Matter Reconstruction v0.1

Pass 1 — Independent Conceptual Reconstruction

Working paper | August 2026

Research program: An Elaboration of Smuts's Holism and Evolution

Methodological status: conceptual reconstruction prior to systematic Smuts/UPA comparison.

Abstract

This working paper records Pass 1 of the Matter Reconstruction: an independent conceptual reconstruction of the physical domain from fundamental interactions through atoms, molecules, condensed matter, and non-equilibrium organization. The inquiry deliberately does not assume Holism, UPA, Axiomatic Ontology, polarity, spheres, or any present vocabulary as its foundation. Its purpose is to identify concepts repeatedly required by contemporary physical description, expose them to counterexamples, and preserve unresolved distinctions before structural synthesis and historical comparison.

The principal findings are that identity requires explicit criteria; identity and state must be distinguished relative to those criteria; distinguishability is broader than polarity; transformation is intelligible only with specified invariants; aggregation, composition, relation, organization, and collective order must be distinguished; organized composites can possess new identity-bearing state spaces; organization can constrain subsequent constituent behavior; polarity can be generated by collective organization rather than assumed primordial; and nonliving matter already exhibits cooperation-like coupling, coordination-like collective order, differential constraint among alternatives, hierarchical organization, and dynamically sustained non-equilibrium order. Regulation, self-maintenance, function, and biological information remain unresolved and are not inferred from these physical phenomena.

Pass 1 therefore ends not with a completed ontology but with a provisional physical conceptual ledger and a handoff to Pass 2, which will test recurring structures, dependencies, terminology, modeling opportunities, and the limited cases—if any—in which axiomatization is warranted.

1. Research Purpose and Methodological Status

The Matter Reconstruction is the first domain study in a broader sequence: Matter → Life → Mind → Social Organization → Cross-Level Synthesis. "Matter" is retained as the historical/programmatic label, but Pass 1 quickly showed that the actual subject is more accurately the physical domain: matter particles, fields, interaction structures, energy, spacetime, states, symmetries, atoms, molecules, phases, and organized physical systems.

The governing method is conceptual reconstruction → modeling where useful → axiomatization only where sufficiently definite primitives, relations, operations, and assumptions support meaningful derivation → theorems/countermodels within the model → conceptual revision. Formal success is not automatically interpreted as metaphysical truth.

This version is intentionally written before systematic comparison with Smuts or UPA. Smuts supplies the historical research challenge and candidate concepts; UPA supplies a Legacy Findings Ledger. Neither is permitted to determine what Pass 1 finds. The later comparison will therefore be able to distinguish independent recovery from retrospective resemblance.

The three Smutsian strengths/senses of Holism remain in view for the later comparison: whole-formation/organization; Holism as an evolutionary or creative factor; and the stronger metaphysical conception of Holism as a pervasive principle. Pass 1 does not adopt any of them as an explanatory premise. Smuts's distinctions among co-operation, co-ordination, and regulation, including regulatory selection/deselection, are likewise preserved as later comparison targets rather than imported categories.

2. Fundamental Physical Description

2.1 Matter is not an adequate fundamental primitive

Contemporary physical description does not map neatly onto a single primitive category of "matter." Fundamental physics requires fields, particles or field excitations, interaction structures, energy-momentum, and dynamical spacetime. Accordingly, the reconstruction does not begin with Reality → Matter → kinds of matter. It begins more neutrally with distinguishable physical structures, states, relations, interactions, transformations, and constraints.

$$\text{physical} \neq \text{material} \quad \text{(if "material" retains its narrower conventional sense)}$$

2.2 Four interactions and the non-uniformity of "force"

Electromagnetic, strong, weak, and gravitational phenomena do not instantiate one uncomplicated universal structure called force. Electromagnetism provides a clear binary charge polarity; the strong interaction demonstrates structured non-binary differentiation; weak processes make type-changing transformations salient; and general relativity replaces the simple object-to-object force picture with dynamical spacetime geometry.

The comparison therefore supported a broad category of interaction while rejecting the assumption that every interaction has the same internal form.

Interaction	Conceptual lesson
Electromagnetic	Interaction-enabling properties can be distinguished from actual interactions; positive/negative charge is a genuine polarity.
Strong	Interaction-relevant differentiation need not be bipolar; structured distinction is broader than polarity.
Weak	Transformations can alter type/classification, sharpening state-change versus identity-change questions.
Gravity	The contextual structure in which behavior occurs can itself be dynamically related to physical contents; a passive-container model is inadequate.

Across the four interactions, distinguishability, state, relation, constraint, transformation, and invariance survived more robustly than polarity or a universal object-object force relation.

3. Identity, Distinguishability, Symmetry, and Transformation

3.1 Identity requires a criterion

Elementary-particle physics immediately distinguishes type identity from numerical individuality. An electron can be identifiable as an electron without requiring a classical picture of a permanently individuated little object. The reconstruction therefore records not merely identity but an identity criterion.

Distinguishability also splits into multiple forms: type distinguishability, state distinguishability, relational distinguishability, structural distinguishability, and physical indistinguishability. Representational difference need not imply physical difference.

$$\text{representational difference} \not\Rightarrow \text{physical difference}$$

3.2 Transformation and invariance are mutually informative

Symmetry makes clear that transformation and invariance should not be treated as simple opposites. A transformation is characterized partly by what it changes and what remains invariant; an invariant is specified relative to a class of transformations. Conservation is closely related but not identical to invariance and remains theory- and symmetry-structure dependent.

Identity-through-transformation depends upon specified invariants.

A central recurring result of Pass 1 is therefore that the distinction between state change and identity change is relative to what identity is being tracked and by what criterion. The same physical event can preserve one identity while destroying another.

4. Atoms: Layered Identity

Chemical elements supply an unusually clear identity criterion: atomic number. Isotopic, ionization, and electronic-state variation can occur while elemental identity persists. At the same time, an atom is already an organized composite at the chemical level; it is not an ontologically simple starting object.

This establishes layered identity. A process may preserve elemental identity while changing isotope identity, ionization state, electronic state, or a higher-level composite identity. The concept later called Level will therefore have to accommodate identity criteria and organizational descriptions, not merely physical size.

5. Molecular Reconstruction: $H \to H_2, O \to O_2, H_2/O_2 \to H_2O$

5.1 Aggregation is not composition

$$\{H, H\} \neq H_2 \quad \text{and} \quad \{O, O\} \neq O_2$$

A collection of atoms is not thereby a molecule. Molecular formation requires a bound electronic organization. The transition from atoms to H_2 or O_2 therefore establishes a new composite identity, a composite state space, and properties attributable to the molecular system.

Constituent identity may persist in a useful sense while the isolated state of the constituent does not. Membership in the composite changes the physically relevant electronic organization.

5.2 Water and transformation under invariance

$$2H_2 + O_2 \to 2H_2O$$

The reaction preserves elemental identities while destroying and creating molecular identities. Chemical transformation is therefore an especially clear instance of organizational change under specified invariants. Molecular polarity also shows that system properties depend not merely on constituent inventory or even on polar bonds, but on bonding, electronic distribution, and geometry.

The comparison with CO_2 supplies an immediate counterexample to simple additive reasoning: polar constituent bonds can cancel at the molecular level because of organization and symmetry.

5.3 Organization creates a new bearer of states and properties

The strongest result of the H/O sequence is not merely that "the whole has new properties." Formation of an organized composite establishes a new legitimate bearer of identity with a corresponding space of possible states and transformations. Molecular rotational, vibrational, and electronic states are meaningful at the composite level.

constituents + organized relations → composite identity → composite state space → system properties

6. Molecular Counterexamples and Conceptual Saturation

6.1 Isomerism: constituent inventory does not determine identity

Isomers demonstrate that the same kinds and numbers of atoms can support different molecular identities and properties when connectivity or spatial configuration differs. Organization can therefore be constitutive of molecular identity, not merely a source of secondary properties.

Stereoisomerism further forces organization to split into at least connectivity and configuration/geometry.

6.2 Delocalization: structure is broader than pairwise relations

Benzene and other delocalized systems challenge an atomistic picture in which organization is exhausted by a list of independent pairwise bonds. Physically relevant electronic structure can be distributed across multiple constituents. The reconstruction therefore requires a category broad enough for system-level relational structure, not only binary relations.

6.3 Macromolecules: organizational change need not change identity

Macromolecular conformations provide the counterweight to isomerism. Different organization can sometimes constitute a different identity and sometimes a different state of the same identity. This again makes the identity criterion indispensable.

Macromolecules also reveal hierarchical organization: atomic structure, bonded sequence, local motifs, and global conformation can all be simultaneously legitimate descriptions.

6.4 Provisional molecular saturation

Counterexample	Assumption rejected
Isomerism	Constituent inventory determines composite identity.
Delocalization	Organization is reducible to independent pairwise relations.
Macromolecular conformation	Every organizational change is an identity change.

These counterexamples revised the framework without requiring a new conceptual foundation. Pass 1 therefore treats the molecular level as provisionally conceptually saturated for the purposes of this research program, not as an exhaustive reconstruction of chemistry.

7. Condensed Matter: Iron and Ferromagnetism

7.1 Collective order without chemical identity change

Ferromagnetism moves the reconstruction from composite molecular identity to collective organization across enormous populations of already structured constituents. Iron can retain its chemical identity while entering a

different collective magnetic phase. This requires a new category: phase, characterized by system-level order and an order parameter.

The scientifically appropriate progression is not nonmagnetic atoms → magnetic whole. It is magnetically capable electronic constituents plus interaction → collective magnetic order.

7.2 Emergent-to-formative effects

The ferromagnetic case provides a concrete, modest sense of an emergent-to-formative effect. Microscopic interactions produce collective organization; once established, that organization contributes to the effective conditions constraining subsequent local behavior.

micro-interactions → collective organization → modified effective constraints on microstates

This does not require a mysterious new downward force. The same physics supports both explanatory directions: constituent interactions explain organization, while organization explains effective constraints on constituents.

7.3 Polarity can be generated

Ferromagnetism strongly supports polarity as a real physical structure while simultaneously weakening any claim that polarity is primordial. Macroscopic directional polarity can arise through electronic structure, interaction, collective organization, and symmetry breaking. Emergent polarity can then become formative by affecting subsequent interactions.

8. Physical Counterexamples

8.1 Antiferromagnetism

Antiferromagnetism breaks the inference that strong collective magnetic organization must produce net macroscopic polarity. Opposed sublattice order can yield highly coordinated structure with little or no net magnetization. The broader recurring category is therefore structured collective order, not polarity.

8.2 Frustration and competing constraints

Frustrated magnetic systems show that interaction plus constraint does not guarantee one simple stable coordinated order. Multiple local preferences can be mutually incompatible. This introduces a general category of constraint incompatibility or frustration.

The result also refines selection language: constraints need not simply eliminate alternatives. More generally, they differentially structure a possibility space.

8.3 Nonmagnetic and non-equilibrium organization

Solidification confirms that major collective organizational change can occur without chemical identity change and without magnetism. Non-equilibrium dissipative organization goes further: organized patterns can persist only while energy or matter continues to flow through the system.

This requires a distinction between structural persistence and dynamic persistence. A pattern dynamically maintained by external throughput is not thereby self-maintaining in the biological sense.

9. Organization, Cooperation, Coordination, Selection, and Regulation

Pass 1 has reached the conceptual neighborhood of Smuts's distinctions without adopting them. Nonliving matter already exhibits coupled constituent behavior, coordinated collective order, differential constraint among alternatives, hierarchical organization, and organization-dependent constraints on subsequent behavior.

This means none of cooperation-like interaction, coordination-like order, selection/favoring among alternatives, or dynamic persistence can by itself define Life.

9.1 Organization versus regulation

Organization describes structured relations/configurations and the constraints associated with them. Regulation may require something additional. Pass 1 does not yet define that addition, because doing so would prejudge the Life reconstruction and the later comparison with Smuts's broader concept of regulatory selection/deselection.

A provisional neutral distinction is nevertheless useful: physical organization can differentially structure available possibilities; a stronger concept of regulation may require state-dependent selection among processes in relation to persistence, restoration, or trajectory of the organized system. Whether Smuts's regulation is broader than this is explicitly deferred to Pass 3.

9.2 When variation becomes significant

Variation occurs throughout physics. Pass 1 identifies several increasingly consequential thresholds:

- A difference exists.
- The difference changes physical interaction.
- The difference is differentially constrained by organization.
- The difference alters the subsequent trajectory of the organized system.
- Still unresolved for Life: the difference matters relative to persistence, function, reproduction, or other system-relative conditions.

The general physical formulation carried forward is therefore not yet "selection" in a biological or Smutsian sense, but differential structuring of a possibility space by constraints.

10. Provisional Conceptual Ledger at the End of Matter Pass 1

Concept	Pass 1 status
Identity	Strongly recurring; requires an explicit criterion.
State	Distinguished from identity relative to the identity criterion.
Difference / distinguishability	Broader than polarity; physical and representational difference must be separated.
Equivalence / invariance	Central to identifying physically unchanged structure across transformations/descriptions.
Transformation	Meaningful only with specified identities, states, and invariants.
Relation	Required, but not assumed exclusively binary.
Constraint	Strong recurring category; structures possible states and transformations.
Aggregation	Distinct from composition.
Composition	Constituent participation in a composite.
Organization / structure	Required but heterogeneous: connectivity, configuration, distributed structure, collective order, hierarchy.
Composite identity	Not determined by constituent inventory alone.
Composite state space	Organized composites become legitimate bearers of new possible states.
Phase	System-level collective regime that can change without chemical identity change.
Collective order	More general than polarity.
Polarity	Real special structure; can be generated by organization and later become formative.
Frustration	Competing constraints may be mutually unsatisfiable.
Dynamic organization	Organization may persist through continuing throughput without self-maintenance.
Level	Increasingly necessary but undefined; may involve scale, identity criterion, organization, description, or effective theory.
System	Useful but boundary/identity criteria remain unresolved.
Whole	Points toward organized composites but remains too coarse for rigorous use.

Emergence	Organizationally dependent system properties established; strong irreducibility not established.
Regulation	Not independently established as a distinct physical category; relation to constraint/selection remains open.
Self-maintenance	Not recovered from Matter.
Function / biological information	Not required by Matter Pass 1.
Axiomatization	No cross-domain axiomatic ontology warranted at this stage.

11. Principal Findings of Pass 1

- "Matter" is not a satisfactory primitive for fundamental physical reconstruction; the physical domain is broader.
- Identity must be accompanied by an identity criterion; identity/state distinctions can change with Level or description.
- Distinguishability is substantially broader than polarity.
- Transformation and invariance are conceptually interdependent.
- Aggregation, composition, relation, and organization are distinct.
- Organization is not one simple structure and must be allowed to split into multiple forms.
- Constituent inventory does not determine composite identity.
- Organized composites can establish new identity-bearing state spaces.
- Organization can become part of the effective constraints governing subsequent constituent behavior.
- Collective order can occur with or without polarity.
- Polarity can be emergent and subsequently formative rather than primordial.
- Constraints can compete; organization need not produce a single simple coordinated outcome.
- Nonliving physical systems can display cooperation-like coupling, coordination-like order, differential selection/favoring, hierarchical organization, and dynamic persistence.
- Those phenomena therefore cannot individually define Life.
- Regulation, self-maintenance, function, biological information, reproduction, inheritance, adaptation, and evolution remain to be reconstructed rather than inferred.

12. Unresolved Questions

- What exactly constitutes an identity criterion, and can identity criteria themselves be classified?
- Is Level one concept or several: scale, organization, description, effective theory, identity criterion, or mapping among them?
- Can System be defined without importing a privileged boundary or observer-relative partition?
- Does Whole designate anything more precise than an organized system/composite, and if so what?
- Can Organization be given a useful general structure without collapsing distinct physical mechanisms?

- What is the most general relation among constraint, differential favoring, selection/deselection, and regulation?
- At what point does dynamically sustained organization become self-maintenance?
- When does a physically consequential difference warrant concepts such as signal or information?
- Which organizational structures genuinely recur across physical Levels, and which are merely analogical?
- Which, if any, of these structures are sufficiently precise to warrant a mathematical or axiomatic model?

13. Matter-to-Life Boundary: What Pass 1 Has and Has Not Established

Matter has taken the reconstruction much closer to Life than a simple matter-versus-life dichotomy would suggest. Complex molecules and condensed systems already exhibit composite identity, hierarchical organization, collective order, constraint, state selection/favoring, dynamic persistence, and effective reciprocal dependence between local behavior and system organization.

However, Pass 1 has not established self-maintenance, biological function, biological information, reproduction, inheritance, adaptation, or evolution. Nor has it shown that complexity itself becomes life. The Life reconstruction should therefore ask what additional structures appear when organized physical systems become self-maintaining, bounded, metabolically active, regulatory, reproductive, inheritable, functional, informational, developmental, adaptive, and evolutionary.

A particularly important open question is whether regulation is simply a stronger form of physical selection/constraint or introduces a qualitatively different system-relative organization of variation and response.

14. Relationship to Smuts and UPA — Deliberately Deferred

Pass 1 does not decide whether its findings recover Holism. Several results invite comparison—organized composite identity, collective order, whole/part-like reciprocal constraint, cooperation-like coupling, coordination-like organization, selection/deselection-like differential constraint, and emergent-to-formative effects—but resemblance is not yet evidence of conceptual identity.

Pass 3 will compare the independent reconstruction with Smuts's three strengths/senses of Holism and with his distinctions among co-operation, co-ordination, regulation, and regulatory selection/deselection. Correspondences will be classified as strong structural recovery, transformed analogue, superficial analogy, domain-specific use, contradiction, or unresolved.

UPA will likewise be treated as a Legacy Findings Ledger. In particular, Unity, Polarity, World, System, Level, Transformation, Mapping, Context, Recursion, geometric realizations, category-theoretic realizations, and prior theorem claims will be tested against the reconstructed structures rather than presumed.

15. Pass 2 Handoff — Structural Reconstruction and Modeling

Pass 2 should begin in a new session and use this v0.1 paper as its principal fixed record of the independent Matter reconstruction. Its purpose is not to add more physical examples unless a structural claim requires a counterexample. Its task is to determine what conceptual architecture, if any, is justified by Pass 1.

15.1 Governing instruction

Do not begin with Smuts, UPA, Axiomatic Ontology, or a desired formal system. Treat the Pass 1 findings as provisional evidence. Look for recurring dependency structures, necessary distinctions, concept splits,

counterexamples, and minimal models. Preserve domain-specific differences. Axiomatize only a sufficiently precise local structure whose assumptions and domain can be stated explicitly.

15.2 Pass 2 tasks

- Reconstruct the dependency relations among identity, identity criterion, state, difference/equivalence, relation, constraint, transformation, invariance, composition, organization, composite identity, phase, collective order, and dynamic persistence.
- Determine which concepts are primitive candidates, which are derived, and which are family terms requiring subdivision.
- Test whether identity-through-transformation can be modeled in terms of explicit criteria and invariants without overgeneralizing from physics.
- Determine whether Organization admits a useful abstract model encompassing connectivity, configuration, distributed structure, collective order, and hierarchy—or whether several distinct models are required.
- Clarify the relationship among aggregation, composition, system, composite identity, and the still-unresolved concept Whole.
- Reconstruct Level independently: test scale, organizational level, descriptive level, effective-theory level, identity-criterion level, and mappings among these possibilities.
- Model possibility spaces and constraints sufficiently generally to include favoring, exclusion, competing constraints/frustration, and phase-dependent behavior.
- Examine the emergent-to-formative pattern: local interactions → system organization → changed effective local constraints. Determine whether this warrants a formal model and what claims that model can and cannot support.
- Determine whether polarity is best modeled as a special relational/organizational structure within a broader theory of distinguishability or structured alternatives.
- Identify a small number of worked formal models if warranted. Candidate cases include identity/state under transformation, molecular composition/organization, symmetry/polarity, and ferromagnetic collective order. Do not force the spherical model or any UPA geometry into the reconstruction.
- Maintain explicit countermodels and state the domain of every formal result.
- End Pass 2 with a Structural Reconstruction paper or revision that cleanly separates conceptual findings, model assumptions, formal consequences, empirical interpretation, and unresolved issues.

15.3 Questions Pass 2 must not answer prematurely

- Whether the resulting framework is Holism.
- Whether Smuts's cooperation, coordination, or regulation have been recovered.
- Whether regulatory selection/deselection is identical to physical differential constraint.
- Whether UPA Unity, Polarity, World, Level, or System should be restored.
- Whether Axiomatic Ontology is the final form or name.
- Whether Matter's recurring structures are universal across Life, Mind, or Social Organization.

15.4 Pass 2 stopping rule

Stop Pass 2 when the Pass 1 concepts have been organized sufficiently to state: (a) which recurring physical structures have defensible definitions; (b) which concepts split into multiple structures; (c) which dependency relations are well supported; (d) which limited structures warrant formal models; (e) what the models prove only within their stated domains; (f) what remains unresolved; and (g) what evidence and formal apparatus should be carried into Pass 3 for comparison with Smuts and UPA.

16. Status at Handoff

Matter Pass 1 is provisionally complete. It has not produced an ontology and has deliberately not attempted to vindicate or refute Smuts. Its result is a constrained conceptual map of the physical domain, a set of counterexample-tested distinctions, and a more precise boundary question for Life. The next task is structural reconstruction and modeling, not further expansion of the physical survey unless Pass 2 exposes a gap that requires additional evidence.

Selected Scientific Reference Points Used During Pass 1

- CERN. Standard Model overview and fundamental interactions.
- CERN and related particle-physics educational materials on fields, weak interactions, and symmetry.
- NIST. Atomic/isotopic reference materials and molecular/chemical data.
- IUPAC Gold Book and terminology materials for chemical bonding and polarity.
- NIST and condensed-matter literature on magnetic domains, antiferromagnetism, frustration, phase-field modeling, and disordered/hyperuniform materials.
- General-relativity educational references on dynamical spacetime and the geometric description of gravitation.
- Peer-reviewed condensed-matter literature used during the working analysis for ferromagnetism, exchange interactions, phase transitions, and non-equilibrium organization.

Note: v0.1 is a conceptual working paper, not yet a publication-ready literature review. Pass 2 should preserve the conceptual findings; a later publication pass should replace this reference-point list with a fully verified bibliography and citations tied to individual scientific claims.