correction proxy.
MAR-G3	G3	55	195.998	26.348	2.000	0.875	5.902	20.446	0.534	0.341	15.646	2.000	African Padauk	155502	C3-C6 chromatic	Workbook-derived from Marimba sheet; resonator bore currently follows width/end-correction proxy.
MAR-Gsharp3	G3	56	207.652	25.598	2.000	0.875	5.734	19.864	0.521	0.354	14.676	2.000	African Padauk	155502	C3-C6 chromatic	Workbook-derived from Marimba sheet; resonator bore currently follows width/end-correction proxy.
MAR-A3	A3	57	220.000	24.869	2.000	0.875	5.571	19.298	0.508	0.367	13.760	2.000	African Padauk	155502	C3-C6 chromatic	Workbook-derived from Marimba sheet; resonator bore currently follows width/end-correction proxy.
MAR-Asharp3	A3	58	233.082	24.161	2.000	0.875	5.412	18.749	0.495	0.380	12.896	2.000	African Padauk	155502	C3-C6 chromatic	Workbook-derived from Marimba sheet; resonator bore currently follows width/end-correction proxy.
MAR-B3	B3	59	246.942	23.473	2.000	0.875	5.258	18.215	0.482	0.393	12.080	2.000	African Padauk	155502	C3-C6 chromatic	Workbook-derived from Marimba sheet; resonator bore currently follows width/end-correction proxy.
MAR-C4	C4	60	261.626	22.805	1.750	0.875	5.108	17.697	0.469	0.406	11.515	1.750	African Padauk	155502	C3-C6 chromatic	Workbook-derived from Marimba sheet; resonator bore currently follows width/end-correction proxy.
MAR-Csharp4	C4	61	277.183	22.156	1.750	0.875	4.963	17.193	0.456	0.419	10.788	1.750	African Padauk	155502	C3-C6 chromatic	Workbook-derived from Marimba sheet; resonator bore currently follows width/end-correction proxy.
MAR-D4	D4	62	293.665	21.525	1.750	0.875	4.822	16.704	0.443	0.432	10.102	1.750	African Padauk	155502	C3-C6 chromatic	Workbook-derived from Marimba sheet; resonator bore currently follows width/end-correction proxy.
MAR-Dsharp4	D4	63	311.127	20.912	1.750	0.875	4.684	16.228	0.430	0.445	9.454	1.750	African Padauk	155502	C3-C6 chromatic	Workbook-derived from Marimba sheet; resonator bore currently follows width/end-correction proxy.
MAR-E4	E4	64	329.628	20.317	1.750	0.875	4.551	15.766	0.417	0.458	8.843	1.750	African Padauk	155502	C3-C6 chromatic	Workbook-derived from Marimba sheet; resonator bore currently follows width/end-correction proxy.
MAR-F4	F4	65	349.228	19.739	1.750	0.875	4.421	15.317	0.404	0.471	8.266	1.750	African Padauk	155502	C3-C6 chromatic	Workbook-derived from Marimba sheet; resonator bore currently follows width/end-correction proxy.
MAR-Fsharp4	F4	66	369.994	19.177	1.750	0.875	4.296	14.881	0.391	0.484	7.722	1.750	African Padauk	155502	C3-C6 chromatic	Workbook-derived from Marimba sheet; resonator bore currently follows width/end-correction proxy.
MAR-G4	G4	67	391.995	18.631	1.750	0.875	4.173	14.458	0.378	0.497

7.208 | 1.750 | African Padauk | 155502 | C3-C6 chromatic | Workbook-derived from Marimba sheet; resonator bore currently follows width/end-correction proxy. |
MAR-Gsharp4	G4	68	415.305	18.100	1.750	0.875	4.054	14.046	0.365	0.510	6.723	1.750	African Padauk	155502	C3-C6 chromatic	Workbook-derived from Marimba sheet; resonator bore currently follows width/end-correction proxy.
MAR-A4	A4	69	440.000	17.585	1.750	0.875	3.939	13.646	0.352	0.523	6.265	1.750	African Padauk	155502	C3-C6 chromatic	Workbook-derived from Marimba sheet; resonator bore currently follows width/end-correction proxy.
MAR-Asharp4	A4	70	466.164	17.085	1.750	0.875	3.827	13.258	0.339	0.536	5.833	1.750	African Padauk	155502	C3-C6 chromatic	Workbook-derived from Marimba sheet; resonator bore currently follows width/end-correction proxy.
MAR-B4	B4	71	493.883	16.598	1.750	0.875	3.718	12.880	0.326	0.549	5.425	1.750	African Padauk	155502	C3-C6 chromatic	Workbook-derived from Marimba sheet; resonator bore currently follows width/end-correction proxy.
MAR-C5	C5	72	523.251	16.126	1.500	0.875	3.612	12.513	0.312	0.562	5.245	1.500	African Padauk	155502	C3-C6 chromatic	Workbook-derived from Marimba sheet; resonator bore currently follows width/end-correction proxy.
MAR-Csharp5	C5	73	554.365	15.667	1.500	0.875	3.509	12.157	0.299	0.576	4.881	1.500	African Padauk	155502	C3-C6 chromatic	Workbook-derived from Marimba sheet; resonator bore currently follows width/end-correction proxy.
MAR-D5	D5	74	587.330	15.221	1.500	0.875	3.409	11.811	0.286	0.589	4.538	1.500	African Padauk	155502	C3-C6 chromatic	Workbook-derived from Marimba sheet; resonator bore currently follows width/end-correction proxy.
MAR-Dsharp5	D5	75	622.254	14.787	1.500	0.875	3.312	11.475	0.273	0.602	4.215	1.500	African Padauk	155502	C3-C6 chromatic	Workbook-derived from Marimba sheet; resonator bore currently follows width/end-correction proxy.
MAR-E5	E5	76	659.255	14.366	1.500	0.875	3.218	11.148	0.260	0.615	3.909	1.500	African Padauk	155502	C3-C6 chromatic	Workbook-derived from Marimba sheet; resonator bore currently follows width/end-correction proxy.
MAR-F5	F5	77	698.456	13.957	1.500	0.875	3.126	10.831	0.247	0.628	3.621	1.500	African Padauk	155502	C3-C6 chromatic	Workbook-derived from Marimba sheet; resonator bore currently follows width/end-correction proxy.
MAR-Fsharp5	F5	78	739.989	13.560	1.500	0.875	3.037	10.523	0.234	0.641	3.348	1.500	African Padauk	155502	C3-C6 chromatic	Workbook-derived from Marimba sheet; resonator bore currently follows width/end-correction proxy.
MAR-G5	G5	79	783.991	13.174	1.500	0.875	2.951	10.223	0.221	0.654	3.091	1.500	African Padauk	155502	C3-C6 chromatic	Workbook-derived from Marimba sheet; resonator bore currently follows width/end-correction proxy.
MAR-Gsharp5	G5	80	830.609	12.799	1.500	0.875	2.867	9.932	0.208	0.667	2.849	1.500	African Padauk	155502	C3-C6 chromatic	Workbook-derived from Marimba sheet; resonator bore currently follows width/end-correction proxy.
MAR-A5	A5	81	880.000	12.435	1.500	0.875	2.785	9.649	0.195	0.680	2.620	1.500	African Padauk	155502	C3-C6 chromatic	Workbook-derived from Marimba sheet; resonator bore currently follows width/end-correction proxy.
MAR-Asharp5	A5	82	932.328	12.081	1.500	0.875	2.706	9.375	0.182	0.693	2.404	1.500	African Padauk	155502	C3-C6 chromatic	Workbook-derived from Marimba sheet; resonator bore currently follows width/end-correction proxy.
MAR-B5	B5	83	987.767	11.737	1.500	0.875	2.629	9.108	0.169	0.706	2.200	1.500	African Padauk	155502	C3-C6 chromatic	Workbook-derived from Marimba sheet; resonator bore currently follows width/end-correction proxy.
MAR-C6	C6	84	1046.502	11.403	1.250	0.875	2.554	8.848	0.156	0.719	2.212	1.250	African Padauk	155502	C3-C6 chromatic	Workbook-derived from Marimba

sheet; resonator bore currently follows width/end-correction proxy. |

 photo-shotlist.md

Project artifact.

 Photo Shotlist

This shotlist follows the repo-level photo pipeline expectations from instrument-maker/docs/photo-pipeline.md: capture real process images first, use generated or supplier images only as labeled placeholders, and keep build-log image names stable enough for site/index.html.

 Intake And Materials

- images/01-workbook-table.png: screenshot of marimba-design-table.xlsx showing the Marimba sheet.
- images/02-padauk-stock.jpg: rough Padauk boards with ruler and grain direction.
- images/03-resonator-tube-options.jpg: tube material and cap options.
- images/04-cnc-tooling.jpg: ball-end mills and profile bits.

 Bar Fabrication

- images/10-blank-layout.jpg: labeled rough blanks before cutting.
- images/11-thickness-check.jpg: calipers on surfaced blank.
- images/12-node-marking.jpg: node positions marked on one bass and one treble bar.
- images/13-cnc-arch-setup.jpg: bar blank held for underside arch.
- images/14-arch-detail.jpg: finished underside arch with straightedge.
- images/15-support-hole-detail.jpg: clean support hole at node.

 Resonators And Frame

- images/20-resonator-cutting.jpg: tube cutting/deburring setup.
- images/21-resonator-cap-detail.jpg: adjustable cap or stopper.
- images/22-frame-rail-layout.jpg: rail layout with node/support marks.
- images/23-dry-fit-overview.jpg: bars, rails, and resonators dry-fit.

 Validation

- images/30-pilot-c3-tuning.jpg: C3 supported at nodes and measured.
- images/31-pilot-a4-tuning.jpg: A4 tuning reference.
- images/32-pilot-c6-tuning.jpg: C6 treble validation.
- images/33-validation-log.jpg: tuner, microphone, and validation.csv workflow.

 Final Documentation

- images/40-finished-front.jpg: full instrument front view.
- images/41-finished-player-view.jpg: player reach/ergonomics view.
- images/42-resonator-underneath.jpg: underside resonator alignment.
- images/43-detail-beauty.jpg: finish/detail close-up.

risks.md

Project artifact.

Marimba Risk Register

Acoustic Risks

Bar pitch misses workbook prediction

- Risk: The selected Padauk stock has a different effective stiffness/density than the workbook K constant.
- Impact: All bars may cut sharp or flat by a consistent amount.
- Test: Cut and measure C3, A4, and C6 pilot bars before the full run.
- Pass criterion: Post-arch bars can be brought within +/- 10 cents by normal sanding/tuning allowance.
- Mitigation: Update K constant or arch schedule before cutting the remaining bars.

Resonator bore proxy is wrong

- Risk: The workbook currently uses bar width as the resonator bore/end-correction proxy.
- Impact: Tube lengths may be wrong after real tube diameters are selected.
- Test: Select actual tube ID, recalculate C3/A4/C6 resonator lengths, and compare response.
- Pass criterion: Resonator reinforcement peaks near target pitch without strong buzz or deadening.
- Mitigation: Update family-spec.csv and regenerate resonator drawings before cutting all tubes.

Structural Risks

Arch cut-through or weak low bars

- Risk: C3 reaches the 0.250 in minimum center thickness.
- Impact: Bass bars may crack, warp, or lose sustain.
- Test: Measure remaining center thickness after CNC and after final sanding.
- Pass criterion: No pilot bar falls below 0.250 in; no visible checking under normal strike force.
- Mitigation: Increase minimum center thickness or choose denser/stiffer stock.

Support holes weaken bars

- Risk: 1/4 in holes near nodes may split if drilled too close to edges or with poor backing.
- Impact: Cracks, buzzes, or support failure.
- Test: Drill sample holes in offcuts and pilot bars with the intended bit and backing board.
- Pass criterion: Clean holes with no breakout or splitting.
- Mitigation: Reduce hole diameter, use cord grooves, or add rubber support posts instead.

Ergonomic Risks

Frame too wide or awkward for reach

- Risk: C3-C6 chromatic layout may become too wide/deep once resonators and accidental row are placed.
- Impact: Poor playing ergonomics or impossible transport.
- Test: Tape full-size bar positions on a bench and test mallet reach before building the final frame.
- Pass criterion: Natural and accidental rows are reachable without shoulder strain for intended player.
- Mitigation: Use a compact portable range, split frame, or revised bar spacing.

Supply Risks

Padauk availability and quality

- Risk: Clear long Padauk stock may be expensive, unstable, or unavailable.
- Impact: Build delays or inconsistent tone.
- Test: Request current quotes and inspect board quality/moisture before purchase.
- Pass criterion: Enough straight stock for 37 bars plus pilot failures.
- Mitigation: Use hard maple/cherry for an education prototype and update material constants.

Tube/cap system mismatch

- Risk: Selected tube caps may leak, rattle, or be hard to tune.
- Impact: Weak or noisy resonators.
- Test: Build three tube prototypes with removable caps.
- Pass criterion: Tubes hold adjustment and do not buzz under playing vibration.
- Mitigation: Use adjustable stoppers, gasketed plugs, or alternate tube material.

Fit And Finish Risks

Finish shifts pitch or damps sustain

- Risk: A heavy finish adds mass and damping to tuned bars.
- Impact: Bars go flat or lose sustain after finishing.
- Test: Finish an offcut and one sacrificial tuned test bar; measure before/after Hz and decay.
- Pass criterion: Pitch shift is predictable and within final tuning allowance.
- Mitigation: Use thin finish, tune after finish, or mask underside tuning zones until final pass.

Frame buzzes after assembly

- Risk: Bars, tubes, caps, or fasteners touch unintentionally.
- Impact: Audible buzzes and unreliable validation data.
- Test: Strike every bar at soft, medium, and loud dynamics while muting adjacent parts.
- Pass criterion: No persistent buzz in the assembled frame.
- Mitigation: Add clearance, isolate hardware, and use thread-locking or removable dampers where appropriate.