

Vessel Flutes Build Packet

Instrument-Maker Print Packet

Build packet folder: /tmp/vessel-flutes-codex-bob-r3-build-packet

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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.
CHECKLIST.md	Project artifact.
README.md	Project artifact.
concept-matrix.csv	Project artifact.
experiments.csv	Project artifact.
family-spec.csv	Project artifact.
jig-decision.md	Project artifact.
mold-workflow.md	Project artifact.
photo-shotlist.md	Project artifact.
resources.md	Project artifact.
review-evidence.md	Project artifact.
risks.md	Project artifact.

design.md

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

Design

Design Intent

Create an L2 root-mode build packet for vessel flutes whose pitch behavior is set by Helmholtz resonance. The first prototype is a 130 cc ceramic ocarina lab body with a conservative voicing and undersize finger holes. The purpose is to validate cavity volume, voicing response, cumulative hole area, and shrinkage before committing to a polished slip-cast family.

This packet supports issue #1 as a reviewable packet candidate. It does not claim L3/build-ready status until measured cavity volume, shrinkage, and tuner data are added to `validation.csv`.

Governing Model

Helmholtz resonance:

$$f = c / (2\pi) * \sqrt{A / (V * L_{eff})}$$

$$L_{eff} = wall_thickness + end_correction$$

$$end_correction \approx 0.6 * \sqrt{A/\pi}$$

Variables:

- `f`: target frequency in Hz.
- `c`: speed of sound, about 34300 cm/s at 20 C.
- `A`: effective open area in square centimeters.
- `V`: cavity volume in cubic centimeters.
- `L_eff`: effective neck length in centimeters.

For finger-hole notes, `A` is cumulative effective area, not tube length. Hole interaction and hand coverage require empirical correction.

Starter Bodies

| Body | Role | Volume | Voicing area | Target | Notes |

| --- | --- | ---: | ---: | ---: | --- |

| VF-130-A4 | First lab body | 130 cc | 0.45 cm² | A4 | Ocarina-style proof body |

| VF-95-C5 | Smaller response body | 95 cc | 0.35 cm² | C5 | Tests higher voice and hand size |

| VF-180-G4 | Larger warm body | 180 cc | 0.55 cm² | G4 | Tests low response and wall stiffness |

Finger-Hole Area Plan

1. Calculate required cumulative area for each target note.
2. Convert each incremental area into an undersize drill diameter.
3. Drill small, measure, enlarge, and record the final diameter.
4. Update the hole-area curve before copying the body into a mold.

Starter scale for VF-130-A4 is a simple major pentatonic: `A4, B4, C#5, E5, F#5, A5`. A chromatic fingering chart is out of scope for this L2 pass.

Ceramic And Prototype Path

- Quick prototype: hand-shaped clay or sealed printed/plaster mockup with water-fill volume measurement.
- Ceramic path: slab or pinch body first; slip-cast mold only after shrinkage and voicing are measured.
- Mold workflow: preserve the existing `mold-workflow.md` notes and add fired shrinkage rows after test tiles.

SolidWorks/OpenSCAD Handoff

The CAD handoff should expose volume, voicing area, wall thickness, hole diameters, and mold split line as named inputs. A pretty exterior is secondary until the Helmholtz measurements agree with the design sheet.

L2 To L3 Gates

- Actual cavity volume measured within +/-5 cc.
- First sound is stable at low and medium breath pressure.
- Fundamental is within +/-20 cents before tuning holes.
- Tuned pentatonic notes are within +/-10 cents or documented as correction data.
- Fired shrinkage is measured before a slip-cast production mold is claimed.

bom.csv

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

item	qty	unit	estimated_cost	notes
Low-fire or mid-fire clay body	5	lb	derived estimate 12	Enough for two small prototypes and test tiles
Calibrated syringe or graduated cylinder		each	derived estimate 8	Water-fill cavity volume measurement
Digital caliper	1	each	shop tool	Measure hole diameters and wall thickness
Needle files and reamers	1	set	derived estimate 18	Gradual hole enlargement
Small drill index	1	set	derived estimate 20	Undersize tuning holes
Plaster for test mold	5	lb	derived estimate 15	Only after hand-built body validates
Food-safe shellac or ceramic finish test		set	derived estimate 10	Prototype sealing and surface tests

sourcing.csv

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

item	required_spec	search_terms	preferred_source	current_check_needed	substitution_notes
Clay body	known shrinkage clay with slip recipe	clay body shrinkage	ceramic supplier	yes	Use same body for test tiles and prototype
Graduated cylinder	100 to 250 ml with readable scale	250 ml graduated cylinder	lab or craft supplier	yes	Syringe acceptable for small cavities
Needle files	small round and tapered profiles	needle file set round tapered	hardware supplier	yes	Needed for controlled hole enlargement
Drill bits	number or metric bits under final hole size	final hole size bit set	tool supplier	yes	Undersize holes are required
Plaster	mold plaster suitable for slip casting	mold plaster slip casting	ceramic supplier	yes	Do not buy bulk until shrinkage plan is complete

cut-list.csv

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

part	qty	material	rough_dimensions_in	final_dimensions_in	operation_notes
VF-130 clay blank	2	clay	4 x 4 x 3 equivalent	130 cc cavity with 0.4 cm wall	Make one playable and one sectioned test
Test tiles	3	clay	3 x 1 x 0.25	measured fired shrinkage coefficient	Fire with prototype body
Voicing test coupon	2	clay or sealed scrap	2 x 2 x 0.5	window and windway practice	Use before cutting final body
Hole-area gauge card	1	card or acrylic	3 x 5	diameter/area reference	Keep with tuning tools
Plaster mold test block	1	plaster	6 x 6 x 3	small split-line trial	Only after hand-built validation

drawing-brief.md

Manufacturing drawing and technical product sketch brief.

Drawing Brief

Required Sheets

1. VF-130-A4 body overview with approximate cavity, voicing, and hand position.
2. Section view showing cavity volume, wall thickness, windway, and labium.
3. Finger-hole area chart with undersize drill diameters and final measured diameters.
4. Mold split-line concept after shrinkage validation.

Datum Scheme

- A: voicing centerline.
- B: mouthpiece/windway reference face.
- C: body midplane for hole layout and mold split discussion.

Tolerance Notes

Volume, voicing, and hole area are validation variables. Drawings should label starter dimensions as first-pass values until the measured body is logged.

assembly-manual.md

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

Assembly Manual

Scope

This manual covers the VF-130-A4 lab body. A slip-cast version should wait until the hand-built or sealed proof body validates volume, voicing, and hole area.

Steps

1. Weigh clay and form a simple closed cavity with an inspection/fill opening.
2. Shape the body around the 130 cc target volume, leaving extra wall thickness near the voicing.
3. Cut a conservative windway/window and smooth the labium edge.
4. Measure wet cavity volume by water fill and record in `validation.csv`.
5. Dry slowly; measure shrinkage against test tiles.
6. Seal the proof body if needed for first acoustic tests.
7. Establish first sound before drilling tone holes.
8. Drill tone holes undersize according to the area plan.
9. Tune by gradual enlargement, recording final diameters and cents error.
10. Fire or finish only after the acoustic target is stable.
11. Re-measure cavity volume after firing or sealing.
12. Update `mold-workflow.md` with the measured shrinkage before any slip-cast mold is cut.

Stop Conditions

- Stop if the cavity leaks; pitch observations are meaningless until sealed.
- Stop if volume differs by more than 10 cc; update design before drilling.
- Stop if first sound requires high breath pressure only; adjust voicing before tuning holes.

validation.csv

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

check	target	method	tool	actual	pass	notes
Wet cavity volume	130 cc +/- 5 cc	water fill before drying	graduated cylinder	pending	pending	Record before shrinkage
Dry/fired shrinkage	measured percent on test	pressure before/after firing	caliper	pending	pending	Required before mold claims
Voicing first sound	stable tone at low and medium breath	play test	shop notes	pending	pending	Fix voicing before drilling scale
Fundamental A4	440 Hz +/- 20 cents before notes temp	control notes	tuner	pending	pending	Adjust voicing or volume if far off
Hole 1 B4	493.88 Hz +/- 10 cents	air drilling then enlarge	reamer	pending	pending	Record final diameter
Hole 2 C#5	554.37 Hz +/- 10 cents	air drilling then enlarge	reamer	pending	pending	Track cumulative area
Hole 3 E5	659.25 Hz +/- 10 cents	air drilling then enlarge	reamer	pending	pending	Check hand coverage
Hole 4 F#5	739.99 Hz +/- 10 cents	air drilling then enlarge	reamer	pending	pending	Watch tone stability
Octave A5	880 Hz response check	overblow and fingering test	tester	pending	pending	Do not overclaim if unstable
Leak check	no leaks around seam	water leak test	visual/play test	pending	pending	Seal prototype before judging pitch

supplier-rfq.md

Supplier email/request-for-quote starter.

Supplier RFQ

Request

Please quote the following public-safe, non-proprietary instrument-build materials or fabrication services.

Items

- Item: TBD
- Quantity: TBD
- Material/spec: TBD
- Tolerance: TBD
- Finish: TBD
- Lead time target: TBD

visual-bom-brief.md

Art direction for an image-forward visual BOM.

Visual BOM Brief

Create a one-page visual BOM after the first prototype is shaped. Required image panels:

- Clay body or proof cavity before closure.
- Water-fill measurement setup.
- Voicing window and labium close-up.
- Drill/reamer set used for tuning holes.
- Test tiles used for shrinkage measurement.
- Final tuned prototype, front and back.

Each panel should link to the validation row it supports.

wolfram-starter.wl

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

(* Vessel flute Helmholtz starter: cavity volume and hole area. *)

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

```
cCmPerSec = 34300;
```

```
a4 = 440;
```

```
volumeCc = 130;
```

```
wallCm = 0.40;
```

```
areaCircleCm2[dmm_] := Pi*(dmm/20)^2;
```

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

```
helmholtzHz[area_, volume_, neck_] := (cCmPerSec/(2*Pi))*Sqrt[area/(volume*neck)];
```

```
areaForHz[f_, volume_, neck_] := volume*neck*(2*Pi*f/cCmPerSec)^2;
```

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

```
baseArea = 0.45;
```

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

```
baseHz = helmholtzHz[baseArea, volumeCc, baseNeck];
```

```
scale = {
```

```
  {"A4", 440.00},
```

```
  {"B4", 493.88},
```

```
  {"C#5", 554.37},
```

```
  {"E5", 659.25},
```

```
  {"F#5", 739.99},
```

```
  {"A5", 880.00}
```

```
};
```

```
areaTable = Table[
```

```
<|
```

```
"Note" -> note,
```

```
"TargetHz" -> hz,
```

```
"CumulativeAreaCm2" -> areaForHz[hz, volumeCc, baseNeck]
```

```
|>
```

```
{ {note, hz}, scale}
```

```
];
```

Dataset[areaTable]

(* Validation reminder: effective hole area must be measured on a prototype;
this is not an open-pipe tone-hole model. *)

CHECKLIST.md

Project artifact.

Public-Ready Checklist

Readiness Level

- L0 Concept: target sound, family, and rough build method are documented.
- L1 Design: governing equations, assumptions, dimensions, BOM, and sourcing candidates are present.
- L2 Shop Packet: build sequence, drawings/briefs, cut list, validation checklist, hazards, and artifact paths are complete enough for careful builder review.
- L3 Validated Packet: validator passes, generated/rendered artifacts open, units are consistent, and sourceability/tolerance claims are checked.
- L4 Empirical Packet: measured build data, tuning deviations, correction loop, and catalog feedback are included.

Only L3 or L4 work should be described as build-ready.

Packet Completeness

- Replace `Vessel Flutes`, `L2 root-mode build packet for Helmholtz vessel flutes: ocarina, xun, gemshorn, and ceramic cavity prototypes.`, and other placeholders.
- Add cultural attribution and sources of inspiration.
- Replace placeholder photos with owned photos, renders, or honest public-safe placeholders.
- Fill `design.md` with instrument-specific governing equations and assumptions.
- Fill BOM, sourcing, cut list, validation, and family spec rows with non-placeholder values.
- Add OpenSCAD/SolidWorks/Wolfram handoff notes without pretending final CAD exists.
- Add drawings and a CNC/setup plan where applicable.
- Fill `resources.md` with public-safe provenance, education, maker, and license notes.
- Fill `jig-decision.md` for any make/order/buy/borrow fixture decisions.
- Run `instrument-maker-v4/scripts/validate_packet.py . --mode root --json`.
- Confirm no local absolute paths, private repo links, or frozen supplier-price claims.

Review Evidence

- PR body includes changed behavior/artifact, physics/manufacturing assumptions, validation run, known gaps, reviewer focus, and do-not-merge-until bar.
- Physics gate passed: model, assumptions, units, tuning targets, and sensitivity ranges are reviewable.

- Manufacturing gate passed: toolchain, materials, tolerances, cut lists/jigs/CAD, and assembly order are plausible.
- Safety gate passed: dust, finishes, adhesives, sharp tools, tension, heat/pressure/electrical risks, and workshop constraints are addressed.
- Artifact gate passed: BOM, sourcing, cut list, validation, risks, drawings/CAD briefs, and rendered/generated artifacts are present or gaps are named.
- Empirical gate passed: measurement plan, pass/fail criteria, tuning correction path, and catalog feedback destination are stated.

README.md

Project artifact.

Vessel Flutes

- > L2 root-mode build packet for Helmholtz vessel flutes: ocarina, xun,
- > gemshorn-inspired ceramic studies, and quick cavity-volume prototypes.

![[Hero photo placeholder]](images/README-placeholder.txt)

What This Is

This repository documents a vessel-flute build packet where pitch is governed primarily by cavity volume, voicing aperture area, and effective neck length, not by open-pipe tube length. The first build target is a small ceramic ocarina lab body because it can validate volume measurement, voicing response, and finger-hole area formulas before more ornate forms are attempted.

The packet is **L2**, not **L3**. It is a reviewable root-mode packet with formulas, shop sequence, and validation gates, but it is not build-ready until a fired or prototype body has measured volume, shrinkage, and tuning data.

Refs #1.

Design Overview

- | Topic | Packet decision |
- | --- | --- |
- | Governing model | Helmholtz: $f = c / (2\pi) * \sqrt{A / (V * L_{eff})}$ |
- | First prototype | 130 cc ocarina-style lab body |
- | Voicing | Rectangular windway/window with measured effective area |
- | Tuning method | Drill holes undersize, track cumulative open area, tune by enlargement |
- | Materials | Clay slab/pinch prototype first; slip-cast workflow after shrinkage data |
- | Validation | Volume fill test, voicing response, scale tuning, shrinkage log |

Why Hole Area Matters

For vessel flutes, a tone hole does not "shorten a tube." It increases the

effective open area of the resonator. The practical tuning loop is:

1. measure dry/fired cavity volume;
2. calculate target cumulative open area for each note;
3. drill holes undersize;
4. enlarge holes gradually while measuring pitch;
5. update the hole-area curve with real data.

This packet keeps that distinction explicit so pipe-flute shortcuts do not creep into the vessel-flute workflow.

Packet Map

Path	Purpose
`design.md`	Helmholtz model, cavity-volume assumptions, hole-area logic
`family-spec.csv`	Three starter bodies with volume, aperture, and pitch targets
`bom.csv`	Clay/prototype materials, measuring tools, and finish supplies
`sourcing.csv`	Supply/spec tracker with live purchasing checks deferred
`cut-list.csv`	Clay blanks, gauges, templates, and fixture components
`assembly-manual.md`	Prototype sequence from volume target through tuning
`validation.csv`	Volume, shrinkage, voicing, and tuning measurements
`mold-workflow.md`	Existing ceramic lab context retained for follow-up
`concept-matrix.csv`	Existing concept matrix retained as design inputs
`wolfram-starter.wl`	Helmholtz and hole-area calculation starter

Build Order

1. Make a quick clay or sealed prototype body with measurable volume.
2. Cut a conservative voicing window and establish first sound.
3. Measure cavity volume by water fill before and after drying/firing when applicable.
4. Drill tone holes undersize and tune by cumulative open area.
5. Record fired shrinkage and update the mold/slip-cast plan.

Status

| Area | Status |

| --- | --- |

| Packet docs | L2 root-mode candidate |

| Ceramic lab notes | Existing docs retained under `docs/ceramic-vessel-lab` |

| Drawings/CAD | Drawing brief and mold workflow included |

| Photos | Placeholder only |

| Validation | Planned, no measured prototype yet |

| Issue linkage | Refs #1, does not close #1 |

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concept-matrix.csv

Project artifact.

concept_id	name	form	play_method	primary_model	creative_hook	first_target	prototype_notes
VF-01	Seed Vessel	Asymmetric seed pod	fipple	Single Helmholtz	Organic small flute with 4 holes	4th 5th pentatonic	Start first vessel-flute prototype.
VF-02	Water Bird	Small rounded pod w/ fipple port	fipple plus water	Variable-volume Helmholtz	fipple bends by changing water volume	TBD	Start as sound effect then tune a note
VF-03	Double Pod	Two connected bulbs	fipple	Coupled Helmholtz	Two chamber colors	for one breath	Needs coupled-mode measurement
VF-04	Drone Vessel	Melody bulb plus drone bulb	fipple	Coupled Helmholtz	Native-flute-like drone	TBD	Ceramic vessel for design drone as fixed port first.
VF-05	Transverse Vessel	Sculptural side-blown vessel	blow across edge	Edge tone plus Helmholtz	for transverse flute gesture	TBD	without long bore Higher risk because embouchure port
VF-06	Hand-Wah Vessel	Udu/ocarina hybrid	fipple plus palm port	Variable-port Helmholtz	hand opens a port for wah effects	TBD	Good bridge from udu experiments
VF-07	Shell Labyrinth	Folded shell-like chamber	fipple	Measured-volume Helmholtz	complex outside shape	TBD	with simple acoustic model Create Demold showcase if released

experiments.csv

Project artifact.

experiment_id	question	controlled_variables	changed_variable	measurements	success_criteria	next_action
VF-EXP-001	How accurately does the fipple flute model predict actual body lengths? Schedule	material, green/bisque/fired volume	body length	pitch	within +/-50 cents	empirical correction
VF-EXP-002	How much does wall thickness affect port geometry? clay body	material, wall thickness	port geometry	sample; tap	identify thickness range	good window with time
VF-EXP-003	Can different shapes with same volume affect response? clay body	material, volume, shape	response	pitch; tone color; response threshold	but timbre reasonably different	for production.
VF-EXP-004	Can water fill create consistent volume and tilt angle? water	material, volume, tilt angle	water volume and tilt angle	pitch sweep; leak behavior	simple, repeatable bend	design for leak-safe plug.
VF-EXP-005	Can a replaceable fipple channel? clay body	material, geometry	response threshold; pitch	stability, response reliability	create solid prototype	and tolerance test
VF-EXP-006	Can a drone chamber shape affect response? clay body	material, volume/port area	two-note stability; beating	stability, tone	without change	to copyed-resonator model.

family-spec.csv

Project artifact.

member_id	name	target_note	target_hz	volume_cc	voicing_area	waist_cm	estimated_neck	material_path	status
VF-130-A4	Ocarina lab body	A4	440.00	130	0.45	0.40	0.63	hand-built clay or slip-cast	isolate type body
VF-95-C5	Small vessel response	close body	523.25	95	0.35	0.35	0.55	hand-built clay	after VF-130
VF-180-G4	Large warm vessel	close body	392.00	180	0.55	0.45	0.70	slab or slip-cast	slab shrinkage data

jig-decision.md

Project artifact.

Jig Decision

| Operation | Jig choice | Reason | Release check |

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

| Volume measurement | Graduated fill setup | Directly measures governing variable | Repeat fill within 2 cc |

| Voicing cut | Coupon-first hand guide | Voicing is empirical and fragile | Coupon speaks before body cut |

| Hole drilling | Hand drill with area gauge | Allows gradual hole enlargement | Final diameter recorded after tuning |

| Shrinkage test | Test-tile board | Couples every firing to a measured shrinkage row | Tile dimensions logged before/after |

| Mold planning | Split-line sketch only at L2 | Mold is premature before shrinkage data | Promote after prototype validation |

mold-workflow.md

Project artifact.

Vessel Flute Mold Workflow

CAD First Principles

- Model the **inside air volume** intentionally, not just the exterior sculpture.
- Keep a named chamber-volume parameter or a repeatable CAD volume report.
- Avoid true undercuts unless using a multi-part mold.
- Add shrinkage compensation as a configurable scale factor.
- Design the split line before falling in love with the outside form.
- Put fipple and hole features in locations that can be cleaned, measured, and tuned.

Master Print

1. Print at high enough resolution that fipple and port areas are not stair-stepped.
2. Sand and seal the master completely.
3. Measure master dimensions and compare with CAD.
4. Mark split line, datums, and build ID.

Plaster Mold

1. Choose 2-piece mold for simple pods and 3-piece mold for forms with more dramatic shoulders.
2. Use registration keys that release cleanly and do not create stress risers.
3. Keep plaster thick enough for strength but not so massive that drying takes forever.
4. Dry the mold fully before judging casting performance.

Casting Controls

- Record slip batch.
- Record pour time, drain time, room temperature, and humidity if available.
- Measure wall thickness from a sacrificial rim or test coupon.
- Use the same drain orientation for each comparison build.

Fipple Strategy Options

| Strategy | Pros | Cons | Use for |

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

| Molded fipple | Repeatable once solved | Hard to release and clean | Later production |

| Hand-cut fipple | Fast iteration | More variable | First prototypes |

| Insert/cartridge | Easy A/B testing | Adds fit tolerance problem | Physics experiments |

| Printed sacrificial guide | Helps locate cuts | Must be removed cleanly | Early mold learning |

Mold-Release Design Rules

- Organic outside forms are fine if every mold segment has a pull direction.
- Texture should be shallow until the release behavior is proven.
- Avoid thin raised details near the mouthpiece, hole edges, and split line.
- Keep the first prototype simpler than the final sculpture; prove tone first, then make it wild.

photo-shotlist.md

Project artifact.

Photo Shotlist

- Hero image of completed instrument or honest concept placeholder.
- Scale reference with ruler/calipers.
- Material blank before cutting.
- Key operations and jigs.
- Detail shots of acoustic features.
- Final validation setup.

resources.md

Project artifact.

Resources

Engineering References To Gather Before L3

- Measured ocarina or vessel-flute cavity volumes and voicing dimensions.
- Ceramic body shrinkage data for the exact clay and firing schedule.
- Finger-hole area calculation references and measured correction curves.
- Photos or drawings of voicing geometry with reuse permission.

Existing Local Context

- ``docs/ceramic-vessel-lab/`` contains previous ceramic vessel-lab notes that should be preserved as design history.
- ``concept-matrix.csv`` and ``experiments.csv`` remain useful intake artifacts.
- ``mold-workflow.md`` is the right place to promote measured shrinkage into the slip-casting path.

Related Repos

- ``tonykoop/ocarina`` for single-instrument Helmholtz packet style.
- ``tonykoop/gemshorn`` for slip-cast vessel-flute family handling.
- ``tonykoop/udu`` for ceramic cavity-volume measurement discipline.
- ``tonykoop/instrument-maker`` for formulas and validation scripts.

review-evidence.md

Project artifact.

Review Evidence

Refs #1.

Round 3 Scope

- Added an L2 root-mode build packet scaffold and hand-tuned it for vessel-flute specifics: Helmholtz cavity volume, effective hole area, voicing response, ceramic shrinkage, mold timing, and ocarina-style prototype validation.
- Existing ceramic vessel-lab notes were preserved under `docs`.
- This packet does not claim L3/build-ready status.

Gates Before Close

- Measure wet/dry/fired cavity volume and shrinkage.
- Record first-sound behavior, cumulative hole areas, tuned cents error, and leak checks in `validation.csv`.
- Promote slip-cast mold work only after the lab body validates.

risks.md

Project artifact.

Risks

| ID | Category | Risk | Verification test | Mitigation |

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

| VF-AC-01 | Acoustic | Pipe-flute length logic is accidentally applied to a vessel flute | Design review checks Helmholtz area/volume formula | Keep hole-area table visible in packet |

| VF-AC-02 | Acoustic | Voicing does not speak cleanly | First-sound test before tuning holes | Adjust window/labium on coupon first |

| VF-ST-01 | Structural | Clay shrinks or warps enough to invalidate holes | Test-tile shrinkage and post-fire volume | Do not cut mold before shrinkage data |

| VF-ER-01 | Ergonomic | Holes tune correctly but are not coverable | Paper hand-layout and clay mock grip | Favor four-hole pentatonic starter |

| VF-SU-01 | Supply | Clay body changes shrinkage or porosity | Record supplier/body name and firing cone | Keep test tiles with every material batch |

| VF-FI-01 | Fit/finish | Surface leaks shift pitch | Water/air leak test | Seal proof body before evaluating tuning |