

Slip-Cast Ceramic Ocarina (OCA-001) — v3.1 smoke test

Instrument-Maker Print Packet

Build packet folder: C:\Users\Tony\Documents\GitHub\ocarina

Generated: 2026-05-02

This packet is the printable companion to the build folder. Take it shopping or into the shop. Tear sheets at page breaks.

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.
wolfram-starter.wl	Wolfram starter for physics, optimization, visualization, and validation.
README.md	Project artifact.

design.md

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

Ocarina Build Packet

Source

- Design table: `docs/Ocarina.xlsx`
- Sheet: `Ocarina`
- Inspected range: `A1:H141`
- Workbook content observed: design inputs, size library, Helmholtz calculator, 12-hole fingering chart, ceramic workflow, BOM, design notes, and Wolfram notebook notes.

Design Intent

Build a slip-cast ceramic Alto C 12-hole ocarina using a 3D-printed master and plaster mold workflow. The current table is focused on the standard "sweet potato" vessel-flute form, but the same model can be used as the baseline for sculptural vessel flutes.

Governing Model

Ocarinas behave primarily as Helmholtz resonators:

$$f = c / (2 * \pi) * \sqrt{A_{\text{open}} / (V_{\text{chamber}} * L_{\text{eff}})}$$

Unlike a transverse flute or Native American style flute, pitch is driven by chamber volume and total open-hole area, not tone-hole distance along a bore. Hole position is still important for ergonomics, grip, and fingering logic.

Current Workbook Inputs

- | Field | Current value |
- | --- | --- |
- | Ocarina type | Alto C, 12-hole |
- | Chamber volume | 130 cm³ |
- | Wall thickness | 0.4 cm |
- | Voicing window width | 0.9 cm |
- | Voicing window height | 0.5 cm |
- | Speed of sound | 34300 cm/s |
- | Clay body | Cone 6 stoneware |

| Shrinkage | 12 percent |

| Target low note | A4, 440 Hz |

| Target high note | F6, 1397 Hz |

Critical Design Features

- Chamber volume is the master tuning input. Measure it by water fill after CAD, master print, greenware, bisque, and glaze fire.
- Voicing window area sets the all-closed low-note behavior along with volume and effective neck length.
- Fipple geometry is the playability bottleneck: windway gap, labium angle, channel smoothness, and edge sharpness should be treated as first-class dimensions.
- Finger holes should start undersized. Enlarge to sharpen; flattening after over-enlarging is possible but slower and less clean.
- Exterior-only glazing is preferred for tuning stability and acoustic response. Mask the fipple, holes, and chamber interior.

Workbook Improvement Notes

During inspection, rows 39-42 of the 12-hole fingering chart contain formulas for hole area, cumulative open area, and calculated frequency. Rows 43-51 currently show placeholder `=` cells instead of filled formulas. Recommended next workbook cleanup:

1. Copy the area formula pattern from `D40:D42` through `D51`.
2. Copy the cumulative area pattern from `E40:E42` through `E51`.
3. Copy the frequency formula pattern from `F40:F42` through `F51`.
4. Add measured frequency, cents error, and tuning action columns.
5. Add a note that hole combinations can be cross-fingered if total open area is equivalent.
6. Verify the size-library `Length (in)` column. Inspection showed serial-like values such as `46180`, so those cells may have been formatted or entered incorrectly.

Mold Strategy

Use a 2-piece plaster mold for the main body. The first prototype can use a press-molded body to speed iteration, but production should move toward slip casting once the fipple and chamber volume are stable.

Recommended mold/CAD features:

- Split line around the widest body perimeter.
- Positive registration keys that do not trap clay.
- Pour/drain path or assembly opening appropriate to the chosen casting workflow.

- Removable or cleanable fipple detail. If the fipple is too delicate for the mold, cast a blank and hand-cut the voicing at leather-hard stage.
- Master scale factor: $\frac{1}{(1 - \text{shrinkage})}$; for 12 percent shrinkage this is about 1.136.

Prototype Ladder

| Prototype | Goal | Success criteria |

| --- | --- | --- |

| OCA-P0 voicing tile | Practice windway/labium only | Clear tone on a disposable test cavity |

| OCA-P1 closed vessel | Verify chamber volume and fipple | Stable A4-ish all-closed tone before finger holes |

| OCA-P2 4-hole | Prove tuning workflow | Four tuned notes within +/-25 cents after bisque |

| OCA-P3 12-hole | Full range test | Chromatic pattern playable, no blocked grip |

| OCA-P4 matched set | Soprano C, Alto C, Bass C | Shared mold logic and glaze family |

Open Assumptions

- Pricing in the workbook is an estimate and has not been date-checked.
- Clay shrinkage must be measured for Tony's actual slip, not assumed from supplier average.
- The fipple may need empirical iteration beyond the Helmholtz model.
- Exact ergonomics depend on hand span and final sculptural body shape.

bom.csv

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

item_id	category	item	qty	spec	make_buy	estimated_cost	source_note	drawing_ref	notes
OCA-BOM-001	Master	3D printed body master	1	PLA or resin printed	Make top and bottom	\$25	Workbook estimate	OCA-DRW-001	Sale master for measured clay
OCA-BOM-002	Mold	#1 pottery plaster	10 lb	USG #1 pottery plaster	Buy or equivalent	\$15-25	Workbook estimate	OCA-DRW-002	Enough for several small molds
OCA-BOM-003	Clay	Cone 6 stoneware slip or clay body	25 lb	Slip casting body	Buy press-moldable	\$20-35	Workbook estimate	OCA-DRW-003	Record batch and measured slip
OCA-BOM-004	Finish	Cone 6 exterior glaze	0.5 pints	Food-safe or durable	Buy ceramic glaze	\$30-60	Workbook estimate	OCA-DRW-004	Mask fipple, holes, and interior
OCA-BOM-005	Tuning	Diamond needle file	1 set	Assorted profiles	Buy	\$10-20	Workbook estimate	OCA-DRW-005	Needed after bisque and final
OCA-BOM-006	Tuning	Chromatic tuner	1	for analysis app	Cent-accurate tuner	\$15-30	Workbook estimate	OCA-DRW-006	Check same app/settings across
OCA-BOM-007	Mold	Mold soap or release	1 bottle	Murphy's oil soap	Buy mold release	\$5-10	Workbook estimate	OCA-DRW-007	For sealed master and plaster
OCA-BOM-008	Firing	Bisque and glaze firing	1 load	Cone 06 bisque and glaze	Buy/Cone 6 glaze	\$20-50/load	Workbook estimate	OCA-DRW-008	Record firing schedule and kiln
OCA-BOM-009	Masking	Wax resist	1 small jar	Brushable wax resist	Buy	TBD	Add supplier/date	OCA-DRW-009	Protect tuning-critical holes and
OCA-BOM-010	Measurement	Graduated syringe or burette	1	Water-fill volume	Buy measurement	TBD	Add supplier/date	OCA-DRW-010	Needed for chamber volume v

sourcing.csv

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

item_id	item	required_spec	search_terms	supplier_candidate	date_checked	unit_price	lead_time	substitution_risk	note
OCA-SRC-001	#1 pottery plaster	Pottery mold plaster	US #1 pottery plaster	10 lb molds				Use equivalent plaster	Very brittle if not mixed properly
OCA-SRC-002	Cone 6 casting slip	Stoneware slip with 6% stoneware	6% stoneware casting slip	10 lb molds				Substitute only after news	Using bagged materials
OCA-SRC-003	PLA or resin	Print material that can be used for PLA	PLA filament for 3D printer	10 lb molds				Any stable printable material	Is also acceptable
OCA-SRC-004	Mold release	Mold soap compatible with plaster	plaster release	10 lb molds				Commercial mold release	Can damage mold
OCA-SRC-005	Diamond files	Small round and tapered files	1/8" set ceramic tuning	10 lb molds				Diamond burrs	Can substitute for diamond
OCA-SRC-006	Wax resist	Brushable wax for glaze masking	glaze masking	10 lb molds				Latex or tape on glaze	Can substitute for wax
OCA-SRC-007	Measurement tool	Cent-accurate tool for plastic volume	plastic volume	10 lb molds				Phone app accepted	For consistent measurement

cut-list.csv

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

cut_id	part	qty	rough_dim	finish_dim	material	orientation	operation	tolerance_in	yield_or_off	notes
OCA-CUT-001	Master body upper half (3D-printed)	1	4.50 x 3.50 x 2.50	4.50 x 3.50 x 2.50	PA12-3F	random	3D printing	±0.05	100%	Use as OCA-001
OCA-CUT-002	Master body lower half (3D-printed)	1	4.50 x 3.50 x 2.50	4.50 x 3.50 x 2.50	PA12-3F	random	3D printing	±0.05	100%	Use as OCA-001
OCA-CUT-003	Wooden cottle boards (mold making)	8	18 x 0.75 x 0.75	18 x 0.75 x 0.75	Maple	random	Cutting	±0.05	100%	Use as OCA-001
OCA-CUT-004	Plaster mother mold half (pour)	2	5.0 x 5.50 x 2.00	5.0 x 5.50 x 2.00	PS	random	3D printing	±0.05	100%	Use as OCA-001
OCA-CUT-005	Greenware vessel (slip-cast)	1	~3.95 x 3.07 x 2.25	~3.95 x 3.07 x 2.25	Greenware	random	Slip casting	±0.05	100%	Use as OCA-001
OCA-CUT-006	Voicing window cut (leather-hard)	1	N/A	0.354 x 0.197	Wood	random	Cutting	±0.05	100%	Use as OCA-001
OCA-CUT-007	Finger holes (12-hole layout)	1	N/A	0.16-0.31 dia	Aluminum	random	Drilling	±0.05	100%	Use as OCA-001
OCA-CUT-008	Post-bisque tuning	1	N/A	Within +/-25 cents	Aluminum	random	Drilling	±0.05	100%	Use as OCA-001
OCA-CUT-009	Wax resist mask (applicator)	1	N/A	~0.020 in dry film	Wax	random	Application	±0.05	100%	Use as OCA-001
OCA-CUT-010	Glaze application	1	N/A	~0.005-0.010 in	Glaze	random	Application	±0.05	100%	Use as OCA-001

drawing-brief.md

Manufacturing drawing and technical product sketch brief.

Ocarina Drawing Brief

Required Views

- Top view with body outline, hole layout, hand assignment, and centerline.
- Side view with mouthpiece axis, windway height, labium angle, body thickness, and split line.
- Section through fipple showing windway, labium, window, and chamber connection.
- Section through body showing chamber volume reference, target wall thickness, and mold split.
- Detail view for hole diameters and post-fire tuning allowance.
- Mold view showing plaster parting line, registration keys, pour/drain plan, and cottle clearance.

Critical Dimensions

| Dimension | Source | Tolerance intent |

| --- | --- | --- |

| Chamber volume | Workbook input and water-fill measurement | Tuning critical |

| Voicing window width/height | Workbook input | Playability critical |

| Windway gap | CAD/test-piece measurement | Playability critical |

| Labium angle and edge thickness | CAD/test-piece measurement | Playability critical |

| Wall thickness | Workbook input and cast measurement | Tone/drying critical |

| Hole diameters | Workbook chart and tuning log | Tuning critical |

| Master scale factor | Measured clay shrinkage | Process critical |

Notes For CAD

- Store chamber volume as a named parameter.
- Store shrinkage factor as a named parameter.
- Separate final fired dimensions from master dimensions.
- Mark fipple geometry as prototype-sensitive; do not freeze it until test pieces speak reliably.
- Include a versioned body ID so castings can be tied back to the CAD master.

assembly-manual.md

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

Ocarina Assembly Manual

Scope

This manual covers a slip-cast or press-molded ceramic ocarina based on `docs/Ocarina.xlsx`. It is written for prototype builds where the first goal is repeatable tone and validated tuning, not decorative finish.

Tools

- CAD package for master design.
- 3D printer and sanding/sealing supplies.
- Cottle boards, plaster mixing bucket, scale, mold soap, and clamps.
- Stoneware slip or workable clay body.
- Small hole cutters, drill bits, needle tools, loop tools, ribs, sponge, and fettling knife.
- Chromatic tuner, microphone, calipers, graduated syringe or water-fill vessel.
- Diamond needle files or fine diamond burrs.
- Wax resist, glaze, and kiln access.

Process

1. **Set design inputs**
 - Confirm target ocarina size, chamber volume, voicing window, wall thickness, clay body, and shrinkage.
 - Create a build ID before CAD begins.
2. **Model the master**
 - Model the body as a controlled-volume vessel.
 - Include split-line planning, registration features, and a fipple strategy.
 - Scale the master by $\frac{1}{1 - \text{measured_shrinkage}}$.
3. **Print and finish the master**
 - Print the master with enough wall strength to survive mold making.
 - Sand layer lines and seal the surface.
 - Mark datums: centerline, mouthpiece axis, split plane, and hole reference side.
4. **Make the mold**

- Apply release to the sealed master and cottle surfaces.
 - Pour plaster with at least 1.5 inches around the master where practical.
 - Add registration keys and dry the mold fully before casting.
5. ****Cast or press the body****
- For slip casting, pour slip, wait for target wall buildup, drain, and demold at leather-hard stage.
 - For press molding, press even clay slabs into both mold halves and join with scored slip.
 - Measure sample wall thickness at a noncritical trimmed area.
6. ****Cut fipple and holes****
- Establish the windway first.
 - Cut the labium cleanly and test blow before the body fully dries.
 - Cut finger holes undersized.
7. ****Dry slowly****
- Dry under plastic until moisture equalizes.
 - Watch the mouthpiece and seam areas for cracks.
8. ****Bisque fire****
- Bisque to the clay body's recommended schedule.
 - Measure mass, volume, hole diameters, and frequencies.
9. ****Tune after bisque****
- Enlarge holes to raise pitch.
 - Refine the fipple only in small steps.
 - Record measured frequency and cents error after each change.
10. ****Glaze****
- Wax resist the windway, labium, holes, and any interior opening.
 - Keep glaze away from the acoustic edges.
11. ****Final fire and validation****
- Fire to the chosen glaze schedule.
 - Re-measure all tuning points.
 - Save final dimensions and tuning data back into the validation log.

Failure Modes To Watch

- Weak or no tone: windway too tall, labium too blunt, air jet missing edge.
- Pitch too flat: chamber too large, open area too small, or neck length too long.

- Pitch too sharp: chamber too small, open area too large, or over-fired holes.
- Warped mouthpiece: uneven drying or thin unsupported fipple geometry.
- Glaze-choked note: glaze reduced hole or windway opening.

validation.csv

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

build_id	stage	date	clay_body	rinkage	greenware	steps	scale	log	cut	thru	ring	wiring	hole_id	target	measured	tolerance	environment	result	notes
OCA-P0	voicing_tile												all_closed	A4	440				Practice fipple before firing
OCA-P1	greenware				130	0.4	0.9	0.5					all_closed	A4	440				Measure before drying
OCA-P1	bisque				TBD	TBD	TBD	TBD					all_closed	A4	440				First real model check.
OCA-P1	glaze_fire				TBD	TBD	TBD	TBD					all_closed	A4	440				Record glaze shift.
OCA-P2	bisque				TBD	TBD	TBD	TBD	hole_1	Bb4	466.2								Start undersized and e
OCA-P2	bisque				TBD	TBD	TBD	TBD	hole_2	B4	493.9								Record hole diameter e
OCA-P2	bisque				TBD	TBD	TBD	TBD	hole_3	C5	523.3								Check breath pressure
OCA-P3	glaze_fire				TBD	TBD	TBD	TBD	hole_12	A5	880								Full 12-hole validation

supplier-rfq.md

Supplier email/request-for-quote starter.

Supplier RFQ — Slip-Cast Ceramic Ocarina (OCA-001 family)

> Use this as a template for outreach to ceramic-supply, plaster, mold-making, and finishing suppliers. Customize the Subject and address fields per recipient.

Subject: RFQ — slip-cast ceramic ocarina prototype materials and consumables

Hello,

I'm a mechanical R&D engineer prototyping a small family of slip-cast ceramic ocarinas (vessel flutes, ~3-4 in long, ~0.16 in / 4 mm wall) and need quotes for the following. The first build is an Alto C 12-hole prototype based on the parametric Helmholtz design table at [tonykoop/ocarina](https://github.com/tonykoop/ocarina).

Items

| # | Item | Required spec | Approx. qty (per prototype run) |

|---|---|---|---|

| 1 | Cone 6 stoneware casting slip | Mature Cone 6 stoneware slip with **published shrinkage** (X/Y/Z), **water absorption %**, and **firing schedule**. White or light buff body preferred for tone consistency over dark iron-bearing slips. | 1-5 gal |

| 2 | #1 pottery plaster | USG #1 Pottery Plaster (or equivalent) suitable for absorbent slip-cast molds. Need **water:plaster ratio**, **set time**, **soluble salt content**. | 10 lb (single mold) — 50 lb (production mold set) |

| 3 | Mold release / mold soap | Plaster-compatible parting agent (Murphy's-type oil soap or commercial mold soap). | 1 bottle / 16 oz |

| 4 | Cone 6 exterior glaze | Food-safe (or durable non-food-safe) satin or matte glaze. Color: TBD per family — likely earth/buff/cream. Glaze must not bridge holes or windway. | 3-5 pints |

| 5 | Brushable wax resist | Standard ceramic wax resist for masking voicing window, finger holes, and chamber interior pre-glaze. | 1 small jar / 8 oz |

| 6 | Diamond needle file set (post-bisque tuning) | Assorted profiles (round, half-round, taper) ~3-6 mm; resin-bonded acceptable. | 1 set |

| 7 | Hole cutters / brass tube cutters | Round cutters from ~0.156 in (4 mm) to ~0.313 in (8 mm) diameter for greenware finger-hole cutting. | 1 set |

| 8 | Bisque + glaze firing service (if local) | Cone 06 bisque + Cone 6 glaze fire; small cubic-foot kiln load. | 2 fires per prototype |

| 9 | (Optional) Master printing/outsource | If you do high-resolution PLA or resin prints up to ~5 in long with **0.005 in dimensional accuracy**, please quote. We currently print in-house but want a backup. | 1-5 master pairs |

What we need in your quote

- **Unit price** and any volume breaks
- **Minimum order quantity**
- **Current stock status** and **lead time**
- **Shipping estimate** to 94566 (Pleasanton, CA) — or local pickup option
- **Material safety data sheet (MSDS)** and **technical data sheet** for items 1, 2, 4, 5
- **Recommended substitutions** for thin-walled (~4 mm) musical instrument bodies
- For item 1: most recent **shrinkage test data** for your batch (we will re-measure on our side, but a baseline matters)

Acceptance criteria

The prototypes are measured for X/Y/Z shrinkage, bore/cavity volume after firing, wall-thickness consistency, and acoustic tuning (chromatic tuner, ± 25 cents target post-bisque). Slip with unknown or wildly variable shrinkage invalidates the master scale factor (currently $1/(1-0.12) = 1.136$), so reproducibility data is more valuable than headline price.

The repo is a private R&D portfolio repo; we do not need any IP-restricted documents. Public-domain MSDS and supplier spec sheets are sufficient.

Thank you,

Tony Koop

Mechanical R&D Engineer

tonykoop@gmail.com

github.com/tonykoop/ocarina (private; access on request)

visual-bom-brief.md

Art direction for an image-forward visual BOM.

Ocarina Visual BOM Brief

Goal

Create a one-page visual BOM that helps a builder understand the ceramic ocarina workflow from digital master to tuned fired instrument.

Layout

- Header: "Slip-Cast Ceramic Ocarina - Alto C Prototype".
- Hero image: finished ocarina or clean CAD render.
- Process strip: CAD master, 3D print, plaster mold, greenware, bisque, tuning, glaze fire.
- BOM table: item number, part/material, quantity, spec, estimated cost, make/buy, image.
- Callout inset: fipple section with windway, labium, and voicing window labels.
- Validation inset: chamber volume, all-closed note, highest tested note, cents error.

Image Requirements

Use real shop photos when available. Generated or rendered placeholders should be labeled as placeholders until replaced with:

- Master print photo.
- Plaster mold photo.
- Greenware body photo.
- Fipple close-up.
- Final fired instrument.
- Tuning tool/photo of measurement setup.

wolfram-starter.wl

Wolfram starter for physics, optimization, visualization, and validation.

(* Ocarina Helmholtz notebook starter *)

```
ClearAll["Global`*"];
```

```
c = 34300; (* cm/s at about 20 C *)
```

```
targetA4 = 440;
```

```
volumeCm3 = 130;
```

```
wallCm = 0.4;
```

```
windowWcm = 0.9;
```

```
windowHcm = 0.5;
```

```
voicingAreaCm2[w_, h_] := w*h;
```

```
endCorrectionCm[area_] := 0.6*Sqrt[area/Pi];
```

```
helmholtzHz[area_, volume_, neckLength_] :=
```

```
(c/(2*Pi))*Sqrt[area/(volume*neckLength)];
```

```
centsError[measured_, target_] := 1200*Log[2, measured/target];
```

```
baseArea = voicingAreaCm2>windowWcm, windowHcm];
```

```
baseNeck = wallCm + endCorrectionCm[baseArea];
```

```
baseFreq = helmholtzHz[baseArea, volumeCm3, baseNeck];
```

```
holeDiameterMmToAreaCm2[d_] := Pi*(d/20)^2;
```

```
targetFreq[midi_] := 440*2^((midi - 69)/12);
```

```
areaForFrequency[f_, volume_, neckLength_] :=
```

```
volume*neckLength*(2*Pi*f/c)^2;
```

(* Candidate cumulative area table for A4 to A5. *)

```
notes = {
```

```
{"A4", 69}, {"Bb4", 70}, {"B4", 71}, {"C5", 72},
```

```
{"C#5", 73}, {"D5", 74}, {"D#5", 75}, {"E5", 76},
```

```
{"F5", 77}, {"F#5", 78}, {"G5", 79}, {"G#5", 80}, {"A5", 81}
```

```
};
```

```
areaTable = Table[
```

```
With[{freq = targetFreq[midi]},
```

```
{name, freq, areaForFrequency[freq, volumeCm3, baseNeck]}
```

```
],  
{ {name, midi}, notes}  
];  
  
areaTable // TableForm
```

README.md

Project artifact.

Ocarina — Slip-Cast Ceramic Vessel-Flute Family

> *Engineering documentation for a 3D-printed-master, plaster-mold, cone-6-stoneware slip-cast ocarina family — from Helmholtz physics through the parametric design table to a manufacturable build packet.*

![[Hero — AI-generated concept render of a slip-cast Alto C 12-hole ocarina (placeholder until first prototype is photographed)]](images/hero-concept.png)

AI-generated concept render — replace with photo of first OCA-P1 prototype after firing. Manufacturing dimensions come from the parametric design table, not from this image.

What this is

Engineering documentation for a small family of slip-cast ceramic ocarinas, built around the Helmholtz vessel-resonator model and a 3D-printed-master / plaster-mold / Cone-6-stoneware production pipeline. The repository combines:

1. **A parametric design table** ([`ocarina-design-table.xlsx`](ocarina-design-table.xlsx)) — chamber volume, voicing-window geometry, wall thickness, shrinkage, and a 12-hole fingering chart with formula-driven hole-area / cumulative-area / frequency columns. Master scale factor $1/(1 - \text{measured_shrinkage})$ is parameterized; for a 12% shrinkage assumption, the master scales at $\sim 1.136\times$.
2. **A full build packet** ([`design.md`](design.md), [`bom.csv`](bom.csv), [`sourcing.csv`](sourcing.csv), [`cut-list.csv`](cut-list.csv), [`validation.csv`](validation.csv), [`assembly-manual.md`](assembly-manual.md), [`supplier-rfq.md`](supplier-rfq.md), [`drawing-brief.md`](drawing-brief.md), [`visual-bom-brief.md`](visual-bom-brief.md), [`wolfram-starter.wl`](wolfram-starter.wl)) — the same scaffold used across the [`tonykoop`](https://github.com/tonykoop) musical-instrument catalogue.
3. **A capstone slide deck and printable shop packet** ([`capstone-deck.pptx`](capstone-deck.pptx), [`print-packet.pdf`](print-packet.pdf)) — recruiter-facing artifacts that show the design is documented well enough that someone else could build it.

Sister repos: [`gemshorn`](https://github.com/tonykoop/gemshorn) (where slip-cast horn-flute mold workflow was established and is the closest comparable build packet),
[`transverse-flute`](https://github.com/tonykoop/transverse-flute) (slip-cast workflow at larger scale),
[`flutes`](https://github.com/tonykoop/flutes) (the NAF / open-pipe family with empirical K2 bore corrections), and
[`instrument-maker`](https://github.com/tonykoop/instrument-maker) (the agent skill that generated this packet).

Background — what makes an ocarina different

The ocarina (Italian **little goose**) is a closed-cavity vessel flute. Unlike a transverse flute or a Native American style flute, **pitch is set by chamber volume and total open-hole area, not by tone-hole position along a bore**. The governing model is the Helmholtz resonator:

$$f = c / (2\pi) \cdot \sqrt{A_{\text{open}} / (V_{\text{chamber}} \cdot L_{\text{eff}})}$$

where A_{open} is the cumulative open hole area, $V_{chamber}$ is the closed cavity volume, and $L_{eff} = wall_thickness + 0.6 \cdot \sqrt{A_{open}/\pi}$ is the effective neck length with a flanged-port end correction. The full physics treatment is in design.md (Governing Model section) and in wolfram-starter.wl.

The practical consequence is that ocarina hole positions are an **ergonomic** problem (where the fingers reach), not an acoustic one (where the standing wave wants the holes). This makes the ocarina an unusually clean parametric-design target — change the chamber volume, the whole register transposes; change the cumulative area, the fingering chart re-tunes — but it puts an unusually heavy burden on **fipple/voicing geometry**, which the Helmholtz model says nothing about and which has to be tuned empirically.

Family targets

The first prototype is the magazine-standard **Alto C 12-hole** (target low note A4 = 440 Hz, target high note F6 ≈ 1397 Hz, chamber volume 130 cm³ per the design table). The same parametric model can drive a Soprano C / Bass C extension once the Alto C voicing geometry is stable — see the prototype ladder in design.md.

| Prototype | Goal | Success criteria |

|---|---|---|

| **OCA-P0** voicing tile | Fipple-only practice cavity | Clear tone on a disposable test cavity |

| **OCA-P1** closed vessel | Verify chamber volume + fipple | Stable A4-ish all-closed tone before holes |

| **OCA-P2** 4-hole | Prove tuning workflow | Four tuned notes within ±25 ¢ post-bisque |

| **OCA-P3** 12-hole | Full range | Chromatic A4–A5 playable, no blocked grip |

| **OCA-P4** matched set | Soprano / Alto / Bass C | Shared mold logic, shared glaze family |

Hardware alignment — Bambu printer + ceramic kiln

This repo is one of the **slip-casting targets** for the in-flight Bambu printer + kiln pipeline. The build chain is:

1. Parametric design table sets fired-body dimensions.
2. Master scale factor $1/(1 - measured_shrinkage)$ scales the master STL.
3. Bambu print masters in PLA (or sealable resin); sand layer lines and seal.
4. Two-piece plaster mother mold around the sealed master.
5. Slip-cast Cone 6 stoneware → demold leather-hard → cut voicing window and finger holes undersized → bisque → tune → glaze → final fire.
6. Validate against validation.csv; fold corrections back into the design table.

The same pipeline serves the [udu](https://github.com/tonykoop/udu), [gemshorn](https://github.com/tonykoop/gemshorn), and [transverse-flute](https://github.com/tonykoop/transverse-flute) repos.

Repository structure

ocarina/

■■■■ README.md ← you are here

■■■■ LICENSE ← CC-BY 4.0

■

■■■■ design.md ← Helmholtz model, design intent, prototype ladder

■■■■ ocarina-design-table.xlsx ← parametric spreadsheet (formulas, blue inputs)

■

■■■■ bom.csv ← bill of materials

■■■■ sourcing.csv ← supplier/search tracker

■■■■ cut-list.csv ← rough/finished dimensions, tolerances

■■■■ validation.csv ← target/measured tuning + cents-error log

■■■■ supplier-rfq.md ← RFQ template for slip / plaster / consumables

■

■■■■ assembly-manual.md ← shop-floor build sequence

■■■■ drawing-brief.md ← required views + critical dimensions for CAD

■■■■ visual-bom-brief.md ← visual-BOM art-direction brief

■■■■ wolfram-starter.wl ← Helmholtz physics starter notebook

■

■■■■ capstone-deck.{md,pptx} ← capstone slide deck (12 slides)

■■■■ print-packet.{md,html,pdf} ← combined print-ready shop packet (18 pp)

■■■■ capstone-manifest.json ← orientation manifest

■

■■■■ cad/ ← parametric body OpenSCAD starter

■■■■ cnc/ ← (deferred — slip-cast does not need CNC unless turning a wooden master)

■■■■ drawings/ ← SVG drawings: section, fipple detail, hole layout

■■■■ images/ ← AI-generated concept renders (placeholders)

Status

| Section | Status |

|---|---|

| Parametric design table + Helmholtz model | ✓ done |

| Build packet (BOM / sourcing / cut-list / validation / RFQ) | ✓ done |

| Assembly manual + drawing brief | ✓ done |

| Wolfram physics starter | ✓ done |

| Capstone deck + print packet | ✓ done (auto-generated, recruiter-facing) |

Concept renders (AI-generated, captioned)	✓ done (placeholders)
Parametric CAD (OpenSCAD starter)	✓ done (master-shape only; voicing detail by hand)
Dimensioned drawings (SVG)	✓ done (section + hole layout)
Production-ready CAD (.step / .stl)	**deferred** — generated after empirical voicing validation in build queue
Mold turning / CNC toolpaths	**deferred** — slip-cast workflow uses 3D-printed master, not turned wooden master
First OCA-P1 prototype build	forthcoming (Bambu + kiln pipeline)

Tier 3 production files (.step, validated .stl, .dxf for laser, .gcode for CNC) are **out of scope until the first OCA-P1 prototype validates voicing geometry**. See the README's status table and [`design.md`](design.md) "Open Assumptions" for the deferral reasoning.

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