
Another New Wittgenstein: The Scientific and Engineering Background of the *Tractatus*

Alfred Nordmann

Department of Philosophy

Technische Universität Darmstadt

Introduction

In recent years an entirely “New Wittgenstein”¹ has grown up around the idea that the *Tractatus* should be read as a critical engagement with Frege’s notion of ‘elucidation’ and thus with a particular conception of philosophy. This is supposed to solve the puzzle of how Wittgenstein’s sentences can really be nonsensical while there is yet a way to understand their author and learn to see the world right (TLP 6.54).²

Less conspicuously than this “American” school of interpretation,³ there has also grown up in recent years another New Wittgenstein. This one brings together rather heterogeneous strands of investigation. They help solve a puzzle that has been declared to be unsolvable by Brian McGuinness: How did Wittgenstein become a philosopher rather than an engineer? McGuinness argues that looking for a cause here, e.g., for the question or intellectual problem that prompted the transition, is a misguided attempt to construct a kind of teleology:

We may of course try to say *what* particularly interested him about it, but there will come a point at which no explanation can be given of why he was interested in this or that (McGuinness 1988, pp. 76f.).

1. Thus the title of one of three recent collections of papers devoted to this programme (Creary and Read 2000).

2. References to the *Tractatus Logico-Philosophicus* (TLP) are to its numbered statements (Wittgenstein 1922 and 1961); references to the *Notebooks 1914–1916* (*Notebooks*) by date (Wittgenstein 1979). While informed by extant translations, all translations are my own. For critical responses to the “New Wittgenstein” see McGinn 1999 or Hacker 2000.

3. Thus the title of another of the three collections of papers (McCarthy and Stidd 2001). The third one is Reck 2002.

Such questions are “the expressions of a confused feeling that not everything fits” and McGuinness elaborates this puzzling lack of fit:

We can assume that he had no mentor [during his years devoted to engineering]—and it is indeed difficult to trace a probable one at Charlottenburg or Manchester. We can point to the books he knew well and the passages he later quoted. But what it was that first caught his eye seems to be a fruitless conjecture. Yet there is a certain puzzle to be resolved. [. . .] His mathematical education and sophistication barely qualified him to discuss the foundations of mathematics the way he did. So it was not by difficulties or obscurities in his everyday work that he was led to his problems. . . . [And as for Russell, Frege and the paradoxes that inform so much of the *Tractatus*] [t]hese problems were not only unconnected with his technical concerns as an engineer; at first sight they also seem to be quite different from his other preoccupations [such as music and literature] (McGuinness 1988, p. 76).

The puzzling lack of fit does not even arise, however, if one inverts the perspective. Perhaps, Wittgenstein never became a philosopher but was always a scientist or engineer. After all, not only did he patent in 1911 a jet-fuelled propeller but invented as late as 1943 an apparatus for recording blood-pressure (Hamilton 2001b; Nedo 1983, pp. 313, 359).⁴ While growing up to become an engineer in Vienna, Berlin, and Manchester, he developed powerful philosophical intuitions and when he finally encountered Russell and Frege, he brought these intuitions along with his engineering approach to their philosophical problems.⁵

4. Matthias Kroß provides the most general argument, perhaps, that Wittgenstein was always an engineer. Considering his early and late work together, he highlights Wittgenstein’s destruction of a scientifically-minded philosophy that is interested in truth, certainty, (first) causes, and the representation of the world really and substantially. In contrast, Wittgenstein’s language games and the whole engineering perspective is interested in the workings of a machine, the smooth interaction of gears and levels as they propel language games and the whole machinery of life (Kroß 2003; see Abel and Kroß forthcoming).

5. Compare Hamilton 2001a, p. 89: “In this paper, I have explored one important aspect of the manner in which Wittgenstein came to his logical work under Bertrand Russell with a world view and set of problems embedded in his background as a ‘Viennese engineer.’” Hamilton also suggests that Wittgenstein kept leaving philosophy because, as an engineer, he tried to satisfy himself that this or that philosophical problem had been dissolved (2001a, p. 97). Graßhoff discusses Wittgenstein’s 1911 complaint that Frege would not talk with him about “anything but logic and mathematics” (1998, p. 246). He takes this as evidence that Wittgenstein “had a philosophical problem that perturbed him.” Graßhoff also pointed out that, before taking him on as a student, Russell asked Wittgenstein to write a philosophical paper for him. This unknown paper impressed Russell and

This inversion of the problem has considerable implications for our understanding of the *Tractatus*. Rather than an enterprise internal to questions of language, logic, and mathematics, it now appears driven by epistemological, metaphysical, and ontological intuitions that had been cultivated throughout the nineteenth century by philosophically minded scientists and engineers. Gerd Graßhoff refers to this as a replacement of a “logician” by a “metaphysical” interpretation of the *Tractatus* (1998, p. 254).⁶

In particular, three claims have been advanced in support of this interpretation. This review will treat each of them in turn. Since they don’t quite work in tandem they deserve not just to be debated but to be debated especially among those who advance them.

- (1) Though Wittgenstein was not led to philosophical problems “by difficulties and obscurities in his everyday work” as an engineer, those difficulties and obscurities gave shape to the problems and the manner of their resolution.
- (2) When Wittgenstein requires that a proposition be completely analyzable in order to unambiguously afford truth conditions and thus to be meaningful, the most promising candidate strategies are well-established analytic procedures in physics and sense-physiology.
- (3) Wittgenstein’s conception of the isomorphism of language and world draws on the representational device of spatial manifolds as developed by physicists, mathematicians and sense-physiologists after Helmholtz.⁷

1. Engineering Models: Hamilton, Wilson, and Sterrett

The first of the three claims was established primarily by Kelly Hamilton (1996, 2001a, 2001b, 2002). Drawing heavily on archival research, Hamilton makes her case in a cumulative, piecemeal fashion. She develops vari-

may have expressed the philosophical intuitions Wittgenstein brought to engineering and the study of philosophy (see Nedo 1983, pp. 74, 352). Graßhoff suggests: “While Wittgenstein sought logical clarification from Frege and Russell, he brought with him a philosophical conception of philosophy of nature, which is largely due to Heinrich Hertz’s *Prinzipien der Mechanik*” (1998, p. 246; note that Russell’s *Principles of Mathematics* concludes with a chapter on “Hertz’s Dynamics”).

6. Lampert 2000, p. 14, prefers the labels “logician” and “physicalist.”

7. All three claims identify scientific and engineering contributions to Wittgenstein’s philosophy. As such, they differ markedly from previous and ongoing attempts to look for antecedents of Wittgenstein’s philosophical views in the philosophical views of, for example, Heinrich Hertz (see Barker 1979 and 1980; A. Wilson 1989; and many others). The latter are therefore not included in this review.

ous lines of evidence to show that Wittgenstein had a particular way of visualizing philosophical problems and that these visualizations, or metaphors, derive from his training and practice as an engineer.

She begins with general considerations of Wittgenstein's engineering curriculum and its mixture of laboratory, drawing, and mathematical exercises that, together, were to enable the conceptualization of states of affairs as "form displayed in space" or as simples combined in complexes (2001a, pp. 54–67). Most recently she considered along similar lines the familiar story of the relation between Hertz and Wittgenstein: both analyze the world in the general manner of Helmholtz's "experimental interactionism" according to which causal forces are not representable other than through measurements obtained from varied spatial configurations of a pair of objects. Hertz's "force," she concludes, is just the kind of thing that can only be shown but not be said (2002, p. 64).⁸

Hamilton's most compelling line of evidence concerns Wittgenstein's familiarity with the "mechanical alphabets" that played an important part in the visual education of engineers (2001a, pp. 68–73). Franz Reuleaux, for example, provided such a mechanical alphabet by developing physical models of "mechanical movements" such as gears, cranks, levers. A particular gear, for example, stands ready to combine with certain other elementary devices to form a great number of mechanical devices. To know an elementary mechanical movement is to know how it can combine with others and thus how it can occur in a machine. For a given gear or crank, new modes of occurrence cannot be invented retroactively. As such, Reuleaux's models prepare the ground for Wittgenstein's strict analogy between (simple) objects in states of affairs and names in propositions: "Once I know an object [or a name], I also know all the possible ways of its occurrence in states of affairs [or in propositions]. [. . .] A new possibility cannot be found retroactively" (TLP 2.0123; see 2.03, 3.22, 3.311, 4.0311, 4.22, 4.26). To the extent that Reuleaux's models are both physical objects and symbols, they anticipate Wittgenstein's assimilation of physical states of affairs to pictures and of pictures to propositions: All of them are "facts" (TLP 2.06, 2.141, 4.021, 3.14).

8. This is a difficult point, to be sure. It is unclear whether Hertz advances ontological skepticism or agnosticism about "forces" or critically recommends parsimony concerning postulated entities. Hertz's ambiguity may fruitfully extend to the *Tractatus* and the question whether or in which sense "there is" what cannot be said, but can only be shown. Moreover, if Hertz merely "shows" force as a specific character internal to his system of relations, one should conclude that his explicit definition of force in paragraph 455 of the *Principles of Mechanics* is itself only a verbal way of showing something, rather than a manner of saying or asserting anything. This would yield a conception of "showing" that is rather more broad than allowed for by most readers of the *Tractatus*.

This emphasis on Reuleaux models complements observations by Mark Wilson who identifies Wittgenstein's conception of science with that of Reuleaux.⁹ In particular, Wilson focuses on Reuleaux's conception of kinematics as a science of "machine essences." This science provides the engineer with numerical algorithms to draw out the future states of any idealized machine from its starting configuration (1994, pp. 291–293). Wilson goes on to point out that "almost coincidentally, at the same time as Reuleaux articulated his hypotheses, there grew up a widely accepted tendency to regard physics itself" along strikingly similar lines as using algorithmic rules to draw out what is set up in an idealized model. According to Heinrich Hertz, in particular, "science is alleged to achieve its predictive objectives by clamping rather *artificial descriptions* onto ordinary sensory presentations and running the results through *artificially constructed inferential machinery*" (M. Wilson 1994, p. 294). For better and worse, Reuleaux and Hertz thus shaped the conception of science not only of Wittgenstein's *Tractatus* but also of the *Philosophical Investigations*.¹⁰

Hamilton's third line of argument is also the most tenuous. Once one considers the visual education of engineers, it is tempting to place TLP 3.11 to 3.13 and 4.0141 into an engineering context that involves projective geometry and the problem of scaling up models to fully realized devices.

We use the perceptible sign of a proposition (spoken or written, etc.) as a projection of a possible situation. [. . .] And a proposi-

9. Wilson's main interest is not to claim Wittgenstein for a particular tradition but to appreciate Wittgenstein's background in order to better subject his work to a subtle and ingenious critique. However, for statements like this one he clearly belongs into the context of this review: "As is well known, Wittgenstein was both the scion of a famous industrialist family and a somewhat unhappy student of engineering in his youth. It is less widely recognized that late-nineteenth-century textbooks on machinery often contained appreciable amounts of philosophizing, and these passages seem to have influenced Wittgenstein's understanding of science deeply" (1994, p. 290).

10. Reuleauxian kinematics feature prominently in paragraphs 193 and 194 of the *Philosophical Investigations* and thus in Wittgenstein's discussion of rule-following. Wilson argues that this impoverished view of science haunts Wittgenstein's conception of a philosophy that sets itself off against science (1994, p. 312f.), one that leaves to science the assignment of ontologized referents and withholds an account of how signs become meaningful. In the *Tractatus* significant propositions get "their life" pneumatically, "through being projected outward to their references by an unseen Ego that stands outside the limits of the World." The *Philosophical Investigations* do not fare much better by providing "rather amorphous delineations of the ways in which we directly know our life is charged with publicly oriented meaning, while shunning any attempt to hypothesize public or private ontological realms to support these experiences" (M. Wilson 1994, p. 309).

tion is a propositional sign in its projective relation to the world (TLP 3.11, 3.12).

The inner likeness of these seemingly quite dissimilar formations [grammophone record, musical thought, score, sound waves] consists precisely in there being a general rule by which the musician can discern the symphony in the score, by which one can derive from the groove on the grammophone record the symphony and according to the first rule again the score. And this rule is the law of projection which projects the symphony into the language of notes. It is the rule for the translation of the language of notes into the language of the grammophone record (TLP 4.0141).

Previous readers of the *Tractatus* have noted that Wittgenstein here alludes to projective geometry. They have also remained unsure, however, why Wittgenstein would employ this “metaphorical extension of the mathematical use” (Anscombe 1971, p. 69) along with other metaphors like translation (*Übersetzung*), coordination (*Zuordnung*), and mapping (*Abbildung*). Max Black suggests that the reference to descriptive drawing serves as a reminder also “of the ‘distortion’ resulting—the ‘accidents’ of the resulting representation,” even though there is no discussion in the *Tractatus* of such distortions.¹¹ Elizabeth Anscombe points out that Wittgenstein’s metaphor renders salient a particular aspect of the relation between proposition and fact:

It is the peculiarity of a projection that from it and the method of projection you can tell what is projected; the latter need not physically exist, though the points in space that would occupy it must. The idea of a projection is thus peculiarly apt for explaining the character of a proposition as making sense independently of the facts: as intelligible before you know whether it is true (Anscombe 1971, 72).

In her first discussion of this issue (2001a, pp. 73–84), Kelly Hamilton extends Anscombe’s suggestion and thereby arrives at an impasse, which she surmounts in her second discussion (2001b). She extends Anscombe’s suggestion by taking quite literally that there may be an articulated set of rules that leads from the proposition to the fact and *vice versa*. Hamilton quotes TLP 2.1511 to 2.15121: “*That is* how a picture is bound to reality; it reaches right out to it. It is laid against reality like a measure. Only the end-points of the graduating lines actually *touch* the object that is to be measured.” “How literally does he mean this?” Hamilton asks and contin-

11. While TLP 4.013 refers to apparent irregularities in the representational notation, it emphasizes that these do not disturb the essential character of representation.

ues in a somewhat hypothetical vein: “If he means what he has said about the method of projection, then these feelers do in some sense ‘touch’ reality. They are like the descriptive rays of the projective geometer” (2001a, p. 82). To her credit, Hamilton goes on from here to explore whether Wittgenstein can literally mean this. In the case of descriptive drawing, a three-dimensional figure is projected onto a two-dimensional plane such as Alberti’s window in the Renaissance “discovery” of linear perspective (Hamilton 2001a, pp. 75f., see also p. 79). As these rules have become a uniform standard for the pictorial representation also of engineering objects, they are substantial in several respects—not only were they discovered, they also need to be learned, and they have become the subject matter of debates such as whether or not linear perspective achieves a universally most “natural” manner of representation.

However, with its “logic must take care of itself” (TLP 5.473; *Notebooks*, 22.8.14, 13.10.14) the *Tractatus* famously denies that there are substantial rules of representation which might serve as the subject matter of a science of logic: The picture cannot depict its form of depiction, nor can the proposition represent how it can represent reality (TLP 2.172, 4.12). Accordingly, Wittgenstein pulls the rug from under the analogy to projective geometry right in the middle of its discussion: “We use the perceptible sign of a proposition (spoken or written, etc.) as a projection of a possible situation. The method of projection is thinking the sense of the proposition” (TLP 3.11). Thinking the sense of a proposition is not, of course, a “method of projection” at all, if by that is meant a methodical derivation or the establishment of a possible situation by drawing it out of the sense of the proposition through the application of articulable rules. In contrast to representational drawing or the derivation of a score from the groove of a record, this “method of projection” issues immediately in a possible situation which can then be compared to reality.

This immediacy results not from rule-governed projection but from mere coordination: “The relation of mapping or depiction [*abbildende Beziehung*] consists in the coordination between the elements of the picture and the things” (TLP 2.1514). And indeed, as opposed to Anscombe’s suggestion, the notion of coordination is perfectly sufficient “for explaining the character of a proposition as making sense independently of the facts”: From the proposition and the coordinating information as to what objects the names in the proposition stand in for (TLP 4.0311), a state of affairs can be designated before we know whether the proposition is true (TLP 4.021).¹²

12. Quoting TLP 4.04 I should add “(Compare Hertz’s *Mechanics*, on Dynamical Models.)”

Similarly, TLP 2.1511 to 2.512 should be read in terms of coordination rather than projection.¹³ How the picture reaches right out to reality was stated by Heinrich Hertz in regard to the pictures of mechanics:

We form for ourselves pictures or symbols of external objects; and we make them in such a way that the necessary consequents of the pictures in thought are always the pictures of the necessary consequents in nature of the things pictured (Hertz 1956, p. 1).

While the picture's antecedents and consequents are coordinated with nature, its other elements do not represent nature at all but serve merely to configure the antecedent and the consequent in thought. The picture is not as a whole somehow projected into nature but it is "laid against reality like a measure." What touches the objects to be measured are only "the end-points of the graduating lines," e.g., the antecedents and consequents of Hertz's pictures of mechanics. Accordingly, Wittgenstein nowhere suggests that the correctness of a picture can be determined by checking whether the rules of projection have been applied correctly. Instead, "[i]n order to know whether a picture is true or false," we must see whether it is coordinated with nature: "[W]e must compare it with reality" (TLP 2.223).

At this impasse, Hamilton is not prepared to abandon the idea that the practice of engineering may be relevant to Hertz's notion of the proposition as an experimental model of reality that stands in a projective relation to it. She leaves the matter unresolved in somewhat ambiguous formulations that attempt to marry the notions of projection and coordination.¹⁴ And following Anscombe she maintains that even if Wittgenstein doesn't literally apply notions of projective geometry, these notions nevertheless provide a powerful metaphor that is satisfying to the engineer (2001a, pp. 86f.).

Hamilton revisits the issue in a paper that goes beyond the consideration of engineering drawings but begins with the historical argument that Wittgenstein was most probably confronted with and therefore aware of scaling issues during his time as an aeronautical engineer in Manchester

13. Wittgenstein makes this explicit especially in 2.1515 where he equates coordinations with the "feelers" that touch reality.

14. "The law of projection thus enables us to translate from the musical idea, to the written notes, to the groove on the grammophone record; and it can do that because what is projected is the logical form, the internal pattern of depiction" (2001a, p. 84). Hamilton offers a similarly ambiguous formulation in 2001b, p. 26: "The law of projection constitutes the 'inner similarity' of the grammophone record, the musical idea, the written notes, and the sound waves in the air, and it does that because what is projected is the logical form, through the internal relation of depicting."

(Hamilton 2001b). In particular, she explores how roughly during this time Lord Rayleigh's principle of dynamical similarity was developed into dimensional analysis by Edgar Buckingham but also by Horace Lamb in Manchester.¹⁵ Wittgenstein's propeller experiments would seem to require a certain awareness of dimensional analysis.¹⁶ Just like the model cars and dolls that were used to represent a car accident in a Paris court room,¹⁷ Wittgenstein's "[e]ngineering models also served as propositions, presenting descriptions of possible states of affairs" (Hamilton 2001b, p. 32). And just as in propositions, in these models "a situation is put together experimentally" (TLP 4.031).

Assessing the relevance of this material for the *Tractatus*, Hamilton finds a lowest common denominator between dimensional analysis and a more generic "Hertzian" account of dynamical similarity. Relying on Langhaar's *Dimensional Analysis and Theory of Models* from 1951, Hamilton characterizes a typical scaling issue in engineering as follows:

It may happen that forces that have practically no effect on the behavior of the prototype significantly affect the behavior of the model. For example, surface tension does not influence ocean waves, but if the waves in a model harbor are less than one inch long, their nature is dominated by surface tension (Langhaar 1951, p. 62, quoted in Hamilton 2001b, pp. 30f.).

In this instance, geometrical similarity would violate dynamical similarity: "[T]wo systems are said to be dynamically similar if homologous parts of the system experience similar net forces" (Langhaar 1951, pp. 69f., Hamilton 2001b, p. 29). In order to attain dynamical similarity, horizontal and vertical lengths have to be reduced by different scales, that is, a geometric distortion needs to be introduced. Hamilton goes on to note that these distortions do not seem to be relevant at all in the *Tractatus* because such scaling problems simply do not occur there.¹⁸ Once the differ-

15. The mathematician Horace Lamb was one of the few people at Manchester with whom Wittgenstein is known to have engaged in intellectual exchange. Indeed, Lamb may have been why Wittgenstein went to Manchester in the first place; see Sterrett 2002, p. 130 and Spelt and McGuinness 2001, pp. 134f.

16. Hamilton details how the advances of dimensional analysis were paralleled by advances in wind tunnel construction and experimentation. She points out, however, that Wittgenstein's propellers were constructed and tested on an open railroad car (2001b, p. 33).

17. A newspaper article about this use of a model was to have prompted the picture theory of the *Tractatus*; see von Wright 1974, pp. 20f., *Notebooks*, 29.9.14, and Wittgenstein 1994, pp. 279.

18. Hamilton writes: "This difficulty [geometrical distortion for the sake of dynamical similarity] is accommodated by the *Bild* [picture] theory, for the rule of translation be-

ential effects of different forces (such as surface tension) need not be accounted for, however, what remains of Langhaar's dynamical similarity is a rather straightforwardly Hertzian account of dynamical models: "The motions of two systems are similar if homologous particles lie at homologous points at homologous times. [. . .] Dynamic similarity exists if the systems are kinematically similar, and the mass distributions are similar" (Langhaar 1951, p. 69f., Hamilton 2001b, p. 29f.). Indeed, precisely because dynamical similarity needs to be distinguished from geometrical similarity, Langhaar's formal apparatus does not rely on principles of projective geometry but on the dynamics of coordinated mechanical systems. Accordingly, when Hamilton summarizes the picture theory of the *Tractatus*, the term "projective" does not in any way go beyond "coordinated":

The names stand in the same relation to one another in the propositional sign as the objects stand to one another in the represented state of affairs. [. . .] The projective relation between the two homologous sets of points (or signs and points) is how they are "geared together" (2001b, pp. 31f.).

Hamilton therefore arrives at the implicit acknowledgment that, despite appearances, Wittgenstein's engineering background does not elucidate a "method of projection" that consists in "thinking the sense of the proposition." To the extent that this method can be understood at all, it is, in effect, quite enough to refer to the standard Hertzian account of the picture theory.

Susan Sterrett offers an alternative proposal that aims to avoid this defect by setting out to provide a systematic argument for the relevance of the engineering rather than the Hertzian background. Like Hamilton, she reconstructs the intellectual milieu of experimental scale modeling in Manchester. But in contrast to Hamilton, she adopts not a historical but a systematic point of departure, arguing that Wittgenstein's picture theory is not really Hertzian at all and that one can legitimately infer that his engineering background made all the difference.¹⁹ In particular, she proposes

between model and the prototype (how the one situation is projected into the other) would adjust for the distortions to keep the relationships among the elements of the model and the prototype consistent. Making sure of that is an important part of the skill of the model engineer" (2001b, p. 31). Is it due to Wittgenstein's skill as a model engineer that questions of size or scale do not enter into the relation between words in a proposition (model) and objects in a state of affairs (prototype)?

19. Despite the remarkable overlap of their investigations, Hamilton and Sterrett do not refer to each other. This may be due to the near-simultaneity of their researches and publications. It may also reflect their fundamental differences which deserve a more extensive discussion than I can provide here. These differences concern methodology (cf. the

that much of what people see in common between the *Tractatus* and Hertz's book are very basic themes dating to eighteenth century mechanics and that these themes are also common between experimental engineering scale models and Hertz's book. What I will show, in addition, is that there are in fact important differences between the notion of model and picture in the *Tractatus* and in Hertz's book, and that these differences are also differences between experimental scale models and the dynamical models of Hertz's book (2002, p. 130, see also p. 132).

Sterrett's paper only begins to substantiate this claim.²⁰ Her starting point is Boltzmann's contrast between mental models (the kind of models he and Hertz are interested in) and "experimental models which present on a small scale a machine that is subsequently to be completed on a larger, so as to afford a trial of its capabilities." As opposed to mental models, "a mere alteration in dimensions is often sufficient [in these experimental scale models] to cause a material alteration in the action" (Boltzmann 1974, p. 219, quoted in Sterrett 2002, p. 128). The success of experimental scale models therefore depends on the achievement of a relevant physical similarity to the full-scale device or state of affairs. This physical similarity is achieved by translating measures of the model into measures of the full-scale device.²¹ Sterrett comments:

It certainly seems to me that this is the notion of model involved in the idea of a proposition as a picture. [. . .] For this kind of model [as opposed to Boltzmann's and Hertz's mental models], the picture "reaches right up to reality" as Wittgenstein put it in the *Tractatus*. It is not in a separate realm somewhere and in need of application.

rather different place in their narratives of Buckingham's work) and the interpretation of TLP 2.12 to 2.1515. Most significantly, perhaps, on Sterrett's reconstruction, the scaling issues of engineers are not associated with those of projective geometry.

20. She further elaborated some of its points at the Third International Conference on History of Philosophy of Science (Vienna, July 2000). Both Hamilton and Sterrett promise book-length works on the subject.

21. Sterrett's example concerns the model of a ship towed through water (2002, p. 131f., quoted from Rouse and Ince 1957, p. 229). In order to accurately model the relative size of the waves made by the ship one needs to determine what velocities of the model correspond to those of the full-scale ship. A diagram is therefore produced that "exhibits to scale the resistance of a model at various successive velocities." The resistance exhibited "will express equally the resistance of a ship" that is similar to but many times larger than it if the stated velocities and resistances are translated properly, that is, multiplied each by a definite factor. Since the values for velocity and resistance are factored differently (on different scales), the examples offered by Sterrett and Hamilton highlight some of the same features of engineering scale modeling.

It is not ambiguous in regard to what it pictures. It needs no interpretation (2002, p. 132).

Not by way of the geometer's projective rays does the model therefore touch up with reality but through a process of physical assimilation. Model and modeled reality are in the same physical realm, both are articulated facts that have the same logical or mathematical multiplicity (TLP 4.04). This, according to Sterrett, distinguishes experimental scale models from the mental models of Hertz and Boltzmann. And as in experimental scale models,

to the picture belongs also the picturing relation [*abbildende Beziehung*, mapping relation] that makes it a picture. The picturing relation consists in the coordinations of the elements of the picture and the things (TLP 2.1513, 2.1514, see 3.13).

The proposition is not a mere mental construct that can be used to model this or that state of affairs. It is itself created in the material medium of language so as to represent a particular possible situation. The model or proposition is therefore neither in need of application nor interpretation.²²

Sterrett is well aware that this argument relies entirely on an adequate construal of the distinction between the two types of model (2002, p. 132). And indeed, it is questionable whether she does justice to Boltzmann's contrast between models that rely on physical similarity (engineering scale models) and those that do not (the physical models of Hertz and Boltzmann). Characteristic of the latter is not that they are "mental" rather than physical models. It makes no difference to them whether they are physically articulated as long as they possess the same logical or mathematical multiplicity as what is modeled. Also, these physical models can serve as pictures or models only when their mapping relation is specified and thus belongs to the picture.²³ What Hertz and Boltzmann insist on, however, is that the model need not have any further similarity to what is modeled than this mapping relation:

22. Sterrett adds another point of similarity between the engineering scale model and Wittgenstein's propositions as models. Both are constrained by a shared logical form, which in the case of experimental scale modeling is exhibited in the language of dimensional analysis. Sterrett goes on to suggest that the formal similarity of Wittgenstein's "general form of a proposition" (TLP 5.5, 6) and Buckingham's simultaneously proposed "most general form of a physical equation" in terms of dimensionless parameters testifies to underlying commonalities of their projects (Buckingham 1914; Sterrett 2002, pp. 132, 125).

23. In TLP 4.04 Wittgenstein explicitly refers to Hertz's dynamical models, which become dynamical models only in virtue of fixed coordinations; see Hertz 1956, §418.

We can indeed have no knowledge as to whether the systems that we consider in mechanics and the systems of nature which we mean to consider agree in anything else than in one being the model of the other (Hertz 1956, §427; compare Boltzmann 1974, p. 214).

Since this question of knowledge cannot arise, the dynamical models of Hertz are entirely unambiguous and not in need of interpretation. As we saw above, they immediately reach up to reality; they are laid against reality like a measure. Wittgenstein's propositional pictures and the model of an accident in a Paris court room are just such models. Striking about them is that they can serve as unambiguous models while being so radically dissimilar from what they model (TLP 4.011, see 3.1431).²⁴ According to Boltzmann it is this feature (and not that they are mental) which sets these models apart from experimental scale models. In engineering experiments the agreement between model and prototype extends further than one being a model of the other, and it is precisely this demand for a closer physical similarity which gives rise to sometimes unforeseen scaling issues.

Wittgenstein's training and practice as an engineer may well have given shape to the way he conceived of and treated philosophical problems. It remains doubtful, however, whether this extends to his notion of propositions as pictures of reality or as propositional signs that stand in a projective relation to reality.

2. Physically Analyzed Propositions: Lampert and Graßhoff

Timm Lampert provides a third account of the relation between Franz Reuleaux and Wittgenstein. According to him, Reuleaux shaped Wittgenstein's conception not of science but of philosophy, a conception that would lead the philosopher to attend very carefully to the science of his day.

Reuleaux develops a general procedure of analysis for machines in order to be able to distinguish useful and useless constructions, and for this purpose even develops a machine symbolism that serves an improved recognition of the usefulness or uselessness of a construction. But he leaves to the application of his theory the specific deci-

24. See note 17 above. According to Wittgenstein 1994, p. 279, modeling an accident by means of dolls raises the following question: How do we distinguish between a puppet-play and a representational practice? We do so by assigning a specific significance to the configuration of dolls, that is, by coordinating the elements of a puppet-play to the elements of a car accident. (Sterrett considers the Paris court room event as a case of experimental scale modeling, see her 2002, pp. 126f.).

sion whether a construction is useful or useless, and this application requires a special effort. Accordingly, Wittgenstein provides a general procedure of analysis for propositions in order to be able to distinguish significant and senseless combinations of symbols, and he develops a symbolism for this which expresses unambiguously what the sense of a proposition is or that a grammatically well-formed expression is senseless. The specific decision whether or not a combination of symbols is a significant proposition or not is left to the execution of the analysis (2000, pp. 12f.).

Lampert's central thesis is that Wittgenstein's general procedure of analysis should not be reconstructed within a logicist framework (2000, 2002). It wasn't developed by a philosopher who critically responds to procedures recommended by Frege and Russell: "Wittgenstein draws on analytic procedures established in the natural sciences, he doesn't develop them" (2000, p. 15). According to Lampert, Wittgenstein calls for physical analysis to achieve the goal of expressing "unambiguously what the sense of a proposition is."

What Wittgenstein calls the "determinateness of sense" (TLP 3.23, see 3.325) requires that we can specify truth-conditions exactly: We know what a proposition means only if we know under which conditions precisely it is true and under which conditions it is false.

When I say "the book lies on the desk," does this really have a completely clear sense? (A HIGHLY significant question!)

Its sense must be clear, after all, for we do mean *something* with this sentence, and as much as we *surely* mean, must be clear, after all.

If the sentence "the book lies on the table" has a clear sense, then, whatever *the case may be*, I must be able to say whether the sentence is true or false. But there might easily occur *cases* in which I couldn't straightforwardly say whether the book should still be designated as "lying on the table." And so? (*Notebooks*, 20.6.15).

If a book lies on a pile of other books and if that pile of books lies on the table, we might also say that the book lies on the table, but whether we can do this depends on the meaning we give the verb "to lie on." However, if that meaning admits of degrees, it would appear that we no longer know what the sentence means and are therefore not saying anything at all. To the extent that we really do mean something by uttering this sentence, the sense must be clear. But to the extent that the book might not really be lying on the table at all but on another book, we cannot actually

determine unambiguously whether the sentence is true or false, but in this case its sense is not clear and we therefore didn't really mean anything in the first place. Wittgenstein puts this dilemma in the form of a paradox: "Even to *the UNTUTORED mind* it is therefore clear that the sense of the sentence 'the watch lies on the table' is more complicated than the sentence itself" (*Notebooks*, 22.6.15).

What is true of the sentences in our ordinary language does not apply, perhaps, to the propositions of mathematics and natural science. In the *Notebooks*, Wittgenstein clearly expresses his conviction that, indeed, there might be a language of science or perhaps of sense-data in which the sense of propositions is no more complicated than the sentences themselves and in which propositions are meaningful because they succeed in sharply delineating their truth conditions. This conviction entails a seductive possibility and the question raised by Lampert's interpretation is whether or not Wittgenstein finally resisted that temptation. Since the *Notebooks* are a document of the struggle, the textual evidence they provide is ambiguous throughout. The double-question mark, for example, may signal Wittgenstein's attractedness or his incredulity.

But should it be possible that (leaving aside their truth or falsity) our ordinary sentences have as it were imperfect sense only and that the sentences of physics approximate so to speak a state in which a proposition really has perfect sense?? (*Notebooks*, 20.6.15)

On the one hand, a physicalist language of simple data-points or Hertzian material points achieves the desired goal of matching the simplicity of clear-cut sense to the simplicity of sentences: "When the point doesn't exist in space, then its coordinates don't exist either, and when the coordinates exist, then also the point" (*Notebooks*, 21.6.15). On the other hand, if the sense of ordinary sentences must be sought in a more perfectly sensible physical language, it becomes difficult, if not impossible to salvage our intuition that our ordinary sentences mean anything: "Can there be any talk of a sentence having a more or less sharply delineated sense??" Wittgenstein asks and by way of answer knows only that "what we MEAN must always be '*sharp*'" (*Notebooks*, 20.6.15).

Occasionally, matters come to a head as in the following passage which prepares for a parting of the ways:

Though we do not know simple objects from experience; the complex objects we *know* from experience; we know from experience that they are complex.—And that in the end they must consist of simple things?

We take, for example, a part of our visual field, we see that it is still complex, that a part of it is still complex but simpler already, etc.—

Is it conceivable that, for example, we *see* that *all points of a surface are yellow* without seeing any *one* point of this surface? It almost seems that way.

The emergence of problems: the oppressive tension [*drückende Spannung*] which builds up in a question and objectifies itself.

How, for example, would we describe a surface evenly covered in blue? (*Notebooks*, 24.5.15).

Here we become witness to an oppressive tension that is cousin to the one between meaning what an ordinary sentence asserts and knowing that clear-cut truth-conditions are not to be found at the level of ordinary language. Here, the tension obtains between our knowledge that something is complex and composed of points and our perception of this complex object without acknowledgment of its parts. Indeed, our acquaintance with the object seems to be incommensurable with our knowledge that it is complex.²⁵ In view of this incommensurability, are we to privilege the knowledge of simple parts composing complex objects just because it seems deeper, ultimate, or complete? Wittgenstein continues this line of questioning on the following day:

Does the visual image of a *minimum visibile* really appear indivisible? Whatever is extended, is divisible. Are there parts of our visual field that have *no* extension?²⁶ The fixed stars, for example?—

The drive toward the mystical comes from the fact that science leaves our wishes unfulfilled. We *feel* that even when all *possible* scientific questions have been answered, *our problem has not yet even been touched upon* (*Notebooks*, 25.5.15).

This passage provides at once a complete vindication of Lampert's interpretation and a devastating criticism. It vindicates the claim that the *Tractatus* engages a notion of "complete analysis of propositions" which draws on well-established analytic procedures in physics and sense-physiology. However, it also suggests that science cannot address the

25. In the first paragraph of the quoted passage, Wittgenstein speaks of "*kennen*" (knowing in the sense of acquaintance) twice and only in the last clause of "*wissen*" (knowing in the epistemic sense of recognition or acknowledgment).

26. The editors of the *Notebooks* use the term "visual image [*Gesichtsbild*]" twice. However, while one can ask of the image produced by a smallest visual impression whether it is really indivisible, Wittgenstein must mean "visual field [*Gesichtsfeld*]" when he asks whether there can be any part of what we see that has no extension.

problem but leaves the oppressive tension entirely unresolved. In other words, it suggests that the *Tractatus* can only succeed if it can account for the determinateness of sense without referring to science or sense-physiology. And therefore, it suggests also that one should not look to the science of his day in order to understand the definitions of Wittgenstein's basic concepts in the *Tractatus*.

Lampert's book aims to provide such scientific definitions and thus, according to its subtitle, "the sense-data analysis of the *Tractatus Logico-Philosophicus*." But instead, it should be read as offering a richly detailed reconstruction of the theories engaged by Wittgenstein only in his *Notebooks*. Wittgenstein's reference to a supposedly indivisible "visual image of a *minimum visibile*" is a case in point. His very choice of terms reveals that he is familiar with the debates prompted by Gustav Theodor Fechner's proposed analysis of the visual field. Lampert firmly establishes that Wittgenstein struggles very seriously with the question of whether a point in the visual field is a simple object (2000, pp. 23–54, 137–162). Another case in point is color theory, especially the problem of color-exclusion and the underlying question whether colors are material properties of states of affairs or properties of points and facts in the visual field (Lampert 2000, pp. 55–133, 163–239). Lampert goes on to suggest that Wittgenstein's answer to these questions gave rise to a notion of physical analysis (in Hertz's sense) that affords a justified certainty of the finiteness of analysis even where this analysis cannot be performed (2000, p. 329, see pp. 152–162).²⁷

27. It is impossible to do justice within the scope of this review to the diligence, originality, and keen intelligence of Lampert's reconstruction. Just one example may provide a glimpse of how his argument proceeds. "In TLP 6.3751 Wittgenstein claims that the statement—a point in the visual field has two different colors at the same time—is a contradiction." This contradiction "presupposes a psychophysical analysis of colors into color units and of visual space into points. But from this it does not follow that this contradiction 'presents itself' as a contradiction in physics, too." In order to establish a physical contradiction, a different, namely Hertzian kind of analysis is offered by Wittgenstein. In physical terms, writes Wittgenstein, color-exclusion results from the same kind of contradiction as the one according to which "a particle cannot at the same time have two velocities, i.e., [. . .] that particles in different places at the same time cannot be identical" (TLP 6.3751). Since the last clause echoes Hertz's definition of a mass-particle, Lampert eventually concludes that Wittgenstein's "criterion of logical possibility lies in the compatibility with the mechanical world description according to Hertz's definition of a mass-particle": Two colors cannot simultaneously be at the same point of the visual field because this would violate the physical constitution of the world according to which particles denote points in space. This is a kind of logical (not physical) impossibility "which does not have the form of a contradiction," moreover, it marks nonsensicality where contradictions are merely senseless (Lampert 2002, pp. 36–41).

At this point, Lampert's interpretation proves complementary to the account which inspired it in the first place, namely *Gerd Graßhoff's* proposal that Wittgenstein's simple objects are to be equated with Hertz's material points (1997, 1998, 2002; see Lampert 2000, p. 15f.).²⁸ Both run up against the same difficulty, namely that their attribution to the *Tractatus* of a finite, physical solution to the problem of analysis comes at an exceedingly high price: Their proposed clarification of Wittgenstein's concepts either destroys the isomorphism of propositions and states of affairs or deprives "names" of their function and grammatical meaning, namely of the very possibility of their occurrence in ordinary propositions.

The following entry in the *Notebooks* has usually been taken as Wittgenstein's last word on the subject of "simple objects" and, as such, has become a kind of commonplace among Wittgenstein scholars:

Our difficulty was this, after all, that we were always speaking of simple objects and were never able to cite a single one (*Notebooks*, 21.6.15).²⁹

Graßhoff denies that Wittgenstein here confesses his failure (1998, p. 260). Instead, this passage announces the presentation, finally, of the simple object, namely Hertz's material point. Indeed, Wittgenstein continues: "When the point doesn't exist in space, then its coordinates don't exist either, and when the coordinates exist, then also the point" and adds "The simple sign is *essentially simple*." The immediate context makes clear that the points in question are, indeed, Hertz's material points:

The analysis of the body into *material points*, as we see it in physics, is nothing but analysis into *simple components*. [. . .]

It always seems as if there were complex objects that function as simple ones, and then also *really* simple ones like the material points of physics, etc. (*Notebooks*, 20.6.15, 21.6.15).³⁰

Graßhoff shows that Wittgenstein's notion of a really or essentially simple object and the corresponding notion of composition may well have been modeled on Hertz's analysis. Hertz defines the material point in such a way that a regress cannot arise, i.e., that one cannot even speculate about

28. Graßhoff's 1997 and 1998 make essentially the same point. His most recent, as of yet unpublished, contribution was not available for this review.

29. Wittgenstein offered a variant of this confession many years later in a conversation with Norman Malcolm; see Malcolm 1958, p. 86 and Lampert 2000, pp. 330f.

30. A few lines further down, Wittgenstein refers even more explicitly to Hertz, namely to his invisible masses. In the *Tractatus*, Wittgenstein speaks of material points in 6.3432; see Graßhoff 1998, pp. 252f.

its further division. It really is *essentially* simple in that it does not refer to a quantity of mass but to a space-time region that is point-like in that it is uniquely specified by a set of coordinates. As such, the material point is essentially simple in respect to a coordinate system, not in respect to the number of particles that is amassed at this point.³¹ The physical analysis of a phenomenon is therefore not directed at smallest parts but treats it as an interaction of systems of material points. A system of material points would thus be an archetype or *Urbild* (*Notebooks*, 21.6.15, TLP 3.24) of a state of affairs:

Material points (things) are denoted by their space-time locations. Thus, simple external objects—things—can be named in the following form:

Material point $a = x, t$

A state of affairs composed of simple external objects, which can be described by an elementary sentence, consists of a combination of material points:

State of affairs $aRb = x_1, t_1 \ R \ x_2, t_2$
(Graßhoff 1998, p. 259)³²

Heinrich Hertz relates these systems of material points to the macroscopic objects of ordinary experience:

{The mass} of tangible bodies has the properties which we attributed to the conceptually defined mass. For it can be thought of as divided into arbitrarily many equal mass-particles, each of which indestructible and immutable and able to serve as a characteristic in order to definitely and unambiguously coordinate one point in space at one time with another point in space at another time (Hertz 1956, §300).³³

Hertz may thus have provided Wittgenstein with a solution to the problem of analysis as a merological problem: This is how we imagine complex objects without also imagining their infinite analysis into ever simpler ones. Hertz does not, however, suggest a juxtaposition between “complex

31. Indeed, Hertz defines that a material point always consists of an infinitely great number of mass-particles (Hertz 1956, §5).

32. Note that in Graßhoff’s reconstruction the “normal” case of a state of affairs requires either $x_1 = x_2$ or $t_1 = t_2$. In light of Wittgenstein’s and Hertz’s fundamentally timeless conception of the world one might ask whether $t_1 \neq t_2$ can ever be true for a state of affairs or a given system of material points (but see also Hertz 1956, §300 cited below).

33. The hypothesized mass-particles thus serve to coordinate material points. Indeed, our freedom to arbitrarily hypothesize mass-particles extends to the assumption of hidden or invisible masses (Hertz 1956, §301, compare *Notebooks*, 6.12.14 and TLP 6.343).

objects that function as simple ones, and then also *really* simple ones.” The idea that this might be a fruitful juxtaposition comes only with the suspicion that when a name designates a complex object, this renders the sentence indeterminate (the question of determinateness of sense), and it comes with the demand that states of affairs be logically independent while propositions about complexes appear to imply propositions about their parts.

In the *Notebooks*, Wittgenstein explores at least two competing accounts in order to deal with these issues. One is to seek out the *really* simple objects or at least to specify a method through which, in principle, one might arrive at these. According to Graßhoff and Lampert, the *Tractatus* is implicitly premised on that account. But parallel to this, Wittgenstein continuously seeks to secure determinateness of sense also for propositions about complex objects that function as simple ones in the proposition. For example,

When I say to someone “the watch is lying on the table,” and now he says “yes but if the watch would be lying like this or like that would you still be saying then that ‘it is lying on the table’.” And I would become unsure. This shows that I didn’t know what I meant by “lying” *in general*. If one thus drove me into a corner in order to show me that I don’t know what I mean, I would say: “I *know* what I mean; I just mean THAT” and would, for example, point to the complex. And in this complex I have indeed the two objects in relation to one another.—But this *really* means only: The fact can be pictured SOMEHOW also in this form.

If I go ahead and do this and designate the objects by *names*, do they thereby become simple?

And yet this sentence is a picture of that complex.

This object is *simple* for me! (*Notebooks*, 22.6.15).

Graßhoff and Lampert show that it is possible to “justify the vagueness of ordinary sentences” (*Notebooks*, 22.6.15) by referring them to the sharpness of scientific propositions. But they discount Wittgenstein’s suspicion that the entire project of separating names of really simple objects from names of complexes revolves around a fundamental mistake.

The mistake of this conception must lie in the fact that on the one hand it juxtaposes complex and simple objects, and on the other hand treats them as related (*Notebooks*, 30.5.15).

In the *Notebooks* Wittgenstein is haunted by this mistake. It keeps reappearing in the following form: In the pursuit of the determinateness of sense, the juxtaposition of complex and simple objects seems to recom-

mend itself. But they have to be treated as related in that names can be used to designate both. In other words, when an object is named it always appears as a simple object: Names are points and not pictures, names cannot be further analyzed through definitions, they are archetypal signs [*Urzeichen*], names stand in for (analyzable) objects, names indicate a commonality of form or of content: “The simple sign is *essentially simple*. It functions as a simple object. (What does that mean?) *Its composition* becomes a matter of *complete indifference*. It vanishes from view” (*Notebooks*, 21.6.15).³⁴

When Graßhoff suggests that names name material points by providing their coordinates and when he further associates a Hertzian analytic procedure with a metaphysical philosophy of nature, he appears to ignore Wittgenstein’s warning: “Mind you: even if the name ‘N’ vanishes in the course of further analysis, it still indicates *A Commonality*” (*Notebooks*, 14.6.15). On Graßhoff’s account, neither “Einstein” nor “Berne” are names in the sentence “Einstein is in Berne”—these names vanish in the course of analysis. But when a sentence is used to locate a person in a city, it is not locating a spatio-temporal concatenation of molecules in respect to buildings, streets, let alone bricks or the other molecules that the bricks are made of.³⁵ None of these are properly elements of the thought that is to be expressed by the sentence. Or, inversely, once the pertinent elements of thought are identified (such as Einstein, Berne, etc.), the sentence is for all practical purposes completely analyzed:

In a proposition the thought can be expressed in such a way that elements of the propositional sign correspond to elements of the thought.

These elements I call “simple signs” and the proposition I call “completely analyzed.”

The simple signs employed in propositions are called names (TLP 3.2 to 3.202).

34. For the preceding collage of pronouncements about “names,” see TLP 3.144, *Notebooks*, 3.10.14, TLP 3.26 (along with 3.3, 3.203), *Notebooks* 29.12.1914 (TLP 3.22), 23.5.15 to 30.5.15, etc.

35. It seems that Graßhoff’s Hertzian account might be saved along the following lines: Since frames of reference and coordinate systems can be adopted arbitrarily, Einstein is a configuration of infinitely many mass-particles which characterizes a single material point, as such he is an essentially simple object. The city of Berne, to be sure, would have to be a system of points that can include Einstein . . . —But be that as it may, Graßhoff ascribes to Hertz and Wittgenstein a substantive ontology according to which the *real* simples “make up all possible facts of reality” (1998, pp. 267, 254–264, but see 261f.).

In the *Tractatus* Wittgenstein therefore does not prospectively exclude the possibility of a situation in which someone might no longer say “Einstein is in Berne.” All he can offer is that for any given situation one can finally arrive at a determinate sense: While we may not always assign meaning to the words in quite the same way, the proposition will be unambiguously true or false once meanings have been assigned (see TLP 5.4732, 5.4733, 5.5536).³⁶

Even where they fail to persuade, Graßhoff’s and Lampert’s accounts afford us a first opportunity to clearly pose the question why Wittgenstein retreated in the *Tractatus* from the original goal of prospectively guaranteeing determinateness of sense. For an answer to this question we can finally turn to David Hyder’s proposal.

3. Spatial Manifolds: Hyder

In the *Notebooks* Wittgenstein struggles with the question of what is required to sharply delineate truth-conditions.³⁷ He finds that a certain high ideal of precision proves not only unnecessary but actually inappropriate. If one wants to attain a precise measurement of the length of a room, measurements in angstroms are less and not more precise than measurements in meters and centimeters. Indeed, one is far more likely to obtain a definite measurement and fixed value if one doesn’t treat macroscopic objects on subatomic scales (compare Wittgenstein 1993, p. 449). Similarly, what is needed for a sharp delineation of truth-conditions is not an analysis in terms of material points or data points, but merely that sentence, thought, and state of affairs have the same multiplicity, i.e., that one distinguishes just as much in the proposition as one means to distinguish in the state of affairs. If that criterion is satisfied, one can call the proposition “completely analyzed”:

One must be able to distinguish just as much in the proposition as in the possible situation which it represents.

Both must have the same logical (mathematical) multiplicity.
(Compare Hertz’s *Mechanics* on dynamical models.)

36. For example, if Einstein is currently in a separately named suburb in the Berne area, the sentence “Einstein is in Berne” has different truth-conditions when someone asks whether Einstein is still in Berne (or has already left for Paris) and when someone asks whether he is in properly so-called downtown Berne.

37. Compare “There is of course also what [the proposition] does *not* say—but it says in its entirety *what* it says and it must be capable of delineating this SHARPLY” (*Notebooks*, 16.6.15).

This mathematical multiplicity cannot, of course, be pictured [*abbilden*, mapped] in turn. In the picturing [or: mapping] one cannot get outside it (TLP 4.04, 4.041).

This passage from the *Tractatus* serves as the main text for David Hyder's analysis (2002).³⁸ It explains why Wittgenstein sought an account for the determinateness of sense without referring to science or sense-physiology, and it shows that Wittgenstein's resources for this can be found in the scientific and mathematical practice of Hermann von Helmholtz and Heinrich Hertz.³⁹ It also underscores why projective geometry and the scaling procedure of engineers have little relevance to the relation of proposition and state of affairs.⁴⁰ And it only rarely exhibits weak moments of its own where it is tempted to ontologize Wittgenstein's conceptual devices.

When Wittgenstein refers the reader to Hertz's account of dynamical models he provides more than a mere reference. He appreciates it as a first attempt to consider the relation of mind and nature in terms of a representational device that was developed by Hertz's teacher Hermann von Helmholtz and further articulated by 19th century mathematicians, physicists, and sense physiologists. Arguing that all sensibilia are organized in manifolds, Helmholtz paved the way for Hertz to speak of mind and nature as dynamical models of one another (Hertz 1956, §428). And it was this notion of isomorphic representation that provided Wittgenstein with his solution to the central problem of Russell's theory of judgment, namely, what Hyder calls its sense-truth regress. According to Wittgenstein, whether a proposition has sense must not depend on whether

38. Again, I have not been able to include in this review Hyder 2003.

39. Hyder comments on Graßhoff's interpretation only once: "Wittgenstein would have seriously distorted Hertz's theory, on my view, had he adopted hypothetical elements of models as his elementary objects" (2002, p. 171; see the discussion above of §300 of Hertz's *Mechanics* and whether it provides for a distinction between real simples and complexes functioning as simples). However, I may be exaggerating their differences by downplaying some of Hyder's unnecessary hesitations. He is worried, for example, that Hertz allows for a greater number of distinguishable mass-points in the model than in what is being modeled "whereas Wittgenstein insists on an absolute isomorphism, at least at the deepest level of analysis." But according to Hertz it belongs to the nature of the modeled systems that an arbitrary number of mass-points can be distinguished in them and, indeed, that the model imposes a grain of distinctness. At this ("deep"?) level of analysis, an ("absolute"?) isomorphism meeting the criterion of TLP 4.04 can therefore always be attained (see Hyder 2002, p. 187).

40. Hyder comments on Sterrett's proposal: "I agree with her that there are a plethora of possible model-theoretical predecessors (all of a more or less Lagrangian stripe) to Wittgenstein's picture theory, and I do not see that we have to choose just one. I do find a quite specific neo-Kantian argument in Helmholtz, Hertz, and their German-speaking successors that cannot come from the engineering side of things" (Hyder 2002, p. 46).

another proposition is true (TLP 2.0211) while Russell's theory abounds with such dependencies: "but if the meanings of words always depend on further knowledge, we could never get started with the business of speaking meaningfully" (Hyder 2002, p. 1, see 61–67).⁴¹ On Wittgenstein's view,

the possibility of significant elementary propositions depends on the existence of two isomorphic spatial structures, the one consisting of the field of elementary facts, and the second of the field of elementary propositional signs (Hyder 2002, pp. 10f.).

This isomorphism is secured not by a knowledge from outside the system of representation but by the internal structure of the propositional signs which reflects the internal structure of the facts they pick out. Helmholtz argued that his work on color- and tone-spaces proved that all experience of the world was displayed in an extended manifold of experiences. Drawing his inspiration from Hertz, Wittgenstein effectively reinterpreted Helmholtz's perceptual manifolds as a "logical space" which allows for the mapping or depiction of states of affairs in their multiplicity:

The logical space, whatever its exact elements may be, is obviously the field in which our experience plays out. For the totality of facts is the world, and "I am my world." Meaningful statements about the world are always statements about appearances in logical space. At the same time, the properties of this logical space are reflected in the elementary propositions that describe it, as well as in the complex logical propositions that we construct on its basis. This logical form, claims Wittgenstein, is inherited by any picture we may construct. In Hertz's theory of science, every scientific picture contains mathematical characteristics that make it amenable for representing characteristics of other phenomenal appearances. For Wittgenstein, each combination of signs that we can construct has logical characteristics that can be used to represent aspects of other

41. As opposed to Hamilton and Sterrett, Graßhoff and Lampert, David Hyder is not set to establish that Wittgenstein's philosophical problems were motivated in the mostly German nineteenth century science and engineering context. Instead, he views Wittgenstein's recourse to the neo-Kantian tradition as a response to Russell: "I have no quarrel with the suggestion that Wittgenstein had earlier acquaintance with the works of Helmholtz, Hertz, or others, nor quite obviously with the suggestion that he had learned much about mechanics before he went to work with Russell. My only claim is that the problems that led to his adopting a logical theory involving a spatial semantics were not initially related to such physical and mechanical theories. One could argue that the attack on Russell's theory was motivated all along by neo-Kantian convictions, however, I have not found any textual evidence to indicate this" (Hyder 2002, p. 157).

facts. The existence of these logical properties is guaranteed metaphysically by the fact that the picture itself is composed of elements in the logical space—it is itself a fact, as Wittgenstein observes in 3.14. And one cannot do without this guarantee, just as little as Hertz can do without the guarantee that both the phenomena and the scientific pictures that describe them are situated in the same spatio-temporal manifold of intuition. If this were not the case, then there would be no commonality of form (mathematical for Hertz, logical for Wittgenstein) between the picture and the sets of appearances that it represented. In other words, such a theory of picturing rests necessarily on the assumption of a shared space of representation that ensures that both experiences and their representations have common features (Hyder 2002, pp. 186f.).

On this account, Wittgenstein appropriates Hertz's representational device with its built-in metaphysical guarantee. In contrast, borrowing Hertz's hierarchical conception of physical systems in order to metaphysically underwrite the meanings of words would reopen the sense-truth regress. Once the manifolds in our inner world are used to construct the physical world which they are thought to reflect, "the existence of signs that could express a particular sense was in some sense a guarantee for the existence of appropriate objects" (Hyder 2002, 184f.). The projective relation between elements of perceptual or intuitive manifolds thus arises from a self-regulating or self-determining syntax that can do without descriptions of the actual internal constitutions of the corresponding systems; indeed, "the notion of 'picturing' in general is far less important to our understanding [of Hertz's or Wittgenstein's theories] than is that of a mapping within spaces of representation" (Hyder 2002, p. 14, see pp. 152, 172, 192, 206).

In light of this elegant and parsimonious account of "The Mechanics of Meaning," it is—finally—odd to note that Hyder occasionally physicalizes and ontologizes Wittgenstein's logical space. It often occurs as a representational space pure and simple for the placement of propositional signs (TLP 3.4ff.), but Hyder treats it also as a material medium which somehow registers sense. This oscillation may result from a certain uneasiness regarding the relationship of Helmholtz and Hertz. Hertz is indeed "a far more rigorous Kantian than his mentor" (Hyder 2002, p. 186). Hyder fails to fully appreciate, however, that for this reason Hertz is also more reluctant than Helmholtz to enter and to sense-physiologically explore the "no-man's land" that runs between our consciousness and the world of real things (Hyder 2002, pp. 154f., see 14).⁴² By passing too

quickly from Helmholtz to Hertz and on to Wittgenstein, Hyder leaves somewhat unclear whether Wittgenstein wants to distinguish the two worlds of consciousness and reality or the three realms consciousness, reality, and “the state-space which records the action of external systems on the subject’s mind” (Hyder 2002, pp. 153, 156). Hyder suggests that Wittgenstein may be interpreting logical space as such a state-space of perceptual records and this would give him license to reify Wittgenstein’s logical space as a medium of sorts. Hyder thus speaks of propositions determining the core logical space, he speaks of quantified propositions allowing us to select “slices” of the manifold and to posit connections between the elements of such slices, and he speaks of the existence of complexes in logical space (Hyder 2002, pp. 153, 161, 162, 166). However, this assimilation of Wittgenstein to Helmholtz may underestimate the intervention of Hertz who turned Helmholtz’s perceptual manifolds into a mathematically refined and epistemologically purified space of representation. In light of Wittgenstein’s dismissal of a science of logic with a proper subject-matter, objects, and properties of its own, Hyder’s reification becomes particularly problematic in regard to logical propositions:

Each elementary proposition points to what Wittgenstein calls a “logical place” in the space of elementary facts. The dimensions of these manifolds correspond to sets of intersubstitutable objects and names, so that the symbol that results when one of these names is replaced by a variable selects a cut through the field of elementary propositions. Significant propositions in the strict sense always assert something about the connections between points (logical places) in the space of elementary propositions, and can therefore be true or false depending on whether these connections obtain. In contrast, logical propositions pick out invariant structural properties of the space itself (Hyder 2002, p. 6).

While this reification of a representational device is deeply problematic, it affords Hyder a sustained treatment of a neglected class of propositions, namely the completely general propositions of the *Tractatus*. These cer-

42. Hyder is quoting from Hertz’s essay about Helmholtz (Hertz 1896, p. 335). In it, Hertz pays homage to Helmholtz and yet proceeds to mark his distance: “[I]t is of the greatest importance for all knowledge of the world and of ourselves that we be thoroughly acquainted with this no-man’s land, in order that we do not mistake that which belongs properly to it for a property of the one or the other of the worlds that it divides . . .” While Helmholtz made a name for himself exploring this no-man’s land, Hertz is interested in a clear division and immediate juxtaposition of the worlds of consciousness and real things, that is, he literally wants to hold them apart (compare Hertz 1956, pp. 2f, 38).

tainly include the laws of mechanics and probably also the principle of sufficient reason, the law of causality, and the principle of induction (TLP 5.526, 6.3432, 6.35, 6.36, 6.362, 6.363). These propositions do not straightforwardly belong to any of the three familiar sentence-types of the *Tractatus*—they are not on a par with ordinary significant or empirical sentences, they are no logical truths or tautologies, and they are not plain nonsense. Hyder argues that they are fully general, contingent propositions that function as *a priori* principles in the construction of scientific propositions according to a single plan (TLP 6.343). They are empirically meaningful because they make statements about correlations of appearances in the logical space and could fail to have any empirical correlates. And they are *a priori* in that they refer only by means of the formal properties of that space (Hyder 2002, pp. 164, 174–183, see TLP 6.3ff.).

Like Hamilton's and Sterrett's, Graßhoff's and Lampert's before his, Hyder's work exemplifies just how much there is to learn from this other New Wittgenstein, and more perhaps than can be learned from the old and by now well-established New Wittgenstein. It also exemplifies that the science and engineering context has provided Wittgenstein with skills and paradigms, with problems and resources, with analytic proposals and representational devices. But as one ventures beyond that and claims the implicit reliance of the *Tractatus* on particular scientific theories, experimental practices, theories of nature, or sense-physiological mediations, the problems of interpretation really begin.

References

- Abel, Günter and Mathias Kroß, eds. forthcoming. *Wittgenstein: Ingenieur-Künstler-Philosoph*. Frankfurt: Velbrück.
- Anscombe, G. E. M. 1971. *An Introduction to Wittgenstein's Tractatus*. London: Hutchinson University Library.
- Barker, Peter. 1979. "Untangling the Net Metaphor." *Philosophy Research Archives*, 5:182–199.
- . 1980. "Hertz and Wittgenstein." *Studies in History and Philosophy of Science*, 11:243–256.
- Black, Max. 1964. *A Companion to Wittgenstein's 'Tractatus'*. Ithaca: Cornell University Press.
- Boltzmann, Ludwig. 1974. "Model." Pp. 213–220 in *Theoretical Physics and Philosophical Problems: Selected Writings of Ludwig Boltzmann*. Dordrecht: Reidel.
- Buckingham, Edgar. 1914. "On Physically Similar Systems: Illustrations of the Use of Dimensional Equations." *Physical Review*, 4(4):345–376.
- Crary, Alice and Rupert Read, eds. 2000. *The New Wittgenstein*. London: Routledge.

- Graßhoff, Gerd. 1997. "Hertzian Objects in Wittgenstein's *Tractatus*." *British Journal for the History of Philosophy*, 5:87–120.
- . 1998. "Hertz's Philosophy of Nature in Wittgenstein's *Tractatus*." Pp. 243–268 in *Heinrich Hertz: Classical Physicist, Modern Philosopher*. Edited by Davis Baird, R. I. G. Hughes and Alfred Nordmann. Dordrecht: Kluwer.
- . 2002. "From Lonesome Material Points to the *Tractatus*." Paper at the workshop "Hertz et Wittgenstein." College de France, Institut d'Histoire et de Philosophie des Sciences et des Techniques. June 7, 2002.
- Griffin, James. 1964. *Wittgenstein's Logical Atomism*. Oxford: Clarendon Press.
- Hacker, P.M.S. 2000. "Was He Trying to Whistle It?" Pp. 353–388 in *The New Wittgenstein*. Edited by Alice Crary and Rupert Read. London: Routledge.
- Hamilton, Kelly. 1996. *The Philosophical Significance of Wittgenstein's Scientific Training for the Tractatus*. Unpublished Ph.D. dissertation, University of Notre Dame.
- . 2001a. "Wittgenstein and the Mind's Eye." Pp. 53–97 in *Wittgenstein: Biography and Philosophy*. Edited by James C. Klagge. Cambridge: Cambridge University Press.
- . 2001b. "Some Philosophical Consequences of Wittgenstein's Aeronautical Research." *Perspectives on Science*, 9:1–37.
- . 2002. "*Darstellungen* in the *Principles of Mechanics* and the *Tractatus*," *Perspectives on Science*, 10:28–68.
- Hertz, Heinrich. 1896. *Miscellaneous Papers*. London: Macmillan.
- . 1956. *The Principles of Mechanics*. New York: Dover.
- Hyder, David. 2002. *The Mechanics of Meaning: Propositional Content and the Logical Space of Wittgenstein's Tractatus*. Berlin: de Gruyter.
- . 2003. "Image, Schéma, Multiplicité: Le Néo-Kantisme de Hertz et Wittgenstein." Forthcoming in *Hertz et Wittgenstein*. Edited by G. Garreta and J. J. Rosat. Paris: Vrin.
- Kroß, Matthias. 2003. "Engineering Phenomena: Wittgenstein and Goethe on Scientific Method." Pp. 27–45 in *Goethe and Wittgenstein: Seeing the World's Unity in its Variety*. Edited by Fritz Breithaupt, Richard Raatzsch, and Bettina Kremberg. vol. 5. *Wittgenstein Studien*. Frankfurt: Peter Lang.
- Lampert, Timm. 2000. *Wittgensteins Physikalismus: Die Sinnesdatenanalyse des Tractatus Logico-Philosophicus in ihrem historischen Kontext*. Paderborn: Mentis.
- . 2002. "Psychophysical and Tractarian Analysis," unpublished manuscript.

- Langhaar, Henry. 1951. *Dimensional Analysis and Theory of Models*. New York: John Wiley and Sons.
- Malcolm, Norman. 1958. *Ludwig Wittgenstein: A Memoir*. Oxford: Oxford University Press.
- McCarthy, Timothy and Sean C. Stidd, eds. 2001. *Wittgenstein in America*. Oxford: Clarendon.
- McGinn, Marie. 1999. "Between Metaphysics and Nonsense: Elucidation in Wittgenstein's *Tractatus*." *Philosophical Quarterly*, 49:491–513.
- McGuinness, Brian. 1988. *Wittgenstein: A Life. Young Ludwig, 1889–1921*. London: Duckworth.
- Nedo, Michael. 1983. *Ludwig Wittgenstein: Sein Leben in Bildern und Texten*. Frankfurt: Suhrkamp.
- Reck, Erich, ed. 2002. *From Frege to Wittgenstein: Perspectives on Early Analytic Philosophy*. Oxford: Oxford University Press.
- Rouse, Hunter and Simon Ince. 1957. *History of Hydraulics*. State University of Iowa: Iowa Institute of Hydraulic Research.
- Spelt, P. D. M. and Brian McGuinness. 2001. "Marginalia in Wittgenstein's Copy of Lamb's *Hydrodynamics*." Pp. 131–147 in *From the Tractatus to the Tractatus and Other Essays*. Edited by Gianluigi Oliveri Liveri. vol. 2. *Wittgenstein Studen*. Frankfurt: Peter Lang.
- Sterrett, Susan. 2002. "Physical Pictures: Engineering Models circa 1914 and in Wittgenstein's *Tractatus*." Pp. 121–135 in *History of Philosophy of Science: New Trends and Perspectives*. Edited by Michael Heidelberger and Friedrich Stadler. Dordrecht: Kluwer.
- von Wright, Georg Henrik. 1974. *Wittgenstein*. Minneapolis: University of Minnesota Press.
- Wilson, Andrew. 1989. "Hertz, Boltzmann and Wittgenstein Reconsidered." *Studies in History and Philosophy of Science*, 20:245–263.
- Wilson, Mark. 1997. "Wittgenstein: Physica Sunt, Non Leguntur." *Philosophical Topics*, 25:289–316.
- Wittgenstein, Ludwig. 1922. *Tractatus Logico-Philosophicus*. Translated by C. K. Ogden. London: Routledge and Kegan Paul.
- . 1961. *Tractatus Logico-Philosophicus*. Translated by D. F. Pears and B. F. McGuinness. London: Routledge and Kegan Paul.
- . 1979. *Notebooks 1914–1916*. Edited by Elizabeth Anscombe. 2nd ed. Oxford: Basil Blackwell.
- . 1993. *Philosophical Occasions*. Edited by James C. Klagge and Alfred Nordmann. Indianapolis: Hackett.
- . 1994. *Philosophische Betrachtungen, Philosophische Bemerkungen. Wiener Ausgabe*. Vol. 2. Vienna: Springer.