

Orientation Before Place A Structural History of Successive Conservations — and One Recovery — in the Formation of Objects

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Abstract

This paper extends the Place, Path, Rewrite synthesis — the claim that an object is a conserved path — into a diachronic argument. Where the earlier papers established a synchronic and structural case (San spatial epistemology, Lakoff's embodied cognition, and Homotopy Type Theory converge on the priority of place and path over object), this paper asks a historical question: when, and by what mechanism, did paths become invisible and turn into objects — and can the same mechanism run in reverse?

We propose that the history of Western formal knowledge — geometry, mechanics, logic, and set theory — is not a history of increasing abstraction in the usual sense, but a sequence of conservation waves: recurring Create/Conserve rewrites (in the sense of the

Universal Rewrite System, URS) in which a previously visible, viewpoint- or process-dependent path is stabilized into a viewpoint-independent object, at the cost of the path's visibility. We reconstruct six such waves — Greek geometry, projective geometry, Cartesian coordinates, Newtonian mechanics, Fregean/Russellian logic, and Zermelo–Fraenkel set theory — using primary sources, and argue that each wave repeats the same abstract pattern: Place → Path → Conserve → Object.

We then examine a seventh case that does not fit this direction: Hermann Grassmann's *Ausdehnungslehre* (1844), which targets an object that had already been conserved millennia earlier — number itself — and recovers the path (displacement, motion) underneath it. We argue this is not a counter-example to the conservation-cascade model but a finer-grained confirmation of it: Create operations can target already-conserved objects, not only raw place-material, and the resulting local reversal is itself subject to re-

conservation, occlusion, and delayed uptake — the three-stage, 122-year occlusion-and-recovery sequence from Grassmann (1844) through Clifford (1876–1878) to Hestenes (1966) is offered as an internal, mathematics-only test case for this paper's Prediction 4.

We further propose a still more primitive layer, orientation, as the pre-cultural substrate from which place itself is a first conservation, drawing on San narrative material (Bleek–Lloyd archive) as an empirical anchor with an unusually low degree of subsequent conservation. The paper closes with a falsifiable research programme and an explicit statement of the genealogy/structural-continuity distinction that must govern any further historical claims in this programme.

1. Introduction

Place Before Object argued, on grounds of San spatial epistemology, Lakoff's embodied cognition, and Homotopy Type Theory (HoTT), that place is epistemologically prior to object. Semantic Panarchy argued that stable lexicons are downstream projections of a

deterministic Create/Conserve rewrite process. Place, Path, Rewrite fused these into a single claim:

An object is a conserved path.

That claim is structural: it says what an object is in relation to place and path, independent of when or how any particular object-concept arose historically. It leaves two open questions, which this paper takes up. First: is there historical evidence — not merely structural analogy — that objects actually arise this way? And if place is the primitive from which paths and objects are built, is place itself a historical or cognitive achievement rather than a starting point? Second, and newly raised here: if conservation is a real historical mechanism and not just a one-way metaphor for "abstraction," can it be run in reverse — can a path be recovered from beneath an object that has already been conserved?

We argue for all three. Section 2 sets out the theoretical apparatus: a five-term chain — difference, orientation, place, path, object —

each level a conservation of the one before it. Section 3 states a methodological constraint that must discipline everything that follows: the distinction between genealogy (A historically caused B) and structural continuity (A and B instantiate the same organizational pattern, without a claim of causal descent). Section 4 uses San narrative material as an empirical anchor for the orientation/place transition. Section 5 is the core historical reconstruction: six conservation waves in the history of Western geometry, mechanics, logic, and set theory, each read as an instance of the same Create/Conserve pattern, followed by a seventh case — Grassmann — that runs the pattern in reverse. Section 6 synthesizes the pattern as "the occlusion of path" and extends it to cover recovery as well as occlusion. Section 7 draws out the implications for Place, Path, Rewrite. Section 8 sets out a testable research programme, now including a mathematics-internal test case. Section 9 states the limitations candidly, because this is precisely

where the argument is currently weakest and most in need of further primary-source work.

2. Theoretical Framework: The Conservation Cascade

The URS (Universal Rewrite System) formalism used throughout this research programme distinguishes two operators: Create, which generates a new relational structure from existing elements, and Conserve, which stabilizes a structure so that it can be re-used without being reconstructed. The central proposal of this paper is that both place and object arise from applications of these two operators to a common substrate, and that the same two-operator pattern recurs at several nested scales:

difference

↓ (differentiation)

orientation

↓ Conserve

place

↓ Create

path

↓ Conserve

object

↓ **Conserve**

category

↓ **Conserve**

logic

Orientation is not yet a place. It is a field of differences — light/dark, warm/cold, up/down, wet/dry, the direction of a prevailing wind, the position of a constellation — of the kind every organism is embedded in before it has any concept of a location. This is closer to what ecological psychology (Gibson) calls an affordance field than to a Cartesian frame: it has no fixed origin, no coordinates, and no object-permanence requirement.

Place is the first conservation: certain orientations recur reliably enough that a stable node can be re-identified. A water source is not first an object and then given a location; it becomes a place because it is found again, season after season, relative to the same constellation, the same migration, the same set of relations. This is consistent with the "Place

Before Object" thesis, but reframes place itself as an achievement rather than a primitive.

Path is a Create operation between two or more conserved places: a route, once two places are stable enough to be related by a repeatable journey. This is the point of contact with HoTT, where identity between two points is not a primitive property but a path — evidence, not proof, that the same abstract move (relation-before-property) recurs independently in a twentieth/twenty-first century formal system and in oral spatial epistemologies with no historical contact.

Object is the second-order conservation: when a path is used so often that it no longer needs to be reconstructed, it is conserved as a single term. This is the definition inherited from Place, Path, Rewrite: an object is a path whose origin has been forgotten, not because forgetting is a defect, but because conservation is precisely what makes cognitive and cultural economy possible. Compression is not falsification of the underlying dynamics; it is what conservation is for.

Category and logic are further conservations of the same kind, now operating over sets of objects rather than sets of places — this is beyond the scope of the historical reconstruction in Section 5, which stops at set theory, but the chain is presented in full because the historical waves below should be read as successive instances of exactly this two-step Create/Conserve pattern, not as a new mechanism invented anew at each stage.

A consequence of stating the cascade this explicitly, developed in Section 5.7, is that nothing in the formalism restricts Create to acting only on raw, unconserved place-material. If Conserve can act on the output of Create, there is no formal reason Create cannot in turn act on the output of Conserve — that is, on an already-stabilized object — and recover a path from beneath it. Sections 5.1–5.6 document six cases where the cascade runs forward; Section 5.7 documents a case where it runs in the opposite direction, inside a domain that had already been conserved.

3. Methodological Note: Genealogy versus Structural Continuity

Two very different claims can be made about a recurring pattern across history:

Genealogical claim: system A historically caused, influenced, or gave rise to system B.

Structural-continuity claim: system A and system B instantiate the same organizational pattern, independently of whether any causal or transmission link between them can be established.

This paper makes structural-continuity claims almost exclusively. Where a genealogical link is well documented (e.g., Desargues → Pascal → Poncelet → Klein within projective geometry; Frege → Russell within logicism; Grassmann → Clifford → Hestenes within geometric algebra), it is stated as such. Where no such documentation exists (e.g., between Sanskrit narrative structure and Greek geometry), no genealogical claim is made or implied. The argument is that independently developed systems display convergent structural

organization — a convergence argument, in the same sense that Place, Path, Rewrite argued for structural convergence between San epistemology, Lakoff, and HoTT, rather than for historical influence between them.

This distinction matters because the pattern proposed here (conservation waves) could otherwise be read as a teleological just-so story — "history progresses toward objects" — which is not the claim. The claim is narrower and more falsifiable: when a domain of knowledge stabilizes a new class of objects, it is possible to identify, in the primary sources of that domain, a specific relational or process-dependent precursor that the new object-class renders invisible. That is a claim about textual and conceptual structure, testable against primary sources, not a claim about inevitability or progress. Section 5.7 requires the same discipline in the opposite direction: Grassmann's recovery of path from within number is a genealogically documented sequence (Grassmann's own texts, Clifford's explicit citation of Grassmann, Hestenes'

explicit citation of both) *and* a structural parallel to San narrative organization (Section 4) that carries no genealogical claim whatsoever.

4. Empirical Anchor: San Narrative Structure as a Low-Conservation Baseline

The Bleek–Lloyd archive of !Xam and !Kun narratives (digitalbleeklloyd.uct.ac.za), already used in *Place Before Object* as primary evidence, functions in this paper specifically as a baseline case with comparatively few subsequent conservation waves layered on top of the orientation/place transition. This is not a claim that San epistemology is "earlier" in a chronological or evolutionary sense — the !Xam narrators recorded by Bleek and Lloyd in the 1870s were contemporaries of Frege — but a claim that their narrative structure exhibits fewer of the specific historical conservation waves reconstructed in Section 5 (no Cartesian coordinate system, no Newtonian point-mass mechanics, no ZFC-style extensional set theory as an organizing structure for kinship or land).

This makes the corpus useful as a comparative control: a knowledge system in which orientation-to-place organization is still visible as the dominant structuring device, rather than occluded beneath several further layers of conservation.

The recurring narrative opening — orientation to water, star, kin, or ancestral movement, rather than to the identity or properties of a thing — is treated here as textual evidence for the orientation → place transition specifically, not as evidence for the later waves (path → object → category → logic), which are reconstructed independently from the history of Western mathematics and logic in Section 5.

5. Seven Conservation Events in the History of Formal Knowledge

Each of the first six subsections below follows the same structure: (i) what was previously visible as a path, viewpoint, or process; (ii) what is conserved in its place; (iii) the primary source in which the conservation is textually locatable; (iv) what becomes invisible as a

result. The seventh subsection (5.7) inverts this structure by design, and is presented separately in Section 5.7's own terms.

5.1 Greek Geometry: the Ideal Figure Conserves Local Construction

Euclid's *Elements* (c. 300 BCE) does retain construction as a visible operation — propositions are proved by explicit compass-and-straightedge construction (Postulates 1–3) — but the object of geometry is the ideal figure, invariant under the specific act of drawing it. A triangle is not this drawn triangle, in this place, made by this construction; it is the form that the construction merely instantiates. Plato's theory of forms supplies the philosophical conservation: the particular, place-bound act of drawing is downgraded to an imperfect trace of an object that exists independently of any construction. What becomes invisible is not construction as a procedure — the *Elements* preserves that — but the place-dependence of the figure: where, by whom, and with what instrument it is drawn ceases to matter to what the figure is.

Euclid's treatment of ratio and proportion (Book V) is worth flagging here for continuity with Section 5.7: for Euclid, a ratio is a relation between magnitudes — geometric objects such as lines, areas, or volumes — not a number obtained by dividing one number by another. The Greek *arithmoi* (numbers) were positive integers; the objects of geometry were *magnitudes*, and had no numbers attached to them as such. This is the state of affairs Section 5.7 shows Grassmann implicitly reopening thirty-one centuries later.

5.2 Projective Geometry: Perspective Conserves Concrete Place

Renaissance perspective construction (Alberti, *Della pittura*, 1435) makes the viewpoint explicit and load-bearing: the entire construction is organized around a single eye-point, a picture plane, and a horizon — the geometry is unintelligible without specifying where the viewer stands. Desargues (*Brouillon project*, 1639) and Pascal (*Essai pour les coniques*, 1640) formalize this into projective geometry proper: points at infinity, cross-ratio, and theorems (Desargues' theorem, Pascal's

"mystic hexagram") that hold for any choice of viewpoint. This is the crucial move: the theorems are proved to be invariant under change of viewpoint, which requires the viewpoint to still be explicitly present in the construction in order to be varied. Poncelet's *Traité des propriétés projectives des figures* (1822) and later Klein's Erlangen Programme (1872) — which redefines a geometry as the set of properties invariant under a specified transformation group — complete the conservation: the group of projective transformations is conserved, and any single, concrete standpoint becomes, by construction, interchangeable with any other. What is conserved is invariance under perspective; what becomes invisible is the necessity of any one concrete standpoint at all.

5.3 Descartes: Coordinates Conserve Viewpoint

Descartes' *La Géométrie* (1637) takes the next step, and it is this step, not the Renaissance one, that removes the viewpoint altogether rather than merely relativizing it. By fixing an arbitrary but absolute axis system, every point

is redescribed as an ordered pair of numbers, independent of any eye-point, horizon, or picture plane. Algebraic manipulation replaces geometric construction as the operative method: a curve is a solution set of an equation, not the trace of a constructive or perspectival act. This is the historically precise location of the transition the Place, Path, Rewrite paper needed: projective geometry still requires a viewpoint (even while proving invariance across viewpoints); Cartesian geometry requires none, because "viewpoint" is replaced by an origin and axes that are, by stipulation, nowhere in particular. Coordinates conserve out the very idea of standing somewhere to look.

5.4 Newton: the Point-Mass Conserves Relation

Galileo's mechanics is still fundamentally relational: motion and rest are discussed in terms of the relative motion of bodies (the ship-cabin argument in the *Dialogue*, 1632), and no body has a privileged, non-relational state of motion. Newton's *Principia* (1687) conserves this relational structure into a single

non-relational object: the point-mass, possessing inertia, position, and momentum as intrinsic properties, situated within absolute space and absolute time — a scaffold that exists independently of any body or relation between bodies (*Principia*, Scholium to the Definitions). Leibniz's relational objections (in the Leibniz–Clarke correspondence, 1715–16) are historically important precisely because they register, in real time, what has just been conserved away: a body's motion, on the Newtonian object-picture, is no longer defined by its relations to other bodies but by its state relative to a fixed and empty absolute frame. What was a path of relative displacement becomes a property of an object.

It is also, on the strict terminology Newton himself uses, a conservation performed on *number* as well as on motion. In the *Arithmetica Universalis*, Newton redefines number as "not so much a Multitude of Unities, as the abstracted Ratio of any Quantity, to another Quantity of the same Kind, which we take for Unity" — explicitly

overturning the Euclidean magnitude-based conception flagged in 5.1. This second, quieter conservation (ratio-as-object rather than ratio-as-relation-between-magnitudes) is the specific object Section 5.7 shows being reopened.

5.5 Frege and Russell: the Proposition Conserves Context

Frege's *Begriffsschrift* (1879) introduces a formal notation in which a judgment is separated from the psychological or conversational context of its assertion, and truth-value becomes a property a proposition possesses independently of speaker, audience, or occasion of utterance. This is stated as an explicit methodological principle in *Der Gedanke* (1918): a thought (*Gedanke*) is timelessly true or false, independent of who thinks it or when. Russell and Whitehead's *Principia Mathematica* (1910–1913) extends this logicist programme, treating mathematical truths as derivable from purely logical propositions, again independent of any constructive or contextual act of derivation. What is conserved is propositional content, stable across contexts; what becomes invisible

is the pragmatic path — the specific speech-act, occasion, or dialogic exchange — through which a claim comes to be asserted at all. This is the same move as 5.3, run on meaning rather than on space: an absolute "coordinate system" for truth (context-independent propositional content) replaces a viewpoint-dependent act of assertion.

5.6 Zermelo–Fraenkel: the Set Conserves the Construction Process

Cantor's original set theory (1874–1897) is still tied to explicit constructive procedures — the diagonal argument, for instance, is a demonstrated process for generating a new element. Russell's paradox (1901) exposed the danger of treating "the set of all sets satisfying a condition" as unproblematically given. Zermelo's axiomatization (1908), refined by Fraenkel and Skolem (1922) into what is now ZFC, resolves this by conserving sets as objects governed by axioms (Extensionality, Separation, Replacement, etc.) rather than by any single canonical construction procedure. A set, in ZFC, simply *is*, subject to the axioms; the process by which one might construct or

enumerate its members is no longer part of what the object is. This completes, for pure mathematics, the same conservation pattern found in 5.1–5.5: a formerly visible constructive path (Cantor's explicit procedures) is replaced by an object (the set) whose existence is now secured axiomatically rather than procedurally.

5.7 Grassmann's Ausdehnungslehre (1844): A Counter-Wave — the Recovery of Path Within an Already-Conserved Domain

The six waves reconstructed above share a direction: a viewpoint- or process-dependent path is conserved into a viewpoint-independent object. Grassmann's *Die lineale Ausdehnungslehre* (1844) is structurally significant precisely because it runs the operator in reverse, inside a domain — arithmetic — that had already undergone conservation millennia earlier, and again, more recently, by Newton (5.4).

Grassmann's starting move is to reject the inherited object, number-as-quantity, and reconstruct it from an operation: the *Strecke*, a directed displacement between two points.

Where Euclidean magnitude (5.1) had already been conserved into Newton's "abstracted ratio" (5.4), Grassmann re-opens that object and shows a path underneath it — motion, not static quantity, as the primitive. Hestenes (2003) later formalizes this distinction as the *operational* interpretation of number (number as the record of a rotation or displacement) against the *quantitative* interpretation (number as a static abstracted ratio), crediting Grassmann and Clifford jointly with having been the first to separate the two.

This is a Create operation applied not to raw place-material, as in the six waves above, but to an object that the historical record had already stabilized — and it is immediately re-conserved by the mathematical community's inability to use it: Grassmann's contemporaries did not understand the *Ausdehnungslehre*; several partially reinvented fragments of it under their own names; the whole was ignored for over three decades. Clifford's 1876–1878 uptake, combining Grassmann's exterior product with Hamilton's

quaternions into what is now Clifford algebra, is a second Create operation on the same material; Clifford's early death in 1879, before wide dissemination, produced a second occlusion. The pattern repeats a third time: Hestenes' 1966 identification of the Dirac algebra as the geometric algebra of spacetime is the moment this lineage is finally re-conserved into a stable, teachable object — geometric algebra — over a century after Grassmann's original Create.

Read against the URS formalism of Section 2, this is not a counter-example to the conservation-cascade model but a finer-grained confirmation of it: conservation is not monotonic across history, and a Create operation can target an already-conserved object rather than raw place-material, producing a local reversal that is itself subject to re-conservation, occlusion, and delayed uptake. This is precisely the release-and-reorganization dynamic that Holling's panarchy model predicts at the end of a K-phase (Prediction 4, Section 8) — except that

here the "external perturbation" is not institutional collapse but an individual's re-derivation of path from within a system that had already forgotten it had one. The roughly 32-year gap between Grassmann (1844) and Clifford's uptake (1876), and the further 90-year gap to Hestenes (1966), are independently checkable against the historical record and offer a third, mathematics-internal test case for Prediction 4 alongside the Newtonian-to-relativistic transition already proposed there.

A structural-continuity observation, not a genealogical one (Section 3): Grassmann's recovery of the *Strecke* as prior to the static number-object is the same abstract move this paper's Section 4 locates in San narrative material — place/path prior to object — independently arrived at, roughly thirty-one centuries after the Euclidean magnitude/number distinction described in 5.1, by a mathematician working alone with no access to, or awareness of, non-Western spatial epistemology. The parallel is offered exactly as far as the evidence supports it and no further:

two independent structural instances of path-before-object organization, with no claim of transmission between them.

6. Synthesis: The Occlusion — and Occasional Recovery — of Path

Read across the table, the recurring pattern in 5.1–5.6 is not "increasing abstraction" in a generic sense, but a specific two-step rewrite, repeated at each historical threshold: a path (a construction, a viewpoint, a relation, a context of assertion, a construction procedure) that was previously indispensable to using a concept correctly is conserved into a term that can be handled as if it had no history — an object, in exactly the sense defined in Place, Path, Rewrite. The historically interesting fact is not that this happens once, but that it happens again, independently, in geometry, in mechanics, in logic, and in set theory, each time using the domain-specific vocabulary of that discipline, without those disciplines citing one another as a methodological template. This recurrence is what elevates the pattern from a single anecdote about Descartes to a structural

claim of the kind this research programme requires.

Section 5.7 adds a second, rarer pattern to the synthesis: occlusion is not historically irreversible. A path conserved into an object can be recovered by a subsequent Create operation targeting that same object — but the recovery is itself precarious, subject to the same conservation dynamics (non-uptake, occlusion by the surrounding K-phase, delayed re-conservation) that governed the original wave. Grassmann's case suggests a testable asymmetry: forward conservation (5.1–5.6) tends to be relatively rapid once a primary source states it explicitly (Descartes' text is absorbed within decades; ZFC within a generation), whereas reverse recovery (5.7) tends to be slow and repeatedly interrupted, because it requires overturning an object the surrounding K-phase already treats as foundational rather than merely extending unconserved material. This asymmetry is stated here as a further falsifiable claim, additional to Predictions 1–4 in Section 8.

7. Implications for Place, Path, Rewrite

Place, Path, Rewrite argued, synchronically and structurally, that object = conserved path. The reconstruction above supplies the missing diachronic evidence that the earlier paper explicitly flagged as its open question, and Section 5.7 supplies something the earlier paper did not anticipate: evidence that the rewrite is not strictly one-directional. Each of the six forward waves can now be redescribed in the paper's own notation:

Place (construction / viewpoint / relation / context / procedure)

↓ Create

Path (the specific act of constructing, viewing, relating, asserting, deriving)

↓ Conserve [long K-phase]

Object (figure / invariant / coordinate / point-mass / proposition / set)

The "long K-phase" language from panarchy theory (Holling) now has a historically specific referent in each case: the roughly two-centuries-long stabilization of Euclidean geometry as unquestioned background knowledge; the near-simultaneous

crystallization of Cartesian coordinates as the default spatial ontology of physics after 1637; Newtonian mechanics' near-two-century reign as unquestioned background physics (1687–1905); and the rapid, mid-twentieth-century absorption of ZFC as the default foundational language of mathematics. Each is a K-phase in the technical sense: a period in which the conserved object is treated as foundational rather than as the outcome of a prior rewrite.

Grassmann's case (5.7) is redescribed as the same notation run against the grain:

Object (number as abstracted ratio – Newton's conservation, 5.4)

↓ Create [reopening an already-conserved term]

Path (the Strecke – directed displacement recovered beneath the object)

↓ Conserve [delayed: Clifford 1876, Hestenes 1966]

Object₂ (geometric algebra – a new, operationally-grounded conservation)

This gives Place, Path, Rewrite a resource it previously lacked: a documented case in which the object → path direction is not merely logically conceivable but historically instantiated, with dates, primary sources, and

an explicit, named mechanism (the operational vs. quantitative interpretation of number) for how it was done.

8. Research Programme: Testable Predictions

The following are stated as falsifiable, primary-source-checkable claims rather than as philosophical assertions.

Prediction 1 (textual marker of conservation). In each of the six primary sources identified in Section 5.1–5.6, the moment of conservation should be textually locatable as the point at which the source explicitly asserts independence from the prior path (e.g., Descartes' explicit rejection of compass-and-straightedge construction as necessary; Frege's explicit separation of *Sinn* and psychological act; Zermelo's explicit axiomatic rather than constructive definition of set membership). This is checkable against the primary texts cited above and should be falsified if no such explicit independence-claim can be found.

Prediction 2 (comparative convergence). Other independently developed knowledge systems

with a documented orientation-first narrative structure (e.g., Aboriginal Australian songline traditions, early Polynesian wayfinding systems) should show the same orientation → place → path sequence prior to any object-first reorganization, checkable against ethnographic and linguistic primary sources independent of the Bleek–Lloyd corpus.

Prediction 3 (formal/dynamical test). The Create/Conserve rewrite proposed here should be modelable as a dynamical system in which Place = state space, Path = a Create-transition between states, Conserve = phase-locking/synchronization (in the Kuramoto sense), and Object = a stable attractor. This is the direction already flagged in the prior working session as the next formalization step, and would allow the historical claims above to be tested against a quantitative oscillator model rather than resting on textual analysis alone.

Prediction 4 (K-phase duration). If conservation waves behave as panarchy K-phases, their duration should correlate with the institutional and infrastructural

investment made in the conserved object (textbooks, instruments, professional training), and should be disrupted by the same kind of external perturbation that ends any K-phase (Holling) — a testable historical-sociological claim about, e.g., the transition from Newtonian to relativistic mechanics as a panarchy release-and-reorganization event rather than a purely internal theoretical refutation. Section 5.7 supplies a second, mathematics-internal test case: the Grassmann (1844) → Clifford (1876) → Hestenes (1966) sequence should show the same textbook/instrument/training-investment correlation for geometric algebra's eventual re-conservation as a taught object, checkable against the history of its adoption into physics and computer-graphics curricula from the 1980s onward.

Prediction 5 (asymmetry of recovery, new). Reverse Create operations that recover a path from beneath an already-conserved object (of which Grassmann's is, at present, this programme's only documented instance)

should show systematically longer occlusion-to-reconservation intervals than forward conservation waves of comparable domain-generality, because the surrounding K-phase actively resists rather than merely fails to notice the new material. This predicts that any further cases of this type identified by future work in this programme should show multi-decade, not multi-year, uptake lags — falsified if a comparably general reverse-Create episode is found to have been absorbed as quickly as, say, Cartesian coordinates were.

9. Limitations

This reconstruction is, by design, a first pass, and four limitations should be stated plainly rather than allowed to surface later as objections.

First, the waves in Section 5 are presented in a sequence for expository clarity, but 5.1–5.6 were not historically sequential in any strict sense — projective and Cartesian geometry overlap chronologically with the tail end of scholastic Aristotelian physics, and Newtonian mechanics predates the logicist and set-

theoretic waves by nearly two centuries. Section 5.7 is doubly non-sequential: it is chronologically interleaved with 5.4–5.6 (Grassmann 1844 precedes Frege 1879 and Zermelo 1908) while targeting an object conserved earlier, in 5.1/5.4. The claim throughout is one of structural recurrence, not of a single historical timeline; Section 3's genealogy/structural-continuity distinction applies here with full force.

Second, each wave necessarily compresses a large secondary literature (history and philosophy of mathematics, history of science) into a few paragraphs organized around a single primary source. A "volwaardig" (full-fledged) version of this paper would need, for each wave, a dedicated review of the relevant secondary scholarship — for 5.2, Field's *The Invention of Infinity*; for 5.4, Stein's and DiSalle's work on Newtonian absolute space; for 5.5, Sluga's *Gottlob Frege*; for 5.6, Moore's *The Infinite* or Ferreirós's *Labyrinth of Thought*; for 5.7, the secondary literature on the reception history of Grassmann's algebra

(e.g. Crowe's *A History of Vector Analysis*) specifically — to confirm that the "conservation" (and, for 5.7, "recovery") reading is not merely consistent with but actually supported by specialist historiography.

Third, the dating in 5.7 (Clifford's uptake at 1876–1878, Hestenes' identification at 1966) is stated as this paper's current best reading and should be independently verified against the primary Clifford and Hestenes texts before the 32-year and 90-year intervals are used in any published or quantitative form; the intervals are load-bearing for Predictions 4 and 5 and are therefore exactly where independent verification matters most.

Fourth, and most importantly for this research programme's own stated epistemic standard: the criterion for accepting this reconstruction should not be falsificationist "proof," but ecological/track-record adequacy in the sense of testable, checkable prediction — does the conservation-wave model generate correct, checkable predictions about where in a

primary text the moment of conservation will be found (Prediction 1), and does it survive comparative testing against independently developed knowledge systems (Prediction 2) and against the one documented reversal case so far identified (Predictions 4–5)? That is the standard against which this paper should be judged, and it is a standard this paper has not yet met — only proposed a procedure for meeting it.

10. Conclusion

Place, Path, Rewrite established, structurally, that an object is a conserved path. This paper has shown that the history of Western formal knowledge — from Euclid to Zermelo — can be read as a sequence of exactly such conservations, each rendering a previously indispensable path (a construction, a viewpoint, a relation, a context, a procedure) invisible in favor of an object that appears, from within the K-phase that follows, to have no history at all. Section 5.7 has shown something further: that this direction is not historically forced. Grassmann, working alone

and largely unread by his contemporaries, took the already-conserved object of Western arithmetic — number as abstracted ratio — and recovered the path beneath it, only for that recovery to be occluded and re-conserved across three further stages (Clifford, Hestenes) before becoming, in turn, a stable taught object over a century later.

The deeper claim advanced here — that even place is a first conservation of a still more primitive orientation field, for which San narrative material provides a comparatively low-conservation empirical anchor, and that the same cascade Grassmann ran against arithmetic converges structurally, without any genealogical link, on the same path-before-object organization already documented in that narrative material — reframes Place Before Object as a special case of a more general principle: every stable knowledge structure is a conservation of a more dynamic, relational level beneath it, and that conservation is occasionally, laboriously, reversible from within. The task that remains,

and that the research programme in Section 8 is designed to force, is to convert this from a compelling structural narrative into a body of specific, checkable claims against primary and secondary historical sources — including, now, against the dating and reception history of Grassmann's own recovery.

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