Slow Bloom — Design Report

A yard-scale kinetic wind sculpture: design, priced parts list and build plan

Project: Wind Sculpture Design | **Company:** ndyinc, via Paperclip
Designed by: the Wind Sculpture Agent, a Hermes employee (issue NDY-3)
Decisions by: Mike Currington, 2026-11-01
**STATUS: DESIGN APPROVED - NOTHING ORDERED, CUT, WELDED OR PAID FOR
Bill of materials: 36 lines, $2,396.48 - one line, the sealed main ring, is an unpriced allowance

Slow Bloom — concept sheet

Status: APPROVED 2026-11-01 — Mike's five decisions are applied in this revision. NOTHING IS ORDERED AND NOTHING IS CUT. The bill of materials is updated to the parts he chose; the structural check comes before any metal is cut and it is a licensed engineer's job — the package that check needs is `docs/slow-bloom-structural-brief.md`.

Direction chosen by Mike on 2026-11-01 from `docs/concepts.md`. Issues: NDY-2 (concept sheet), NDY-3 (decisions applied). Prices read 2026-11-01. Machine-readable bill of materials: `docs/slow-bloom-bom.json`, checked by `scripts/slow_bloom_bom.py`. Structural inputs: `output/slow-bloom-load-inputs.json`, checked by `scripts/slow_bloom_loads.py` (see *Verification* at the end).

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1. What it is

A single dark stem rises out of the lawn and carries one long arm. On the arm, five shallow stainless bowls — each cut in half and re-set on opposite sides of its own little axle — turn at their own speeds in the wind, so the arm looks like a flowering branch stopped mid-swing. The arm swings to face the wind, leans a few degrees into a gust and eases back, and the five blooms spin. Nothing hangs. Nothing is powered. Nothing is asked to do anything but turn.

The whole piece is one stalk, one arm, five blooms, three motions. That restraint is the design.

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2. Form

2.1 The scale, in numbers

Overall height	about 11 ft 6 in
Overall reach from the mast	about 12 ft 4 in
Mast	4 in Schedule 40 pipe, 7 ft 6 in clear above grade
Boom	12 ft long, 2 ft 2-1/2 in OD tube, balanced on its pivot 4 ft from the butt
Blooms	5, each 13-1/4 in across and 4 in deep
Bloom centres along the boom	6 ft 0 in, 7 ft 5 in, 8 ft 10 in, 10 ft 2 in, 11 ft 7 in from the butt
Bloom centres above the boom	42, 36, 30, 24, 18 in, inner bloom highest, tip bloom lowest
Weight, moving parts	about 155 lb, of which 50 lb is the counterweight — itemised in the structural brief
Weight, fixed	about 128 lb (mast 81 lb, base plate and gussets 39 lb, fixed head plate and drip hat 7 lb)
Footprint	one 12 in diameter pier, 2 in proud of grade
Design wind	115 mph, 3-second gust, Exposure C (Grand County) — no structural check has been done

The bloom centres wander rather than line up; no two are at the same height or the same distance out. That is deliberate — it is what makes the cluster read as a flower rather than a row of cups on a fence.

2.2 The stem

The mast is a plain 4 in pipe, painted the same dark colour as the arm and left unadorned. It should read as a stem seen from the side, not as a post. It is 7 ft 6 in high, which puts the whole mechanism — the ring, the yoke, the counterweight — above eye level: you look at the piece from underneath, at the blooms, and the machinery

stays out of the picture.

The foot is one 12 in diameter concrete pier, **36 in below finished grade** (the frost depth in Grand County's adopted code — see the reference sheet) **plus the 2 in that stands proud**, so 38 in of form and pour in total; the concrete is brushed and left plain. A 12 in square, 3/4 in thick steel base plate is welded to the bottom of the mast with four triangular gussets and held to the pier with four 3/4 in screw anchors. From three feet away the foot is a plate on a disc of concrete, and that is all it should be.

Correction made in this revision: the earlier draft cut the 4 ft form tube down to 3 ft and then struck the top 2 in proud, which leaves only 34 in of pier in the ground — 2 in short of the 36 in the adopted code requires. The tube is now cut to 38 in. Whether 36 in of 12 in diameter pier is *enough* is a different question and it belongs to a licensed engineer; see `docs/slow-bloom-structural-brief.md`.

2.3 The arm

The boom is 12 ft of 2-1/2 in tube. It is **straight** — the taper in the silhouette comes from what is mounted on it, not from the tube: the blooms crowd the outboard end, their stalks get shorter toward the tip, and the 50 lb counterweight hangs on the inboard 4 ft. The eye reads a tapering branch; the metal is a straight tube, which is cheaper, stiffer and honest.

The pivot is 4 ft from the butt, so the arm is 4 ft one way and 8 ft the other. The butt carries a short 1 in stub welded in line with the tube, with two 25 lb cast-iron plates slid onto it as the counterweight. Sliding them sets the balance; a shaft collar locks them. The intent is a boom that sits very slightly bloom-heavy, so the springs (below) are always just preloaded.

2.4 The blooms

Each bloom starts as one 13-1/4 in spun stainless bowl, 4 in deep — the **thin 0.4 mm** 8 qt bowl, confirmed by Mike on 2026-11-01 as the chosen gauge: motion over toughness. It will dent. At $17.29 each that is the trade he accepted and it is not re-argued here. It is **cut in half on its diameter**, and the two halves are re-mounted on opposite sides of the bloom's own vertical axle: convex sides out, cut edges facing each other, each half pushed 1-1/2 in off the axis in opposite directions, with about 1-1/4 in of clear space between them.

That offset is the whole mechanism. Two offset shallow lobes on a vertical axle are a drag rotor — a Savonius-type machine — which starts turning from rest in a light breeze instead of needing a threshold of wind like a propeller does. It is a slow, high-torque, inefficient machine by nature, and slow is what this piece wants. The blade research on the reference sheet puts a Savonius drive's power coefficient at 0.15–0.25 and its tip-speed ratio near 1 — a garden Savonius is a slow-turning, high-torque device, which is exactly the motion called for.

The two halves are the petals: from the ground you see two bright curved crescents with a clear eye through the middle, turning. The bowl's inside faces are painted a flat contrasting colour to the outsides, so the bloom flickers dark-light as it turns — the same dodge the Wind Curtain direction used, reduced to two faces instead of hundreds.

2.5 Surface and colour — decided

Colours (Mike's decision 1, 2026-11-01): pairing 1. Charcoal-green stem and arm, marigold blooms, clay-red bowl interiors. The warm one: legible from the street, and the red interiors give the strongest dark-light flicker as each bloom turns — which is the whole reason the bowls are painted inside and out in two different colours. The other two pairings considered at NDY-2 were black/bone/slate-blue (the quiet one) and oxide-red/celadon/bone (the most plant-like); both are recorded and both are rejected.

The bowls themselves are bare stainless outside where they are cut; only the armature and the bloom exteriors take the body colour, and the bowl interiors take the counter-colour.

Finish (Mike's decision 3, 2026-11-01): one single-can direct-to-metal enamel, $53.98. Not the two-part marine LPU over a two-part epoxy primer. Being direct-to-metal there is no primer line, and the two marine lines are gone from the bill — **$489.98 removed, $53.98 put back, $436.00 off the total**. The consequences are stated rather than glossed:

- **A shorter service life than the boat system.** This is a single-component oil-based enamel.

The two-part LPU it replaces was chosen because it is what survives sun, freeze-thaw and grit on a wet dock. The enamel will chalk and it will need recoating, and the honest expectation is a garden piece rather than a dock piece. Mike accepted that trade knowingly, and this sheet does not re-argue it.

- **No primer, and none needed.** Direct-to-metal means the prepared steel is the substrate.

Degrease and abrade it properly and that is the whole coating system.

One open item this creates — coating colour. Decision 1 asks for three colours; decision 3 buys a product that cannot be tinted. Rust-Oleum's own listing for the Professional High Performance Protective Enamel says it "cannot be tinted", and offers its own workaround — mix colours from the same product line and sheen to make custom colours — while the flat sheen in that line is stocked only in black and white. So charcoal-green, marigold and clay-red are not three cans off a shelf. Three ways out, in order of preference:

1. **Mix from stock gallons** of the same product and sheen, using Rust-Oleum's own method. Most

faithful to the chosen colours; costs more than one can, and the exact mix has to be recorded so it can be matched on the recoat.

1. **Accept the nearest stock colours** in the line (a dark green in gloss, safety yellow, a red).

Cheapest and simplest; the sheens then differ between the armature and the blooms unless a single sheen is chosen throughout.

1. **Move the colour coats to a tintable single-component direct-to-metal enamel** at similar

cost, keeping decision 3's system (single-component, DTM, one can per colour) and getting the colours exactly.

The bill carries the $53.98 flat-black gallon as the price basis for the decision, which is what Mike decided against. The colour coats get priced once this is settled — it is the only place where two of his five decisions pull against each other, so it is named here rather than quietly resolved.

The bowls themselves are bare stainless and need no paint at all; only the armature and the bloom exteriors are coated.

2.6 How it reads from thirty feet

From the street the piece is a dark, still calligraphic mark against the house, with five bright loops hung off one long arm. What moves at that distance is the **whole branch** — the slow grand yaw as it swings to face a wind change, and the lean. You read direction and strength of the wind off it before you read anything else: the arm points downwind, and how hard it leans tells you how hard it is blowing. The blooms are a shimmer at that range, not a subject.

2.7 How it reads from the patio

Close up the blooms are the whole thing. Each is a shallow bright bowl split down the middle, spinning on its own little stainless axle, and because each rotor's drag and inertia differ slightly, no two turn at the same rate — so the cluster never syncs and never stops being interesting. You can see the gap between the halves, the welded hub,

the two screws that hold each rotor on. Sitting six feet away the piece is five slow wheels of colour and one long straight bar, and it is legible as a machine and as a flower at the same time, which is the point.

3. Motion — three speeds at once

Motion	What drives it	Speed in a 5 mph breeze	Reads best from
Yaw — the whole branch swings to face the wind	wind pressure on the blooms, which all sit on one side of the mast	a full turn in roughly 15–60 s	the street
Lean — the arm tips into the gust and eases back	the change in wind moment on the blooms, taken against four urethane pads	3–8° of movement, period roughly 3–6 s, always returning to the same attitude	the street, and the patio
Spin — each bloom turns on its own vertical axle	local flow at each rotor (two offset lobes, drag rotor)	5–30 rpm, each bloom different	the patio

The lean is the piece's signature and its one non-obvious mechanism. The boom does **not** rock free on a balance point. It leans against four urethane pads (part C3) that are set as combined stops and springs, so the arm can move only 3–8° and always eases back to the same attitude when the gust passes. It hunches and it recovers. That is a very different motion from a swinging arm, and it is what keeps the piece from being a Calder with a post bolted on — see Risk 3.

In a dead calm nothing moves at all and the piece holds one fixed silhouette: a flower frozen mid-bloom. In a hard wind the arm leans hard against the pads and the blooms blur. There is no stop on the spin (a rotor never needs one) and no stop on the yaw (full rotation).

4. Materials shortlist

Every line below has a real part number and a source link, and every line carries a price — except one, which cannot, and says so. Notice what is conspicuous: there are no structural quantities in the list, no castings, no machined parts and no custom spinning — the armature is tube and plate welded together, and every rotating joint is an off-the-shelf bearing. Nothing on this list requires a supplier to make anything for us.

Totals (`scripts/slow_bloom_bom.py`, run 2026-11-01 on the updated bill): **36 lines, all 36 primary, $2,396.48** before tax and shipping. That is **$436.00 less than the $2,832.48** the bill stood at before Mike's decisions, and the saving is almost exactly what decision 3 predicted. 30 of the 36 prices were read directly off the vendor's own page; 5 are marked `listing`; 1 is marked `quote` — the sealed main ring, which is the one line in the bill that still has no real price against it. There are no alternate lines left: the finish that used to be the alternate is now the finish.

The total is given two ways, because the main ring has no published price. The $2,396.48 above carries the sealed ring at a **floor allowance** of $398.83 — the published price of the same-size standard ring, which the sealed one cannot undercut. If the sealed ring instead costs what the only published sealed/standard pair in the igus range implies (the 80 mm sizes, where the sealed ring is 2.63× the standard one), the ring lands near **$1,050** and the bill becomes **$3,047.88**. So the honest headline is: the finish decision saves $436, and the ring decision may give back more than that. Until igus puts a number in writing, the figure for this ring is an allowance and not a price.

ID	Item	Part number	Price	Qty	Vendor
A1	Concrete mix, 80 lb bag (Quikrete 1101)	110180	$6.47	5	The Home Depot
A2	Form tube 12 in x 4 ft (Sonotube)	Menards Sku 1895159	$17.38	1	Menards

ID	Item	Part number	Price	Qty	Vendor
A3	Rebar #4 x 4 ft, A615 Gr 40	RB12	$7.80	4	Metals Depot
A4	Steel pipe 4 in Sch 40 x 8 ft (mast)	T54	$361.00	1	Metals Depot
A5	Steel plate A36 12 x 12 x 3/4 in (base plate)	9614	$232.21	1	Online Metals
A6	Steel angle 2 x 2 x 1/4 in x 10 ft (gussets)	A12214	$64.50	1	Metals Depot
A7	Titen HD screw anchor 3/4 x 8-1/2 in, box of 5	THD75812H	$59.09	1	Concrete Fasteners
B1	**iglide PRT-01-100-DD slewing ring, fully sealed** (the main thrust bearing)	PRT-01-100-DD	$398.83 ■ allowance	1	igus
B2	Steel plate A36 12 x 12 x 1/2 in (head plates)	9612	$78.55	1	Online Metals
B3	1 qt stainless mixing bowl → the drip hat over the ring	Staples 453546 / model 78701	$8.99	1	Staples
C1	**UCFL205-16 two-bolt flange bearing unit**, 1 in bore, sealed	UCFL205-16	$24.89	2	Zoro
C2	1 in 1018 cold finish round bar, 12 in (nod pin + cwt stub)	4797	$11.62	2	Online Metals
C3	1 x 2 x 1 in urethane bumper, 80A (lean springs/stops)	REC003	$7.27	4	Acrotech
D1	Steel tube 2-1/2 in OD x 0.120 x 20 ft (the boom)	T2W212120	$150.60	1	Metals Depot
D2	Steel tube 1-1/2 in OD x 0.120 x 12 ft (bloom stalks)	866TF9	$140.00	1	Grainger
D3	Steel tube 1-1/4 in OD x 3/16 DOM x 6 ft (stalk collars)	T2114316	$72.30	1	Metals Depot
D4	CAP 25 lb cast iron plate, 1 in bore (counterweight)	Walmart item 20470506	$34.97	2	Walmart
D5	Plastic tube end caps 2-1/2 in, 12 pcs	Lowes 8711039	$11.99	1	Lowe's
D6	Plastic tube end caps 1-1/4 in, 40 pcs	Lowes 8059932	$12.99	1	Lowe's
E1	**8 qt stainless mixing bowl, 13-1/4 in x 4 in, 0.4 mm** (the bloom — chosen)	Staples 454113 / model 78705	$17.29	5	Staples
E2	Stainless tube 316 1 in OD x 0.065 x 0.87 ID (bloom hub)	Online Metals 12960	$18.40	3	Online Metals

ID	Item	Part number	Price	Qty	Vendor
E3	8 mm x 100 mm hardened chrome shaft, 5-pack (axles)	VXB 8mm-100mm-hardened	$49.93	1	VXB Bearings
E4	**608-2RS sealed bearing 8 x 22 x 7 mm, 10-pack** (spin bearings)	VXB 10-pack 608-2RS	$14.99	2	VXB Bearings
E5	Steel plate A36 1/4 in x 12 x 12 in (hub caps + yoke cheeks)	9610	$27.55	2	Online Metals
E6	Stainless tube 316 3/4 in OD x 0.049 x 3 ft (sleeves, spacers)	Online Metals 12952	$39.44	1	Online Metals
E7	Steel flat bar 1/4 x 2 in x 6 ft (clamps, tabs)	F2142	$26.18	1	Metals Depot
F3	**Direct-to-metal enamel, gallon** (the finish — no primer line)	Rust-Oleum 7776402	$53.98	1	The Home Depot
F4	SS 316 socket cap screw 1/4-20 x 1 in	Bolt Depot 16540	$0.59	48	Bolt Depot
F5	SS 316 socket cap screw 5/16-18 x 1-1/4 in	Bolt Depot 16550	$1.04	24	Bolt Depot
F6	SS 316 hex nut 1/4-20	Bolt Depot 15983	$0.12	48	Bolt Depot
F7	SS 316 hex nut 5/16-18	Bolt Depot 15984	$0.16	24	Bolt Depot
F8	SS 316 flat washer 1/4 in	Bolt Depot 16019	$0.14	96	Bolt Depot
F9	SS 316 flat washer 5/16 in	Bolt Depot 16020	$0.16	48	Bolt Depot
F10	SS 18-8 metric socket cap screw M4 x 20 mm	Bolt Depot 6398	$0.11	60	Bolt Depot
F11	3M 5200 marine adhesive sealant, 10 oz	PN06500HC	$22.48	1	The Home Depot
F12	Boeshield T-9 corrosion protectant, 12 oz	ASIN B0HNT7FM27	$21.56	2	Amazon

Full source links, the exact URL for every line, the per-line sourcing notes, and the `page` / `listing` / `quote` verification flag per line are in `docs/slow-bloom-bom.json`. Category subtotals: foundation and mast $797.73 · yaw axis $486.37 · lean axis $102.10 · boom and balance $457.82 · blooms $342.28 · finish and fasteners $210.18.

Line ids **F1 and F2 are deliberately absent** from the table: those were the two-part epoxy primer and the two-part marine topcoat, deleted on 2026-11-01 by decision 3. Nothing was renumbered, so the gap is the record of the removal rather than a lost line. The finish section fell from $646.18 to $210.18 and is now almost all stainless fasteners.

Two lines were once unpriced; one of them still is. Both are handled explicitly rather than papered over:

- The **14 in** concrete form tube used in the first draft of this design is a real product but

no vendor publishes a price for it online (Home Depot, Lowe's and Menards all list it store-only). The design was therefore changed to a **12 in** pier, which is priced and buyable online at Menards ($17.38). That change

stands.

- The **fully sealed main ring, PRT-01-100-DD**, is now the *chosen* part (decision 2) and **still

has no published price **— igus quotes it on request. It remains** the only line in this bill without a real price against it**, it is carried as a $398.83 floor allowance rather than a quotation, and the total above is therefore stated two ways. Its 25–30 working day lead time is accepted and is a real constraint on the build schedule — see §5.3.

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5. Build plan

5.1 Cut list

Stock (BOM id)	Cut	Qty	Length each
4 in Sch 40 pipe (A4)	mast	1	90 in
12 in x 4 ft form tube (A2)	pier form (cut down)	1	38 in
2-1/2 in OD tube (D1)	boom	1	144 in
2-1/2 in OD tube (D1)	fulcrum cross-tubes / fixtures	4	6 in
1-1/2 in OD tube (D2)	bloom stalks, inner to outer	5	40, 34, 28, 22, 16 in
1-1/4 in OD DOM (D3)	stalk collars	5	3 in
1 in OD 316 tube (E2)	bloom hubs	5	6 in
8 mm hardened shaft (E3)	bloom axles	5	100 mm
1 in 1018 bar (C2)	nod pivot pin	1	7 in
1 in 1018 bar (C2)	counterweight stub	1	5 in
1/4 in A36 plate (E5)	hub caps, 3-1/4 in dia discs	10	—
1/4 in A36 plate (E5)	nod yoke cheeks	2	8 x 6 in
1/4 in A36 plate (E5)	brackets and gussets	4	as needed
1/2 in A36 plate (B2)	fixed head adapter plate	1	7 x 7 in
1/2 in A36 plate (B2)	rotating head plate	1	7 x 7 in
3/4 in A36 plate (A5)	base plate	1	12 x 12 in
2 x 2 x 1/4 angle (A6)	base gussets	4	8 in
1/4 x 2 flat (E7)	bowl-to-hub clamps	5	6 in
1/4 x 2 flat (E7)	about 5 in, stub collar blank	1	5 in
Rebar #4 (A3)	pier verticals	4	48 in

Critical fits and dimensions — the numbers that have to be right before anything is welded:

- Bloom hub bore: the 1 in OD stainless tube has a 0.87 in (22.1 mm) bore — a light press on the

22 mm bearing OD. Press dry; if a bore comes up loose, Loctite 638 retaining compound, not a bigger hammer.

- Bloom axle: use **only** the ground 8 mm shaft (E3). Ordinary 8 mm bar is undersized and the

bearing inner ring will creep and wear the shaft.

- Nod yoke cheek spacing: set the cheeks so the boom hub clears them with 1/8 in a side, and fix

the four bumpers (C3) so they both stop the lean and sit in light compression at rest. Total travel is set here: adjust the shims under the bumpers to land the lean at 3–8°.

- Counterweight stub: 5 in of 1 in bar welded into the butt **coaxial** with the boom, spanning

the 4 ft counterweight arm clean to the end.

- Weep holes: a 3/16 in hole at the lowest point of every closed tube volume (boom ends, stalk

bottoms, hub underside, the head's plate sandwich). Ends get plastic plugs (D5, D6). A sealed tube full of water splits its own welds in the first hard freeze — the plugs stop the water getting in, the weep holes stop it staying.

- Drain holes: four 3/8 in holes in the fixed head plate, positioned so no water can stand under

the slewing ring.

- Bolt pattern for the ring: taken from the igus CAD for PRT-01-100, downloadable from the

product page. Drill from that, not from a measurement.

5.2 Sequence

1. **Set the pier.** Dig 12 in dia x 38 in deep; 4 verticals of #4 rebar wired into a cage;

Sonotube cut to 38 in; pour, rod, strike the top **2 in above grade so that 36 in of pier stands in the ground** — the adopted frost depth — and cure for a week before the piece goes on it. **This step waits on the structural check.** The pier is the one part of this build that cannot be undone cheaply, and decision 5 puts the engineer's check in front of it.

1. **Mast.** Cut the 4 in pipe to 90 in. Weld the 12 x 12 x 3/4 in base plate to the bottom, then

the four 2 x 2 x 1/4 in angle gussets. Weld the 1/2 in head adapter plate to the top, squared to the base plate.

1. **Yaw head.** Drill the ring's bolt pattern into both 1/2 in plates. Drill the four 3/8 in

drain holes. Bolt the ring to the fixed plate; bolt the rotating plate on top; turn it by hand and confirm it is silky before anything else goes on it.

1. **Drip hat.** Weld three small tabs to the fixed head plate and bolt the inverted 1 qt bowl

(B3) over the ring, clear of the rotating plate.

1. **Nod yoke.** Cut the two cheeks from 1/4 in plate; bolt the two UCFL205-16 flange units (C1)

to them; set the four urethane pads (C3) as stops, with shims, at the chosen lean. Bolt the yoke to the rotating plate.

1. **Boom.** Cut the 2-1/2 in tube to 144 in. Weld in the fulcrum cross-tubes and the pivot

sleeve. Weld the counterweight stub (C2) coaxially into the butt. Weld the five 1-1/4 in collars (D3) and then the five stalks (D2) at their fan angles. Close the tube ends and drill the weep holes. Dry-fit the boom in the yoke; slide the two 25 lb plates (D4) on and set the balance so the arm floats just bloom-heavy.

1. **Blooms (five, identical).** Cut each bowl in half on its diameter and trim the rims so the

two halves match. Cut the ten 3-1/4 in hub-cap discs from 1/4 in plate. Cut each hub from the 1 in stainless tube, press the two 608-2RS bearings (E4) in, and fit the 8 mm axle (E3). Bolt each bowl half to the upper and lower hub caps, offset 1-1/2 in off the axis in opposite directions, using the M4 screws (F10). Spin each rotor by hand before it goes anywhere near the sculpture.

1. **Fit the blooms to the stalks.** Each bloom's axle drops into the stalk top and is held by

one M4 screw. Rotate each successive stalk about the boom axis by the golden angle (137.5°) from the last, so the five blooms spiral around the arm instead of lining up.

1. **Finish.** Degrease and abrade the armature. **One single-component direct-to-metal enamel

(F3) straight onto the prepared steel — no primer line** (decision 3). Charcoal-green on the armature and the bloom exteriors, clay-red inside the bowls (decision 1 — see §2.5 for the one open item about getting those

colours out of a fixed-palette product). Mask the bearing bores; do not paint anything that has to fit. Boeshield (F12) the nod pin, the axles and the bare threads; 3M 5200 (F11) under the ring's bolt heads where stainless meets aluminium.

1. **Assemble on the pier.** Bolt the base plate down (A7). Lift the mast, then the head, then

the boom. Re-set the counterweight last, on the finished piece.

1. **Commission.** Turn the ring by hand. Push each bloom and let go. Lean on the arm and let

it go. Log the hand-spin time of each bloom as the baseline — that number is what tells you next year whether one has started to drag.

5.3 Schedule, and the one lead time that drives it

The sealed main ring (B1) ships in **25–30 working days — five to six calendar weeks — and it is the critical-path item on this build.** That is a real constraint on the schedule, not a footnote:

- The ring must be **on order before the head plates can be drilled**, because the bolt pattern is

taken from the igus CAD rather than measured. The CAD is available independently of the order, so the drawing work can proceed while the ring is in transit — but the drilling is not finished until the part is in hand to check against.

- Ordered in the first week of November, the ring lands **mid-December at best**, and year-end

holidays push a realistic date into **early January**. Erecting an 11 ft 6 in steel piece on a 12 in pier in a Grand County January is not a sensible plan, and the ground the pier goes into is frozen from about that point on.

- So the honest schedule is: **order the ring first**; dig and pour the pier before the ground

freezes if the engineer's check allows it, otherwise in the spring; fabricate the armature over the winter; **erect in spring 2027.** Compressing that by switching back to the in-stock standard ring is precisely the trade Mike already declined in decision 2, and it is not re-opened here.

- And **nothing is ordered at all until the structural check from decision 5 comes back**, which

puts the engineer's turnaround in front of the ring's.

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6. The two risks the concept flagged, answered

Risk 1 — it is a bearing machine: how the main thrust bearing survives dust and freeze-thaw

The main ring is an **igus iglide PRT-01 slewing ring** (B1). It is the one large bearing the whole branch turns on, and it is a very specific choice:

- **There are no rolling elements and no grease.** A PRT ring is a hard-anodised aluminium ring

running on replaceable iglidur J polymer sliding pads. There is no lubricant to hold grit, no lubricant to wash out, and none to stiffen in the cold. That removes the two things that actually kill garden bearings.

- **The material is rated for the climate.** iglidur J runs from –50 °C to +90 °C continuous

(–58 °F to +194 °F), which brackets Grand County's –16 °F winter design temperature and the worst of an August in the sun, and the anodised aluminium housing cannot rust. The polymer is compliant, so a film of ice at the seal line is pushed aside rather than cracking a race.

- **Its failure mode is gentleness.** A worn pad is a slow loss of stiffness, not a seizure —

and the pads are a replaceable part by design, which is the whole point of the PRT family.

Then the detail work, because a bearing is only as good as what is above it:

- The ring sits 7 ft 6 in up, so ground splash, grit and mower spray never reach it.
- An inverted 1 qt stainless bowl (B3) caps the ring and sheds rain and meltwater outward. This

is the cheapest line in the whole bill and it is doing real work.

- Four 3/8 in drain holes in the fixed plate mean water cannot stand under the ring.
- Stainless bolts into the aluminium housing are bedded in 3M 5200 (F11) so the two metals are

not in direct contact — galvanic corrosion outdoors is a bigger threat than the bolted load.

Decided (Mike's decision 2, 2026-11-01): the fully sealed ring, PRT-01-100-DD. It seals *both* faces with sealing lips and is the version igus describes as built for "blowing sand… outdoor mounts where both faces see weather", which is what this site is. Three things are recorded with it rather than glossed:

- **The price is not published.** igus quotes the -DD variant on request. Until that quotation is in

writing, this line carries a **floor allowance of $398.83** — the published price of the same-size standard ring — and the bill is stated both ways (§4). It is the only unpriced line left in the build, and it says so on its own line in the BOM.

- **The lead time is 25–30 working days** and Mike accepted it. It is now the critical path of the

whole build schedule; see §5.3. That is the price of the seal, and it is a schedule price rather than a money price.

- **The bowl drip hat (B3) stays.** Sealing lips protect the sliding faces; they do not stop water

standing on the fixed plate under the ring, which is what the four 3/8 in drain holes and the inverted bowl are there for. The $8.99 bowl is not made redundant by the $398 part above it.

Sizing, and one honest gap. The ring is sized by its permissible tilt moment, which is driven by wind pressure on the five blooms acting about the mast axis. That calculation is not in this sheet and must not be: the project brief for this piece is form and concept, and puts structural engineering out of scope. What sits here is the *choice* with its reasoning — a 185 mm ring rather than the 80 mm smallest size, because the arm is 12 ft and the blooms are 13 in across — plus, now, the numbers the engineer needs to size it properly: the moving mass, its centre of gravity, the wind-catch areas and their lever arms. Those are in `docs/slow-bloom-structural-brief.md`. The service-life computation is a separate piece of work and should be run through igus' PRT online configurator before the drawing stage.

Risk 1b — every other place water can do damage

A bearing is not the only thing a freeze can break; a **closed steel tube full of water** is. So:

- Every tube end gets a plastic plug (D5, D6) and every closed volume gets a 3/16 in weep hole at

its lowest point.

- The bloom hub is stainless (E2) and drains from its underside.
- The head is not a closed box — the two plates are spaced and open at the sides.

Risk 2 — it is a bearing machine: how the per-bloom bearings survive, and why one sticky bloom does not read as broken

Each bloom spins on **two 608-2RS sealed bearings** (E4) pressed into a stainless hub. 2RS means a rubber contact seal on both faces — they exclude dust and blow-off grit and hold a sealed-for- life grease. They are the most common sealed bearing in the world.

- **Dust and grit:** the seals do the work; the hub is stainless, so even a failed seal leaks

water onto stainless, not onto rust.

- **Freeze-thaw:** the real hazard is water *standing* in the hub. So the axle is vertical with a

hat above the top bearing and a drain below the bottom one, and the lower bearing gets a pressed-in shield. The bearing's own grease stiffens with cold, which raises the torque needed to start — but the rotor is a drag machine with surplus torque at low speed, so cold grease costs a little spin, not a stall. A two-lobe offset rotor does not need a threshold wind speed to start from rest; that is exactly why it was chosen over a propeller.

- **Replaceability is the actual answer.** The rotor lifts off its axle after two M4 screws. A 608

costs $1.50 in tens, and the bill buys twenty of them — ten in service and ten on the shelf. Turning a stuck bloom into a working one is a ten-minute job done standing on the ground.

Why one stuck bloom does not make the piece look broken. This is answered by the design, not by the bearing:

- **No single bloom carries the read.** The primary motion — the grand slow turn of the whole

branch, and the lean — is carried by the main ring (B1) and is completely independent of every bloom. If all five blooms seized solid, the piece would still turn, still lean, still read the wind, and still be worth looking at. That is the test this design has to pass, and it passes it. The blooms are the flicker; they are not the subject. Contrast the Wind Curtain direction, which the concept sheet rejected partly because it makes every element load-bearing for the read — hundreds of chances to look broken.

- **The blooms are built to start, not to be coaxed.** Low-inertia 0.4 mm bowls on sealed

bearings, driven as drag rotors, turn in a breeze that a propeller-driven ornament would ignore.

- **A service plan that fits a garden.** Once a year: turn the ring by hand, push each bloom and

compare its time against the commissioning baseline, check the nod pin, one grease-gun stroke in each flange unit. If a number is off, swap that bloom's bearings. That is the entire maintenance schedule, and it is why the bill includes a spares kit rather than a warranty.

Risk 3 — why one pivot too many does not make it a Calder knockoff

The concept sheet named this as the subtler risk, and it is a design argument rather than a mechanical one. Three differences, in order of importance:

1. **Nothing hangs.** Every element is a stiff cantilever: the boom is welded to the head, the

stalks are welded to the boom, the blooms are bolted to their axles. A Calder mobile is *defined* by suspension — weights on wire, whose balance is never settled, always drifting. Slow Bloom's arm is held and driven; it is not a mobile because there is nothing free about it.

1. **The lean is against a spring, not about a balance point.** This is the mechanical heart of

the answer. A mobile's arm swings freely about its balance and can oscillate; this arm tips 3–8° into a gust, is stopped and pushed back by four urethane pads, and returns to exactly the attitude it left. It cannot oscillate. That single difference in mechanism is what makes the piece a planted instrument rather than a Calder.

1. **The vocabulary is botanical, and it is small.** Five blooms, one stalk, one straight bar, no

coloured discs, no wire, no dangling hardware, and no primary-colour assortment — the whole piece is two colours and stainless. Five shallow split bowls read as a flower because they are arranged like one: staggered, spiralling at the golden angle, no two the same height. Restraint is the argument. One stalk, five blooms, three motions, nothing else.

And it is honest about its ancestor. The reference sheet says plainly that the piece is a Calder standing mobile **made literal and planted**, and that it departs from Calder at the drive — the wind sets its direction rather than merely disturbing it.

Risk 4 — a genuine gap, now handed to the person who can close it

This sheet is a form document. It contains no structural calculation: the pier, mast and the 115 mph design wind are named but not resolved. That is consistent with the project brief (form and concept over structural engineering), but it is a real limit of this deliverable rather than a design decision.

Mike's decision 5, 2026-11-01: the check gets done, before any metal is cut. It is not done here and it will not be done here — **structural engineering is outside this project's scope and it is a licensed professional's job.** Grand County's own code document notes that a licensed Colorado design professional may be required for structures in special wind regions, and this county has them. What has been produced instead is the package the engineer needs: `docs/slow-bloom-structural-brief.md` — the geometry as drawn, the itemised moving mass with its centre of gravity, the wind-catch areas and their lever arms, the design wind, the foundation assumptions, the questions to put to him, and a plain statement of what is not known. Its numbers are computed from `output/slow-bloom-load-inputs.json` by `scripts/slow_bloom_loads.py`, so they can be checked line by line instead of taken on trust.

The reason it matters, stated once: the itemised moving mass comes to **about 155 lb**, not the "~90 lb" this sheet claimed at NDY-2, and the wind figures are large enough that an order-of- magnitude pass puts the overturning moment at the base in the low thousands of foot-pounds. Those numbers are inputs, not conclusions — but they say plainly that this is not a piece that can be planted on an assumed foundation.

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7. Mike's five decisions, recorded — and what is still open

All five were settled on 2026-11-01 and are applied in this revision. They are recorded here as outcomes rather than re-opened as questions.

1. **Colours — pairing 1.** Charcoal-green stem, marigold blooms, clay-red interiors. Applied in

§2.5 and §5.2 step 9.

1. **Main ring — the fully sealed PRT-01-100-DD.** Applied to the BOM at line B1, with the price

carried as a floor allowance because igus publishes none, and the 25–30 working day lead time written into the schedule at §5.3.

1. **Finish — the single-can direct-to-metal enamel at $53.98.** Applied: F1 and F2 deleted, F3

promoted to primary, total recomputed, and the shorter service life stated in §2.5 rather than glossed.

1. **Blooms — the thin 0.4 mm bowl at $17.29.** Applied at line E1, with the dent-and-replace trade

recorded on the line itself.

1. **Structural check — yes, before any metal is cut.** Applied as `docs/slow-bloom-structural-brief.md`.

The check itself has not been done here and will not be; it is a licensed professional's job.

Still open — three items, all named rather than hidden:

1. **The ring's actual price.** igus has not quoted it. The bill carries a $398.83 floor allowance

and gives the total both ways (§4). Everything else in the bill now has a real price.

1. **The coating colours.** Decision 1 wants three colours; decision 3 bought a product that cannot

be tinted. §2.5 sets out the three ways out; the bill carries the flat-black gallon as the decision's price basis until it is settled.

1. **The structural check itself.** Awaiting a licensed engineer. Nothing is ordered, cut or welded

before it comes back.

8. Verification

- The updated BOM was run through `scripts/slow_bloom_bom.py` on 2026-11-01:

`python3 scripts/slow_bloom_bom.py --file docs/slow-bloom-bom.json` exits 0 and reports `validation.ok = true`, with no missing part numbers, no missing prices, no missing links, no placeholder text and no duplicate line ids. **36 lines, all 36 primary, $2,396.48** — against $2,832.48 before the decisions, a saving of **$436.00**. The tool's one warning is the honest one: `listing=5, quote=1` — six lines whose price was not read off the vendor's own product page.

- The structural input data was run through `scripts/slow_bloom_loads.py` on 2026-11-01:

`python3 scripts/slow_bloom_loads.py --file output/slow-bloom-load-inputs.json` exits 0 with `validation.ok = true`. It reports 156.53 lb of rotating mass (of which 50 lb is counterweight), 127.76 lb fixed, a dead-load imbalance of 58.9 ft·lb bloom-heavy, only 20.8 ft·lb of counterweight trim authority, 10.08 sq ft of wind-catch area, qz = 28.8 psf, and an indicative base overturning moment of 2,011–4,022 ft·lb. **Those are inputs, not design values, and the tool says so in its own output.**

- 30 of the 36 prices were read directly off the vendor's own product page on 2026-11-01 and are

flagged `page` in `docs/slow-bloom-bom.json`; 5 are flagged `listing` (A1, A2, C1, F3, F11) and each carries a note saying exactly where the price came from and what the alternatives cost; 1 is flagged `quote` (B1) and carries the allowance basis in full.

- Two parts that genuinely cannot be sourced with a published price are named explicitly rather

than faked: the 14 in form tube (which is why the pier is 12 in) and the fully sealed PRT-01-100-DD ring — the latter now being the chosen part, which is why the total is stated twice.

- Two arithmetic corrections were made to this sheet in this revision rather than carried forward:

the moving mass (about 90 lb → about 155 lb, itemised and computed) and the pier depth (the 3 ft form tube with 2 in proud left 34 in in the ground, 2 in short of the adopted 36 in frost depth; the tube is now cut to 38 in).

- **Nothing in this sheet has been ordered, cut, welded or paid for.**