

HRED — Human-Robot-Environment Design

Interior design for the age of service robotics. A book whose first edition is complete (2026) and being prepared for publication; written in Portuguese, English edition in preparation. Author: Pedro Satlher, student of interior design, Lippstadt, Germany. This summary is written for robotics companies, operators and research groups considering a research partnership.

The problem in one paragraph

Service robots already work. They deliver in hotels, transport in hospitals, clean retail floors and move goods in warehouses. Almost without exception, the spaces they work in were designed exclusively for humans. When a robot operates in a corridor drawn only for people, it does not fail outright — it runs at a fraction of what it could do. As robots improve, the space does not matter less: it becomes the limiting factor. The decisions that determine this — floor material, corridor width, where the charging hub sits, how light is distributed, what kind of doors, whether the lift is integrated — are taken at the interior-design stage, where they cost far less than any later change. HRED proposes that this is a problem of the built environment, and that it belongs to a discipline that does not yet exist.

What the book proposes

HRED is presented as a **proposed discipline**, not an established one. Its components are the author's theoretical contribution and are labelled as such throughout.

- **A factor model — $HRED(A) = f(T, C, E, V)$.** The autonomous capacity a space can support is treated as a function of four factors: the **task families** to be automated (T), the **human context** of operation (C), the **robot equipment** (E) and the **physical venue** (V). The notation is a structuring device, not a numerical equation: it obliges the designer to work through all four dimensions and find the incompatibilities between them.
- **Nine task families, T1–T9**, classified by function rather than by technology: horizontal transport, surface maintenance, manipulation, inspection, human assistance, materials handling, environmental management, security interface and exception management. Two technologically different robots that both "move things from A to B" place similar demands on the space; the taxonomy is the hinge between the operator's intention and the designer's decisions. It is consistent with the market distribution reported by the IFR (transport and logistics, then hospitality and cleaning).
- **Six spatial zones, Z1–Z6**, that classify any building by its profile of human and robotic activity: guest area, active service, transition corridor, back-of-house, hub, and night-autonomy circuit. Z5 — the hub — is the only genuinely new room the designer creates. Z3 — the transition corridor — is hypothesised to be the parameter with the greatest impact on autonomous capacity.
- **Twelve building typologies** specified in detail — restaurants, hotels, healthcare and senior care, offices, retail and indoor logistics, residential, airports and transport, spa and wellness, education, arenas, mixed-use, emerging — each with its own specification sheet, mandatory questions and commissioning indicators.
- **Design parameters** chapter by chapter: robot dimensions as design data, floor and wall materiality and its interaction with sensors, lighting, acoustics, circulation, robot-friendly furniture, network and power infrastructure, human acceptance and proxemics, maintainability, failure engineering, life cycle.

- **A design process and a toolkit:** briefing protocol, zoning checklist, scorecard, hub sheet, commissioning and post-occupancy sheets, and a **twelve-step audit protocol** for existing buildings, executable by one person in half a day to two days with tape, camera and lux meter.
- **A proposed standard technical data sheet** (Appendix G): the minimum set of data a service-robot manufacturer would need to publish for an interior to be designed correctly — including fields that no commercial data sheet currently gives, such as the measured rotation envelope and the position of the rotation axis, the height of the main sensor plane, the maximum threshold crossable *without loss of localisation*, reaction latency before braking, and behaviour in front of glass and mirrors.

How the book handles evidence

Every relevant claim carries an explicit epistemological status: **fact** (verifiable primary source), **industry** (institutional market data, not peer-reviewed), **HRED hypothesis** (the author's original proposition, stated with its conditions of refutation) or **open** (a question the literature does not yet answer). Where there is no established science, the book declares the gap instead of filling it. Earlier drafts that contained unsourced figures were corrected and the corrections are recorded in the text. Illustrative scenarios are marked as pedagogical constructions, not as cases. The scorecard's weights are explicitly provisional: until calibrated against field data it is to be used as a structured checklist, not as a number with predictive authority.

The research programme

The book's central open question, from which the rest of the agenda follows:

What fraction of a service robot's field performance is attributable to the space rather than to the machine?

Dependent variable: missions completed without human intervention, per robot and period.
Secondary: mean mission time, emergency stops, manual repositionings, downtime, distance travelled versus optimal. Independent variable: quality of the space, operationalised by the HRED rubric. Mandatory controls: robot model and generation, software version, task family, human density, schedule, operational maturity of the team, maintenance regime — because the effect of the space is confounded with the quality of management, and the book names this as the most serious threat to validity.

Eight falsifiable predictions are stated with the result that would refute each and the consequence for the book if it falls — among them: that the space explains a non-trivial fraction of performance (P1); that vertical transition is the critical point of multi-storey deployments (P2); that task family predicts sensitivity to the space (P3); that floor materiality affects localisation (P4); that furniture stability affects map-based systems (P5); that physical information anchors improve resilience under network failure without a performance penalty (P6). P1 has first published support (Mohan, Rojas & Chua, ICRA 2014: 92% versus 71% floor coverage for the same robot in a robot-inclusive versus a default layout) and P4 has independent corroboration (Borusu et al., 2024); both await replication in service contexts.

Four minimum studies, in order of increasing cost, none requiring institutional funding:

1. **Inter-rater agreement.** Three trained assessors apply the rubric independently to eight to ten spaces. Tests whether the instrument measures anything consistently. No robots required. Precondition for everything else.

2. **Floor and localisation drift.** A fixed closed circuit repeated on four floor finishes; deviation between reported and real position; repeated with fiducial markers installed. Tests P4 and P6. Requires access to one robot.
3. **Before/after audit in a real building.** Baseline measurements, three to five defined spatial interventions, repeat measurements. The building is its own control. The study that changes the status of the work. Requires a willing operator.
4. **Cross-building comparison.** Several buildings, same robot and task, rubric score and operational indicators. Correlational only; to be done last, not first.

An anti-circularity protocol accompanies the programme: spaces are assessed before performance data are known and by someone who does not know them; predictions are written and dated before collection; assessors are independent and their agreement is published; documented cases and illustrative scenarios never count as validation.

What is asked of partners, and what is offered

Asked	Offered
Technical site-requirements documentation given to integrators or customers before an installation	Full attribution in the next edition and in any resulting publication
A twenty- to thirty-minute conversation with someone from deployment, field operations or research	Early access to findings, shared with partners before anyone else
Where possible, a visit to a showroom, test floor or open client site, at the author's expense	A voice in the standard technical data sheet (Appendix G) the book proposes designers request from every manufacturer
Deployment data, anonymised is fine; failure cases where the space was the cause; the questions you wish an interior designer had asked	For operators: the robot-readiness audit from the book applied to the installation, with a written, prioritised result

This is a student research project, not a commercial offer. The author is a student of interior design (BA (Hons), BAID, validated by the University of Hertfordshire, in progress) and would rather be corrected than cited.

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HRED — Human-Robot-Environment Design, 1st edition 2026 (PT), publication forthcoming. 42 chapters, 7 working appendices: glossary PT·EN; index of standards; construction details D1–D8; workbook of ten sheets; specification sheets for twelve typologies; three projects worked end to end, including what went wrong; the standard technical data sheet. English edition in preparation.