Ceramic Hang Capstone

Instrument-Maker Print Packet

Build packet folder: /mnt/c/Users/Tony/Documents/GitHub/ceramic-hang

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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.
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.

Ceramic Hang Design

Design Intent

Design a slip-cast ceramic, handpan-inspired tonal vessel that explores raised/isolated ceramic tone fields on a shallow resonant shell. The project is a research instrument first: the goal is to learn whether molded ceramic tone fields can produce musically useful fundamentals and partials after firing, and what clay body, wall thickness, tone-field geometry, and firing schedule make that repeatable.

The visual target is an approachable 18 inch handpan-like form, but the engineering target is more careful: a ceramic tonal vessel whose final design may diverge from steel handpans if the material asks for a different geometry.

Governing Model

This instrument is governed by coupled plate/shell vibration plus Helmholtz body resonance.

tone_field_f1 ~= (kappa / (2*pi)) * (h / a^2) * sqrt(E / (rho * (1 - nu^2)))

Where `h` is local tone-field thickness, `a` is effective field radius, `E` is Young's modulus, `rho` is density, `nu` is Poisson ratio, and `kappa` is an empirical boundary/shape coefficient. For ceramic this equation is a sanity check, not a final predictor.

f_gu = c/(2*pi) * sqrt(A_gu / (V_shell * L_eff_gu))

L_eff_gu = wall + 0.6 * sqrt(A_gu/pi)

The gu/port resonance should be measured as a coupled body mode. It may support warmth and sustain, but it will not tune the tone fields the way hammered steel tuning does.

Design Targets

| Parameter | Target | Status |

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

| Outer diameter | 18 in | design target |

| Overall height | 4.5 in | design target |

| Fired wall thickness | 0.22-0.30 in | experiment range |

| Clay shrinkage | 12 percent | assumption until measured |

| Shell volume | 600-850 in3 | derived estimate |

| Gu diameter | 3.5 in | first prototype |

| Clay body | Cone 6 stoneware or porcelain casting slip | TBD |

| Finish | Exterior-only glaze or burnished/oxide surface | TBD |

| Primary key | G minor 9-note layout | assumption |

Target Note Layout

| Field | Note | Target Hz | Function | First geometry assumption |

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

| Ding | G3 | 196.00 | center fundamental | 4.0 in raised oval/circle |

| T1 | Bb3 | 233.08 | low outer field | 3.4 in oval |

| T2 | C4 | 261.63 | outer field | 3.2 in oval |

| T3 | D4 | 293.66 | outer field | 3.0 in oval |

| T4 | F4 | 349.23 | outer field | 2.75 in oval |

| T5 | G4 | 392.00 | outer field | 2.55 in oval |

| T6 | Bb4 | 466.16 | outer field | 2.35 in oval |

| T7 | C5 | 523.25 | outer field | 2.20 in oval |

| T8 | D5 | 587.33 | outer field | 2.05 in oval |

The note layout is intentionally marked as an assumption. Ceramic fields may prefer fewer larger notes, different intervals, or a tongue/slit hybrid if isolated plate fields do not ring cleanly.

Manufacturing Strategy

Use a slip-cast two-shell body:

1. CAD an upper dome with raised tone-field islands and a lower shell with gu port.
2. 3D print master positives oversized by measured clay shrinkage.
3. Make plaster molds with clean registration and no trapped undercuts.
4. Slip cast upper and lower shells separately.
5. Join at leather-hard stage with a reinforced rim/luting band.
6. Bisque fire before any glaze commitment.
7. Measure tone fields, body modes, gu resonance, cracks, and distortion.
8. Iterate field thickness, island geometry, and clay body before decorative finishing.

Prototype Ladder

| Prototype | Goal | Success criteria |

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

| CHG-P0 tone coupon | Test isolated ceramic field shapes | At least one coupon rings with a clear decay and measurable pitch |

| CHG-P1 mini dome | Test 3 tone fields on a small shell | No cracks; pitch trend follows field size/thickness |

| CHG-P2 18 in blank | Test full shell casting, gu, seam, and body mode | Shell survives drying/bisque and gu resonance is measurable |

| CHG-P3 5-note vessel | First musical layout | Five fields within +/-75 cents after bisque or clear correction path |

| CHG-P4 9-note G minor | Full concept | Playable hand pattern, stable fields, acceptable sustain |

Empirical Questions

- What clay body gives the longest decay without excessive fragility?
- Do raised tone fields, thinned tone fields, or cut/relief-bounded fields speak best?
- Does glaze damp the fields too much?
- Can tone fields be tuned at greenware/leather-hard stage accurately enough to survive firing?
- Is a 9-note layout realistic in ceramic, or should the first product be 5-7 notes?
- Should the final instrument become a ceramic tongue-handpan hybrid instead of a pure tone-field shell?

Assumptions And Unknowns

- Elastic properties are derived estimates until test bars are fired and measured.
- No empirical ceramic handpan correction data exists yet in this repo.
- The screenshot reference is visual inspiration only; no supplier dimensions or pricing are used as source data.
- Final tuning may require new mold masters rather than post-fire correction.
- Structural safety matters: the instrument must survive hand strikes, thermal gradients, and transport.

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
CHG-BOM-001	Clay	Cone 6 casting slip	5 gal	Stoneware or porcelain	Buy	derived estimate	$40-80	CHG-DRW-001	Choose one clay body for the f
CHG-BOM-002	Mold	#1 pottery plaster	75 lb	Absorbent pottery plaster	Buy	derived estimate	$50-90	CHG-DRW-002	Large dome molds will consum
CHG-BOM-003	Master	3D printed upper shell master	1	Oversized by measured shrinkage	Make	derived estimate	$60-200	CHG-DRW-003	Segmented print acceptable if
CHG-BOM-004	Master	3D printed lower shell master	1	Oversized by measured shrinkage	Make	derived estimate	$60-150	CHG-DRW-004	Lower shell can be simpler tha
CHG-BOM-005	Fixture	Drying support cradle	1	Breathable foam or plaster cradle	Make	derived estimate	$10-40	CHG-DRW-005	Prevents dome sagging and ri
CHG-BOM-006	Fixture	Firing setter or support ring	1	Kiln-safe support shelf	Make/Buy	derived estimate	$20-120	CHG-DRW-006	Must not fuse to body or block
CHG-BOM-007	Tools	Diamond files and burrs	1 set	Fine diamond abrasive tools	Buy	derived estimate	$15-40	CHG-VAL-001	For cautious post-bisque edge
CHG-BOM-008	Measurement	Tuner and microphone	1	Cent-accurate tuner plus recording device	Buy	derived estimate	$0-150	CHG-VAL-002	Use same setup across prototy
CHG-BOM-009	Measurement	Scale and calipers	1 set	Mass and dimensional tracking	Buy	derived estimate	$0-80	CHG-VAL-003	Mass change helps track glaze
CHG-BOM-010	Finish	Exterior glaze or underglaze wash	1 batch	Cone-compatible finish	Buy	derived estimate	$15-60	CHG-DRW-007	Test glaze damping on coupon
CHG-BOM-011	Protection	Rim wrap or bumper	1	Leather/rope/silicone/wax protection	Buy/Make	derived estimate	$10-75	CHG-DRW-008	Protects fragile rim and improv
CHG-BOM-012	Transport	Padded bag/case	1	18-20 in protective case	Buy	derived estimate	$40-180	CHG-DRW-009	Ceramic transport risk is high.

sourcing.csv

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

item_id	item	required_spec	search_terms	supplier_candidates	date_checked	unit_price	lead_time	substitution_rule	risk_note
CHG-SRC-001	Cone 6 casting slip	Known shrinkage and mature Cone 6 firing schedule	cone 6 stoneware porcelain casting slip shrinkage	TBD				Substitute only after test bars	Unknown shrinkage invalidates
CHG-SRC-002	#1 pottery plaster	Pottery mold plaster in bulk quantity	USG #1 pottery plaster 75 lb	TBD				Equivalent plaster acceptable if [illegible]	Wrong plaster can ruin [illegible]
CHG-SRC-003	Large 3D print service	18 in dome master [illegible]	large format PLA print service mold master	TBD				Segmented print acceptable with sealed seams	[illegible]
CHG-SRC-004	Refractory support material	Kiln-safe setter/support ring	kiln furniture refractory support ring ceramic firing	TBD				Use known kiln-safe material only	Body can slump or stick during
CHG-SRC-005	Diamond abrasives	Fine diamond tools for ceramic cleanup	diamond [illegible] file ceramic	TBD				Use fine grits and light pressure	Coarse grinding can chip tone
CHG-SRC-006	Recording microphone	Repeatable measurement	measurement microphone tuner musical instrument	TBD				Phone mic acceptable for first pass	Inconsistent measurement hid
CHG-SRC-007	Rim protection	Soft durable bumper or wrap	handpan rim [illegible] 18 leather bumper silicone edge guard	TBD				Prototype with removable wrap first	Rim protection may damp shel
CHG-SRC-008	Transport case	Padded 18-20 in case	18 inch handpan padded bag hard case	TBD				Oversize case acceptable	Transport damage is a major c

cut-list.csv

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

item_id	part	qty	rough_dimensions_in	final_dimensions_in	material	operation	fixture_or_tool	yield_note	notes
CHG-CUT-001	Upper master print segments	1 set	20 x 20 x 5 envelope	18 in fired-equivalent dome scaled for shrinkage	PLA or resin	3D print and seal	Printer or print service	Segment if printer is smaller than master	Do not treat printed geometry a
CHG-CUT-002	Lower master print segments	1 set	20 x 20 x 3 envelope	18 in fired-equivalent lower shell scaled for shrinkage	PLA or resin	3D print and seal	Printer or print service	Segment if needed	Include gu reference and rim r
CHG-CUT-003	Upper plaster mold	1	24 x 24 x 8 cottle	Upper dome mold with registration	#1 pottery plaster	Mold pour	Cottle boards	Single-use setup until mold design proven	Plan parting line before printing
CHG-CUT-004	Lower plaster mold	1	24 x 24 x 6 cottle	Lower shell mold with gu area	#1 pottery plaster	Mold pour	Cottle boards	Single-use setup until mold design proven	Keep [illegible] for fi
CHG-CUT-005	Drying cradle	1	20 x 20 x 5	Support upper shell without point loads	Foam/plaster/soft [illegible]	Cut/form	Knife/saw/rasp	Reusable	Must not trap moisture at rim.
CHG-CUT-006	Firing support ring	1	18-20 OD	Support shell rim or neutral zone	Refractory clay/fiber/kiln furniture	Form/cut	Kiln-safe tools	Reusable if it survives	Test with scrap before full shel
CHG-CUT-007	Tone coupons	12	4 x 4 x variable thickness	3-4 in test fields	Casting slip or slab clay	Cast/press small coupons	Simple plaster tiles	Many small tests better than one large failed shell	Label every coupon with clay/b

drawing-brief.md

Manufacturing drawing and technical product sketch brief.

Ceramic Hang Drawing Brief

Required Views

• Top view with center ding, outer tone-field layout, note labels, field axes, and radial datum.

• Side section through center showing upper dome, lower shell, rim seam, wall thickness, and gu.

• Tone-field detail showing raised/thinned field geometry, relief boundary, thickness target, and strike zone.

• Bottom view showing gu diameter, lower shell curvature, support/rim datum, and optional feet or stand interface.

• Mold split view showing upper mold, lower mold, registration, cottle clearance, and release directions.

• Firing support view showing setter/ring contact areas and shrinkage clearance.

Critical Dimensions

| Dimension | Why It Matters |

| --- | --- |

| Outer diameter | Ergonomics, mold size, shell volume |

| Dome height | Body volume and shell stiffness |

| Wall thickness | Tone, durability, drying risk |

| Tone-field major/minor axes | Primary pitch lever |

| Tone-field thickness | Primary pitch lever |

| Relief boundary depth/radius | Field isolation and crack risk |

| Gu diameter and wall | Helmholtz/body coupling |

| Rim seam width | Strength and joining repeatability |

| Master scale factor | Fired final geometry |

CAD Notes

• Mark all values as fired dimensions or master dimensions.

• Keep tone-field geometry as named parameters.

• Add build ID and CAD revision to every drawing.

• Do not hide the `TBD` status of ceramic material constants.

• Include a validation table once measured data exists.

assembly-manual.md

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

Ceramic Hang Assembly Manual

Scope

This manual covers the first ceramic handpan-inspired tonal vessel prototypes. It assumes the instrument is slip-cast from upper and lower shell molds and validated as a research build before decorative finishing.

Tools And Setup

• CAD model for upper shell, lower shell, tone-field islands, gu, rim, and mold split.

• Large-format 3D printer or outsourced print service.

• Plaster mold-making setup: cottle boards, scale, bucket, plaster, mold release, clamps.

• Cone 6 casting slip and known firing schedule.

• Drying cradle and firing support ring.

• Calipers, scale, tuner, microphone, recording app, and spreadsheet/validation log.

• Diamond files/burrs for minimal cleanup.

• Kiln access.

Process

1. **Make shrinkage bars**

- Cast or form test bars from the actual clay body.

- Fire through the intended bisque and glaze schedule.

- Replace the assumed 12 percent shrinkage with measured data before final master printing.

2. **Build tone coupons**

- Make small raised/thinned field coupons before a full shell.

- Vary thickness, field diameter, relief depth, and clay body.

- Record pitch, decay, cracking, and perceived strike feel.

3. **Model the first shell**

- Model the fired target geometry first.

- Apply `master_scale_factor = 1/(1 - shrinkage)`.

- Keep the first upper shell conservative: fewer undercuts, larger radii, and enough wall thickness to survive handling.

4. **Print and seal masters**

- Print upper and lower shell masters or segments.
- Fill segment seams, sand, and seal.
- Mark centerline, tone-field index, rim datum, and gu center.

5. **Make plaster molds**

- Build cottle boxes with enough plaster thickness for a large dome.
- Include registration and mold handling features.
- Dry molds fully before slip casting.

6. **Slip cast shells**

- Cast upper and lower shells separately.
- Record slip batch, pour time, drain time, demold time, room condition, and measured wall thickness.
- Support shells in a cradle as they stiffen.

7. **Join and refine**

- Join upper/lower shells at leather-hard stage.
- Smooth seam and rim.
- Keep post-join tone-field carving minimal and documented.

8. **Dry slowly**

- Dry under plastic with frequent inspection.
- Watch tone-field edges, gu, rim seam, and support contact points.

9. **Bisque fire and measure**

- Fire to the clay body's recommended bisque schedule.
- Measure every tone field and the gu/body resonance before glazing.
- Decide whether to continue, revise the mold, or return to coupons.

10. **Finish test**

- Test glaze or oxide on coupons before the full body.
- If glazing the full shell, leave tone-field strike zones and acoustic edges as controlled test variables.

11. **Final validation**

- Record pitch, cents error, decay time, body mode, gu response, crack status, and playability.
- Feed results back into the next design table revision.

Shop Notes

- Do not chase final tuning on the first shell. The first shell is a measurement object.
- Never grind aggressively on fired tone fields.
- Add a protective rim strategy early; ceramic rims are vulnerable.
- Treat transport as a design requirement, not an afterthought.

validation.csv

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

build_id	stage	date	clay_body	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	action	result	notes
CHG-P0	bisque		TBD	12	1.136	coupon_A	C4	392	TBD	TBD	TBD				none			Measure coupon before committing fu		
CHG-P0	bisque		TBD	12	1.136	coupon_B	C5	523.25	TBD	TBD	TBD				none			Compare thickness sweep		
CHG-P1	greenware		TBD	12	1.136	T1	Bb3	233.08	3.4	TBD	TBD				none			Check drying distortion		
CHG-P1	bisque		TBD	12	1.136	T1	Bb3	233.08	3.4	TBD	TBD				TBD			First shell tone-field measurement		
CHG-P2	bisque		TBD	12	1.136	Ding	G3	196	4.0	TBD	TBD				TBD	TBD	TBD	Measure center ding and gu coupling		
CHG-P2	bisque		TBD	12	1.136	Gu	TBD	TBD	TBD	TBD	TBD				TBD	TBD	TBD	Tap/blow gu and record body mode		
CHG-P3	glaze_fire		TBD	12	1.136	TBD	TBD	TBD	TBD	TBD	TBD				TBD	TBD	TBD	Compare glaze shift and damping		

supplier-rfq.md

Supplier email/request-for-quote starter.

Supplier RFQ - Ceramic Hang

Subject: RFQ - materials and services for slip-cast ceramic tonal vessel prototype

Hello,

I am prototyping an 18 inch slip-cast ceramic tonal vessel and need pricing/lead time for the following items or services:

- Cone 6 stoneware or porcelain casting slip with published shrinkage and firing schedule.
- #1 pottery plaster or equivalent pottery mold plaster, 75 lb class quantity.
- Optional large-format 3D print service for an 18-20 inch dome master, or segmented master parts.
- Kiln-safe refractory support material or custom setter/ring options.
- Optional padded case suitable for a fragile 18 inch ceramic handpan-style object.

Please include:

- Unit price and quantity breaks.
- Current availability and lead time.
- Shipping estimate to Santa Clara, CA.
- Technical data sheet or material specification.
- Recommended substitutes if the exact item is unavailable.

Notes:

- Shrinkage and firing schedule are critical.
- The first run is prototype/research scale, not production volume.
- If substitutions are proposed, please include material compatibility and firing temperature notes.

Thank you,

Tony Koop

visual-bom-brief.md

Art direction for an image-forward visual BOM.

Ceramic Hang Visual BOM Brief

Goal

Create an image-forward one-page visual BOM that explains the ceramic handpan workflow at a glance: digital master, plaster mold, cast shells, tone fields, support fixtures, finishing, and measurement tools.

Layout

• Header: "Ceramic Hang - Slip-Cast Tonal Vessel Research Build".

• Hero image: CAD/render or finished prototype clearly labeled as concept/prototype.

• Process strip: tone coupons -> master print -> plaster molds -> greenware shell -> bisque measurement -> final finish.

• BOM table: item number, material/tool, quantity, spec, make/buy, cost/date status, image.

• Physics inset: plate/tone-field model plus gu Helmholtz model.

• Validation inset: field ID, target note, measured pitch, decay, crack status.

Required Images

• Upper shell CAD/render.

• Lower shell/gu CAD/render.

• Tone coupon test set.

• Mold halves.

• Greenware shell in drying cradle.

• Firing support/ring.

• Measurement setup with mic/tuner.

• Finished or bisque prototype.

Generated images or CAD renders should be marked as placeholders until replaced by shop photos.

wolfram-starter.wl

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

```
(* Ceramic Hang first-order physics starter *)

ClearAll["Global`*"];

(* Units: SI inside formulas unless noted. *)
c = 343; (* m/s *)

(* Ceramic material placeholders. Replace with measured test-bar data. *)
Eceramic = 45*10^9; (* Pa, derived estimate *)
rhoCeramic = 2200; (* kg/m^3, derived estimate *)
nuCeramic = 0.23; (* Poisson ratio estimate *)
kappaDisk = 10.2; (* boundary/shape coefficient estimate *)

plateHz[h_, a_, E_, rho_, nu_, kappa_] :=
(kappa/(2*Pi))*(h/a^2)*Sqrt[E/(rho*(1 - nu^2))];

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

centsError[measured_, target_] := 1200*Log[2, measured/target];
targetFreq[midi_] := 440*2^((midi - 69)/12);

(* G minor 9-note target layout. *)
notes = {
{"Ding", "G3", 196.00, 0.1016},
{"T1", "Bb3", 233.08, 0.0864},
{"T2", "C4", 261.63, 0.0813},
{"T3", "D4", 293.66, 0.0762},
{"T4", "F4", 349.23, 0.0699},
{"T5", "G4", 392.00, 0.0648},
{"T6", "Bb4", 466.16, 0.0597},
{"T7", "C5", 523.25, 0.0559},
{"T8", "D5", 587.33, 0.0521}
};

(* Solve rough thickness for each field using the first-order plate model. *)
roughThickness[targetHz_, radiusM_] :=
```

```
targetHz*(2*Pi)/kappaDisk*radiusM^2/Sqrt[Eceramic/(rhoCeramic*(1 - nuCeramic^2))];

thicknessTable = Table[
{id, note, hz, radius, roughThickness[hz, radius]},
{ {id, note, hz, radius}, notes}
];

thicknessTable // TableForm

(* Gu estimate, using a 3.5 in port and rough 700 in^3 body volume. *)
inch = 0.0254;
guDiameter = 3.5*inch;
wall = 0.25*inch;
bodyVolume = 700*inch^3;
guArea = Pi*(guDiameter/2)^2;
guLeff = wall + 0.6*Sqrt[guArea/Pi];
guHz = helmholtzHz[guArea, bodyVolume, guLeff];

guHz
```

README.md

Project artifact.

Ceramic Hang

Slip-cast ceramic handpan-inspired tonal vessel: a research build for exploring whether a fired ceramic shell can produce playable handpan-like tone fields while retaining the sculptural freedom of 3D printed mold masters.

This is not a conventional steel handpan clone. Steel handpans rely on plastic forming, hammer tuning, and elastic plate behavior. Ceramic is brittle, damped, formulation-dependent, and mostly tunes before firing. This repo treats the idea honestly: first as an empirical acoustic study, then as a buildable instrument family if the test coupons speak.

Start Here

• design.md - design intent, governing model, target G minor layout, assumptions, prototype ladder.

• Ceramic-Hang-Design.xlsx - parametric design table for shell geometry, gu resonance, tone-field targets, and validation inputs.

• [bom.csv](bom.csv) - bill of materials.

• sourcing.csv - supplier/search tracker with date-check fields.

• cut-list.csv - print, mold, fixture, and ceramic blank preparation list.

• assembly-manual.md - shop workflow from CAD master through fired validation.

• validation.csv - measurement log for tone fields, shell/gu coupling, shrinkage, and cracking.

• risks.md - red-team risk register with verification tests.

• drawing-brief.md - drawing/CAD requirements and critical dimensions.

• visual-bom-brief.md - image-forward documentation plan.

• wolfram-starter.wl - first-order plate + Helmholtz model starter.

• cad/ceramic_hang_master.scad - OpenSCAD starter for shell/mold concept geometry.

Concept

The first serious target is an 18 inch ceramic tonal vessel in a G minor 9-note layout:

• Center ding: G3.

• Outer tone-field targets: Bb3, C4, D4, F4, G4, Bb4, C5, D5.

• Bottom gu port: tuned near the low-body resonance, not used as a primary melodic note.

• Clay target: Cone 6 stoneware or porcelain casting slip, measured shrinkage required.

• Manufacturing path: 3D printed master -> plaster mold -> slip-cast upper/lower shells -> bisque test -> glaze strategy -> final validation.

Development Rule

Every prototype gets a build ID and a measured record. Ceramic handpan work will only become predictable if the measured data loops back into the next mold, thickness, tone-field, and firing choices.

Related Repos

- [handpan](../handpan) - conventional handpan design table placeholder.
- [ceramic-tongue-drum](../ceramic-tongue-drum) - ceramic idiophone research neighbor.
- [udu](../udu) - slip-cast ceramic vessel and dual Helmholtz reference.
- [tongue-drum](../tongue-drum) - idiophone documentation done bar.

License

[MIT](LICENSE) - see LICENSE for details.

family-spec.csv

Project artifact.

member_id	name	outer_diameter_in	height_in	target_key	note_count	wall_target_in	gu_diameter_in	prototype_goa
CHG-P1	Mini 3-field coupon dome	10	2.75	G minor subset	3	0.24	2.0	Validate tone-field geometry on a
CHG-P2	Full blank body	18	4.5	None	0	0.26	3.5	Validate casting/drying/firing and
CHG-P3	Five-note vessel	18	4.5	G minor pentatonic	5	0.24	3.5	First musical ceramic shell.
CHG-P4	Nine-note G minor	18	4.5	G minor	9	0.22-0.30	3.5	Full handpan-inspired target.

photo-shotlist.md

Project artifact.

Ceramic Hang Photo Shotlist

Purpose

Capture enough photos to support the README, capstone deck, visual BOM, print packet, and build-log site.

Shot List

Shot	Stage	Required Content	Notes
Hero concept	CAD/prototype	Full instrument on neutral background	Label render/prototype status.
Tone coupons	P0	Array of test fields with labels	Include ruler/calipers.
Master print	CAD/print	Upper and lower master or print segments	Show scale.
Mold making	Plaster	Cottle, plaster pour, registration	Useful for makerspace documentation.
Greenware upper shell	Casting	Tone fields visible in drying cradle	Capture support method.
Lower shell/gu	Casting	Bottom port and rim seam	Show gu diameter reference.
Bisque measurement	Validation	Mic/tuner setup and field strike	Keep same setup for comparison.
Rim/protection	Fit	Bumper/wrap or stand contact	Important for real-world durability.
Final detail	Finish	Tone-field close-ups	Show surface finish and strike zones.

risks.md

Project artifact.

Ceramic Hang Risks

| Risk ID | Category | Risk | Verification Test | Mitigation |

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

| CHG-RISK-001 | Acoustic | Ceramic tone fields may not sustain like steel handpan fields. | Fire tone coupons and record decay time for at least 12 field geometries. | Pivot to fewer larger fields, a tongue/relief hybrid, or ceramic resonator with metal tone fields. |

| CHG-RISK-002 | Acoustic | First-order plate formulas may miss fired pitch by large margins. | Compare predicted vs measured frequency on coupons and first mini dome. | Build empirical correction table before full 9-note shell. |

| CHG-RISK-003 | Structural | Raised/thinned tone fields may crack during drying or firing. | Inspect coupon and P1/P2 fields at greenware, bone dry, bisque, and glaze stages. | Increase radii, reduce relief depth, slow drying, change clay body. |

| CHG-RISK-004 | Structural | Large slip-cast dome may slump or warp. | Fire a blank dome on proposed setter before tone-field body. | Add support ring, revise dome height, change firing schedule. |

| CHG-RISK-005 | Ergonomic | Ceramic body may be too heavy or fragile for lap playing. | Weigh P2 shell and test seated/stand support with non-playing handling. | Use stand/cradle, reduce wall thickness, design protected rim. |

| CHG-RISK-006 | Finish | Glaze may damp tone fields or change pitch. | Glaze matched coupons and compare before/after decay/pitch. | Use exterior-only, oxide wash, burnish, or unglazed tone zones. |

| CHG-RISK-007 | Supply | Clay body shrinkage may differ from assumption. | Fire shrinkage bars before printing final master. | Update design table and master scale factor. |

| CHG-RISK-008 | Fit/Finish | Post-fire grinding may chip tone fields. | Test diamond tool cleanup on scrap fired coupons. | Tune in greenware/bisque stage; avoid aggressive fired correction. |

| CHG-RISK-009 | Transport | Finished ceramic shell may break in normal handling. | Drop/handling tests only on failed/scrap shells; case fit check. | Design rim bumper and hard/padded transport case. |