

# Design Concept — "STRIDE" Wearable Warehouse Scanner

*Industrial design concept · Ring-scanner program kickoff · Dieter Krahel Working name STRIDE — a placeholder for the client's brand; no mark is engraved into any render (brand is a text/vector layer, applied later).*

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## 1. The one-line form

**A two-body worn scanner: a near-weightless scan module on the index finger, tethered by a flat flex bridge to a wrist-and-back-of-hand pack that carries every heavy part.** The finger carries grams. The wrist carries the battery, the compute, and the radio. Nothing that weighs anything rides the knuckle.

*(Form note: the locked hero renders a single-finger scan module — a low finger saddle with an integrated loop, the ambidextrous single-finger register of the reference set. The two-body split, not a finger-vs.-two-finger choice, is the design's differentiator; the single-finger module keeps the aiming digit's profile minimal and the glove line clean.)*

That sentence is the whole design. Everything below is why it takes this shape.

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## 2. Why two bodies — the argument against the single-body ring

The reference set proves the ceiling of the single-body approach. Zebra's **RS5100** is the best ring scanner in the world and it is *one body*: 70 g of optics, battery, radio and trigger all mounted on a single finger,  $61 \times 28 \times 21$  mm. Seventy grams is "practically weightless" for a scan. It is not weightless for **eight thousand scans across a twelve-hour shift**, cantilevered off the proximal phalanx, with a lever arm every time the finger flexes. ProGlove's **MARK 3** answers this by going the other way — ~40 g on the *back of the hand*, aiming from the hand — but that trades away the one thing a picker's body does for free: it **points with the fingertip**. You do not aim the back of your hand at a label on a low shelf; you point at it.

Our form refuses the trade. We keep the aim at the fingertip (natural, no wrist contortion, works into tight bin locations) **and** we get the mass off the finger (twelve-hour comfort). The only way to have both is to **split the body**:

- **Body A — the scan module (finger).** Optics, aimer, scan window, the primary trigger, a status LED, a haptic tap motor. Target mass  $\leq 22$  g — roughly a third of an RS5100, because the battery and compute are gone. It is a low finger saddle with an integrated loop, riding the index finger. Removing the battery and

radio is what lets it stay this light and this low-profile; a single-finger module keeps the smallest possible profile on the aiming digit and clears bin lips reaching in.

- **Body B — the wrist pack.** Hot-swap battery, main board, BLE/Wi-Fi radio, the second (thumb-reachable) trigger, and the loud feedback stack (piezo beeper + the strong haptic). It rides the back of the hand and cuffs the wrist, where the human body is happiest carrying a small mass — close to the wrist's rotational axis, against the flat of the back of the hand, off every joint that flexes during a pick.
- **The bridge.** A flat, ribbon-thin over-molded flex cable runs along the back of the hand from saddle to pack, following the line of the index metacarpal. It carries power and data. It is the only thing crossing the knuckle and it is 2 mm thick and cloth-soft on the skin side, so the knuckle bends and the bridge just folds with it.

This is the differentiator the program is built on, and it is defensible on human-factors grounds, not styling grounds: **carry mass where the body carries it best, put the aimer where the body aims naturally, and connect them with something that disappears.**

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### 3. The scan saddle — form derived from the hand

The scan module is the piece the picker feels every second, so its geometry is driven entirely by the hand.

- **Low finger saddle, integrated loop.** The module is a low saddle seated over the index finger with an integrated loop that captures it — the ambidextrous single-finger form of the reference set, chosen so the aiming digit carries the smallest possible profile. Because the battery, radio, and compute are *gone to the wrist*, this module can be a third of the reference weight, which is what makes single-finger seating comfortable across a shift where a full-weight ring is not. Anti-roll comes from the loop capture and the low center of mass, not from spanning two fingers.
- **Low and forward-raked.** The scan window sits just past the first knuckle, raked  $\sim 15^\circ$  down-and-forward so the aim line follows where a relaxed pointing finger already looks — at a label on a shelf at chest-to-knee height without lifting the wrist. Low profile (target  $\leq 15$  mm above the finger) so it clears the lip of a bin and never snags reaching in.
- **The window is recessed and hooded.** The exit window sits a few millimeters back inside a molded hood so a dropped hand or a box corner strikes the shell, never the glass. The hood doubles as the aim reference the eye reads.
- **Elastomer saddle floor, hard shell roof.** The face against the finger is over-molded elastomer with a shallow anatomical channel; the roof and window hood are the hard glass-filled nylon shell. Soft where it touches skin, hard where it takes the hit.
- **Trigger on the thumb-side flank.** The primary trigger is a large, softly proud paddle on the thumb-facing side of the module, so the thumb of the *same hand* falls onto it naturally with the fingers curled — and it is big and proud enough that a gloved thumb finds it without looking. (Glove-first: see §6.)

Target module mass  $\leq 22$  g. That number is the whole point of the split and it is the number the human-factors document must hold me to.

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#### 4. The wrist pack – form derived from where mass belongs

- **Rides the back of the hand, cuffs the wrist.** The pack's footprint sits on the flat back of the hand and its strap wraps the wrist just above the styloid, so the mass is carried by the wrist and forearm, not by any finger joint. This is the Dreyfuss principle applied literally: put the load on the structure built to carry it.
  - **Wedge section, thin at the knuckles, thicker at the wrist.** The pack tapers — thin ( $\approx 8$  mm) where it meets the bridge over the knuckles so it never fights the hand closing, thickening toward the wrist ( $\approx 18$  mm) where the battery lives and where thickness costs nothing ergonomically. The mass is deliberately biased *rearward*, toward the wrist axis, to shorten the lever arm on the hand.
  - **Hot-swap battery is the shift-length answer.** Twelve hours is not solved by a bigger cell on the finger (that was the trap); it is solved by a **slide-and-latch battery** in the wrist pack that a picker swaps in ten seconds at a cart without removing the wearable. The pack shows charge state on a small LED bar. Spent cells go to a bay charger. This is the standard enterprise answer (Zebra's PowerPrecision hot-swap logic) placed where the mass can afford it.
  - **The second trigger.** A large trigger paddle on the thumb-side edge of the wrist pack lets the *opposite hand* fire the scan, or lets the same thumb fire it when the fingers are wrapped around a heavy box and the finger trigger can't be reached. Two triggers, either fires — this is how the picker keeps scanning with a full hand.
  - **Feedback stack lives here.** The loud piezo beeper and the strong LRA haptic sit in the pack against the back of the hand, where a strong tap transmits into the wrist and is felt through a cold-storage glove, and where the beeper has a hard shell to resonate against. (See §7.)
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#### 5. The mount / strap system

- **One hand mount, size-adjustable, ambidextrous.** A single glove-over back-of-hand mount in three shell sizes (S/M/L), each with an adjustable hook-and-loop-and-cam wrist closure, covers the anthropometric range for right and left hands. The saddle clips to the mount's finger loops and can be positioned along the fingers and rotated to tune aim — the picker sets it once and forgets it.
- **Glove-over by default.** The whole system is sized and strapped to go *over* a warehouse or cold-storage glove, not under it and not bare-handed. The straps have long adjustment range and cam buckles a gloved hand can work.
- **Everything swaps without tools.** Saddle, bridge, and pack separate at two connectors so a worn saddle or a frayed strap is replaced at the cart, not sent back. Interchangeable, launderable strap set (the mount is

the part that gets sweaty; make it the cheap, replaceable, washable part).

- **Left/right is a strap flip, not a second SKU.** The saddle trigger rotates to either flank and the mount is symmetric, so one product fits either hand — matching the RS5100's ambidextrous logic, which is table stakes in this category.
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## 6. Glove-first ergonomics (the constraint that shapes everything)

The picker wears a glove. Every touch target is sized and spaced for a gloved digit that has lost fine proprioception and tactile edge-finding:

- **Triggers are large, proud, and edge-defined** — a gloved thumb finds them by feel, by the raised rim, without looking. No flush membrane buttons anywhere on the primary path.
  - **The saddle channel and the strap closures are sized for the gloved hand's larger cross-section**, with adjustment range that also fits a bare hand at the small end.
  - **Feedback is multi-channel because the glove kills one channel.** A gloved, cold hand may not feel a weak buzz — so the haptic is a strong LRA in the wrist pack (felt through the glove into the wrist), *and* there is an audible beep, *and* there is a bright LED. No single feedback channel is trusted alone. (See §7.)
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## 7. Interaction & feedback model

**Trigger.** Two mechanical triggers (finger-saddle flank + wrist-pack edge), either fires a scan. Large, proud, gloved-thumb-findable, tactile detent so the picker feels the fire without watching. A press-and-hold enters continuous/aim mode; a single press is a single scan.

**Three-channel confirm, because the warehouse is loud, cold, and gloved:**

- **Haptic** — a strong LRA tap in the wrist pack on a good read, a distinct double-tap pattern on a bad read/no-read. Felt through a cold-storage glove because it fires into the wrist, not the fingertip.
- **Audible** — a piezo beeper in the pack, loud enough to clear ambient warehouse noise (target  $\geq 90$  dB at the ear at arm's length), with distinct good-read vs. error tones. Volume settable/mutable for quiet-hours facilities.
- **Optical** — a bright status LED on the *saddle* (in the picker's line of sight while aiming — green good / red error) plus a directional LED bar on the *pack* usable for pick-path guidance (the RS5100 left/right/straight logic), where the picker can see it on the back of the hand.

The redundancy is the point. The design assumes any one channel can be defeated by the environment (noise defeats the beep, a thick glove dulls a weak haptic, a glance away misses an LED) and never relies on a single one to confirm the scan.

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## 8. Material story

- **Shell — glass-filled nylon (PA66-GF30, ~30% glass).** The structural roof of the saddle, the wrist-pack housing, and the trigger cores. Glass-filled nylon is the enterprise-rugged default (it is what survives the concrete-drop and MIL-STD-810H canon) — stiff, dimensionally stable across a freezer-to-dock temperature swing, and it takes a matte, low-gloss texture that hides scuffs.
- **Grip & contact — over-molded TPE/TPU elastomer.** Every surface that touches skin or takes an impact — the saddle floor, the wrist-pack underside, the trigger caps, the bumper rails on the pack's corners — is a co-molded thermoplastic elastomer, ~60–70 Shore A. Soft against the hand, high-friction so the pack doesn't migrate on the back of the hand during a shift, and it is the sacrificial impact layer that meets the concrete first.
- **The bridge — over-molded flex.** A flat flex circuit encased in a thin elastomer ribbon; cloth-soft on the skin side, sealed against sweat and freezer condensation.
- **Window — hardened optical polycarbonate,** recessed inside the molded hood so it never takes a direct strike.
- **Sealing — the whole system targets IP65/67;** the material split (hard shell for structure, elastomer for the sealing gaskets and impact rails) is chosen so the seams that must seal are elastomer-gasketed.

The material logic is one sentence: **hard where it must be stiff and take the hit, soft where it touches the human and where it meets the floor.**

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## 9. Colorway — proposal and defense

**Body: graphite-black rugged shell. Accent: high-visibility safety amber. Detail: cool grey elastomer.**

- **Dark rugged body (graphite / near-black, matte PA66-GF).** This is the enterprise-rugged register (Zebra black, Honeywell dark grey) and it is a *maintenance* decision, not a taste one: a dark matte shell hides the scuffs, grease, and shelf-dust of a warehouse life, so the device still looks like equipment worth respecting after six months, not a scraped toy. Matte also kills glare under high-bay lighting.
- **High-vis safety amber accent** on the triggers, the LED surrounds, the strap pull-tabs, and a single band on the wrist pack. Defense, three reasons: (1) **findability** — an amber trigger against a black body is found instantly by a gloved thumb and by a supervisor checking a device is worn correctly; (2) **safety register** — hi-vis amber is the visual language of the warehouse floor (vests, forkliftlines, hazard edges), so the device *reads as safety equipment*, which is what it is; (3) **wayfinding** — the accent marks exactly the two things the picker interacts with (the triggers) and the two things they read (the LEDs), so the color does interaction-design work, not decoration.

- **Cool grey elastomer** on the non-accent soft parts (saddle floor, pack underside) — neutral, hides sweat-sheen, and separates the "touch/impact" material from the "structure" material visually so a glance tells you what's soft.

Amber over the more common safety-yellow for two reasons: it holds contrast against both the black body *and* a hi-vis yellow vest (yellow-on-yellow disappears), and amber reads as the warmer, equipment-grade signal (think machine-guard amber) rather than PPE-vest yellow, keeping the device in the "tool" family, not the "wearable-toy" family.

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## 10. What the renders must hold (the one-truth spec)

Every commissioned frame depicts *this* device, identically:

- Two bodies: low single-finger scan module (saddle with integrated loop) on the index finger; wedge wrist pack thin-at-knuckles / thick-at-wrist; flat over-molded bridge along the index metacarpal.
- Graphite-black matte shell, high-vis **amber** triggers/accent, cool-grey elastomer contact surfaces.
- Recessed hooded scan window at the fingertip end of the saddle, raked forward.
- Amber trigger paddle on the saddle's thumb-side flank; second amber trigger on the wrist pack's edge.
- Status LED on the saddle; LED bar + charge LED + piezo grille on the pack.
- Slide-and-latch hot-swap battery in the wrist pack.
- Over-molded elastomer bumper rails on the pack corners.
- Ambidextrous, S/M/L glove-over strap mount with cam wrist closure.
- **No brand text anywhere in the pixels** — the mark is a later text/vector layer.

The locked hero frame is the reference for every subsequent frame. Wide and context shots are conditioned on it, never regenerated from words.