AETHERMOORE RESEARCH PACKET

Task-Autonomous Fabrication Cell Tech Tree

A build-sense-correct loop for governed fabrication workflows inside a human-specified goal envelope.

fabrication robotics agents governance receipts

Abstract. A task-autonomous fabrication cell receives a human-specified target, decomposes it into build steps, dispatches tools under governance, senses results, corrects its model, and emits receipts for physical actions.

Claim boundary. Not a canonical SCBE production commitment and not a claim of unbounded physical autonomy.

Status: R&D stepping-stone note and build queue seed.

Research grade: Research Brief

Review model: Concept stress-test with unsafe claims fenced before publication.

PDF | Source note

Source Text

Task-Autonomous Fabrication Cell Tech Tree

Status: R&D stepping-stone note / build queue seed; not canonical SCBE architecture Date: 2026-05-22 Scope: agentic fabrication, robotics, embodied AI safety, GeoSeal runtime assurance Canonical constraint: task-autonomous within

a human-specified goal and safety envelope Audience: internal R&D triage; not a patent claim, proposal claim, or production commitment

0. Status Boundary

This note is adjacent to SCBE-AETHERMOORE. It shares the governance principle: every embodied action stays inside a deterministic envelope and leaves an audit receipt. It is not part of the canonical SCBE architecture unless later promoted through a separate review.

The win preserved here is the method, not just the conclusion:

```
vivid idea -> stress test -> fenced overreach -> kept core
```

If a later draft carries only the kept core and drops the fence, the claim is unsafe. The correction travels with the claim.

0.1 Provenance Ledger

Vivid idea	Stress test	Fence that must travel with it	Kept core
Spin voxels / magnetics	Physical spin claims were asserted, not derived	Do not claim Heisenberg physics, topological crypto, magnonics, or Grover resistance	Vector-field coherence and angular disorder are useful read-side drift signals
Tesseract build orchestration	No fourth spatial dimension was specified	Use 3D plus build-time only; do not imply real 4D spatial machinery	Build sequence can be modeled as a time-indexed state space

Vivid idea	Stress test	Fence that must travel with it	Kept core
Printer builds itself smaller	The first machine was built by an external supply chain	Do not claim total self-fabrication; silicon/controllers remain sourced until a real semiconductor process exists	Raise the self-fabricable fraction one capability at a time
Full autonomy by stacked tasks	Subtask generation still traces back to a root goal	Do not claim unbounded or self-originating autonomy	Use task-autonomy inside a human-specified goal-and-constraint envelope
Private crash testing	Concealment framing is wrong and harmful	Do not frame safety testing as hiding failures	Dangerous failures belong in simulation/closed environments, with audit logs that survive review

Every section below should be read through this ledger.

1. One-Sentence Mechanism

A task-autonomous fabrication cell receives a human-specified target artifact, decomposes it into build steps, dispatches fabrication tools as governed tool calls, senses the result, corrects its model, and emits receipts proving every physical action stayed inside a bounded safety envelope.

Short form:

```
task-autonomous, human-specified goal-and-constraint envelope, ur
```

Do not shorten this to bare "autonomous fabrication cell" in technical, proposal, patent, or customer-facing materials.

2. What This Is Not

This is not a claim of unbounded autonomy.

This is not a claim that a 3D printer can fabricate every component needed to replicate itself.

This is not a claim that simulation removes the need for physical testing.

This is not a claim that a kiln, foundry, or printer is the key invention. Those are possible test articles. The key invention candidate is the governed build-sense-correct loop.

The honest scope is:

```
human specifies the target
system owns the how
governance owns the envelope
receipts prove the path
```

That is task autonomy, and it is the useful level for this adjacent R&D line.

3. The Senku Step

The generative step is not the kiln, the foundry, or the printer.

The generative step is the closed build-sense-correct loop:

```
plan -> act -> sense -> compare -> correct -> receipt
```

This is the "kiln" of the system because it produces a reusable capability rather than a one-off artifact. Once the loop is reliable, harder build targets become a schedule instead of a guess.

Fence: this does not make self-fabrication solved. It only makes future fabrication claims measurable because the system can compare intended action against observed result.

4. Capability Ladder

Rung	Capability	Why it matters	Status target
0	Digital twin / simulator	Failure is cheap; test policies before hardware	software-first
1	Tool-call registry	Printers, cameras, scales, heaters, arms become typed operations	buildable now
2	Self-modeling sensor loop	System measures its own tool/body state and calibration drift	first hard rung
3	Closed-loop trivial build	Make/assemble a simple bracket or block stack, verify tolerance	first demo
4	Multi-step thermal artifact	Kiln-like target with heat schedule and crack/failure checks	first real target
5	Output becomes tool	Built artifact extends the cell's capability, e.g. kiln used for next material step	first recursion
6	Collaborative machine buddies	Multiple tools hold, hand off, inspect, and correct each other	robotics expansion
7	Continual learning under rate limits	Online adaptation without catastrophic forgetting	controlled R&D
8	Fabrication fraction increases	Structure + conductors + coils + simple actuators	capability curve
9	Silicon remains sourced	Chips/controllers remain bought-in until a real fab process exists	hard boundary

The self-fabrication question becomes measurable:

```
self-fabricable fraction = components made in-cell / components r
```

The goal is to raise that fraction honestly, not claim total self-replication.

Boundary: if a target depends on chips, controllers, sensors, precision bearings, or materials the cell cannot make, those components are sourced. Sourced components are allowed, but they must be named.

5. Tool Calls For Physical Fabrication

Treat each physical machine as a governed tool surface.

Tool class	Example operations	Required gate
3D printer	slice, print, pause, resume, cancel	thermal/workspace safety
CNC / subtractive	cut, drill, surface, deburr	material + collision gate
camera / scanner	capture, measure, compare	read-only provenance
scale / caliper	weigh, measure, tolerance check	read-only provenance
kiln / heater	ramp, hold, cool, emergency stop	high-risk thermal gate
robot arm	grasp, hold, move, handoff	collision + human-zone gate
winder	wind coil, count turns, tension check	actuator fabrication gate
human interface	approve, reject, abort, re-scope	explicit envelope boundary

Every tool call should produce a receipt:

```
{
  "schema_version": "scbe-fab-receipt-v0.1",
  "tool": "printer.main",
  "operation": "print",
  "target": "calibration_bracket_v1",
  "decision": "ALLOW",
  "pre_state_hash": "sha256:...",
  "post_state_hash": "sha256:...",
  "sensor_refs": [],
  "risk": {
    "thermal": "low",
```

```
    "collision": "none",
    "human_zone": "clear"
  }
}
```

6. Safety Envelope

Constraints are not the weakness of the system. They are the safety case.

They are also the liability case: the system should be able to show what was requested, what was allowed or denied, why the decision was made, and which sensor evidence supported the decision.

The envelope must make the following impossible or fail-closed:

- tool motion outside workspace bounds
- heater/kiln runaway
- robot arm entering human exclusion zone
- printer continuing after thermal fault
- destructive operation without a dry-run or explicit authorization
- model-generated command reaching actuator without deterministic gate
- post-release learning changing actuator policy without rate limits and rollback

Minimum decision tiers:

Tier	Meaning	Physical action
ALLOW	within bounds, low risk	execute
PROBE	uncertain but safe to simulate/test	dry-run or sensor-only
ATTENUATE	allowed only at reduced speed/power/scope	execute bounded
ESCALATE	needs human approval	stop and request
DENY	unsafe or out of envelope	stop and receipt

Fence: the envelope is not optional polish. Removing it does not produce a more advanced system; it removes the system's safety case.

7. Training And Learning Boundary

The system can learn during use, but only in controlled lanes.

Allowed first:

- update calibration offsets
- update sensor-noise estimates
- update tool wear estimates
- store failure cases for offline replay
- train small adapters in a sandbox

Not allowed first:

- live weight updates to actuator-control policy
- irreversible changes to safety thresholds without review
- model-originated expansion of allowed operations
- hidden "goal" creation outside human target and envelope
- task generation that detaches from the human-specified root goal

Safe architecture:

```
fast actor: executes bounded task plan
slow learner: consolidates logs offline
gate: promotes changes only after tests
rollback: restores previous policy on regression
```

8. Cross-Platform Transfer

The transferable asset is not the hardware. It is the abstract governance loop.

The same state-vector gate can support:

- fabrication cell

- wheelchair / adaptive mobility platform
- drone / aerial platform
- robot arm / lab automation platform

Shared state fields:

```
{
  "pose": [],
  "velocity": [],
  "energy": 0.0,
  "thermal_state": {},
  "tool_state": {},
  "human_zone_clear": true,
  "risk_scalar": 0.0,
  "intent": "human-specified-target",
  "workspace": "bounded-volume-id"
}
```

Vehicle/platform-specific testing still remains required. The shared gate can be validated once as logic; actuators and dynamics are validated per platform.

Fence: cross-platform transfer applies to the abstract governance loop and representation. It does not transfer vehicle dynamics, actuator safety, certification evidence, or physical hazard testing.

9. First Demo

Do not begin with kiln-to-foundry.

Begin with:

```
task: make and verify a calibration bracket
tools: printer + camera/scanner + caliper/scale if available
loop: plan -> print -> inspect -> compare -> reprint/correct -> r
```

Acceptance:

- target dimensions specified before print
- printer command generated as a governed operation packet
- sensor inspection produces a measured error vector
- system chooses either accept, adjust, or reject
- all steps emit receipts
- no live dangerous action occurs without a deterministic gate

This is the first demonstrable milestone because it proves the method:

```
the loop closes unmanned on a trivial task
```

It is more important than the artifact being impressive.

10. Later Demo: Kiln-To-Foundry

The kiln/foundry path is a strong later target because controlled heat unlocks many downstream capabilities.

Frame it as:

```
the closed loop builds a tool that expands the closed loop's futu
```

not:

```
the machine is self-replicating
```

Milestones:

1. simulate kiln build and thermal ramp
2. build passive refractory test piece
3. measure cracks/deformation after firing
4. close thermal feedback loop
5. use kiln output in a second controlled build

Fence: kiln-to-foundry is a later integration target, not the first milestone and not evidence of full autonomy or self-replication.

11. Claims Safe For External Use

Safe:

- task-autonomous fabrication workflow
- governed physical tool calls
- digital twin before hardware
- closed-loop self-modeling and calibration
- auditable safety receipts
- platform-agnostic runtime assurance for embodied AI
- increasing self-fabricable fraction over time

Avoid:

- fully autonomous self-originating goals
- self-replicating machine without component-boundary disclosure
- no-human-input without specifying level of autonomy
- hiding failures to avoid liability
- claims that simulation replaces physical validation

11.1 Audience Split

This note should not be copied unchanged into proposals, patent material, or public pages.

Destination	Use	Required rewrite
internal R&D	Preserve the whole correction ledger	keep fences and dead ends visible
implementation build card	Simulated bracket loop only	remove kiln/foundry except as deferred target
SBIR/capability statement	Platform-agnostic runtime assurance	lead with bounded autonomy and audit receipts
patent counsel packet	Mechanism disclosure	identify human root goal, envelope, receipts, and sourced components

Destination	Use	Required rewrite
public demo	Safe visual proof	no self-replication or full-autonomy language

If this idea feeds the SBIR/capability-statement track, the phrase to carry forward is:

```
platform-agnostic runtime assurance for embodied AI systems
```

not:

```
self-replicating autonomous fabrication
```

12. Build Card

```
{
  "schema_version": "scbe-doc-build-card-v1",
  "title": "Task-Autonomous Fabrication Cell",
  "status": "research-only/design",
  "not_canonical_scbe": true,
  "do_not_build_yet": [
    "live hardware actuation",
    "autonomous goal origination",
    "self-replication claims",
    "kiln/foundry endpoint"
  ],
  "core_claim": "A bounded agentic system can dispatch physical f
  "repo_anchors": [
    "docs/research/TASK_AUTONOMOUS_FABRICATION_CELL_TECH_TREE_202
    "docs/specs/AETHERFAB_PUF_NEGATIVE_RESULT.md",
    "docs/research/drone_autonomy_training_patterns_2026-05-02.mc
    "docs/ops/REGENERATIVE_AI_MOBILITY_OPEN_SOURCE_STACK_2026-05-
    "docs/superpowers/specs/2026-05-22-geoseed-infinity-box-runti
```

```
  ],
  "risk_class": "physical-action",
  "first_slice": {
    "goal": "simulate a governed build-sense-correct loop for a c
    "files": [
      "scripts/system/fab_cell_sim.py",
      "tests/system/test_fab_cell_sim.py",
      "artifacts/fab_cell/"
    ],
    "tests": [
      "safe print plan emits ALLOW receipt",
      "out-of-bounds tool path emits DENY receipt",
      "measured error triggers adjust/retry decision",
      "no hardware command is emitted in simulation mode"
    ],
    "acceptance": [
      "deterministic JSON receipts",
      "human target remains root of task tree",
      "all physical action stays simulated"
    ]
  }
}
```

Generated from `research/TASK_AUTONOMOUS_FABRICATION_CELL_TECH_TREE_2026-05-22.md` by `scripts/research/build_research_library.py`.