

JOURNAL > SITE 1: LOGIC GATE, THE POLITICS OF THE ARTIFACTUAL MIND | 2017

## Anti-Eureka

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*“In their spoken language, a noun has a case marker indicating whether it’s a subject or object. In their written language, however, a noun is identified as a subject or object based on the orientation of its logogram relative to the verb [...]. I’ll bet you that learning their two-dimensional grammar will help you when it comes time to learn their mathematical notation.”*

*“You’ve got a point there. So, are we ready to start asking about their mathematics?”*

*“Not yet. We need a better grasp on this writing system before we begin anything else,” I said, and then smiled when he mimed frustration. “Patience, good sir. Patience is a virtue.”<sup>1</sup>*

*It would be easy to worry unnecessarily about the feasibility of the matter. It is impossible, someone might say, to advance science with a conceptual notation, for the invention of the latter already presupposes the existence of the former. Exactly the same difficulty arises for [ordinary] language. This is supposed to have made reason possible, but how could man have invented language without reason?<sup>2</sup>*

The proposal for an ideal language manifests itself as a problem concerning the order of creation. Chiang’s short story renders this as a paradox by asking how beings born within time could invent a language which took them outside of it—but more about that later. Our intention is rather to take the construction of ideal language as a case of a more general tension between two schemas of genesis: the empirical and the formal.

By the *empirical schema*, we name the factual order by which a subject or subjects come to know anything at all, or, simply to develop representations about the world. We are thus using the term empirical in a broader sense than we might take it in the context of classical empiricism, where it indexed the methodological principle of grounding theory in experience. Rather, we use it to refer in a quite blanket manner to the *located* character of concept formation, its history, the “fact” that knowledge is situated. Nevertheless, the reference to empiricism should be allowed to linger, for it was Hume who so valiantly attempted to reduce all ideas to the content of experience, as a consequence developing an account of skepticism as the methodological realization that the “leaky weather-beaten vessel”<sup>3</sup> of our situated faculties was all that we had to rely upon in this sea of concepts.

Our second schema is difficult to define other than negatively, as it concerns the degree to which the process of thinking can be said to grasp or, more radically, be dependent upon, that which is *outside* of that process. Naming this the problem *of the formal* has a certain polemical valence, highlighted by the discussion of ideal language, but we could also call it the question of the relative autonomy of concepts. This would be consistent with a conception of philosophy as historically wagered upon the possibility of this autonomy, the hope that the factual equation of concepts and facts is false. If we return to these quite traditional problematics, it is because we believe that many contemporary debates surrounding philosophical authority might be more fruitfully reorientated as questions about a potential disjunction between the *generation* and *content* of concepts. The immediate problem is that this disjunction remains vacuous so long as the putative autonomy of conceptual content is only defined in a general manner as the degree of abstraction from an empirical reference base. Rather, what is required is a method of analysis that allows conceptual invariance to emerge progressively across different domains. Such a method is proposed by Swoyer under the name *surrogate reasoning*, in which different *structural representations* are marshalled in order to exhibit a mappable consistency of relations between said representations. Swoyer seeks to generalize the function of *expression* in the Leibnizian sense, wherein, for example, “the model of the machine expresses the machine” or “the projective delineation on a plane expresses a solid”.<sup>4</sup> In Swoyer’s language, the expression stands for the expressed as a *surrogate*. Such reasoning via the expression or surrogate relation was proposed by Leibniz as a mode in which:

... [W]e can pass from a consideration of the relations in the expression to a knowledge of the corresponding properties of the thing expressed. Hence it is clearly not necessary for that which expresses to be similar to the thing expressed, if only a certain analogy is maintained between the relations.<sup>5</sup>

In extending Leibniz's account, we take Swoyer to advance a measurement theoretic account of philosophy as dialectic between *artifact* and *invariance*. However, the distinction between the invariant and the artifactual is itself fraught, and in many ways, turns upon the above mention of a "certain analogy," and its distinction from similarity. Leibniz is here using "analogy" in the sense of maintaining proportion, which we name here as invariance, and this must be distinguished from a more contemporary sense of analogy as simple resemblance, founded on the perception of empirical continuity. Only following such a distinction can we claim to demarcate a notion of surrogacy which is informative rather than obfuscating. Indeed, as Swoyer insists, there is a trivial sense in which "with sufficient perseverance—or perversity—we can use anything to represent virtually anything else."<sup>6</sup> In other words, philosophy is haunted by the threat of an analogical overextension, of constructing a *lingua universalis* in which all "content" is an artifact. In order to cleave invariance from artifact, analogy must be constrained. For Swoyer, this involves a formal notion of "shared structure"<sup>7</sup> that can localize invariance as preservation of relevant structure across different representational systems, whilst discarding artifacts as those features for which no consistent mapping obtains.

It is insofar as this formal constraint of structure is to be articulated using *formalism* that we arrive at the problem of ideal language. This should be differentiated from the debate around "mathematical platonism." Whereas the "platonic" problematic concerns the seeming necessity of ontologizing the purported "objects" of formalism, resulting in endless ratiocinations around the status of "numbers" or "the abstract general idea of a triangle," the puzzle of ideal language concerns the degree to which it is necessary to reify a particular formal structure as the condition of legibility for inter-representational invariances. The aim of ideal language is not to cut nature at the joints, nor simply to do the same for concepts, but rather to give the conditions of identity for concepts across the different representations in which they appear. It is precisely this dynamic which is illustrated by the fact that the structure of surrogacy on Swoyer's account turns out to always be a *doubled* structure, in which the generalized expression or surrogate relation holds only between different idealized models of the domains in question, and this must be supported by a certain opaque idealization of a particular formal apparatus. What this

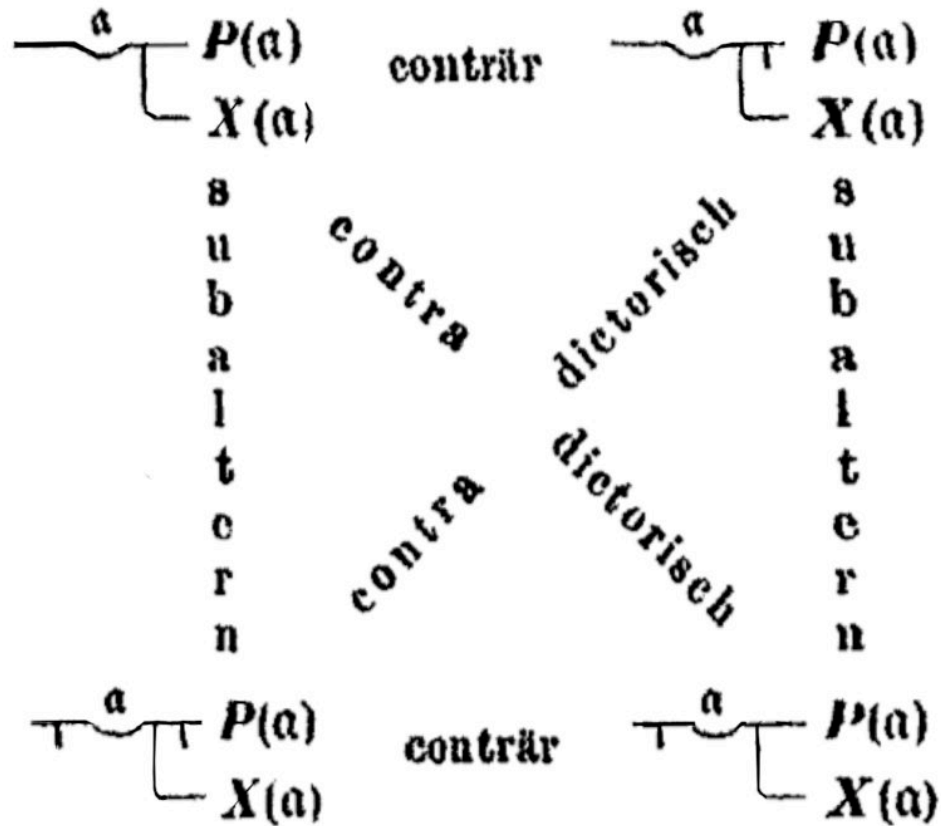
seems to point to is the paradoxical structure of surrogative reasoning: the institution of an ideal formal language appears as the *precondition* of legibility for the very notion of surrogacy.

In this manner, Swoyer's project points to a dynamic inherent to the deployment of formalism in the investigation of the formal, that of *reified artifactuality*. The ever-present shadow of the philosophical deployment of formalism is that the idiosyncratic features of a representational system are illegitimately extended when they are taken as irreducible, and hence given a chimerical purchase outside of the domain in which they developed. This problem of reified artifactuality is a useful way of framing the pitfalls inherent to both schemas of genesis: the empirical schema is reified when an identity is assumed between conceptual content and the conditions of generation, the formal schema is reified when the validity of ideal representation is assumed, by fiat, as governing.

This might appear as a critique of the philosophical crutch of formalism. The matter is not so simple, for the crux of the difficulty is that the analogical structures of natural language are no less reified in philosophies that seek to bypass formalism. What, for example, are Hume's principles of association—resemblance, continuity, cause and effect—if not a reification of the linguistically mediated associations inherent to the natural attitude? It is precisely this point that was most viciously attacked by Frege in his numerous critiques of the manner in which empiricism had developed into a dominant and anti-philosophical strain of scientifically-minded naturalism.<sup>8</sup> We can focus here on two points that were fairly consistent across Frege's writings. The first concerned the impossibility of experience alone—and its philosophical sedimentation in empiricism—overcoming the incessant flow of sensory input, the manner in which “[t]he vivacity of sense-impressions surpasses that of memory-images.”<sup>9</sup> It is this unfortunate fact which requires the deployment of concepts as a kind of stabilizing function on experience. The philosophical investigation of these concepts quickly runs into a second, more insidious foe: its reliance on natural language, which imports into thinking an architecture foreign to concepts owing to an after-image of speech. Thus, “a great part of the work of a philosopher consists—or ought to consist—in a struggle against language.”<sup>10</sup> Although Frege never stated it so bluntly, we could almost say that insofar as philosophy proceeds solely within natural language, it does not even think. Nevertheless, it was clear that even in cases where thinking deployed formal symbols to combat these empirical weaknesses, an initial reliance on experience was coded into the very *sensible* nature of those symbols. Frege thus acknowledged that we were stuck with

the “leaky vessel” of the faculties, but took the opposite lesson from this than Hume, asking how it was that we could use “the realm of the sensibles to free ourself from its constraint,” to make something of the fact that “[s]ymbols have the same importance for thought that discovering how to use the wind to sail against the wind had for navigation.”<sup>11</sup>

So ergibt sich die **Tafel der logischen Gegensätze:**



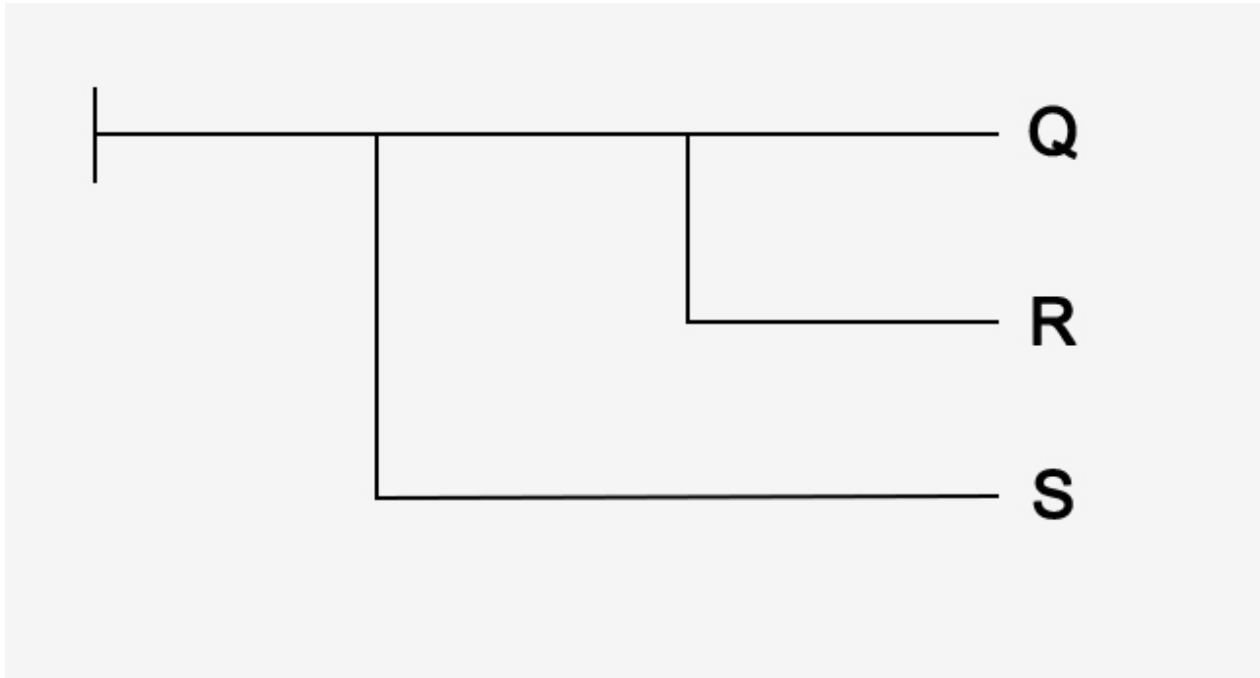
Gottlob Frege's “square of opposition”, taken from “Begriffsschrift, eine der arithmetischen nachgebildete Formelsprache des reinen Denkens”, Halle a/S: Verlag von Louis Nebert, 1879.

For the next step, Frege was going to need a bigger boat: the *Begriffsschrift* or conceptual notation (literally, “concept-script”). According to Frege, the crucial failing of past attempts to give expression to logical rules governing the formation and relation of concepts was that these rules were invariably “external to content.”<sup>12</sup> This is to say that, on the one hand, they imported a subject/predicate structure from natural language, obscuring the character of concepts as *unsaturated functions*—for which mathematical

concepts are the paradigmatic example—and, on the other, they relied on breaking concepts up into successive concatenations, the inferences between which remained ambiguous and prone to error:

*In this respect, [ordinary] language can be compared to the hand which despite its adaptability to the most diverse tasks is still inadequate. We build for ourselves artificial hands, tools for particular purposes, which work with more accuracy than the hand can provide. And how is accuracy possible? Through the very stiffness and inflexibility of parts the lack of which makes the hand so dexterous. Word-language is inadequate in a similar way. We need a system of symbols from which every ambiguity is banned, which has a strict logical form from which the content cannot escape.<sup>13</sup>*

Collapsing the illusory distinction between form and content would thus require the development of what Frege would later call a *Hilfssprache*, an artificial or *surrogative* language.<sup>14</sup> The method by which the project for a *Begriffsschrift* pursued this ideal was by undermining the order of succession inherent to the articulation of thoughts in natural language, and which has persisted in the dominant forms of propositional logic in the 20th century. To give an example, in first-order propositional logic we can express the syllogism a) “if S, then if R then Q” as “ $S \rightarrow (R \rightarrow Q)$ ,” and the syllogism b) “if S and R, then Q” as “ $(S \ \& \ R) \rightarrow Q$ .” In turn, we can express the formal equivalence of a) and b) by writing c) “ $S \rightarrow (R \rightarrow Q) \dashv\vdash (S \ \& \ R) \rightarrow Q$ .” However, the latter is something which has to be *proved*; it is not immediately evident from the expression of a) or b). In contrast, these propositions can all be written in a single *Begriffsschrift* “sentence” as follows:



Whether we read a), b) or c) out of this sentence will depend precisely on the “reading” adopted, but they are all presented mutually as its content. A *Begriffsschrift* sentence of this type is hence an abstract prism of logical relations, through which different linear interpretations are refracted relative to an analysis.

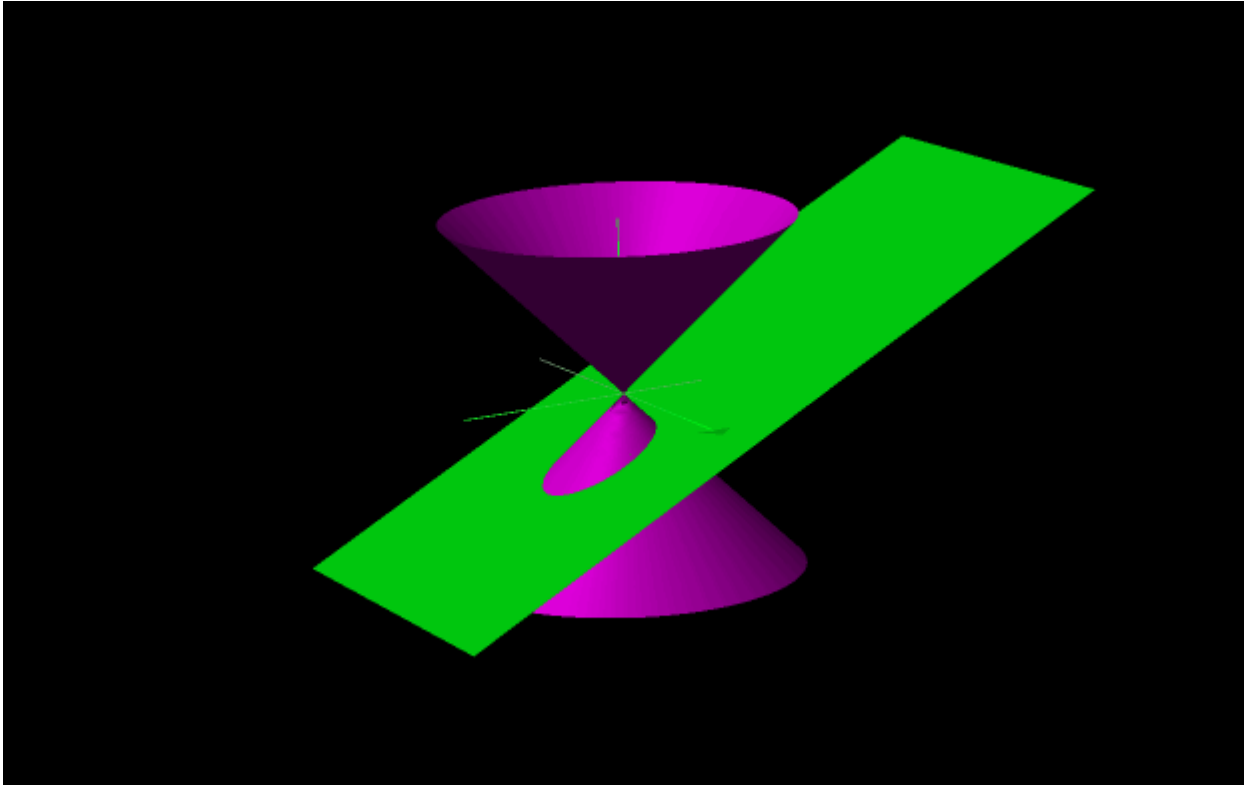
It is this synthetic role which is emphasized by Macbeth in *Frege’s Logic*, an appropriately named work, since the book is a narrative in which the protagonist is not, properly speaking, Frege himself, but rather his formal notation. There is a mirroring between the form of the narrative which Macbeth gives and the form of the script itself: the ideal language of the *Begriffsschrift* emerges as site where the angles of approach to its content, even Frege’s own, are ultimately erased. The key to this reading is the claim that Frege’s notation is in fact not a *Begriffsschrift* at all, but, developing from Frege’s later distinction between sense [*sinn*] and reference [*bedeutung*], a *Sinnschrift*, a presentation of the content of senses. In Macbeth’s language, what the notation objectively presents is not *concepts* but *conceptions*—conceptions that, although historical, can be rendered properly “objective” as senses in their written presentation, insofar as Frege’s script allows us to write them in a form which would be the same for any being capable of grasping them. On Macbeth’s reading, the lesson of the *Begriffsschrift* is that logic “is a science like any other” because “no more than in any other science is it simply *given* what the basic logical concepts are or how best to conceive them.”<sup>15</sup> In other words, it is because logical concepts are not transparent to reason that Frege’s notation can fulfill the ideal of a science of logic in which:

*Our conceptions of things, the medium through which they are grasped by us, can become transparent to us in a fully axiomatized system, but such conceptions must be distinguished in principle from the concepts we seek to grasp by their means. We can make mistakes.*<sup>16</sup>

This picture is highly suggestive. However, the realization of Frege's ideal language in a historically localized form of writing exemplifies what we earlier called the problem of reified artifactuality. The distinction that Macbeth draws, between historically located but nonetheless objectively presentable conceptions and strictly transhistorical concepts seems to be a necessary one for articulating the purchase of a project like Frege's *Begriffsschrift*. Thus, *what* Frege's language writes is the situated objectivity of conceptions *as* a full-fledged realization of objectivity, a standpoint of knowing understood as a stabilization of different relations of mediation. Macbeth's perspective aligns with our earlier sketch of Swoyer, wherein the achievement of the ideal is, in effect, the realization of invariance. Yet, given that such invariance is simply invariance across historically situated conceptions, it seems that Frege's script ultimately reifies a particular historical form of understanding, transforming generation *into* content via a systematization of the former. Any access afforded to the timeless nature of concepts remains riddled with artifactuality.

Our concern then is the sufficiency of thinking formalization's relation to content without merely side-stepping genesis as such, a point of tense contact between Frege and the experiments of Châtelet, who excavated a philosophy of formalism latent within the legacy of German Idealism, in particular Schelling's *Naturphilosophie*. It was Schelling who sought to think the imbrication of the formal and the natural in order to avoid the traps whereby the attempt to locate *where* thought takes place all too often leads to trial by anti-Platonism, thereby foreclosing alternative means of articulating an autonomy of the concept, the idea, or the formal. It is important not to assume that Schelling merely imparts thought to nature. Rather, the project of *Naturphilosophie* is one in which, from the point of view of thought, nature should be treated as thought-matter, even though it requires *our* mental activity.





Rendition of a “conic section”, a concept used by G. W. Leibniz to illustrate surrogative reasoning.

Here, we might posit a certain structural analogy between Schelling and Frege in trying to think the consequences of the assertion that thought is not *in* the head. For Schelling, “[n]ature’s highest goal to become wholly an object to herself is achieved only through the last and highest order of reflection, which is none other than man; or, more generally, it is what we call reason.”<sup>17</sup> Yet, reason is not, pace Kant, the lord of all thought, but merely the faculty that draws conclusions. Along similar lines, Frege finds the essential value of the externalization of thinking in notation in the fact that seemingly mechanistic manipulation of numbers in formal systems “only becomes possible at all after the mathematical notation has, as a result of genuine thought, been so developed that it does the thinking for us.”<sup>18</sup> A syncretic axis drawn through Schelling and Frege would thus insist on the artifactuality of all actually existing thought processes: thought is an artifact of nature in a similar manner that thinking is an artifact of the “genuine thought” glimpsed in external formalization.

It is the inseparability of the logical from the natural that is taken up by Châtelet’s deployment of the diagram, in that the diagram *finds* thought partially by exhibiting it as properly dynamic. Châtelet writes in *Figuring Space*:

*In its ordinary functioning, science seems to limit itself to the gestures that guarantee the preservation of knowledge and leave undisturbed the patrimony of those that set it alight and multiply it. Those are also the ones that save it from indefinite accumulation and stratification, from the childishness of established positivities, from the comfort of the transits of the “operational” and, finally, from the temptation of allowing itself to be buckled up in a grammar. They illustrate the urgency of an authentic way of conceiving information which would not be committed solely to communication, but would aim at a rational grasp of allusion and of the learning of learning. The latter, of course, would be far removed from the neuronal barbarism which exhausts itself in hunting down the recipient of the thought and in confusing learning with a pillaging of informational booty. Schelling perhaps saw more clearly: he knew that thought was not always encapsulated within the brain, that it could be everywhere, “outside ... in the morning dew.”<sup>19</sup>*

There is no obvious agreement between Frege and Châtelet here, but we can situate both as attempting to go beyond the limits of thinking through thought via inventive attempts at modeling immanent relations and the behavior of concepts. We might say that Châtelet presents us with an extreme case of this trajectory, one which touches upon the problem of the hard limit of expressibility and exhibition. Whilst this is often taken up in a poetic mode (that is, of breaking language with language), Châtelet’s attempt at “touching” the outside through the diagram represents an alternative to Frege’s deployment of the *Begriffsschrift*. The creatures of diagrammatic space are formal entities that not only express a concept but express their own construction in their very form. This invocation of the outside by way of an engagement with the diagrammatic must, however, immediately be shorn of any categorization as either naive romanticism or anti-formal expressionism. As a positive construction, Châtelet invokes *Naturphilosophic* method as a model of the experimental consequences of the formal on the formal and the nonformal simultaneously in the context of post-Newtonian field physics. But, at the same time, if the danger in Frege/Macbeth was a reified artifactuality, the danger in Schelling/Châtelet is a trivial genesis.

An orientating tension here concerns the ways in which Frege and Châtelet deploy the philosophical notion of containment, and the influence this has on how they aim to keep one foot (or one hand) always in the world of experiential content. Just to compare:

*The expression “grasp” is as metaphorical as “content of consciousness.” The nature of language does not permit anything else. What I hold in my hand can certainly be regarded as the content of my hand: but all the same it is the content of my hand in quite another and more extraneous way than are the bones and muscles of which the hand consists or again the tensions these undergo.<sup>20</sup>*

For Châtelet, however, the auto-spatiality performed by the use of diagrams demonstrates “a revenge of the hand” which presents a notation which “contaminates to some extent the calculations, in order to create a new context like literary metaphor.”<sup>21</sup> In both cases, content and form are playing in a diagonal, or ingrown space, between inside and outside, and it is this thought which Châtelet wishes to emphasize through his use of the concept of *extainment*, recently advanced by Grant in a series of texts highlighting the connection between Châtelet and Schelling.<sup>22</sup> Effectively, extainment makes explicit the difference between representation as expression and representation as exhibition, a difference modeled in turn by Schelling’s reconceptualization of the subject/predicate relation as one of ground and consequent. Keeping in mind Frege’s grasp and Châtelet’s avenging hand, Grant’s emphasis on Schelling’s *Naturphilosophie* aims at describing a process whereby exhibition is not merely one thing expressing another smoothly, but an asymmetrical identity relation<sup>23</sup> whereby the second exhibited element expresses what was *in* the first while the second element is only possible by treating the first element as its ground.<sup>24</sup> The consequent can only be what it *is* by having the particular ground that it has, but it must differentiate itself from that ground in order to be a consequent.



Still from the film "Arrival" (2016) by Denis Villeneuve.

Thus, while containment expands the ground to engulf what has issued from it, extainment expands ground in order to exist as consequent, and, thus, the idea of the ground productively changes along with the topologically unpredictable behavior of what has emerged. Thus, the lesson which Grant seeks to draw from the Châtelet quote above regarding thought being in the morning dew is that “thinking is done in a nature whose nature is not boxed in, but boxed out. Exhibition, therefore, is the exhibition of precisely what is thought when what is doing the thinking is outside, everywhere.”<sup>25</sup> Perhaps as an imperfect reversal of Frege’s comment on how to think in a language before inventing it, the fact that conceptually grasping is imprecise is what makes it productive, not only intersubjectively, but in terms of any concept’s autonomy. Our concern is thus: what does conceiving formalism as a figure of *surrogative autonomy* tell us about the genesis of the formal? There are no simple answers here, but Chiang’s “Story of Your Life,” with which we began, dramatizes the problem. Chiang’s narrative follows a linguist charged with deciphering the script of alien visitors, the Heptapods. The fundamental challenge she faces stems from a feature of this language which we have already touched upon, namely that the written language of the aliens (Heptapod B) is radically disjunct from their spoken language (Heptapod A), in a manner opposed to the normal function of human inscription. Heptapod B seems to correspond to an order of cognition quite distinct from linear speech—one that poses a barrier to human comprehension because its writing seems to require a break from the temporal order of

empirical thinking: in order to “write” a sentence in Heptapod B, you must already *know* exactly how it will end. The “problem” of the story, as we read it, is thus the relationship between construction and intelligibility. For Chiang’s protagonist, the conditions of linguistic construction in Heptapod B are unintelligible, and thus the script appears as radically exterior. This appearance of exteriority, however, is a result of the epistemic standpoint of the human interlocutor, and as readers our interest immediately turns elsewhere: how did the aliens *write* this thing? It is this pole of construction which effectively vanishes in *Arrival* (2016), the recent film adaptation of Chiang’s work, a charmless fable in which aliens gift humanity with the *Begriffsschrift* in order to save the nuclear family. Everything objectionable about the film’s “only Kang and Kodos can save us now” drama of transcendental-linguistic xenophilia is condensed in a scene inserted into the narrative, in which the linguist—a woman, of course—has to be transported into the alien’s inner sanctum in order to receive cognitive rewiring through some mystical inception, the veritable *arrival* of the film’s title. At this moment, the “learning of learning” the audience has been following is revealed to have been nothing but fertilizer for one thinking process to erase another. We could say that what is bypassed here is the problem of formalization as such, insofar as we are forced to assume a one-one mapping without genesis between thinking, writing, and thought, wherein the relation between different systems of conception can only be one of replacement.

The problem of surrogative autonomy is that thinking can quite readily formalize itself into a plethora of exteriorities, but that these will not necessarily be intelligible to it. All writing is at least a partial autonomization of thinking, but this fact is quite banal. The task is rather to try and develop the process of formalization as a model of transcendental reflection wherein thought is revealed *to* thinking through a mapping of relations back into the thinkable, a process which always teeters between a romance of the unintelligible and an acceptance of reified artifactuality. With respect to our title, we wish to avoid any cult of novelty as well as any dogmatism of formal control. The Châtelet-Frege axis we have sketched is thus intended to avoid two fairy tales: the former of a philosopher listening to the whispering dew for the sake of automatic writing (trivial genesis), and the latter of a massive computational hand gloved in implicative strokes that clutches all of sense and thought always and forever (reified artifactuality). There is a conflict between formal literacy and the scalability of reason over time and across thinkers in which thought—as grasped in the experience of a cognitive shift following a newly acquired conceptual or formal literacy—unnecessarily bears the halo of an event or

an alien arrival if we hold too strictly to either an empirical or formal schema of genesis. In other words, patience for the formal to *do its work* requires a certain abandonment of cause and assumptions about the formal in its supposedly *native* environment, the mind. This paper was developed out of a workshop entitled “PS: Surrogat(IV)e Autonomy,” as part of a broader series of events under the banner of “The Stubbornness of the Empirical” at Performing Arts Forum. We would like to thank our co-organizers and all other participants in that and other events in the series. Particular note should go to Lendl Barcelos, who introduced us to Swoyer’s concept of *surrogative reasoning*. (#\_ftnref25)

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## Footnotes

1. Ted Chiang. *Story of Your Life and Others*. New York: Tor, 2008. 131-135. Print.
2. Gottlob Frege. “On the Scientific Justification of Conceptual Notation.” *Conceptual Notation and Related Articles*. Oxford: Clarendon Press, 1972. 89. Print.
3. David Hume. *A Treatise of Human Nature*. Oxford: Oxford University Press, 2000. 172. Print.
4. G. W. Leibniz. “What Is an Idea?” *Philosophical Papers and Letters*. Dordrecht: Springer, 1989. 207. Print.
5. *Ibid.*
6. Chris Swoyer. “Structural Representation and Surrogative Reasoning.” *Synthese* 87 (3). Print; Dordrecht: Kluwer Academic Publishers, 1991. 452. Print. (For an extension of Swoyer’s account, see “Leibnizian Expression.” *Journal of the History of Philosophy* 33 (1), 65-99. Baltimore: John Hopkins University Press, 1995. Print.)
7. *Ibid.* Swoyer. 451.
8. For an excellent history on this point, see Hans D. Sluga. *Gottlob Frege*. London: Routledge & Kegan Paul Ltd, 1980. Print.
9. Frege. *Op. cit.* 1972. 84.
10. Gottlob Frege. “Sources of Knowledge in Mathematics and the Mathematical Natural Sciences.” *Posthumous Writings*. London: Blackwell, 1979. 270. Print.
11. Frege. *Op. cit.* 1972. 84.
12. *Ibid.* 86.
13. *Ibid.* 86.
14. See the late fragment “Logical Generality” in Frege. *Op cit.* 1979. The distinction which Frege sets up in this essay, between *Hilfssprache* and *Darlegungssprache* (language of explanation or commentary—in short, the language of the philosophical text) is often translated through Tarski’s later distinction between “object language” and “meta-language,” but in the present context we find this to be an unhelpful importation.
15. Danielle Macbeth. *Frege’s Logic*. Cambridge, MA: Harvard University Press, 2005. 154. Print.
16. *Ibid.*

17. F.W.J. von Schelling. *System of Transcendental Idealism*. Trans. Peter Heath. Charlottesville: University of Virginia Press, 1978. 6. Print.
18. Gottlob Frege. *The Foundations of Arithmetic*. Trans. J.L. Austin. Evanston: Northwestern University Press, 1980. xv-xvi. Print.
19. Gilles Châtelet. *Figuring Space: Philosophy, Mathematics, and Physics*. Trans. Robert Shore and Muriel Zagha. London: Springer, 1999. 14. Print.
20. Frege. "Thoughts." *Collected Papers on Mathematics, Logic and Philosophy*. London: Blackwell, 1994. 368. Print.
21. Gilles Châtelet. "Interlacing the Singularity, the Diagram, and the Metaphor." Ed. Charles Alunni. *Virtual Mathematics: The Logic of Difference*. Ed. Simon Duffy. Bolton: Clinamen Press, 2006. 36. Print.
22. *Extainment* is Grant's translation of Châtelet's use of *extimité* taken from Lacan's seventh seminar. While usually translated as *extimacy* in an attempt to override the psychical division of inside and outside, Grant follows the topological traces and opposes to it containment in the form of extainment.
23. Following terminology introduced by Gabriel Catren, we might say that what is at stake here is not so much a relation of identity as one of identification. See "Klein-Weyl's Program and the Ontology of Gauge and Quantum Systems" (forthcoming).
24. Iain Hamilton Grant. "The Law of Insuperable Environment: What Is Exhibited in the Exhibition of the Process of Nature?" *Analecta Hermeneutics* 5. 9-10. Web.
25. *Ibid.*

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Matt Hare is a philosopher whose work has lately been concerned with the various legacies of 'empiricism', the relationship between experience and abstraction, and the process of formalisation, particularly as it occurs in mathematics.

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