HYLOS LABS · FOUNDATIONAL THESIS & SYSTEM ARCHITECTURE

AI can reason about the physical world.
It still cannot be trusted to act in it.

Foundation models have transformed language, images, and code. In the physical world—mechanical assemblies, tooling, and manufactured hardware—that progress hits a wall: generation is not operability. Hylos is the bidirectional physical compiler that turns multimodal intent into coupled, DFM-verified B-Rep CAD and manufacturing reality.

DOCUMENT	FIRST PRODUCT	EMPIRICAL CORPUS	IP & MOAT
Public Whitepaper · v4.0 No NDA · Distribution Safe	Impulse — Delegable CAD & Physical Compiler	4,362 Graded Runs 26.3% False-Pass Catch Rate	USPTO Patent Pending (3 Core Inventions) + Server-Side Compiler Trade Secrets

CONTENTS

01	The Pattern That Builds Platforms & The Physical Gap	Transactions, compilers & the 26.3% silent false-pass wall
02	Why MCP Tool Glue Fails & Why Model Scale Needs a Compiler	The mesh wall, lost Jacobians & the LLVM leverage law
03	The Bidirectional Physical Compiler & The 4 Execution Planes	Bits ⇄ Causal IR ⇄ Atoms & the Standard Library of Matter
04	The 5 Discrete Credit Doors & The 4-Tier Physics Onion	Sub-1ms rigging, OCCT calipers & 6-domain adjoint PDEs
05	Impulse in Action — Verified Multi-Part Assemblies	Live builds from sketches & photos · zero human CAD edits
06	Distilling the Compiler into Weights — The RLVR Flywheel	Teacher → Student distillation & multi-gate corpus quarantine
07	Why Doesn't This Exist Yet? Three Graveyards & The Four-Tribe Moat	Why mesh startups, script wrappers & CAD incumbents stall
08	Where the Money Lives & Where It Truly Ends	Delegable engineering, the BOM SKU rail & Verilog for Matter
09	Disclosure Boundary & Intellectual Property Posture	Public claims vs. patent portfolio & NDA data room
10	What We Believe	Six foundational convictions of physical compilation

01 · THE PATTERN THAT BUILDS PLATFORMS

Every computing era became buildable when a powerful, untrustworthy substrate got a transaction and compiler layer.

Across the history of technology, raw capability has never been enough to build an industry. Commerce across strangers did not scale until **double-entry bookkeeping** forced every credit to reconcile against an equal debit. Shared enterprise software did not work until **ACID transactions** (System R, 1976) guaranteed that multi-step writes either satisfied every schema constraint or rolled back cleanly. Packet networks were unreliable curiosities until **TCP** added sequence numbers, checksums, and retransmission. And modern software engineering—including today's AI coding agents—only works because **compilers and type systems** (LLVM, TypeScript, Rust) turn probabilistic edits into deterministic diagnostics before code ever ships.

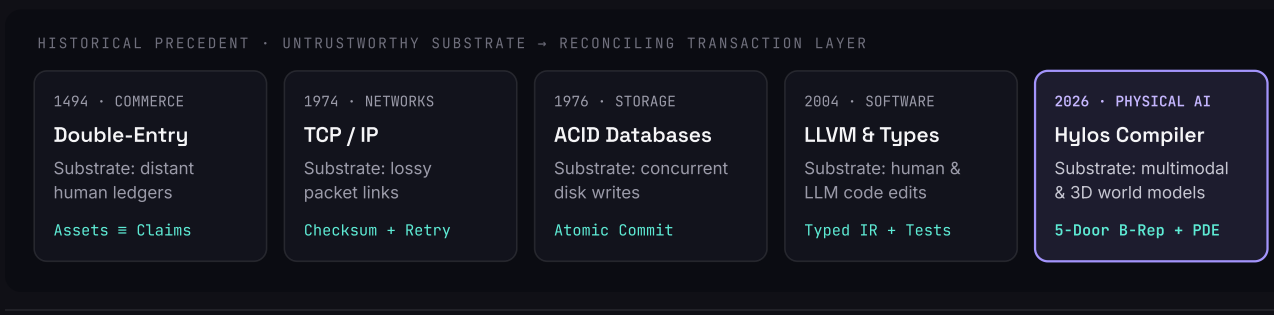


FIGURE 1 · WHY FOUNDATION MODELS NEED A PHYSICAL TRANSACTION & COMPILER LAYER HYLOS LABS ARCHITECTURE

Today, foundation models are the newest powerful, untrustworthy substrate. Nearly half of US adults (`49%`) and `68%` of knowledge workers use AI daily. In software engineering—where compilers, type checkers, and test suites sit underneath the model—`42%` of organizations already trust AI agents to execute multi-step workflows (`12×` efficiency). Yet in physical engineering and CAD, the numbers tell a starkly different story:

17.5%
BEST-AGENT SUCCESS ON REAL CAD TASKS · CADWORLD (2026)
ZERO TASKS SOLVED ON THE HARDEST TIER

25% vs 78%
EXPERT ACCEPTANCE OF FRONTIER-MODEL CAD EDITS VS. HUMAN DESIGNERS
NEURALCAD-EDIT · AUTODESK RESEARCH (2026)

26.3%
RAW MODEL TURNS CAUGHT CLAIMING COMPLETION OVER BROKEN GEOMETRY
HYLOS EMPIRICAL LEDGER · 4,362 GRADED RUNS

Discontinuous Physical Boundaries & The Silent False Pass

Physical matter does not forgive approximations. A `0.2 mm` wall-thickness error on a cantilever snap-fit changes bending strain by `$\propto t^2$` and snaps the hook on first closure. A `1.7 mm` un-rounded hinge knuckle backstop binds solid at `42°`. Worse, when a foundation model writes CAD operations directly, its primary

failure mode is not a syntax crash—it is **silent false success**. Across `4,362` graded runs in our engineering corpus, **`26.3%` (`1,148` runs)** of raw model turns claimed success while the realized solid was physically defective:

WITHOUT A PHYSICAL COMPILER · THE SILENT FALSE PASS

"Done. I hollowed the lower enclosure to a 1.8 mm wall, added the two M3 mounting bosses, and aligned the lid seam."

WHAT ACTUALLY HAPPENED INSIDE THE KERNEL (UNCAUGHT WITHOUT VERIFICATION)

SILENT GEOMETRY DEFECT · The inner cavity cutter was extruded along +Y above the rim instead of -Y into the body. The boolean subtract returned a valid solid with **0.0 mm³ removed**. The enclosure is a solid brick, and the M3 bosses have **0.25 mm wall thickness** (shears on assembly).

WITH HYLOS · CAUGHT & REPAIRED VIA EXACT SENSITIVITY BEFORE COMMIT

TRANSACTION REFUSED → AUTO-INVERTED REPAIR · Independent B-Rep calipers caught zero cavity volume (`ΔV = 0.0 mm³`) and thin boss wall (`0.25 mm < 1.20 mm`). Hylos computed the exact parameter sensitivity via its proprietary inverse-law solver, inverted the cut normal, thickened the boss outer diameter, and verified the repaired solid on the next turn (`ΔV = -41,820 mm³`, wall `1.80 mm`, `5/5` credit doors `PASS`).

02 · THE ARCHITECTURAL PROOF

Why you cannot wire legacy CAD & sim tools via MCP—and why smarter models make compilers 10× more valuable.

Every technical investor and engineering leader eventually asks two questions: *(1) "Why not just connect Onshape, SolidWorks, SimScale, and Omniverse to a frontier LLM with MCP tool calls?"* and *(2) "Won't a 10× smarter foundation model solve this without a compiler?"* There is a rigorous mathematical answer to both: **API glue loses the physical sensitivity (the Jacobian) across exported triangle meshes**.

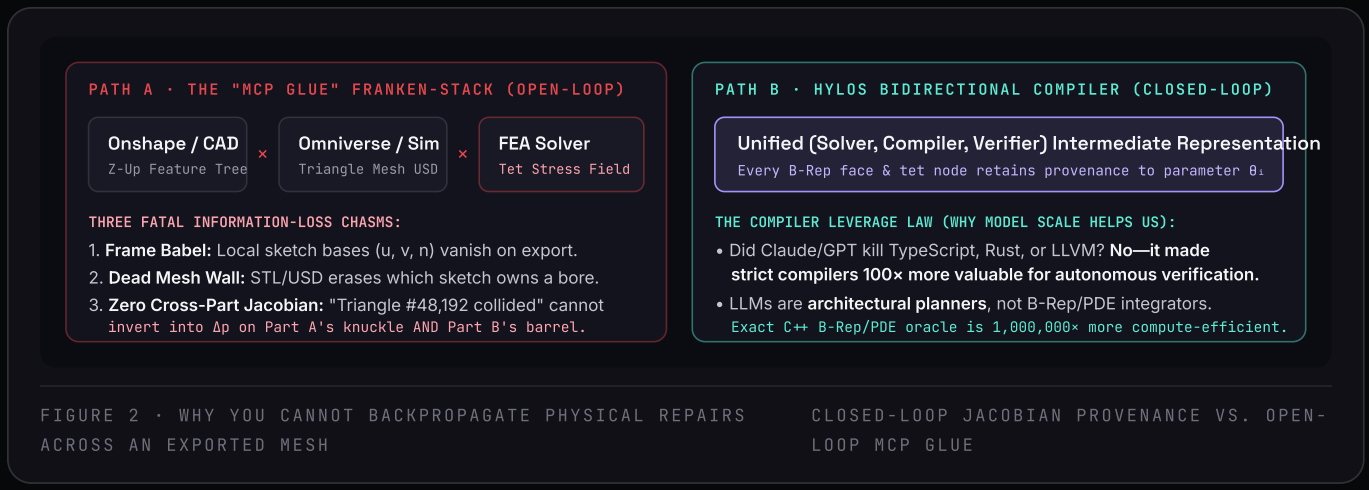


FIGURE 2 · WHY YOU CANNOT BACKPROPAGATE PHYSICAL REPAIRS ACROSS AN EXPORTED MESH — CLOSED-LOOP JACOBIAN PROVENANCE VS. OPEN-LOOP MCP GLUE

03 · THE BIDIRECTIONAL PHYSICAL COMPILER

One shared intermediate representation for synthesis (Bits → Atoms) and decompilation (Atoms → Bits).

Hylos is organized around a single **Causal Intermediate Representation `(Solver, Compiler, Verifier)`** that runs in both directions. In the **forward direction (`Bits → Atoms`)**, multimodal evidence and engineering briefs compile into coupled, multi-part B-Rep assemblies and tooling. In the **inverse direction (`Atoms → Bits`)**, existing STEP files, multi-view photographs, or physical test measurements decompile back into editable coordinate frames, coaxial joint axes, and parametric feature trees:

1 · FORWARD SYNTHESIS

Coupled Multi-Part Compilation

Instead of an LLM guessing coordinates part-by-part in isolation, Hylos compiles mating features across Part A and Part B **simultaneously from one physical law**—guaranteeing coaxial hinge bores, `0.00 mm` parting seams, and non-yielding snap clasps on first compile.

2 · INVERSE DECOMPILATION

X-Ray Mechanical Comprehension

Given vendor STEP solids or reference photos of an existing mechanism, Hylos extracts exact cylindrical bore/boss inventories, screw axes, parting lines, and hidden internal clearances into an editable constructive operation program.

3 · CLOSED-LOOP SYSTEM ID

Self-Correcting Physical Laws

When a physical prototype or continuum solve measures resin shrinkage or a `19 N` snap insertion force against a `15 N` target, the residual feeds back through the exact same parameter sensitivity matrix (`∂g/∂θ`) to recompile the geometry automatically.

Four Deterministic Execution Planes × Six Orthogonal Schema Axes (`2,592` Cells)

Impulse does not use product-noun templates or category hacks. Every assembly—whether a hinged consumer enclosure, a planetary gear reducer, or a medical autoinjector—flows through **Four Deterministic Execution Planes** governed by **Six Orthogonal Schema Axes** (swept exhaustively across `2,592` Cartesian cells in `0.47 s` offline):

PLANE 01 · PERCEPTION & DECOMPILATION

Calibrated 3D Perception & COTS Ingest

Enforces a strict epistemic hierarchy across measured solids, visual references, and user briefs. Corrects perspective foreshortening on articulated assemblies via calibrated `SO(3)` camera projection, synthesizes exterior and **interior-cutaway** spatial evidence, and ingests standard off-the-shelf hardware (STEP assemblies and industrial catalog components) into the scene graph.

PLANE 02 · RELATIONAL PACKAGING & SEAT SOLVING

Automated Packaging & Interface Solving

Resolves internal component packaging (PCBs, batteries, motors, connectors) and physical access clearances before synthesizing outer enclosures. Simultaneously solves `46` mechanical interface classes across mating bodies—enforcing positive mechanical engagement, non-interfering clearance envelopes, and shared parting geometry.

PLANE 03 · COUPLED CAD LOWERING & RECOVERY

Simultaneous Seam & Joint Compilation

Compiles mating enclosure shells and parting interfaces simultaneously for guaranteed `0.00 mm` seam alignment. Lowers cross-part mechanical joints via **The Standard Library of Matter**: (1) *Knuckle-Pin Hinge*, (2) *Cantilever Snap Clasp*, (3) *Conjugate Gear Pair*, (4) *Ratchet & Pawl*, (5) *Annular O-Ring Gland*, (6) *Bearing Pocket & Shoulder*, and (7) *Fastened Boss & Counterbore*—backed by deterministic kernel recovery.

PLANE 04 · COMPILE-TIME SINGLE-AUTHORITY LAW

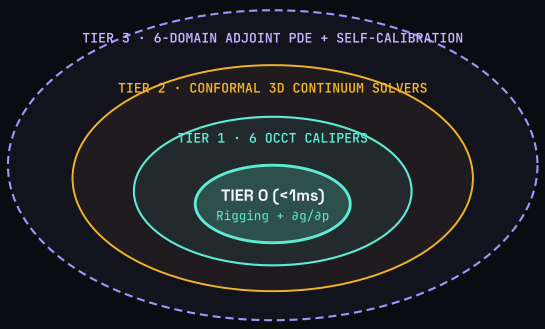
Single-Authority Type & State Invariants

The deadliest failure in neuro-symbolic CAD is a *split-authority bug*: the planner prescribes geometry against one coordinate frame while the verifier grades against another. Hylos makes this unrepresentable at compile time via strict constructor-restricted type invariants across planning, realization, and verification—proven across `228/228` reachable runtime states.

04 · MULTI-FIDELITY VERIFICATION & CONTINUUM PHYSICS

Every part must clear Five Discrete Credit Doors backed by a 4-Tier Concentric Physics Onion.

You do not replace millisecond analytical equations with slow 3D finite-element solvers—and you do not pretend beam formulas can solve 3D stress risers, watch-escapement inertia, or fluid manifolds. Hylos wraps them in a **4-Tier Multi-Fidelity Solving Continuum** where fast inner rings filter `90%` of geometric and kinematic errors in milliseconds, outer rings certify 3D continuum fields and backpropagate **Differentiable Adjoint PDE sensitivities** straight into the CAD feature tree, and every 3D PDE solve continuously **self-calibrates the inner-loop analytical surrogates**:



THE 5 DISCRETE CREDIT DOORS + LYAPUNOV DESCENT CLOCK

DOOR 1 · MANIFOLD	Watertight B-Rep solid, V > 0, live material zone
DOOR 2 · OPERABILITY	6-process DFM (wall/draft/undercut) & 11-pose sweep
DOOR 3 · ASSEMBLY	Coaxial bores, cross-seam clasp ≥1mm, 0.0mm³ clash
DOOR 4 · CONTINUUM	Elasticity, modal resonance, snap strain, thermal & flow
DOOR 5 · FORM ($0)	Deterministic SO(3) anchor alignment & seam step ≤0.5

FIGURE 3 · THE 4-TIER CONCENTRIC PHYSICS ONION & THE 5 DISCRETE CREDIT DOORS CLOSED-LOOP SENSITIVITY BACKPROPAGATION · ZERO IN-LOOP VLM CRITIQUE ($0.00)

PHYSICS TIER	CAPABILITIES & PHYSICAL DOMAINS	LATENCY	CLOSED-LOOP OUTPUT
Tier 0 · Pre-Kernel & Rigging USPTO PATENT PENDING	**Foundational Spatial Operability Inventions:** (I) Dual-stream geometric/symbolic token generation with synchronous spatial validity linter & next-token masking; (II) Contract-violation-triggered latent spatial repair / Test-Time Adaptation (TTA) loop; (III) Parametric neural edit handles & predictive spatial Jacobian fields (`∂X/∂h`, `∂g/∂h`) for **`60–120 FPS` zero-kernel viewport handle dragging** + 7 analytical physics laws.	< 1 ms	Masks or projects out-of-bounds parameters onto the feasible manifold before invoking OCCT; clamps user handle drags to DFM limits in real time.
Tier 1 · Exact OCCT Calipers 6 B-REP INSTRUMENTS	Proprietary B-Rep geometric and mass-property calipers verifying uniform wall thickness, moldability draft angles, coaxial bore alignment, full-range articulated motion sweeps, internal containment volume, and parting-seam continuity.	50 – 300 ms	Evaluates all 5 Credit Doors deterministically at `$0.00` VLM cost and synthesizes exact millimeter parameter repairs via our proprietary law-inversion engine.
Tier 2 & 3 · Continuum Adjoint PDE 6 PHYSICAL DOMAINS	Proprietary B-Rep-to-continuum lowering across **6 physical domains**: (1) 3D structural elasticity, (2) Modal resonance & mechanism inertia, (3) Kinematic backlash & contact stress, (4) 3D thermal conduction & thermo-elastic drift, (5) Internal fluid flow & pressure drop, and (6) Coupled electromechanical system dynamics.	150 ms – 30 s	Single-pass adjoint sensitivities across all CAD parameters simultaneously, plus continuous self-calibration of Tier 0 surrogates.

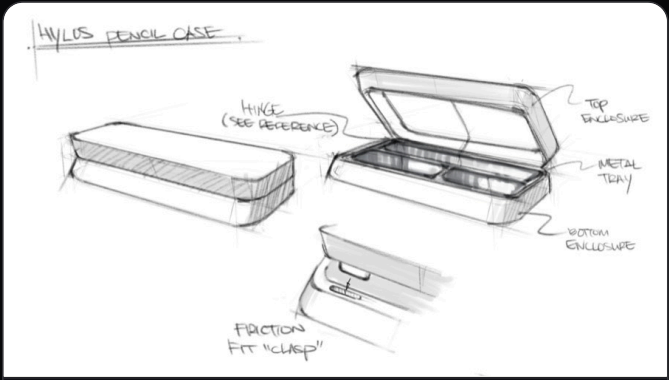
THE MONOTONE CONVERGENCE CLOCK · WHY USERS NEVER PAY FOR FAILED TURNS

Every assembly turn is governed by a proprietary strict-descent progress measure `Φ(S)` over verified physical state. The runtime mathematically forbids oscillating repair cycles—and because internal recovery and repair turns are absorbed by the compiler, **customers are billed strictly for monotone forward physical progress (`ΔΦ > 0`).**

05 · IMPULSE IN ACTION · EMPIRICAL PROOF

From rough sketches and reference photos to watertight, articulated CAD assemblies—with zero human CAD edits.

Impulse is our commercial product built on the Hylos compiler. An engineer drops in whatever inputs they have—a hand-drawn dimension sketch, a smartphone photo of a mechanism to match, or a functional brief—and Impulse plans the bill of materials, resolves dimensional contradictions via explicit engineering ballots, and compiles every part through all five credit doors.



INPUT 01 · ENGINEER'S HAND SKETCH

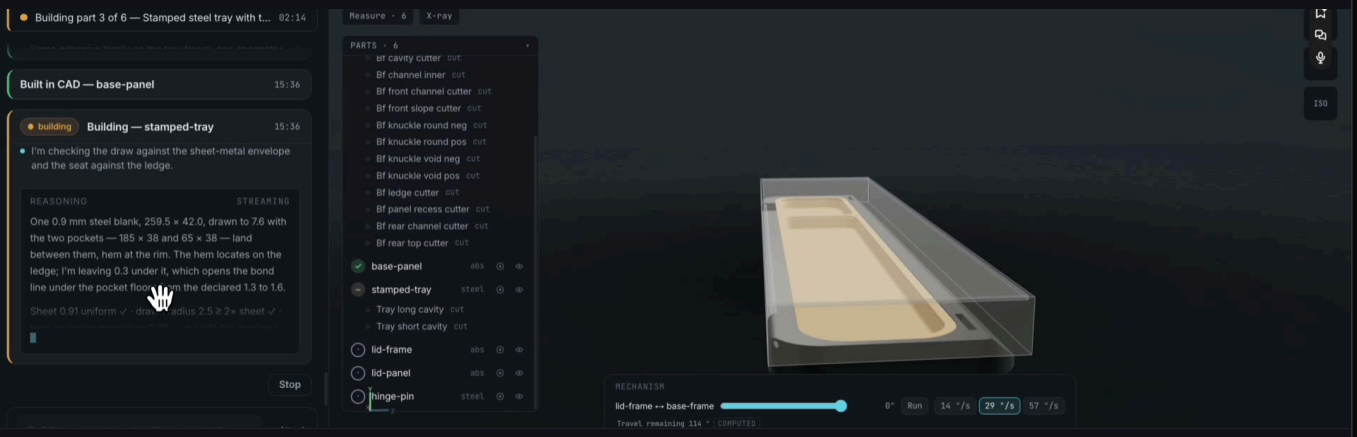
Overall envelope (`215 × 65 × 22 mm` closed), `1.8 mm` nominal shell wall, and three interior storage bays (`185 × 14 mm`, `125 × 28 mm`, `58 × 28 mm`).



INPUT 02 · REFERENCE MECHANISM PHOTO

Flush rear knuckle barrel with a `Ø2.0 mm` stainless hinge pin and integrated front snap clasp across the parting seam.

LIVE PRODUCT RECORDING · SKETCH + REFERENCE PHOTO → VERIFIED 4-PART ARTICULATED ASSEMBLY



Unedited capture from the live Impulse workspace (`02:13`). The compiler extracts dimensions from the hand sketch, resolves the `1.0 mm` closed stack conflict between the `12.0 mm` tray + `10.0 mm` lid labels and the `22.0 mm` overall height callout, and compiles all four mating parts (`Lower Tray`, `Top Lid`, `Ø2.0 mm Hinge Pin`, and `Front Snap Clasp`) through the 5 Credit Doors.



VERIFIED CUTAWAY SHEET

Three-bay interior layout (`1.80 mm` uniform walls and floor) with zero exterior wall breach.



OPEN KINEMATIC POSE (`110°`)

Verified collision-free across `0° → 113.9°` coaxial pin rotation; rear backstop contacts at `113.9°`.



MASTER-SPLIT SEAM (`0.00 MM` STEP)

Lower tray and top lid rims share a coupled boundary profile (`215.0 × 65.0 mm`, `R4.0 mm` corners).

PROOF 01 · ARTICULATED ENCLOSURE

4 / 4 Credited

Sketch + Photo Input: `21.0 mm` closed stack (`≤ 22.0 mm` limit), `0.00 mm` seam step, `113.9°` collision-free hinge sweep, `3 µm` backstop contact, `0` human CAD edits.

PROOF 02 · AUTOMATIC FEEDER

11 / 11 Credited

Single Reference Photo: Complete housing, hopper, motorized rotor vane, chute, and sealed lid assembly—every part watertight and clearance-verified in one run.

PROOF 03 · SPRING MECHANISM

13 / 13 Credited

Functional Spec Brief: Multi-part coaxial spring-driven mechanism with concentric cylindrical housing, plunger, latch, and retention cap—`0.00 mm³` interference.

06 · THE RLVR DATA FLYWHEEL & SPECIALIST SPATIAL WEIGHTS

Static 3D datasets only show final shapes. Hylos mines verified (Conviction → Jacobian Repair → +ΔΦ) trajectories.

Public 3D datasets (Objaverse, ShapeNet, ABC) contain static final meshes or unverified part files. They never contain the **causal engineering process**: how an ambiguous human sketch was disambiguated, why an initial shell or boss failed a physical check (`y_l`), which upstream coordinate frame owned the contradiction, and what exact constructive edit resolved it (`y_w`). Because every live Impulse session runs through our 5-Door OCCT + Continuum PDE verifier, commercial usage continuously generates the training corpus required to distill our compiler into specialist spatial weights.

PHASE A · ACTIVE TODAY

Frontier Teacher + Mining

Frontier multimodal models serve live planning & authoring while the 5-Door verifier harvests greenfield SFT exemplars, multi-turn repair traces, and DPO pairs `(x, y_w, y_l)`.

→

PHASE B · OFFLINE RLVR

SFT + DPO + 5-Door GRPO

Specialist open-weights models train on verified constructive programs, DPO negative false-passes, and online GRPO scored directly by the 5-Door + Continuum PDE reward oracle.

→

PHASE C · INNER-LOOP SWAP

Zero-Code Task Cutover

Once a specialist checkpoint beats the Frontier Teacher on Turn-1 5-Door pass rate and latency, inner-loop CAD authoring & repair cut over—driving gross margins from `~60%` past `80%+`.

NOUN-FREE CROSS-DOMAIN TRANSFER

Indexed by Structural & Topological Signature, Never Product Labels

Trajectories are indexed strictly by proprietary geometric and interface signatures rather than product category nouns. A verified snap-fit or coaxial bore repair learned on a consumer enclosure transfers automatically to a medical autoinjector or aerospace actuator.

MULTI-GATE ASSEMBLY QUARANTINE

Zero False-Pass Poisoning in the Positive Pool

A training flywheel only compounds if false positives are ruthlessly excluded. A part trajectory enters the positive training pool only when the complete assembly clears our multi-gate physical and topological quarantine under the current verifier epoch—while historical false passes are converted into high-signal DPO negative pairs.

07 · COMPETITIVE LANDSCAPE & DEFENSIBILITY

Why hasn't a startup or CAD incumbent shipped this? Three Startup Graveyards and the Four-Tribe Chasm.

If a Bidirectional Physical World Compiler unlocks hundreds of billions in engineering labor and manufacturing, why hasn't Autodesk, Siemens, a foundation-model lab, or a venture startup already built it? Because every previous attempt has died in one of **Three Predictable Graveyards**—and crossing over requires uniting four engineering disciplines that almost never coexist in the same company:

GRAVEYARD 01 · MESH MIRAGE

Tripo / Meshy / Rodin / Splats

Optimize for 10-second visual plausibility using diffusion or Gaussian splats. Output is a fused, non-manifold triangle soup with zero internal walls, zero coaxial bores, and zero STEP faces—unusable for CNC, molding, or real mechanisms.

GRAVEYARD 02 · PROMPT-TO-SCRIPT

1-Part Text-to-CadQuery

Ask an LLM to write raw Python CAD scripts in a blind retry loop. Works on a single L-bracket; collapses on a 10-part assembly because there is no shared `SE(3)` frame solver, no coupled cross-part joint compiler, and no Jacobian when parts collide.

GRAVEYARD 03 · SEAT PRISON

SolidWorks / NX / Onshape

Built on 1990s single-part mouse-click history trees where a part knows nothing about its neighbor's physics—and trapped by `$5,000/yr` human seat licenses where an autonomous compiler that `15×`'s output cannibalizes their core business model.

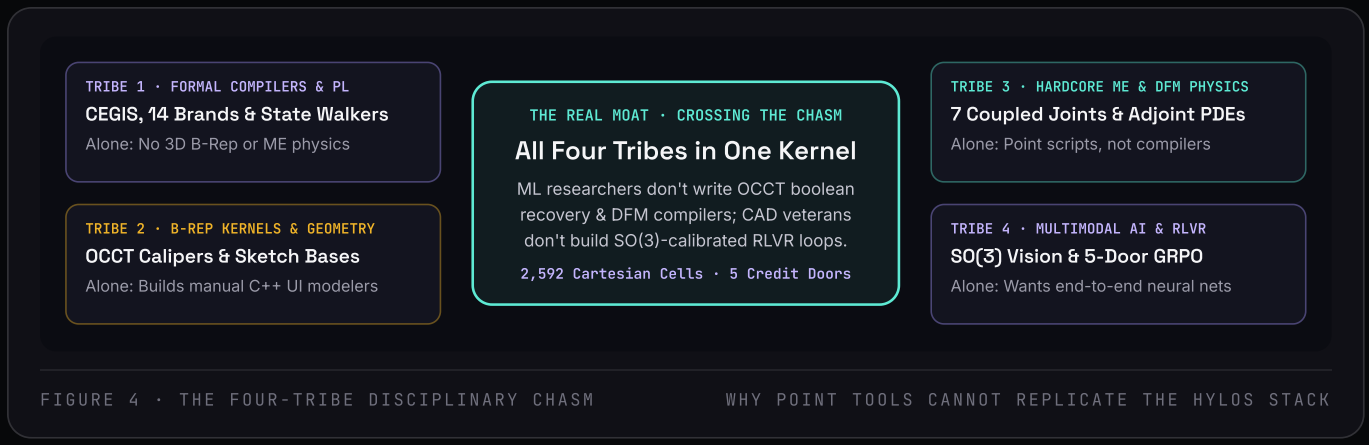


FIGURE 4 · THE FOUR-TRIBE DISCIPLINARY CHASM — WHY POINT TOOLS CANNOT REPLICATE THE HYLOS STACK

PLATFORM / CATEGORY	WATERTIGHT STEP B-REP	COUPLED MULTI-PART JOINTS	AUTO-INVERTING PHYSICS (`∂G/∂P`)	INVERSE PHOTO / STEP DECOMPILE
SolidWorks / Onshape / NX	MANUAL ONLY	MANUAL MATES	NONE (OPEN-LOOP)	DUMB IMPORTED SOLIDS
Tripo / Meshy / World Labs	TRIANGLE SOUP / SPLATS	FUSED SINGLE SHELL	NONE	VISUAL ONLY
Zoo.dev / Text-to-CAD	YES (SINGLE PART)	UNCONSTRAINED	BLIND LLM RETRY	NONE
PhysicsX / Luminary / Dirac	REQUIRES EXISTING CAD	POST-DESIGN ONLY	FORWARD SURROGATE ONLY	NONE
Impulse & Hylos	5-DOOR OCCT VERIFIED	7 COUPLED COMPILERS	TIER 0-3 JACOBIAN + ADJOINT	SO(3) + STEP HARVESTER

08 · COMMERCIAL WEDGE, THE BOM RAIL & THE ENDGAME

Selling software seats (`$55B`) is just the entry wedge. The prize is engineering work (`$2T/yr`), the BOM rail, and Verilog + TSMC for Matter.

Calling Hylos "just a CAD tool" is like looking at **Verilog and Design Rule Checking (DRC) in 1986** and calling it "just a circuit drawing program"—when in reality it decoupled chip design from fab ownership and created **Synopsys, Cadence, NVIDIA, and TSMC (`$4T+` combined value)**. In physical industry, the money is bled across four massive bottlenecks: manual engineering hours (`$2T/yr` global payroll), injection molds that fail first-article (`$T_0$`) sampling (`70%+` failure rate at `$25k–$150k` per tool), RFQs stalled in manual DFM redlines (`80%`), and the `5–20×` secondary tooling assemblies (mold cores, CNC soft-jaws, assembly fixtures) required for every single product.

The Immediate Wedge: Delegable Engineering via Impulse

We enter the market by turning multi-day mechanical design and verification into delegable compute for North America's `1,500–2,500` product development and engineering consultancies (`2–30` staff on fixed-fee programs), where every hour saved drops straight to gross margin:

~$175
IMPULSE COST FOR A VERIFIED 10-PART ASSEMBLY
VS. $900–$2,000 MANUAL LABOR

~1 hr
WALL-CLOCK TIME TO VERIFIED STEP ON PRINTER
VS. 12-16 ENGINEER-HOURS (2 DAYS)

$200 + $1/cr
PLATFORM + CREDIT PRICING · ~60% → 80%+ GM
FAILED TURNS ARE NEVER BILLED

$450 → $15K+
MONTHLY ACV EXPANSION ESCALATOR
TASK → PRODUCT → PROJECT → PORTFOLIO

Four Compounding Revenue Engines

Once the compiler owns the constructive intermediate representation of an assembly, four monetization layers compound on top of the same scene graph:

ENGINE 01 · NOW

SaaS + Compute (`$60–160B` Wedge)

`$200/mo` workspace + `$1/credit` per verified assembly, kinematic sweep, and continuum PDE pass—scaling from single-task delegation (`~$450/mo`) to firm-wide portfolio seats (`$15K+/mo`).

ENGINE 02 · BOM RAIL

The Compiler Picks the SKU (`$50B+`)

When our 7 coupled compilers synthesize a hinge, bearing pocket, O-ring gland, or fastened boss, **the compiler specifies the exact McMaster/Misumi catalog SKU**—capturing a `15–25%` distribution take rate.

ENGINE 03 · TOOLING

Zero-Touch DFM & Molds (`$300B+`)

Every Hylos solid is born DFM-certified and paired with its auto-compiled geometric duals: injection mold cores/cavities, 5-axis CNC soft-jaws, and assembly fixtures (`~20%` brokerage margin).

ENGINE 04 · LICENSING

Spatial Weights & Inverse API (`$100B+`)

Licensing our RLVR verification oracle, specialist spatial weights, and inverse `Atoms → IR` decompiler to defense, industrial automation, and embodied AI programs.

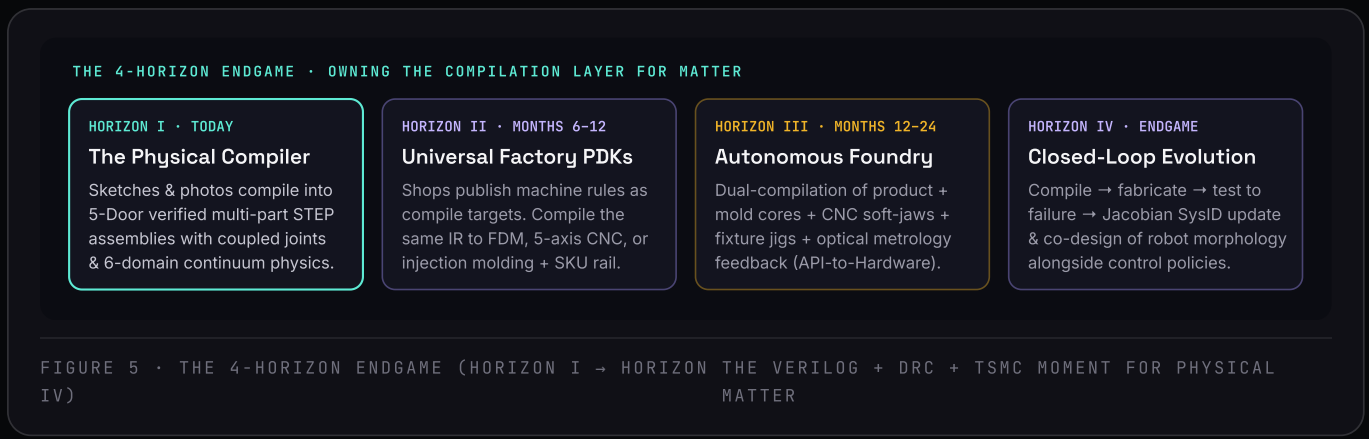


FIGURE 5 · THE 4-HORIZON ENDGAME (HORIZON I → HORIZON IV)

THE VERILOG + DRC + TSMC MOMENT FOR PHYSICAL MATTER

09 · DISCLOSURE BOUNDARY & INTELLECTUAL PROPERTY POSTURE

Patenting the outer operability contract—while locking the server-side compiler & solver mechanics as trade secrets.

We deliberately split our intellectual property between **USPTO Patent-Pending protection** on the model-native spatial operability interface and **strict server-side Trade Secrets** on the internal compiler, solver, and trajectory-mining machinery. Because customers and competitors only ever see the input brief and the output verified `.STEP` assembly—never the compiler's internal execution graph—patent-publishing our internal solver algorithms would hand competitors a blueprint for a backend they cannot otherwise reverse-engineer:

IP & DISCLOSURE TIER	LEGAL POSTURE & ACCESS	PROTECTED ARCHITECTURE & CORE MECHANISMS
Tier 1 · Public & No-NDA THIS WHITEPAPER	Public website (`hyloslabs.com`), prospective customers, and initial investor overview.	System thesis, black-box capabilities of the Bidirectional `(S, C, V)` Compiler, the 5 Credit Doors, the 4-Tier Physics Onion, empirical corpus metrics (`4,362` graded runs), live Impulse assembly proofs, commercial model, and public research (`arXiv:2605.24728`).
Tier 2 · Foundational Patent USPTO PATENT PENDING	*"Hylos: Systems and Methods for Spatial Operability Models"* (USPTO Patent Pending, Oct 2026).	**Three Core Foundational Spatial Operability Inventions (+ Operability Transaction Boundary):** **I. Dual-Stream Geometric/Symbolic Token Generation** with synchronous relational spatial validity linter and next-token probability masking; **II. Contract-Violation-Triggered Latent Spatial Repair & Test-Time Adaptation (TTA) Loop** for gradient/Jacobian-guided in-loop repair prior to transaction commit; **III. Parametric Neural Edit Handles & Predictive Spatial Jacobian Fields (`J(u; z)`)** for real-time constraint-preserving 3D manipulation across the **Operability Transaction Boundary**.
Tier 3 · Core System Trade Secrets PROPRIETARY SERVER-SIDE IP NDA DATA ROOM ONLY	Held as proprietary server-side Trade Secrets (plus 8 unreleased internal papers & confidential diligence specs under mutual NDA).	**The "Secret Sauce" Inside the Compiler & Solver Engine (Unobservable from `.STEP` Outputs):** **1. Deterministic Physical Law & Kernel Recovery Engine:** Proprietary compilation of physical/DFM failure states into exact parametric repairs and automated recovery of brittle kernel operations; **2. Simultaneous Multi-Part Seam & Joint Synthesis:** Proprietary zero-step parting alignment and interlocking multi-body joint compilation; **3. Coupled Packaging & Localized ECN Isolation Engine:** Proprietary multi-constraint resolution, automated COTS clearance harvesting, and blast-radius-isolated assembly edits; **4. Monotone Convergence & Non-Regression Ledger:** Proprietary strict-descent verification gating, historical repair conservation, and outcome-tied compute settlement; **5. Category-Invariant Retrieval & Verified RLVR Distillation:** Proprietary geometric indexing, multi-gate training corpus quarantine, self-calibrating physics surrogates, and specialist spatial weights.

10 · WHAT WE BELIEVE

Six convictions behind the physical world compiler.

01 **Visually plausible is not physically operable.**

A 3D asset you cannot inspect by part, mate across a `0.00 mm` parting seam, sweep across its joints, and cut into steel tooling is a picture—not an engineering state.

02 **You cannot backpropagate a physical repair across an exported mesh.**

Connecting legacy CAD and simulation tools over MCP breaks the moment a STEP file is exported to a dead STL/USD triangle mesh. Intent, B-Rep topology, and continuum physics must share one intermediate representation.

03 **Mating parts must be compiled together, never guessed in isolation.**

A hinge, a snap clasp, an O-ring gland, or a gear pair is a single physical law spanning two bodies. Compiling both sides simultaneously eliminates cross-part coordinate drift by construction.

04 **Instrument === Verifier === Solver.**

Every physical law should be registered once so the runtime derives the measurement caliper, the credit gate, and the inverse parameter repair from the same authority.

05 **Smarter foundation models make deterministic compilers exponentially more valuable.**

Just as coding agents made TypeScript and LLVM indispensable, stronger multimodal planners amplify the value of a fast, exact 5-Door physical compiler—while customers pay only for verified forward progress.

06 **The compiler that verifies the part will own the BOM rail and the factory compile target.**

Software got compilers, DRC, and foundries forty years ago. Owning the verified intermediate representation between digital intent and physical matter is the Verilog + TSMC opportunity of this century.

hyloslabs

The compiler and verification layer between AI reasoning and manufactured reality.

Impulse is live today for multi-part mechanical design, DFM verification, and STEP compilation. For product access, technical diligence, or NDA data-room inquiries, reach out directly.

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