



Introduction:

The Madness of Dramatization

But I think for the communication of what happened and what we can draw from it, that will have to wait until we put it into a publication. Because it's going to take us a long time to work out exactly what happened and put it in order.

— RM, Tape #19, 28:58

Given any concept, we can always discover its drama.

— Gilles Deleuze, 'The Method of Dramatization'

An experiment in (or without) method, *Secrets of Creation* traverses the most exalted terrains of higher mathematics and makes the most unreasonable demands on art, only to terminate inconclusively with the construction of an assemblage whose rudimentary gesture scarcely reaches the level of elementary arithmetic and whose aesthetic indifference disbars it from claiming any artistic merit. A project designed as an antidote to the PR slickness and spectacular vaunting of science typical of the 'sci-art' that was a feature of the cultural landscape in the early 2000s,¹ its focus on the *insistence of the problem*—"the urgency of comprehension before any attempt at a solution"²—meant that, rather than art serving the cultural promotion of science under cover of a celebratory invocation of vague notions of their common 'creativity', art was knotted together with science and philosophy in a thoroughly perplexing fashion.

The artist Conrad Shawcross and the mathematician Matthew Watkins spent a week in discussion, with no expectation that anything would be 'produced', the intention being to present to the public the process of collaborative research itself, in the form of whatever it left behind. The question posed to the two

1. For a review of the trend and its historical relationship to 'science PR' see C. Sleight and S. Craske, 'Art and Science in the UK: A Brief History and Critical Reflection', *Interdisciplinary Science Reviews* 42:4 (2017), 313–30. In their programmatic conclusion the authors call for 'neutral spaces—neither art nor science galleries—for transdisciplinary display and criticism, such that the rules of politesse that govern the home turf of either discipline do not pertain' (327).

2. J.-M. Salanskis, 'Idea and Destination', in P. Patton (ed.), *Deleuze: A Critical Reader* (Oxford: Blackwell, 1996), 57–80: 67.

residents in effect invited them to extend their existing practice: In Watkins's case, presenting his speculative research on prime numbers to nonmathematicians, and in Shawcross's, creating artworks from meticulously engineered systems that employ space and motion to explore scientific and philosophical questions. It also opened onto the broader social question of the widening gulf between those with scientific training and a majority subjected to a technological regime with little comprehension of the underlying concepts that make it possible. We hoped to attack the question of whether the work of artists can somehow help to cross this gulf—as the sci-art credo assumes—through an approach at once philosophical and oriented toward pragmatic experimentation.

Looking back, the philosophical interest of the project documented here lies not so much in this misguided question with which it was announced—*How can artists and artworks stage a 'dramatization' of abstract concepts that allows them to be grasped by non-experts*—nor in the comedy of its eventual unfolding into a fraught attempt to demonstrate, by means of miniature wooden chariots and CCTV cameras, "how 2×5 is a novel approach to reality", but in the way that the project engaged with the concept of dramatization itself: thematically, by retracing the most important open question in number theory back to an elementary concept of arithmetic and its anthropological origins, and immanently, in the collaborators' attempt to present these fundamental concepts in a way that would engage the sensory-motor system.

A Platonism of Problems

In an introduction to his work, Albert Lautman, one of the few thinkers to have linked the mathematics of his own time with contemporary developments in philosophy, insists that although

[i]t may seem strange to those who are used to separating the 'human' sciences from the 'exact' sciences, to see brought together in the same work, reflections on Plato and Heidegger, and remarks on the law of quadratic reciprocity or the distribution of prime numbers [...] this rapprochement of metaphysics and mathematics is not contingent but necessary.³

3. A. Lautman, *Mathematics, Ideas and the Physical Real*, tr. S.B. Duffy (London and New York: Continuum, 2011), 197.

A mathematical thinker of his time—irrevocably marked by Gödel's consummation of the failure of foundationalism, inspired by the Bourbakian flowering of structuralism in mathematics, an enemy of the constructivism and conventionalism that would deprive mathematical objects of any claim to independent reality—Lautman shared with his friend and colleague Jean Cavailles⁴ a conviction in 'the solidarity that unites the nature of the mathematical object with the singular experiment of its elaboration through time.'⁵ That is, although an outlier of the early twentieth-century French epistemology emblematised by Gaston Bachelard's theorisation of science as a dynamic transcendental structure,⁶ Lautman, like many of that current, interrogated the *historicity* of mathematics and the *reality* of its objects, regarding mathematics as an experimental discipline⁷ dealing in genuine discovery rather than arbitrary invention.

To reconcile history and eternity in a stance that excludes classic Platonist idealism (the 'conception of an immutable universe of ideal mathematical beings')⁸ and a collapse into constructivism, Lautman rather surprisingly calls upon the philosophy of Martin Heidegger. Mathematical concepts are historical manifestations of a dialectic of Ideas which, although it cannot be expressed without them, surpasses them as Being does beings. The questions posed to this dialectic, the framing of its Ideas according to a particular epoch and circumstance, bring forth mathematical entities whose difference from the Ideas they 'incarnate' must be honoured. It is the problematic Being of the dialectic, rather than mathematical beings, that is eternal. In an articulation that fuses a Platonism, and perhaps Hegelianism, with a Heideggerian gesture, Lautman claims that

[t]here is therefore a sense in which one can speak of the 'participation' of distinct mathematical theories in a common dialectic that governs them.

4. See J. Cavailles, *On Logic and the Theory of Science*, tr. K. Peden and R. Mackay (Falmouth and New York: Urbanomic and Sequence Press, forthcoming 2021), and J. Cavailles and A. Lautman, 'Mathematical Thought' [1939], tr. R. Mackay, <<https://www.urbanomic.com/document/mathematical-thought/>>.

5. Cavailles and Lautman, 'Mathematical Thought'. For a detailed philosophical introduction to Lautman's thought see also J. Petitot, 'To Remake the "Timaeus"' [1987], tr. R. Mackay, <<https://www.urbanomic.com/document/jean-petitot-remaking-the-timaeus/>>.

6. E. Barot, 'L'objectivité mathématique selon A. Lautman: Entre Idées dialectiques et réalité physique', *Cahiers François Viète* 6 (2003), 3–28: 6.

7. *Ibid.*, 4.

8. Cavailles and Lautman, 'Mathematical Thought'.

The Ideas of this dialectic must be conceived as Ideas of possible relations between abstract notions [...].⁹

Even though the indeterminacy of these dialectical dynamisms means that the Ideas that emerge from them continue to transcend their actualisations, they find a favoured material in the mathematical concept:

It seems to me that [the] meaning [of mathematical concepts] lies in their attachment to a metaphysics (or dialectic) of which they are *the necessary extension*. In short, they constitute *the matter the closest to Ideas*. It doesn't seem to me at all that this would belittle mathematics, on the contrary it confers upon them an exemplary role.¹⁰

The exemplary role of mathematics, then, relates paradoxically to its being a concrete testing ground. Philosophy may well contemplate and muse upon what Lautman terms the possible *liaisons* between the *notions* of an *Ideal dialectic*—continuous and discontinuous, local and global, whole and part, etc.—and may even produce 'metaphysical sketches' of them.¹¹ But it is mathematics that offers the concrete means to construct precise determinations of these liaisons, and generate fields of possible solutions to the problems they describe:

[T]hought necessarily becomes involved in the elaboration of a mathematical theory as soon as it claims to resolve in a precise way a problem that could be raised in a purely dialectical way [...].¹²

As well as providing an account of the reality of mathematical objects, then, Lautman's approach affords the philosopher willing to attend to actual

9. Ibid.

10. Ibid., emphasis mine.

11. '[A] non-technical, non-mathematical, so to speak metaphysical sketch', Salanskis, 'Idea and Destination', 67.

12. Lautman, *Mathematics, Ideas and the Physical Real*, 218. As I have described elsewhere, '[t]he successive posing of questions and generation of concepts operates an "enframing" of the Being-Idea-Problem, historicising it by constraining it to bring forth "cases of solution" [beings] to which it remains irreducible but without which it would remain the object of a sterile and mute contemplation'. R. Mackay, 'Editorial Introduction', *Collapse 3: Unknown Deleuze* (Falmouth: Urbanomic, 2012).

mathematics a unique opportunity to contemplate the process of the genesis of the real from an Ideal register characterised as 'problematic'. In this Platonism of the problem,¹³ the presence of fundamental unresolved themes perpetually organises the objects of contemporary mathematics and constitutes the ground of the possibility of mathematical objects as such.

A Perpllicated Drama

Although the theory of Ideas first presented by Gilles Deleuze in 'The Method of Dramatization' [1967]¹⁴ is certainly indebted to Lautman, it renounces mathematics' privilege as primary field of actualisation, '*the matter the closest to Ideas*'.¹⁵ The materials in which Ideas find their actualisation are now more various, and seem to play more of a part in determining the course of actualisation. There is not merely emanation but a mutual interplay between Ideal differentiations and their expression in actuality on an embryological model ('the world is an egg').

In Deleuze's account of the passage to actualisation, the Idea is incarnated via a movement of 'dramatization' which develops its virtual differentiations into the qualitative and organisational characteristics of actual phenomena. The 'spatio-temporal dynamisms' that express Ideas are to be found 'in a physical experiment, no less than psychic experiments of the Proustian variety', along with biological and even seismic phenomena,¹⁶ the suggestion being that every objective phenomenon and every concept attests to a distributive field of Ideal events, and so every domain in which there is a construction of objects involves the dramatization of problems-Ideas. The prerogative of Ideal intimacy with which Lautman endowed the precision of mathematics gives way to a 'perplication' that 'usher[s] the Idea into culture' at large.¹⁷

13. Or, according to Barot, more of a 'differential' reappropriation of esoteric Platonism, a Plotinian doctrine of 'emanation'. Barot, 'L'objectivité mathématique', 7.

14. G. Deleuze, 'The Method of Dramatization', tr. M. Taormina, in D. Lapoujade (ed.), *Desert Islands and Other Texts 1953–1974* (Los Angeles: Semiotext(e), 2004), 94–116.

15. 'The conceptual link between Deleuze and Lautman is that the former theorized ideal actualization in a general way, while the latter studied its philosophical logic and technical examples within the framework of mathematics alone. Deleuze privileges mathematical language, making use of mathematical terms to describe the properties of all Ideas, but he thinks the Idea in a general, transcultural way: indeed, one aspect of his conception is that the Idea is essentially pluridisciplinary'. Salankis, 'Idea and Destination', 58.

16. Deleuze, 'The Method of Dramatization', 98.

17. Salankis, 'Idea and Destination', 77.

Which Way? Which Way?

Deleuze speaks of dynamisms being '*reprised*' in different systems, across different domains—'all sorts of resonances [...] between physical, biological, and psychic dynamisms'¹⁸—where Lautman spoke of 'schemata which, in order to be *drawn out*, must be embodied' in mathematical theories.¹⁹ In the course of our project somehow it became conventional to speak of Ideas being 'drawn down', as if through a sort of witchery, into experience. The orientation of the vector of emanation became ever more difficult to determine. Kinaesthetic gestures and concepts belonging to everyday experience (*alongside, in front of, between*) were mobilised to explore the fundamental Ideas that lie behind elaborate mathematical developments. At the same time we addressed historical genesis: Does the domain of number arise from our manipulations of physical reality? What are the bridges between the anthropological and the mathematical? What encounters enable us to operate the *counteractualisation* that takes us from everyday experience to abstract motions with no precedent in lived reality?

Our attention was drawn to multiplication, variously described as an 'innovation', a 'machine', or a 'technology' that is foundational for the discovery of the terrain of the prime numbers and their irregular distribution—that ultimate residuum of irregularity, a 'mess' of 'holes' which are also atomic factors, and whose analysis, as documented by Watkins, ultimately brings to light some startling unexplained connections between number theory and physics. Inspired by the physical presence of Shawcross's systems, the modelling of this mathematical gesture of multiplication in such a way as to make its remarkable properties available to the sensory-motor system became an engineering mission. The attempt to attain a balance between visual expression, effective motion, fidelity to the mathematical gesture, and technical (not to mention time and budget) constraints, became a kind of pragmatic dramatization in itself, under pressure on both sides by Watkins's concern for mathematical elegance and Shawcross's preference for the impossible and the productively malfunctional.

At the same time other processes were underway. Every salient point of the Idea that made an incursion into the actual, as if imbued with a magnetic force, attracted inessential determinations that fastened themselves onto the

18. Deleuze, 'The Method of Dramatization', 115.

19. Cavallès and Lautman, 'Mathematical Thought'.

model, inflecting its development and introducing new twists into its actualisation. Imaginative leaps, metaphors, and metonymies flourished and were winnowed, wheat of elucidation separated from chaff of deviation. Having suspended all a priori judgments, however, we became increasingly uncertain of the existence of such things as faulty metaphors, irrelevant associations, or 'ethnological red herrings'. An unexpected surreality grenade lobbed by Shawcross brought a tinge of pure delirium to the final days of the project, injecting an animal spirit into the proceedings that proved surprisingly fecund. In fact, at every point where the process really took off, it swiftly entered the realm of nonsense. The full transcript boasts a Carrollian gallimaufry of props ranging from peanuts to boars to quantum chaotic oscillators, from cosmic trombones to floating orbs, from threevens to Jupiterian meters. Perhaps the madness is not surprising, given that we were constantly driven to see the most apparently simple and self-evident things as cryptic dramatizations of the most profound and disturbing problems: *Does one exist? Can there ever be two of anything? What if we were starfish? Does a pistachio without a shell count as a pistachio? Where did that vibrating thing come from?*

The Unpredictability of Their Coming

This process reprised or extended the Ideal dynamism that connects higher mathematics and physics with simple arithmetical operations by 'drawing down' those operations into a kinaesthetic and mechanical lexicon. This relay was in fact anticipated in the title *Secrets of Creation*, which referred both to Watkins's intuitions in regard to the profound mysteries of the prime distribution, and to the general question of how any creative process, whether artistic or scientific, arrives at unforeseen outcomes—how novel syntheses occur on the way to actualisation. This question, at least, can be said to have been answered, performatively. As to the mysteries of the prime distribution, success came in the form of the generation of further questions.

Lautman himself addresses the distribution of primes as an important mathematical fact:

The existence of primes in the series of whole numbers has always seemed to present a type of mathematical fact that is as objective, as independent of any prior intellectual construction, as the most manifest physical facts. The passage

from 15 to 16 and that from 16 to 17, for example, are achieved by one and the same act—the addition of one to the preceding number—and yet the second operation gives a very different result from the first, since 17 is prime and 16 is not. So that what confers upon the primes their objective character is the unpredictability of their coming.²⁰

For Lautman, the importance of Riemann's formula for the distribution of the primes is ultimately that it sheds light upon the structural affinities between analysis and arithmetic, and thus upon the dialectic of the continuous and the discontinuous.²¹ Watkins's claim is different, but arguably of a 'Lautmannian' order: it is the dialectic between addition and multiplication that makes possible the concept of primality; consequently, within the apparently simple operation of multiplication there must be some fundamental problematic at play which, in the process of its extravagant dramatization, unfolds the infinitely uneven landscape of the primes and, in turn, reveals the presence of the oscillating 'machine' of which they are the music.

Again, Lautman too pays some attention to the multiplication operation, using it to demonstrate the importance in mathematical thought of a gesture of 'dissociation': 'the Idea of multiplication contains both the formation of arithmetic products and the action of operators on a domain of elements distinct from these operators',²² and thus indicates '[t]he distinction [...] between the intrinsic properties of an entity or notion and its possibilities of action'. This distinction is effectively invisible in ordinary arithmetic but becomes visible in the case of, e.g., multiplying a vector by a whole number. This is raised in the context of an enumeration of 'methods of division', where Lautman suggests that generalisation in mathematics, as in experimental physics, often proceeds not from a subsumption of the particular under the general, but from a 'dissociation' that reveals as complex what was previously seen as simple. According to Lautman

20. Lautman, *Mathematics, Ideas and the Physical Real*, 213 [translation modified].

21. *Ibid.*, 218. Lautman claims that the pursuit of the prime distribution function lends weight to his thesis that 'mathematical reality does not lie in the greater or lesser degree of curiosity that isolated mathematical facts may present, but only in the dependence of a mathematical theory with respect to a dialectical structure that it incarnates'. He points to how, historically, the research moves from a specific investigation into more abstract procedures that bring 'a more hidden structure into play' (*Ibid.*, 213–14 [translation modified]).

22. *Ibid.*, 40.

this type of dissociation demonstrates 'the close connection of critical reflection and effective creation'²³ when 'concrete experiences present themselves to the intelligence as resulting from the exceptional encounter of certain notions whose separation can be carried out abstractly'.²⁴

Much of the dialogue in the transcript can be understood as an attempt to discover a cognitive lever that will enable the notion of multiplication to be prised open like this. Early on, through a discussion of one of Shawcross's early works, the notion of feedback emerges as a suitable metaphor to identify the 'possibilities of action' unleashed by the introduction of multiplication. Feedback, however, leads inevitably to the question of time.

When is Dramatization?

For Lautman, unlike Cavallès, the chronological timeline of historical epistemology is secondary to the genetic time of emanation.²⁵ Yet this genesis of actual theories via the formation of Ideas from dialectical liaisons, the time of the incarnation of structural schemas, or, we might say, the time of mathematical anamnesis, remains somewhat enigmatic. There is an axis that crosses chronological time, punctures it, but whose movement remains distinct from and anterior to it. For Deleuze this would be the axis of differentiation, the time in which the differentiated virtual body of the Idea is dramatized into (or generates) a field of solutions. For Lautman,

[t]he extension of the dialectic into mathematics corresponds [...] to what Heidegger calls the genesis of ontic reality from the ontological analysis of the Idea. One thus introduces, at the level of Ideas, an order of before and after which is not that of time, but rather an eternal model of time, the schema of a genesis constantly in the making, the necessary order of creation.²⁶

This question of another temporal axis, in a related sense, repeatedly makes its appearance in the discussions below, naturally following from the notion of oscillations or 'spiral waves' that seem to be 'generating' the prime distribution:

23. Ibid., 32–34.

24. Ibid., 33.

25. Barot, 'L'objectivité mathématique', 19.

26. Cavallès and Lautman, 'Mathematical Thought'.

'We're not talking about historical time, we're not talking about clock time, we're talking about something outside that [...] But again it comes back to this question of time [...] what is the time parameter? [...] it's a different kind of time [...] you can't escape from the time thing...'. Perhaps ultimately the 'surprising connections between mathematics and physics'²⁷ could profitably be addressed from Lautman's philosophical perspective, by seeing in mathematics and physics two declinations of the same ultimate dialectical schemas that shape reality.²⁸ Equally, the emergence of themes and concepts during the week-long residency seemed to obey a temporality of its own, and certainly not a linear one.

For if the questions of number theory presented by Watkins lend themselves to being understood in terms of the movement of dramatization, so does the collaborative process. In its experimental attempt to incarnate mathematical ideas into experiences available to the non-specialist, *Secrets of Creation* seemed to recapitulate (or even reverse) the unfolding of fundamental dialectical Ideas into mathematical theories.

A Week is a Long Time in Number Theory

This volume contains, firstly, the participants' re-presentation of the research at the symposium held at the end of the residency period. But in an experiment where methodology itself is in question and the presentation of results matters less than the process of research, there is every reason to preserve the loose talk, divagations, and digressions that actually took place, and so there follows an edited transcript of the week's discussions, which covers a far larger range of topics than is addressed above.

In particular, Shawcross's account of his own experience of the artistic process and of the genesis of his works serves as a corrective to any notion of a straightforward relationship between scientific model and artwork. What emerges instead is a general admission of the heterogeneity of science and art and the dangers of forcing them into too close a proximity—along with the suggestion that 'a new discipline, a new type of activity' might serve the purposes of 'dramatizing abstract concepts for non-experts'. The need for such a discipline is repeatedly brought into focus throughout the discussion by Watkins's remarks on the cultural

27. See <<http://empslocal.ex.ac.uk/people/staff/mrwatkin/zeta/surprising.htm>>.

28. See Barot, 'L'objectivité mathématique', 21.

ramifications of the image of number, 'math fear', and the problems of mathematics education. If the result of the inability to culturally 'integrate' scientific thinking is endemic illiteracy in the fundamental cognitive gestures that built the machines upon which the modern world runs, further experiments in developing this new discipline of dramatization may contribute toward a corrective.²⁹

We were extremely fortunate in our choice of collaborators for this project—an artist whose systems, built as a means to think through metaphysical and philosophical questions, function at an oblique angle to the self-important discourses of contemporary art, and a mathematician more likely to be found presenting workshops at festivals and psychedelic fayres than in a lecture hall. Playing the role of 'dark precursor' between these two for the period of the residency was quite an experience, and one it has been fascinating to subject to 'redaction at a distance'. As well as thanking Conrad and Matthew for their participation in this experiment and their commitment to the process, I would like to thank the team who joined me in facilitating the residency and contributing to the discussion: Paul Chaney, whose extraordinary ability to design, find materials for, and construct just about anything, no matter how absurd, at ridiculously short notice, was crucial; Kenna Hernly, whose work behind the scenes ensured that the whole week went smoothly and was properly documented; Andrea Poças, who generously volunteered her time to support the project; and photographer Catherine Frowd, whose presence with her camera during the latter half of the week not only ensured that we had visual documentation of the process, but in the moment inspired all those present to become more animated and demonstrative. Thanks also to Don Mackay who photographed the wall drawings and diagrams, and Elaine Tam for her work on the images.

Robin Mackay, Plymouth, September 2020

29. The 'hands-on' kinaesthetic tendency that pervades *Secrets of Creation* should give pause for thought for the fact that, at the sharp end of this cultural deficit, while research consistently indicates that spatial and kinaesthetic awareness and physical manipulation of shape in early childhood is a key contributor to later mathematical cognitive ability, we are increasingly educating and entertaining our children through flat screen images. See S. Gifford, 'The Importance of Shape and Space in the Early Years', NRICH, <<https://nrich.maths.org/14544>>, and the papers listed in the bibliography of this article. For a wider perspective on this question see M. Fisher, 'Touchscreen Capture', *Noon: An Annual Journal of Visual Culture and Contemporary Art* 6 (2016), available at <<https://egressac.wordpress.com/>>.