

“Das Unmögliche zu leisten”: On the Role of Mathematical Cognition in the Philosophy of Symbolic Forms

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Cassirer’s philosophy of symbolic forms affirms the autonomy and plurality of distinct modes of objectification, yet assigns mathematical cognition a distinctive systematic role. This paper reconstructs his functional conception of mathematics and argues that its privilege lies in the relation it establishes between spontaneity and the given. In pure mathematics, ideal manifolds are constituted through relational principles; mathematical natural science extends this formative activity to empirical nature through lawful functional determination. Scientific cognition thus becomes a privileged site of spirit’s self-recognition without providing a standard for the validity of the other symbolic forms.

Keywords: symbolic forms – mathematics – function – Cassirer

Introduction

The role of mathematics and mathematical natural science in Cassirer’s transformation of Kantian transcendental philosophy has been extensively examined (Ihmig 1997; Heis 2015; Matherne 2021; Biagioli 2023; Aarnes 2024; Schneider 2024; Koenig 2025). Their systematic position within the philosophy of symbolic forms nevertheless remains disputed (Truwant 2015; Luft 2015;

Kinzel 2024). This paper argues that mathematical cognition occupies a distinctive position within this framework.¹

Cassirer's functional conception transforms the Kantian transcendental project by replacing the opposition between a given manifold and spontaneous synthesis with the progressive reduction of the "given" to spontaneity. Pure mathematical manifolds are generated through relational and serial principles, while mathematical natural science extends this conception to empirical cognition by determining physical objects through mathematical relations, laws, and invariants. The systematic significance of this extension appears within the broader architecture of the philosophy of symbolic forms. Although Cassirer insists on the irreducibility and relative autonomy of myth, religion, language, art, and science, mathematical cognition nevertheless occupies a qualified but privileged position. The question is in what respect this privilege can be maintained without subordinating the other symbolic forms. The answer concerns the degree to which symbolic activity becomes explicit to itself. Since such self-awareness is not exclusive to science, what distinguishes scientific cognition is not reflexivity as such, but the reach of this self-recognition.

Nature appears to exist independently of spirit, yet mathematical natural science reconstructs its objective determination through law-governed relations. The tension is already present in Kant: although the understanding legislates *a priori* to nature, the sensible manifold to which its laws apply is given through receptivity. Cassirer transforms the status of this givenness: the given no longer functions as an ultimate *datum* of cognition but as a *task* of further determination. What appears as given marks the still-undetermined moment that must be progressively articulated through lawful functional relations. In this process, spirit recognizes its own law-governed formative activity precisely in what initially appears as other than thought.

I first reconstruct Cassirer's functional reinterpretation of mathematics through his engagement with Kant and the Marburg tradition, focusing on his rejection of the Kantian conception of mathematics as construction in intuition and on his claim about the relational constitution of mathematical objects. I then examine how this conception grounds mathematical natural science and transforms the relation between the pure and the empirical. Finally, I situate

¹ I mean by *mathematics* or *pure mathematics* the constitution of mathematical manifolds through relational and serial principles; *mathematical natural science* designates the mathematical determination of empirical or physical manifolds. *Mathematical cognition* encompasses both. Outside quotations, *science* means theoretical cognition in this mathematically articulated sense.

this epistemological project within the philosophy of symbolic forms, where scientific cognition makes symbolic mediation especially explicit.

The argument is that pure mathematics and mathematical natural science disclose complementary dimensions of spontaneity: the former displays the generation of ideal structures, while the latter reveals the reach of this activity in the constitution of objective nature. Mathematical cognition can therefore occupy a privileged systematic position without subordinating the other symbolic forms.

I. Kant and Cassirer on Mathematical Cognition

For Kant, mathematics is cognition through the construction of concepts, that is, through the a priori exhibition of their corresponding intuitions. Since “only the concept of magnitudes can be constructed,” the form of mathematical cognition explains why it pertains solely to *quanta* (KrV, A714 / B742). Cassirer rejects this restriction: “Mathematics is no longer the science of magnitude and number” (Cassirer 2001, 40). Mathematical cognition extends wherever complete determination can be achieved through law. It does not begin by applying concepts to a given manifold, but by establishing the principles through which a manifold is generated according to an intellectual law. (cf. KrV A716 / B744).

Cassirer emphasizes the role of differential calculus in the transition from a mathematics centered on magnitude to one governed by the concept of function, explicitly connecting this interpretation with Hermann Cohen. In the *Logik der reinen Erkenntnis*, Cohen rejects independently given elements as the starting point of knowledge and conceives the object through the lawful relations by which it is generated in accordance with “the logic of the principle of infinitesimal calculus” (Cohen 1922, 477). For Cassirer, the philosophical significance of the calculus lies precisely in this shift from pre-given magnitude to functional determination (Cassirer 1953, 99). His appeal to Cohen is therefore methodological: mathematical objectivity must be reconstructed from rules of determination rather than from a received manifold.

Cassirer finds the same methodological principle across modern mathematics: despite their material diversity, these fields converge on Cohen’s concept of origin [*Ursprung*] wherever the elements of a multiplicity are generated and exhaustively determined from a serial principle (Cassirer 1953, 99).

In *Substance and Function*, number provides the paradigmatic example.² Following Dedekind, Cassirer treats a natural number as a position within a sequence, determined by its relations to all other positions. Its being is exhausted by these relational determinations: the relata do not precede the relation; the relation is logically prior to them (Cassirer 1953, 36). Number therefore presupposes no given manifold, not even a pure one: “The intuition of pure time, upon which Kant based the concept of number, is indeed unnecessary here” (Cassirer 1953, 40). Number is a product of pure thought, which generates an ordered manifold through a rule of serial production. Dedekind’s ordinal conception is consequently central to Cassirer’s idealism because it displaces intuition as the foundation of arithmetic. In this respect, Dedekind’s position is logicist: expressed in Kantian terms, the grounding of mathematics depends solely on the functions of understanding and remains entirely independent of sensibility (Klev 2017).

For Kant, number is the pure schema of magnitude (*KrV*, A142 / B182), a transcendental determination of time and thus both intellectual and sensible. Cassirer, by contrast, grounds number in the logical activity of positing and distinguishing, without appealing to an alogical element.³ He nevertheless distinguishes numerical from conceptual synthesis. Both arise from the same fundamental activity of positing and distinguishing, but arithmetic gives it a specifically serial form: each position is determined by the rule that orders it in relation to the other positions of the sequence.

Dedekind’s notion of mapping provides a model of arithmetic as free intellectual construction. The rule of succession is not obtained from empirical or pure intuition but originates in the spontaneous activity of thought. Yet “free” does not mean arbitrary. Once a serial principle is fixed, the positions generated within it are exhaustively determined, and the extension of numerical domains responds to objective problems of mathematical thought rather than subjective choice (Cassirer 1950, 68). Freedom concerns independence from pre-given objects; necessity concerns the consequences of the rule.

² The focus on arithmetic is methodological. Geometry provides a parallel instance of functional concept formation; number is emphasized because Dedekind’s ordinal conception displays serial generation with particular clarity. A fuller account of Cassirer’s geometry lies beyond this paper.

³ Cassirer develops this point in connection with Rickert’s critique of Natorp. He accepts that numerical difference cannot be reduced to generic difference but rejects the conclusion that number therefore requires an “alogical” element: numerical synthesis remains logical while assuming the specific form of series and serial order (Cassirer 2021b, 417).

This conception also clarifies the synthetic character of mathematics. Mathematical construction does not consist in exhibiting a pure sensible object corresponding to a concept. Mathematics constructs networks of relations designated by mathematical signs. Construction is therefore grounded in intellectual and relational activity rather than in intuition in the specifically Kantian sense. More generally, mathematical cognition proceeds neither from given objects nor from the analysis of pre-given concepts, but from relations and rules through which its objects are generated and determined. In this sense, mathematical cognition is synthetic and genetic in character (Cassirer 2021b, 460).⁴

The formation of pure mathematical manifolds is, however, just the initial logical moment in scientific knowledge: the full philosophical significance of mathematics emerges only in relation to the forms of knowledge it makes possible. Mathematics mediates between the logical and empirical domains (Cassirer 2021b, 447 – 448). It therefore possesses no wholly self-sufficient logical dignity: its *quid juris* becomes fully manifest in its role in structuring empirical knowledge (Cassirer 2021b, 426; cf. *KrV*, B147).⁵ The internal law of a mathematical structure accounts for its determinacy; the transcendental question concerns its objective validity within knowledge. Following Cohen and Natorp, Cassirer locates this objective significance in mathematics' capacity to construct the structural form of nature and make it intelligible according to laws (Cassirer 2021b, 443). The analysis of pure manifolds thus leads to that of empirical manifolds in mathematical natural science.

Here Cassirer again departs from Kant. Kant treats the distinction between empirical and pure cognition in terms of the different origins of matter and form: sensation results from affection, whereas pure form originates in our

⁴ Heis (2015, 129 – 140) argues that in the third volume of *The Philosophy of Symbolic Forms* Cassirer revises important aspects of his earlier account of arithmetic. However, the determinacy of mathematical objects remains inseparable from the relational and symbolic structures through which they are constituted. Biagioli (2023) emphasizes both continuity and transformation in Cassirer's philosophy of mathematics: the functional conception developed in his earlier neo-Kantian epistemology is retained, while the *Philosophy of Symbolic Forms* raises the further question of mathematical objectivity in its own right. For a related account stressing the continuity between Cassirer's early functional conception of the mathematical sciences and their place within his mature philosophy of symbolic forms, see Aarnes (2024).

⁵ Schneider (2024) argues that mathematics cannot straightforwardly be treated as an autonomous symbolic form: despite its distinctive mode of objectification, it is integrated into the broader symbolic form of scientific cognition.

cognitive faculties (KrV, A19 – 20 / B34). Cassirer rejects such a separation of matter and form by origin (Cassirer 1953, 310 – 311). The difference between the pure or empirical nature of a manifold does not depend on any reference to a reality beyond knowledge. Rather, it corresponds to an immanent aspect of cognition: while the formation of pure manifolds in mathematics reaches an end, the formation of empirical manifolds cannot be completed (Cassirer 1953, 254). The empirical nature of physical manifolds does not lie in them being passively received, but in their formation always remaining unfinished (Cassirer 2006a, 121 – 122).

This functional interpretation explains how a mathematical science of nature is possible. Application does not impose a ready-made structure on an independent being; the mathematization of nature is rather an endless construction of rational order. As Cassirer writes, number “stands at the threshold of a series of relationships” that should lead toward the determination of reality (Cassirer 1950, 66). This unending process is experience itself (Cassirer 2021b, 494). Pure mathematics and mathematical natural science are therefore correlative: mathematics provides serial principles for the formation of empirical manifolds, while only their deployment in the infinite process of experience provides mathematical cognition with objective validity (Cassirer 2000, 357, footnote 112).

II. Mathematical Cognition and Self-Knowledge of the Spirit

Cassirer accords mathematical natural science a privileged position within a philosophy that nevertheless insists on the autonomy and irreducibility of the symbolic forms. *An Essay on Man* makes the systematic issue explicit by asking how science is to be situated within the “system of symbolic forms” (Cassirer 2006b, 223). Here, Cassirer characterizes modern science in emphatically hierarchical terms:

Science is the last step in man’s mental development and it may be regarded as the highest and most characteristic attainment of human culture. ... It is held to be the summit and consummation of all our human activities (Cassirer 2006b, 223).

This passage indicates science’s distinctive status without yet explaining its basis. The cautious formulations “may be regarded” and “it is held” also leave open whether Cassirer simply endorses the hierarchy attributed to modern culture. The systematic ground of scientific privilege must therefore be sought

in his account of mathematical cognition and, above all, in its role in constituting empirical nature.

The privileged position of mathematical natural science within the system of symbolic forms remains contested. Kinzel (2024) argues that Cassirer's epistemic pluralism cannot ultimately be separated from his teleology of self-understanding, since scientific objectivity, liberation from sensibility, and symbolic self-understanding are systematically connected. The resulting objectivist hierarchy, she contends, conflicts with Cassirer's requirement that each symbolic form be assessed according to its own internal standards.⁶

The interpretation defended here accepts Kinzel's connection between scientific objectivity, liberation from sensibility, and self-understanding, but draws a different conclusion concerning pluralism. Mathematical cognition occupies the highest position with respect to a specific dimension of symbolic activity: the liberation of spontaneity from the given and the corresponding self-consciousness of spirit. This privilege cannot be reduced to reflexive awareness, since other symbolic forms may also become reflexive. What distinguishes mathematics is the particular relation it establishes between spontaneity and the given: in pure mathematics, the manifold itself is generated through relational principles, whereas mathematical natural science extends this spontaneity to the progressive determination of nature. The resulting hierarchy therefore concerns self-consciousness and self-liberation, not the validity or immanent achievement of the symbolic forms, each of which must still be assessed according to its own formative principle.

In the third volume of *The Philosophy of Symbolic Forms*, Cassirer distinguishes three fundamental functions of consciousness (Cassirer 2021b, 101 ff.). Expression characterizes a world in which appearance and essence are not yet sharply separated, as in myth. Representation establishes enduring objects within a unified spatiotemporal framework and underlies language and

⁶ Truwant (2015) interprets Cassirer's hierarchy in terms of the self-understanding of symbolic consciousness: while each symbolic form retains its own standards of validity, mathematical natural science ranks highest because it most fully recognizes its symbolic mediation. Luft (2015, 203 – 205), by contrast, conceives the teleology of culture as open and denies that it culminates in any determinate symbolic form. Kinzel (2024) criticizes Truwant's separation of epistemic pluralism from an ethical teleology of self-understanding. Although she subsequently identifies historically situated reinterpretation as an alternative path through which symbolic consciousness may understand itself as human expression rather than as pure functional symbolization, she does not regard this pluralization as resolving the underlying tension.

ordinary perception. Signification emerges in the pure category of relation and culminates in the functional concepts of mathematical natural science.

Cassirer uses “function” here in two related senses (Kinzel 2024). In the broader sense, symbolization as such is functional: expression, representation, and signification organize particulars within relational wholes. In the stricter scientific sense, function-concepts not only situate particulars within a structure but provide rules for their determination and grasp invariant relations of dependence.

Mathematical cognition therefore does not introduce relational organization for the first time; myth and language are already relationally articulated. Its specificity lies in treating objectivity through productive rules of thought. In pure mathematics this productivity is categorical: mathematical objects are generated through relational principles. In mathematical natural science it is hypothetical: empirical nature is approached under the assumption that its determinations can be progressively reconstructed as lawful functions of thought. In this stricter sense mathematical cognition provides the paradigmatic realization of the function-concept (cf. Cassirer 2021b, 479).

Pure mathematics displays this productivity most clearly. The elements of a manifold are not first given and then ordered, but generated and exhaustively determined through a serial principle. What Kant still attributed to receptivity therefore ceases to function as a ground of mathematical knowledge; even a sensible multiplicity supplied by pure intuition is unnecessary. The spontaneity of spirit becomes transparent in the generation of pure mathematical manifolds. Mathematical natural science raises the harder question of how far this spontaneity extends into the empirical domain. Nature appears to confront cognition as a reality whose determinations exist independently of subjectivity. Cassirer treats this apparent limit as a task of progressive determination: empirical manifolds are reconstructed through mathematical relations, laws, and invariants, so that what first appears as given is progressively determined as an element within a lawful system of relations. Pure mathematics generates its objects from relational principles; scientific cognition progressively reduces the empirical given to functional determinations. Spirit thereby discovers the reach of its formative activity precisely in what initially appears as given and heterogeneous to thought.

In physics, thought accordingly “*aspires to perform the impossible*: to treat and regard the ‘given’ as though it were not alien to thought but instead posited by thinking itself and produced by its constructive conditions” (Cassirer 2021b, 479;

emphasis added). The factual manifold must be worked through by seeking rules of transition and transposed into the form of a conceptual manifold.

This language of construction must not be understood subjectivistically. To say that thought constitutes nature is not to say that an individual consciousness invents a world or arbitrarily imposes a scheme on an independent reality. Objectivity increases as empirical manifolds are articulated through functional laws whose validity transcends individual standpoints. Spirit contributes lawful form, not subjective caprice. Nature is an expression of spirit insofar as its objectivity consists in the relational structure through which it is determinable as nature at all: the construction of nature is simultaneously its objectification.

The hypothetical character of scientific construction also shapes the role of experience. Theory does not derive its possible forms of order from empirical data; rather, it anticipates a field of possible relations whose applicability to nature must be established through experience. In *Substance and Function*, mathematics provides possible relational syntheses, while experiment establishes which of them are realized (Cassirer 1953, 257). The third volume of *The Philosophy of Symbolic Forms* makes the same point with geometry: pure systems articulate possible orders, while experience selects among them in their application to physical space. Cassirer accordingly assigns experience a determining rather than constitutive role (Cassirer 2021b, 490). The question is therefore how this contribution of experience is to be reconciled with the spontaneous activity of thought. Cassirer's answer emerges from the open-ended character of scientific determination. Experience does not introduce an independently constituted factor heterogeneous to thought; its determining role expresses instead the incompleteness of theoretical cognition. Scientific cognition treats the "given" as susceptible to progressively more comprehensive functional determination without assuming that this process can ever be completed. This becomes especially clear in the case of physical constants. In *Substance and Function*, Cassirer argues that universal equations do not suffice for the construction of the physical object: specific numerical constants are also required, and their values can be established only through experimental observation (Cassirer 1953, 311). Yet what must be accepted as empirically fixed at one stage can become the point of departure for further theoretical integration. Cassirer therefore describes the correlation of the empirical and mathematical-ideal serial forms as a process that "never ceases" (Cassirer 2021b, 486 – 487). Even universal physical constants may prove to be special cases of a more comprehensive lawfulness (Cassirer 2021b, 550). The empirical character of physical cognition thus lies not in an irreducible and absolute

element, but in the necessary incompleteness of the theoretical determination of the given.

This infinite process takes the form of the constitution of increasingly general invariants of experience. In *Determinism and Indeterminism in Modern Physics*, Cassirer explicitly distinguishes three types of physical statements: statements of the results of measurements, statements of laws, and statements of principles (Cassirer 1956, 29 – 57). Statements of measurement results attain invariance with respect to the subjectivity of the observer, though they themselves remain variable in relation to the laws that govern and unify individual cases. The multiplicity of such laws, moreover, is itself subordinated to more fundamental invariant principles that ground their systematic unity. This structure allows the task of transcendental philosophy to be compared with the conception of geometry advanced in the *Erlangen Program* by Felix Klein: just as geometry seeks relations unchanged under specified transformations, critical philosophy seeks “universal elements of form” that persist through changes in the material content of experience (Cassirer 1953, 268 – 269; Ihmig 1997).

The critical task carried out through the transcendental method consists in identifying these structural invariants and thereby advancing toward the self-knowledge of reason. In the domain of scientific cognition, these invariants reveal the *a priori* rules underlying the determination of lawful connections in nature. “Categories” such as space and time, magnitude, and the functional dependence of magnitudes are thus identified as formal elements that cannot be absent from any empirical judgment (Cassirer 1953, 269). Yet these categories are not confined to scientific cognition. They express fundamental functions of spiritual activity and therefore recur throughout the different symbolic forms, although in each case they are modulated according to the specific lawfulness of the form in question. Paraphrasing Kant’s formulation in §10 of the *Critique of Pure Reason*, one might say that it is one and the same spirit that exercises its symbolic function in mathematics, myth, language, or art. Mythical space, artistic space, and physical space are not identical, but each gives a specific articulation to the same fundamental function of objectification. The same holds for time, causality, magnitude, and the other basic categories: their configuration varies from one symbolic form to another without ceasing to express a common constitutive activity of spirit.

Transcendental philosophy seeks to bring these invariant functions to light across the plurality of symbolic forms. Its object is not any single world but the formative activity through which spirit constitutes worlds of knowledge, action, art, religion, and historical understanding. The symbolic

forms are therefore “not different modes in which some actual reveals itself to spirit but rather paths by which spirit proceeds in its objectivization – i.e., its *self-revelation*” (Cassirer 2021c, 7; emphasis added).

Against this background, science is one mode of symbolic objectification among others, distinguished not by escaping symbolic mediation but by the way this mediation becomes explicit. The symbolic means through which scientific objectivity is constituted are themselves recognized and understood as such:

For what distinguishes science from the other stages of spiritual life is not that it requires no mediation of signs and symbols and confronts the unveiled truth, the truth of ‘things in themselves,’ but that, differently and more profoundly than is possible for the other forms, it knows and understands the symbols it employs as such (Cassirer 2021a, 30 – 31).

In mathematical cognition, spirit attains an especially explicit consciousness of the relational and functional structures through which theoretical objectivity is constituted. Such reflexivity is not altogether absent from other symbolic forms: art may reflect upon its own procedures, while cultural sciences recognize that their objects bear meanings inseparable from human practices and interpretations. What distinguishes mathematical cognition is rather its relation to spontaneity and givenness. In pure mathematics, the given ceases to function as a ground of knowledge, since mathematical manifolds are generated through relational and serial principles established by thought itself. The constitutive activity of spirit thus becomes maximally transparent. Mathematical natural science confronts spirit with its most radical challenge: empirical manifolds cannot simply be generated as pure mathematical manifolds are; rather, they must be treated as susceptible to progressive determination through mathematical relations, laws, and invariants. This is what Cassirer characterizes as attempting “*das Unmögliche zu leisten*” (Cassirer 2021b, 479). Precisely in confronting this apparently impossible task, the objectifying power of spirit is deployed to its fullest extent. When cognition passes from mathematical to physical objects, “thought discovers in itself a new power which had hitherto seemed locked within it” (Cassirer 2021b, 470). Nature, although it appears to exist independently of subjectivity, becomes progressively intelligible as a lawful order whose objective determination is constituted, rather than merely found or received, through the activity of spirit. Through the principles of pure science, spirit “truly discovers itself as that which contains within itself the principle, the

beginning of movement" (Cassirer 2021b, 400). Pure mathematics and mathematical natural science are thus complementary: the former displays the spontaneity of thought with maximal clarity, while the latter reveals how far its objectifying power can be extended.

This scientific determination is intrinsically infinite. The empirical given can never be absorbed into a completed system of functional relations; each stage leaves further determinations to be integrated into more comprehensive structures. As givenness loses its status as an independent ground, the contribution of thought becomes increasingly explicit. The attempt to accomplish the impossible is therefore sustained as an open-ended task rather than resolved in a final construction of nature. Transcendental reflection accompanies this development by identifying invariant functions and deepening reason's knowledge of its own activity. Mathematical cognition thus provides no final or absolute standpoint, but an indefinitely advancing process of self-disclosure.

Within the philosophy of symbolic forms as a whole, this process acquires a broader phenomenological meaning. Cassirer himself characterizes the relation between the symbolic forms as a progressive movement of self-recognition: "the relationship between myth, language, and art constitutes a specific systematic gradation, an ideal progression whose end marks a point at which spirit not only is and lives in its own formations, its self-created symbols, but also knows them for what they are" (Cassirer 2021a, 30 – 31). The relevant gradation therefore does not concern the presence or absence of symbolic mediation, but the progressively explicit recognition by spirit of its own symbolic activity. Myth already involves a genuine symbolic transformation of experience: spirit lives in and through its own formations, even though it does not yet explicitly recognize them as products of its own formative activity. The development of the symbolic forms can thus be understood as an increasing self-understanding of this activity. At the opposite pole, mathematical natural science extends such self-recognition even to nature, the domain of what appears to exist independently of subjectivity. The contrast is therefore not between an inferior and a valid form of objectivity. Myth retains its own irreducible mode of objectification, as do language, art, religion, and the other symbolic forms. What changes is the relation of spirit to its own activity and, more specifically, the degree to which that activity becomes explicit to itself. Cassirer's hierarchy can thus be understood as a hierarchy of progressive self-knowledge without compromising the pluralism of symbolic forms.

Conclusions

Our analysis shows that mathematical cognition occupies a distinctive position in Cassirer's philosophy of symbolic forms because its two moments disclose complementary dimensions of spirit's formative activity. Pure mathematics makes the generation of ideal relational structures maximally transparent, while mathematical natural science displays the reach of this spontaneity in the determination of nature, precisely in what initially appears as given and alien to thought. Its privilege therefore rests neither on an exclusive claim to objectivity nor on reflexivity alone, but on the conjunction of transparency and objectifying reach. Understood in this qualified sense, Cassirer's hierarchy of progressive self-knowledge remains compatible with the autonomy and irreducibility of the symbolic forms.⁷

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