ZTHR

ZTHR: The Brief

Zero Trust – High Reliability. Why software built by AI should earn its quality from the environment, and how to build that environment.

Russ Little · v1.0 · © 2026 Russ Little, CC BY 4.0 · DOI: [10.5281/zenodo.23826734](https://doi.org/10.5281/zenodo.23826734)
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1. Generation outran assurance

Generative models have made a candidate implementation cheap and the decision about whether it is fit to use expensive. A workflow that speeds up authorship while leaving every later decision in a human queue moves the bottleneck rather than removing it. Three failures follow.

- **The reviewer bottleneck.** Under volume, reviewers either become the constraint on delivery or approve changes they have not truly checked. Approval becomes evidence of attention, not of correctness, and attention is least reliable exactly when volume is highest.
- **The echo chamber.** Replacing the human reviewer with the model that wrote the change, or one like it, gives the appearance of review without its substance.
- **Probabilistic governance.** A safety property that depends on a model following its instructions is a property that holds most of the time.

The instinct is to wait for a model good enough to trust. That repeats the craft assumption that quality lives in the author. Better models shorten the path to an acceptable candidate. They do not supply the acceptance.

ZTHR instead makes the repeatable parts of engineering a property of the environment. Identity, authorization, audit, deployment and failure reporting arrive with the foundation an application is built on. Acceptance is decided by evidence the author cannot bypass. People spend their expertise on defining intent, governing the checks and judging consequential exceptions.

2. Principle A: Symmetric Zero Trust

In network security, zero trust means location confers nothing. Symmetric Zero Trust applies the same rule to everything in a delivery system that can make a claim, in four directions.

DIRECTION	WHO IS UNTRUSTED	WHAT THEIR ASSERTION CANNOT DO
Build time	The author, human or model	Its explanations are not evidence, and cannot waive a check
Run time	A model inside the product	Its confidence cannot grant access or authorize a consequential action
The checks	Every gate, scanner and test	Green counts only if the check has been shown able to go red, and actually ran
Operators and reports	Automation and documents	A dispatched action is not a result until a later observation confirms it

Stated as something a system can enforce: **no participant can unilaterally redefine, suppress or substitute the evidence that authorizes its own consequential action.**

3. Principle B: the Fixture Inversion

In craft production, quality lives in the craftsperson and a master confirms it by inspection. Conventional software follows that model: quality is attributed to the engineer, and code review is the master's inspection. Manufacturing left the craft model two centuries ago. Jigs, fixtures and gauges let operators of ordinary skill produce parts to tolerances no craftsman could hold. Skill did not disappear; it moved upstream, to the people who designed the fixtures.

ZTHR makes the same move. The author is a generator of candidates. Quality is defined, enforced and evidenced by the fixtures.

Why it is rational now. The craft model made sense when every attempt cost hours of scarce attention. Generative models cut the cost of an attempt by orders of magnitude. When attempts are cheap and evaluation is reliable, the rational strategy is generate-and-test: produce candidates, let fixtures judge them, discard failures without regret. First-pass correctness stops being the goal. Convergence is.

What makes a fixture force quality. It runs rather than being read. The author cannot supply its verdict. It has been proven to fail on the defect it exists to catch. A change cannot weaken the fixture that judges it. Its verdict is pass, fail or unknown, and unknown never becomes pass. It states what it protects, so a generator satisfying it is steered toward the intent and not only the letter.

Jigs before gauges. A jig constrains what can be built; a gauge measures the result. The jig is what makes iteration converge: every decision moved into a governed part is a class of defect no gauge has to catch.

The ceiling. A generator iterating against fixtures produces what the fixtures demand and no more, and it will exploit any gap between a fixture's letter and its purpose. Quality is bounded by fixture fidelity. Every defect that slips through is evidence of a fidelity gap and becomes a

new fixture.

The economics. Code is a liability that grows with every line. A fixture, built once, protects every future change to every application that inherits it. Engineering effort moves from producing code, which does not compound, to producing fixtures, which do. That is why quality and scale are not a trade: one builder or a small team can operate at a level conventional teams reach only with far more people.

The review question changes. Not "is this code good?" but: *which fixture forces that, and has it been shown to bite?*

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4. The six families of patterns

Thirty-three patterns implement the principles. Each states a problem, the forces acting on it, a solution a system can enforce, and its consequences.

Construction (the jigs). Every application starts from a governed foundation that already carries identity, audit, deployment and required checks. Generators assemble from a catalog of qualified parts that state what they are for and what they deliberately do not do, each tested inside a real consumer rather than in isolation. Authorship is a dial set by consequence: the higher the stakes, the less the generator may author, down to an assembly-only tier where it composes qualified parts and has no channel to emit code at all.

Verification (the gauges). No check may be bypassed by anyone. Every named safety gate is proven able to fail by planting the defect it exists to catch, and the proof expires the moment the gate changes. Mutation testing replaces coverage, so tests that execute code without asserting anything cannot satisfy the bar. Ratchets let strict standards enter any codebase: existing debt may stay, but it may not grow. Drift is measured from fixed datums, not from the previous build, so a long series of acceptable steps cannot walk the system somewhere nobody chose.

Intent. User intent is the primary datum. Whole activities a user comes to do are written as journeys, with goals, forbidden outcomes and action budgets, and locked so that no change can edit the goal it is judged by. Journeys walk the product the way people do, by accessible name, reading each screen both as structure and as pixels. Expected values come from the data, never typed into the test. A broken intent stops value delivery, and each team declares in advance what it stops.

Independence. Use the most deterministic tool that can solve the problem; reserve large models for open generation and judgment. Every role is defined as much by what it is denied as by what it receives. At least three model families review every change before commit, one with context, one without, one checking the code independently, and a fourth reviews it in place before promotion. The deepest defense against correlated failure is reading the system in different representations: source, database, built artifact, rendered screen, running service.

Operational. Done means serving: deployment is by content identity, and the system proves what is running is what passed. A persistent operator keeps the pipeline moving under one rule: act, unless the action is destructive, faces an outside audience, or carries a wide blast radius. Every hold must name the loss a person's click prevents. Its limits are enforced by structure, never by its own judgment.

Runtime and environment. Deterministic layers surround any model that speaks to users, so no model is ever the floor. Services refuse to start when a safety condition is missing. Capabilities that should not exist are not mounted or granted at all. In regulated and safety-critical settings the default is caution, and the standard rises as the system proves itself against the human level already accepted. External services are cloned as behavioral twins calibrated to the real, as-built service, the way offline robot programming calibrates its simulation to the real cell.

5. Authority and the control plane

The inversion depends on fixtures the work cannot weaken. The rule for what proceeds on its own is simple. A change that is deterministic, fully audited and revertible in one step proceeds automatically. A destructive or multi-step change requires sign-off, and so does any change to the AI itself or any agent request for wider permissions or scope. If an agent decided to stop running tests, it would have to ask a person to go around the protocol.

The gates, thresholds, journeys, datums and policies form the control plane. Changes to it travel their own attributable path. Ratchets apply steady pressure but occasionally lock in the wrong floor, so every ratchet has a reset lever that only a person pulls, with a stated reason and an audit record.

6. A system that improves itself

Two loops run through ZTHR. The generation loop turns intent into an accepted candidate, with diagnostics written for a model reader and an explicit unresolved state when a budget is spent. The improvement loop turns every escape, stall and recurring cost into a better shared fixture, and counts an improvement as real only when observation shows it worked.

Named gates catch named defects. Three mechanisms go after the rest: mutation testing with ratchets, nightly campaigns that inject bad input and hostile calls against the composed system and its twins, and adversarial re-review by each new generation of models. Because fixtures judge outcomes rather than model responses, a model change, announced or not, faces the full battery on every build. Self-improvement runs as often as it is viable, in small units that can be understood completely and reverted in one step.

7. How to judge it

The headline measure is **intent completion**: how often the software does what it is supposed to do for the people using it. Measure the incumbent first, and compare on equal terms: revision rate per change, time to usable software, time to detect and restore, human hours and cost per accepted change, all normalized for volume. ZTHR spends compute to save attention, and the case for it is that the total is far below the fully loaded cost of the human process it replaces, at equal or better intent completion.

8. Limits

The largest risk is that the system builds what it is told. A bad specification or process definition is enforced faithfully, so specifications are mapped to the existing parts catalog and reviewed from first principles before generation, and the parts themselves carry the integrations, security, documentation and tests a specification might forget. Fixtures cannot force the right intent, taste or design coherence. Model diversity reduces correlated error but does not remove it. People are not removed; they move to where judgment compounds.

9. Adopting it

Adoption is incremental. Establish a governed construction path that produces one useful application. Make acceptance executable and observable. Operate continuously with a bounded operator. Then generalize every lesson into the shared foundation. The patterns describe how and why, not a toolset, so they carry over to most software engineering: each situation defines what success means and builds the machine that makes sure the software does it.

ZTHR is in production use for the development of greenfield systems in a regulated industry, where it has proven highly effective.

The full paper sets out all thirty-three patterns with their forces and consequences, traces failures through the whole system, details the economics and measures, and closes with anticipated objections and open questions for review. It is published openly at zthr.ai.