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Formalism, Modernism, Mathematics

by

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Abstract

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Modernism happened in mathematics, too. Between about 1890 and 1930, the field turned toward dramatic, previously unimaginable abstraction, as radical innovations dispensed with inherited conventions. The recognition of non-Euclidean geometry raised the strange notion that multiple, contradictory realms of mathematics could coexist and remain equally correct, even if some seemed non-representative of the world or nonsensical in human experience. Mathematicians grew frenzied in the effort to resolve newfound paradoxes. The turn of the century saw a series of attempts to rethink math's most basic foundations, and the 1920s witnessed explosive controversies about the role of language in mathematics. These developments do not merely constitute change in one field; they demonstrate that modernism was a broader cultural phenomenon than literary scholars have realized.

This dissertation begins from the shared intellectual history of literary and mathematical modernism: a common attempt to rethink foundational axioms, a common ambivalence toward growing abstraction, and a common interest in and anxiety about form. This convergence, I argue, exposes an interpretive dilemma intrinsic to form in mathematics and writing alike. Modernist shifts in cultural assumptions gave rise to newly abstract forms that revealed form to have been always already abstract—so abstract as to estrange its own cultural function. Formalism, in literature, skates uncomfortably between profundity and superficiality, because attention to literary language in and of itself risks discounting language's fundamental function: to express, refer, and communicate. But decades before formalism named a school of thought in literary interpretation, formalism—by that name—identified an understanding, and an interpretation, of mathematics.

Mathematical formalism has roots reaching back to the 17th century, but after a long history it reached its heyday in the 1920s, when the field's escalating abstraction had led many to question math's grounding in the real world, i.e., to doubt its basic capacity for meaning. The influential mathematician David Hilbert argued that such a grounding could be secured via attention to form—in effect, that formalism could rescue mathematical meaning by deferring that meaning, first treating mathematics as though it were only meaningless marks on paper. This dissertation uses Hilbert's mathematical formalism to explain the apparent contradictions of literary formalism. I demonstrate that writers and mathematicians discovered the same solutions to an urgent common problem, developing technical apparatuses (variables, equivalence relations, axiom systems) through which meaning can develop

directly from patterns and rules rather than terms and symbols. Mathematics has a remarkable relationship with reality, because it is both a maddeningly ethereal realm of thought and an undeniably descriptive tool that reliably predicts physical phenomena. I argue that the bond between mathematics and science is not only a metaphor for the relationship between literature and reality, but an imitable model that multiple modernist authors knowingly seized upon and manipulated. It is in this mathematical manner that the most abstract, formal, and seemingly unworldly moments in modernism acquired relevance to history, world, and culture. They did so by describing the world without making reference to the world, expressing the shapes of reality via pattern and form.

My first chapter, "Opposition, Polysemy, Pattern: Virginia Woolf's Mathematical Generality," begins from the more commonly understood relation between literature and mathematics: one of radical difference. In her early novel *Night and Day* Woolf resists the rigidity of mathematics, consistently imagining mathematical communication as a negative image of her own art, an inaccessible language that resists translation into English. But this opposition, I argue, also makes visible a likeness between the two fields, glimpsed in the "sacred pages of symbols and figures" that Woolf consistently uses to frame their common signs and signifying processes. The formalism of mathematical writing thus promises to explain many of the escalating formal complexities of Woolf's later novels. I demonstrate that, even where she makes no direct reference to mathematics, Woolf uses the greater generality of mathematical modes of meaning to reinvent the force of ambiguity in *Jacob's Room* and contradiction in *To the Lighthouse*, before settling into the enormous patterns that establish a formula for "the life of anybody" in *The Waves*.

In mathematics, such generality is most meaningful in conjunction with structured systems—the patterns that make unrestricted meaning possible. I take up the problem of defining and theorizing literary structure in the following two chapters. In "The Metaphor as an Equation: The Formal Abstraction of Ezra Pound's Precisions," I trace Pound's repeated descriptions of image and metaphor as instruments of equation, and I demonstrate that technical mathematical definitions of equation characterize some of Imagism's starkest innovations. Between 1890 and 1910, mathematical understandings of equation had shifted, reaching beyond number to become newly applicable to shapes, ideas, and words. Pound, I argue, harnessed recent mathematical redefinitions of equality to place a new weight on syntax: in his early poetry, semicolons unseat verbs, and ellipsis makes possible new forms of comparison. Pound's early metaphors invented a newly symmetric and iterable relationship between tenor and vehicle, one capable of underlying more procreant forms. And form, here, acquires a newly interdisciplinary definition: the patterns and arrangements of relations between things that can exist independent of those things.

Pattern has to start from somewhere: a problem that consumed Eliot across his long career. In pure, modern mathematics, absolute knowledge and incontrovertible proof are built from patterns that always stand upon unproven assumptions—axioms. Eliot had examined those axioms in detail. In 1914, as a student at Harvard, Eliot took Bertrand Russell's graduate course in advanced logic, intensively studying the modernist axiom systems of Gottlob Frege, Alfred North Whitehead, and Russell himself. In "From Axiom to Leap of Faith: T.S. Eliot's Formal Systems," I trace Eliot's ambivalent preoccupation with logical assumption in "Prufrock" and *The Waste Land* and argue that, in *Ash Wednesday* and *Four Quartets*, Eliot ultimately used Russell's formal systems to reimagine poems as infinitely intricate patterns built from finite starting points: an idea that already existed, in more troubled ways, in his earliest poetry. Eliot conceived of the most complex poetic forms as axiom systems, wherein whole aesthetic universes develop from mere handfuls of beliefs and linguistic links, just as, in mathematical axiom systems, complex meaning and sophisticated beauty develop from strikingly few assumptions, definitions, and rules.

Axiom systems refer, intrinsically and everywhere, to themselves, and in this way the patterns loop back upon themselves, at once referring to themselves and anticipating their own analysis. I conclude by turning from poetry and fiction to the literary scholarship and theory engendered by modernism, generalizing the ways in which the philosophy of mathematics reframes the critical stumbling blocks of form and reference. Mathematics was a regular trope, and often a conceptual source, in the first defining works of twentieth-century formalist criticism, evincing a continuing association between the logical analysis of form and the commingling of mathematics and language. The Russian formalists, British practical critics, and American New Critics all saw mathematics as a closed linguistic system, making it uniquely useful as a descriptive analogue for literary form: mathematics offered the prime example of a system that models isolated signifying processes while lying (by general consensus) utterly outside of literature.

I argue that the mathematics of form made these literary formalisms a natural and necessary response to literary modernism, determining their near-simultaneous development across different cultural contexts. When modernist form unsettled modernist content, a meta-content emerged: texts by Woolf, Pound, and Eliot all self-consciously refer to the interpretive difficulties they create. During exactly the same era, Hilbert pushed the intuitive sense of mathematics into a separate plane only to find that a new discipline derived from that distinction: metamathematics, which uses mathematics to study mathematics itself. Far from pushing the world out, formalist analysis indirectly drags the world back in, for writers and mathematicians alike. *"A Few Sheets of Paper Covered with Arbitrary Symbols": Formalism, Modernism, Mathematics* thus culminates in the argument that the apparent paradoxes of formal literary interpretation—wherein formalist reading sees only the façade yet penetrates to the heart of the thing itself—are not coincidental to how we have practiced literary formalism. In fact, they are logically attendant on any application of formalist analysis, in any field. Formalism depends on the deferral of meaning but then, elaborating its own rules, bypasses that assumption to uncover a meaningful pattern, a meaning *in* pattern. Modernists from Woolf to Hilbert discovered and elaborated this interpretive loop. Our literary practice of formalism today remains dependent on that logical process of form.

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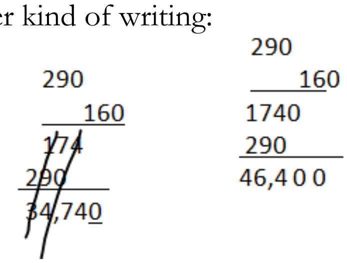
Chapter One

Opposition, Polysemy, Pattern: Virginia Woolf's Mathematical Generality

In *Night and Day*, Katharine Hilbery fantasizes about herself with "a pile of books in her hand, scientific books, and books about mathematics and astronomy which she had mastered," while her fiancé William Rodney tells her "you don't read books… but, all the same, you know about them. Besides, who wants you to be learned? Leave that to the poor devils who've got nothing better to do" (141-2). Katharine struggles with her position as a mathematical woman while William condescendingly tells her that she at once understands literature and also needn't know anything about it. He implicitly dismisses the one kind of book that Katharine wants to read—the book of mathematics—as not really a book at all. Shakespeare and Woolf wrote books; science, mathematics, and astronomy must be something else entirely. Yet here if we flip over the leaf of Woolf's holograph, we come across something very different. Just on the other side of the page, reflecting the spot where William paradoxically informs Katharine that she does know literature even as she doesn't read it, we encounter another kind of writing:



Here, Woolf calculated a word count on the back of her writing. The reflection is both out of place and oddly fitting: buried amid Woolf's novel about a young woman who longs to become a mathematician, opposite a page that muses about the experience of writing and reading, we find a blank sheet scratched with arithmetic. These marks are literally, physically reversed: recto—literature; verso—mathematics.

Virginia Woolf methodically counted and calculated her own words. In her handwritten manuscripts, over a hundred of these calculations remain to us. Usually they stand by themselves on the unoccupied verso pages, the blank backs of her writing; sometimes instead they crowd into the margins of her recto pages. Either way, the difference is apparent. Her handwriting changes with these numerals, becoming abrupt, jagged, and irregular, markedly changed from her fluid, smooth script. Ironically, the unfamiliarity of these numerals often makes them easier to read; they never flow together as her letters do. Here, we can say with certainty what is right, what wrong—Woolf crosses out the first calculation above because of an error. Yet, as a measurement of Woolf's writing, the second calculation is every bit as inadequate. 46,400 could never articulate the value of *Night and Day*.

Across her long writing career, Woolf depicted mathematics as the contrary of literature, constructing an ongoing opposition between literary fluidity and mathematical rigidity. Her novels reflect on mathematics as though drawn to that which is most different from themselves, and by considering what writing is not, Woolf further pins down what writing really is. Like a shadow that illuminates the self in perfect negative, Woolf's negative depictions of mathematics illuminate the prominent contradictions and ambiguities of her own writing.

In the process, Woolf develops a play of opposites which represents rivalries that are inherent in communication generally, fundamental to the division between written symbols and the world they describe; the division between mathematics and literature quickly reveals itself as a defamiliarizing illustration of the division between words and their meanings. Mathematics becomes a symbol for writing even as it remains the opposite of literature. Eventually, Woolf's simultaneous communication of such opposite meanings within the locus of single, common terms enables a newfound generality that is capable of transcending the contradictions which gave birth to it. Where a concept and its opposite can be simultaneously conveyed by one common string of words, language expands from isolated reference to potentially unbounded flexibility of meaning—without ever deserting the accuracy that enabled its conception. Woolf embeds mathematical modes of meaning in her writing even where she never refers to mathematics as content, and this chapter will argue that mathematical form actually allows Woolf to escape mathematical meaning. To borrow symbolism from mathematics need not entail such a night-and-day notion of right and wrong as belongs to the calculations above. Woolf uses the generality of mathematical language to communicate the fluidity, ambiguity, and uncertainty of human experience.

In *Night and Day*, Katharine Hilbery "would not have cared to confess how infinitely she preferred the exactitude, the star-like impersonality, of figures to the confusion, agitation, and vagueness of the finest prose" (42). Katharine's love of mathematics does not exist in and of itself; instead it is repeatedly, reliably juxtaposed with her dislike of literature, and as Katharine moves toward mathematics and maturity, her desires exist only in oppositional struggle with the arts. Katharine has a heritage to contend with. Her deceased grandfather was a celebrated poet, and her blossoming selfhood is circumscribed by his fame as well as by the exclusively literary attitudes of her prominent Victorian family. Here in the shadow of great poetry, mathematics—like the stray calculations scattered across the backs of pages in Woolf's drafts—is an interloper, positioned as an intellectual and physical reversal. Woolf tells us explicitly, "in [Katharine's] mind mathematics were directly opposed to literature" (42).

Even the title, *Night and Day*, describes the divide between mathematical, practical, modern Katharine and her literary, dreamy, Victorian mother. It also more specifically refers to Katharine's repressed mathematical longings:

> [S]he would rather have confessed her wildest dreams of hurricane and prairie than the fact that, upstairs, alone in her room, she rose early in the morning or sat up late at night to … work at mathematics. No force on earth would have made her confess that. Her actions when thus engaged were furtive and secretive, like those of some nocturnal animal. Steps had only to sound on the staircase, and she slipped her paper between the leaves of a great Greek dictionary which she had purloined from her father's room for this purpose. It was only at night, indeed, that she felt secure enough from surprise to concentrate her mind to the utmost. (42, ellipsis original)

Mathematics is the pursuit of the night, literature that of the day, and the two are poles apart. But this opposition is complicated, like that of a shadow or doppelganger: shadows cannot exist without light, and day would have no name if it were not followed by night. The enduring link between mathematics and literature becomes apparent as Katharine chooses to hide her mathematical dreams textually, deferring them with ellipsis ("sat up late at night to … work at mathematics") and burying them, quite literally, inside the dictionary. Here written language conceals mathematics, but it also guards mathematics. Moreover, these particular letters communicate mathematics. Higher level mathematics employs letters far more than numerals, and it employs the Greek alphabet especially. Katharine deliberately steals a Greek dictionary to hide and hold her studies, and just as mathematics repurposes Greek letters for its own uses, Katharine is repurposing both lexicon and language.

As written pages, Woolf complicatedly pairs literature and mathematics. *Night and Day*'s description of Katharine's secret studies bears undeniable resemblance to Woolf's later description of Jane Austen's efforts in *A Room of One's Own*, where we learn that "Jane Austen hid her manuscripts or covered them with a piece of blotting-paper," "careful that her occupation should not be suspected" (67)—exactly as Katharine hides her work between the leaves of a dictionary at the first sound of steps outside. In addition to the secrecy of composition, both descriptions emphasize the physical pages involved, which can be covered to mask their content, or flipped over to alternate between language and calculation. With this parallel in working form, Katharine becomes a twentieth-century heir to Austen. Katharine just exercises her own type of written expression.

Night and Day repeatedly metonymizes mathematics with its form, the "sacred pages of symbols and figures" (477) that Katharine dreams about and endows with great beauty. "How visibly books of algebraic symbols, pages all speckled with dots and dashes and twisted bars, came before her eyes" (314). She "cast her mind alternately towards forest paths and starry blossoms, and towards pages of neatly written mathematical signs" (224). Emphasizing the visual and tangible aspects of marks on paper, Woolf describes math's written form rather than its intellectual content, and Katharine treasures and romanticizes the material manifestations of her study. This representation emphasizes the written signs that are common to mathematics particularly, but it also defamiliarizes written language generally, using the foreign marks of mathematics to call attention to the intrinsic strangeness of all written symbols. In fact, written sheets exist as strange artifacts throughout *Night and Day*, because Katharine lives in a house overcrowded with piles of dusty, valuable manuscripts left behind by her famous grandfather. She is his involuntary archivist, examining handwriting, framing fragments, and forever handling innumerable pages without caring what they signify. Thus, as marked pages, mathematics parallels literature in *Night and Day*. Woolf aligns the disciplines by emphasizing their common form, and in the process she raises the paradoxical possibility that mathematics is another kind of writing.

The double reversal that occurs here—from literature to its opposite and then onward to the realization that these opposites are aligned—creates a contradictory collision of extremes that can be hard to follow. In *Night and Day* mathematics is at once a metaphor for literature and a paradigm for everything that literature is not. This paradoxical relation is not unique to Woolf's second novel; it is characteristic of parallels and oppositions that are fundamental to the fields of writing and mathematics themselves, and mathematicians have investigated this relationship as well. In fact, the formalism that Woolf's emphasis on written pages implies was a revolutionary movement in the history of mathematics, one which was almost perfectly contemporaneous with Woolf's work and high literary modernism generally. The relationship between symbols and what they symbolize is a real problem in the philosophy of mathematics as well as in literary theory. Woolf seized upon this commonality in the most opposite of fields to comment very generally on the oddly unexplained role that language plays in communicating human life, because, often, where we are least attentive to language's meaning, it reveals itself to mean the most.

Hilbert and Hilbery: Mathematical Form

> The solid philosophical attitude that I think is required for the grounding of pure mathematics—as well as for all scientific thought, understanding, and communication—is this: *In the beginning was the sign.*
>
> David Hilbert

Katharine Hilbery has a doppelganger in history. David Hilbert, his surname identical to Katharine's in all but the final letter, was possibly the single most important mathematician working during Woolf's lifetime. When he died in 1943, *Nature* stated that "there can be few mathematicians nowadays whose work does not in some way derive from that of Hilbert" (Taussky 182). It is unclear whether Woolf knew of Hilbert's work, but during her lifetime Hilbert was about as famous as it is possible for mathematicians to be, and he and Woolf shared many colleagues and acquaintances in common, including Bertrand Russell, Frank Ramsey, G. H. Hardy, and Alfred North Whitehead.[1] Indeed, the leading mathematicians, logicians, and analytic philosophers among the Bloomsbury group substantiate the very prominent interest in mathematical philosophy among Woolf's acquaintances—which has gone generally unrecognized.[2] Formal mathematics such as Hilbert's has also been credited as an important influence on Woolf's close friend John Maynard Keynes.[3] Yet whether or not Woolf ever did read of Hilbert's work, more subtle and various influences can be discerned. Historians Jeremy Gray, Herbert Mehrtens, and Amir Alexander have all demonstrated that modern mathematics participated in the broad societal sweep of modernism, demonstrating intellectual cross-pollinations with sources that sometimes remain difficult to pin down even when their results are indisputable.[4]

Hilbert worked during an explosive time, because in the late nineteenth and early twentieth centuries mathematics went through enormous transformations. The field became dramatically more abstract and apparently remote from the empirical world. Subfields became multifarious and diverse in their outlooks and assumptions. Mathematicians questioned and reexamined the foundational assumptions of their discipline, worrying that matters which had been taken for granted were much more complicated than previously assumed, even as if the structure of mathematics might have been

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[1] On Woolf's relationship with Russell, see Ann Banfield. Woolf did discuss mathematics with Russell: for example, in 1921, see *The Diary of Virginia Woolf* II, 146-8. Ramsey, Hardy, and Whitehead travelled in Woolf's larger social circle. Meeting Ramsey at a dinner party in 1923, she described him as "like a Darwin, broad, thick, powerful, & a great mathematician" (*Diary* II, 231). She knew the Whitehead family (see *The Letters of Virginia Woolf* I, 135, and II, 78). Leonard Woolf and Hardy were friends; he appears several times in Leonard's autobiographies (*Sowing* 123-6, *Beginning Again* 18, 20, and 52).

On Woolf and the mathematics of her era, see also Makiko Minow-Pinkney, "Virginia Woolf and December 1910: The Question of the Fourth Dimension." More broadly, a growing body of scholarship has established both Woolf's interest in and knowledge of the sciences. See, for example: Gillian Beer, *Virginia Woolf: The Common Ground*; Michael H. Whitworth, *Einstein's Wake: Relativity, Metaphor, and Modernist Literature*; Holly Henry, *Virginia Woolf and the Discourse of Science: The Aesthetics of Astronomy*; and Christina Alt, *Virginia Woolf and the Study of Nature*.

[2] Banfield has gone furthest toward fleshing out these connections, but her emphasis is on other aspects of analytic philosophy.

[3] See, for example, Theodore M. Porter 159 or one of Keynes's many biographies.

[4] Regarding the complex and often attenuated nature of influence across fields so different as literature and the sciences, see also Whitworth 13-19, Beer 112-113, and Daniel Albright, *Quantum Poetics: Yeats, Pound, Eliot, and the Science of Modernism*, 1-2.

built upon sand. When Georg Cantor invented set theory in the 1870s, many mathematicians became excited that the foundational new field might ground the entirety of mathematics. However, when Russell and others found paradoxes in set theory at the turn of the twentieth century, mathematicians feared that the paradoxes might strike at the core of mathematics—that mathematics itself might not be, in a rigorous sense, true. The controversies and innovations that resulted led mathematicians to reframe the abstraction, philosophy, and ontology of their field, problematizing the relationship between mathematics and the world it describes. Histories of mathematics specifically describe this period as modern and modernist, highlighting parallels with modern art and culture.[5]

David Hilbert was at the very center of high modernism in mathematics. His books and publications were exemplary of the inventiveness, formality, and axiomatic method that characterized his period. The powerful generality, diversity, and prescience of his work made it difficult for conservative mathematicians to deny the watershed moment that mathematics was undergoing. And, also active as a speaker, teacher, and philosopher, Hilbert always vehemently defended recent innovations from detractors who sought to dismiss modern mathematics as too strange or out of touch with reality.

To support modernist mathematics, in the 1920s Hilbert developed a philosophy that called attention to signs and symbols in the field, arguing that such written marks not only communicate but can actually embody the foundations of mathematics itself. This perspective, termed formalism in the philosophy of mathematics, holds that the form of mathematics—its written signs and the grammars that govern relations between them—can support all mathematical truth and mathematical knowledge. Mathematical formalism has a long history, with antecedents reaching back to G. W. Leibniz's work on the infinitesimal and George Berkeley's explanations of arithmetic, but Hilbert was by far its most influential proponent.[6] An extreme mathematical formalist would assert that numbers are fundamentally written signs, and that mathematics is only the study of consistent rules for manipulating such signs; more moderate formalists, including Hilbert, instead assert that numbers should be regarded *as if* they are only signs, arguing that although matters of meaning (such as scientific application or intuitive sense) may be very real, they are not necessary to support the foundations of mathematics. As a methodology, mathematical formalism devotes particular attention to the syntax, rather than the semantics, of mathematics; that is, it directs attention to the relationships between mathematical signs, while the meaning of these signs remains undecided.

Mathematics *does* have form and content, syntax and semantics. When Woolf calculated word counts on the backs of her drafting pages, she wrote down numbers in a column and then followed a series of arithmetic rules to determine a product—we can see from the scratch marks. The rules are the same regardless of the particular numbers, and at no point would they have required Woolf to hold at once in her mind the entire magnitude and meaning of the large numbers involved. In this way, written multiplication engages with mathematical form (written signs), and

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5 See for example Herbert Mehrtens, "Modernism vs. Counter-modernism" and *Moderne, Sprache, Mathematik*; Jeremy Gray, *Plato's Ghost: The Modernist Transformation of Mathematics* and "Modern Mathematics as a Cultural Phenomenon"; Moritz Epple, "An Unusual Career between Cultural and Mathematical Modernism"; and Amir Alexander, *Duel at Dawn: Heroes, Martyrs, and the Rise of Modern Mathematics*. While Mehrtens, Gray, and Epple all compare modernist mathematics to modernist art and literature, Alexander instead attributes modernity in nineteenth and twentieth century mathematics to the earlier cause of romanticism. Yet Alexander agrees with these other authors about the character of modern mathematics, only placing greater emphasis on its root causes and its earliest manifestations. In fact, his perspective bears striking resemblance to studies that have portrayed literary modernism as indebted to literary romanticism.

6 The multiplicity of mathematical formalism is underlined by the fact that Hilbert's movement itself went through identifiably different stages: see Mancosu, *The Adventure of Reason*, 125-58.

syntax (established relational rules), but not semantics (the sense and significance of the written numbers). Of course, Woolf made these calculations for a reason—to measure how many words she had written—and in that sense the calculations always retained a meaning. But in practice such semantic motivations quickly yield to a pattern of syntactical procedures that can be abstracted from their original referents. In this sense, mathematics has a great deal in common with language, and it can be conceived and practiced in a manner that emphasizes form, or content, or a combination of the two.

Hilbert's formalism operated at a high level, far beyond the scope of calculation. Hilbert argued that attention to mathematical form could—far from emptying mathematics of its content—ultimately enable a more effective and multiple engagement with mathematical meaning. As he wrote in 1922 in a seminal paper on mathematical formalism, "I am of the opinion that the foundations of mathematics are capable of full clarity and knowledge" ("New Grounding" 198); that is, to take a formalist approach to mathematics in no way impedes clarity and knowledge but actually enables that understanding. Moreover, as Hilbert wrote in the same paper, the goal of his formalist project was "to regain for mathematics the old reputation for incontestable truth, which it appears to have lost as a result of the paradoxes of set theory" (200). That which is meaningless cannot be true, but Hilbert deferred meaning in order to ultimately regain both meaning and truth.

Hilbert considered formal mathematical proof to be a worthy subject for mathematical investigation, thus reversing the typical conception of form and content in mathematics and allowing form to become content, very literally. He represented mathematical theories, theorems, and proofs as structures of variables, which themselves could then be analyzed with the existing methods of mathematics, thus elucidating the relationships among mathematical processes and methodologies as well as among mathematical truths. The resulting subfield, metamathematics, prompted mathematics to examine itself. As he explained, "we must… make the concept of specifically mathematical proof itself into an object of investigation, just as the astronomer considers the movement of his position, the physicist studies the theory of his apparatus, and the philosopher criticizes reason itself" (*Kant to Hilbert* 1115). Hilbert used mathematics to analyze mathematics, much like language used to characterize language. In the process, mathematics had to be conceived as an ordered language with an absolutely consistent grammar, but nonspecific meanings.

In *Night and Day*, Woolf addresses literature in a meta-representational manner by writing about mathematics, a relative unknown, which itself eventually points toward writing. Here mathematics—frequently referred to as form but hardly ever endowed with any evident content—operates like a variable, because it can be shuffled whole from page to page even as its meaning remains unknown. In mathematics Woolf constructs a symbol that forestalls its own meaning yet remains intelligible via an anchored formal position. The analytic interspace which develops—wherein readers understand the relationships between symbols before they understand the meanings of those symbols—allows *Night and Day* to consider very broadly the links and breakages inherent to signification. Math's undecidedness in *Night and Day* enables Woolf to examine at once the rupture and the continuity that exists between Katharine's modern mathematical expression and that of her literary ancestors. The basic rules of written symbols (grammar, orthography, linearity) yoke the syntaxes of Katherine's mathematical studies together with the processes of Woolf's novels because we are constantly reminded of their physical commonality (letters, written on pages, read from left to right, with common practices of definition and iterability). But this very focused link can only become apparent after we recognize and bypass the gaping chasm between the assumptions of each field. Truth does not operate like night and day in literature, but that dichotomous right-or-wrong vision is utterly crucial to mathematics. By sidestepping the obvious differences between literature and mathematics—after she herself emphasizes them—Woolf characterizes general commonality without denying specific discrepancy. The ability she thereby gains to examine relations between human thought patterns without specifying those patterns makes the same meta-representational move as Hilbert's formalism, because it depends on the semantic undecidedness of the very processes that it proceeds to syntactically specify and compare.

As Katharine struggles to express herself in a new mathematical form, she repeats the struggle that Woolf herself faced as she strove toward modern literature that still remained unrealized. *Night and Day* depicts the struggle to speak in a strange and unknown language about things that are not yet known themselves, because *Night and Day* is an early novel about modernism by a modernist author who had not yet written a modernist novel. Where meaning is so far undecided, the relations between formal symbols gain prominence—readers become acutely aware that they are interpreting those "pages all speckled with dots and dashes and twisted bars" (314). Vis-à-vis the prominently formal unknown, interpretation itself gains at once theoretical abstraction and signatory grounding.

From Ambiguity to Polysemy: Naming the Indeterminate

> We have been so often fooled in this way by words, they have so often proved… that it is their nature not to express one simple statement but a thousand possibilities
>
> "Craftsmanship"

Woolf's representations of order and number parallel and refigure Hilbert's philosophy of mathematics. Katharine Hilbery's absorption in mathematical signs as central but nonspecific signification is one key case, but related attention to mathematics as writing and relation appears elsewhere in Woolf's work. In *To the Lighthouse* Mr. Ramsay's alphabet exemplifies formalist mathematics: "if thought is like the keyboard of a piano, divided into so many notes, or like the alphabet is ranged in twenty-six letters all in order, then his splendid mind had no sort of difficulty in running over those letters one by one, firmly and accurately, until it had reached, say, the letter Q" (33). Mr. Ramsay steps, in order, from A to B and onwards up to Q. He is counting. But whereas if he did so with numerals his position would have a particular denotation, by choosing letters Mr. Ramsay evades the exact in favor of the general, reducing his count to relation and order. These letters are variables and, like variables, their meaning is open-ended. Woolf explicitly tells us that Mr. Ramsay's choice of this particular letter is arbitrary: he "had reached, say, the letter Q." Indeed, his thought process demonstrates that the signifiers may just as well be any other ordered sequence, such as "the keyboard of a piano" which he considers first. As under Hilbert's mathematics, there is a particular sign and a rigorous order, but a flexible, nonspecific meaning.

From here, Mr. Ramsay marches deeper into the ordered relations of mathematical formalism: "But after Q? What comes next? … If Q then is Q—R— … 'Then R …'" (34). This process is exclusively relational, based on order and not meaning. In a sense, this purely formalist approach does lead him to his goal, because Mr. Ramsay knows that R follows Q, and despite his claims later that he cannot reach R, in this passage, he technically does: "If Q … Then R" (34). In fact, Mr. Ramsay never fails with letters, orders, or relations, but the moment that he tries to step outside of his mathematically formalist system: "R is then—what is R? A shutter, like the leathern eyelid of a lizard, flickered over the intensity of his gaze and obscured the letter R. In that flash of darkness he heard people saying—he was a failure—that R was beyond him. He would never reach R" (34). Mr. Ramsay does not struggle to step from Q to R, he struggles to understand what R is. He cannot explain or even negotiate the relationship between his mathematical system and the outside world. And while elsewhere in *To the Lighthouse* Lily Briscoe struggles with "two opposite forces; Mr. Ramsay and the picture" (193), here we see once more how mathematics and art remain opposed in Woolf's writing: they may both be languages, but to translate between them would be no simple matter.

Important modernist mathematicians ranging from the reactionary L.E.J. Brouwer to the revolutionary Kurt Gödel feared that Hilbert's formalist philosophy would reduce mathematics to meaningless rules. This group even included Gottlob Frege, who spent much of his career emphasizing the connections between mathematics and language.[7] Mr. Ramsay's alphabet is a case in point, because it misses out on everything that is vital in life; we could read the alphabet passage as a satire of the failings of logical thought. But unlike Mr. Ramsay, Hilbert resisted this sort of reductive formalism. Instead, by focusing on signs and relations and sidestepping direct reference, Hilbert preserved mathematical generality: the capacity of a theorem to retain meaning in multiple contexts and applications. In a mathematical context, generality is one of the highest aims of research and proof, an unambiguously positive quality carrying no connotations of vagueness. Generality is, in fact, a defining characteristic of pure mathematics.[8] Turning back to literary terminology, we could call this ambiguity: the capacity of language to retain meaning under multiple interpretations. Here, the advantage of Mr. Ramsay's alphabet system rematerializes, because although Mr. Ramsay fails to see its implications, Woolf enables P, Q, and R to evoke many further words. Scholars have frequently observed that R can stand for Ramsay and reality, among several other possibilities.[9] In turn, Hilbert was famous for his ability to endow mathematical descriptions with multiple meanings. In his *Foundations of Geometry* he reconstructed all of classical geometry using traditional terms but absolutely flexible semantics, expanding geometry far beyond any of its previously recognizable boundaries. He asserted that the work was meant to be so totally, beautifully ambiguous that one could "say at all times—instead of points, straight lines, and planes—tables, chairs, and beer mugs" (Reid 57). This assertion recalls Andrew Ramsay's instruction to Lily Briscoe: she may as well "Think of a kitchen table… when you're not there" (23). But here, the choice of a table is emphatically, deliberately random. It does have associations in history,[10] just as P, Q, and R do in symbolic logic,[11] but the important point—for Hilbert and for Lily—is to find one form, one sign, that can ambiguously indicate other objects in the real world without ever reductively pointing to any one of

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[7] Hilbert's philosophy of mathematics was controversial, itself a direct response to a reactionary movement led by Brouwer, who maintained that any mathematics lacking clear intuitive sense should be dismissed. The debate between Hilbert and Brouwer eventually developed vitriolic intensity, leading Albert Einstein to resign his post at the *Annalen* in protest of what he called a "frog-and-mouse battle" (see Paolo Mancosu, *Brouwer to Hilbert* 3 or Constance Reid 187). See also the Frege-Hilbert controversy that erupted at the turn of the century (Blanchette).

[8] See, for example, Whitehead: "The certainty of mathematics depends upon its complete abstract generality" (*Science and the Modern World* 22); Russell: Bertrand Russell: "in mathematics… the greatest possible generality is before all things to be sought" ("Study of Mathematics" 56); G. H. Hardy: "The propositions of logic and mathematics share certain general characteristics, in particular complete generality" ("Mathematical Proof" 6); and Henri Poincaré: "if we open any book on mathematics… on every page the author will announce his intention of generalizing" (32).

[9] For particularly rich examples, see Elizabeth Abel 55-7 and Christine Froula 149, 167-73.

[10] Ann Banfield has elaborated on these associations at length in *The Phantom Table*.

[11] Sandra Donaldson and Ann Banfield have both noted instances where *p*, *q*, and *r* appear as variables in Russell's work, arguing that Woolf may be referring to Russellian symbolic logic with Mr. Ramsay's alphabetic reasoning (Donaldson 331, Banfield 189-90). However, *p*, *q*, and *r* are the standard variables in symbolic logic, and their presence in the field is pervasive, reaching well beyond specific thinkers such as Russell.

them. And although Hilbert and Lily both very specifically home in on their chosen sign, building the formalist system of relations that is both his mathematics and her painting, they simultaneously remember the power of ambiguity.

Even if readers cannot directly translate between these alternate systems of signs and relations on paper, they come together in their formal similarities and their common modes of meaning. In the process, meaning itself emerges from commonality, becoming not merely indeterminate but fully and affirmatively multiple. This is the height of positive ambiguity. This is polysemy: the rich combination of many meanings coexisting under the same sign.

In his preface to the second edition of *Seven Types of Ambiguity*, William Empson writes, "I claimed at the start that I would use the term 'ambiguity' to mean anything I liked" (viii). That is, ambiguity is itself ambiguous. We know, in literary studies, that ambiguity is important and that it is everywhere. But I am not sure if we know what it is or how it works. When ambiguity's range is large, directed toward not two or three potential confusions but innumerable and unlimited possibilities, then how, exactly, does the symbol still symbolize?

Woolf tells us that her "ambiguity is intentional… as much elasticity as possible is desirable,"[12] and her most central terms are characteristically elastic. Besides the polysemous mathematics that sits at the center of *Night and Day*, Woolf's writing more generally involves an unusual breadth of ambiguity, a markedly open range of meaningful possibilities. Consider the lighthouse in *To the Lighthouse*: frequently sought after but largely unknown, an imposing figure of significance that shifts meanings with its observers. Then there are the three guineas that organize *Three Guineas*. With weighted yet undirected symbolism, *Three Guineas* shuffles its guineas around as markers of prominently undetermined value.[13] In *The Waves*, waves signify so much that to name their significance, even mere examples of their significances, starts to seem reductive, like the undersized attempt to describe one drop of water in a whole ocean.

These enormous central symbols mark the possibilities of symbolism even more than they actually symbolize. They telegraph the multiplicity of their meanings more than they attach to those meanings themselves. It is no coincidence that these symbols, at once expansively meaningful and surprisingly unknown, are also the organizing objects in Woolf's titles. Such symbolic entities naturally become titles because they already function like titles; they are labels for that which seems too slippery or unwieldy to be labeled, just as titles are shorthand for the piles of pages that cannot be reread every time they are discussed. In *Jacob's Room*, Woolf locates the relationship between book and title as that between person and name: "friends could only read the title, James Spalding, or Charles Budgeon," while others "could read nothing at all—save 'a man with a red mustache,' 'a young man in grey smoking a pipe'" (65). Here, name devolves into whatever limited handle the observer has on that which is much too complicated to fully grasp. Such titles label undetermined expansiveness. They provide us with terms for speaking about—but not determining—the indeterminate.

Consider the glaring unknown among Woolf's characters: Jacob Flanders. Always already dead, Jacob surfaces only in remembered glimpses, anecdotes, and bits of information, which never cohere into one stable person. Indeed, readers have long understood that Jacob himself is an

[12] Virginia Woolf, "Women and Fiction," in *Collected Essays*, vol. II (New York: Harcourt, Brace & World, 1967), 141.
[13] By Woolf's era guineas expressed currency more than they were currency; they connoted worth, but what they denoted was not entirely clear.

unknown. In 1922, the very first published review of *Jacob's Room* declared, "we do not know Jacob" (Majumdar 97).[14]

Jacob's room is the most concrete emblem of his selfhood, but it remains almost as undetermined as Jacob himself. Above the doorway there is "a rose, or a ram's skull" (70), we don't know which. Like Jacob, it is unfixed, shifting with him from Scarborough to Cambridge to London as readers only glean details of fragmented understanding. In fact, this room is prominent particularly as a name: *Jacob's Room*. And that exact title interjects oddly, surfacing repetitively and identically in the text itself—"in the middle of Jacob's room" (176)—"What do we seek through millions of pages? Still hopefully turning the pages—oh, here is Jacob's room" (97).

Names and titles possess an odd prominence throughout *Jacob's Room*, with its overweening accumulation of names for unfamiliar characters. By my count, this little novel presents over 200 named characters—proliferating more than one per page. To keep track of so many names in such a short text is impossible, so that in *Jacob's Room* names repeatedly highlight our own ignorance, building a peculiar association between names and the unknown. Each new name presents another potentiality: another open possibility for personhood. Yet at the same time, as the terms themselves multiply, the fabric of the text becomes increasingly opaque. Here readers perceive words more easily than meanings, and the increased possibility for meaning that comes with undetermined terms is accompanied by a step into formalism—a deeper attention to the forms of description than to what may be described—as readers simply give up on understanding the characters as subjectivities. As with Katharine's mathematical writings, where reference is so multiple and so indefinite our attention reverts to the relations between formal symbols—we become self-consciously aware that the "eye goes down the print" (*Jacob's Room* 40). So many unknowns drive us toward a self-conscious re-evaluation of symbolism itself.

As witnesses continually fail to capture Jacob's character, his name becomes the only consistent grip on him remaining to us. The stability of this name forestalls the instability of Jacob himself, allowing us to, at least, discuss that which is unknown. And the novel repeatedly introduces Jacob by his name before he himself ever appears: the typographically emphasized and already doubled "Ja—cob! Ja—cob!" interjects three times on a single page at the beginning of the novel (8). From the very first page name also preempts the story, announcing Jacob's death more directly than the narrative ever does: Flanders Field will swallow Mr. Flanders with all the inevitability of post-facto history. Woolf named Jacob not at birth but by death, and as an unknown soldier she endows his name with a symbolic logic too multidirectional to function as a mere marker for one person. Jacob Flanders might have been one hypothetical man, but "Jacob Flanders" marks the very possibility of signifying personhood. In this way, Jacob's constant, prominent name marks the innumerably unknown.

In an experimental novel where character is utterly unstable, the stability of name offers solid ground. This constancy in naming is very far from being a foregone conclusion— James Joyce proved that with the relentlessly shifting names in *Finnegans Wake*. In fact, Woolf's secure (albeit numerous) use of name and description is among the only techniques binding *Jacob's Room* to more traditional form, allowing the sense in which any single page of *Jacob's Room* could have sprung from a Victorian novel, yet the accumulation of those pages is utterly strange and new. We do not know who Jacob is, but we know absolutely that he is called Jacob. This unknown significance marked by

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[14] On Jacob's indeterminacy, see also Anna Snaith, *Virginia Woolf: Public and Private Negotiations* 79-80; William R. Handley, "War and the Politics of Narration in *Jacob's Room*"; and Judy S. Reese, *Recasting Social Values in the Work of Virginia Woolf*, 121-2. Mark Hussey has argued that this fundamentally undetermined identity reaches beyond Jacob, inhering in other characters and figures across Woolf's work. See *The Singing of the Real World*, 21-45.

a stable signifier echoes the undecided value of mathematics in *Night and Day*, but by shifting that variable semantic weight onto the protagonist himself, Woolf takes the entire process up a level, rendering *Jacob's Room* markedly more modern and massively more abstract. Here the single signifier marking a multifarious, undetermined significance mirrors undecided values marked by variables—the semantic method central to pure mathematics, where single terms serve as reliable markers for utterly undetermined referents. Mathematical variables do not merely label items yet to be determined; instead, they mark that which we refuse to determine. Amid such generality, reliable terms keep us from floating away in confusion.

Jacob's name is not without its own confusions, but the degree of these confusions underscores my point. One character, Mrs. Papworth, repeatedly mistakes Jacob's surname: "Mr. Sanders was there again; Flanders she meant" (102). But here, and elsewhere where Mrs. Papworth fails to correct herself, readers are perfectly able to identify the mistake. We could easily inform Mrs. Papworth of Jacob's true surname. Yet we look on in uncertainty during the many moments where characters are confused about Jacob's personality and identity rather than his name. When the narrator asks us, "But how far was he a mere bumpkin? How far was Jacob Flanders at the age of twenty-six a stupid fellow?" (154) we are unable to answer.

Jacob is not merely confusing or apparently indeterminate; he is everywhere always only potentially determinate. And, as Shankar Raman has noted, the introduction of mathematical variables constitutes "a shift from representing things—be they commodities, people, or algebraic unknowns—as determinate-but-unknown to representing them in their merely potential determinateness" (213). This distinction is crucial, because it marks the difference between the limited ability to represent any one example and the expanded capacity to demarcate and characterize entire fields of possibility. Jacob's personality and actions are to a remarkable extent only possibilities. He may well run off with Sandra Wentworth Williams or turn back and marry Clara Durrant. He might yet acknowledge Bonamy's love. He may be one of those young men who "will soon become fathers of families and directors of banks" (151), or he might actualize his bohemian impulses. He "might become stout in time" (153)—or might not. These possibilities do not only pertain to the unrealized future; they crucially indicate the great degree to which we cannot precisely describe Jacob's present inclinations, personality, and selfhood. Individual readers are bound to have intuitions about which of these possibilities ring truest to Jacob as they understand him, but certainly Woolf has constructed the text so that they are all legitimate possibilities.

Or at least, they would be if we could suspend Jacob's inevitable and over-determined death. In some sense, the unknown, potentially determinate is exactly what those who die young leave behind them. Jacob is one configuration of Woolf's brother Thoby Stephen, who died at 26, and even such a conflicted and various representation as Jacob stands in competition with several other versions. Woolf's various reincarnations of Thoby—Jacob Flanders, Andrew Ramsay from *To the Lighthouse*, Percival in *The Waves*—are so multifarious, so mutually contradictory, and so generally opaque because, like variables, the aborted futures of the young dead are always only potentially determinate. In that way, they can *potentially* take on many mutually exclusive instantiations without generating actual inconsistency. And here it is also well worth remembering that this particular memory was already mathematical. In "A Sketch of the Past" Woolf recalls Thoby often studying mathematics with their father at the dinner table (111), and Quentin Bell describes the subject as Thoby's singular talent among the Stephen children (*I* 26): like Andrew Ramsay, perhaps he "should have been a great mathematician" (*Lighthouse* 289).

In *To the Lighthouse*, Lily Briscoe aligns the engagements fostered by poetic phrases and mathematical symbols:

> It was love, she thought, pretending to move her canvas, distilled and filtered; love that never attempted to clutch its object; but, like the love which mathematicians bear their symbols, or poets their phrases, was meant to be spread over the world (47)

Woolf demands that we set symbols free, that we do not "clutch" at them but allow them to "spread over the world," and here, in a swift double step, this demand pertains just as much to the relation symbols bear to their meanings. She describes a mode of meaning that ranges over many possible referents, irrespective of discipline, context, or genre. Woolf's symbols do not clutch at their objects, but instead spread widely, as Jacob evokes at once all the young men who died in the Great War, and even Thoby, who did not. Elsewhere Woolf explains that "We have been so often fooled in this way by words, they have so often proved that they hate being useful, that it is their nature not to express one simple statement but a thousand possibilities." ("Craftsmanship" 246). Then she defines the "useful statement" which words so detest as "a statement that can mean only one thing" (247), hammering home the claim that words "hate anything that stamps them with one meaning or confines them to one attitude" (250-1). This refusal of delimited meaning has its apotheosis in the variable—a sign that exists to mark potentially infinite possibilities of meaning. *Jacob's Room*, I argue, is an entire novel constructed around not only the unknown or the indeterminate, but the everywhere potentially determinate; it is an entire novel constructed around a variable.

On Variables and Meanings

> She cast her mind alternately towards forest paths and starry blossoms, and towards pages of neatly written mathematical signs
>
> *Night and Day*

The variable is a semantic model not used in literary theory,[15] but philosophers of language and linguistics have long since compared the multiplicities of variables in logical language to the ambiguities of words in natural language. Raman has examined algebra's influence on Renaissance culture, analyzing literary multiplicities alongside algebraic variables to great effect. Yet, during the Renaissance, algebra remained a young idea in the West, and variables in algebra were limited in the sense that they could only take on numbers as their values. By Woolf's era, the possibilities had exploded, after late-nineteenth-century innovations by George Boole, Georg Cantor, and Gottlob Frege, among many others, expanded the range of semantic applications for variables. Far from

[15] Apart from Raman, exceptions include Steven Cassedy, who points out that attention to literary forms as relational systems has sometimes prompted the comparison of literary meanings and algebraic variables, and Jennifer Ashton, who argues that Gertrude Stein turned to literary variables in her late work in the attempt to write a "history of every one." Elsewhere, where variables arise in literary criticism, scholars usually assume that they flatten rather than amplify meaning. Megan Quigley identifies mathematics as contrary to symbolic ambiguity in Woolf's work, assuming that meaning in mathematics is "fixed," "concrete," and "static" (108, 119). The flaw in this argument reveals itself in the particular mathematics that Quigley herself quotes from *Night and Day*, "A plus B minus C equals *xyz*," which consists almost entirely of variables—symbols that mathematics employs particularly for their ability to stand for the unknown, existing among multiple possibilities. Mathematically speaking, if Woolf's character were describing a static value with "A plus B minus C," she would not have described it in terms of variables.

merely indicating numbers, by the modernist era variables could stand in for sets, propositions, objects, events, phrases, and, very generally, anything that might exist or be thought of at all. Variables had taken off from mathematics and science to land in diverse and far-flung fields. Woolf's friend Bertrand Russell was revolutionizing philosophy in large part through the use of variables and mathematical quantifiers to analyze and refer to descriptions in language.

Variables can be thought of as simply one name for many possible referents. Russell defines variables as terms which do not "have a meaning that is definite though undefined" but instead are truly "undetermined" (*Mathematical Philosophy* 10). Elsewhere he writes, "I take the notion of the *variable* as fundamental… *x*, the variable, is essentially and wholly undetermined" ("On Denoting" 480). Joseph Shoenfield writes that "Unlike a name, which has only one meaning, a variable has many meanings. In an analysis text, a variable may mean any real number; or, as we shall say, a variable *varies through* the real numbers"[16] (7). Variables are the most extreme instance of polysemy: the state of possessing many meanings. Yet, from a mathematical vantage point, what exactly does multiplicity of meaning mean? What exactly does meaning mean?

In 1892, the mathematician, logician, and language philosopher Gottlob Frege divided meaning into *Sinn* and *Bedeutung*, often translated as sense and reference, or sense and denotation. Frege writes that "It is natural, now, to think of there being connected with a sign (name, combination of words, written mark), besides that which the sign designates, which may be called the *Bedeutung* of the sign, also what I should like to call the *sense* of the sign, wherein the mode of presentation is attained" (152). Edward Zalta explains the distinction thus: "The expressions '4' and '8/2' have the same denotation but express different senses, different ways of conceiving the same number. The descriptions 'the morning star' and 'the evening star' denote the same planet, namely Venus, but express different ways of conceiving of Venus and so have different senses." In more complicated constructions, Frege connects denotation to problems of truth value, whereas sense, entailing word choice and perspective, has much to do with the subtler connotations and evocations of literature: "In hearing an epic poem, for instance, apart from the euphony of the language we are interested only in the sense of the sentences and the images and feelings thereby aroused"—not the denotation (157). The interest of artistic description lies in its expansive implications more than in the literal objects, actions, or values referenced, and in literature the sense becomes staggeringly larger and more complicated than in the simple distinction between 4 and 8/2. In fact, I would say that the senses of artistic symbols can frequently be so complex and multifarious as to blur, eclipse, or swallow up their denotations entirely. In much of literature, it seems, to draw a line between sense and reference may be to risk generating a false binary.

The division has its difficulties elsewhere as well, underscored by continuing disagreement over any English translation of Frege's terms. Russell influentially translated *Sinn* as "meaning" and *Bedeutung* as "denotation," thus swapping out the most literal translation of *Bedeutung* to use it to indicate, instead, *Sinn*. In Russell's hands, the denotation developed extreme mathematical precision: in 1905 he argued that the phrase "All men are mortal" actually indicates the claim that " 'If *x* is human, *x* is mortal' is always true" ("On Denoting" 481).[17] In this way, he claimed to be able to translate any denoting phrase into a logical statement. This theory of descriptions depends on variables, on the great generality that can attach to *x*. However, Russell does not only import the semantic breadth of variables: he brings mathematical and logical rules into language together with

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[16] Here by "analysis" Shoenfield indicates the formalized version of calculus.

[17] Russell's system became even more convoluted for other denoting phrases:

> Thus "the father of Charles II. was executed" becomes:— "It is not always false of *x* that *x* begat Charles II. and that *x* was executed and that 'if *y* begat Charles II., *y* is identical with *x*' is always true of *y*". (482)

those variables. In the process he actually neglects multiplicities of meaning: for example, above, the fact that "men" is not necessarily gender neutral.

Woolf, on the other hand, insisted that meaning was multiple, fluid and even amorphous. In "Craftsmanship" she distinguishes between "surface" and "sunken" meanings, generating a boundary that roughly corresponds to Frege's line between *Bedeutung* and *Sinn*, insofar as the surface meaning seems to indicate more literal denotation, whereas sunken meanings are implications and associations. But Woolf also makes it clear that, in natural language, such demarcations can never be stable: "At the first reading the useful meaning, the surface meaning, is conveyed; but soon, as we sit looking at the words, they shuffle, they change" ("C" 246). Russell's logical system for denotation cannot apply here, because the meaning is constantly shifting, offering no static reliability. Describing a statement as simple as that of a signboard in the London Tube, she explains,

> [I]t is the nature of words to mean many things. Take the simple sentence 'Passing Russell Square'. That proved useless because besides the surface meaning it contained so many sunken meanings. The word 'passing' suggested the transiency of things, the passing of time and the changes of human life. Then the word 'Russell' suggested the rustling of leaves and the skirt on a polished floor; also the ducal house of Bedford and half the history of England. Finally the word 'Square' brings in the sign, the shape of an actual square combined with some visual suggestion of the stark angularity of stucco. Thus one sentence of the simplest kind rouses the imagination, the memory, the eye and the ear—all combine in reading it.
>
> But they combine—they combine unconsciously together. The moment we single out and emphasize the suggestions as we have done here they become unreal; and we, too become unreal—specialists, word mongers, phrase finders, not readers. In reading we have to allow the sunken meanings to remain sunken, suggested, not stated; lapsing and flowing into each other like reeds on the bed of a river. (247-8)

To "single out and emphasize" one meaning, setting it apart from the others, is to make it unreal. The distinction between surface and sunken meanings, between denotation and sense, may be apparent and useful, but it is also somewhat artificial, and logical indications cannot be categorically separated from fluid implications. Woolf is weighing in on the same demarcations of meaning posed by Russell and by Frege before him; she makes this clear by bringing in her friend Russell by name—in sense and sunken meaning if not direct reference. The ducal house of Bedford, for which Russell Square is named, was Bertrand Russell's family. The 6th Duke of Bedford was his great-grandfather, the 1st Earl Russell, his grandfather. Bertrand Russell grew up in that grandfather's home. As she passes Russell Square on the Tube, contemplating a relentless intermingling of meanings, Woolf tells us, beautifully and indirectly, that she is passing Bertrand Russell by. It is an appropriately elliptical allusion, since she is arguing that isolated direct reference is ultimately ineffective. Here Russell's presence, like Woolf's preferred meanings,[18] remains sunken, fluid, and intermingled.

Yet Woolf does distinguish between surface and sunken meanings even as she tears down any wall between the two. There is a difference even if there is no reliable distinction. On an abstract

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[18] In deference to Woolf's intermingling of meanings, throughout this chapter I use "meaning" as an all-embracing term, encompassing at once *Sinn* and *Bedeutung,* sense and denotation, sunken meaning and surface meaning. When I intend specifically to refer to the former, I use sense, connotation, or evocation. To indicate the latter, I speak of denotation or referent.

level, these two types of meaning can clarify how variables mean, and they can also help us characterize the particularly fluid semantics of Woolf's most central figures. Literary symbols usually involve a range of connotations and evocations. It is usually their sense, rather than their reference, that is most complicated, most multifarious, and most interesting. But, I want to argue, symbols such as Jacob, or the lighthouse, or Woolf's waves, do the opposite instead: like mathematical variables, they have relatively singular senses, but remarkably multiple referents. The really odd thing about Jacob is not that we associate him with many different kinds of men, but that we cannot seem to choose which man he is. Woolf's waves not only connote many things, but also denote many, many things. That is exactly the semantic mode embodied by variables in pure mathematics, where a single variable will point toward many referents or denotations, but it will have only one sense, only one name, only one mode of presentation.

Literary symbols do not usually behave in this way. Allegory is one clear counterexample, offering symbols that are too far married to individual referents to allow for this level of variability. However, the greater gulf separating most literary symbols from Woolf's variables involves not the quantity of meanings but the paths by which symbols lead to those meanings. Variables choose no favorites from among their possible referents. Literary symbols typically claim some natural, or at least culturally pre-determined, connection to their meaning, because authors create symbols that are relevant to their content, that naturally open it out for us, playing on cultural expectations. Usually, the symbol itself is indispensable to the meanings it comes to reverberate with, and the range of meanings usually ramifies via pre-existing cultural associations, the metonymic senses of the symbol. In "The Love Song of J. Alfred Prufrock," when Prufrock announces that he "shall wear the bottoms of [his] trousers rolled" (*Collected Poems* 7), T. S. Eliot's symbolism relies on the assumption that we will have known old men who wear their trousers rolled. There is certainly slippage and multiplicity to the meaning of this phrase, but it proceeds along lines of metonymy as well as metaphor, of sense more than reference. Its pre-existing cultural associations mean that it reaches to complicate and ramify existing tropes more than to strive for generality.

Mathematical variables exist at an opposite symbolic extreme: when I use x to designate some range of values, I don't assert that there is any natural or pre-existing connection at all between the written mark and its referents. The object chosen to carry these meanings is arbitrary, and the multiplicity of x has nothing to do with the written letter. Any cultural associations we do have with that x become pale and irrelevant up against its references and denotations.[19]

Meanwhile, Woolf frequently seems to delight in choosing symbols that are to some extent arbitrary. Jacob himself often seems inadequate to the book that contains him, as though he might as well be any young man who died in the Great War. The first draft of *The Waves* was explicitly subtitled *The Life of Anybody*, and the final novel is interested in personhood more than in its characters specifically. *To the Lighthouse* tells us quite directly that the particular significance of that lighthouse is an accident of whim: in "Time Passes" we read of "some random light… from some uncovered star, or wandering ship, or the Lighthouse even" (126), as though characters' attentions might just as well be directed elsewhere. Even in the midst of his own passionate quest to reach the lighthouse, Mr. Ramsay thinks "The Lighthouse! The Lighthouse! What's that got to do with it?" (151). The lighthouse is only one among many possible loci of meaning; great significance does

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[19] Mathematical variables cannot be completely free of associations. For example, $E = mc^2$ offers cultural meanings that $x = yz^2$ does not, even though the two equations are mathematically identical. Choices in mathematical notation can definitely involve cultural connotations, both intended and otherwise. However, while mathematical language—like all language—inevitably carries some non-denotative associations, it generally involves far fewer such implications than most language does.

settle on that particular object, but *To the Lighthouse* demonstrates that it could easily have been otherwise. Woolf does play on readers' pre-existing associations when she presents Jacob, or the lighthouse, or her crashing waves, but those associations come to seem minor, even somewhat arbitrary, up against the denotations that Woolf presents anew.

As the symbolic object becomes arbitrary, we find ourselves cut off from possibilities for metonymy. Natural associations become questionable when the object itself has only questionable relevance. That troubled relevance of metonymic contiguities leaves the possible referents floating freely, without any network or hierarchy among them. Instead they exist interchangeably, though each different from the others. Across her career, Woolf repeatedly created enormous, central symbols that rely on newly drawn comparisons more than preexisting associations, metaphor more than metonymy, reference and denotation more than sense or connotation. Variables allow for an infinity of potential referents, opening up greater ranges of ambiguity and generality, but what most fully distinguishes them from standard artistic symbols is a kind of equality among their referents. Selection from among the field of possible meanings is free and unattached. Symbols such as these allow for more complete slippage among their referents.[20]

Variables retain the capacity for precision while also embodying this height of multiplicity in meaning. It may be tempting here to recall variables in their most simplistic form, e.g., solve for x in $2x = 6$. However, to do so would be dangerously misleading, because there is only one value for x that makes that equation true. Regarding the role of variables in pure, modern mathematics, it is necessary to imagine cases where many meanings are possible, e.g., $ax = b$, where x may take an infinite number of meanings, but at the same time it is delimited by the values of a and b. In pure, formal mathematics, variables exist to generalize possibilities, not as mere placeholders for single solutions.[21] That generality need not entail any vagueness or confusion.

Mathematical variables are well defined in particular ways. First, the context rigorously specifies certain bounds (in the example above, we can determine that x may be any number, rational or irrational, real or imaginary, but it cannot be a table or chair, even though there do exist other mathematical instances where x may well be such an object). Second, although a variable might possess the power to stand in for an infinite number of possible values, once decided it must remain constant and thus iterable within a given expression (x can hold an infinite number of values in $ax^2 + bx + c = 0$, but we always know that $x = x$ both times that it appears). Regarding their bounded iterability, linguists have often compared variables to pronouns. That is, "she" is a flexible term that can stand in for an infinite number of subject positions, but it remains bounded (it must refer to a female) as well as iterable (within any single well-understood phrase, "she" should always stand for the same female). And, like variables, "she" tends to shift among denotations more than senses; when "she" refers to two different women in two different contexts, its reference shifts without its connotation changing. Variables can model a much more extreme form of deixis.

The importance of variables in mathematics can hardly be overstated. Near the beginning of his *An Introduction to Mathematics*, which Woolf and her husband Leonard held in their library,[22]

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[20] Elsewhere in literature, symbols such as these are less common, yet when they do appear they tend to take over, frequently acting as titles and lying at the centers of texts. Other dominating examples might include the great whale in *Moby Dick* or the scarlet letter in *The Scarlet Letter*.

[21] Technically, even in $2x = 6$, while only one value for x will make the equation true, x (as a free variable) still possesses an infinite number of possible denotations. The multiplicity of potential references characteristic to variables remains the case here as anywhere else. It is only the case that this multiplicity is easier to envision in contexts such as $ax = b$, where we are less tempted to assume that the variable's denotation must be that which makes the equation true.

[22] The volume was signed by Leonard, which may indicate that he purchased it. The edition is undated. See King and Miletic-Vejzovic, 242.

Alfred North Whitehead credits the generality belonging to variables with the origin and basis for mathematics itself: "Mathematics as a science commenced when first someone… proved propositions about any things or about some things, without specification of definite particular things" (15). Similarly, in the very first line of *The Principles of Mathematics*, which the Woolfs also owned,[23] Russell tells us that "Pure Mathematics is the class of all propositions of the form '*p* implies *q*'" (3), prefiguring Mr. Ramsay's "If Q… Then R" (*Lighthouse* 34) and emphasizing the variable as the determining factor in the generality that distinguishes pure mathematics. Here *p* and *q* are variables denoting propositions which themselves must contain only variables and relations,[24] because, according to Russell, "we do not, in [pure mathematics] deal with particular things or particular properties: we deal formally with what can be said about *any* thing or *any* property" (*IMP* 196). In this sense, variables can be regarded as the defining feature of mathematics and even of any general study of relations. Variables are the means by which the forms of truths may be uncovered independent of their particulars.

Notice that, as Russell uses them here, variables need not point to numbers, and their range is emphatically general. In turn, the linguistic comparison of variables and pronouns is limited insofar as pronouns are typically used in sentences where they only have one appropriate referent. Regarding pure mathematics, this analogy will be more informative if we contemplate scenarios where a pronoun indicates not one person, but (at least potentially) any number of people. Consider the sentence "reading *Jacob's Room*, one loses track of names." This sentence refers neither to one particular person nor to all people. Instead, it refers to as many people as read *Jacob's Room*, and the exact number of people involved has no effect on its truth or meaningfulness. Under Russellian analysis this sentence has an if-then logical structure: "if *x* reads *Jacob's Room*, then *x* loses track of names." Here the important point is that the sentence may just as well refer to a million people as to one person, without that polysemy compromising any of its accuracy or sensibility. That capacity for specific meaning, always operating within full generality, is at the heart of what makes variables so powerful.

A variable is one semantic model for how language can mean both one thing and another. Given that language must adapt to describe a potentially infinite variety of circumstances with only a finite number of words at its disposal, this polysemy is at the heart of language's very ability to refer. By extension, variables model how language works. And variables offer literary theory a semantic structure for the radical simultaneity of generality and specificity, indicating all possible entities in a manner wherein a specific entity may still be characterized. In this sense, variables very literally exist so as to allow us to rigorously discuss everything or anything at once. This is generality without vagueness, loftily reaching toward the capacity to describe commonalities, diversities, and entireties all in one fell swoop.

Jacob's Room frequently embraces possibilities that are not only multiple and varied, but mutually exclusive. Recall that, carved above the doorway to Jacob's room, we see "a rose, or a ram's skull" (70). Although this carving is unknown to the narrator, it cannot actually be both a rose and a ram's skull. Even if worn wood makes them indistinguishable, they are not identical. Yet the rose

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[23] 1903 edition, signed by Leonard (King and Miletic-Vejzovic 193).

[24] Russell's opening sentence in full: "Pure Mathematics is the class of all propositions of the form '*p* implies *q*,' where *p* and *q* are propositions containing one or more variables, the same in the two propositions, and neither *p* nor *q* contains any constants except logical constants" (*The Principles of Mathematics*, 3). Here logical constants are terms whose only semantic value involves matters such as relation or implication; they alter the logical form of a proposition without adding particular content. Examples include "and," "or," "if," "then," "not," "every," "some" "such that," and sometimes "is." Apart from terms such as these, for Russell the propositions of pure mathematics can contain *only* variables.

and the ram's skull do coexist perfectly well as potentialities—as two possible realities mutually designated by *x*. Woolf tells us that this is a rose *or* a ram's skull, but in the suspended space of the novel readers imagine the rose *and* the ram's skull. And, like Jacob's constant name marking a seemingly undetermined and multiple personhood, Woolf's particular words for these varying possibilities remain markedly constant and ordered: on the final page she describes it again as "a rose or a ram's skull" (176). While the object is variable, its description is static. This constancy is crucial to mathematical modes of meaning: where reference is at least partially determined, descriptions can shift, but where all that we know about *x* is that it is marked by "*x*," if we shift abruptly (and without notice) to calling it "*y*" we will have given up all knowledge entirely.

Relying on stable signs for unknown referents, *Jacob's Room* repeatedly reuses the same descriptions of that which is prominently undecided. As the narrator uses the same words, in the same order, to describe the indistinguishable doorway to Jacob's room, Mrs. Durrant similarly repeats an observational contradiction with the same words in the same order: to her Jacob is "extraordinarily awkward… Yet so distinguished looking" (61) and then "Extremely awkward… but so distinguished-looking" (70). Later, Sandra Wentworth Williams's description is nearly identical: she notes Jacob's "extreme shabbiness" as he remains "very distinguished looking" (145). By the end of the novel, the words have been taken up by the narrator and by an unindividuated "they": "'That young man, Jacob Flanders,' they would say, 'so distinguished looking—and yet so awkward'" (155). By now, although the order shifts, the pattern has become so well established that the inverted phrase remains utterly familiar. While it is possible to imagine young men who are both awkward and distinguished looking, this remains a generally contradictory set of characteristics. Woolf highlights human inconsistency with consistent terminology. But far from being paradoxical, this may be cause and effect: descriptive variety is difficult when so little knowledge is available to describe, and rather than split one unknown into several, the narrator settles for the formal knowledge that repetition achieves. This mode of meaning that underpins mathematical variables functions equally well with letters, names, phrases, or entire works of literature, because the level of expression has no influence on a variable's effectiveness. As Woolf constructs Jacob as well as *Jacob's Room* using the semantic processes of variables, she constructs a higher-level patterning that gestures toward the great commonalities of personhood and of modernity; any direct description of such broad trends would be subject to innumerable exceptions, but as simple structures of repetition these modernist commonalities function indisputably.

Where reference is truly unavailable, repetition, or the absence of repetition, is actually all that remains for readers to analyze. Woolf's narrator tells us twice that "it is no use trying to sum people up" (31, 154): this doubling communicates emphasis even as the words admit the speaker's ignorance. As an explanation of Jacob himself (which it is), this comment actually retracts previously accumulated understanding, announcing that the anecdotes composing *Jacob's Room* cannot be meaningfully combined. Instead of providing new knowledge or new language, these repetitions emphasize meta-commentary on the status of knowledge and language themselves. And, as Hilbert's study of formalism in mathematics led to the development of metamathematics (a new subfield analyzing mathematical theorems and proofs just as traditional mathematics analyzes numbers or shapes) so too does a rigorous study of formalism in literature lead analysis to step up to meta-analysis, because the deferral of particular meaning leads to a generalizing analysis of literature itself.

The representation of multiple possibilities works as well with people and their thoughts as with objects, even though Jacob and *Jacob's Room* are profoundly more complex than any wooden carving. Toward the end of his life Jacob composes "one of those scribbles upon which the work of a lifetime may be based; or again, it falls out of a book twenty years later, and one can't remember a word of it. It is a little painful. It had better be burnt" (150). In a practical sense, either Jacob's "scribble" builds the work of a lifetime or it doesn't. But the coexistence of these mutually exclusive possibilities becomes sensible when described with the simultaneous multiplicity and specificity of variables. *x* can be potentially multiple because we discuss it generally without restriction to its specific instantiations, and while in a particular context it must ultimately resolve to one value *or* another, our descriptions of it function equally well whether it is *either*, so that, descriptively but not ontologically speaking, it is *both*. Jacob may be undecided as to the worth of his scribble, and it is entirely reasonable, as a writer and as a conflicted human being, that Jacob would simultaneously conceive of that note as both a masterpiece and an embarrassment. Regarding the possibly illogical realities of personhood, there is no conflict here. But the variable provides one powerful semantic model for how these mutually exclusive possibilities can still coexist within logical language. From this perspective they exist, like Jacob, as potential.

For Woolf, subjectivity itself may be contradictory: Jacob seems to genuinely be both conventional and bohemian, both excited by the world and scornful of it. Like most people, he is conflicted. But my model of Jacob and the other conflicts and multiplicities of *Jacob's Room* as variables in no way contradicts this genuinely conflicted model of reality and subjectivity. Instead, it provides a language, a model, and a theoretical structure for thinking through the many conflicts and multiplicities of Woolf's writing. A variable is one semantic model for how language can mean both one thing and another.

Given that language must adapt to describe a potentially infinite variety of circumstances with only a finite number of words at its disposal, this polysemy is at the heart of language's very ability to refer. By extension, variables model how language operates. And variables offer literary theory a semantic structure for the radical simultaneity of generality and particularity,[25] indicating all possible entities in a manner where a specific entity may still be substituted at any time. Moreover, mathematical polysemy can denote the experience of contradiction in a framework that is free from contradiction. That's because, here, the signifier sits over and above the potential contradiction: *x* can potentially indicate both one thing and its opposite, but it never actually instantiates both at the same time. In the actual world, for Woolf, contradictions are sometimes irrevocable and irreconcilable. Variables offer an account that faithfully makes space for those contradictions while still explaining the consistencies of form that communicate those contradictions.

Turning to one more example from Woolf's writing, recall the very first line of *A Room of One's Own*: "But, you may say, we asked you to speak…" (3). Woolf opens with a reversal before she has written anything yet to reverse. With "but" readers know syntactically that there must come some contradiction, but what it contradicts remains outside the text—Woolf provides the relationship between terms before she provides the terms themselves. Moreover, the oddly undirected yet decisive syntax does not stop there, made yet more prominent by semantic generality: this brief quote presents three unanchored pronouns and no specified or delimited objects at all. While the first "you" refers with total generality to any reader, real or imagined, the "we" shifts and multiplies that generality further by switching both perspective and apparent number. Finally, the second "you" repeats a signifier while multiplying its referents—now the second-person pronoun refers to the writer as well as the reader, and even though these positions are directly opposed Woolf

[25] Megan Quigley has characterized the breadth of Woolf's symbolism in terms of a fundamental imprecision; she argues that modern novels characteristically use and probe vagueness. For Quigley, vagueness indicates indefinite definition, meaning with blurry boundaries. Generality, as I use it here, indicates instead multiple definitions: each meaning, individually, might be utterly precise, but stands as only one among a glut of other potential meanings. See "Modern Novels and Vagueness," *Modernism/Modernity* 15 (2008): 101-29.

indicates them by repeating exactly the same term. Meanwhile, both the unidentified writer and the generalized reader "say," "ask," and "speak," hammering home the fact that discourse's relations continue on all sides amid these multiplying meanings.

Formulations such as these, with continuously jumping perspective amid immersive yet unanchored free indirect discourse, are absolutely trademark to Woolf's style. And although these contradictions and confusions are utterly nonmathematical in their implications and conclusions, they are stunningly mathematical in their method and their structure, because they particularly foreground the complex relationships and patterns among terms. Mathematical interpretations represent the world like night and day, with a black or white vision of truth and falsehood, but mathematical modes of meaning require none of the dichotomous reduction that mathematical axioms assume. My analysis of literature through mathematical symbolisms works to bypass that oppositional notion of truth and falsehood. Woolf used mathematical language to dislocate mathematical meaning. Such is the utmost realization of cross-disciplinary formalism, whereby the deferral of meaning can work to multiply meaning across fields. Here the interdisciplinary enables not influence, but coexistence and interactive multiplicity. Woolf navigates the opposition between literature and mathematics to find their common commitment to polysemy; in so doing, she achieves generality that never sacrifices particularity, and formalism that never sacrifices meaning.

Opposition and Contradiction: The Threat of Meaninglessness

> How did one add up this and that and conclude that it was liking one felt or disliking? And to those words, what meaning attached, after all?… the voice was her own voice saying without prompting undeniable, everlasting, contradictory things
>
> *To the Lighthouse*

Ann Banfield has argued that "The 'solid, mathematical universe' [Stephen 147] supplies an abstract, intangible support" to Woolf's writing (149): "what upholds the fabric… is fact, the totality of things that are. Mathematical truths or the facts of history… can provide support like propositions true although never thought of or understood" (152). In other words, a "logical skeleton" lies at the core of Woolf's very shimmery and fluid art (259). I disagree. Very far from saying that mathematics, logic, and analytic philosophy are at the basis of Woolf's art, I instead want to claim that they provide uniquely powerful models by which we can read and understand Woolf's artistic and realistic contradictions without surrendering to analytic contradiction ourselves—for while ambiguity and contradiction are powerfully evocative in Woolf's writing, they are often simply tortuous in criticism and analysis. In my opinion, Woolf actually rejects logic on many levels. Yet that rejection coexists with a manifest interest in mathematical symbolisms. Here, mathematics emerges as a mode of meaning rather than as a guarantor of truth. In the same manner that mathematics in *Night and Day* is at once a symbol for literature and the self-conscious opposite of literary creation, Woolf sometimes unites differing paradigms under common symbolism, but she never merges them. The semantic intervention of polysemy allows for common analysis without conflation—it need never entail forgetting the differences among these multiple meanings.

In contrast to Katharine's passionate love for mathematics in *Night and Day* (which, already, some critics have read as negative, as a sort of dysfunctional withdrawal from the linguistic world[26]), Woolf's direct representations of mathematics are generally negative. In *The Waves*, Rhoda's struggle with arithmetic leads her to envision herself as "The other, [that] painfully stumbles among hot stones in the desert. It will die in the desert" (21); in her imagination, the harsh lines of numerals written on a blackboard swell into walls forcing her outside of society. That isolation is literalized when she must stay indoors struggling at mathematics while the other children go out to play: Rhoda's failure to understand numbers leads to her actual exclusion from human society. In *Mrs. Dalloway*, "proportion" is Sir William Bradshaw's primary justification for the cruel regulation of society's outsiders, and Woolf highlights the term's mathematical meanings by emphasizing the divisions that Bradshaw produces: "slicing, dividing and subdividing, the clocks of Harley Street nibbled at the June day, counselled submission, upheld authority, and pointed out in chorus the supreme advantages of a sense of proportion" (102). In *To the Lighthouse*, a discussion of square roots leads Mrs. Ramsay to contemplate "the masculine intelligence," asserting her own ignorance and leaning pointedly, instead, on the support of men (106).

Woolf condemns mathematics dishonestly applied to realms where it can claim no certainty. Here, mathematics becomes the figurehead of false objectivity, the dictatorial (and almost always masculine) proclaimer of doubtful absolutes. People are far too complicated to be reducible to simple figures, and while Mr. Ramsay's grave error is in thinking he could understand the complexities of life, including the complex loves, desires, and needs of his own family, as "If Q… then R," *Jacob's Room* repeatedly tells us: "It is no use trying to sum people up" (31, 154).

Woolf's cutting condemnations of such dictatorial and ultimately false claims to mathematical certainty seriously problematize Banfield's central claim that "Mathematical truths… provide support" to Woolf's writing (152). Troublingly implicit in Banfield's model generally is the assumption that art cannot stand up on its own strength—hence the need for a "logical skeleton." Perhaps Banfield would counter that logic and mathematics need not be opposed to art—a fact which I would generally concede, except that Woolf very frequently opposed the literary to the logical and mathematical. Katharine tells us that "mathematics were directly opposed to literature" (*Night and Day* 42), while in Woolf's diary, when she recalls Bertrand Russell arguing that mathematics and literature share much in common, she repeatedly, drily questions his assertions and writes that she "disagreed" (*Diary* II 146-8). In one essay on writing, she contemplates "stillness, sunlight, flowers, the passage of time and the presence of death," concluding that "None of this could be conveyed by simple words in their logical order; clarity and simplicity would merely travesty and deform such a meaning" ("De Quincey" 134). It seems to me that the Russellian logical "skeleton" which Banfield claims lies at the heart of Woolf's work is closer to being the intellectual context against which Woolf struggled; although she doubtless imbibed some of it, it is not the support system for her larger vision or innovation, which are far too fluid, emotional, and ambiguous for basis in Russell's extremely demarcated logical system.

But Woolf couples opposites often, and these oppositions certainly arise as pairings. While the title of *Night and Day* recalls literary-mathematical opposition, it also emphasizes

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[26] See, for example, Lucio Ruotolo, *The Interrupted Moment*: "*Night and Day* turns from the death of a heroine to explore what for a writer remains no less critical, the demise of language. Her second novel, like her last, confronts the question of why words fail. In the spirit of D. H. Lawrence and those American writers she praises for daring to take liberties with the English language, she would have us recoil from words gone dead" (48). Quigley writes that "Katharine craves 'figures, laws, stars, facts'… Her disbelief in language actually foils the story and stretches Woolf's novel out much longer than one could conceive (and perhaps, honestly, than one would desire)" (119-20, quoting *Night and Day* 297).

complementarity and interdependence: neither light nor shadow can exist without the other. "[I]f there, in that corner, it was bright, here, in this, she felt the need of darkness" (*Lighthouse* 52). In turn, Andrew Ramsay's "subject and object and the nature of reality" may be read as an insistence on the mutual necessity as well as the irreconcilability of subjective and objective thought (*Lighthouse* 23). The concurrence of opposites is one of Woolf's signature descriptive moves. As she tells us, "Such was the complexity of things," for we "feel violently two opposite things at the same time" (*Lighthouse* 102). So frequently Woolf articulates at once the polar extremes of experience, the best and the worst in her characters, the timelessness and ephemerality of existence. On the same page Mr. Ramsay is "a bit of a hypocrite" and also "the most sincere of men, the truest" (46). Mrs. Ramsay is "unquestionably the loveliest of people… the best perhaps," yet in the same paragraph and according to the same character she acts with "highhandedness," "maliciously twist[ing]" the cares and perspectives of others (48-9). If these characteristics are not directly contradictory, they are certainly generally opposed. Their pairings generate complexity, their necessarily multifarious implications, polysemy. Woolf directly emphasizes and upholds the apparent contradictions. Early in *To the Lighthouse*, as Lily contemplates William Bankes's character, she swings swiftly from one extreme to the other before settling in explicit contradiction:

> I respect you (she addressed silently him in person) in every atom; you are not vain; you are entirely impersonal… you are the finest human being that I know… praise would be an insult to you; generous, pure-hearted, heroic man! But simultaneously, she remembered how he had brought a valet all the way up here; objected to dogs on chairs; would prose for hours (until Mr. Ramsay slammed out of the room) about salt in vegetables and the iniquity of English cooks.
>
> How then did it work out, all this? How did one judge people, think of them? How did one add up this and that and conclude that it was liking one felt or disliking? And to those words, what meaning attached, after all? Standing now, apparently transfixed, by the pear tree, impressions poured in upon her… and to follow her thought was like following a voice which speaks too quickly to be taken down by one's pencil, and the voice was her own voice saying without prompting undeniable, everlasting, contradictory things, so that even the fissures and humps on the bark of the pear tree were irrevocably fixed there for eternity. (24)

William Bankes's insistence on a valet might negate the claim that he is not vain; Lily's complaints about his pickiness certainly contradict her assertion that she respects him "in every atom." Lily is tempted to view the paradox mathematically ("how did one add up this and that?") but here any arithmetic application is obstructed by questionable semantics ("to those words, what meaning attached, after all?"). What ultimately remains to us is not technically a contradiction, but it handily represents the irresolvable formal conflicts of life: "even the fissures and humps on the bark of the pear tree were irrevocably fixed there for eternity." Lily has previously imagined this pear tree as the site of the non-human ideal, where she nests Mr. Ramsay's "scrubbed" Platonic table in her mind's eye (23). Yet that site of the ideal, even unsullied by human intervention, remains every bit as confusingly multiple as William Bankes's conflicting personality: it is covered simultaneously with both "fissures and humps," each the opposite of the other and yet certainly coexisting side by side.

Considering many of life's opposing conclusions, Woolf's solution is very pointedly not that one assertion or the other is mistaken, nor even that each is an exaggeration, but rather that the inconsistency itself is inevitable, irreconcilable, and necessary. Banfield has argued that

> the voice Lily Briscoe hears 'saying… contradictory things'… does not establish 'the identity of opposites' [Russell, *Mysticism* 3] because its statements concern events in time, like, centrally, the Ramsays' disagreement about the morrow's weather. There is no 'simultaneous assertion of contradictory propositions' [Russell, *Mysticism* 9]. The contradictions are resolved in real time. (145)

But Banfield's quotation excises Lily's insistence that these are "*everlasting*, contradictory things"—Woolf explicitly tells us that this conflict will go on "for eternity," making it a matter entirely different from the Ramsays' argument about one day's weather. Moreover, these contradictions are "undeniable," so that unlike Mrs. Ramsay's hope that it will be fine tomorrow, no fact or event can prove them false. In fact, the great prominence and prevalence of contradiction in Woolf's writing is inescapable.

For some formalists, truth in mathematics is precisely and entirely the absence of contradiction, so that true mathematical propositions are any statements following consistently from foundational axioms, and falsehood exists only wherever there is contradiction. Leibniz wrote that "The great foundation of *mathematics* is *the principle of contradiction or identity*, that is, that a proposition cannot be *true and false* at the same time, and that therefore *A* is *A* and cannot be *not A*. This single principle is sufficient to demonstrate every part of arithmetic and geometry, that is, all *mathematical* principles" (217-8). Hilbert wrote that consistency made mathematical truth possible: "a satisfactory conclusion to the research into [the foundations of mathematics] can only be attained by the solution of the problem of the consistency of the axioms of analysis. If we can produce this proof, then we can say that mathematical statements are in fact incontestable and ultimate truths" ("New Grounding" 202).[27] Even under other philosophies of mathematics, and throughout actual mathematical practice, mathematics abhors contradiction. It seeks to root out even the mere possibility of contradiction far more than any other discipline does. As Jerrold Katz explains, "consistency is a necessary condition for truth in mathematics but not a necessary condition for truth in fiction. A fictional character's having incompatible properties (in the fictional work) does not rule the character out of fictional existence, but a mathematical object's having incompatible properties does rule that object out of mathematical existence" (142). This criterion of consistency as necessary for mathematical existence is no abstruse or controversial matter so much as a simple explanation of a practice that all mathematicians share. Contradiction cannot exist within any single mathematical system.[28] Consistency is not sufficient to define mathematics, but it is certainly necessary to any standard conception of the field. In this sense, Woolf's embrace of literary

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[27] Hilbert was very careful to avoid positions which might imply some arbitrariness in mathematical truth, instead advocating formalism as a useful means by which the difficulties of realist or intuitive applications might be separated from mathematics while the possibility of their ultimate truth could still be preserved. For Hilbert, consistency was a crucially necessary factor in mathematical truth, but it was not by itself a sufficient factor—his choice of axioms retained external motivations, although under formalist methods he could treat them as though arbitrary. As he wrote in 1925, "If, apart from proving consistency, the question of the justification of a measure is to have any meaning, it can consist only in ascertaining whether the measure is accompanied by commensurate success. Such success is in fact essential, for in mathematics as elsewhere success is the supreme court to whose decisions everyone submits" ("On the Infinite" 135). That is, consistency is necessary to mathematical truth, but successful application also plays a necessary role.
[28] Possible contemporary exceptions include work on paraconsistent logic by Newton Da Costa, Ross Brady, and Graham Priest. However, this research underscores my point with the very limited degree to which it accepts inconsistency, as well as with the marginal position that most working mathematicians would accord it. Moreover, this research postdates the modernist era by several decades at least; certainly for those working in the 1920s, inconsistency was anathema to mathematics.

contradiction preserves *Night and Day*'s most explicit conception of writing and mathematics as "directly opposed" (42).

Yet mathematics cannot be totally isolated from contradiction; its deep commitment to proof and epistemic certainty make contradiction and paradox constant specters on the horizon, since that which must be purged must always be watched for. During the modernist era particularly, contradiction became deeply and pervasively controversial among mathematicians, because many began to fear that it had somehow crept into mathematics through a back door. In the nineteenth century, non-Euclidean geometry had raised the strange notion that mutually contradictory realms of mathematics could co-exist and remain equally correct—much like fictions or parallel worlds—even when they appeared nonsensical beside science and the natural universe. This was a contradiction between different axiom systems instead of within one, but it was deeply problematic for those who had conceived of mathematics as one cohesive system rather than a bifurcated collection of independent disciplines. Then, in the later nineteenth century, set theory began to characterize and categorize the infinite, absorbing regions previously preserved for philosophy while opening itself up to strange contradictions. These latter contradictions were intra-systemic, unlike those between Euclidean and non-Euclidean geometries, and they caused considerable panic among mathematicians, who worked for many years and from many directions to cleanse the contradictions.

In the early twentieth century, mathematicians became increasingly disturbed by the apparent potential for contradiction in the heart of previously accepted mathematics, and their efforts to seek out and cleanse these contradictions became increasingly frenzied and controversial. In 1901 Russell formulated one particularly clear and problematic paradox (Russell's Paradox[29]) which led him and Whitehead to embark on the massive project of *Principia Mathematica*—releasing the first volume in December, 1910, that exact moment when Woolf tells us that "human character changed" ("Mr. Bennett and Mrs. Brown" 4). So exhaustive was the *Principia*'s attempt to define and prove the originary foundations of mathematics that its proof that 1 + 1 = 2 did not appear until page 379.[30] Yet the potential for contradiction extended further than Russell and Whitehead had hoped, and, at least in terms of cleansing the paradoxes through definition and proof based on intuitive logical principles, the *Principia* failed.

Then L. E. J. Brouwer prominently claimed that contradictions could not be cleansed from set theory's treatment of the infinite, and so mathematics must not examine completed infinity at all. He denied (to Hilbert's abject horror) the applicability to infinite sets of the law of the excluded middle—the basic logical law that a proposition must be either true or false, with no middle option. Brouwer's program would have required enormous swathes of modern mathematics to be purged, absolutely throwing out the baby with the bathwater. It was his movement that spurred Hilbert in the 1920s to respond with his own project of consistency proofs and metamathematics. Hilbert wanted to use modern mathematics to incontrovertibly demonstrate that modern mathematics was free of contradictions and thus valid. Then, in 1931, Kurt Gödel proved that Hilbert's project too

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[29] Russell's Paradox instructs us to imagine the set of all sets not containing themselves, and then to ask ourselves if it contains itself. Such a set becomes manifestly impossible, because if it contains itself, then it cannot contain itself, and if it does not contain itself, then it must contain itself. This contradiction, made possible by self-reference, is related to the older and more widely known liar's paradox: if I tell you that "I am lying right now," then either the truth or falsehood of my statement leads to contradiction and impossibility. In the late nineteenth century the newfound foundational generality of set theory allowed such logical paradoxes to enter mathematics for the first time.

[30] Actually, even there Whitehead and Russell did not provide a complete proof, which they developed in full only in the following volume, appearing two years after the first.

faced hurdles which might be too high. Gödel showed irrevocably that it will always be impossible for any sophisticated segment of mathematics[31] to prove its own consistency.

We could prove the consistency of arithmetic (in fact, Gerhard Gentzen did in 1936), but to do so would require methods foreign to arithmetic itself, and to demonstrate the consistency of those foreign methods would then require another proof entirely. There probably is not contradiction at the heart of mathematics, but Gödel proved that there can never be certainty that there is no contradiction. The modernist era proved that no one can ever guarantee the complete absence of contradiction in the entirety of mathematics. Instead, mathematicians must proceed step by step, content to know that there is no contradiction in the particular segment of mathematics they currently work in as long as certain axioms can be agreed upon. The overwhelming, pan-systemic approaches to cleansing contradiction which characterized mathematical modernism are now a thing of the past.[32]

In turn, Woolf's ongoing attention to contradiction can make her work comparable to modern mathematics rather than opposed to it.[33] Although the ultimate embrace of contradiction in her work certainly differs from its overwhelming rejection in mathematics, the deep and continuing preoccupation with contradiction was an expansively modernist trend, common among the most distant intellectual disciplines.

The intensity of mathematicians' rejection of contradiction is related to the troubling contingency of mathematical existence itself—another acutely modernist matter in the history of mathematics. The question of how numbers and other mathematical objects exist in the world is no simple matter. Plato claimed that they are ideals, more real than the actual world, which is a mere reflection of those ideals. That perspective has been dominant among mathematicians for thousands of years. But in the modernist era many mathematicians newly feared that the multiplicity of modern geometries and the antinomies of set theory jeopardized that ideal existence. The troubling implication was that mathematics might be neither real nor reliable. Whitehead and Russell sought to resuscitate mathematical realism by proving that mathematics was built from logic. Brouwer threw out the realist perspective entirely, arguing that mathematics is rooted only in nonlinguistic human thought. Hilbert's formalist program endeavored to be theoretically reconcilable with all of the above. He carefully avoided defining any ultimate meaning or mode of existence for mathematical objects, instead treating them as signs which could be taken to point toward any number of ultimate options. By deferring mathematical meaning, Hilbert retained the potential for many meanings, but he also opened himself up to accusations of meaninglessness, because he refused to provide any one absolute answer. The proofs of consistency were crucial under Hilbert's system because they ensured that mathematics was rigorous and solid as a system even when no ontology was directly

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[31] Defined as any consistent system complex enough to contain Peano arithmetic.

[32] Mathematicians today generally agree that the Zermelo-Fraenkel axioms for set theory are contradiction free, but any proofs of this fact require even stronger axioms (which, in turn, would require still stronger axioms if their own consistency were to be proven). The ZF axiom system was constructed by the elimination of known contradictions through some subtraction; it simply removes those methods that are known to lead to contradiction, rather than guaranteeing the permanent absence of contradiction from the ground up. That process is somewhat piecemeal, less elegant than the various programs conceived by Whitehead and Russell, Brouwer, and Hilbert, who each (in very different ways) hoped to construct, axiomatize, or re-conceive mathematics so as to be pan-systemically contradiction free. In contemporary mathematics, foundational axioms have increasingly come to be seen as a matter of mathematicians' choice, rather than a reflection of universal inevitability.

[33] In one essay, Mark Colyvan makes the unusual claim that consistency is not, in fact, so crucial to mathematics as generally believed. But in his own title, "Who's Afraid of Inconsistent Mathematics?" Colyvan substitutes inconsistent mathematics for Virginia Woolf (from Edward Albee's famous title), implicitly identifying Woolf with inconsistency and indicating that inconsistency requires a leap to literature.

indicated. In this way, consistency acted much like grammar in language—the common rules that ensure the possibility for understanding and significance. Consistency was necessary to make formalism tenable and to retain the possibility of relevance.

Although accusations of reductive formalism certainly get made in literary studies, the overwhelming perspective there would never equate formalism with meaninglessness. Yet, in some very literal sense, the concept of formalism necessarily flirts with that possibility. Modernist authors were overwhelmingly aware of that radical eventuality. Woolf continually returned to such exclusive and reductive form, repeatedly representing it as mathematical—those "pages all speckled with dots and dashes and twisted bars" (*Night and Day* 314). Yet, of course, novels might also appear as pages of dots, dashes, and twisted bars, and this problem extends far beyond Katharine's idiosyncratic interests, reaching forward across Woolf's entire corpus and consistently indicating a troubling possibility of copious, complicated written pages that say nothing. Jacob often feels empty; if he exists as many different people, he could just as easily be no one at all. As Lily insists on contradictory things, some might accuse her of saying nothing. Polysemy and contradiction both threaten to devolve into meaninglessness, which loomed troublingly in modern literature as well as modern mathematics. As Daniel Albright writes, "the tendency toward amplitude and inclusiveness of meaning would lead to a collapse into generality and abstraction… the very procedures intended to multiply the vertigo, the awe, the polysemous tensility of *symbols*, would lead to their impoverishing. The idea of the *symbol* might usurp the *symbol* itself" (124). It is crucial that, as Lily embraces contradiction, she also worries about the possibility of meaninglessness: "to those words, what meaning attached, after all?" (24). From a mathematical perspective, meaninglessness necessarily follows from contradiction, because in a contradictory system anything at all can be proven, so that no conclusions from contradictions can carry any weight or consequence. As Hilbert writes, with Wilhelm Ackermann,

> It might seem as though we were giving a preferred position to one particular logical principle—the principle of contradiction. The fact is, however, that the occurrence of a formal contradiction, *i.e.* the provability of two formulas U and $\neg U$ [U and its negation], would condemn the entire calculus as meaningless; for we have observed above that if two sentences of form U and $\neg U$ were provable, the same would be true of any other sentences whatsoever. Thus consistency of the calculus in the sense of the definition has the same meaning as the stipulation that not every arbitrary formula be provable. (38)

In mathematics, contradiction implies meaninglessness, and Lily is directly following mathematical fact when paradox prompts her to wonder if any meaning attaches to the words involved. However, Woolf seems to dangle that prospect of meaningless contradiction before our eyes rather than actually endorse it. In *To the Lighthouse* contradiction is meaningful rather than meaningless, yet characters seem to know that somehow, logically, it seems as though it should be meaningless.

The natural urge to resolve contradiction is immense even where its effects are productive; it might simply be aborted, it might be permuted into balance, or one side of the scales may be chosen over the other. At the closings of Woolf's works we see this repeatedly. Jacob's life comes to an end, his conflicts and the book's abruptly halted. Lily connects and balances the oppositions of her universe, dashing "a line there, in the centre" (209). *The Waves* never denies continuing conflict, but does finally slant it in Bernard's univocal narrative voice, irrevocably privileging one among six competing perspectives. Opposition and contradiction can be represented as formal difference rather than real world conflict. This, too, is an ever-present process in Woolf's writing. The formal structure of *To the Lighthouse* has often been represented in this light, as two distant and conflicting universes formally balanced by "Time Passes." Lily's painting takes the same structure as she struggles to "achieve that razor edge of balance between two opposite forces" (193). Less commonly noted is the same pattern of formal balance popping up repeatedly, elsewhere. The interludes of *The Waves* balance and formally connect differing experiences and subjectivities even more literally than "Time Passes" does, doing so over and over again as though to reinforce the ubiquity and continuing possibility of such patterns. *Jacob's Room* explicitly portrays discourse and disagreement as formal balance: "Nothing settled or stayed unbroken. Like oars rowing now this side, now that, were the sentences that came now here, now there, from either side" (57). Here, we never learn what the sentences say or mean. *Jacob's Room* presents only the pattern of their presence—an extreme formal representation that elucidates only the balance of multiple, opposing possibilities. When Woolf resolves conflict as formal pattern, she unites polysemy and contradiction under methodological formalism.

Formalism as a methodology can paradoxically ward off formalism as an ontology; that is, the choice to behave *as if* there is no meaning can initiate the careful investigation of signs that ultimately leads us toward a deeper understanding of their many meanings. This may be common knowledge in literary studies after New Criticism and Marxist formalism, but when Hilbert proposed the approach in mathematics in the 1920s it was radical and new. In fact, the first English use of formalism, as a term for an established school of thought, seems to have been in mathematics, not in art or literature.[34] Hilbert's methodological formalism is strikingly similar to formalism as it is practiced in literary criticism, and crucially divergent from formalism as it is often conceived elsewhere in analytic philosophy and the philosophy of mathematics, where the term can come to stand for the radical refusal that meaning exists at all.[35] In turn, the mathematical conception of methodological formalism can fill in gaps that troublingly remain in the literary understanding of formalism, because formalism is commonly and successfully practiced in literary studies, but it is not nearly so well theorized.

The example of mathematics can indicate how it is possible that attention to literary form ultimately sparks understanding of the same worldly meanings that formalism explicitly dismisses. There *is* an apparent contradiction here, even though the process is so common that it is easy to ignore in literary practice. In mathematics, how and whether meanings (i.e. mathematical objects) exist has been debated for thousands of years, but meanwhile the real-world usefulness of

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[34] In more general usages, "formalist" was used as far back as the seventeenth century to indicate a stickler for superficial rules. Raymond Williams identifies a few intermediate usages suggesting how the term migrated from that meaning toward designating a theory of literature. The earliest uses of the term to indicate a school of literary theory seem to belong to the Russian formalists, beginning around 1916. On the other hand, mathematicians recognized a formalist school of thought before that, particularly in German (*formal*, *der Formalismus*). Eduard Heine and Johannes Thomae outlined formalist philosophies of mathematics in the second half of the nineteenth century, and Frege influentially contested their formalism in 1903. In English, as early as 1900, Russell used formalist to describe a philosophy too entangled with rule-bound symbols to be useful; he compared that philosophy to the more effective formal methods of mathematics. In 1913, an English translation of a paper by L.E.J. Brouwer described formalism as a school of thought wherein mathematics could be realized only in language. See the *O.E.D*, "formalist" and "formalism"; Williams, 138; An excerpt from Frege's *Grundgesetze*, "Frege Against the Formalists"; Russell, *A Critical Exposition of the Philosophy of Leibniz*, 170; and Brouwer, "Intuitionism and Formalism," as translated by Arnold Dresden.

[35] Defenses of this more extreme formalism might be found in the work of Johannes Thomae, Ludwig Wittgenstein, and Rudolf Carnap, and in the early writing of W. V. Quine and Nelson Goodman. However, there is reason to doubt that these diverse thinkers were so radically or reductively formalist as has sometimes been claimed. See Alan Weir, "Formalism in the Philosophy of Mathematics."

mathematics has repeatedly, predictably, even tiresomely proven itself. While mathematicians and philosophers wrung their hands about how non-Euclidean geometry could possibly exist, how any ontology could meaningfully attach to it, Albert Einstein swept in from another direction entirely and proved that non-Euclidean geometry actually describes the real physical universe with greater accuracy than traditional geometry. Einstein showed that, even as its existence had been doubted, non-Euclidean geometry had always been in some sense scientifically truer than the ontologically accepted geometry of Euclid. In this way, proven relevance can irrevocably overtake formal removal. The pattern repeats itself again and again in the history of mathematics: innovations accused of being utterly divorced from the real world eventually become indispensable to scientific descriptions of that world. And, returning to literature, the fact that readers read, think about, and respond to books, however formally, always makes it impossible that those books exist in total formal removal—their circulation already prevents their nonexistence as anything other than form. In one hyper-realistic sense, if formalism makes readers read, then formalism already isn't formalism.

But the link doesn't stop there. Literary and mathematical formalism are not only analogous, with similar roles and uses vis-à-vis the real world, but also homologous—they share common histories and structures of operation. Meanings and applications can be elucidated not despite formalism but because of it, because in any field, the deferral of worldly application allows for a focused logical rigor that can be difficult to achieve otherwise. This process is underscored by the fact that, although Einstein responded to some physical data, his process of proof was formal—that is, mathematical—rather than empirical. Until experiments confirmed Einstein's mathematical explanation, many accused him, too, of extreme formalism. But as long as the analytic and logical axioms and relations applied during formal analysis are valid, the result of formalist consideration should be no more nor less relevant to worldly application than the original data. Work such as Einstein's, Hilbert's, or Woolf's was never formalist in the sense of attempting to deny the existence or importance of meaning and application; rather, it was methodologically formalist in that it isolated the complex instantiations of meaning as form, so as to more concentratedly unravel the relationships amongst its factors, ultimately making meaning and application *more* accessible. Mathematics provides an undeniable model that formalist reasoning can directly lead to useful and meaningful knowledge of the world, and although the apparent paradoxes of formalism may seem to imply meaninglessness, the reality of the situation proves that contradictions can be deeply meaningful in literature.

In *The Singing of the Real World* Mark Hussey underlines Woolf's insistence on ideological multiplicity; up against Moore's epigraph to *Principia Ethica* ("Everything is what it is, and not another thing") Hussey designates "an epigraph to… Woolf's 'philosophy'" (99): "So that was the Lighthouse, was it? No, the other was also the Lighthouse. For nothing was simply one thing. The other Lighthouse was true too" (*Lighthouse* 186). Thus multiple, contradictory truths coexist. Yet here multiplicity and contradiction emerge hand-in-hand with a fundamentally unifying polysemy. Hussey seems to miss the unifying move that Woolf accomplishes in the same signifying moment. By repeatedly capitalizing "Lighthouse," Woolf drives home the fact that both of these true yet mutually exclusive realities are indicated by one common sign. And while Hussey argues that Woolf opposes "the intervention of unifying systems (99), polysemy is itself a unifying system. "Lighthouse" indicates differing truths under only one symbol. Polysemy and contradiction together allow Woolf to portray simultaneously the unity and multiplicity of reality. By repeatedly elevating contradiction in her writing, Woolf creates a pattern—which, in turn, is its own kind of consistency.

"Words… Fall and Rise, and Fall and Rise Again": Form as Self-referential Pattern

> [I]n the rough and tumble of daily life, with all those children about, all those visitors, one had constantly a sense of repetition—of one thing falling where another had fallen, and so setting up an echo which chimed in the air and made it full of vibrations.
>
> *To the Lighthouse*

When *Jacob's Room* relays discourse as a pattern ("Like oars rowing now this side, now that, were the sentences that came now here, now there, from either side" [57]) Woolf skips over not only the meaning of what gets said but the signs and sounds exchanged as well; all that remains is the structure of how discourse emerges in a rhythm of comment and response. This formalism takes us up another level, for here Woolf dispenses with literal form (words) in favor of a kind of meta-form (the fact that words exist, and a consequent examination of how their existences interrelate). The conjunction of this meta-representation with Woolf's description of rhythmically bobbing water can do much to expose and explain Woolf's characteristic fluidity: words, phrases, and sentences become waves insofar as they are distinguishable yet interconnected, repetitive yet variable, following each upon the last in a predictable yet subjective pattern.[36] That vision of language, exemplified in this moment of *Jacob's Room* but apparent throughout Woolf's oeuvre, constitutes a reexamination of pattern over object, syntax over semantics, form over content. But this is not the formalism of New Criticism or even of the Russian Formalists, because here form is not merely the important factor of consideration; instead it becomes literally and radically all that exists, all that is reported. Inscrutable yet predictable, these patterns register form not as more important than content, but as the only available meaning: as the displacement of content.

When *To the Lighthouse* reports "constantly a sense of repetition—of one thing falling where another had fallen, and so setting up an echo which chimed in the air and made it full of vibrations" (199), it never specifies what is repeating. Implied possibilities include "all those children… all those visitors" (199), so that the characters themselves are repetitions, reiterations, and reverberations of each other. Here Lily is also thinking of repetitions and patterns in human experience and memory. But, as she thinks so, she stands outdoors by the sea, and falling waves constitute the most absolute and continuing repetitions enabling Lily's sense of a pattern. In fact, Woolf explicitly refers to many kinds of waves here: "one thing falling where another had fallen, and so setting up an echo which chimed in the air and made it full of vibrations" (199). Along with the metaphorical waves of life and memory and the physically present waves of the ocean, Woolf also meticulously describes sound waves vibrating through the air. All of these patterns come in waves, and all of these waves are constituted by patterns.

In Woolf's work, it is where symbolic generality most utterly takes over that patterns also dominate—in *The Waves*. Water has been variously theorized in Woolf's work as diversely as a realm for the other, for nature, for womanhood, for the past, and for revolution, among innumerable other possibilities. All of these arguments can be convincing, and I do not seek to refute any of them particularly. I do seek to postulate a simpler and more generally applicable model for waves in Woolf's work: waves, whether ocean waves, sound waves, or mathematical waves, are that which is most reliably repetitive and continual in time. Anything that recurs over and over and over again is a wave. In mathematics, even the most complex forms of linear repetition can be modeled with simple

[36] Here see also Lorraine Sim, *Virginia Woolf: The Patterns of Ordinary Experience*, and Mark Hussey, *The Singing of the Real World*.

waves, because (as Joseph Fourier proved) any periodically repeating function can be broken down into sums of sine curves. Whereas Woolf tells us repeatedly that we cannot sum people up, we can, with all the certainty of mathematics, sum waves up.

From this perspective, waves make obvious sense as the title that eventually overtook *The Life of Anybody*: how else could Woolf possibly write "the life of anybody" otherwise than as a network of repetition and an examination of patterns? To describe *anyone*, she must have believed that *everyone* shared something in common – that something, somewhere, repeated reliably in all human lives. Hence the soliloquies that break, over and over, like waves, and the characters and the lives that themselves mimic waves, crashing over and over again, "speaking" (not thinking or writing) monologues in verbal sound that itself only exists as complex repeating vibrations composed of simple waves. Waves are a meaningful metaphor for the generalized description of human life because, as complicated as waves can be, we can still describe and understand them as combinations of singular, accessible events that repeat indefinitely—the "echo which chimed in the air and made it full of vibrations." In *The Waves* we can predict speakers' consonances and intersections. We can see the interludes coming. We know that the sun will set again and that the waves will continue to fall. Mathematically speaking, that's what makes them waves. And that's what most interests *The Waves* in waves.

By taking up the continual motion of waves Woolf does not only make a statement about commonalities in human life. She also describes the structural core of language itself. Language describes an unlimited wealth of different events and experiences with only a finite number of words, meaning that repetition is necessary to its function—the same words must be able to convey different things in different contexts. As Neville describes, "Now begins to rise in me the familiar rhythm; words that have lain dormant now lift, now toss their crests, and fall and rise, and fall and rise again" (82). Neville's experience of writing involves a "familiar rhythm" in large part because he has, of course, used all these words before. If they come now in a different recombination, each individual use remains a kind of repetition as "words that have lain dormant now lift… again." The words themselves are waves, but Neville does not relate them to waves for archetypal or associative reasons but for their most definite and defining quality; they "fall and rise, and fall and rise again." Neville enacts this repetition not only by describing it, but also by mimicking it, repeating the exact words that themselves describe repetition. As he conceives words as waves, his words continue to repeat themselves in a newly literal wave: "Words and words and words" (83). Repetition is always crucial to language, but it is particularly central to the formal ingenuity of *The Waves*, wherein diversity is legible within commonality, and commonality emerges from repetition.

Repetitions operate from different perspectives and on innumerable different levels in *The Waves*. Consider Louis's more urban perception of a pattern very much like Neville's: "People go on passing… They pass the window of this eating-shop incessantly. Motor-cars, vans, motor-omnibuses; and again motor-omnibuses, vans, motor-cars—they pass the window" (92). And then again: "They go on passing, they go on passing… I repeat" (93). These reiterations are only a couple among many that populate the entirety of *The Waves*, and they operate on higher structural levels well beyond individual words. Consider the opening sentences of each and every single one of the interludes:

> The sun had not yet risen. (7)
>
> The sun rose higher. (29)

> The sun rose. (73)
>
> The sun, risen, no longer couched on a green mattress darting a fitful glance through watery jewels, bared its face and looked straight over the waves. (108)
>
> The sun had risen to its full height. (148)
>
> The sun no longer stood in the middle of the sky. (165)
>
> The sun had now sunk lower in the sky. (182)
>
> The sun was sinking. (207)
>
> Now the sun had sunk. (236)

This descriptive pattern is relentless in its reliability, exhausting in its absoluteness. And, containing this predictability, consider the predictability of the interludes themselves, with their regularly repeating italicized descriptions that follow the sun over the steadily beating waves. The sun's course is, of course, a natural event that will itself repeat again and again, just as the waves crash and the lives of differing voices rise and fall. These repetitions may occur on different time scales, but Woolf seems to tell us that those time scales do not matter. The pattern matters. Repetition is what both allows for and itself constitutes the underlying structure of *The Waves*, because pattern is what allows pure form to take on meaning, to prevent it from becoming a mere collection of indistinguishable and unrelatable factors.

In *The Waves* a substantial and continuing degree of self-reference allows for a semantic generalization of repetition, which in turn makes possible the book's meaningful structure. Strictly speaking, self-referential patterns and relations are all that remain when formalism is taken to its logical conclusion, because absolute formalism would exclude absolutely everything not contained in the written text itself, even sonic features and the most literal kinds of meaning (the assumption that "table" could refer to a physical object, let alone its consequent historical or social connotations). In literary studies, formalism has often focused on the play of sound, but sound requires certain external cultural knowledge that cannot, strictly speaking, be found in the written text itself. In extreme cases such as *Finnegans Wake* the subtle variations in pronunciation (between, say, an Irish and an American accent) can generate profound consequences for the meaning. On the other hand, mathematical formalism focuses far more rigorously on the most restricted form: Hilbert goes so far as to specify that differences in handwriting should not change the mathematics, that if I write down an equation on a chalkboard and you copy it onto a sheet of paper, it remains, for his purposes, the same set of written signs, the same form.[37] The enormously greater level of abstraction in mathematics allows for the matter of form to be dramatically purified, down to its very source.

Mathematics is important for the theory of literary formalism because it is actually the purest possible system wherein the internal relations of terms can be utterly formalistically bounded and still maintain cohesion and sensibility. In any formal system, if meaning or application is truly deferred, only interrelations remain for the understanding, so that forms and structures only emerge

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[37] "the signs themselves, whose shape [*Gestalt*] can be generally and certainly recognized by us—independently of space and time, of the special conditions of the production of the sign, and of insignificant differences in the finished product" (Hilbert, "New Grounding" 202).

if the text maintains some substantial relationship with itself. Under such a stringent formalism, only the presence or absence of repetitions could be analyzed. In this sense, formalism, followed to its logical extreme, is a fundamentally mathematical concept, because where denotation and connotation are both utterly, absolutely excluded, all that remains is the study of patterns—that which *The Waves* focuses on most.

Strictly speaking, syntactical patterns of relations are absolutely all that remain when formalism is strictly considered. These patterns, in turn, can ultimately become meaningful in and of themselves. As far back as 1834, the early mathematical formalist George Peacock argued that in arithmetic "the definitions of the operations determine the rules," whereas in algebra "the rules determine the meanings of the operations, or more properly speaking, they furnish the means of interpreting them" (qtd. in Detlefsen 276). That is, whereas in applied mathematics and science semantics determines syntax, in pure formal mathematics syntax determines semantics. The rules of relation among signs are crucial in any formalism, whether mathematical, literary, or otherwise; this emphasis on syntax follows from the exclusion of semantics, but it also enables that exclusion of semantics, all while ultimately generating a new kind of semantics. As Hilbert's student Haskell Curry wrote in 1939:

> According to formalism the central concept in mathematics is that of a formal system. Such a system is defined by a set of conventions, which I shall call its *primitive frame*.… It should be noted that in such a formal system it is immaterial what we take for the tokens (and operators), —we may take these as discrete objects, symbols, abstract concepts, variables, or what not. Any such way of understanding a formal system we may call a representation of it. The primitive frame specifies, independently of the representation, which elementary propositions are true, and therefore determines the meaning of the fundamental predicates. In this sense the primitive frame defines the system. ("Remarks" 153)

Curry is explicit about the fact that the fundamental innovation of formalism is not to focus on the signs themselves, but on the grammars in which they participate. Meaning emerges not from these signs but from the frame or structure of relations that allows those signs to operate. This relational formalism is fundamental to *The Waves*, at once stitching its terms together and embodying those terms themselves, because the terms are meaningless without the patterns in which they participate. In *The Waves* general form is at the root of any meaning, and it inaugurates that meaning in a mathematically rather than poetically formal manner, by emphasizing interrelations of nonspecific terms rather than exemplary elevations of specific terms. In fact, I argue that *The Waves* is itself a formal system such as Curry describes, defined by a primitive frame that makes meaning possible even as its operation is exclusively formal.

When Bernard tells us that "Now I am getting his beat into my brain (the rhythm is the main thing in writing). Now, without pausing I will begin, on the very lilt of the stroke" (79), he not only describes words as waves, waves as rhythm, and rhythm as the heart of good writing, but he also emphatically describes writing without any reference to content. Later, he elaborates:

> That goes on. Listen. There is a sound like the knocking of railway trucks in a siding. That is the happy concatenation of one event following another in our lives. Knock, knock, knock. Must, must, must. Must go, must sleep, must wake, must get up—sober, merciful word which we pretend to revile, which we press tight to our hearts,

> without which we should be undone. How we worship that sound like the knocking together of trucks in a siding! (234)

Rhythm is central to *The Waves*, and sound is crucial here not only because it evokes the sound of rhythmically crashing waves and because we associate it with rhythm in music, but also, even more vitally, because sound is actually only made possible by rhythms, *i.e.* the regularly patterned vibrations of air particles sensed by our ears. And here Woolf emphasizes the necessity of these repetitions, which not only do but "must" continue. That "must" evokes the irrevocable undeniability of mathematical law, and, unlike compulsion or obligation in much of Woolf's work, necessity here is not an unpleasant requirement. It is "the *happy* concatenation of one event following another"; it indicates reassuring continuity and the certainty that something will always come next. In a sense, concatenation, the repetition of one event following another, is the surest way in which we can ever recognize the Life of Anybody to go on. Because what is life but a continual progression of witnessed events? And although those events will certainly not all be the same, there is a necessary pattern in the simple sense that we do witness and participate in one event after another, continually, always, until we die. Concatenation and repetition are the formal acknowledgement that someone is alive, that something is still happening, that the waves beat on the shore.

The repetitions and patterns running throughout *The Waves* are sometimes so predictable as to become tiresome. In every single monologue "said" intervenes reliably, without synonyms and without variation. The interludes always begin with the position of the sun. We know to expect the alternation of standard font with italic interludes. The constant use of the simple present tense creates a sense of things happening again and again, in rhythm, a kind of relentless pattern of event following event, always in the same syntax, repeating in an exhaustively present moment that constantly changes yet refuses to ever leave us. These prominent constancies and repetitions require explanation and analysis that they generally have not received. I argue that they demonstrate and elucidate how meaning can emerge from pure, unadulterated form.

The most interesting and analyzable patterns of *The Waves* are those that persistently repeat, but complicatedly so—like waves in water themselves, the overall pattern remains unmistakable and reliable, and yet every single wave remains unique, different from those that came before and those that will follow. Consider the ways in which speakers echo themselves while still evolving, growing, and changing. Consider how Rhoda's ongoing fears still alter, develop, recede and recur as she ages, or how Louis's continuing insecurities take on new forms as he accumulates successes. Think how dramatically Bernard's vision of himself changes in response to the divide between his ambitions and his achievements, and the oddly reliable way in which his behavior and speech patterns still never change in response to those disappointments. In *The Waves* the patterns of personhood are more striking and meaningful than the verse-like patterns of language, although the former patterns mimic the latter on many levels. Woolf's great achievement in *The Waves* was to apply the repetitions of verse not to the rhythms of prose, but to the rhythms of human experience.

The most interesting kinds of rhythms cannot be quoted, because they occur on levels far larger than individual passages. But, nonetheless, as Woolf wrote in "Modern Fiction," "let us trace the pattern, however disconnected and incoherent in appearance" (107). In 1926, Woolf wrote to Vita Sackville-West:

> Style is a very simple matter: it is all rhythm. Once you get that, you can't use the wrong words. But on the other hand here I am sitting after half the morning,

> crammed with ideas and visions, and so on, and can't dislodge them, for lack of the right rhythm. Now this is very profound, what rhythm is, and goes far deeper than words. A sight, an emotion, creates this wave in the mind, long before it makes words to fit it and in writing (such is my present belief) one has to recapture this, and set this working (which has nothing apparently to do with words) and then, as it breaks and tumbles in the mind, it makes words to fit it. But no doubt I shall think differently next year. (*Letters* 247)

Here Woolf is not, I think, referring to the rhythms of music or of poetry, which are beautiful and structuring but never absolute and unending. She refers, instead, to the rhythms of water, of vibrating sound, of mathematics. This rhythm is "far deeper than words" and, like Curry, Woolf is explicit about the fact that the pattern here is the important point, not the individual terms of which the pattern is composed. The rhythm exists prior to the terms themselves, "long before it makes words to fit it," and "once you get that, you can't use the wrong words". Compare this theorization of the act of writing to G. H. Hardy's famous poetics of mathematics: "A mathematician, like a painter or a poet, is a maker of patterns. If his patterns are more permanent than theirs, it is because they are made with *ideas*. A painter makes patterns with shapes and colours, a poet with words" (*Apology* 84). Formalists such as Hilbert or Curry would disagree with Hardy that mathematics is necessarily made with "ideas," but they would concur that the pattern is the heart of what is being made, regardless of the medium. These patterns are not only absolute, they are the meat of what the work presents for examination. And regardless of what content may or may not compose them, these patterns are form, they are formal, and they are formalist.

Banfield's major argument is that Woolf's impressionist fluidity is held together, at the core, by a kind of solid, objective skeleton. My argument, instead, is that Woolf's fluidity *is* the object to be relied upon – neither solid nor skeletal, but offering a degree of representational certainty of a kind not normally seen in art or literature, but certainly to be found in mathematics. Waves repeat reliably over time; that's what makes them waves. In turn, Woolf's emphasis on relational knowledge and relative experience emphasizes interconnected patterns over singular certainties. In the process, Woolf uses formal abstraction to reach at once greater subtlety and greater generality in the application of her writing to the world it describes.

The Life of Anybody: Formal Generality and Meta-representation

> When I came in just now everything stood still in a pattern.
>
> *The Waves*

Looking back, the rigidly enduring yet fluidly creative structure saturating *The Waves* was already present in the beating waves of *To the Lighthouse*, in the stroking oars of discourse in *Jacob's Room*, and in the permanent yet unknown "forest paths and starry blossoms, and… pages of neatly written mathematical signs" in *Night and Day* (224). This is a formal theory of artistic structure that can be traced across Woolf's career.

Mathematical conceptions of form and formalism articulate the motivating potential behind this prominent emphasis on pattern in Woolf's work. In mathematics, when a treatment becomes exclusively formal—that is, based on polysemous variables rather than limited particulars—it becomes completely general, thus acquiring immense descriptive applicability as it emphasizes relations and processes, which could still be just as well applied to particulars at any time. It thus achieves far greater (sometimes infinitely greater) descriptive power without ever devolving into vagueness. Woolf's use of polysemy directly leads to her examination of pattern, because formalism, taken to its logical conclusion, requires an analysis of the relations among general terms within a closed system. As long as the patterns are rigorously developed, the terms can be utterly general without their conglomeration becoming vague. As Bertrand Russell writes, "the absence of all mention of particular things or properties in logic or pure mathematics is a necessary result of the fact that this study is, as we say, 'purely formal' (*Mathematical Philosophy* 198). He goes on to explain what he means by form: "The 'form' of a proposition is that, in it, that remains unchanged when every constituent of the proposition is replaced by another. Thus 'Socrates is earlier than Aristotle' has the same form as 'Napoleon is greater than Wellington,' though every constituent of the two propositions is different" (199). In this way, form is, by definition, never specific. Instead, it exists in the relationships between terms irrespective of the terms themselves. Analysis of form thus becomes the analysis of pattern or structure.

My model of mathematical formalism in literature is different from formalism as it is generally conceived in literature in part for its elaboration of consistent patterns. The New Critics generally devoted attention to paradox, contradiction, and inconsistency. My focus is thus in some sense the opposite of theirs, while in another sense it is simply a more general articulation of the basis for their interest. Although contradiction and paradox are frequently the most interesting loci of a text to read formally, (and, as I argued earlier, are crucial to an accurate understanding of Woolf's vision) this analysis of contradiction can only become recognizable within some formal system of consistency, whether presumed or actual. As Hilbert points out,

> If logical inference is to be reliable, it must be possible to survey these objects completely in all their parts, and the fact that they occur, that they differ from one another, and that they follow each other, or are concatenated, is immediately given intuitively, together with the objects, as something that neither can be reduced to anything else nor requires reduction. This is the basic philosophical position that I regard as requisite for mathematics and, in general, for all scientific thinking, understanding, and communication. ("Foundations" 464-5)

Here consistency and sameness precede difference in the sense that, before difference can be conceivable, some term must first possess enough definition for its repetition to be recognizable. Otherwise, all difference would reduce to a mere mishmash of indistinguishable items. Hilbert requires that we examine the signs not to consider their individual identities, but so as to be aware of their differences from each other and, consequently, to become able to analyze the patterns of their concatenation.

In Woolf's work, consequent mathematical conceptions of meaning and form become both a cautionary tale and an example to be emulated. Woolf outlined two different models of mathematics across her long career: one demonized, the other a doppelganger for her own literature. The first view of mathematics exists rigidly in the numerals that imprison Rhoda, wherein "meaning has gone" for good, leaving her to "die in the desert" (*Waves* 21); but the second kind of mathematics emerges liberatedly in the "love that never attempted to clutch its object; but, like the love which mathematicians bear their symbols, or poets their phrases, was meant to be spread over the world" (*Lighthouse* 47). The first mathematics claims exclusive control over objectivity, too often enabling false masculine declarations of absolute knowledge and consequent hegemony; the second mathematics elaborates the flexibly meaningful pattern-making that originates feminine creations (whether Katharine's mathematics or Lily's painting), which deny the validity of the first. The first mathematics collapses into a flat, reductive, and meaningless formalism; the second blossoms into a living, polysemous, methodological formalism.

The common notion of mathematics as black and white, right or wrong, is, to some extent, a misunderstanding founded on secondary school pedagogy, and is limited and problematic as a vision of modern mathematical practice. Indisputably, once a matter is proven in mathematics it remains true with a kind of certainty that could hardly be rivaled anywhere else in human thought, and that sort of irrevocable truth is very different from the relative truths we see everywhere in humanistic investigation. As G. H. Hardy articulated this in 1929, "no philosophy can possibly be sympathetic to a mathematician which does not admit, in one manner or another, the immutable and unconditional validity of mathematical truth. Mathematical theorems are true or false; their truth or falsity is absolute and independent of our knowledge of them" ("Mathematical Proof" 4). However, this absolute truth, however total once proven, is nowhere to be found in cutting-edge mathematical research, where the facts have yet to be known, and where mathematicians argue among themselves about truth, relying on conflicting intuitions very much like humanists argue about matters which they, too, cannot prove absolutely. Hardy himself went on to write, "I am interested in mathematics only as a creative art" (*Apology* 115). The reality so often overlooked by those who have only studied mathematics that is already known and proven is that working mathematicians are constantly forced to face the unknown—and we can only experience the unknown creatively and intuitively, as shades of gray, or perhaps as the mere possibility of some future black and white reality. There is no certainty, no objectivity, and no binary determinability to that which is unknown, and the final truth or falsehood of a mathematical proposition does nothing to eliminate the experiential shades of gray lived by the mathematical community prior to its proof.

Thus there are two mathematics: one already determined and the other creatively unknown, the first demonized in Woolf's work and the second emulated and admired. These two divergent conceptions interact tellingly with Woolf's representations of form and meaning, because while Woolf associates creative, multi-representational mathematics with a rich, polysemous, methodological formalism, she connects the predetermined mathematics with both flat, emptied-out form *and* autocratic singular meaning. That is, the demonized mathematics points toward any facile formulation of the relationship between form and meaning, whether that formulation presumes to be able to permanently dodge all meaning or whether it presumes to jump instantaneously to the one true meaning. Either mistake amounts to the same kind of arrogance.

A divide exists in literary theory between form as superficial and form as structural, and that dichotomous and seemingly paradoxical simultaneity is longstanding.[38] According to the *Oxford English Dictionary*, historical uses of the term "form" indicate at once "the visible aspect" and "the essential determinant principle of a thing"; that is, form is at once an outward appearance and an essential determining structure. The literary history of formalism similarly ranges from the vital to the superficial, encompassing both an attention to the richness of pure language and a danger of reductive reading that evacuates words of reference or meaning. Rare is the account of formalism that resolves this paradox without collapsing into simple appreciation or bursting into purely theoretical abstraction. However, conceptions of formalism in the philosophy of mathematics can elucidate the contradictory formalisms of modernist literature, because a strikingly similar divide to

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[38] See Raymond Williams, *Keywords* 137-40 and Samuel Otter, "An Aesthetics in All Things." Also important here is Paul De Man, "Semiology and Rhetoric," 27-8.

be found there demonstrates that the relationship between these two notions of form is far more fundamental and wide-ranging than any singular idiosyncratic history of the term or its development in a particular discipline or region. In fact, the term "formalism" in mathematics predates its use in any literary or artistic context.

In mathematics many have portrayed formalism as superficial and even ridiculous in its reduction of mathematical meaning, but formalism's logical rigor has also been credited with historical developments that led to such undeniably society-changing developments as general relativity and the modern computer. This simultaneously superficial and vital role for formalism is not paradoxical, but a direct logical consequence of the structural interdependence of individual terms in both formal and natural languages. The dichotomies of form in literary studies logically follow from language's dependence on the combination of semantics and syntax.

Mathematics can be constructed entirely without reference to the actual world and still retain perfect accuracy in that world. It thus has a remarkable relationship with reality, because it is at once a maddeningly ethereal realm of thought and form, and also an undeniably descriptive tool that reliably predicts physical phenomena. The bond between mathematics and science is not only a metaphor for the relationship between language and reality, but an imitable model, demonstrating how Woolf's most abstract writing could describe the world without referencing the world, modeling real processes directly via form.

Under such an expanded conception of meaningful syntax and inter-relational form, questions about the role and nature of self-reference arise, because such a self-conscious conception of formal representation naturally develops into a kind of meta-representation. The same process naturally developed in the history of mathematics when Hilbert's formalism naturally led to an entirely new field of metamathematics. In fact, the most polished elaboration of formalism in mathematics was developed by Hilbert's student Haskell Curry. In his work, as Alan Weir describes:

> [M]athematics in general becomes metamathematics, a contentful theory—Curry's sentences express propositions with truth values—setting out the truths about what is provable from what in underlying formal systems whose interpretation, or rather interpretations, are not taken to be mathematically important. This standpoint, however, threatens to collapse into structuralism, into viewing mathematical utterances as schemata implicitly generalising over a range of (in general) abstract structures which satisfy the schemata.

The self-reference inherent to Woolf's written patterns of patterns is naturally meta-representational, and the resulting structures of abstracted experience do threaten to merge formalist experimentation with structuralist literary theory; this is an important theoretical overlap. In fact, the substantial commonality involved points back toward the mutually constitutive and fundamentally unbreakable relationship between syntax and semantics in any language. Mathematical form can explain the convergence of appearance and structure in literature, because it demonstrates that that convergence is inherently present in formal languages as well as natural languages. The distinction of level involved here only comes down to a marked difference in the degree of abstraction involved.

Mathematics was the natural endpoint of *The Life of Anybody*, and in the same sense that "anyone," as a pronoun and like Jacob, functions like a mathematical variable, so too does the patterning of *The Waves* exist like mathematics—at least on the level of structure and form. Of course, *The Waves* is much more than only form or structure; it is also about human lives, about education, about gender and personal choice. None of these things can be explained by mathematics, while they can certainly be illuminated by Woolf's writing. My point is not at all that the mathematical superstructure of *The Waves* in any way overpowers or eclipses these matters; it is rather that, by abstracting away from more particularized content, by generalizing upon human life or, indeed, upon anything else, *The Waves* necessarily flirts with mathematical reasoning. Generalization, abstraction, and structure are always, in the extreme, mathematical—and *The Waves* does certainly attempt a new degree of formal extremity in all of those realms.

In *The Waves* aesthetic patterns are unbendably regular while significance is slippery and always difficult to locate. Whereas *Jacob's Room* circles its protagonist as an unknown, *The Waves* takes a step further, not so much symbolizing the unknown as generalizing on the unknowable. It was, after all, conceived as *The Life of Anybody*. In important ways, *The Waves* does not describe the life of anyone: its six speakers are uniformly white, British, and the poorest and most troubled among them still possess considerable privilege. But this homogeneity cannot explain away the deeply original and surprisingly mathematical senses in which *The Waves* does generalize. Despite its multiplication of minds and varieties of approaches, the "anybody" in *The Waves* does not exist in the variety encompassed by Bernard, Susan, Rhoda, Neville, Jinny, and Louis, but in the expansiveness indicated by the attempt to write unspecified minds. The "anybody" is nowhere signified by the variety of the individual, but everywhere marked by the representability of the individual. The possibility of demonstrating and connecting these six minds most importantly demonstrates the possibility of capturing personhood generally. *The Waves* depicts anyone (and everyone) not by locating that which human beings have in common so much as by articulating the possibilities of diversity which human beings realize. It has frequently been noted that the persons of *The Waves* are not so much characters as speakers. They are possibilities of communication. They are loci of experience and of understanding. They are markers for generalizing possibilities. They are variables that allow us to speak about the unknown, and the undetermined, with potentially infinite range.

Formal pattern is crucial to Woolf's work because it is her theory of how art makes reality whole; it renders the relations among experiences scrutable, thus allowing for a cohesive and representable vision of the world. For as she explains in "A Sketch of the Past," "what I might call a philosophy; at any rate it is a constant idea of mine; that behind the cotton wool is hidden a pattern; that we—I mean all human beings—are connected with this; that the whole world is a work of art; that we are parts of the work of art" (72). In a sense, waves are exactly that: parts that only gain their individual identities via concatenation and interconnection with each other. It is only in their repetition, their cohesion, that they hold meaning or reality.

A consequence of this rendering of the waves that crest again and again in Woolf's work is to see a steady and reliable strand of meta-representational formalist theory that itself reliably repeats itself in her writing. As Woolf constructed experimental novels using the semantic processes of variables, she constructed a higher-level patterning that gestures toward the great commonalities of personhood and of modernity; any direct description of such broad trends would be subject to innumerable exceptions, but as simple structures of repetition these modernist commonalities function indisputably.

Although in "Sketch of the Past" Woolf says the pattern is *behind* the cotton wool, in *The Waves* and elsewhere in Woolf's work the pattern is imbricated with the wool; to declare either in front and the other behind is only to switch perspectives, because there is no privileged position that can locate which is front and which back. The only structure to waves is form, and the only form to waves is structure. Foreground, background, inside, outside, appearance and structure all become radically one and the same. That merging already happens naturally when readers read without differentiating between syntax and semantics—although, in some sense, their processes are fundamentally at odds. *The Waves* explodes that duality of language as it reinvents human life in the greatest possible generality, not so much writing the *Life of Anybody* as writing the possibility of writing the life of anybody.

Strictly speaking, patterns of relations are absolutely all that remain when formalism is rigorously adopted. The suspension of direct reference enables the generality of abstract meaning without ever introducing any vagueness into the system. *Jacob's Room*, in spite of all its fragmentation and confusion, is also symbolically over-determined, like an elegant brief pattern that is too perfect to describe one flawed and complicated human life. *The Waves* exhibits a similar quality of perfection at the price of any direct reality, because it represents meta-people instead of people. Realism is still there to be found, but now it's two levels down, existing alongside language and abstraction amid the greatest possible generality.

Chapter Two

The Metaphor as an Equation: The Formal Abstraction of Ezra Pound's Precisions

In "Vorticism," Pound tells us that "In a Station of the Metro" first came to him as an equation: "I found, suddenly, the expression. I do not mean that I found words, but there came an equation" (87). Elsewhere, he writes that "Poetry is a sort of inspired mathematics, which gives us equations," and that, in the effort to define Imagism, he seeks "to formulate more clearly my own thoughts as to the nature of some mystery or equation" (*Spirit of Romance* 5, "Affirmations, IV" 349) In fact, he credits equation as the very seed for Imagism: "By the 'image' I mean such an equation" ("Vorticism" 92). He is explicit that he uses the term in its mathematical sense—offering $(x - a)^2 + (y - b)^2 = r^2$ as an example of such an artistic equation (91)—but he also makes it clear that the ramifications are literary. "Great works of art contain this […] sort of equation. They cause form to come into being" (92). Pound's emphasis on equation in fact points toward the heart of his Imagist and Vorticist poetics because, for Pound, equation offered to characterize abstract form.

This chapter takes seriously—mathematically as well as literarily—what these equations entail, for modernism, for metaphor, and, especially, for form. My argument will move through modern mathematical definitions of equality (which reach well beyond simple equalities between numbers, able to link far more various and complicated ideas) in the effort to analyze Pound's use of similarity and sameness. After the turn of the twentieth century, equality can be understood—broadly—to assert simply that a sameness exists between two things, that they are alike in some aspect, although they may be different in others.

Pound was very far from alone in his turn to equation. Gottlob Frege's "On Sense and Reference," the 1892 essay about meaning and denotation that became foundational to the philosophy of language, opens not with language but, apparently, with mathematics: "Equality gives rise to challenging questions which are not altogether easy to answer. Is it a relation?" (151). Emphatically, here he does not refer to equality between numbers or values, but far more broadly to equality between any manner of things. Frege uses an understanding of equality that is not delimited to numbers, not even delimited to mathematics, but descriptive of far more ambiguous, open-ended processes. Yet, at the same time, Frege's use of equality here is more unforgiving than the modernist definition laid out above, insofar as Frege uses equality as a synonym for identity—that is, for the state in which two things are completely identical, with no distinctions among them. While Frege's examination of language begins from that examination of the state of total sameness, it exists as part of a mathematical movement that examined what happens when sameness exists alongside difference. Frege goes on to characterize how things which differ can still share commonalities. In fact, modern mathematical definitions of equality can offer us an understanding of what it means for two things to share something in common. As such, they offer an understanding of sameness's form—that is, of the patterns attendant to its application.

Metaphor poses one thing as another. That process, whereby one thing stands for or stands in for something else, works through substitution, likeness, and—under the modernist mathematical definition—equality. And modernist poetry repeatedly seized upon that feature of metaphor, so often isolating the substitutive process whereby representation posits one thing as another; indeed, new levels of abstraction in modernist poetry worked to foreground the problem of how one thing can stand for another at all. The urgency of that problem becomes more difficult to avoid with the deletion of context so characteristic of works such as *The Waste Land*, the *Cantos*, and Ezra Pound's shortest Imagist and Vorticist poems. Pound's early work particularly gives new prominence to the puzzle of how the linkage inherent to metaphoric representation operates, probing metaphor's ontology and its very possibility. Modernism self-reflexively examines and criticizes its own route toward meaning, and this chapter argues that Pound's use of metaphor asserts and interrogates the inextricability of representation and equality. This works against more familiar post-Structuralist conceptions, wherein signification is predicated on difference.

In his volume *Lustra*, Pound reframes relation with both great precision and great generality.[39] There and in his critical essays, he contemplates how relations can be characterized independently of that which they relate. Pound characterizes these syntactical connections between terms as mathematical linkages, but his poetry and poetics have never been examined in such terms.[40] For Pound, in his early work, poetic representation depends on creative samenesses: it depends on modernist mathematical equations. In the context of the modern mathematical understanding of equality, that theory of representation leads to an emphasis on reflexive and tautological statements, which refer to themselves or otherwise turn back upon themselves. Those tautologies, reflections, and repetitions in turn feed into Pound's precisions upon precisions, an apt process since precision is itself self-referential in its scientific definition. I close this chapter with the argument that Pound uses all these various repetitions, reflections, and equalities to develop an interdisciplinary understanding of form. For Pound, form can only become recognizable via some repetition and rearrangement of perceivably similar, as well as dissimilar, elements. Developing, thus, from the capacity to recognize sameness, form ultimately becomes an arrangement or pattern of things that is capable of abstraction from those things. Form, as something fundamentally abstract (like mathematics is abstract), has neither the palpability nor the insecurity of particulars: it is the component in art that is universal.

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[39] As explained in my previous chapter, my use of "generality" in this dissertation draws from the mathematical definition: it is an unambiguously positive quality, involving no vagueness or confusion. Here, generality is language's capacity to describe a multiplicity of different situations or possibilities in one fell swoop. It is the ability for relatively few words to convey many individual meanings at once. This multiplicity of descriptive reach can coexist with careful precision, because it is possible for readers to understand the breadth of reference without being muddled about any of the signifiers involved. Pound saw the value in this kind of generality, writing that "the really great artists have seldom been without this faculty for generalization" (*Gaudier-Brzeska* 20).

[40] Daniel Albright, Joseph Urbas, and Ian Bell (in *Critic as Scientist*) all take note of Pound's writing on mathematics, but their interests lie in science, and as they use Pound's mathematics to support arguments about Pound's science, they miss the formal purity of Pound's mathematical linkages. Pound's interest in empirical science is distinct from his interest in mathematics, which he conceives as not empirical at all, but as the generator of clean, absolute, and unadulterated form. As he explains:

> The poet's true and lasting relation to literature and life is that of the abstract mathematician to science and life. As the little world of abstract mathematicians is set a-quiver by some young Frenchman's deductions on the functions of imaginary values—worthless to applied science of the day—so is the smaller world of serious poets set a-quiver by some new subtlety of cadence. ("Wisdom of Poetry" 361)

Elsewhere, in "Ezra Pound and the Materiality of the Fourth Dimension," Ian Bell focuses further on mathematics, but still the argument draws not from pure mathematics but from its applications, both in physics and in popular mythologies. Those mythologies should be carefully distinguished from mathematics proper. Forrest Read's essay, "The Mathematical Symbolism of Ezra Pound's Revolutionary Mind" is not about mathematics but numerology – an interesting topic regarding Pound, but one that is largely irrelevant to the present study, which reads Pound alongside the mathematics of his own era.

"In a Station of the Metro": A Model Equation

When Pound described "In a Station of the Metro" as "an equation," he emphasized the similarity, the particular qualities of sameness, that it locates between things:

> The apparition of these faces in the crowd;
> Petals on a wet, black bough. (*Personae* 111)

The faces in the crowd resemble petals on a wet, black bough. Pound represents the faces as petals. He identifies the faces with petals. Readers consider what it would mean for the faces to be those petals. And over the course of this tiny poem, the faces do somehow come to be those petals. In a sense, this is the very definition of metaphor: two generally different things enter into analogy as one is named as the other. William Empson defines a metaphor as the process whereby "One thing is said to be like another, and they have several different properties in virtue of which they are alike" (2). I. A. Richards's definition is more open-ended, identifying tenor and vehicle while refusing to specify the nature of their relation: "when we use a metaphor we have two thoughts of different things active together," such that "meaning is a resultant of their interaction" (93). The interaction central to "In a Station of the Metro" particularly emphasizes commonality as it proffers an especially surprising similitude. We do not expect faces in a crowded Metro station to share very much in common with petals on a wet, black bough, but they do.

At the same time, "In a Station of the Metro" avoids stating the relationship between the faces and petals outright. Pound omits the connecting words that would form the pivot point of the entire poem, and the central semicolon wordlessly hinges the two phrases together, setting them on parallel planes without explained connection. A more typical metaphor would pinion the phrases together with "are," or any number of relating verbs or prepositions. Instead, the semicolon leaves readers with a profoundly indicative and yet abortive relation. This substitution is never named as such, opening a crevice in which "In a Station of the Metro" stages and investigates the relationship between representation and likeness, between being, sameness, and metaphor.

In "Vorticism," when Pound describes the metaphor central to "In a Station of the Metro" as an equation, he first recalls that, in that Metro station, he perceived a kind of iterating commonality or sameness:

> Three years ago in Paris I got out of a "metro" train at La Concorde, and saw suddenly a beautiful face, and then another and another, and then a beautiful child's face, and then another beautiful woman, and I tried all day to find words for what this had meant to me, and I could not find any words that seemed to me worthy, or as lovely as that sudden emotion. And that evening, as I went home along the Rue Raynouard, I was still trying, and I found, suddenly, the expression. I do not mean that I found words, but there came an equation (*Gaudier-Brzeska* 86-7)

Pound saw "suddenly a beautiful face, and then another and another, and then a beautiful child's face, and then another beautiful woman." He struggled with how to represent the correspondence between all these beautiful faces, each distinct and yet each existing in commonality with all the others. He could find no words to match the pattern, "another and another." Here Pound wants not only a description, but words that are "as lovely as," and "worthy" of, the emotion evoked by the original experience. In this sense, his efforts to describe the original experience are a search for an "abstract equivalent" (Kenner 184).[41] Pound perceived a series of repeating beauties, and he seeks a poetic beauty that can sit alongside the others, equal to them. He settled, finally, on an expression that he explicitly tells us did not itself consist of words. Instead, he found "an equation." Pound saw faces in the crowd; he set them equal to petals on a wet, black bough.

If we read this as not only an account of Pound's writing process but also an example of Pound's theory of representation, we can see a whole network of equations. Pound's original experience in the Metro station revolved around the recognition of a series of equivalent beauties. Then he attempted to set his experience equal to written lines, to the poem itself. In turn, he frames the poem's two terms as equal to one another. The poem's two lines become two sides of one equation. In arithmetic, to say that two quantities are equal is to say that they are identical, and to say that they are identical is to assert their equality.[42] With his description of "In a Station of the Metro" Pound emphasized not only that the identity staged by this poem is mathematical, but that the mathematical understanding of identity informs poetic composition, readerly interpretation, and representation generally. Pound frames the act of representation as one of equation.

When he dubbed "In a Station of the Metro" an equation, Pound also described the poem's relational and syntactic process. The semicolon grammatically renders these phrases parallel to map "faces" onto "petals," and, indeed, a semicolon is a kind of grammatical equals sign: it joins two independently complete sentences in a homology that requires no further explanation.[43] With two marks lying one on top of the other, the two signs are even typographically related (; to =). Visually mimicking an equals sign, the two spare lines of "In a Station of the Metro" similarly float just above and below each other. The resulting phrasal parallelism—not to mention the geometric parallelism of just two adjacent lines upon a page—forms an equality. In fact, an earlier version of the poem offers even more visual equivalence. As it was first published in 1913, Pound uses a colon, set off by extra spacing:

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[41] Here see also Bell, "Ezra Pound and the Materiality of the Fourth Dimension" 141.

[42] In some contexts, some mathematicians and logicians do distinguish between equality and identity. Identity is sometimes considered a stronger case, such that $x + x = 2x$ is an identity, because it is *always* true (in standard, and not modular, arithmetic), whereas $x = 2$ is only an equality, because it is only true for the particular case where x is, in fact, 2. Other definitions would render equality a more specialized case than identity; as a person, I am identical with myself, but equality may not be well defined for people (as opposed to numbers), and so I may not be equal with myself. However, putting aside these more specialized definitions, the mathematical community generally uses equality and identity as synonyms. In Alonzo Church's *Introduction to Mathematical Logic*, the index entry for identity simply directs the reader to the index entry for equality (364); elsewhere he writes that "The use of the sign = to express that things are identical is assumed familiar to the reader. We do not restrict this notation to the special case of numbers, but use it for identity generally" (17).

Today we are more accustomed to hearing identity used to describe selfhood, but it is worth noting that the usage of identity to describe the state wherein two things are identical both predates and informs that kind of personal identity. As a term for individuality and personality, identity was historically predicated on the belief that individuals are identical to themselves, and so formal identity gave rise to personal identity. In one early usage of personal identity, in 1638 William Rawley wrote (translating Francis Bacon): "The Duration of Bodies, is twofold; One in Identitie, or the selfe-same substance; The other by a Renovation or Reparation" (*OED*).

[43] In the case where semicolons join many clauses in a list rather than two independently complete sentences, semicolons still offer a kind of homology, because any semicolon signals the fact that the clauses before and after it carry the same grammatical position. Semicolons do not impart order, valuing one rhetorical item above or below another, but instead provide nonlinear structure, placing clauses in equivalent positions.

The apparition   of these faces   in the crowd :
Petals   on a wet, black bough. (12)[44]

The colon offers even more visual equality, with identical marks floating one above the other. The colon also offers a more direct link, since grammatically what follows a colon typically offers a specification or enumeration of whatever precedes it. There is some immediate equivalence in the original colon. Yet the semicolon that Pound later settled on establishes more complete syntactical equality, since the two independent clauses before and after a semicolon carry equal weight, reversible in their identity.[45]

Pound's theories of signification place great emphasis on visual imagery, and that is intrinsic here. The sign of equality (=) itself originated with exactly this succinct parallelism and pictorial equality in mind. As Robert Recorde, inventor of the sign, wrote in 1557: "to avoide the tedious repetition of these woordes: is equalle to: I will sette… a paire of paralleles, or Gemowe [twin] lines of one lengthe, thus: =, because noe .2. thynges, can be moare equalle" (238). Recorde regarded two twin parallel lines as the natural mark of equality "because no two things can be more equal." By design, the equals sign not only signifies equality but directly pictures and exemplifies equality. The equals sign is, in fact, an ideogram—that very rare, directly signifying mark that so fascinated and preoccupied Pound. As he wrote in his *ABC of Reading*:

> The Egyptians finally used abbreviated pictures to represent sounds, but the Chinese still use abbreviated pictures AS pictures, that is to say, Chinese ideogram does not try to be the picture of a sound, but it is still the picture of a thing; of a thing in a given position or relation, or of a combination of things. It means the thing or the action or situation, or quality germane to the several things that it pictures.
>
> Gaudier Brzeska, who was accustomed to looking at the real shape of things, could read a certain amount without ANY STUDY. He said, 'Of course, you can see it's a horse' (21)

Pound exaggerated the extent to which modern Chinese calligraphy remains ideogrammatic and pictorial. On the other hand, mathematical notation is very often ideogrammatic. Mathematical and logical marks such as =, >, <, ≈, or → are all designed to directly, pictorially embody their meaning, creating a firm and immediate link between signifier and signified that is very rare elsewhere in written language.

That kind of direct signification may seem like the semantic extreme most opposite the formalism on which this dissertation is focused. However, ideograms are predicated on the same relations within and between written signs that formalist analysis emphasizes and examines. Ideograms can highlight and make distinct the signifier's internal relations, which more standard signification relies on but also blurs. Pound writes that ideograms particularly highlight the "given position or relation, or… combination of things." Meanwhile, mathematical ideograms such as =, >, <, ≈, or → particularly tend to address modes of relation—unlike non-ideogrammatic marks such as

[44] Randolph Chilton and Carol Gilbertson have exhaustively traced the revisions of "In a Station of the Metro" in "Pound's "'Metro' Hokku": The Evolution of an Image." There were several iterations of spacing as well as punctuation. The version containing the semicolon represents the poem as it appears in *Personæ*, and this seems to have been the final version, as Pound never altered it after that.
[45] See Albright 140-1.

6 or *x*, which indicate things rather than relations between things. Relations, distilled from the specific things they relate, lend themselves to a kind of formal immediacy which ideograms realize well. Pound's interest in ideograms was tied to a modernist hope that mathematical marks could make modes of relation clearer in literature. Attempts to borrow, imitate, or reflect on the direct and efficient signification of mathematical marks—especially to clarify links and relationships—were manifestly characteristic of a whole strain of radical avant-garde modernism, from Vorticism to futurism.

In the first edition of *Tarr*, Wyndham Lewis punctuated with an equals sign—two em dashes, one on top of the other—to indicate the finality of a period but also some substantially equating link to the following sentence. Lewis used that equals sign very much like a finalistic semicolon.[46] F. T. Marinetti wrote in his "Technical Manifesto of Futurist Literature" that "To accentuate certain movements and indicate their directions, mathematical signs will be used: + – × ÷ : = > <" (120). All of these are signs of linkage: the first four signs above indicate distinct ways in which values can be combined, brought into new relations, while the last four designate existing relationships between things. All of these signs focus not on things in themselves but on how things can interact with other things. Elsewhere, Marinetti endorses

> a swift, brutal, and immediate lyricism, one that would appear to all our predecessors as antipoetic, a telegraphic lyricism… Always for the purpose of rendering a maximum quantity of vibrations and a deeper synthesis of life, we abolish all stylistic connectors, all the shiny buckles with which traditional poets have linked images to the period. Instead we employ very brief or anonymous mathematical and musical signs ("Destruction of Syntax" 149)

Marinetti argues that mathematical modes of linkage and relation should replace more traditional "stylistic bonds" and "bright buckles." Mathematical relations are "brief" and "anonymous," clarifying more directly how literary elements relate to each other. In another essay, Marinetti writes:

> The mathematical signs + – × = can be used to obtain marvelous syntheses and, with the abstract simplicity of anonymous gear-works, they collaborate to give geometrical and mechanical splendor. For example, it would have required almost an entire page of description to render the enormous and complicated horizon of battle which I wanted to render, but instead I found this definitive lyrical equation: '*horizon = sharp bore of the sun + 5 triangular shadows (1 kilometer wide) + 3 lozenges of pink light + 5 fragments of hillocks + 30 columns of smoke + 23 flames.*' ("Geometrical and Mechanical Splendor" 180)

Marinetti explicitly replaces description with a "definitive lyrical equation," a long poetic line that sets one phrase equal to another through the "=" sign itself (180). In lieu of describing the "enormous and complicated horizon," he sets it equal to something else. Mathematical symbols do not appear in Marinetti's work as things, but as connectors, as coordinating conjunctions of a sort; they "collaborate" to create "syntheses." Numbers (as numerals) appear often, but as adjectives rather than nouns, and in a frequency that lends itself to analysis of their relation to other numbers,

[46] Selecting a couple of examples from among so many: "To sum up this part of my disclosure.=No one could have a coarser, more foolish, slovenly taste than I have in women"; "I see I am boring you.=The matter is too remote!" (Lewis 13).

rather than their existence as things in and of themselves. Marinetti also wrote that "It is imperative to destroy syntax and scatter one's nouns at random, just as they are born," yet his use of mathematical relation in his poetry seems to organize much like syntax does ("Technical Manifesto" 119). As he uses mathematical relations in place of standard syntax, he implies that these mathematical relations are a more natural kind of connector: closer to the interrelation of things "as they are born." Marinetti literally transformed his poems into equations, and envisioned equality as a purer mode of artistic relation.

Eliot argued, perhaps even more expansively, that exacting equivalence could be a paradigm for artistic representation:

> The only way of expressing emotion in the form of art is by finding an "objective correlative"; in other words, a set of objects, a situation, a chain of events which shall be the formula of that *particular* emotion; such that when the external facts, which must terminate in sensory experience, are given, the emotion is immediately evoked.… The artistic "inevitability" lies in this complete adequacy of the external to the emotion; and this is precisely what is deficient in *Hamlet.* Hamlet (the man) is dominated by an emotion which is inexpressible, because it is in *excess* of the facts as they appear. And the supposed identity of Hamlet with his author is genuine to this point: that Hamlet's bafflement at the absence of objective equivalent to his feelings is a prolongation of the bafflement of his creator in the face of his artistic problem. Hamlet is up against the difficulty that his disgust is occasioned by his mother, but that his mother is not an adequate equivalent for it; his disgust envelops and exceeds her. It is thus a feeling which he cannot understand; he cannot objectify it, and it therefore remains to poison life and obstruct action. None of the possible actions can satisfy it; and nothing that Shakespeare can do with the plot can express Hamlet for him. And it must be noticed that the very nature of the *données* of the problem precludes objective equivalence. To have heightened the criminality of Gertrude would have been to provide the formula for a totally different emotion in Hamlet; it is just *because* her character is so negative and insignificant that she arouses in Hamlet the feeling which she is incapable of representing. (*Sacred Wood* 67-8)

Eliot's objective correlative is a "formula": it is a kind of external object or trigger that offers an "immediate" and "inevitab[le]" connection to its consequent emotion. It is also a kind of descriptor that works by radical equality between symbol and affect, and in this essay Eliot describes it in terms of equivalence four times over. Here he speaks of the "adequate" and the "deficient" in *Hamlet* as though each quality is not a relative descriptor but a measurable quantity locatable on a kind of number line. Eliot seems to set up both the emotion and its external causes as numerical values, such that equality between them—or inequality between them—can be adjudicated with finality. This is how Eliot proceeds to assert that authors must establish an "objective equivalent," an "adequate equivalent" for the text's emotional content. Eliot took up perhaps the most amorphous aspect of literature—its emotions—and he sought to make it not only logical and objective but specifically mathematical. The objective correlative offers up its meaning with all the directness of an ideogram, and it does so specifically because it is "equivalent" to that meaning.

Equality can serve as an emblem for the logocentric myth of absolute, originary, unconfusable signification. Equality indicates sameness and unbreakable linkage, a relation that would obviate any meandering path between sign and signified, instead rendering them one and the same. Pound's investment in ideograms was in large part a way of trying to revivify that logocentric, absolute sign, which could be inextricable from its signified, which the great reader should be able to understand "without ANY STUDY," because "Of course, you can see it's a horse" (*Gaudier-Brzeska* 21). Equality brings all these strands together: it is itself denoted by an ideogram, it articulates the relationship between the ideogram and that which it represents, and it is so fundamental that it can itself serve as a kind of logical origin.

Above, Eliot speaks particularly of equivalence, while Pound refers most often to equation. Lewis and Marinetti prefer simply "=." There are differences here: with equivalence Eliot highlights the substitutability and interchangeability of the objective correlative and its attendant emotion, while with equation Pound draws further attention to the larger phrase or relational system which articulates an equality between two terms. Lewis and Marinetti's usages may be as much syntactical and typographical as mathematical. Yet nonetheless we have accumulated, to this point, a pile of synonyms and near-synonyms—equivalence, equality, equation, sameness, similarity, substitutability…—this list could continue. What needs to be examined is the commonality among all these commonalities. To do that, we will need a broader and deeper understanding of mathematical equality: one that reaches beyond and outside of number. Because, obviously, "In a Station of the Metro" is not 2 + 2 = 4. In fact, mathematicians of the modernist era were developing exactly those ideas, studying equality as a further reaching articulation of commonality.

Equality and the Modernist Equivalence Relation

Any language, any mimesis, any symbolism is founded on the fundamental claim that *this* is *that*. Pound's briefest Imagist and Vorticist poems isolate and interrogate that ontological foundation of linguistic description, foregrounding the terms on which one thing can be another and underlining how much representation relies on that kind of identity. As Pound explains: "The 'one image poem' is a form of super-position, that is to say, it is one idea set on top of another" (*Gaudier-Brzeska* 89). And as Daniel Albright has pointed out, such poems are actually "bi-representative, abstract because doubly concrete" (139). The concreteness of two distinct images makes their relation to each other even more noticeably abstract, because that relation (similitude or otherwise) cannot exist in such a material form as the images or objects themselves. The concreteness of Pound's descriptions of things works to emphasize the abstraction of the relations between those things. "In a Station of the Metro" is far from being the only example. Consider, for instance, "The New Cake of Soap," another poem of exactly two lines:

> Lo, how it gleams and glistens in the sun
> Like the cheek of a Chesterton. (*Personae* 100)

Here the equality is both more tenuous and more explicit than in "In a Station of the Metro." The "like" describes similarity rather than absolute sameness, and in that sense it asserts a less radical equality than would a direct renaming (as of faces in the crowd as petals on a wet, black bough). "The New Cake of Soap" isolates and interrogates explicit simile rather than implicit metaphor. Yet it remains every bit as dependent on a central, unstated "is"—the fundamental representational claim that, on some level, the new cake of soap is like the cheek of a Chesterton.[47]

Literary theory's most familiar accounts of signification analyze the complexity of the link between signifier and signified by working subtractively—deconstructing the implicit *is* at the center of the signifying link. But a related investigation could be carried out constructively—by instead examining what the *is* at the center of that link could still do when taken in abstract, formal, mathematical isolation. I propose, here, deeper attention to sameness instead of difference,[48] to constancy instead of change. When Ferdinand de Saussure wrote that "a segment of language can never in the final analysis be based on anything except its noncoincidence with the rest," that "differences carry signification" (118), his focus was as divergent as it could be from Frege's, for Frege opened his treatment of language by analyzing sameness and equality. Frege sought out the equations by which words and groups of words refer to concepts and objects in the world, and rather than unraveling the differences that open up within language, he identified the commonalities: the moments when we might know that two different words denote the same things, or, transversely, when two differing things come together in being labeled by the same word. Those two paths are not simply two sides of the same coin, because they lead to both differing methodologies and differing conclusions. While continental theory inherits an understanding of the intricacies of difference from Saussure, analytic philosophy follows the path laid out by Frege. It is tempting to define difference simply as the state wherein things are not the same, and sameness simply as the absence of any difference; however, each can be accounted for without any reference to the other. The mathematical definition of equivalence relations—an account of the properties of similarity—never makes any reference to either difference or inequality. Similarity and difference are not simply opposites, but distinct and complementary building blocks through which relationships can be constructed and explained. Following Pound's lead, and Frege's, I argue that the formal links within Pound's poetry—and, more generally, the linkage of sign and signified that is fundamental to representation itself—can be fruitfully described as relations sharing the abstract formal properties of equality.

Technically generalizable definitions of equality were actually only very recent to Pound's era. In the final decade of the nineteenth century, modernist mathematicians made great progress in categorizing modes of relation in ways capable of abstraction from specifics, toward defining not only equality but equivalence relations more broadly. The kind of generality involved here is similar to that belonging to the variables I examined in my first chapter: the way in which $a + b = c$ can describe a much wider variety of situations than can $1 + 2 = 3$. Generality, one of the highest aims of mathematical research, offers a multiplicity of possible applications without introducing confusion or vagueness. However, while in my first chapter I examined variables generalizing mostly on things, here I will examine mathematical definitions that generalize, instead, on relations between things. In the equation above, only the things become variables: 1, 2, and 3 turn into *a*, *b*, and *c*. But we could do something similar for the processes and relations, turning + into any operation,

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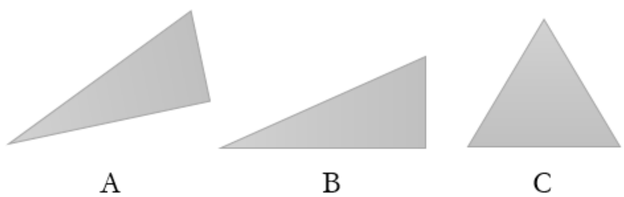
47 In *Wallace Stevens and the Demands of Modernity* Charles Altieri analyzes the intricacies of such similes, particularly focusing on "as" and equivalence in Stevens's writing; much of his argument could apply to the valences of Pound's use of "is" and equality. However, Altieri's primary interest is in how resemblance can open out into difference, how simile points in other directions via contrast as much as similarity. On the other hand, Pound's motivations for his metaphors were more absolute, and so I direct my argument toward equality more than resemblance. Where similarity does not reach the bar of identity in Pound's writing, Pound's work still emphasizes the elements of equality that similarity retains, continuing to focus on sameness rather than difference.

48 For an analysis of literature, mathematics, and Derridean difference, see Mairéad Hanrahan, "Literature and Mathematics: The Difference."

including not only addition but potentially multiplication, division, subtraction, etc. Similarly, = could be ~, ≡, or ∥ (similarity, congruence, parallelism). None of these signs mean the same thing as equality, but they each name relations between two things, and each articulate something that those two things share in common. The relations above all occupy the same position. We can thus generalize on them all in one fell swoop if we choose to, thus characterizing not their specific applications but their common structure. As with variables, the specific relation could still be substituted for the general relation at any time, and without loss of meaning. This kind of generalization involves abstraction from particulars, and it rests on the realization that these relations all play the same syntactic role, that they share one and the same form.

Equality is most often defined between numbers, while identity can exist between all manner of things, but equality and identity share something essential and intuitive in common. Meanwhile, when we say that two triangles are congruent—that they have exactly the same size and shape—that relation seems to bear an intuitive commonality with the equality that exists between numbers. For example, looking at the three triangles below, it feels natural to say that A and B are somehow equal to each other in a way that C is not.



We could cut out A, rotate it slightly, and we would find that it fits exactly on top of B. That is, although A and B might differ in position and orientation, they are identical in size and shape. In geometry, we would thus say that A and B are congruent, that A ≡ B. Congruence, like equality, is a relation of sameness. But for the vast majority of mathematical history, from the ancient Greeks all the way up until the 1890s, mathematicians had to define these relations separately.[49] They had no well-defined way to speak about both equality and congruence at once. Whatever 1 + 2 = 3 had in common with A ≡ B, there was no precise way to talk about that commonality, no single definition that described the pattern of what those assertions of commonality shared in common.

It was around the turn of the twentieth century that modernist mathematicians built that kind of further reaching definition of identity relations. In 1884 Frege noted that "The relationship of equality [*Gleichheit*] does not hold only amongst numbers" (*Foundations* 110). In 1889 Giuseppe Peano defined equality using properties that also describe sameness more generally,[50] and in 1899 David Hilbert published a definition of congruence that could similarly generalize to equality and identity.[51] In 1903 Bertrand Russell further explained the generalization that Peano's properties were capable of, writing about what "All kinds of equality have in common" (*Principles of Mathematics* 159), and in the first volume of their *Principia Mathematica* in 1910 Whitehead and Russell offered an explicit generalization of identity which they claimed "covers all the common uses of equality that

[49] See Amir Asghari, "Experiencing Equivalence but Organizing Order," for an analysis of how far historical definitions of identity were and were not capable of generalization, from Euclid up until the modernist era. Arguably, in the seventeenth century René Descartes provided another way of understanding equality and congruence together, but that method depended on a kind of translation from geometry into arithmetic, rather than the more direct, universal generalization that nineteenth- and twentieth-century modernist mathematicians developed.
[50] See "The Principles of Arithmetic" 109, where Peano specifies that equality must be reflexive, symmetric, and transitive, the same properties which define equivalence relations generally.
[51] See Hilbert, *Foundations of Geometry*, 10-11.

occur in mathematics" (168). In 1926 Helmut Hasse used the term that continues in modern circulation today: equivalence relation (in German, *Äquivalenzrelation*).[52] Hasse stated directly that his equivalence relation was utterly nonspecific about the particular relations that might exemplify its properties, and that it was indifferent to the particular meanings of the signs it used, indicating instead more general form, structure, and behavior: "Für das Bestehen dieser Tatsachen, gleichgültig welche Bedeutung dabei den Zeichen… zukommt" (17) ("the existence of these facts is indifferent to which meaning the signs possess"[53]). Instead of defining any particular meaning, Hasse used the new concept of an equivalence relation to define what a whole class of linkages shared in common, to specify their single form independent of their many meanings. In fact, in 1907, Alessandro Padoa had given equivalence relations their first name: "relazione egualiforme," a neologism that translates directly as "equal-form relation," because the specific property of equality that equivalence relations preserve is its form.

The sheer quantity of mathematicians independently involved in the development of equivalence relations, of "equal-form relations," is compelling evidence of the fact that mathematical modernism was a mass movement, involving a cultural shift across an entire field and not just the work of a few brilliant innovators. The movement from specific types of sameness toward equivalence relations more broadly also exemplifies the ways in which mathematical modernism comprised a shift away from concrete, particular objects (numbers, shapes) toward more abstract, non-particular forms. Modernist mathematicians were no longer content to characterize particular things within mathematics. Instead they sought to characterize the patterns by which all those things related to each other.

What equality, equivalence, identity, and sameness have in common is, mathematically, a single form; that is, the way in which they relate things, and the pattern of their use. Equality's form does not include its meaning—sameness—but does include the logical syntax that all kinds of sameness share in common. Equality's form in fact characterizes much broader kinds of similarity: the state of sharing something—anything—in common defines an equivalence relation. For example, the property of having the same last name as somebody else is an equivalence relation, even though that property is utterly nonmathematical. Equivalence relations pinpoint the commonalities of identity, equality, congruence, similarity, and many other related relations, all under one single, global form, and they were only defined for the first time in the modernist era.

The accepted contemporary definition of an equivalence relation depends on three properties laid out by Peano. Given an otherwise undefined relation "~,"[54] that relation is an equivalence relation if and only if it possesses all three of the following features, for any x, y, and z:

1) Reflexivity: $x \sim x$
2) Symmetry: If $x \sim y$, then $y \sim x$
3) Transitivity: If $x \sim y$ and $y \sim z$, then $x \sim z$

If we know that "~" is reflexive, symmetric, and transitive, then we know that "~" is an equivalence relation, no matter whether x, y, and z are a triangle, the number 2, or a kitchen table. And, if we

52 See von Neumann, "Zur Prüferschen Theorie der idealen Zahlen," 197, and Hasse, *Höhere Algebra*, 17. In tracing this history I drew from Paolo Mancosu, "The Mathematical Practice of Definitions by Abstraction from Euclid to Frege," Amir Asghari and Henry Cohn, "Who Introduced the Terms 'Equivalence Relation' and 'Equivalence Class'?", as well as Hermann Weyl, *Philosophy of Mathematics and Natural Science*, 9-11.
53 My translation.
54 Technically, it is also necessary to specify that ~ is a binary relation: that is, that it relates two things.

know that "~" is an equivalence relation, then we always know that "~" is reflexive, symmetric, and transitive. As Whitehead and Russell explain:

> The first of these expresses the *reflexive* property of identity: a relation is called *reflexive* when it holds between a term and itself, either universally, or whenever it holds between that term and some term. The second of the above propositions expresses that identity is a *symmetrical* relation: a relation is called *symmetrical* if, whenever it holds between x and y, it also holds between y and x. The third proposition expresses that identity is a *transitive* relation: a relation is called *transitive* if, whenever it holds between x and y and between y and z, it holds also between x and z.
>
> We shall find that no new definition of the sign of equality is required in mathematics. All mathematical equations in which the sign of equality is used in the ordinary way express some identity, and thus use the sign of equality in the above sense. (*Principia* 22-3)

Notice that Whitehead and Russell speak here not of "equivalence relations" but of "equality"; the former term had not yet been coined, and in its absence Whitehead and Russell were comfortable referring to this whole class of relations as, simply, equality, which, for them, marks simply the "express[ion] of some identity." Terms get used interchangeably here not because Whitehead, Russell, and others did not take care to be precise, but rather because the intersection among these terms is exactly what is being discussed.

After the interventions of modernist mathematics, equality does not imply only numerical sameness; it can indicate commonality much more inclusively. In the *Principia*, Whitehead and Russell exhibit this fact when they harness the equals sign to mark a linguistic process: they state all their definitions using the sign for equality. For example, were Whitehead and Russell to define a person as a human being, they would write

a person = a human being Df.

"Df." allows readers to distinguish between this definitional use of the equals sign and more general kinds of equality. Yet this use of the equals sign is nonetheless a metaphor marking an intrinsic commonality. By representing definition in this way, Whitehead and Russell indicate the fact that (direct, defined, understood) meaning in language operates under properties very much like those that distinguish equality. Precise definition is reflexive, symmetric, and transitive, and is thus an equality in the sense defined above.[55]

Roman Jakobson also used equality and equation to characterize definition and substitution in language. Describing aphasic patients who struggle with word selection and semantic substitution, he writes:

> A reply like 'a bachelor is an unmarried man' or 'an unmarried man is a bachelor' would present an equational predication… The [aphasic] patient was able to select the appropriate term *bachelor* when it was supported by the context of a

[55] Reflexivity: I can define a person as a person, and I will be correct, although uninformative. Symmetry: if a person is defined as a human being, then a human being can be defined as a person. Transitivity: if a person is defined as a human being, and if a human being is defined as a member of the classification *Homo sapiens*, then a person can be defined as a member of the classification *Homo sapiens*. This analysis assumes that definition is only "precise" if it does not pick out a proper superset: that is, "a gorilla is an animal" is not a precise definition, because an animal is not necessarily a gorilla.

> customary conversation about 'bachelor apartments' but was incapable of utilizing the substitution set *bachelor* = *unmarried man* as the topic of a sentence because the ability for autonomous selection and substitution had been affected. The equational sentence vainly demanded from the patient carries as its sole information: '*bachelor* means an unmarried man' or 'an unmarried man is called a *bachelor*.' (122)

Jakobson tells us that aphasics, when unable to articulate how words equal one another, how *bachelor* = *unmarried man*, become unable to use language. Jakobson distinguished two fundamental processes of language: combination and selection. The former process both creates and depends on context, the stitching between words that get said together. The aphasic patients described above used that linguistic process perfectly well, but they lacked the selection process, in which "A selection between alternatives implies the possibility of substituting one for the other, equivalent in one respect and different in another" (119). Jakobson argued that metonymy depends on the former process, metaphor on the latter, because "Similarity connects a metaphoric term with the term for which it is substituted" (132). And Jakobson repeatedly described that similarity process, the process underlying metaphor, in terms of equation. He was not alone. Northrop Frye, in a brief aside, also notes the "curious similarity in form… between the units of literature and of mathematics, the metaphor and the equation" (352).

My equational reading of "In a Station of the Metro" applies to its metaphoric qualities, and not to its metonymic ones. The apparition may recall literary apparitions past, but those are absent in the equation that develops between faces and petals. The title signals some celebration of technological modernity, which goes unexamined here. My reading of "In a Station of the Metro" is a reading, particularly and exclusively, of the similarities that Pound locates, posits, and creates. More generally, if equation can inform our understanding of metaphor, as Pound, Jakobson, Frye, and others have argued that it can, it can do so only insofar as it is possible to distinguish metaphor from metonymy, because the substitutions involved in metonymy do not necessitate any kind of sameness, but only contextual contiguity. Pound, in fact, showed no love for metonymy in his early work.[56] Criticizing the French Symbolists, he wrote that they "dealt in 'association'… They degraded the symbol to the status of a word. They made it a form of metonymy" ('Vorticism" 84). "In a Station of the Metro" violates metonymic contiguities: fluttering petals come up against the great grinding wheels of the Metro train, urban crowds violate the pastoral landscape. Its clipped precision provides nearly no context by which metonymy can proliferate. An equational reading of the poem works, instead, to examine the central hinge that the poem does offer us, by which the unlike become alike—or, by which the apparently unlike reveal themselves to have always already been alike. This equation encompasses the fragility of human faces beside the ploughing enormity of a subway train, and of delicate petals beside the firmness of a wooden bough, because each line shares that contemplation of fragility beside might. This equation holds the stark chiaroscuro of (white) faces in the dark underground metro station, and of pale petals on a black bough, because both lines share that implicit contrast. The two lines of "In a Station of the Metro" are not, in their entirety, equivalent, but much of what they set forth—particularly of what their metaphor sets forth—is equivalent.

In these regards, "In a Station of the Metro" is in fact reflexive, symmetric, and transitive. That is, to make a very strange formulation, if *a* is "these faces in the crowd" and *b* is "petals on a wet, black bow," and *c* some undetermined third term, then: either *a* and *a* both evince chiaroscuro

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[56] Importantly, this viewpoint shifted later in his career. The *Cantos* accumulate metonymy richly and everywhere. See Marjorie Perloff, *The Poetics of Indeterminacy*, 172.

or neither does; if *a* and *b* both evince chiaroscuro then *b* and *a* both evince chiaroscuro; and if *a* and *b* both evince chiaroscuro, and *b* and *c* both evince chiaroscuro, then *a* and *c* both evince chiaroscuro. This is inadequate as a reading of the poem. But, as a logical analysis, it is also simply true.

I am aware that formulations such as this seem very foreign to poetry; their mode of analysis depends on strict rules that must never be allowed to delimit or undercut the complexities of Pound's verse. As William Empson wrote, regarding his own method of delineating seven distinct "types of ambiguity":

> There is much danger of triviality in this, because it requires a display of ingenuity such as can easily be used to escape from the consciousness of one's ignorance… and because it gives no means of telling how much has been done by meanings latent in the mode of action of the language, which may be far more elaborate and fundamental than those that can be written up. My methods can only be applied at intervals; I shall frequently pounce on the least interesting aspect of a poem, as being large enough for my forceps; and the atoms which build up the compounds I analyse will always be more complex than they. But in so far as anything can be said about this mysterious and important matter, to say it ought not to require apology. (7)

In other words, the fact that this analysis leaves something out does not imply that this analysis is not worthwhile; although it does not describe everything, it does describe something—and that something, in fact, is central, critical, indispensible. "In a Station of the Metro" is not reflexive, symmetric, and transitive in its entirety, but the sameness that it at once discovers and invents *is* reflexive, symmetric, and transitive. And without understanding the qualities of that sameness, whe cannot understand "In a Station of the Metro."

The mathematics itself never claims any absolute application that would put it at odds with this definitively partial description. Mathematical equality always only applies to particular properties of the things it relates. When I say that $2 + 2 = 4$, I say that $2 + 2$ is the same as 4, but I do so particularly regarding the fact that they have the same numerical value. In no way do I deny other distinctions ($2 + 2$ and 4 are written with different signs; one involves a process of combination while the other is only a single completed value). In the same way, when we speak of human equality, we insist on absolute sameness, but we do so only regarding certain properties: we might assert that all people deserve the same treatment under the law, or that all people possess the same intrinsic value as human beings, but we do not assert that people are all the same in skin color, beliefs, backgrounds, bodies. We do not deny human individuality when we assert human equality because it is understood that we mean only the equality and identity of particular aspects of personhood. Equality promises a way to contemplate similarity without denying difference, but also without depending on difference. Because the modernist mathematical understanding of equality allows us to define sameness without any reference to difference.

Reflexive Tautology and Pound's "is"

The move from equality to equivalence relation, from specific identity to general commonality, constituted a shift in perspective and a remarkable expansion in scope. Modernist mathematicians and logicians such as Frege, Peano, Whitehead, and Russell were the first to abstract from particular equalities to define not only equality's semantic content (sameness) but also its syntactic form (reflexivity, symmetry, transitivity). They defined not just what "=" means but what its form must involve.

Yet, in another sense, the understanding of equality's structure is much older than this; identity is too basic a concept for its characterization to have first come about with the modernists. As early as 300 BC, Euclid's first Common Notion explained that "things which equal the same thing also equal one another" (155). Already, that property (often called the Euclidean property) is very closely related to transitivity. In fact, it involves a combination of transitivity and symmetry, and, mathematically, if a relation is both Euclidean and reflexive, then it must also be an equivalence relation in the modern sense. All that is really missing from Euclid's definition is reflexivity, the declaration that anything must always equal itself. Euclid might have simply deemed this fact too obvious to need pointing out. On the other hand, he may have considered equality a relation which one could only want to state between two things. To point out that one thing is equal to itself would have been, perhaps, not only a tautology but an absurdity, senselessly simple-headed.

Yet the careful investigation of that which had previously seemed too basic to warrant serious attention was a crucial aspect of modernism across all fields. James Joyce rewrote the *Odyssey* as one mundane day in the life of an advertising agent while Virginia Woolf declared that we must "not take it for granted that life exists more fully in what is commonly thought big than in what is commonly thought small" ("Modern Fiction" 107). That kind of foundational analysis—which great thinkers such as Euclid had skipped over for hundreds or thousands of years, knowing tacitly without caring to precisely analyze and clarify—was typical of Modernism. When Pound restricted his vision to just one moment in the Metro, readers were forced to develop a reciprocal explosion in interpretation. Stream-of-consciousness novels and Imagism alike—indeed, modernism in general, across fields—grew in large part from a commitment to the complexity of the simple. In some ways, my argument here is also a deliberate turn back to the complexity of the obvious.

The similarity indicated by the simplest metaphor has the same syntactic form as $a = b$. That is, to select a deliberately flat-footed example, if I say that "she is a lion," I imply that she is fierce like a lion. Shared fierceness is in fact symmetric (if she and the lion are both fierce, then the lion and she are both fierce) and transitive (if she and the lion are both fierce, and if the lion and the tiger are both fierce, then she and the tiger are both fierce). These claims depend on my initial interpretation of the similarity the metaphor indicates—if you say that "she is a lion" in fact implies that "she" is brave, then my point about fierceness fails—but I could just as easily then demonstrate the symmetry and transitivity of shared braveness. This leaves reflexivity, the final defining property of equivalence relations and the one that mathematicians missed until the modernist era. Reflexivity does pertain: the lion should be exactly as fierce as the lion is fierce, and "she" should be neither more nor less fierce than she is fierce. Yet this last formulation seems perhaps even less intuitive to our common understanding of metaphor than do those above.

The reflexivity of identity—the very simple fact that *a* is *a*—marks some of the most haunting and characteristic lines of modernist poetry. It asserts itself aggressively and paradoxically in Gertrude Stein's "Rose is a rose is a rose is a rose" (395), and it girds the religious stabilities of both *Ash Wednesday* and *Four Quartets*: "Because I know that time is always time / And place is always and only place"; "the roses / Had the look of flowers that are looked at" (*Collected Poems* 85, 176). While "a rose is a rose is a rose" begins as a senselessly simple-headed fact, with every repetition of "rose" we become further estranged from the word, as though the fact that the rose is a rose reveals that it is so much more and so much else. Eliot underscores the fact that time is an incredibly complicated, paradoxical thing, and yet when he reminds us "time is always time" he grounds *Ash Wednesday* with the universalities that we are nonetheless capable of knowing, and which somehow enclose complexities that seem unenclosable.

Whether Euclid would have recognized the reflexivity of equality or not, when modernist mathematicians thought to state it outright as part of a definition of equivalence relations, they hit on something important. Reflexivity allowed them to articulate new kinds of questions and to expand the application of their claims. And I argue that the value and generality of reflexivity, of the understanding that *x* is always *x*, proved vital for literary modernism as well. Reflexivity is critical to Pound's use of and attention to similitude. It is central to his rhetoric of insistence, his continual emphasis and reemphasis of assertions. The understanding and insistence that *x* is always *x* proffers, at once, both singular, universal truth and accommodation for the great multiplicity of particulars—because the fact that *x* is *x* is true no matter what *x* is. In his poetry it underlies and enables both his deployments of metaphor and his characterizations of being.

Reflexivity involves a kind of tautological marking of the obvious and a pattern of statement and restatement that is typical of Pound's poetry and poetics. More particularly, in his Imagist and Vorticist poems, Pound repeatedly emphasizes the reflexivity of being. He argues for the explanatory value of a "presentative method," which "calls a calf a calf," because "The presentative method is equity" ("Approach to Paris" 662). He identifies a thing and then presents that thing, as though we must pause to note that the thing is indeed itself.

> The taste of my boot?
>   Here is the taste of my boot (*Personae* 75-6)
>
> Let us deride the smugness of "The Times":
> GUFFAW! (*Personae* 75)

Here presentation seems to somehow ensure precision, verisimilitude, or even stable existence. Lest we think Pound is being merely suggestive with imperative to deride the smugness of "The Times," he provides the actual manifestation of that derision, putting forward the act that he had already described. The "GUFFAW!" does match the derision promised, and Pound makes sure readers will be able to verify that fact. *x* does equal *x*, as is standard, as is always expected, yet it is important that we announce and verify that which we already knew to be true.

At other times, the complexity of the object seems only to further underline the importance of its reflexive identity:

> Your mind and you are our Sargasso Sea
> …
> No! there is nothing! In the whole and all,
> Nothing that's quite your own.
>   Yet this is you.
> (*Personae* 57, 58)

"Your mind" and "you" are not quite the same. But they are utterly intertangled, each defined by the other, and to combine them additively under a single "are" is to insist on a kind of tautology which "is"—when it identifies two things as one and the same—actually always entails and implies. In his *Tractatus*, Ludwig Wittgenstein distinguished three different kinds of "is." There is "is" as in "to exist" ("there is an author of this poem"); "is" expressing the possession of a property, usually attributing an adjective to a noun ("the poem is short"); and "is" as a marker of identity, usually equating two nouns ("he is Ezra Pound").[57] I argue that the final, equality form of "is" is a fundamental basis for Pound's conception of precision, a foundation for his Imagist and Vorticist poetics. In the equality sense, "is" and "are" always announce a kind of repetition, because if they tell us that *a* is *b* then—in terms of the single object denoted—they are also telling us that *a* is *a*. Pound emphasizes this inherent repetition when he follows "are" immediately with "our," as the homophone for "are" marks the repetition inherent in that term's meaning. The woman Pound writes about may be many things, but first and foremost she is herself. Outside of that, "there is nothing… nothing that's quite your own. / Yet this is you." If Pound's deictic "this" does indicate the lady before him, that final line cannot possibly impart new information. Of course she is she. But he returns to where he started—"your mind and you," "this is you"—because the reflexivity of her selfhood is hauntingly important and maddeningly complicated even as it remains obvious. That applies, insistently, everywhere and always, "in the whole and all"—a quantifier for ubiquity that itself insists on its own reflexivity, in meaning as well as sound.[58]

Such repetitions might seem even more characteristic of Stein's writing, e.g. "Rose is a rose is a rose is a rose." However, Pound's repetitions, unlike Stein's, insist on a stable, singular logic, as each reiteration drives home some fundamental solidity communicated by terminological consistency. Across texts, Pound repeats the same words with striking constancy, as when he writes so many times of his "watchword" of precision.[59] However, he does so with an insistence that forestalls doubts about the term itself.

Often, Pound's tautologies depend on grammar and logic instead of semantic or oral repetition. In "Salvationists":

> Let us apply it in all its opprobrium
> To those to whom it applies. (*Personae* 100)

Perhaps the speaker could attempt to apply "it" to those to whom it didn't apply, except that by definition then it would apply, since he had applied it as such. Pound is stating an obvious kind of logical fact which cannot be escaped any more than the truth of a tautology can be escaped. But the truth of a tautology is not its problem. Nobody denies the truth of tautologies. People deny, instead, their usefulness. However, that which is true everywhere is everywhere relevant, and Pound values the reflexive repetition which is intrinsic to tautology because it provides certainty, constancy, and the capacity to characterize the nature of the identities that objects, things, and even people intrinsically possess. He emphasizes and considers this reflexivity in parallel with the modern mathematical understandings of equivalence relations, which stated reflexivity as a criterion outright, unlike previous mathematical definitions such as Euclid's, which left it unstated and unexamined. For Pound, the reflexivity of human and poetic identity offered poetry deeper epistemic certainty and more expansive relevance.

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[57] See Wittgenstein 3.323.

[58] This poem, "Portrait d'une Femme," is replete with misogynist presumptions about what the unnamed woman *should* be: a wife, devoted to one man. The reactionary politics of Pound's poetry lies beyond the scope of this project, but it is notable that even in Pound's twisting of a subject into an object, of a woman into what she is not, the poem continues to articulate a kind of identity—albeit a false, unjustified identity.

[59] I expand on this at some length in the next section.

At the same time, Pound often seizes on these identities only to leave them prominently unspoken. The poems of *Lustra*, in particular, repeatedly interrogate forms of similitude, but they very often do so without verbs of identity or similitude. Frequently, as in "In a Station of the Metro," a colon or semicolon takes the place of "is" or "is like." One way or another, the central "is" generally goes unspoken.[60] In "Vorticism," Pound explains this process:

> "The footsteps of the cat upon the snow:
> (are like) plum-blossoms."
>
> The words "are like" would not occur in the original, but I add them for clarity.
>
> The "one image poem" is a form of super-position, that is to say, it is one idea set on top of another…. I dare say it is meaningless unless one has drifted into a certain vein of thought. In a poem of this sort one is trying to record the precise instant when a thing outward and objective transforms itself, or darts into a thing inward and subjective. (*Gaudier-Brzeska* 89)

Pound adds the "are like" which he explicitly tells us would not occur in the original, using parentheses as though to mark the unnecessary intrusion of that statement of semblance even as he also informs us that it is, indeed, the correct interpretation. "For clarity," then, Pound implies that we could fairly read such additions into "In a Station of the Metro": the faces in the crowd (are like) petals on a wet, black bough. In explication he has translated the metaphor into a simile, as though to indicate that the similitude of simile is already embedded in metaphor.

However, what Pound says next characterizes "In a Station of the Metro" even more explicitly. It is, after all, "a form of super-position, that is to say, it is one idea set on top of another." The faces may be like the petals, but they also, even more explicitly, superimpose those petals, sitting on top of them vertically, on the page. This is the means by which Pound aims "to record the precise instant when a thing outward and objective transforms itself, or darts into a thing inward and subjective." Pound remembers the faces in the crowd while he imagines the petals on a bough: the former is outward, objective, the latter inward, subjective. The relation between the two, between objective and subjective, between tenor and vehicle, is the heart of the poem itself. I argue, though, that Pound's theory of the relation intrinsic to representation reveals itself most fully here in his claim that the outward, objective thing "transforms itself" in the Imagist moment. The tenor does not transform into the vehicle, it transforms itself into the vehicle. The metaphor involves the retroactive assertion that each already is the other, an assertion that applies despite its obvious impossibility. Of course, the faces in the crowd *aren't* actually petals on a wet black bough, but Pound demands that we believe that they always already were. The reflexive "itself" marks a transformative moment in thought about identity, implying that, in order for the metaphor to work,

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[60] Pound repeatedly tried to banish the "is" even as it was extraordinarily central to his work. As Perloff points out: "Despite Pound's insistence, in 'The Chinese Written Character as a Medium for Poetry,' that 'The verb must be the primary fact of nature' and that the ideal sentence is transitive ('Farmer pounds rice'), despite his declaration that 'The moment we use the copula poetry evaporates,' that 'We should avoid 'is' and bring in a wealth of neglected English verbs,' that 'The dominance of the verb and its power to obliterate all other parts of speech gives us the model of terse fine style,' his own rhythmic units, whether in his 'prose' or in the 'verse' of *The Cantos*, tend to be suspended noun phrases, and, when there is predication, the copula is much more frequent than the transitive 'action' verb…. The syntax is, in other words, that of *parole in libertà*—nouns and noun phrases in repetitive, oracular sequences" (*The Furturist Moment* 183-4).

we must already believe in a kind of preexisting "is," because to talk about the identity of the faces with the petals is to presuppose the possibility of identity, which is to presuppose the identity of the faces with themselves. This reflexivity both precedes and prefigures the metaphor itself.

Words are not the same as what they describe. As theorists of language, we know that the relation between word and meaning is fraught and inexhaustibly complex. Yet as practitioners of language, we routinely treat it as simple. Asked to explain what a table is, we might point to a wooden surface standing on four legs. Asked, in turn, to explain what that four-legged surface is, we might simply say, "table." That process, whereby one thing directly stands for or stands in for something else, works through substitution and, to some extent, equality. Meanwhile, if a metaphor names one thing as another, it might assert, or at least risk implying, that each one *is* the other. This is a fundamental illusion of language, frequently acknowledged, but only acknowledged to be refuted in terms of actuality. As T. S. Eliot wrote in his dissertation, "A sign has its existence beside its content, and it is just this separate existence—the fact that the sign might be misinterpreted or simply not recognized as a sign at all, which makes it a sign and not an identity" (*Knowledge and Experience* 48). However, with Pound's insistence on reflexivity, he demands that we give credence to the fantasy wherein words are identical to what they describe. He imagines a sign that is an identity, an ideogram that directly embodies its meaning, a metaphor that is an equation, a symbol that is its own referent. His poetics consequently fly in the face of some of the most fundamental tenets of literary criticism, because if words lead directly, automatically, and irrefutably to their meanings, interpretation becomes an automatic activity, and all agency returns to the poem itself.

Frege argued, in his early work, that equality cannot exist between things in the world; it exists instead between signs denoting those things. However, by the time he wrote about equality in "On Sense and Reference," he argued, instead, that an equality between signs marked the identity of their denotations—a theory which still allowed for differences in the connotations of signs. He reached this conclusion because "$a = a$ and $a = b$ are obviously statements of differing cognitive value [*Erkenntniswert*]; $a = a$ holds *a priori* and, according to Kant, is to be labelled analytic, while statements of the form $a = b$ often contain very valuable extensions of our knowledge and cannot always be established *a priori*" (151). Frege concluded that the difference between those two equations arose from the fact that we always know that $a = a$, because it is true by definition, whereas $a = b$ may or may not be true, and might impart new information about the identity of the denotations. Addressing the same problem, Russell writes:

> If *a* is identical with *b*, whatever is true of the one is true of the other, and either may be substituted for the other in any proposition without altering the truth or falsehood of that proposition. Now George IV. wished to know whether Scott was the author of *Waverley*; and in fact Scott *was* the author of *Waverley*. Hence we may substitute *Scott* for *the author of* "*Waverley*," and thereby prove that George IV. wished to know whether Scott was Scott. Yet an interest in the law of identity can hardly be attributed to the first gentleman of Europe. ("On Denoting" 485)

"Scott is the author of *Waverley*" has to differ from "Scott is Scott" because the former sentence has the potential to impart new information[61]; $a = b$ might tell us something we didn't already know, whereas $a = a$ follows simply from the meaning of "=."

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[61] In fact *Waverley*'s first edition, in 1814, appeared anonymously, and its authorship was a topic of eager speculation. When George IV invited Scott to dine with him in 1815, Scott's identity as the author of *Waverley* remained an open secret.

Russell and Frege each concluded that the difference between these statements arises from the fact that people might not know that differing signs indicate one and the same referent. On the other hand, in the sentence "Scott is Scott," it is impossible not to already know that. In this latter sentence, the identity of the signs forces attention toward the only other term in the statement: "is." While "Scott is the author of *Waverley*" is a statement about the identity of reference of two different signs, "Scott is Scott" becomes a statement about the nature of identity itself. Any analysis of that latter sentence must revert to interrogating identity, in full generality. The identical signs force us to reexamine what "is" is.

Pound wrote poems that characterize "is" and "=" with the same focused attention as does "Scott is Scott" or $a = a$. Frequently, repetition and tautology do that work directly in *Lustra*. However, even more often, Pound placed the same interrogative weight on reflexive identity without the repetition of signs that $a = a$ depends on. He wrote statements of the former sort ("Scott is the author of *Waverley*," "$a = b$") which nonetheless place all the same central force on the "is" or the "=." "In a Station of the Metro" never even states the "is," but it nonetheless stands upon and also interrogates that absent, unspoken verb. This is not tautology so much as an examination of the general relational forces that determine tautologies to always be true.

Precision and Self-reference

In "The Serious Artist" Pound writes that "the touchstone of an art is its precision" (48), that "By good art I mean art that bears true witness, I mean the art that is most precise" (44), and that "The more precise [an artist's] record the more lasting and unassailable his work of art" (46). "Space forbids me to set forth the program of the *Imagistes* at length, but one of their watchwords is Precision" ("Status Rerum" 126). Elsewhere Pound explains the necessity of defining Vorticism "with precision" ("Affirmations" 277). "Precise terminology is the first implement, / dish and container, / After that the 9 arts" (*Cantos* 731). After claiming that art provides an ethical compass, he attributes this contribution to pertinent precision: "If any science save the arts were able more precisely to determine what the individual does not actually desire, then that science would be of more use in providing the data for ethics" ("Serious Artist" 43). He speaks of "In a Station of the Metro" as an attempt "to record the precise instant" (*Gaudier-Brzeska* 89). For Pound, matters of value and communication in poetry repeatedly wrap up with reference to the paramount importance of this one reliable and consistent term: precision. He expounds on the necessity of precision over and over again, sometimes even tiresomely often.

In Canto VII, a lack of precision ties to social and linguistic decay:

> The old men's voices, beneath the columns of false marble,
> The modish and darkish walls,
> Discreeter gilding, and the panelled wood
> Suggested, for the leasehold is
> Touched with an imprecision… about three squares;
> The house too thick, the paintings
> A shade too oiled. (24)

Pound adds an ellipsis after "imprecision," as though such a thing will not bear further description. Of course, such trailing off is itself an enactment of linguistic imprecision, and as Pound goes on to describe the decay directly attributed to this leasehold's imprecision, his words themselves become imprecise: "modish," "darkish." The imprecision of the lease itself invades his language – "*about* three squares." Moreover, this linguistic decay continues to crescendo in the remainder of the canto, eventually resulting in "Thin husks I had known as men, / Dry casques of departed locusts / Speaking a shell of speech…" (26). Such images are disturbing. Considering Pound's continual focus on precision, accompanied by the increasingly deliberate vaguenesses scattered throughout, the entire canto becomes an allegory on the evils of imprecise writing, mirrored in imprecise monetary contracts. Imprecise writing itself becomes "a shell of speech"—what Pound elsewhere referred to as "florid rhetorical bombast" ("The Wisdom of Poetry" 359)—words with so little reliability as to deprive them of all sense.

Precision was a technical value for Pound, borrowing from more scientific conceptions of information and communication. He turned to it in an attempt to imbue lyrical writing with scientific certainty. He wrote about how an Imagist writer could "strip words of all 'association' for the sake of getting a precise meaning… He is objective" ("Status Rerum" 125). Equality, as a model for "is," can add some precision. Transitivity, symmetry, and reflexivity, the three mathematical properties defining equivalence relations, can precisely define what semblance has in common with identity, what "is" has in common with "is like." Further, the scientific and statistical definition of precision can explain Pound's particular use of this word and no other.

In statistics and experimental science, precision is opposed to accuracy: precision indicates how reliable and consistent a measurement is, while accuracy indicates how close that measurement is to the real value being measured. Precision refers to self-consistency, while accuracy refers to correspondence with the outside world. Although the two words were historically used as synonyms, M. Norton Wise establishes that the scientific distinction between them developed before the beginning of the twentieth century, originating in "the late nineteenth century, when the width of statistical distributions acquired a commonly cited measure, the standard deviation… and when machine-shop practice distinguished between the capacity to machine parts to match a pattern (precision) and the newly available capacity to machine parts to a precisely specified dimension (accuracy)" (8).[62] This distinction justifies Pound's consistent choice of precision over accuracy. Given his particular insistence on precision as necessary to render poetry a science, it is fair to read his use of the word under the scientific definition. "The serious artist is scientific in that he presents the image of his desire, of his hate, of his indifference as precisely that, as precisely the image of his own desire, hate or indifference. The more precise his record the more lasting and unassailable his work of art ("Serious Artist" 46). As he champions precision, Pound enacts the scientific definition of precision by using repetition and self-consistency in his own language.

Pound refers to accuracy occasionally, but with a rarity that suggests that he does not consider it synonymous with his watchword of precision. Moreover, where he does speak of accuracy, the context frequently aligns with the modern scientific usage, concerning realist correspondence rather than linguistic consistency. When Pound states that "Bad art is inaccurate art. It is art that makes false reports" ("Serious Artist" 43), he explicitly considers the truth or falsehood of the artistic representation—that is, its correspondence with reality—which can be scientifically termed a matter of accuracy but not of precision. "[I]n accurate terms … the phrases correspond to

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[62] Whitehead uses the two terms in a distinct and modern sense in his 1911 *Introduction to Mathematics* (28).

definite sensations undergone" ("Cavalcanti" 162). Accuracy concerns realism and sometimes phenomenology; precision concerns descriptive reliability, internal relations, and form.

There is some intermingling of these meanings, and occasionally Pound does use precision in a way that implies language's correspondence with the referents it describes: "By good art I mean art that bears true witness, I mean the art that is most precise. You can be wholly precise in representing a vagueness. You can be wholly a liar in pretending that the particular vagueness was precise in its outline" ("The Serious Artist" 44). Very often, accuracy and precision line up together, since even under their scientific definitions the same measurement or description can very often be both accurate and precise at the same time—that is, it can be both true to its referent and reliable in its use of terms.

However, even where reference is also involved, Pound's dominant, most overwhelmingly frequent uses of precision depend particularly on reliability, repetition, and linguistic constancy: "I am for the third or fourth time called upon to define, quietly, lucidly, with precision" ("Affirmations" 277). By defining the term again and again, Pound engages in precision. His very choice to return to that single term, precision, again and again, is itself an act of precision. Usage implies that Pound was attuned to the distinction between precision and accuracy, and he deliberately chose precision as the scientific term characteristic of his poetics.

The scientific definition of precision leads back to mathematics. As Wise points out, precision became distinguishable from accuracy due to advances in statistics. In fact, precision is an essentially mathematical concept, concerning the variation among numerical values, whereas accuracy is an empirical one, concerning the relation between numbers and reality. Precision emphasizes relations among descriptors and among terms, and as such Pound's choice of precision over accuracy has ramifications for the role of formalist analysis in his literary theory, because precision is essentially syntactic, addressing the reliability of a discourse, while accuracy is semantic, requiring comparison with outside values. Precision allows a retreat toward the relation of signifiers independent of their signifieds, which accuracy will not allow. Indeed, Pound's repeated, reliable use of the word precision is itself an epitome of precision, a way in which his poetics insist on their own internal reliability with their careful reuse of marked terms and values.

The resulting emphasis on self-consistent form is inflected with the methods of Hilbert's mathematical formalism, which I treated at some length in the previous chapter: in Hilbertian formalism, semantic content is not denied but deferred, elaborated by formal patterns which, in turn, ultimately serve to emphasize the importance of that content. Hilbert insisted on attention to forms and signifiers in mathematics not because he denied the importance of the signified, but because he argued that attention to patterns, structures, and relations among formal symbols could more completely and consistently provide a foundation for how mathematics ultimately applies to the world. Pound, in turn, was not a formalist in the sense of retreating to form in rebuke of content; instead, he demanded deep attention to the relations among forms because that attention could produce writing that more reliably and consequentially referred to the world. For Pound, precision actually led to accuracy, and mathematical form led to scientific application. He conceived the path from one to the other as indirect, but also as utterly reliable.

Precision is defined by repetition, and as such it requires reflexivity. This is not a matter of exact representation, but of the relationship signs have with themselves and with each other. When Pound describes "In a Station of the Metro" as an attempt "to record the precise instant" (*Gaudier-Brzeska* 89), it is tempting to read this as an assertion of the poem's faithful recording of his experience, but the tiny poem's abortive narrative and its fantastical metaphor make it difficult to read "In a Station of the Metro" as an example of realism. The crux of its interest and beauty seems to stem more from the relation of the faces to the petals than of either to what Pound may have actually seen in the Metro. In fact, Pound's insistence on precision here is another kind of insistence on the value of noticing that $a = a$, bringing us back to tautology and reflexivity.

More broadly, Pound's poetics involve frequent reiteration. His oft-repeated dictum "Make it new" is another precisely iterated, exacting phrase that offers nonetheless ambiguous meaning: repeat the old, but do not allow it to remain old. The apparent contradiction here is itself the crux of poetic interest. Ambiguity opens up within Pound's reliable precision just as generality is possible within mathematical exactitude. Pound recognized and seized on that interdisciplinary parallel, comparing literary and mathematical meaning because mathematics provided a fresh and well-defined conception of symbols' breadth of reference. Specifically, he turned to mathematical variables as a model for poetic meaning:

> Imagisme is not symbolism. The symbolists dealt in 'association,' that is, in a sort of allusion, almost of allegory. They degraded the symbol to the status of a word. They made it a form of metonymy. One can be grossly 'symbolic,' for example, by using the term 'cross' to mean 'trial.' The symbolist's *symbols* have a fixed value, like numbers in arithmetic, like 1, 2, and 7. The imagiste's images have a variable significance, like the signs a, b, and x in algebra. (*Gaudier-Brzeska* 84)

Pound deliberately models his Imagist symbols as mathematical variables because of their polysemy. His precision is certainly never meant to be reductive. Pound turns to mathematical signs for their crisply accurate ability to mean exactly what they claim to mean, but at the same time, and every bit as much, mathematical signs are attractive to Pound because of their generality, their ability to flexibly denote an extraordinary variety of signifieds as variables do. A variable such as x can easily denote an infinity of possible values (perhaps any number from 1, 2, or 3 all the way up, further than we can imagine) while the equation containing x may remain inarguably, absolutely, either true or false. We do not always need to know what x is to understand how it behaves. And, as Pound explained, "You can be wholly precise in representing a vagueness. You can be wholly a liar in pretending that the particular vagueness was precise in its outline" ("Serious Artist" 44). Pound aimed to be wholly precise while representing a vagueness, and he turned to mathematics in order to do so. In maintaining that vagueness could and should be represented with precision, Pound demanded a literary understanding not just of the ambiguities of the world, but also of how those ambiguities behave. He insisted that there can be certainty even amid and around ambiguity. Mathematical discourse can offer a kind of objective signification that is exceedingly rare elsewhere, and here mathematical linkage becomes particularly important because it remains utterly precise and self-consistent even while the objects of reference are general and undetermined. Pound demanded the same from poetry.

Elsewhere in Pound's broader poetics, the variable's flexibility within exactitude continues to illuminate his commentary on symbolism. Pound's rants against the gold standard are rooted in the same concern that symbols (whether words, ideograms, variables, or monetary currency) must never be forced into such stolid predictability as would kill their value, but must also never be allowed such total freedom as to escape all control. They must be well defined even as they remain beautifully ambiguous. Pound considers the symbolic problem constant in fields from literature and linguistics to mathematics and economics, and while mathematics provides the ideal symbols via variables, he assigns poetry the task of applying such ideal symbols to the living world.

The problem of how to represent generality with precision was important across fields in the modernist era. In the introduction to Part I of their *Principia*, Whitehead and Russell explain the values and aims that spurred their project:

> In the first place, it aims at effecting the greatest possible analysis of the ideas with which it deals and of the processes by which it conducts demonstrations, and at diminishing to the utmost the number of the undefined ideas and undemonstrated propositions… from which it starts. In the second place, it is framed with a view to the perfectly precise expression, in its symbols, of mathematical propositions: to secure such expression, and to secure it in the simplest and most convenient notation possible, is the chief motive in the choice of topics. In the third place, the system is specially framed to solve the paradoxes which, in recent years, have troubled students of symbolic logic and the theory of aggregates; it is believed that the theory of types, as set forth in what follows, leads both to the avoidance of contradictions, and to the detection of the precise fallacy which has given rise to them. (1)

The *Principia* was a project in mathematical precision, and its connections with writing and language become clear in this selection. Whitehead and Russell's first aim—"diminishing to the utmost the number of… undefined ideas and undemonstrated propositions"—could be a goal of any careful writer. Their second aim parallels and resembles Pound's repeated calls for anchored and concise writing. The *Principia* was an attempt to formalize the entire basis for mathematics within logic, setting down the exact terms and rules that could make mathematics spring forth from the field of reasoning that had previously been considered the domain of philosophy. The convergence of communicative values across disciplines is striking here: like Pound, Whitehead and Russell aimed for precision, consistency, standardized terms, and scrupulous definition.

Russell and Whitehead emphasize the avoidance of contradiction in the third aim listed above. There they refer particularly to certain mathematical paradoxes discovered around the turn of the twentieth century. Most famous among these is Russell's paradox, which uses self-reference to generate contradiction—anathema to mathematics—at the heart of set theory. Here self-reference is the process whereby a statement or formula refers to itself or to its own referent. "This is a sentence about itself" would be one such example. Russell's Paradox, using such loops of self-reference, instructs us to imagine the set of all sets not containing themselves, and then to ask ourselves if it contains itself. Such a set becomes manifestly impossible, because if it contains itself, then it cannot contain itself, and if it does not contain itself, then it must contain itself. This tangle in set theory is related to the older and more widely known liar's paradox: if I tell you that "I am lying right now," then either the truth or falsehood of my statement leads to contradiction and impossibility. Modernist mathematicians formulated a series of these kinds of self-referential statements which all pointed toward paradoxes in set theory, causing some panic about the possibility that set theory—arguably the most foundational among all mathematical fields—might be inconsistent.

In response to these paradoxes, Russell and Whitehead became particularly concerned by self-reference in mathematics, developing the extensive and controversial theory of types in an attempt to expel contradictory self-reference from mathematics. This theory was among the most questioned aspects of the *Principia*, because it seemed inelegant and philosophically unjustified; here the goal of consistency led to strange methods. Later, in 1931, self-reference again led to dashed hopes for very many modernist mathematicians, even as it also originated the utility of much modernist mathematics: dashed hopes, because self-reference enabled Kurt Gödel to show that consistency could not be proven without stepping outside the system; utility, because with the ensuing understanding of self-reference the *Principia* and Gödel together laid the groundwork making computer science possible. Self-reference is critical to how computers can execute complex algorithms, allowing the machine to "think" recursively: the programmer provides only a relatively short set of self-referential instructions, and the computer then executes and re-executes those instructions in application to a vast array of situations. Though sometimes generating beastly contradiction, self-reference proved critically fruitful for twentieth-century mathematics, science, and technology.

Self-reference can describe Pound's precisions upon precisions, his repetitions, and his voluminous poetics that turn inward to self-consciously explain, promote, and interpret his own poetry and poetics. His frequent tendency to quote himself offers the most literal self-reference. In 1910, in *The Spirit of Romance*, Pound published an analysis of how Cartesian geometry could inform literary form and meaning (127); then in 1912, in "The Wisdom of Poetry," he repeated the claim that the Cartesian formula for a circle could model the relationship between literary form and meaning (362); in 1914, in "Vorticism," he published exactly the same explanation, this time in more expanded form; finally, in 1916, he republished "Vorticism" in its entirety in his *Memoir of Gaudier-Brzeska*, explaining that "I reprint that article entire because it shows our grounds for agreement… we wished a designation that would be equally applicable to a certain basis for all the arts" (*Gaudier-Brzeska* 81). Pound underlines the possibility of equal application, of intrinsic repetition, across fields, and it's no coincidence that he repeats the article, because repetition is part of the point. This kind of self-quoting in Pound's work is frequent, a longer-form version of his reiterations about precision. Such repetition exemplifies self-reference by offering language that refers to itself and loops back upon itself. Pound was drawn to self-reference as an explanatory tool, re-hashing and re-interpreting his own words in a kind of performative, ongoing textual reinterpretation.

Self-reference in literature naturally prompts formalist analysis, because where writing insistently refers to itself, in lieu of that which exists outside of itself, readers are left with only form to consider. At the same time, however, the analysis of form is not necessarily formalism, and neither is the analysis of formalism the same as formalism. This applies across fields. Frege, Russell, and Whitehead were all profoundly interested in the role of form and symbolism in mathematics, and in the relationships that mathematical signs had with themselves and with each other. However, none of them were true formalists, because they did not argue that mathematical objects fundamentally *are* forms, nor even, as Hilbert did, that mathematical objects should be treated as though they are forms. Frege, Russell, and Whitehead emphasized the importance of signs and symbols in mathematics, and they investigated the relationship between mathematics and language, without claiming that form was all that mathematics (or language, for that matter) was.

Mathematics makes a distinction between formalism and formalization. The *Principia* was a formalizing work: it was profoundly concerned with the role of symbols, notation, and language in mathematics, and it used mathematical methods that were formally precise.[63] It also aimed for the same consistency and completeness which Hilbert's program sought. However, the *Principia* was not formalist because it did not claim that mathematical objects are fundamentally forms or signs on paper (nor even, like Hilbert's program, that mathematical objects should be treated as such). For

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[63] That is: it endeavored to formalize mathematical proofs, demonstrating facts which had already been known but using much more rigorous methods than had previously been deployed; and it followed the axiomatic method whereby assumptions, definitions, and rules of inference are formally stated prior to the proof of any theorems, which thereby develop as consequences of the explicit assumptions.

philosophers of mathematics, formalism is a philosophy which claims that mathematics is a study of forms, while formalization is a methodology that involves many of the approaches and values associated with formalism, but none of its ontological claims. While formalism is one perspective that mathematicians may or may not subscribe to, formalization is a vital, even indispensable method in both the pedagogy and practice of pure mathematics.

Pound, I argue, was a formalizer and not a formalist. He was firm in the belief that writing should be immediately useful, that its content should offer direct applications for life, behavior, and politics, and thus he was unwilling to subscribe to any version of true formalism. However, his deployments of form in poetic practice, and his instructions to other poets regarding how they should deploy poetic forms, did not necessitate any formalist claims that form is all that poetry is. Instead, Pound developed a theory of form—independently reaching the same definition of form offered by Russell—which enabled rigorous thinking about content and worldly application in modernist poetics while, almost inadvertently, laying the logical groundwork for completer, purer formalisms.

Arrangement and Abstraction: An Interdisciplinary Definition of Form

Formalism in any field denies or defers the application of written symbols to outside referents. In consequence, formalist analysis and methodology naturally turns inward upon itself, resulting in expanded analysis of internal relations, consistencies and inconsistencies, and tangles of self-reference. Where signs are not allowed to refer to the outside world, they are left referring to themselves. New Criticism's ongoing emphasis on tension, conflict, irony, and paradox is a natural literary result of its interpretive focus on written form and, as a consequence, form's internal relations. When Cleanth Brooks writes that his "primary concern is with the work itself as a structure of meaning" (xi) and then that "paradoxes spring from the very nature of the poet's language" (5), he lays out how attention to the structures and patterns intrinsic to literary form force an attention to paradox. Because, unlike the structures embedded in mathematical form, the structures of literary form are not consistent: "paradox is the language appropriate and inevitable to poetry. It is the scientist whose truth requires a language purged of every trace of paradox; apparently the truth which the poet utters can be approached only in terms of paradox" (Brooks 1). While science and mathematics naturally abhor contradiction, poetry depends on contradiction to communicate complexity; it is bored by total consistency.[64] However, in any field, the analysis of form indicates, even necessitates, the analysis of contradiction, and that fact applies equally whether we embrace contradiction or excommunicate it. In fact, contradiction necessarily entails a kind of Poundian repetition and self-reference, insofar as, mathematically, contradiction can always be boiled down to $x \neq x$, or to P and not P. Pound saw this fact. It was in this way that he sought a mathematically consistent, repetitive, self-referential poetics which was nonetheless capable of articulating a path toward complex poems, with all their contradictions.

[64] Despite his fascination with true and total consistency, even Pound could take consistency only so far in his poetry. In the following chapter I will point to "The Game of Chess" (*Personae* 124) as one moment when Pound does reach a kind of total consistency, but it results in a poem that does not offer as much interest or complexity as it could. Pound subtitled that poem a "Dogmatic Statement," as though announcing the fact that it was more poetics than poem. See also Charles Altieri, *Painterly Abstraction*, 291-3.

Pound's explanation of how mathematical form relates to literary form, and of how either form relates to the world, works by pattern and self-reference, and by repetitions and parallels:

> The pine-tree in mist upon the far hill looks like a fragment of Japanese armor.
>
> The beauty of this pine tree in the mist is not caused by its resemblance to the plates of the armor.
>
> The armor, if it be beautiful at all, is not beautiful *because* of its resemblance to the pine in the mist.
>
> In either case the beauty, in so far as it is beauty of form, is the result of "planes in relation."
>
> The tree and the armor are beautiful because their diverse planes overlie in a certain manner. (*Gaudier-Brzeska* 120-1)

Further down the page, Pound concludes:

> This is the common ground of the arts, this combat of arrangement or "harmony." The musician, the writer, the sculptor, the higher mathematician have here their common sanctuary (121)

Poetry and poetics converge in this short verse-like piece that seems to enact the very art it explains. Stacked, flat paragraphs recall the overlaid, parallel planes that Pound describes. The pine tree is not beautiful because of its resemblance to the Japanese armor, and neither is the Japanese armor beautiful because of its resemblance to the pine tree; instead, these separate objects collectively generate beauty in their non-causal but parallel relation. Like the faces and petals of "In a Station of the Metro," these terms come together via abstract relation, as each lies above the next, lines in parallel. Each line exists in a kind of equality with the next, as Pound steps from resemblance ("The pine-tree… looks like a fragment of Japanese armor") to union ("This is the common ground of the arts"). Pound constructs levels of parallel terms to allow us to contemplate how such items can formally inform each other even without any direct contact, and thus how, without direct intersection but via common form, two levels can exist in an equivalence relation with each other.

"Level," in the sense of things being level with one another, is the original Latin root of equation, equivalence, and equality: *aequus*. Pound's levels, his parallels, offer a way to envision relation between term and referent as well as between term and term. Here parallelism also describes the relation between mathematical and literary description, for just as parallel lines share a direction without ever intersecting, so do these interdisciplinary modes of signification resonate formally from across their respective fields, even without any intersecting content. In fact, this disciplinary distance, the reliable refusal to make contact, can define the parallelism.[65] The worldly removal between literature and mathematics, and, practically speaking, between signifier and signified, allows for a more precise articulation of exactly what they do share in common, because it allows articulation of parallels without collapse into sameness. Pound is careful to tell us that this beauty is symmetric, as are the two sides of one equation: $a = b$ no more than $b = a$. The beauty of the pine tree does not derive from the beauty of the armor and neither does the beauty of the armor derive from the

[65] Mathematically, there do exist other ways to define parallelism, such that parallelism remains meaningful in projective geometry, where distance is not defined, and such that parallel lines can be defined as those that intersect only at infinity.

beauty of the pine tree. Instead, beauty develops from the common parallelism of these "planes in relation."

Mathematically, parallel lines are those that, within a plane, run in exactly the same direction, pointing the same way and thus never intersecting. Parallel lines can be relied upon to have exactly the same distance from each other, anywhere, all along their length in both directions. If they are two inches apart here, I know they will still be two inches apart over there, and that anywhere where I can find one line, I will find the other exactly two inches away. Parallelism fits the modern definition of an equivalence relation. That is, it is reflexive (line *A* is parallel to itself),[66] symmetric (if line *A* is parallel to line *B*, then line *B* will be parallel to line *A*), and transitive (if line *A* is parallel to line *B*, and if line *B* is parallel to line *C*, then line *A* must be parallel to line *C*). In this sense, parallel lines are equal even though they might be distinct from one another, because there is at least one aspect (direction) in which they are identical, although they can differ completely in other aspects (position). Parallels, and, more broadly, the abstraction of equivalence relations, provide a precise definition of how common form can exist among differing things.

Russell writes that "the absence of all mention of particular things or properties in logic or pure mathematics is a necessary result of the fact that this study is, as we say, 'purely formal'" (*Mathematical Philosophy* 198). He goes on to explain what he means by form: "The 'form' of a proposition is that, in it, that remains unchanged when every constituent of the proposition is replaced by another. Thus 'Socrates is earlier than Aristotle' has the same form as 'Napoleon is greater than Wellington,' though every constituent of the two propositions is different" (199). In fact, the only segments common to both sentences are "is" and "-er than," because their meanings, like the meaning of "=" and ">," are exclusively relational. According to Russell, form, by definition, never depends on concrete things. Instead, it exists in the relationships between terms irrespective of the terms themselves. Form becomes a recognizable arrangement of things that can exist completely independent of those things. And it can, thus, apply to very many different things.

Meanwhile, in *Gaudier-Brzeska*, Pound describes the beauty of form as dependent on "relation" (121). He writes that "by 'form' I mean the arrangement" ("The Wisdom of Poetry" 360). Pound's definition of form lines up with Russell's. It is, in fact, the same definition of form

> [W]hat do I mean by "forms well organised"?
>
> An organisation of forms expresses a confluence of forces. These forces may be the "love of God," the "life-force," emotions, passions, what you will. For example: if you clap a strong magnet beneath a plateful of iron filings, the energies of the magnet will proceed to organise form. It is only by applying a particular and suitable force that you can bring order and vitality and thence beauty into a plate of iron filings, which are otherwise as "ugly" as anything under heaven. The design in the magnetised iron filings expresses a confluence of energy. It is not "meaningless" or "inexpressive."
>
> There are, of course, various sorts or various subdivisions of energy. They are all capable of expressing themselves in "an organisation of form." ("Affirmations" 277-8)

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[66] This is actually a matter that varies under some mathematical definitions. Not all systems would define a line as parallel to itself. These definitions depend on convention and on the aims of the context in which they are used. Most treatments of equivalence relations regard parallelism as one example of an equivalence relation, and, if we define parallelism as reflexive, then that is definitely the case.

Form, whether scientific or literary, becomes meaningful via organization. Form is a generalized abstraction, and "the really great artists have seldom been without this faculty for generalization" (*Gaudier-Brzeska* 20). The type of force is generalizable, since it may be "the 'love of God,' the 'life-force,' emotions, passions, what you will." When Pound writes that "the energies in the magnet will proceed to organize form," he does not describe any particular means by which the energies will organize form; he has no interest in the specifics of how magnets work. Instead he tells us only that there are "various sorts or various subdivisions of energy." Focusing on organization, Pound describes form in abstraction from content. However, this formalism, this formalization, nonetheless leads to meaning: the design of iron filings "is not 'meaningless' or 'inexpressive.'" Objects are "capable of expressing themselves in 'an organisation of form.'"

While Russell defines the form of a proposition as that which remains when all of its constituents are replaced by other constituents, Pound strives to articulate a poetics that is capable of remaining meaningful even if its constituents are altered and replaced. That generality becomes necessary because he means to write simultaneously about poetry, painting, sculpture, music, economics, mathematics, and physics; he does so with the belief that so many fields share patterns, not content, in common. He, like Russell, believed that language offers exactly one thing beyond its constituents: that lone other thing is its relations and arrangements. For both Pound and Russell, that lone other thing is exactly the definition of form.

Pound argues that poetry and mathematics alike offer forms that ultimately both describe and determine the outside world. Form exists as the originating abstraction behind application, description, and understanding:

> The poet's true and lasting relation to literature and life is that of the abstract mathematician to science and life. As the little world of abstract mathematicians is set a-quiver by some young Frenchman's deductions on the functions of imaginary values—worthless to applied science of the day—so is the smaller world of serious poets set a-quiver by some new subtlety of cadence. ("Wisdom of Poetry" 361)

Form's relation to the world is both "true and lasting," but it is also terribly abstract. Here Pound does offer a relatively specific anchor for poetic form—"some new subtlety of cadence"—but his version of such an anchor for mathematical form is more abstract. To indicate "imaginary values" he could have, more conventionally, referred to complex numbers. However, Pound preferred the former term with all its fantastical connotations. Imaginary: that which does not actually exist. "Great works of art contain this… sort of equation. They cause form to come into being. By the 'image' I mean such an equation; not an equation of mathematics, not something about *a*, *b*, and *c*, having something to do with form, but about sea, cliffs, night, having something to do with mood" (*Gaudier-Brzeska* 92). Again, Pound places equations at the basis for artistic representation, but, again, he portrays abstract form as even more fundamentally mathematical. As Pound insists that abstraction and generalization are at the heart of form—that is, of arrangement distilled from content—he also positions mathematics as the purest locus for such generalizable abstraction. He places mathematics at the origin for poetic form.

Pound conceived universals as mathematical:

> [T]he equation $(x - a)^2 + (y - b)^2 = r^2$ governs the circle. It is the circle. It is not a particular circle, it is any circle and all circles. It is nothing that is not a circle. It is the circle free of space and time limits. It is the universal, existing in perfection, in

> freedom from space and time… [Thus] we come upon a new way of dealing with form. It is in this way that art handles life. The difference between art and analytical geometry is the difference of subject-matter only. Art is more interesting in proportion as life and the human consciousness are more complex and more interesting than forms and numbers. (*Gaudier-Brzeska* 91)

Pound ultimately turns to art as more complex, more interesting, and more important than mathematics. However, mathematics remains as the logical basis and the fundamental origin point. Mathematics is useful because it is capable of articulating absolute homologies. Where there are commonalities, mathematics can characterize both the boundaries and the nature of those commonalities with total exactitude. The equation for the circle describes the form of any and all circles with complete exactitude. Here Pound writes particularly about Cartesian geometry: the means by which mathematical equations can be plotted in two (or more) dimensions to map out shapes, lines, visual forms. With this geometry Descartes actually developed a kind of early precursor to the modernist equivalence relation. He could not articulate the common form of all equivalence relations, but he was able to translate back and forth between two equivalence relations—between arithmetic equality and geometrical congruence. Descartes could translate numerical values into visual forms, and vice versa, and it is in this way that "we come upon a new way of dealing with form. It is in this way that art handles life."

One crucial commonality between mathematics and literature remains: the written symbol on paper. In 1922 Hilbert wrote, from the perspective of mathematics: "The solid philosophical attitude that I think is required for the grounding of pure mathematics—as well as for all scientific thought, understanding, and communication—is this: *In the beginning was the sign*" ("New Grounding" 202). For Hilbert, written form worked as a foundation for mathematics and communication alike. Hilbert placed signification at the basis for mathematics. Ten years earlier, when Pound took up the generative relation of written signs to the outside world, he did so in analogy with the role of written signs in mathematics:

> A certain man named Plarr and another man whose name I have forgotten, some years since, developed the functions of a certain obscure sort of equation, for no cause save their own pleasure in the work. The applied science of their day had no use for the deductions, a few sheets of paper covered with arbitrary symbols—without which we should have no wireless telegraph. ("The Wisdom of Poetry" 361)

Because these written deductions exist "for no cause save their own pleasure in the work," worldly applications, interpretations, and resonances seem to emerge as a remarkable aftereffect. More directed creation is possible: Plarr could have set out deliberately to engineer the wireless telegraph. But crucial for Pound is the fact that Plarr did not do so, focusing instead on "a few sheets of paper covered with arbitrary symbols."

Secondary mathematical applications allow Pound to seize on a formalism—a formalization—that has it both ways. The poem is pure and ideal as marks on paper. Yet, like Plarr's derivations, Pound considers it to mathematically determine the outside world, even as he places it in a tower far above that world. However arbitrary the individual signs, Pound makes clear that this is no mere game. "Is the formula nothing, or is it cabala and the sign of unintelligible magic? The engineer, understanding and translating to the many, builds for the uninitiated bridges and devices. He speaks their language. For the initiated the signs are a door into eternity and into the boundless ether" ("The Wisdom of Poetry" 362). Perhaps a scientist will translate to the real world later. Probably readers will apply poems to their own lives. However, the original value lies not in the application, but in the creative signifying moment. Pound considers mathematics a controlling literary language with an expansive and creative destination: "the signs are a door into eternity and into the boundless ether." Under these interdisciplinary formalist values, writing does not merely describe: it exists as the cause of both knowledge and action. In the end, by dodging the more complicated, less absolute mechanisms of metaphor and symbolism, Pound is able to imagine a fundamentally interdisciplinary means of organizing thought, which grants mathematics the foundational starting point but reserves for poetry the basis of value. Here writing is capable of generating a potentially determinate force, setting logical consequences in motion by way of relation. Pound's account of form and meaning cannot be made to line up with Saussure's vision of signification, because signifier and signified do not exist, here, in any interchange of mutual dependency. Instead, form comes first. Meaning is the effect.

Equality works as a model for Pound's formal reference because it tables the material mechanisms of reading as well as the ambiguities of writing (without foreclosing or disowning either), instead directly marrying the symbol to its reference. That direct connection is in some sense empirically impossible, recalling Pound's assertions about the radical transparency of the Chinese ideogram, which don't stand up to the more conventional realities of Chinese language. However, the fact that this explanation involves a kind of mythos underscores the fact that readings directed particularly at form always involve a methodology that attempts to isolate and elevate texts even as those texts can never truly be separated from their contexts. The paradoxical nature of this process aptly describes the richness and complexity of language itself, which, as it describes or refers to that which is outside itself, simultaneously develops itself as an entity unto itself. In fact, here form points toward meaning even as any form, when carefully analyzed, reveals fundamental abstraction in its arrangement and organization. Pound's theory of representation—even representation that prompts concrete action—is abstract rather than empirical. By postulating the relationship between signifier and signified as an equation, Pound better accounts for language's reflexive and self-referential processes: the way in which language always seems to be talking about itself.

Chapter Three

From Axiom to Leap of Faith: T. S. Eliot's Formal Systems

> April is the cruelest month, breeding
> Lilacs out of the dead land, mixing
> Memory and desire, stirring
> Dull roots with spring rain.
>
> Eliot, *The Waste Land*[67]

The Waste Land begins from a beginning: the first line of *The Canterbury Tales*, an origin of English verse, "Whan that aprill with his shoures soote" (23). That beginning is temporal more than it is philosophical; Chaucer offers Eliot a literary beginning because Chaucer came before Eliot. April offers another beginning, again temporal, as the point on the calendar when spring arrives, when lilacs sprout from "out of the dead land." But this April, imbued with the memory of Chaucer's aprill, spurs time forward without offering any explanation of the basis for change. In this way, "April is the cruelest month" perhaps because it "breeds" so visibly without explaining itself, "mixing / Memory and desire" in an uncomfortably opaque fusion of past and future, so that its existence as a visible beginning only makes more apparent our ignorance of how beginnings begin. April's rain might cause lilacs to grow from "out of the dead land," but April cannot tell us why there are lilacs. These lilacs have origins in the passing of the seasons, in Chaucer, and in time, but if they have more ultimate origins, Eliot has not presented those origins here. Chaucer might well have spurred Eliot to write *The Waste Land*, might even have caused *The Waste Land*, but he is not enough to explain the existence of *The Waste Land*. In this way, the beginning of *The Waste Land* exposes the incompleteness of its own beginnings.

This chapter traces Eliot's search for another kind of origin—a logical origin, a philosophical origin, a religious origin. Such an origin would offer a starting point capable of both creating and explaining unity, a starting point both necessary and sufficient to that which follows from it. The search for an origin such as this was continuous, I argue, across Eliot's long career. Indeed, that search determined the very shape of Eliot's career. The origins Eliot sought, I argue, were actually made solid and unassailable by their very uncertainty. From before *Prufrock* to the end of his life, the beginnings he demanded and ultimately embraced were not facts but logical leaps of faith, secular as well as religious.

This chapter will trace an ambivalent preoccupation with unproven assumption that emerges throughout Eliot's early poetry and prose, and will locate a unity between those troubled early suppositions and the religious faith that Eliot championed in his late work. That unity, I argue, is formal and logical in nature, described and determined by the axiom systems of formal mathematics which Eliot had studied at Harvard as a doctoral student in philosophy. Formal mathematics always begins from some clearly stated definitions, rules, and axioms—that is, unproven assertions—which it simply postulates or assumes. All the reliability of mathematical proofs then depends on those axioms—which are by definition unproven, simply believed. It is not only mathematics that works in this way. Reasoning begins from premises. Structures stand upon foundations. Patterns must begin with some basic element, some atom or atoms to be repeated and rearranged. In all of these cases, knowledge and form have to begin from some starting points, and whether or not those starting

[67] *Collected Poems* 53; hereafter cited in this chapter as *CP*.

points might be named, their certainty and solidity cannot be proven. Eliot claimed, very unconventionally, that his movement toward religion was motivated not by the conviction that Anglo-Catholic doctrine was true, not even by the belief that it was true, but by the conviction that it was necessary to assume its truth in order to found a coherent system. Eliot, at least initially, did not so much believe in God as he believed that he must choose to believe in God—because that choice was capable of establishing knowledge and cultural forms. That process is fundamentally logical in nature, and it entails complex, novel definitions of system and form.

I argue that Eliot ultimately used Russell's formal systems to imagine poems as infinitely intricate patterns built from finite starting points. Eliot conceived of the most complex poetic forms as axiom systems, wherein something must be assumed for something else to be known, and wherein whole aesthetic universes develop from mere handfuls of beliefs and linguistic links. Ultimately, this understanding of formal systems, as they exist in mathematics, explains Eliot's vision of how we should read and interpret form. Across Eliot's work, suppositions offer a basis for intricate pattern, and then pattern flirts with superficiality as it offers depth, and imagines its own meaninglessness as it attains meaning. At the end of this chapter, I read Eliot's claims that poetry is autotelic alongside his own poetry's troubled visions of meaninglessness. This formalism has roots in mathematical form, in the counterintuitive fact that the unproven can offer proof. Here poetic meaning repeatedly emerges from the performance of meaninglessness. Because, for Eliot, poetry describes the world by questioning its own ability to describe the world.

Uncomfortable Beginnings

In Eliot's late poetry, beginnings both reveal and originate unified pattern and knowledge: in *Four Quartets*, "In my beginning is my end," and, at the same time, "In my end is my beginning" (*CP* 182, 190). Those lines, standing as the first and final words of "East Coker," in fact fulfill their own claims, each referring to the other. Thus, very literally, the end does lie in the beginning and the beginning does lie in the end. They form a system that loops back upon itself, a unit that describes itself.

Compare that to "Portrait of a Lady," where "our beginnings never know our ends!" (*CP* 11). This latter statement feels distasteful, coming from the mouth of a woman both desired and detested. The exclamation point seems both excessive and empty. The statement stands in parentheses, an afterthought, almost dismissed. In fact, it exists as a kind of acknowledged sexual rejection embedded in flirtation, while the lady seems to regret spurning the speaker since now he spurns her: "'Perhaps you can write to me… I have been wondering frequently of late / (But our beginnings never know our ends!) / Why we have not developed into friends'" (11). The lady claims ignorance of a future she could have controlled, and the speaker seems to imply that the beginnings *should* contain the ends, should foster some foreknowledge. Here, if beginnings do not contain their ends it is because women are fickle. And the misogyny directed at this lady is marked: her "voice returns like the insistent out-of-tune / Of a broken violin on an August afternoon" (*CP* 10).

Yet claims such as hers, that "our beginnings never know our ends," get repeated across Eliot's early poetry, from "The Love Song of J. Alfred Prufrock" to *The Waste Land*, usually from the mouths of sexualized, apparently empty-headed women, yet repeatedly returned to as though to indicate their distasteful inevitability, their necessity, their uncomfortable truth. In "Portrait of a Lady" the beginnings make apparent the unattainability of wholeness. The opening lines describe the lady's arrangement of the mere appearance of affection: "Among the smoke and fog of a December afternoon / You have the scene arrange itself—as it will seem to do— / With 'I have saved this afternoon for you'" (8). Here "among… the ariettes / of cracked cornets," nothing coheres (9). Eliot seems to mourn the absence of the propositional unity he later develops in *Four Quartets*. In Eliot's early work, beginnings are everywhere attended to but everywhere inadequate.

"Portrait of a Lady" contains also a kind of precursor to *The Waste Land*'s April lilacs, here emptier, a more markedly inadequate beginning:

> Now that lilacs are in bloom
> She has a bowl of lilacs in her room
> And twists one in her fingers while she talks.
> 'Ah, my friend, you do not know, you do not know
> What life is, you who hold it in your hands';
> (Slowly twisting the lilac stalks)
> 'You let it flow from you, you let it flow,
> And youth is cruel, and has no remorse
> And smiles at situations which it cannot see.'
> I smile, of course,
> And go on drinking tea.
> 'Yet with these April sunsets, that somehow recall
> My buried life, and Paris in the Spring,
> I feel immeasurably at peace, and find the world
> To be wonderful and youthful, after all.' (*CP* 9-10)

This lady has lilacs in her room with empty, superficial cause: they are there because they are in bloom, which is to say that they are there simply because they are there to be placed there. April produces lilacs, and so there are lilacs. And the lady idly kills these lilacs, cutting them off at the stalk and twisting them idly in her hands while she accuses the speaker of failing to understand and value life and youth. Readers may be primed to read lilacs as a site of aesthetics, as symbols of poetic beauty, but these lilacs are not valued so much as they are simply there.

If "Portrait of a Lady" contemplates inadequate beginnings, and if *The Waste Land* begins from a beginning that discloses its own failure to act as a complete foundation, "Prufrock" begins from a refusal to locate any foundation, an urge toward movement that claims no beginning: "Let us go then, you and I" (*CP* 3). "Then" should typically follow something, some previous reality or some conditional situation, some "first" or some "if." But here Eliot presents nothing that precedes the urge to forward movement.[68] The imperative "let us go" appears three times in the first stanza:

[68] Except, perhaps, the epigraph from Dante. Yet that epigraph too underscores an absence of foundational cause, because Eliot's selection from the *Inferno* details not so much a reason to speak as the absence of a reason not to speak:

> S'io credesse che mia risposta fosse
> A persona che mai tornasse al mondo,
> Questa fiamma staria senza piu scosse.
> Ma perciocche giammai di questo fondo
> Non torno vivo alcun, s'i'odo il vero,
> Senza tema d'infamia ti rispondo. (*CP* 3)

> If I thought that I were speaking to a soul

Let us go then, you and I,
When the evening is spread out against the sky
Like a patient etherised upon a table;
Let us go, through certain half-deserted streets,
The muttering retreats
Of restless nights in one-night cheap hotels
And sawdust restaurants with oyster-shells:
Streets that follow like a tedious argument
Of insidious intent
To lead you to an overwhelming question…
Oh do not ask, 'What is it?'
Let us go and make our visit (3)

The speaker repeatedly urges himself, his interlocutor, and his reader to step forward, and repeatedly refuses to provide any causal statement, any justification of why they should do so. When his steps threaten to lead him back to the question of origins, of meaning, of why he does as he does, he trails off in ellipses and then forestalls the question by repeating the unsupported imperative: "Oh do not ask, 'What is it?' / Let us go."

Imperative forms don't require justification, but simply command the action they describe. However, while the second-person imperative "go" involves a speaker commanding a listener to go, without need for justification, the first-person imperative "let us go" typically frames the command as contingent on the agreement of some outside party. That is, in conversation, "let's go" usually implies both that I have decided to go and that I am seeking your agreement to do so. But if the first line of "Prufrock" addresses the reader, any such request for consent is a conceit, because the reader cannot change the lines that follow. In fact, as the reader reads, the speaker is already going through those "certain half-deserted streets" and the reader is already accompanying him. In this way, "Let us go then, you and I" disguises a decision as an invitation and masks an inevitability as a choice.

But the "you" in "Prufrock" slips unstably between the reader and the lady, or ladies, whom Prufrock both lusts after and despises. "Let us go then, you and I" thus on the one hand describes an assumed but unexplained movement through the poem, and on the other hand a predetermined but unsupported movement through life. In both cases, the assertion fulfills itself inevitably and circularly: the readers must already have followed Prufrock word-by-word to note that he has commanded them to do so, and the lady in question, like Prufrock himself, grows older in the time it takes to note that she has no choice but to do so. "Let us," in "Prufrock," asserts that some things just happen, even without foundation, just as the lilacs grow every spring with or without any human understanding of how the seasons could have started in the first place.

This "let us" construction recurs three times in "Portrait of a Lady" as well, each time following upon a kind of emptiness, and urging a new action that seems similarly empty.

And I must borrow every changing shape
To find expression… dance, dance

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who someday might return to see the world,
most certainly this flame would cease to flicker;
but since no one, if I have heard the truth,
ever returns alive from this deep pit,
with no fear of dishonor I answer you. (Dante 317)

Like a dancing bear,
Cry like a parrot, chatter like an ape.
Let us take the air, in a tobacco trance (12)

In "Prufrock" and "Portrait of a Lady" alike, the imperative to do something new, to take a walk, to take in the air, always fulfills its own movement, yet that movement only leads back to the same sort of unanswered questions: "Would it have been worth while," "and should I have the right to smile?" (6, 12). We begin without answers, and we end without answers. As Charles Altieri has written, "Prufrock" "den[ies] all claims to a true order of significance beyond the meanings attributed by the dramatized consciousness" ("Steps of the Mind" 185). That is, it asserts that there is no meaning that has foundations deeper than the vicissitudes of individual human choices.

This path from the unknown to the unknown has received much critical attention in terms of its affect, in terms of its fragmentation, and in terms of what, in retrospect, exemplifies a search for religion. But while scholars have typically seen here a dismal cultural and personal state that Eliot described via unanswered questions and unmotivated movements, I will argue the opposite: that *Prufrock*'s and *The Waste Land*'s dismal states were only ways to describe what Eliot saw as the logical necessity of unjustified movement and of unsupported assumptions. Later, in *Four Quartets*, Christianity became another way to describe the same logical necessity.

Seeking Foundations

In the spring of 1914, as a doctoral student in philosophy at Harvard, T. S. Eliot took Bertrand Russell's graduate course in Advanced Logic. For that course he studied Giuseppe Peano's reconceptualization of arithmetic and Georg Cantor's categorizations of infinity. He read Gottlob Frege's *The Foundations of Arithmetic* as well as all three volumes of Russell and Alfred North Whitehead's monumental *Principia Mathematica*. The former text claims to define the sense in which mathematical objects exist in the world. The latter spends just short of 2000 pages, in the technical language of symbolic logic, endeavoring to describe and derive *all* major mathematical ideas and reasoning methods. Eliot's 66 surviving pages of notes on the *Principia* and on Russell's mathematical lectures are extensive, detailed, and mathematically precise.[69] They provide so good a record of Russell's work as to have drawn attention among logicians and philosophers of mathematics.[70] Eliot's study of mathematical logic and the philosophy of mathematics involved extremely technical knowledge and skill, and Brand Blanshard recalls that, in December of 1914 (half a year after Russell's course had concluded) Eliot "sat at the dining room table each morning with a huge volume of Russell and Whitehead's *Principia Mathematica* propped open before him. He had a certain facility in dealing with its kind of symbols; he said that manipulating them gave him a curious sense of power" (32). Eliot studied this material deeply, and Russell described Eliot as "one of my best pupils" (Eliot, *Letters* I 129). But while philosophers and historians of mathematics have noted Eliot's knowledge of this material, which was cutting edge in his era, literary scholars have neglected Eliot's study of logic and mathematics entirely.

[69] Held at the Houghton Library at Harvard.
[70] Bernard Linsky is preparing a forthcoming book on Russell which will include a complete transcription of Eliot's notes as a record of Russell's thinking. While Linsky identifies a handful of errors in Eliot's notes, they are the equivalent of typos: minor mistakes to be expected in any handwritten notes.

What Russell, Whitehead, and Frege sought to do was, literally and completely, to locate the ultimate foundations of their field. Indeed, the modernist era in mathematics which this dissertation treats had, at its center, the *Grundlagenkrise*, the foundational crisis in mathematics, a period from about 1901 to 1931 when mathematicians became newly concerned and increasingly frenzied over the realization that the foundations of mathematics were unknown, over the possibility—which mathematicians found deeply disturbing—that mathematics might not have firm foundations. The question of what mathematics is, of how it really exists, is actually a very difficult philosophical problem. If I ask you in what sense numbers exist in the world, it is much easier to show that they *work*—that arithmetic supports empirical science and describes physical phenomena—than it is to explain what numbers *are*.

Throughout history, one of the most influential answers to this question was Platonist: that is, that numbers are Platonic ideals, more real than the actual world, everywhere reflected in the actual world but fundamentally existing within a more ideal realm. However, after about 1870, the growing diversity and multiplicity of mathematical subfields led many to doubt the feasibility of mathematical Platonism. Mathematicians came to recognize that Euclidean and non-Euclidean geometry were both mathematically correct despite the fact that each contradicted the other, and mathematicians were disturbed by the notion of multiple, divergent, contradictory Platonic ideals for geometry. The Platonic realm of mathematics was supposed to be singular, cohesive. As such, they sought new foundations.

In the last decades of the 19th century, Frege sought to firmly establish the foundations of mathematics upon the ground of formal logic, believing that logic was so intuitively correct, so basic and fundamental a study, that if he could show mathematics to derive from logic then no one could question whether mathematics had firm foundations. However, in 1901 Russell located a paradox[71] at the heart of Frege's efforts, a paradox that undermined the very heart of Frege's work and made impossible his solution to the problem of mathematical foundations.[72] However, Russell, like Frege, still believed that the foundations of mathematics ultimately must lie in logic, and he spent more than a decade, first alone and then together with Whitehead, seeking to resolve the problem of his paradox and thus complete Frege's work by placing mathematics back on the foundation of logic.

If logic is the branch of philosophy that studies and defines the methods and processes of reasoning, symbolic logic, or formal logic,[73] is a discipline that formalizes that study, making it

[71] Russell's Paradox instructs us to imagine the set of all sets not containing themselves, and then to ask ourselves if it contains itself. Such a set becomes manifestly impossible, because if it contains itself, then it cannot contain itself, and if it does not contain itself, then it must contain itself. This contradiction, made possible by self-reference, is related to the older and more widely known liar's paradox: if I tell you that "I am lying right now," then either the truth or falsehood of my statement leads to contradiction and impossibility.

Daniel Albright has argued that Eliot took up and responded to Russell's Paradox in his poem about Russell, "Mr. Apollinax," which, Albright writes, "is a mirror, in which Russell's paradox unrealizes Russell himself" (250).

[72] Frege famously and very generously acknowledged the seriousness of the problem which the young Russell had located in his work—work on which Frege had spent decades: "Hardly anything more unfortunate can befall a scientific writer than to have one of the foundations of his edifice shaken after the work is finished. This was the position I was placed in by a letter of Mr. Bertrand Russell, just when the printing of this volume was nearing its completion" (*Grundgesetze* 234).

[73] For the purposes of this chapter, I will use these terms interchangeably, as did Russell: "Symbolic or Formal Logic—I shall use these words as synonyms—is the study of the various general types of deduction" (*Principles of Mathematics* 10). However, they are not the same thing in all contexts. Formal logic articulates well-defined rules to arrive at conclusions. That does not necessarily demand the technical symbolic language which characterizes symbolic logic, but, since the 19th century, formal logics have typically been symbolic logics, and vice versa. Further back, exceptions exist. Aristotle's logic was the former but not the latter.

standardized, more absolutely and rigorously defined, in a manner which becomes increasingly technical and mathematical in nature. Many laws and processes in formal logic are simple and straightforward (for example, if P implies Q, and if P is given as true, then Q must also be true). However, with Frege, Russell, and Whitehead's work, symbolic logic became far more complex and technical than it had ever been before, such that it increasingly seemed itself to be a kind of mathematics. Indeed, this was one of the major objections to Frege, Russell, and Whitehead's logicist approach to the foundations of mathematics—that it only pushed the foundational problem back one level, basing one mathematics on another mathematics, which only begged the question of the foundation for this latter mathematics.[74]

However, there is one process at the center of formal logic—nowhere denied but in fact openly endorsed by Frege, Russell, and Whitehead alike—which will appear even more vulnerable to this critique. In order to define and standardize reasoning methods, to articulate rules of inference, classification, and relation in technical symbolism, formal logic begins from a few clearly stated definitions, rules, and axioms—that is, unproven assertions. Formal logic—which Frege, Russell, and Whitehead claimed offers a firm foundation for the unproven beginnings of mathematics—itself begins from unproven claims. These thinkers never sought to reject this process, but only to carefully select and precisely define those axioms, beginning from assumptions that were as logical and straightforward as possible.

This process is necessary because, as Whitehead and Russell write, "some propositions must be assumed without proof, since all inference proceeds from propositions previously asserted" (*Principia* 13). In mathematics and logic, as in reasoning and human thought generally, no structure can provide solidity on its own; it has to stand on some foundation. Patterns must begin with some basic element, some atom or atoms to be repeated and rearranged. Logical systems begin from assumptions, definitions, and rules. None of these foundational starting points can be proven, subsumed, or demonstrated by the complexities that stand upon them. The intellectual starting point has to exist previous to the knowledge that it creates. Formal mathematics can only prove theorems by first postulating some axioms, and reasoning more generally begins from premises.

Eliot knew all of this about formal logic and mathematics, as his notes on Russell's course demonstrate. And, as early as *Prufrock and Other Observations*, moving forward into *The Waste Land*, Eliot articulates the intellectual necessity of these kinds of axiomatic assumptions. I argue that axioms, here, develop a formal equivalence with religious leaps of faith insofar as neither claim to be epistemologically demonstrable, yet, once embraced, both claim to offer up entire systems of knowledge. The problem of mathematical foundations which Eliot was studying in 1914 points the way toward something scholars have not as yet understood about Eliot's search for cultural and religious foundations: it provides an explanation for the interplay of universality and specificity which Eliot saw in this process. It explains the odd way in which Eliot had no problem applying a culturally delimited solution to a problem which he himself described as universal in nature. As Eliot wrote in 1933:

> Two years spent in the study of Sanskrit under Charles Lanman, and a year in the mazes of Patanjali's metaphysics under the guidance of James Woods, left me in a state of enlightened mystification. A good half of the effort of understanding what the Indian philosophers were after—and their subtleties make most of the great European philosophers look like schoolboys—lay in trying to erase from my mind all

[74] See, for example, Haskell Curry, "Remarks on the Definition and Nature of Mathematics," 156.

> the categories and kinds of distinction common to European philosophy from the time of the Greeks. My previous and concomitant study of European philosophy was hardly better than an obstacle. And I came to the conclusion—seeing also that the 'influence' of Brahmin and Buddhist thought upon Europe, as in Schopenhauer, Hartmann, and Deussen, had largely been through romantic misunderstanding—that my only hope of really penetrating to the heart of that mystery would lie in forgetting how to think and feel as an American or a European: which, for practical as well as sentimental reasons, I did not wish to do. (*After Strange Gods* 40-1)

There is something singularly odd about Eliot's eventual decision to dismiss Eastern religion and philosophy, for which he had clear admiration, on the grounds that he was not himself of Eastern origins. It might be more reasonable had Eliot stated that he *could* not forget "how to think and feel as an American or a European," but he tells us, instead, simply that he "did not wish to." He very pointedly never tries to justify this final move in his reasoning. Eliot seems to acknowledge, here, that the basis of religion and culture will always be in some sense an accident of fate, insofar as no one controls the place and people into which they are born. And while that fact seems to have disturbed him early on, by the time of his conversion in 1927 he appears to have had no problem with it. He selected Western religion and philosophy because he was Western. He selected the most traditional English religion, even selected England itself, because his native language was English—a fact which was only the result of the luck. Barry Spurr argues that Eliot "scorned 'universalists,'" who, Eliot writes, "maintain that the ultimate and esoteric truth is one… that it is a matter of indifference to which of the great religions we adhere" (Spurr 6). But Eliot's claim above—that it was right for him to choose Western philosophy because he was Western, necessary for him to be Anglo-Catholic because he was Anglo-American—actually implies a kind of universalism oddly bound with arbitrary specificities, insofar as it implies that it is just as necessary for an Italian to be Catholic or for an Indian to be Buddhist or Hindu.

"Arbitrary" shares a root with "arbitrate," and originally meant simply that something was selected by someone's discretion. It was only later that the concept of the arbitrary became inflected with some capriciousness, some meaninglessness. In fact, arbitrary choice, such as Russell's careful selection of axioms or Eliot's deliberate selection of Anglo-Catholic religion, does not need to be capricious. It can stem from a logical necessity that involves a deep understanding of foundations: the fact that the only firm foundation is an acknowledgment that foundations always involve assumptions. This process applies not only to the ambiguities of spiritual belief but equally to those disciplines typically deemed most unassailable in their certainty—mathematics, the sciences. Mathematical proofs offer the most unquestionable kinds of facts. But those facts nonetheless rest on arbitrary assumptions of exactly the sort that Eliot eventually embraced in Anglo-Catholic religion, explaining how Eliot believed that universal truth, secular as well as religious, could derive from idiosyncratic choice.

Accepting Assumptions

Whitehead and Russell's *Principia* was one of the most ambitious works of mathematics ever written. They tell us themselves, in their introduction, that the *Principia* aimed at "the complete enumeration of all the ideas and steps in reasoning employed in mathematics" (3). This was epically immodest. It is hard to imagine any book published today that would claim to completely enumerate "all the ideas and steps in reasoning" employed in mathematics, or in literature, or in any field at all. Whitehead and Russell very literally tried to explain everything that mathematics was, from the ground up, and to tie it indelibly to philosophy and other branches of human thought. They imagined they could complete that work in a year. What followed was more than a decade of laborious collaboration before the *Principia* was first published in December, 1910. Meanwhile, Virginia Woolf tells us, "on or about December 1910 human character changed" ("Mr. Bennett and Mrs. Brown" 4).

The *Principia* was exemplary of the very modernist movement by which, during this era, mathematicians were developing a new conception of what mathematics was. Historically, rigorous mathematical proofs had always depended on axioms (whether stated or not), but before the twentieth century those axioms were not in general a major point of interest. Among the notable exceptions was Euclid's parallel postulate, which had spurred centuries of mathematical research, but it did so because it seemed uncharacteristically complicated: in fact, because it seemed too interesting to be an axiom. Axioms were supposed to be simple, self-evident starting points, not so much selected by mathematicians as inherited from common sense. But in modernist mathematics, as mathematicians sought new, non-Platonic foundations for their field,[75] the axioms took an increasingly central role, becoming newly strange and remarkable. When the *Principia* aimed to reconstruct the entirety of mathematics, it sought to do so on the basis of a new, singular axiom system—an axiom system comprising logical, rather than mathematical, statements. But in the process Whitehead and Russell were forced to turn to axioms that were terribly abstract. As they write about one of their axioms:

> That the axiom of reducibility is self-evident is a proposition which can hardly be maintained. But in fact self-evidence is never more than a part of the reason for accepting an axiom, and is never indispensable. (62)

This represents a radical shift. The word axiom actually comes from the Greek for "that which is thought worthy or fit, that which commends itself as self-evident," and ancient Greek mathematical texts always use the term in the latter sense. For millennia of mathematical history, axioms were by definition self-evident, always conceived as statements too obvious to require proof. However, in a remarkable reversal, Whitehead and Russell argue:

> The reason for accepting an axiom, as for accepting any other proposition, is always largely inductive, namely that many propositions which are nearly indubitable can be deduced from it, and that no equally plausible way is known by which these propositions could be true if the axiom were false. (62)

Modern mathematicians chose to rely on strange new axioms even though they might be unintuitive, because these new axioms allowed them to build useful and powerful systems. Modernist axioms

[75] Some mathematicians did seek to reconcile these newer foundations with Platonism. For example, Frege was a logicist, seeking to place mathematics on a firm foundation in logic, but he was also a Platonist, because he argued that logic, in turn, exemplified a system of Platonic ideals.

were (very often) justified by the results they supported. These newer axioms were practically motivated leaps of faith.[76]

This greater abstractness of axioms also facilitated their use in less technical forms. In *The Concept of Nature*, Whitehead tells us: "Now I assume as an axiom that science is not a fairy tale" (22). Elsewhere, toward the end of *Science and the Modern World*, he seems to speak of the belief in God, and of religious knowledge, as another kind of axiom system, in the sense that the basis of faith is unproven, yet faith is the ground allowing other things to be proven: "No reason can be given for the nature of God, because that nature is the ground of rationality" (178). That overlap of axioms with belief systems was important to Eliot as well. In February, 1927, just before his conversion, Eliot wrote to John Middleton Murry, "You assume that Truth changes—you accept as inevitable what appears to me to be within our own power. I am, in a way, a much more thoroughgoing pragmatist—but so thoroughgoing that I am sure there is nothing for it but to assume that there are fixed meanings, and that Truth is always the same" (*Letters* III 416). Eliot implies not so much that he believed in Christian dogma as that he chose to believe in Christian dogma: that he chose to presuppose its truth. Eliot often spoke of religion in these terms: as a kind of pragmatically necessary axiom system, entwined with culture and heritage but also simply assumed in order to allow for knowledge construction, aesthetic production, and cultural works, which develop on top of religious axioms. In one essay, Eliot endorses "the old Christian tenet that we do not know in order that we may believe, but we believe in order that we may know" (quoting Irving Babbitt, *For Lancelot Andrewes* 154). Eliot used this kind of reasoning for thought, poetry, and form as well as for religion and culture. In his dissertation, he notes that: "In any case of judgment or perception something is assumed to be real, and this something is a background of indefinite extent continuous with the content which is asserted of it…. It is… *accepted*" (*Knowledge and Experience* 37). In "The Function of Criticism" he writes: "I have assumed as axiomatic that a creation, a work of art, is autotelic" (*Selected Prose* 73-4).

The *Principia* and other modern mathematical axiom systems offered a new context and structure for a much older religious, cultural, and artistic problem. This modern mathematics generated a new language for the convergence of logic, belief, and knowledge. And as the *Principia* was a return to the roots and foundations of mathematics, it delved deeply into questions of mathematical meaning, representation, and symbolism. As such, many readers saw in it a path of return to the roots and foundations of language. Eliot thought so. He wrote in the *Criterion*, in 1927, that

> Grammar should be made to lead up to the study of logic, modern logic, not the antiquated discipline of Barbara. Young people who continue the study of English after they are fifteen or sixteen, ought to learn how the language has been formed, ought to learn something of both historical and comparative grammar, and come to understand how much the work of logicians has done to make of English a language in which it is possible to think clearly and exactly on any subject. The *Principia*

[76] Such axioms were controversial. Many rejected the *Principia*'s axiom of reducibility, and Russell himself later criticized it. In 1927, in his introduction to the second edition of the *Principia*, he wrote that "One point in regard to which improvement is obviously desirable is the axiom of reducibility… This axiom has a purely pragmatic justification: it leads to the desired results, and to no others. But clearly it is not the sort of axiom with which we can rest content" ("Introduction" xiv). In the 1910s, Russell's statements about the axiom of reducibility seem to have been universally in its defense. Yet whatever their feelings about such strange or unintuitive axioms, during the modernist period many mathematicians began to resort to them.

> *Mathematica* are perhaps a greater contribution to our language than they are to mathematics. ("Commentary" 291)

Well over a decade after he had studied the *Principia* as a student, Eliot asserted that it was foundational for language.[77] He implies here that syntax—broadly, language's patterns—parallels and even coalesces with formal logic. He identifies the grammars of language with the grammars of mathematics. Whitehead and Russell had sought a more structurally consistent means by which to communicate mathematical ideas, and in the process they had reinvented all the grammar and vocabulary of mathematics. In this way, the *Principia* was the most thorough early development of mathematics as a formal language. Formal languages such as arithmetic or C++ are distinct from natural languages such as English, but they share a mutual dependence on a combination of syntax and semantics which, at the outset, must be simply adopted without justification. The syntactic and semantic rules underlying language, like those underlying mathematics, are axioms.

With his reference to the *Principia*, Eliot insists that English grammar is bound by patterns that work as logical patterns work. By extension Eliot argues that poetry in English has rule-bound foundations. The *Principia* was an attempt to base the entirety of mathematics on a consistent foundation in logic, and Eliot argued that it could similarly explain the foundations of language. Linguistic grammar serves its relational function—meaningfully suturing ideas together—because its speakers accept it and apply it with relative consistency. Whitehead and Russell's modernist re-conception of mathematical axioms articulates the same basis for mathematics. The result is twofold: it provokes the anxiety that mathematics and language alike may not, at their foundations, fundamentally be themselves; yet at the same time it sets in motion a powerfully broad-based, interdisciplinary analysis that offers a new and promising explanation for the structure of human knowledge systems. In fact, Eliot argued that the *Principia*'s vision of language—as a formal system necessitating some philosophically axiomatic starting points—could demonstrate and elucidate the role and nature of unanchored pattern in modernist writing, where pattern is not simply an aesthetic design but a system of knowledge.

Building Patterns from Assumptions

In 1917 Eliot wrote that "there is no freedom in art" (*Selected Prose* 32). There in "Reflections on *Vers Libre*" he argued not in opposition to the poetry which we call free verse, but in opposition to calling that poetry free verse: because, for Eliot, poetry can never be without formal patterns. "There is no escape from metre; there is only mastery," because "even the *worst* verse can be scanned" (35, 36). Eliot argued that patterns are inevitable in poetry, regardless of the fact that some such patterns are obvious and others subtle, that some are simple and others complicated, that some

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[77] It is remarkable that Eliot would deliver such praise for the *Principia* in 1927, because this declaration came years after Eliot's friendship with Russell had ended on very bad terms. After Eliot studied under Russell at Harvard in the spring of 1914, they became much closer in the following year, while Eliot was continuing his studies at Oxford. In October of 1915, Russell wrote to Eliot's mother on his behalf, and that same fall Russell offered his spare bedroom to the struggling Eliot and his new wife Vivienne. The Eliots then lived intermittently under Russell's hospitality and financial assistance for quite some time. For years, Russell's relationship with Eliot seems to have been that of teacher, patron, and surrogate father. However, their relationship became very chilly after 1918, following Russell's extended flirtation, and eventual affair, with Vivienne Eliot. Robert H. Bell has tracked Russell's relationship with T. S. and Vivienne Eliot in great detail.

adhere to our expectations while others do not. Hence "the division between Conservative Verse and *vers libre* does not exist, for there is only good verse, bad verse, and chaos" (36). Eliot implies that verse, even bad verse, can never be chaos.

When I argue that Eliot's poems create and cohere to axiom systems which resemble the axiom systems of mathematics, I do not imply that Eliot's writing takes from mathematics any binary vision of truth and falsehood. I do not imply that Eliot's poetry is in any way deterministic. Eliot's poetic systems resemble and coalesce with the patterns of mathematical axiom systems, but they never resemble or coalesce with mathematics itself, and Eliot's axioms demand ambiguities that mathematics would never tolerate. As C.D. Blanton has pointed out, Eliot "asserts… heteronomy *as* a principle of order," and "Eliot (quoting T. E. Hulme) insisted of Baudelaire: 'Order is thus not merely negative, but creative and liberating'" (31, 40).

I argue that patterns and structures in Eliot's poetry—indeed, in modernism more broadly—have often been misunderstood as fragmentation and chaos, because the starting points of those patterns are modernist axioms rather than self-evident truths. *The Waste Land* does not claim to have located any meaningful starting point, but repeatedly simply starts, and then restarts again and again, always announcing its own lack of meaningful origin and moving onward to elaborate itself nonetheless. There the acknowledged inability to understand the patterns is exactly what enables the patterns to elaborate themselves. *The Waste Land* is actually replete with patterns, which are vital although incomplete and central although without anchor. "Datta. Dayadhvam. Damyata. / Shantih shantih shantih" can never predominantly exist, for Western readers, as the invocation of Sanskrit myth or traditional prayer (*CP* 69). Eliot knew that, with or without annotation (and particularly at first publication, before the inclusion of his notes), these lines would first and foremost offer a recognizably self-similar, repetitive network of sounds, markedly resembling "Twit twit twit / Jug jug jug jug jug jug" and "Weialala leia / Wallala leialala" whatever their origin (61, 64). Those repetitions which *The Waste Land* offers are vital to its form and vital to what it offers to the understanding, and these repetitions are made all the more prominent by the strangeness of what they say, or by the opacity by which they refuse to say anything which could be found in an English dictionary, whether to readers unacquainted with Sanskrit or to readers merely flummoxed by English words reduced to drum beats, such as the "HURRY UP PLEASE ITS TIME / HURRY UP PLEASE ITS TIME" that interjects five times over, increasingly working, with each repetition, more like an onomatopoeic measure of time than a statement thereof (58-9).

Repetition is traditional to verse, but there is something new about how *The Waste Land* sparsely, yet very prominently, uses repetition. There repetition provides minimal, momentary structures amid a globally radical lack of context and stability. Repetition is actually one of *The Waste Land*'s only sources of structure. In fact, I argue, the hope that a network of repetition could directly, intrinsically offer meaning, foundational meaning, despite fragmented context and independently of dictionary semantics, embodied a markedly modernist struggle. In "The Fire Sermon":

> 'On Margate Sands.
> I can connect
> Nothing with nothing.
> The broken fingernails of dirty hands.
> My people humble people who expect
> Nothing.'
>   la la (*CP* 64)

"Nothing with nothing… nothing"; "people humble people"; "la la." Here Eliot circles repeatedly back to the same vocabulary as though there is nowhere else to go. This is not the ongoing rhythm of iambic pentameter nor the regularity of rhymed verse. It repeats words without the structured repetitions of sestina or prayer. But this passage's repetitions are vital even if abortive: they evince Eliot's commitment to pattern even as Eliot concluded that no pattern could help but begin from the unknown. Eliot drafted very much of *The Waste Land* at a hotel "On Margate Sands," so that this passage describes its own composition and its own form, which "can connect / Nothing with nothing" in a counterintuitively positive, constructive sense. "Jug jug jug jug jug jug," "Shantih shantih shantih," and "la la" equally connect nothing with nothing, because a world of scholars carefully tracing Eliot's allusions can never undo these lines' primary formal effects on an English ear: the effect of sounds, apparently meaningless, repeating. And if these sounds, in and of themselves, create the sensation of meaninglessness, as they repeat and iterate in increasingly complex ways, they nonetheless insist on developing some meaning out of that initial meaninglessness, almost like lilacs somehow spontaneously sprouting from "out of the dead land." They are linguistic systems elaborated from words that are not words, they are patterns built from elements we don't understand, and they are knowledge systems developed from unknown, unproven axioms. As *The Waste Land* "connect[s] / Nothing with nothing," it builds something from nothing.

So much of Eliot's career was an analysis of system and structure: of whether and how they can exist and of what they might accomplish. For Eliot, abstract structures make form possible, and cultural structures make analysis possible. And, for Eliot, structure need not be static: it can be an infinitely complex, living thing, even when built from finite, delimited assumptions. When I speak of formal structure in Eliot's work, I do not speak of some objective, determined, singular object. I do not speak of a castle, constructed and complete. I speak of a constantly building and rebuilding castle, reaching to the clouds like a kind of tower of Babel that continually collapses and rebuilds itself, always taking a different shape but always doing so upon the same common foundation. This description is at risk of sounding mystical, but it is also deeply analogous with mathematical form—in fact, homologous with mathematical form, in the sense of having the same shape but not content, the same structure but not assumptions.

The patterns which Eliot builds up from axioms loop back upon themselves, sometimes, as in *Prufrock*, depressingly, elsewhere, as in *Four Quartets*, reassuringly, but always and inevitably. Near the beginning of *Four Quartets*, Eliot writes that

> …the roses
> Had the look of flowers that are looked at.
> There they were as our guests, accepted and accepting.
> So we moved, and they, in a formal pattern (*CP* 176)

In an intuitive sense, we think we know what Eliot describes when he says that the flowers "had the look of flowers that are looked at": they and we seem mutually enclosed in an inexorable system, perhaps disheartening, perhaps soothing. However, setting aside affect: in a logical sense how could these flowers possibly be otherwise? Could there ever be any look to flowers that are not looked at? Even if we say that the answer should be yes, by definition we cannot possibly know what the look of such unlooked at flowers would be. Instead, we only have access to the starting point—the flowers, with the look we look at. We accept them as they accept us. Years earlier, Eliot had written in his dissertation that "The real flower, we can say, will be the sum of its effects—its actual effects upon other entities—and this sum must form a system, must somehow hang together" (*Knowledge* *and Experience* 30). *Four Quartets* repeatedly iterates different forms of its verbs, shuffles and reshuffles different configurations of subject and object, but Eliot refuses to provide us with any terms that would allow us to escape the system. Here we keep circling around our own starting point even though we don't quite seem to know what that starting point is. In fact, what the starting point is does not seem to matter so much as the fact that we start somewhere, and elaborate a pattern from there. And that there is a pattern is absolutely, irrevocably clear throughout *Four Quartets*, which weaves repetition on top of repetition and returns relentlessly even to the word "pattern" (*CP* 176, 177, 180, 181, 185, 189, 194, 205, 208). The term "pattern" thus itself becomes another kind of pattern. Content and culture become a pattern: "history is a pattern / of timeless moments" (208). And pattern, here, can merge with form as form strives to merge with pattern: "Only by the form, the pattern, / Can words or music reach" (180). This pattern not only organizes the poem, it strives to be the poem.

All of this reads like Russell and Whitehead's vision of a cohesive logical system: densely intertwined, a network of repetitions (and make no mistake, the *Principia* is incredibly, awe-inspiringly repetitive as it delves into the tiniest of foundational details).[78] In its repetitions of the same terms and simple details *Four Quartets* builds a knowledge system from a network, relying on generalizable forms rather than particular meanings. The starting point is only an assumption, a modern axiom. The starting point is only any starting point. "What we call the beginning is often the end / And to make an end is to make a beginning" (207). As a faith-based system the poem loops back on itself without—by definition—any proven starting point. But with the belief that everything is interconnected, that "the fire and the rose are one" (209), we emerge from that dense network of pattern having somehow reached a position of knowledge. Or, at least, a knowledge of pattern. That development in Eliot's late work is typically described as religious. It is religious. But in its careful study of the formal knowledge that pattern creates, it is also, crucially, mathematical. Mathematics, after all, is the formal study of patterns.

This process was in place before *Four Quartets*. David Spurr notes that in "The Hollow Men" Eliot's "technique of constant repetition and negation—'The eyes are not here / There are no eyes here'" means that the poem "manages to employ only about 180 *different* words in a work 420 words long" (52, quoting *CP* 81). In *Ash Wednesday* Eliot writes: "I know that time is always time / And place is always and only place… that things are as they are" (85). Here Eliot uses repetition to contemplate the formal relationship that any term inevitably has with itself, independent of its particular identity or meaning. After all, it is always the case that "Things are as they are," it is always the case that if "the eyes are not here" then "there are no eyes here," and it is always the case that "the roses" have "the look of flowers that are looked at." These sorts of repetitions do more than create a rhythm. They characterize the identity which they began by admitting not to know. In this way, "la la" tells us something that "la" cannot.

Deriving Ambiguity from Pattern, Liberty from Structure

Eliot argued both that "there is no freedom in art" and that "Order is thus not merely negative, but creative and liberating" (*Selected Prose* 32, *Selected Essays* 381). These claims can be hard

[78] This detailed repetition can be illustrated by the fact that the *Principia*, famously, did not demonstrate that 1 + 1 = 2 until page 379. Actually, even there Whitehead and Russell did not provide a complete proof, which they developed in full only in the following volume, appearing two years after the first.

to reconcile, but I do not think they contradict each other. In fact, Eliot repeatedly managed to find liberty in structure, complexity in simplicity, and paradox in pattern. Cleanth Brooks articulated a parallel view of literature when he argued that the critic's "primary concern is with the work itself as a structure of meaning" and, at the same time, that "the language of poetry is the language of paradox," that "paradox is the language appropriate and inevitable to poetry" (xi, 1). Brooks went on to assert that, by contrast, "It is the scientist whose truth requires a language purged of every trace of paradox" (1). But Brooks refers, here, to the assumptions of the sciences, not to their structures, systems, and forms. We associate with mathematics a binary vision of truth or falsehood, which is embodied in the principle of bivalence: the basic logical law that a proposition must be either true or false, with no middle option. This law is what creates the binary nature of mathematical truth and falsehood, the fact that, in mathematics, something is either right or wrong, black or white, never existing in shades of gray. However, the principle of bivalence is an axiom and presupposition of mathematics, not something which mathematics can ever prove. And during the modernist era in particular, many important mathematicians were doubting whether it could be safely assumed at all.[79] While Brooks has argued that poetry's capacity to derive paradox from structure is both definitional of literature and what distinguishes it from the sciences, I argue that poetry's capacity to do this involves exactly the same patterns and forms which mathematics uses to avoid contradiction.

The mathematical yet paradoxical nature of pattern in Eliot's work is not only specific to Whitehead, Russell, and the *Principia*. It mirrors modernist mathematical developments very generally. The original groundbreaking development in the modernist reinvention of mathematical axioms occurred with the invention of non-Euclidean geometry, decades before the *Principia*. Eliot was well aware of that development in mathematics, and he argued that it had implications for literary form. Speaking about Ben Jonson's fictional universes:

> It is a world like Lobatchevsky's: the worlds created by artists like Jonson are like systems of non-Euclidean geometry. They are not fancy, because they have a logic of their own; and this logic illuminates the actual world, because it gives us a new point of view from which to inspect it. (*The Sacred Wood* 78)

Across his career, Eliot sought systems and structures of thought—coherent and cohesive "worlds" such as Jonson's. These systems were often mutually exclusive and yet nonetheless coexisting, each with validity, for each possessed "a logic of their own." Early on, Eliot was captivated by Buddhism; but when he eventually concluded that, despite all of Buddhism's apparent advantages, life as a Buddhist was simply irreconcilable with the traditions and culture of English life, he came to the conclusion that it was necessary to simply select a system compatible with his cultural heritage, even if the starting point of that system, its leap of faith, was arbitrary. That choice to embrace an axiom in which he didn't initially believe, and then construct knowledge upon it, was particularly non-Euclidean. The *Principia* set out to establish mathematics on firm foundations and then discovered that this goal required axioms that were not self-evident, and for which Russell struggled to provide philosophical justifications. However, the *Principia*'s axiom of reducibility was not totally implausible

[79] In particular, the influential intuitionist mathematician L. E. J. Brouwer argued against the applicability of the law of the excluded middle, which he defined as "the principle that for every system every property is either correct [richtig] or impossible" ("On the Significance" 335). It is important to note that Brouwer denied the applicability of the law of the excluded middle particularly and exclusively to mathematical statements which referred to infinite sets: i.e., he did not deny its applicability to mathematics as a whole. Nonetheless, his doubts about this fundamental mathematical principle were shocking and field-changing for mathematicians of his era.

so much as it was unusually complicated. Non-Euclidean geometry, on the other hand, began with a far stranger, more radically unintuitive axiom: one that, previously, no one ever could have believed in.

In large part because it was so very strange, non-Euclidean geometry was the single great event in modernist mathematics that most penetrated, and permeated, the public consciousness. Art historian Linda Dalrymple Henderson has thoroughly catalogued the great extent of this popular interest in the new geometries, demonstrating their profound influence on cubism and the modernist visual arts. She argues—with extensive historical and archival proof—that non-Euclidean geometry was a causal factor in the development of cubism, because it indicated to modern artists that space need not be as it appeared, and hence that realist representation was not only unnecessary but even fundamentally in error. For cubists, this new, non-Euclidean geometry was no distant abstract idea, but a radical and applicable innovation with which they were fascinated, a novel descriptor for the space they inhabited.

Non-Euclidean geometry was a particularly representative innovation of modernist mathematics, involving the stark reversal of previous assumptions, intense abstraction, an apparent contradiction of empirical experience, and previously unthinkable innovation. It became a symbol for the era, igniting the popular imagination. The French mathematician Henri Poincaré wrote a series of best-selling and widely translated books that introduced the movement to lay audiences as a system of conventions, a series of genres. He first published his *La Science et L'Hypothese* in 1902; by 1913 it had already been translated into six languages and sold more than 20,000 copies.[80] In the first decades of the twentieth century Poincaré was frequently discussed in popular magazines; in 1914 *The Nation* dubbed him "a genius and master of mathematics for the whole world."

In this context, it is unsurprising that modernist authors demonstrated manifest interest in the non-Euclidean revolution; James Joyce, for example, read Poincaré, and he scrutinized and returned to the rupture between ancient and modern geometries across the entirety of his writing career. Euclidean and non-Euclidean geometries appear in the very first paragraph of *Dubliners*, the coming-of-age climax to *Portrait of the Artist as a Young Man*, the penultimate episode of *Ulysses* and at the very center of *Finnegans Wake*. For Joyce, Euclidean geometry seems to stand for what we thought we knew; non-Euclidean geometry communicates at once the anxieties and the liberties of a starkly confusing and invigorating modernity. But for Joyce as well as Eliot, non-Euclidean geometry also offered more than simple novelty. It demonstrated that form could derive relevance to the world using patterns and systems that had a logic entirely their own, a logic apparently irrelevant to the world. Non-Euclidean geometry proved that the coherence of a system did not depend on the coherence of its axioms, but on the coherence of how it developed from those axioms.

Non-Euclidean geometry was a long time coming. It was one of the very first roots of modernism in mathematics, and the founding work in the field was done by Nikolai Lobachevsky and János Bolyai all the way back in the 1820s. But their work then languished for some 40-50 years, misunderstood, disbelieved, and simply ignored by the mathematical community of their era. It was only in the 1870s, when modern mathematicians independently recreated and republished what Lobachevsky and Bolyai had already known, that the larger mathematical community began to realize how much had already changed. After half a century in which acceptance of non-Euclidean geometry had been unthinkable, the final turnaround was remarkably rapid. In only a handful of years in the 1870s, non-Euclidean geometry was not only accepted but canonized by the upper echelons of the mathematical community. And in the following decades, non-Euclidean geometry

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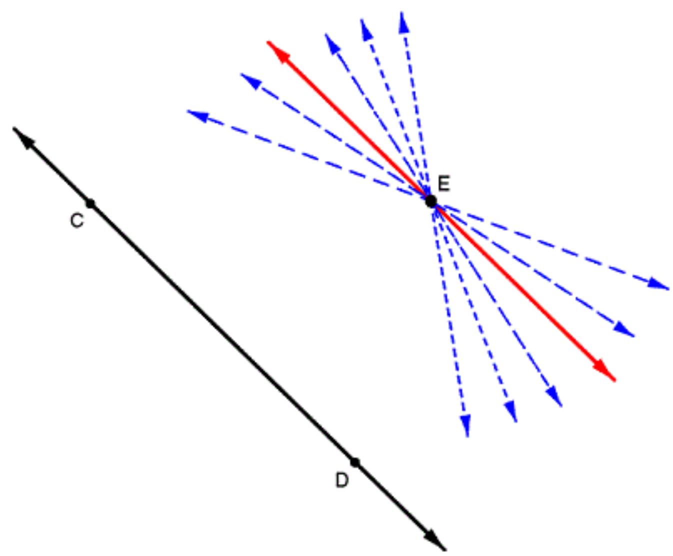
[80] See George Bruce Halstead's introduction to Poincaré's *The Foundations of Science*.

transfixed public attention, leading to popular debate about psychological and philosophical conceptions of space. By 1912 Albert Gleizes and Jean Metzinger could claim that, to understand cubism and modern painting, "we should have to refer to the non-Euclidean scientists; we should have to study, at some length, certain theorems" (quoted in Gray, *Plato's Ghost* 51).

Modernist writers responded. Non-Euclidean geometry raised the strange notion that mutually contradictory realms of mathematics could co-exist and remain equally correct, very much like fictions or parallel worlds. The confirmation of non-Euclidean geometry meant that mathematicians had to accept that these differing mathematical realms could each retain truth and meaning regardless of whether they seemed descriptive of the empirical world—again, very much like fiction. While non-Euclidean geometry was strange in its total contradiction of human experience, it remained true because it was internally consistent—as the characters and events of a novel might fail to exist in the actual world, yet remain truthful insofar as they are decipherable and sensible within the world of the novel. If non-Euclidean geometry was difficult to understand, with its reversal of intuitive human experience, so was modernist writing. Eliot wrote directly about the literary processes that he saw non-Euclidean geometry revealing. When Eliot discussed Jonson's fictional universes as non-Euclidean worlds, he explained that these universes "have a logic of their own; and this logic illuminates the actual world, because it gives us a new point of view from which to inspect it" (*The Sacred Wood* 78). This is an incisive account of non-Euclidean geometry's philosophical process and of why it matters for the intellectual world. Non-Euclidean geometry required the conception and invention of an entirely new mathematical world—as Bolyai himself, upon realization of what he had proven, wrote to his father in passionate excitement, "out of nothing I have created a strange new universe" (Greenberg 226). Non-Euclidean geometry forced the acknowledgment that mathematics is a field with its own various genres and conventions, its own peculiar perspectives, internal relations, and forms. That strange collection of new conventions and forms "illuminates the actual world, because it gives us a new point of view from which to inspect it"—not only in the sense of seeing particular things in a new light, but in the more radical sense by which new perspectives can facilitate positive generalizations: that is, the recognition of what many different things share in common. Broad understanding and universal meaning are dependent, here, on the ability to see particularities as pieces within the relational structures of broad cultural frames. Formal meaning, here, is dependent on the willingness to locate, for abstract creations from literature to mathematics, patterns in the actual world that reproduce the forms of creative abstraction.

Regarding this point, a more specific explanation of how non-Euclidean geometry works can be helpful. Euclid laid out the standard for geometry around 300 BC. His *Elements* was an apparently unassailable work, remaining the standard for geometry for more than two thousand years. Elegantly self-contained, it remains the dominant example of the axiomatic method in mathematics, because Euclid's work starts with a handful of axioms, postulates, assumptions, which are stated without proof. Using those axioms, Euclid then proves all his other assertions, building an entire framework of thought from a few unproven starting points. As I have stated, that axiomatic method later became a defining feature of modernist mathematics, which refined the pure formal approach that Euclid had used 2000 years earlier. However, the axiomatic method of non-Euclidean geometry is crucially divergent from the axiomatic method developed in Euclid's geometry. As they returned to Euclid's axiomatic system, modern mathematicians also irrevocably altered it.

Euclid saw his axioms as fundamental truths, too obvious to require proof, whereas modern mathematicians increasingly came to see their axioms as mere assumptions, selected or imagined, and not inherited by realist necessity. This newly inventive conception of axioms had the effect of divorcing mathematics from empirical science, instead placing it closer to the realm of creative art. Modern mathematicians did not necessarily discover pre-existing truths about the world around them; often, they instead conceived of themselves as creating worlds of their own. As Bolyai wrote, "out of nothing I have created"—not discovered—"a strange new universe." Once modernist mathematicians conceived of axioms as carefully selected yet ontologically arbitrary assumptions, they gained the freedom to use whatever axioms they chose, rather than those axioms that were traditionally accepted or intuitively clear. The entirety of non-Euclidean geometry arose from just one such axiom. Euclid's geometry is based on postulates that are intuitive, quite straightforward, and even obvious. For example, one of those axioms states that between any two points we can draw a line. Another states that all right angles are equal to each other. These statements are so simple and believable that the fact that Euclid stated them without proof never seemed to matter. Why prove that which is already known to be true? Euclid's fifth postulate, also known as his parallel postulate, was just a little bit more complicated. It stated that, given any line and any point not on that line (both in the same plane), there will be one and only one line through the point which is parallel to the first line.[81]



Playfair's axiom *(a formulation of Euclid's parallel postulate): in a plane, given any line (CD) and any point not on that line (E), there must be one and only one line running through E that is parallel to the original line. Above, CD is parallel only to the single solid red line running through E.*

This parallel postulate is slightly more complicated than Euclid's other four postulates, but it remains intuitive. In the diagram above, the red line appears to clearly be the only possible line, through that point, that would be parallel to the black line (CD). The other lines pictured (in blue) all appear to be clearly nonparallel to CD, and it seems impossible to imagine things being otherwise.

[81] Technically, the postulate as I have described it above is a nineteenth-century explanation of Euclid's parallel postulate, called Playfair's axiom. Euclid actually wrote: "if a straight line falling on two straight lines makes the interior angles on the same side less than two right angles, the two straight lines, if produced indefinitely, meet on that side on which are the angles less than the two right angles." Although this latter statement might sound different from Playfair's axiom, these postulates are mathematically equivalent, because each implies the other (assuming Euclid's other axioms).

Initially, nobody ever doubted the truth of the parallel postulate. However, because it was more complex than the other postulates, many mathematicians wondered if they could prove it as a theorem instead of assuming it. They endeavored to demonstrate the parallel postulate using all the other postulates. That process, however, turned out to be astonishingly difficult. For more than a thousand years, some of the greatest mathematical minds worked to prove the parallel postulate—and every single one of them came up short. In fact, they came up short because they were trying to do the impossible. One common mode of mathematical proof is the proof by contradiction, a form of *reductio ad absurdum*. In a proof by contradiction, mathematicians begin by stating something they believe to be false. Then based on that statement they reach a contradiction, an impossibility. If the initial statement leads to a contradiction, then that initial statement must be false, and hence mathematicians will have proven that which they set out to prove. Mathematicians attempted to do exactly this with the claim that the parallel postulate was false. However, when they did so, they realized that no contradiction could be found. If we take all of Euclid's other postulates and then simply assume that the parallel postulate is untrue, we will find an utterly strange and totally consistent new geometry[82]—indeed, in this way we can develop multiple consistent new geometries.[83]

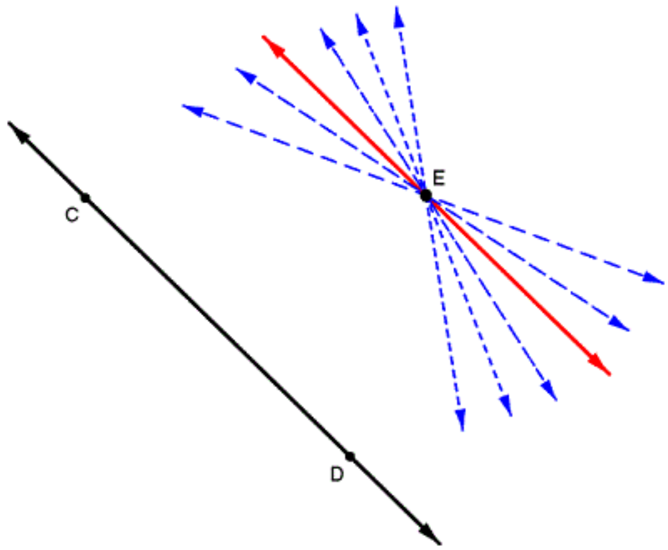
Before Bolyai and Lobachevsky, Carl Friedrich Gauss actually figured all of this out in the first decades of the nineteenth century. However, he never published that work. He imagined that he would become anathema for claiming that such an absurd system had mathematical validity. He felt that this reversal of the parallel postulate was just too bizarre to ever be accepted by the mathematical community. Non-Euclidean geometry did not make sense, and so Gauss kept it to himself as a kind of weird exploration in his notebooks, a private personal eccentricity. A few years later, Lobachevsky and Bolyai independently discovered exactly the same thing. Unlike Gauss, they dared to imagine that this strange, abstract mathematics could be published and accepted as true. In 1829, 1830, and 1832, they published their work. The opposite of Gauss's expectation proved true: instead of fury, controversy, and strife, the mathematical community responded to this bizarre new mathematics by simply ignoring it. The publications of Lobachevsky and Bolyai were all unread and forgotten. Non-Euclidean geometry languished for decades, not even disbelieved so much as erased. Then, in the 1860s and 70s, there began a cultural shift among mathematicians that both presaged mathematical modernism and made its work possible. Suddenly, and in a remarkably short period, mathematicians began to endorse the abstraction of non-Euclidean geometry. After being utterly ignored for thirty years, in less than a decade non-Euclidean geometry was not only accepted but canonized. Non-Euclidean geometry was the original thunder strike at the origin of mathematical modernism.

We can return to the diagram pictured previously to understand why this was such a remarkable development. The non-Euclidean geometers took a clear and utterly intuitive axiom and simply reversed it. Euclidean geometry assumes that, in a plane, given any particular line and any particular point not on that line, there exists only one line through that point which is parallel to the first line. Any other line through the point wouldn't be parallel. To assume otherwise makes

[82] To be a bit more precise, in 1868 Eugenio Beltrami proved that non-Euclidean geometry is consistent if and only if Euclidean geometry is consistent. So the consistency of non-Euclidean geometry is exactly as unimpeachable as consistency of the geometry we know and trust so well.

[83] There are, in fact, two distinct forms of non-Euclidean geometry, both developed in the nineteenth century. The first, hyperbolic geometry, negates the parallel postulate by assuming that there exist infinitely many distinct parallel lines going through the same point. The second, elliptic geometry, negates the parallel postulate by assuming that there exist no such parallel lines.

absolutely no sense. But nonetheless that's exactly what non-Euclidean geometers did. Originally, they did so expecting to find a contradiction arising from this obviously absurd assumption. When they found no contradiction, eventually they decided to just run with it.



Non-Euclidean geometers simply assumed that, in this diagram, there are many different lines parallel to CD. Actually, they imagined an infinite number of distinct lines, running through E and all parallel to CD. The pictured blue lines are all clearly nonparallel to CD, so where could all these other parallel lines be? Even though our intuition screams that such a thing is impossible—in some important sense, *because* our intuition screams that it is impossible—mathematicians simply assumed that the other parallel lines exist. The fact that this makes no apparent sense is exactly my point. Modernist mathematicians discovered that, despite its counterintuitive nature, this strange assumption—this bizarre leap of faith—never leads to a contradiction. Instead, whole new worlds can be elaborated from that premise, built from the reversal of historical assumptions and intuitive truths.

Many mathematicians and popular science writers, including Poincaré, pointed out that the coexistence of Euclidean and non-Euclidean geometry worked by the same process by which multiple, contradictory fictions could be equally real. In his dissertation, Eliot pointed out that fiction, like mathematics, depends on axiomatic assumptions, which makes strange the fact that it nonetheless describes the real world:

> In any case of judgment or perception something is assumed to be real, and this something is a background of indefinite extent continuous with the content which is asserted of it…. It is… *accepted*…Thus, of course, an idea may justly be predicated of an ideal world; and our interpretation of the character of Ivanhoe may qualify the assumed reality of the story just as truly as the story itself, as a story, qualifies reality. The ideal world of the story qualifies reality—in what way, we are ultimately in ignorance—and through this world our conception of the character of Ivanhoe is attached to reality. (*Knowledge and Experience* 37-8)

It makes logical sense that our interpretation of Ivanhoe qualifies the assumed reality of *Ivanhoe*. But it is actually quite a strange and unexplained fact that our interpretation of Ivanhoe also qualifies the real empirical world in which we live.

And while Eliot's vision of fiction illuminates non-Euclidean geometry, non-Euclidean geometry also illuminates Eliot's vision of history. The non-Euclidean renovation of history and intuition, involving a reversal of tradition codependent with an elevation of tradition, is structurally exemplary of Eliot's vision of the relationship between modern poetry and its literary past. Eliot wrote that non-Euclidean geometry "illuminates the *actual* world, because it gives us a new point of view from which to inspect it." He pointed out that the new geometry neither simply echoed nor simply reversed the old geometry, but instead created new systems by altering inherited assumptions, which ultimately enriched our knowledge of the traditional systems as well as the new. Meanwhile, in "Tradition and the Individual Talent," he wrote that

> No poet, no artist of any art, has his complete meaning alone. His significance, his appreciation is the appreciation of his relation to the dead poets and artists. You cannot value him alone; you must set him, for contrast and comparison, among the dead. I mean this as a principle of æsthetic, not merely historical, criticism. The necessity that he shall conform, that he shall cohere, is not one-sided; what happens when a new work of art is created is something that happens simultaneously to all the works of art which preceded it. The existing monuments form an ideal order among themselves, which is modified by the introduction of the new (the really new) work of art among them. The existing order is complete before the new work arrives; for order to persist after the supervention of novelty, the *whole* existing order must be, if ever so slightly, altered; and so the relations, proportions, values of each work of art toward the whole are readjusted (*The Sacred Wood* 32-3)

Eliot wrote about non-Euclidean geometry as a kind of radical creation of a whole new world, which yet was only possible based on a long tradition of previous work. He also wrote that literature was, by necessity, such a historically inflected yet radically new creation. Eliot argued that tradition and history offer axioms—unproven but long since accepted—which are necessary starting points for new cultural productions. Whether those axioms are accepted or rejected, they remain crucially embedded in the new art nonetheless. Eliot's conception of innovation always and necessarily existed in tandem with the powers of tradition and culture, which, in turn, determined for him which assumptions were most natural to any particular place and time. Eliot exploited tradition to serve modern poetic form, and the axiomatic system by which non-Euclidean geometry both echoed and reversed Euclidean history can provide us with a new structure for thinking through how, exactly, Eliot thought innovation should incorporate and reinvent historically possible worlds.

This chapter began by questioning *The Waste Land*'s opening allusion to Chaucer as a foundation. In fact, Eliot's complex and paradoxical emphasis on literary history derived its power from a fundamentally ahistorical vision of history. It valued literary history by denying literary history's existence on a diachronic temporal line. It is in this sense that I deny that *The Waste Land*'s beginning from Chaucer can be correctly deemed a turn back to literary foundations. Because Eliot's vision of literary history, and *The Waste Land*'s compilation and reconstruction of literary history, insists that writing can only ever exist in a kind of deliberately paradoxical synchrony interwoven with diachrony, with texts constantly acting each in alteration of all of the others before and after themselves. As such, for Eliot, even though heritage both informs and determines the greatest literary output, foundations can never be temporal.

In "The Function of Criticism," after quoting himself—the above passage from "Tradition and the Individual Talent"—Eliot writes:

> I was dealing then with the artist, and the sense of tradition which, it seemed to me, the artist should have; but it was generally a problem of order; and the function of criticism seems to be essentially a problem of order too. I thought of literature then, as I think of it now… not as a collection of the writings of individuals, but as 'organic wholes', as systems in relation to which, and only in relation to which, individual works of literary art, and the works of individual artists, have their significance. (*Selected Prose* 68)

Eliot proclaims that his markedly paradoxical conception of tradition was developed in pursuit of understanding literary output as "'organic wholes', as systems." Here, in deliberate clarification of "Tradition and the Individual Talent," Eliot tells us that the problem of literary history is more "generally a problem of order." This sort of order is not deterministic. It involves none of the true-or-false, black-or-white implications of mathematics. This sort of order founds ambiguity, paradox, and infinite complexity.

Eliot opens *Four Quartets* with a pattern that stands upon the breakdown of chronology:

> Time present and time past
> Are both perhaps present in time future,
> And time future contained in time past.
> … My words echo (*CP* 175)

Here Eliot reuses the same words repeatedly, as though he has access only to a limited number of markers, which he shuffles across the page almost as though following the limiting rules of some predetermined game. These lines from *Four Quartets* behave like a chess game in the sense that they seem to live in a kind of enclosed formal world, incredibly complicated yet radically delimited by only a few available signs and syntactic rules. And these lines build order out of something which they never presume to have explained in the first place, something which this order only demonstrates to be more complicated than we can have originally believed.

Time has has received extensive attention in Eliot studies. But I do not think the complexities of tradition, for Eliot, have at their basis a problem of time. Instead, at their basis, there lies a problem of logic. When Eliot, writing about tradition, seeks to understand literatures as "'organic wholes', as systems," when he examines "the function of criticism" as "essentially a problem of order," he interrogates the logical problem of how unity exists in codependence with complexity, and how consistency exists in codependence with paradox.

From Pattern to Form, from Axiom to Formalism

I have argued that an axiom is very much like a leap of faith: the initial decision to accept it as true might be easy, if the axiom corresponds with our intuitions and our traditional expectations; or the leap of faith might be terribly difficult, as it was with non-Euclidean geometry. But once one has made that leap of faith, whole systems of knowledge can be elaborated based on it. On the other hand, before the leap of faith, without its foundational assumptions, we can find ourselves frozen in place. This process of movement and paralysis has consequences for poetic form. Ultimately, the stakes of my argument in this chapter do not lie in the understanding of Eliot's vision of religion and cultural systems, but in the understanding of his vision of how we should read form.

In "Prufrock," the speaker repeatedly finds himself circling around his own lack of knowledge. He tells us,

> It is impossible to say just what I mean!
> But as if a magic lantern threw the nerves in patterns on a screen:
> Would it have been worth while
> If one, settling a pillow or throwing off a shawl,
> And turning toward the window, should say:
>   'That is not it at all,
> That is not what I meant, at all.' (*CP* 6-7)

He is trapped by "a hundred indecisions… a hundred visions and revisions" (4). But even as early as "Prufrock," another model of poetic movement is imaginable, although Prufrock himself lacks the bravery to stay that course: "Oh, do not ask, 'What is it?' / Let us go" (3). In fact, the choice to follow this second mode of development is, perhaps, exactly what constitutes the break between *Prufrock* and *The Waste Land*. The latter poem certainly asks questions about the feasibility of absolute knowledge, but when those questions are answered negatively, it simply chooses to move on, where ultimately Prufrock freezes in place upon acknowledgement of his own ignorance. In *The Waste Land*, we hear:

> 'What shall I do now? What shall I do?'
> … What shall we do tomorrow?
> 'What shall we ever do?'
>   The hot water at ten.
> And if it rains, a closed car at four.
> And we shall play a game of chess (*CP* 57-8)

Whereas "Prufrock" constantly seeks out a starting point, some meaningful origin narrative that it never finds, *The Waste Land* repeatedly simply starts, and then restarts again and again, always acknowledging the absence of ultimate origins and then moving forward nonetheless. The patterns in "Prufrock" become ominous with the speakers' inability to explicate them: "It is impossible to say just what I mean! … as if a magic lantern threw the nerves in patterns on a screen." In *The Waste Land*, the acknowledged lack of meaningful foundation is exactly what allows patterns to develop. With "'What shall I do now? What shall I do?'… What shall we do tomorrow? / 'What shall we ever do?'" the question itself becomes a meaningful pattern even as the speaker knows she cannot answer in any satisfying sense. Unlike Prufrock, though, she simply selects one fundamentally arbitrary answer: "The hot water at ten. / And if it rains, a closed car at four. / And we shall play a game of chess." After all, why not take some hot water, a closed car? Why not play a game of chess? Here, still, there is some anxiety about the fact that the assumptions may be arbitrary. This speaker in *The Waste Land* does not seem to be one of the poem's more admirable or sympathetic voices. Like the lady in "Portrait of a Lady," she is silly, superficial. Yet the arbitrary choice, here, is accepted. Prufrock's deep spiritual dissatisfaction with the fragilities of epistemology remain in *The Waste Land*, but by that point the dissatisfaction has faded from Prufrock's acute emotional crisis into a resigned, unhappy decision to follow the only path forward.

This perspective is fundamentally axiomatic in the modern mathematical sense: just choose an arbitrary statement and move forward, seeing what happens once you choose a perspective. Prufrock's anxieties about the apparent meaninglessness of this exercise had analogues in mathematics, because the apparent arbitrariness of non-Euclidean geometry did provoke great anxiety among mathematicians. Yet these anxieties, both in the mathematical community and in Eliot's poetry, could not negate the real effectiveness of arbitrary assumptions in moving forward. Even if non-Euclidean geometry seemed less natural and less meaningful than Euclidean geometry, mathematicians could not deny that, as a system, it worked. The passage of *The Waste Land* quoted above comes from the second section, "A Game of Chess," and that section is itself the elaboration of this kind of axiom system, because the developments following from arbitrary choices repeatedly move the section forward, even though the speakers in that section of *The Waste Land* seem facile and superficial, preferring false teeth to real ("You have them all out, Lil, and get a nice set") and collecting "satin cases… in rich profusion" without attention to what those cases contain (58, 56). In fact, the arbitrary, surface-bound choices of "A Game of Chess" lead to meaning *because* they seem meaningless. Chess itself is the elaboration of an axiom system, since it is a game composed from purely arbitrary rules. There is no particularly meaningful reason why the knights, bishops, and pawns move in the specifically defined ways that they do. They just do so because those are the rules. Once we have accepted those arbitrary rules, however, it becomes possible to move forward, to elaborate the pattern.

Chess is the standard metaphor that philosophers have used to analyze mathematical formalism—the claim that mathematics is a network of marks on paper, a system of invented terms. Under the logic of mathematical formalism, modern mathematics can be imagined as an arbitrarily selected, enormously complicated, but rigorously rule-bound game. The logicists—Frege, Russell, and Whitehead—were all formalizers methodologically but not formalists ontologically. That is, the mathematics they produced adhered absolutely to formal rules developed from meticulously delineated starting points. But Frege, Russell, and Whitehead also all believed absolutely that mathematics was much more than a game; they believed that mathematics was real, even though they acknowledged that the question of how exactly it exists within reality is incredibly difficult. The chess game comparison is frequently used by philosophers and mathematicians who wish to refute mathematical formalism, because it is unsatisfactory to conclude that mathematics is no more than a game. How can a game be so useful? How can a game describe the world as well as mathematics does? Chess seems to exemplify an intellectually and syntactically complicated system that offers no deeper meaning, as in Eliot's allusions, in "A Game of Chess," to Thomas Middleton's *A Game at Chess* and *Women Beware Women*, wherein chess becomes an ironically artificial distraction from more substantive matters. Philosophers have used the term "game formalism" to describe an empty and superficial formalism, one which never escapes its enclosed formal system, and which never develops meaning in the real world.

In 1916, Ezra Pound had run up against exactly this problem in his "The Game of Chess":

Red knights, brown bishops, bright queens,
Striking the board, falling in strong "L"s of colour.
Reaching and striking in angles,
                    holding lines in one colour.
This board is alive with light;
                    these pieces are living in form,
Their moves break and reform the pattern:
                    luminous green from the rooks,
Clashing with "X"s of queens,
                    Looped with the knight-leaps.

"Y" pawns, cleaving, embanking!
Whirl! Centripetal! Mate! King down in the vortex,
Clash, leaping of bands, straight strips of hard colour,
Blocked lights working in. Escapes. Renewal of contest. (*Personae* 124)

Here Pound finds a chess game attractive as an elaboration of Vorticism because it is so rule-bound and so firm in its dense intellectual process, possessing such clarity of form and such rigor of action. But in the process Pound leaves readers with very little to interpret. This poem is radically formalist in that it leaves very little meaning to accompany this Vorticist pattern; indeed, it seems to deliberately avoid any implication that is semantic rather than methodological. Pound subtitled this poem "Dogmatic Statement Concerning the Game of Chess: Theme for a Series of Pictures," and, as Altieri argues:

> Pound's elaborate subtitle for this poem (originally the title) indicates his discomfort… he defensively acknowledges that the text is only a statement of a poetics, not a poem possessing dynamic resources sufficient to give it an independent life. And the closer we look, the more we realize that this defensiveness reveals a sharp and paralyzed critical intelligence. How awkward the gestures of immediacy seem. (*Painterly Abstraction* 292)

After the first few lines, "The Game of Chess" comes to seem predictable, even formulaic. It is a kind of closed system with a collection of axioms so simple that the poem is left with nowhere to go. It is the epitome of game formalism. The final sentence, "Renewal of contest," illustrates the fact that this process can only loop back on itself, exemplifying itself and only itself. As it insists on a kind of absolute unity, a consistent network far more radically enclosed than Eliot's networks of repetition, "The Game of Chess" works as a poetics because it is clear in its call for intensity, precise definition, movement, and consistency. It offers abstraction based in concrete description. However, as a poem, "The Game of Chess" is too consistent to withstand much complexity of interpretation: its meaning does not expand or proliferate. As Brooks argues, "It is the scientist whose truth requires a language purged of every trace of paradox… the truth which the poet utters can be approached only in terms of paradox," and there is no paradox here (1). While scientific and mathematical assumptions abhor contradiction, poetry requires contradiction to communicate complexity; it is bored by total consistency. But "The Game of Chess" explores the extreme possibility of a poem that stays absolutely and exclusively faithful to its author's poetics. In doing so, it empties itself fully into the faithful elaboration of one (and only one) axiom system.

However, axiom systems—in art—are multifarious and diverse, and they need not be consistent in the way that "The Game of Chess" is, nor in the way that mathematical systems are. Insisting on the critical importance of contradiction, Eliot writes in his dissertation about "the false assumption of epistemology—the assumption that there is one world of external reality which is consistent and complete: an assumption which is not only ungrounded but in some sense certainly false. Reality contains irreducible contradictions and irreconcilable points of view" (*Knowledge and Experience* 112). As popular culture appropriated non-Euclidean geometry and remembered Euclidean geometry alongside it, the two systems, with mutually contradictory axioms, coalesced in the popular imagination. Eliot's axiom systems, like this, exist in a kind of comfortable contradiction; for Eliot novelty existed interdependently with tradition, and this relationship was deliberately, self-consciously contradictory.

At the very beginning of *Ash Wednesday*, Eliot elaborates both patterned form and systemic knowledge claims via the repeated application of fundamentally contradictory axioms:

> Because I do not hope to turn again
> Because I do not hope
> Because I do not hope to turn
> …
> Because I do not hope to know again
> The infirm glory of the positive hour
> Because I do not think
> Because I know I shall not know
> …
> Because I know that time is always time
> And place is always and only place
> And what is actual is actual only for one time
> And only for one place
> I rejoice that things are as they are (*CP* 85)

This passage is remarkable in its intricate use of repetition. The segments repeated here are a good deal more tonally and semantically complex than the briefer, more sonically simple repetitions common to *The Waste Land* ("Twit twit twit / Jug jug jug jug jug jug," "Shantih shantih shantih"). These repetitions seem to borrow the patterned form of prayer while reinventing its logical structure. These repetitions are religious incantations, but this form of religious incantation echoes modernist mathematics because it is at once axiomatic, self-reflexive, and infinitely complicated. Repeatedly altering the statement of its starting point—"Because I do not hope to turn again / Because I do not hope / Because I do not hope to turn"—*Ash Wednesday* begins by invoking and re-invoking unstable claims that then generate increasingly complicated conclusions. The repeated use of "because" labels all of these differing claims as axioms of a sort, since they are the foundational assertions that lead to other assertions. Yet in spite of their nearly identical form, these assertions offer differing meanings. Eliot uses the structure of axiom systems in tandem with contradiction and paradox: "Because I know I shall not know." The simplicity of the repetitive rule invocations in turn allows for a more elemental, clearly developed recognition of the profound complexities those systemic rules elaborate. As Eliot's speaker "rejoice[s] that things are as they are," the convergence of tautology and paradox builds a kind of formal system that is both logical and paradoxical, both culturally inflected and profoundly abstract.

In "The Game of Chess," Pound's use of the definite article demonstrates a commitment to singular, exclusive, non-contradictory knowledge claims that Eliot does not endorse. "The Game of Chess" describes one definitive poetic process, so definitive that it cannot read like poetry. Eliot, instead, titles the second segment of *The Waste Land* "A Game of Chess," implying that this is not *the* course of action but one of many courses of action. And that segment is, unlike Pound's poem, a labyrinth of paths not taken, a whirlwind of differing possibilities. Chess serves—for Pound and Eliot as well as for mathematicians—as the exemplar of formalism, the clearest test case for the problem of how an extreme formalism can generate meaning. Pound addresses chess as a poetics instead of a poem because formalism, for him, offers a desirable artistic practice rather than a desirable method of interpretation, because while he instructs poets to concentrate on the collision of forms, his own poetry refers insistently to concrete objects that emphatically work as denotations, so that meaning can never be deferred in the way that formalist interpretation demands. Eliot, instead, embraces formalism as productive of interesting, variable meanings because he constructs poems upon contradictory axiomatic forms. Each and every one of *The Waste Land*'s proliferating voices has to be regarded and followed with care even as they all claim divergent things, and even as some of those voices seem ridiculous while others articulate profundities. The fact that the voices of Eliot's "A Game of Chess" are particularly inane only underscores the fact that contradictory statements need to be considered within this axiom system. If the voices of "A Game of Chess" (insisting, for example, on the vitality of a set of false teeth) seem superficial and silly up against the enormity of *The Waste Land*, we must recall Eliot's assertion about the non-Euclidean worlds created by Ben Jonson: "a man cannot be accused of dealing superficially with the world which he himself has created; the superficies *is* the world" (*Sacred Wood* 78). I am not asserting, here, that surfaces in *The Waste Land* offer depth (although that also is the case), but rather that *The Waste Land* fundamentally contemplates how the fact that form *seems* superficial directly enables it to be constitutive. Think here, of Raymond Williams's point that form is at once an "outward shape" and "an essential shaping principle" (138). Eliot was a formalist in this sense, a fact which can give meaning to Eliot's difficult-to-believe claim that *The Waste Land* is a "wholly insignificant grouse against life; it is just a piece of rhythmical grumbling" (*The Waste Land: A Facsimile* 1). This claim is not merely a bit of disingenuous dissatisfaction: it divulges an aesthetic theory of the relationship between significance and form—above, the ability of rhythm to generate meaning in the absence of meaning.

"A Game of Chess" resembles a more mature "Prufrock" and a deeper "Portrait of a Lady" in its contemplations of the meaninglessness of social niceties and the silliness of women. Attention to appearances makes clear the inadequacy of what those appearances gloss over. While the lady of "Portrait of a Lady" "ha[s] the scene arrange itself—as it will seem to do— / With… four wax candles in the darkened room, / Four rings of light upon the ceiling overhead," "A Game of Chess" presents "the flames of sevenbranched candelabra / Reflecting light upon the table as / The glitter of her jewels rose to meet it… the pattern on the coffered ceiling" (*CP* 8, 56). "A Game of Chess" describes how "her strange perfumes, / Unguent, powdered, or liquid—troubled, confused / and drowned the sense in odours" in echo of Prufrock's question, "Is it perfume from a dress / That makes me so digress?" (56, 5). "Prufrock," "Portrait of a Lady," and "A Game of Chess" all describe and critique the surfaces people create, very often for flirtatious ends, and the distressing chasm between art and decoration, between beauty and frippery, which seems to derive from those efforts. All three complain about the expectations of polite discourse which thwart more meaningful human connections, forcing Prufrock, instead, to "measure… out [his] life with coffee spoons" (4). But it is a relevant fact, here, that Eliot was himself known for the meticulous observance of such formalities. Woolf's dry mockeries of him, "a polished, cultivated, elaborate young American" who would come to lunch "in a four-piece suit" enact exactly the same complaints about gendered superficialities that Eliot at once detested and performed with perhaps too much care (Woolf, *Diary* 218, Gordon 142). "Formalism," in its original sense, described "strict or excessive adherence to prescribed forms"; a formalist was "a stickler for fixed rule, etiquette, routine, or ceremonial" (*OED*). It indicated exactly the slavish obedience to social forms described above. And in this way, as an insult, the term has often been used in literature and mathematics alike, because if formalism threatens to reduce life to perfumes, candles, and coffee spoons, it threatens in the same way to reduce poetry and mathematics alike to meaningless marks on paper, as in Pound's description of mathematics, from which this dissertation takes its title, "a few sheets of paper covered with arbitrary symbols" ("The Wisdom of Poetry" 361). Yet, in both literature and mathematics, the term migrated from an insult to a positive value. With its attention to formalisms, "A Game of Chess" generates, performs, and discloses an aesthetic theory, whereby the most superficial forms ultimately and paradoxically offer the deepest and most artistically radical poetic meanings.

"A Game of Chess" interrogates sounds and words that say nothing and conjures from that interrogation an axiomatic, patterned, form:

> 'What is that noise?'
>   The wind under the door.
> 'What is that noise now? What is the wind doing?'
>   Nothing again nothing.
>   'Do
> 'You know nothing? Do you see nothing? Do you remember
> 'Nothing?'
>
>   I remember
> Those are pearls that were his eyes.
> 'Are you alive, or not? Is there nothing in your head?'
>   But
> O O O O that Shakespeherian Rag—
> It's so elegant
> So intelligent (*CP* 57)

"Nothing," here, becomes a substantive value. The insistent interrogation of semantically undefined natural sonic forms—"The wind under the door"—leads to patterned and semantically undefined human sonic forms—"O O O O." But those latter sonic forms in fact echo the most definite of literary profundities (Shakespeare) in an apparently lower, sonically simpler, perhaps degenerate form ("that Shakespeherian Rag")—which in turn raises the possibility that "The wind under the door" might be another species of the same: only *apparently* noise, actually the mark of something profound. Scholars have typically noted that "A Game of Chess" exists in conversation with Middleton's *A Game at Chess* and *Women Beware Women*, wherein chess is something superficial, flat, and satirical. It is certainly in conversation with Pound's "The Game of Chess" as well, which similarly points to flat, perhaps ultimately sardonic formal ends. But surely also a vital interlocutor here is Abraham Cowley's "Destinie," which Eliot praises in "The Metaphysical Poets" particularly for its effective use of chess as a meaningful figure, and wherein chess, although apparently only a simple exercise in strategy, a form of intellectual game, ultimately takes on terribly real and heartfelt stakes: those of life. And if chess seems like an artificial game, conducted by players, constrained by rules, those causal players and those foundational rules are explicit in "Destinie": chess is played by, made possible by, founded upon, God.[84]

A formalist analysis of belief can seem counterintuitive regarding Eliot, insofar as it portrays belief systems as mere games. Religion strives to offer spiritual meaning, not arbitrary meaninglessness such as I may seem to have attributed to non-Euclidean geometry or mathematical formalism. However, the irony is that profound meaning ultimately does emerge from the apparently meaningless selection of axioms. Non-Euclidean geometry eventually proved indispensable in science—in 1916, Einstein proved that non-Euclidean geometry actually describes the physical universe more truthfully than Euclid's geometry does. David Hilbert's formalist interrogation of consistency in mathematics ultimately made computers possible, because it developed the sophisticated understanding of syntax and self-reference which was fundamental to the invention of computer languages. Embracing apparently unproven axioms can finally lead us to unassailable truths and unimpeachable utility. Both religious structure and literary form, as Eliot saw them, are axiom systems complicatedly intertwined with history and tradition. And Eliot saw modern poetry as non-Euclidean, formalist, and axiomatic in this sense: it leapt before it could be sure of anything to catch its fall.

That axiomatic approach involved treating the poem as though it had no origins: "Honest criticism and sensitive appreciation is directed not upon the poet but upon the poetry" (Tradition and the Individual Talent," *Selected Prose* 40). It involved treating the poem as though it were only form: "The end of the enjoyment of poetry is a pure contemplation from which all the accidents of personal emotion are removed; thus we aim to see the object as it really is"; "the perceptions do not, in a really appreciative mind, accumulate as a mass, but form themselves as a structure; and criticism is the statement in language of this structure" ("The Perfect Critic," *Selected Prose* 57, 58). While Eliot's insistence on tradition emphasizes that no art can exist apart from history, Eliot's model of poetic impersonality also insists that poetry exists as form in and of itself, capable of offering meaning divorced from the circumstances of its production, like the lilacs that are incontrovertibly beautiful yet sprouted inexplicably not from living seeds but from "the dead land." However, here we need to understand history as itself springing from patterned form, itself developing from those lilacs. When Eliot writes in *Four Quartets* that "The roses / Had the look of flowers that are looked at" he points out a necessary logical fact about how forms describe forms, formalist in the sense that it need not ever involve the semantics of flowers or sight in particular in order to nonetheless meaningfully describe the nature of pattern, the nature of the relationships that things intrinsically and necessarily have with themselves and each other.

It was from out of this kind of formal poetic pattern that Eliot saw criticism developing, and at the same time it was criticism which Eliot deemed to make this kind of formal pattern thinkable. He, wrote, late in his life, that "Literary criticism is a distinctive activity of the civilized mind," while he had insisted, many years earlier, on "the capital importance of criticism in the work of creation

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[84] Cowley writes:

> Lo from my'enlightned Eyes the Mists and shadows fell
> That hinder *Spirits* from being *Visible*.
> And, lo, I saw *two Angels* plaid the *Mate*.
> With *Man*, alas, no otherwise it proves,
> An *unseen Hand* makes all their *Moves*….
> Some *Wisemen*, and some *Fools* we call,
> *Figures*, alas, of *Speech*, for *Desti'ny plays us all*.

itself" (*Selected Prose* 7, 73). *Four Quartets* envisions its own formal, critical analysis when it announces that the flowers have the look of flowers that are looked at. The poem reads like the poem we are reading. It reveals itself to be identical with itself. It invites us, in this way, to see it as an enclosed form, as a chess game. But if this is a chess game, it is a chess game that refuses to stay enclosed within itself precisely because it everywhere imagines its own player—that is, its own reader—indeed, everywhere instructs its own reader how to read. For Eliot, criticism is intrinsic to good poetry, both necessary to its creation and emergent from that creation. In "The Function of Criticism" Eliot wrote, "I have assumed as axiomatic that a creation, a work of art, is autotelic; and that criticism, by definition, is *about* something other than itself" (*Selected Prose* 73-4). But Eliot also argued that criticism both underlies and develops out of poetry, meaning that the autotelic work of art, which need not be about anything but itself, itself contains and generates criticism which by definition is about something outside of itself, meaning that Eliot's initial axiom that art describes and justifies itself opens out into a process of description by which something else is necessarily described. In this way, formalist criticism is itself an axiom system that necessarily describes the world outside of itself.

Conclusion

The Mathematics of Formalism

> My dear Degas, poems are not made out of ideas. They're made out of *words*.
>
> Stéphane Mallarmé, via Paul Valéry[85]

> A mathematician, like a painter or a poet, is a maker of patterns. If his patterns are more permanent than theirs, it is because they are made with *ideas*.
>
> G. H. Hardy[86]

Any understanding of literary form must come back, eventually, to words. Yet how literature is built from words is no simple thing; when Mallarmé told Degas that poems are made of words and not ideas, he implied that Degas was no great writer. The mere accumulation of words is not enough, or any technical manual could rival Shakespeare. In *Four Quartets*, Eliot tells us that

> … Words, after speech, reach
> Into the silence. Only by the form, the pattern
> Can words or music reach
> The stillness (*Collected Poems* 180)

It is the form that allows literature to reach where simple words cannot, and which achieves literary resonance where simple speech dies. Eliot introduces "pattern" apparently as an appositive of "form"; that is, as another name for form. In fact, here form and pattern do become one and the same. In turn, if poems (as Mallarmé tells us) are made out of words, and if literary form (according to Eliot) consists of intricate patterns of words, then form itself, abstracted from words, might exist as patterns of almost anything.

In *Forms: Whole, Rhythm, Hierarchy, Network*, Caroline Levine argues that we are wrong to distinguish form from the social world, because society is organized by forms, both constrained and empowered by them. Levine writes that

> [A]ll of the historical uses of the term, despite their richness and variety, do share a common definition: "form" always indicates *an arrangement of elements—an ordering, patterning, or shaping*.… Form, for our purposes, will mean all shapes and configurations, all ordering principles, all patterns of repetition and difference. (3)

I concur with Levine's definition of form—which, incidentally, is also Bertrand Russell's definition of form, also Ezra Pound's, Virginia Woolf's, and T.S. Eliot's vision of form. Form is a pattern or arrangement, capable of existing independent of that which it arranges. We could examine patterns of words, or social arrangements of people, or configurations of ideas: all, equally, are forms. This vision of form is intrinsically mathematical. On the opening page of her introduction, Levine illustrates her vision of form thus:

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85 "Ce n'est point avec des idées, mon cher Degas, l'on fait des vers. C'est avec des *mots*" (Valéry 1324).

86 *A Mathematician's Apology*, 84.

> Consider the early scenes in *Jane Eyre*, where Brontë first introduces Lowood School. In the morning, a bell rings loudly to wake the girls. When it rings a second time, "all formed in file, two and two, and in that order descended the stairs." On hearing a verbal command, the children move into "four semicircles, before four chairs, placed at the four tables; all held books in their hands." When the bell rings yet again, three teachers enter and begin an hour of Bible reading before the girls march in to breakfast. Although this new world feels overwhelming at first, Jane—quick-witted and obedient—soon achieves success. "In time I rose to be the first girl of the first class." Critics are used to reading Lowood's disciplinary order as part of the novel's content and context, interpreting the school experience as indispensable to Jane's maturation, for example, or as characteristic of trends in nineteenth-century education. But what are Lowood's shapes and arrangements—its semicircles, timed durations, and ladders of achievement—if not themselves kinds of *form*?
>
> This book makes a case for expanding our usual definition of form in literary studies to include patterns of sociopolitical experience like those of Lowood School. (1-2)

Here Levine's chosen quotations—those from the very beginning of her book on form, those with which she defines form—all attend to moments that are mathematical in their sense of shape, order, and units of measurement: "two and two"; "in that order"; "four semicircles, before four chairs, placed at the four tables"; "first girl of the first class." Even the "timed duration" that Levine attends to in "In time I rose" is mathematical, insofar as it describes experience as existing within an ordered progression of time, i.e., as legible on the real number line.[87] Levine organizes her book around arrangements ordered by increasing number: from one ("wholes") to two ("binaries") to ordered multiples ("hierarchies") to, finally, more sprawling groupings that are so multifarious and variable as to make them seem infinite and incomprehensible ("networks"). In fact, at every turn Levine defines form in terms of number and mathematical pattern.

However, she does not go far enough. In particular, she overlooks the power of this mathematical understanding of form to describe ambiguities, gaps, and breakages. Early on, Levine addresses the boundaries of her definition of form, characterizing that which she conceives as non-formal:

> [O]ne might object, if so many things count as forms, from sonnets to prison cells to tenure clocks, then the category is just too capacious. What in this account is *not* form? Is there any way outside or beyond form? My own answer is yes—there are many events and experiences that do not count as forms—and we could certainly pay close attention to these: fissures and interstices, vagueness and indeterminacy, boundary crossing and dissolution. (8-9)

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[87] Here I use the term "real number line" in the mathematical sense, meaning not that the number line is actual, but that it includes both whole numbers and fractions, both rational and irrational numbers. For those not accustomed to these distinctions, the important point is that the real number line is a continuous expanse, without breaks or holes in it. Whereas the natural number line has no name for the spaces between units, refusing to imagine anything in between the neat whole numbers, anything in between one and two, the real number line expresses continuities, encompassing the shades of gray lying between white and black. Whereas "four semicircles, before four chairs, placed at the four tables" counts only in neat, complete units, the real number line reflects instead the continuous, unbroken progression of time.

Here, I argue, Levine is wrong. Or, more precisely, here Levine contradicts herself: her own definition of form implies that fissures and interstices, vagueness and indeterminacy, boundary crossing and dissolution are all just as much formal as are the more orderly arrangements, the more mathematically simple patterns, which she notices in *Jane Eyre*. Geometrically speaking, fissures and interstices have just as much shape as do the forms that they rupture and exist between. Indeterminacy both makes patterns possible and itself constitutes them, as I demonstrated in my first chapter, where it is the ambiguity of Jacob that makes the shape of the world he resides in legible, where it is the semantic multiplicity of Woolf's waves that builds the patterns of those waves, and where it is the undetermined meaning of variables which gives mathematical formulas their relevance. Dissolution is formal as well, and to break or dissolve boundaries is not to escape shape and form; Levine describes prison cells as forms, but were we to blow up the prison, the pile of resulting rubble would have its own shape and arrangement. A trash heap exists just as much in an arrangement as do "four semicircles, before four chairs, placed at the four tables"; it is only the case that the latter arrangement is simpler, less apparently chaotic, less apparently indeterminate. Its apparently disorganized arrangement is in fact one kind of organization, and that apparently disorganized organization is every bit as mathematical as is the organization of a semicircle. Levine's definition of form is more capacious than she realizes.

Then, to return to Levine's question, "What in this account is *not* form? Is there any way outside or beyond form?" Here I offer a more conventional answer: the opposite of form is content. Form is fundamentally a pattern, an arrangement of things, but it does not itself include or encompass those things which it arranges. Given "four semicircles, before four chairs, placed at the four tables," the form includes "*x* shapes, before *x* items, placed at *x* other items," but it does not include chairs or tables, nor does it include semicircles or the number four. As Russell writes, "'Socrates is earlier than Aristotle' has the same form as 'Napoleon is greater than Wellington,' though every constituent of the two propositions is different" (*Introduction to Mathematical Philosophy* 199). A form is an arrangement of constituents, and although it shuffles those constituents around, it does not itself include those constituents. In the specific context of language, we could compare form and content to syntax and semantics: syntax exists as a set of patterns governing the arrangement and rearrangement of terms, and although it both depends on semantics and partially determines semantics, it does not itself include semantics.

Yet, if the opposite of form is content, it is a truism to point out that form and content are perpetually in exchange with each other, that to examine one leads to an understanding of the other, and that although we can demarcate the two in theory, we cannot finally or absolutely distinguish between them in practice. The *Oxford Concise Dictionary of Literary Terms* instructs us that "Distinctions between form and content are necessarily abstractions made for the sake of analysis, since in any actual work there can be no content that has not in some way been formed, and no purely empty form" (Baldick 50). However, to state that form and content are abstractions is not to say that they are not real, but only to point out that they have no purely material manifestations. This is where mathematics becomes the uniquely explanatory analogue, because mathematics provides the clearest, most radical example of something with irrefutable significance in the material world in spite of its intrinsic abstraction. Mathematics is at once a maddeningly ethereal realm of thought and form, and also an undeniably descriptive tool that reliably predicts physical phenomena. It can be constructed entirely without reference to the material world and still retain perfect accuracy in that world.

Repeatedly, across mathematical history, pure mathematicians have proved theorems and derived methods with no thought of applications in science; and repeatedly, across history, scientists have seized upon that abstract mathematics and shown it to describe the material world. When non-

Euclidean geometry developed in the nineteenth century, it seemed an absurd fiction, irrelevant to science and human experience regardless of whether or not it was mathematically correct. But when Einstein used non-Euclidean geometry in his theory of general relativity, he showed it to describe the real physical universe with greater accuracy than traditional geometry. In another mathematical subfield, when the great mathematician Carl Friedrich Gauss said that "Mathematics is the queen of sciences and number theory is the queen of mathematics,"[88] he implied that number theory is the purest part of mathematics: the part most abstract and least tarnished with utilitarian human compromises. G. H. Hardy explains:

> If the theory of numbers could be employed for any practical and obviously honourable purpose, if it could be turned directly to the furtherance of human happiness or the relief of human suffering, as physiology and even chemistry can, then surely neither Gauss nor any other mathematician would have been so foolish as to decry or regret such applications. But science works for evil as well as for good (and particularly, of course, in time of war); and both Gauss and lesser mathematicians may be justified in rejoicing that there is one science at any rate, and that their own, whose very remoteness from ordinary human activities should keep it gentle and clean. (*A Mathematician's Apology* 120-1)

Writing those words at Cambridge in 1940, number theory's intrinsic distance from violence was, for Hardy, an urgent ethical concern. "No one has yet discovered any warlike purpose to be served by the theory of numbers or relativity… So a real mathematician has his conscience clear; there is nothing to be set against any value his work may have; mathematics is, as I said at Oxford, a 'harmless and innocent' occupation" (Hardy, *Apology* 140-1). For centuries mathematicians had worked on number theory comfortable in the assumption that it would never prove useful in war. Yet, even as Hardy was writing these words, Alan Turing was working with British intelligence to use number theory to crack the German Enigma code. Today the U.S. Department of Defense routinely funds and employs number theorists, because number theory has become vital to the cryptography that underpins modern warfare, as well as to digital security and to the discrete mathematics that underlies much of computer science.

In this way the practical and sometimes ugly utility of mathematics has repeatedly proven itself, often centuries after the mathematics developed. This pattern recurs so often in the history of mathematics that it becomes predictable, even tiresome: abstract ideas that seem obviously divorced from the material world eventually become indispensable to scientific descriptions of that world. In the selection above, Hardy's celebration of the uselessness of number theory applies specifically and exclusively to its (erstwhile) uselessness to the military, but elsewhere mathematicians have often seemed to glory in a broader kind of mathematical resistance to utility. The twentieth-century number-theorist Leonard Dickson is very often quoted as having remarked, "Thank God that number theory is unsullied by any application"—without any reference to negative or violent applications.[89] Number theory is a field known for its independent, abstract beauty, a place where, so

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[88] "Die Mathematik hielt Gauss um seine eigenen Worte zu gebrauchen, für die Königin der Wissenschaften und die Arithmetik für die Königin der Mathematik" (von Waltershausen 79).

[89] This quotation can be easily located in many textbooks and histories of mathematics (Yan 303, Young 9, Das 429, MacHale 135); however, I have been unable to locate any authoritative origin for the attribution. If these words do exist as mathematical lore more than biographical fact, that nonetheless underscores something important about mathematical culture: the notion that Dickson uttered these words is definitely attractive to mathematicians. In my own anecdotal

to speak, mathematicians rally to the cry of *l'art pour l'art*. In fact, here even Hardy seems to contradict himself. Further up the same page he writes that

> It is undeniable that a good deal of elementary mathematics… has considerable practical utility. These parts of mathematics are, on the whole, rather dull; they are just the parts which have the least aesthetic value. The 'real' mathematics of the 'real' mathematicians, the mathematics of Fermat and Euler and Gauss and Abel and Riemann, is almost wholly 'useless' (and this is as true of 'applied' as of 'pure' mathematics). It is not possible to justify the life of any genuine professional mathematician on the ground of the 'utility' of his work. (119-20)

Hardy does not quite say that it would be ugly for mathematics to be useful. But he does say that beautiful mathematics is not useful. That claim is all the more striking because for Hardy the beauty of mathematics is of paramount importance: "The mathematician's patterns, like the painter's or the poet's, must be *beautiful*; the ideas, like the colours or the words, must fit together in a harmonious way. Beauty is the first test: there is no permanent place in the world for ugly mathematics" (*Apology* 85). And, "It will be obvious by now that I am interested in mathematics only as a creative art" (115).

In *Art*, Clive Bell writes, regarding mimesis and recognizable artistic content:

> The representative element in a work of art may or may not be harmful; always it is irrelevant. For, to appreciate a work of art we need bring with us nothing from life, no knowledge of its ideas and affairs, no familiarity with its emotions. Art transports us from the world of man's activity to a world of aesthetic exaltation. For a moment we are shut off from human interests; our anticipations and memories are arrested; we are lifted above the stream of life. The pure mathematician rapt in his studies knows a state of mind which I take to be similar, if not identical. He feels an emotion for his speculations which arises from no perceived relation between them and the lives of men, but springs, inhuman or super-human, from the heart of an abstract science. I wonder, sometimes, whether the appreciators of art and of mathematical solutions are not even more closely allied. Before we feel an aesthetic emotion for a combination of forms, do we not perceive intellectually the rightness and necessity of the combination? (25-6)

While Hardy notes that the application of mathematics in the human world might or might not be harmful, Bell writes that "The representative element in a work of art may or may not be harmful." Bell turns and returns to mathematics three separate times in *Art*, using it particularly to justify and support formalism, and particularly to denounce justifications of art that are based on "practical utility" (70, 278). It is Bell's commitment to aesthetic formalism that leads him to reject justifications based on utility, while it is Hardy's belief that justifications based on utility are wrong that leads him to the contemplation of aesthetics. Hardy's vision of aesthetics is formalist in the sense that it is committed to nonrepresentational beauty. The idea of understanding mathematical ontology as a system of scientific descriptions strikes him as wrong, while the idea of justifying mathematics via its utility in the world, whether for war or human welfare, strikes him as disturbing. This belief did not

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experience, I have often heard mathematicians in conversation lament the newfound utility of number theory, that "queen of mathematics."

stem from any indifference—Hardy was someone who cared deeply about peace, equality, and human welfare: he lobbied fiercely against Russell's dismissal from Cambridge for pacifist activities during World War I; he discovered, defended, and promoted the mathematical genius of the self-educated Indian mathematician Srinivasa Ramanujan, bringing him to Cambridge in 1914 when non-white academics were almost unheard of in England; he once complained that "a science is said to be useful if its development tends to accentuate the existing inequalities in the distribution of wealth, or more directly promotes the destruction of human life."[90] In fact, it was in the name of peace and human welfare that Hardy defended math's abstraction from human actualities. Yet he also would never have denied math's intrinsic value in describing the world we live in.

This relationship between mathematics and the material world is not only a metaphor for the relationship between literature and reality, but an imitable model that, I argue, multiple modernist authors knowingly seized upon and manipulated. It is in this mathematical manner that Virginia Woolf used the semantic structures of variables to describe the fluid multiplicities of human life, with the "love that never attempted to clutch its object; but, like the love which mathematicians bear their symbols, or poets their phrases, was meant to be spread over the world" (*Lighthouse* 47). And, from the diametrically opposite political position, it is this same mathematical understanding of the relationship between form and content that allowed Ezra Pound to assert that "Poetry is a sort of inspired mathematics, which gives us equations": equations, that is, between art and world which at one and the same time refuse any direct mimesis, because math everywhere describes the world without anywhere making direct reference to the world (*Spirit of Romance* 5). Regardless of author, position, or viewpoint, it is in this mathematical manner that the most abstract, formal, and seemingly unworldly moments in modernism seized relevance to history, world, and culture. They did so by describing the world without referring to the world, expressing the shapes of reality via pattern and form.

It is a central claim of this dissertation that there is something intrinsically mathematical about formalism in the arts, whether we get there via Levine, or Bell, or via the New Critics and a host of twentieth-century formalists. Because, as Paul Bernays wrote in 1922,

> [T]he sphere of the mathematical-abstract, into which the methods of thought of mathematics translate all that is theoretically comprehensible, is not that of the contentual-logical [*inhaltlich Logisches*] but rather that of the domain of pure formalism. Mathematics turns out to be the general theory of formalisms, and by understanding it as such, its universal meaning also becomes clear. (196)

I agree with Bernays that "Mathematics turns out to be the general theory of formalisms." But here to notice that mathematics sits at the foundation of formalism is not an endpoint, because that only raises the question of the foundation for that foundation. In the same way that Eliot's interrogation of pattern led him to interrogate the foundations for foundations, to notice the mathematical foundations of formalism begs the question of the foundations of mathematics. And as far as we are concerned here, those foundations are everywhere imbricated with language.

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[90] Hardy complained that this statement was sometimes unfairly removed from its context of the first World War. He described it as "a conscious rhetorical flourish, though one perhaps excusable at the time when it was written" (*Apology* 120).

David Hilbert wrote that

> The solid philosophical attitude that I think is required for the grounding of pure mathematics—as well as for all scientific thought, understanding, and communication—is this: *In the beginning was the sign*. ("New Grounding" 202)

Not all the mathematicians I have written about would agree with Hilbert on this point. Bernays fiercely defended this perspective, Whitehead alternately defended and critiqued formalist positions, and Frege, Russell, and Hardy were skeptical, occasionally even hostile to descriptions of mathematics as ultimately based on language or form. The mathematicians I have surveyed in this dissertation had a very wide variety of beliefs about the ontology of mathematics. Yet all of these modernist mathematicians, in their diverse outlooks, were alike in that their studies of logic, of mathematical consistency and completeness, of axiom systems, and of mathematical form led them to interrogate, in a wide variety of ways, the mechanisms of language. Frege, for example, did not believe that the foundations of mathematics ultimately lay in language, but he did conclude that the interrogation of language was necessary labor for the construction of his logicist system for the foundations of mathematics. He concluded that his mathematical logic required a deeper, more technical understanding of how syntax and semantics function, of how symbolism works, leading him to develop a language philosophy as a means to an end, all in the effort to develop a philosophy of mathematics. Frege, Russell, Whitehead, Hilbert, Bernays, and Hardy all, in a very wide variety of ways, turned to the study of language as a vital tool in their explanations of mathematical foundations.

In 1922 Hilbert echoed and altered the New Testament when he declared that "The solid philosophical attitude that I think is required for the grounding of pure mathematics… is this: *In the beginning was the sign*": this in place of the John 1:1 verse that the *King James Bible* renders as "In the beginning was the word." Here Hilbert alluded, too, to the dilemma of Goethe's Faust, who struggles to translate that line from the original Greek ("In the beginning was the *logos*"). And where Faust confronts the difficulty and complexity of the *logos*, Hilbert confronts the difficulty and complexity of the *word*, specifying it, in turn, as the *sign* ["*das Zeichen*" ("Neubegründung" 163)].[91] Part of the trouble that Hilbert confronts, here, is that to conceive of mathematical objects as words is to insist on deferring their meaning (i.e., to read them in a formalist manner), but that to utilize language in the absence of meaning seems to risk dispensing with language itself—or, at least, to discount language's fundamental function: to express, refer, and communicate. As Jeremy Gray writes:

> What might be called uninterpreted but interpretable mathematics has its own philosophy, the minority view by the nineteenth century, going back to Leibniz and preferred by Lambert and Condorcet, that mathematics was a language—indeed the best language, because of the simplicity of its terms and the formality of its arguments. The nature of the allowable rules for an otherwise free play of symbols is a vexed one, as my arguably paradoxical formulation is intended to suggest. (*Plato's Ghost* 28)

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[91] German bibles, it is worth noting, have traditionally translated *Logos* in the same manner as did the *King James Bible*: Luther renders John 1:1 as "Im Anfang war das Wort"; that is, "In the beginning was the *word*."

To conceive of mathematics as a language requires conceiving of it, paradoxically, as a language which is at once interpretable and everywhere uninterpreted. This happens because linguistic and formalist accounts of mathematics aim to preserve semantic multiplicity: that is, to preserve the fact that a variable could be this or that, to preserve the sense in which Jacob might be so many different men, and to preserve the fact that mathematics holds such diverse and multifarious uses and manifestations. One of the primary aims of Hilbert's mature formalism was to satisfy different mathematicians who had radically divergent beliefs about the ultimate ontology of mathematics, but to do so without anywhere reducing or interfering with mathematical practice. In effect, he wanted Jacob's multiplicity to remain in full force, without anywhere interfering with *Jacob's Room*. As Gray notes, Gottfried Wilhelm Leibniz, Johann Heinrich Lambert, and the Marquis de Condorcet had developed precursors to Hilbert's formalism, but they worked with relatively naïve understandings of language, ill-equipped to deal with the inherent multiplicity of words' semantic functions and ill-equipped to deal with the meta-interpretive difficulties of formalist language. In Hilbert's "*In the beginning was the sign*" there lies an acknowledgment of the dualities of the sign and of the complexities of the word, which we can trace from Frege and Goethe, and which is in fact remarkably Saussurean.

In the wake of Hilbert's formalism, and given the much longer history of mathematicians formally and informally declaring that mathematics is a language, when I say that mathematics exists at the root of formalism I do not imply that formalism is mathematical more than it is literary. In fact, I argue that formalism exists intrinsically at the intersection of mathematics and language. Literature and mathematics together constitute the heart of form—which is utterly abstract and yet which inherently communicates. Pound explains:

> A certain man named Plarr and another man whose name I have forgotten, some years since, developed the functions of a certain obscure sort of equation, for no cause save their own pleasure in the work. The applied science of their day had no use for the deductions, a few sheets of paper covered with arbitrary symbols—without which we should have no wireless telegraph. ("Wisdom of Poetry" 361)

Pound tells us that Plarr "developed the functions of a certain obscure sort of equation" for no reason other than his "own pleasure in the work." He identifies, here, an aesthetics of pure mathematics, acknowledging the possibility of a kind of *l'art pour l'art* justification for mathematical abstraction. But Pound's story simultaneously reveals the fallacy in approaching such aesthetics as final, as ever truly or completely sealed off from the material world, because although "The applied science of their day had no use for the deductions," the applied science of later days did. And here, when Pound refers to this abstract yet applicable mathematics—this uninterpreted and yet interpretable mathematics—as "a few sheets of paper covered with arbitrary symbols," he sets up a very definite and deliberate analogy, because "a few sheets of paper covered with arbitrary symbols" describes poems as well as equations, literature as well as mathematics. Moreover, it is no coincidence that the technology Pound describes, the particular scientific application of mathematics which he selects for his anecdote, is a communications technology. The wireless telegraph allows people, across long distances, to speak and to understand. Pound describes a history in which abstract mathematics very literally and directly made transmitted language possible, and in the same moment he describes the form of mathematics—a few sheets of paper covered with arbitrary symbols—so as to emphasize the fact that it shares with language the same form as well as the same effect.

Moreover, the wireless telegraph is a communications technology that depends on artificially encoded signs. The wireless telegraph transmitted messages via radio waves encoded in Morse code, requiring translation, letter by letter, between natural language and the series of Morse code blips and bleeps that are indecipherable to the uninitiated, to those who don't speak the language. This type of coding is critical to what allows mathematics and literature each to isolate and abstract form in a manner that is less natural, less intrinsic, to music or visual art. Walter Pater famously claimed:

> *All art constantly aspires towards the condition of music*. For while in all other kinds of art it is possible to distinguish the matter from the form, and the understanding can always make this distinction, yet it is the constant effort of art to obliterate it. That the mere matter of a poem, for instance, its subject, namely, its given incidents or situation—that the mere matter of a picture, the actual circumstances of an event, the actual topography of a landscape—should be nothing without the form, the spirit, of the handling, that this form, this mode of handling, should become an end in itself, should penetrate every part of the matter: this is what all art constantly strives after, and achieves in different degrees. (90)

Pater was working with a definition of form that differs critically from the definition I have laid out; indeed, it very nearly reverses the understanding of form that comes to us through the modernists. Whereas Pound explains that "by 'form' I mean the arrangement" and whereas Eliot describes "the form" as "the pattern" ("Wisdom of Poetry" 360, *Collected Poems* 180), Pater writes that form "must first of all delight the sense" exciting the "impressions" (88, 91). As Pater tells us that art always strives to exist as form and form alone, he also tells us that "Art, then, is thus always striving to be independent of the mere intelligence, to become a matter of pure perception" (92). Pater's form is fundamentally sensory and sensuous, and as such it is fundamentally material, existing at odds with the more abstract understanding of form as arrangement and pattern that Pound, Eliot, Russell, and others present to us. While Pater concludes that "All art constantly aspires towards the condition of music," if we follow Pound, Eliot, and Russell's understanding of form we will reach almost the opposite conclusion: if form is pattern, then any art which aspires to be formal aspires to the combined condition of mathematics and literature, precisely because these mediums involve an apparently arbitrary encoding, working like Morse code more than sensory mimesis, realizing not Pater's full marriage of form and content, but instead the illusion of a complete divorce of form from content. That is, whereas a painting visually resembles something, and whereas the sounds of music produce direct physiological sensations, there is absolutely no sensory resemblance between "a few sheets of paper covered with arbitrary symbols" and that which those symbols communicate: regardless of whether the arbitrary symbols mark a story narrated in language, or mark equations that govern the motion of the earth around the sun.

Admittedly, this is a generalization, susceptible to exceptions. This claim could be attacked from one direction via research in material book culture, which has demonstrated the very real role that physical volumes play in reading. My claim could be attacked even more broadly by pointing out the arbitrary codings and symbolic processes that music and visual art do involve. I make, here, a generalization, drawing from the ideas and even the stereotypes of art that we carry with us. Painting by virtue of its medium has some content directly accessible to the senses: whether a photorealist landscape or the abstract arrangement of colors and textures, it arranges constituents that are visible to the eye. Music arranges sounds, timbres, and pitches, and under Russell, Pound, and Eliot's definition of form those sounds, timbres, and pitches are themselves content, because they are themselves constituents arranged. Certainly, music and and painting encode other, less directly sensory content as well, but that encoding is neither so obvious nor so arbitrary as the process of converting the alphabet into Morse code, nor the process of naming things with words, the purely arbitrary determination by which "table" refers to a flat wooden surface on four legs.

Mathematics and literature together most fully realize formalism because formalist thought springs from attempting what it knows it cannot complete, whether Hilbert deferring mathematical meaning in order to rescue mathematical meaning, or whether Mallarmé pretending to Degas, in some important sense, that poems aren't about anything. When Russell was imprisoned during World War I for his very political, human, and material pacifist protests, during his time in jail he wrote his *Introduction to Mathematical Philosophy*: the text where he defines his conception of form. He notes, in that text, that this was no accident, because thinking about form, and formal mathematics, was something which his imprisonment could not prevent: "like Browning's Grammarian with the enclitic δε, I would give the doctrine of this word if I were 'dead from the waist down' and not merely in a prison" (167). "Pure logic, and pure mathematics (which is the same thing), aims at being true, in Leibnizian phraseology, in all possible worlds, not only in this higgledy-piggledy job-lot of a world in which chance has imprisoned us" (192). Russell wrote the *Introduction to Mathematical Philosophy* in prison in part because the material deprivations of imprisonment lent themselves to the abstractions of mathematical thought, thus realizing a kind of extreme performance of formalism in human form: mathematics was that which remained formally meaningful in the absence of material and sensory interaction with the outside world. However, writing about mathematics in prison was also itself a profound political act, a way of protesting war by subtracting himself from a world at war. In the same way, when Hardy writes that number theory is harmless, he seems to imply that it is even more than that: that it is, by way of its very abstraction, a kind of material social protest against materialities that are appalling.

Hardy opens *A Mathematician's Apology* by first contemplating, not mathematics, but what it is to write about mathematics, and, by way of that, literary criticism: what literary criticism is, and what value it has. He does so with a kind of stark sadness:

> It is a melancholy experience for a professional mathematician to find himself writing about mathematics. The function of a mathematician is to do something, to prove new theorems, to add to mathematics, and not to talk about what he or other mathematicians have done. Statesmen despise publicists, painters despise art-critics, and physiologists, physicists, or mathematicians have usually similar feelings: there is no scorn more profound, or on the whole more justifiable, than that of the men who make for the men who explain. Exposition, criticism, appreciation, is work for second-rate minds.
>
> I can remember arguing this point once in one of the few serious conversations that I ever had with Housman. Housman, in his Leslie Stephen lecture The Name and Nature of Poetry, had denied very emphatically that he was a 'critic'; but he had denied it in what seemed to me a singularly perverse way, and had expressed an admiration for literary criticism which startled and scandalized me. (61)

Hardy expresses sadness that he is writing about mathematics instead of doing mathematics: "If then I find myself writing, not mathematics, but 'about' mathematics, it is a confession of weakness" (63). By way of contemplating the nature of such a meta-discursis, he turns, particularly, to literary criticism. A substantial contemplation of the relation between literature and literary criticism follows this passage. Housman defends the importance of literary criticism, while Hardy disparages it, as inferior to poetry. Regardless of the successes or failures of literary criticism, what is important here is that, in writing about writing about mathematics, Hardy saw a need particularly to write about writing about literature. He seemed actually fearful that *A Mathematician's Apology* might devolve into literary criticism. And while Hardy worries that to write about mathematics (rather than to do mathematics) is to write a kind of literary criticism, a host of twentieth-century literary formalists have worried that formalist literary criticism might seem to reduce literature to a kind of mathematics.

John Crowe Ransom, in particular, ties close reading to mathematics and science and opposes it to applied technology. In the process, in *The New Criticism* he provides a very extended treatment of the binomial theorem, which he analyzes for its elegant form, for its ability to fold out of itself, essentially, its ripeness for fruitful analysis. But he also takes great pain to distinguish literary analysis from the binomial theorem, in the sense, particularly, that literary analysis is not deterministic. He turns to mathematics as evidence that form can have value in and of itself:

> Winters believes that ethical interest is the only poetic interest. (If there is a poem without visible ethical content, as a merely descriptive poem for example, I believe he thinks it negligible and off the real line of poetry.) Now I suppose he would not disparage the integrity of a science like mathematics, or physics, by saying that it offers discourse whose intention is some sort of moral perfectionism. It is motivated by an interest in mathematics, or in physics. But if mathematics is for mathematical interest, why is not poetry for poetic interest? (213)

However, elsewhere his comparison of mathematics and literature is more fraught:

> A really distinguished prose argument is stated in the Binomial Theorem, as follows:
>
> $$(a+b)^n = a^n + \frac{n}{1}a^{n-1}b + \frac{n(n-1)}{1\cdot 2}a^{n-2}b^2 + \frac{n(n-1)(n-2)}{1\cdot 2\cdot 3}a^{n-3}b^3 \quad . \quad . \quad . \quad . \quad . \\ + \frac{n(n-1)(n-2))}{1\cdot 2\cdot 3}a^3b^{n-3} + \frac{n(n-1)}{1\cdot 2}a^2b^{n-2} + \frac{n}{1}ab^{n-1} + b^n.$$
>
> It would be hard to imagine a structure more neat, symmetrical, self-sufficient, and ingenious. It is also imperious: it obliges its member terms to keep perfectly in order; it can wholly determine them. The equation has $n + 1$ terms, and we can tell in advance what any term that is called for will be like, and exactly like. The r th term, for example, will be
>
> $$\frac{n(n-1)(n-2)...(n-r+2)}{1\cdot 2\cdot 3...(r-1)}a^{n-r+1}b^{r-1}.$$
>
> The Binomial Theorem is a logical structure of great distinction. Its members, on the other hand, have no distinction (I do not mean distinctness) unless it is a distinction to be completely obedient to the prescription laid down by the parent structure; they are not free but determined.
>
> The poetic argument, in comparison, is not highly distinguished; it is comfortably general, and it is weakly regulatory. It is the member details that have all the distinction; they luxuriate, and display energy in unpredictable ways, going far

> beyond the prescription of the paraphrase. (269-70)

Ransom presents this very extended treatment of the binomial theorem (which, in fact, extends further than this, popping up elsewhere in *The New Criticism* as well) to acknowledge that pattern can be incredibly complex, even incredibly beautiful, in fields far outside of poetry. Yet he is concerned that this mathematical version of pattern grants its constituents no freedom, and no distinction. That vision of the formula above disregards the intrinsic semantic fluidity and multiplicity of variables, which I laid out in my first chapter. In fact, Ransom himself is well aware of the fact that variables exist to mark this sort of free multiplicity: elsewhere, he uses variables to explain symbolic freedom itself:

> His sonnet consists in identifying his state by three successive metaphors. The tenor is not expressed; and the procedure amounts to saying:
>
> > My tenor is *x*: it occurs somewhere in each of the following vehicles; find *x*
>
> Here we have a fundamental kind of ambiguity (124)

Ransom, thus, is well aware that the variables in the binomial theorem have intrinsically multiple, flexible referents. He knows that variables evince "a fundamental kind of ambiguity." If, nonetheless, he uses the binomial theorem ultimately to exemplify semantic determinism, ultimately to exemplify reductions in meaning, this evidences a deep anxiety. In Ransom's work, there is a persistent concern that his formalism of poetry might slip into a formalism of mathematics, and Ransom expresses a palpable discomfort with that possibility: a discomfort almost identical with Hardy's concern that he might be doing a kind of literary criticism. This is, in part, the anxiety of any thinker that their work might be reducible to work others have done before; it is also, even worse, the anxiety that their entire field might be reducible to the knowledge already developed in another field. However, it is absolutely vital to note that Hardy feels this concern as much as Ransom does; that while Pound turns to mathematics to justify his form, Russell, Frege, and Hilbert turned to language and even literature to explain and justify the basis for their own work. This process is fundamentally bi-directional.

In his introduction to the 1968 edition of *The Well Wrought Urn*, Cleanth Brooks notes that "Poems do not grow like cabbages, nor are they put together by computors. They are written by human beings" (x). Brooks goes on, of course, to insist on the importance of disregarding authorial intention in criticism, because although poems "are written by human beings," they also "remain mere potentialities until they are realized by some reader" (x). Yet to disregard authorial intention turns out to be difficult work: authors continually insert themselves into their writing, whether emerging via biographical detail and historical fact, or emerging more formally, as Wimsatt and Beardsley noted in Eliot's footnotes to *The Waste Land*. The interesting thing, here, is that Brooks seems to imply that a poem written by a computer, if it were to exist, would lend itself to the fullest sort of formalism: a formalism where a critic would not have to do the difficult labor of setting aside authorial intention, because no such intention would exist. Ogden and Richards describe the same possibility in terms of content and form, writing that it is in "mathematics, where the divorce between symbol and reality is most pronounced and the tendency to hypostatization most alluring" (29).

On the final page of his *Anatomy of Criticism*, Northrop Frye writes that

> Literature, like mathematics, is a language, and a language in itself represents no truth, though it may provide the means for expressing any number of them. But poets and critics alike have always believed in some kind of imaginative truth, and perhaps the justification for the belief is in the containment by the language of what it can express. The mathematical and the verbal universes are doubtless different ways of conceiving the same universe. The objective world affords a provisional means of unifying experience, and it is natural to infer a higher unity, a sort of beatification of common sense. But it is not easy to find any language capable of expressing the unity of this higher intellectual universe. Metaphysics, theology, history, law, have all been used, but all are verbal constructs, and the further we take them, the more clearly their metaphorical and mythical outlines show through. Whenever we construct a system of thought to unite earth with heaven, the story of the Tower of Babel recurs: we discover that after all we can't quite make it, and that what we have in the meantime is a plurality of languages. (354)

There is something definitional at stake in Ransom's efforts to distinguish literature from mathematics, and something equally definitional at stake in Frye's conflation of the two. Something that we've forgotten in the years since. But for the modernists, up through the New Critics, the question of the difference between the humanities and the sciences, and most particularly, between literature and mathematics, was an urgent and important problem. Today, we take for granted that the sciences are different from the humanities. They are. And yet, we have forgotten something which once made that fact nonobvious. We have forgotten that formalism, taken to its logical extreme, is the intersection of literature and mathematics.

Bibliography

Abel, Elizabeth. *Virginia Woolf and the Fictions of Psychoanalysis*. Chicago: University of Chicago Press, 1989.

Albright, Daniel. *Quantum Poetics: Yeats, Pound, Eliot, and the Science of Modernism*. Cambridge: Cambridge University Press, 1997.

Alexander, Amir. *Duel at Dawn: Heroes, Martyrs, and the Rise of Modern Mathematics*. Cambridge: Harvard University Press, 2010.

Alt, Christina. *Virginia Woolf and the Study of Nature*. New York: Cambridge University Press, 2010.

Altieri, Charles. *Painterly Abstraction in Modernist American Poetry*. New York: Cambridge University Press, 1989.

—. "Steps of the Mind in T. S. Eliot's Poetry." *The Bucknell Review* 22 (1976): 180–207.

—. *Wallace Stevens and the Demands of Modernity: Toward a Phenomenology of Value*. Ithaca: Cornell University Press, 2013.

Asghari, Amir. "Experiencing Equivalence but Organizing Order." *Educational Studies in Mathematics* 71 (2009): 219-34.

Asghari, Amir, et al. "Who Introduced the Terms 'Equivalence Relation' and 'Equivalence Class'?" *MathOverflow*. <http://mathoverflow.net/questions/135347/who-introduced-the-terms-equivalence-relation-and-equivalence-class>.

Ashton, Jennifer. *From Modernism to Postmodernism: American Poetry and Theory in the Twentieth Century*. New York: Cambridge University Press, 2005.

Baldick, Chris. *The Concise Oxford Dictionary of Literary Terms*. New York: Oxford University Press, 2004.

Banfield, Ann. *The Phantom Table: Woolf, Fry, Russell and the Epistemology of Modernism*. New York: Cambridge University Press, 2000.

Beer, Gillian. *Virginia Woolf: The Common Ground*. Ann Arbor: University of Michigan Press, 1996.

Bell, Clive. *Art*. New York: Frederick A. Stokes Company, n.d.

Bell, Ian F. A. *Critic as Scientist: The Modernist Poetics of Ezra Pound*. New York: Methuen, 1981.

—. "Ezra Pound and the Materiality of the Fourth Dimension." *Science in Modern Poetry: New Directions*. Ed. John Holmes. Liverpool: Liverpool University Press, 2012.

Bell, Quentin. *Virginia Woolf, A Biography*. Orlando: Harcourt, 1972.

Bell, Robert H. "Bertrand Russell and the Eliots." *The American Scholar* 52 (1983): 309-325.

Bernays, Paul. "Hilbert's Significance for the Philosophy of Mathematics." Trans. Paolo Mancosu. *From Brouwer to Hilbert: The Debate on the Foundations of Mathematics in the 1920s*. Ed. Paolo Mancosu. New York: Oxford University Press, 1998.

Blanchette, Patricia. "The Frege-Hilbert Controversy." *The Stanford Encyclopedia of Philosophy. Fall 2012 Edition.* Ed. Edward N. Zalta. <http://plato.stanford.edu/archives/fall2012/entries/frege-hilbert/>.

Blanshard, Brand. "Eliot at Oxford." *T. S. Eliot: Essays from* The Southern Review. Ed. James Olney. Oxford: Clarendon Press, 1988.

Blanton, C. D. *Epic Negation: The Dialectical Poetics of Late Modernism*. New York: Oxford University Press, 2015.

Brooks, Cleanth. *The Well Wrought Urn: Studies in the Structure of Poetry*. London: Dennis Dobson, 1968.

Brouwer, L. E. J. "Intuitionism and Formalism." Inaugural address at the University of Amsterdam, 1912. Trans. Arnold Dresden, *Bulletin of the American Mathematical Society* 20 (1913), 81-96.

—. "On the Significance of the Principle of Excluded Middle in Mathematics." *From Frege to Gödel, A Source Book in Mathematical Logic, 1879-1931*. Ed. Jean van Heijenoort. Cambridge: Harvard University Press, 1977: 334-41.

Cajori, Florian. *A History of Mathematical Notations*. London: The Open Court Company, 1928.

Cassedy, Stephen. *Flight From Eden: The Origins of Modern Literary Criticism and Theory*. Berkeley: University of California Press, 1990.

Chaucer, Geoffrey. *The Riverside Chaucer*. Ed. Larry D. Benson. Boston: Houghton Mifflin, 1987.

Chilton, Randolph, and Carol Gilbertson. "Pound's "'Metro' Hokku": The Evolution of an Image." *Twentieth Century Literature* 36 (1990): 225–236.

Church, Alonzo. *Introduction to Mathematical Logic*. Princeton: Princeton University Press, 1956.

Colyvan, Mark. "Who's Afraid of Inconsistent Mathematics?" *Philosophy of Mathematics: Set Theory, Measuring Theories, and Nominalism*. Ed. Gerhard Preyer and Georg Peter. Frankfurt: Ontos Verlag, 2008.

Curry, Haskell B. *Outlines of a Formalist Philosophy of Mathematics*. Amsterdam: North-Holland Publishing Company, 1951.

—. "Remarks on the Definition and Nature of Mathematics." *Philosophy of Mathematics: Selected Readings*. Ed. Paul Benacerraf and Hilary Putnam. Englewood Cliffs: Prentice-Hall, 1964.

Dante Alighieri. *The Divine Comedy Volume I: Inferno*. Trans. Mark Musa. New York: Penguin, 2003.

Das, Abhijit. *Computational Number Theory*. Boca Raton: CRC Press, 2013.

Desmet, Ronny. "*Principia Mathematica* Centenary." *Process Studies* 39 (2010): 225-63.

Detlefsen, Michael. "Formalism." *Oxford Handbook of Philosophy of Mathematics and Logic*. Ed. Stewart Shapiro. New York: Oxford University Press, 2005.

Donaldson, Sandra M. "Where does Q Leave Mr. Ramsay?" *Tulsa Studies in Women's Literature* 11 (1992): 329-36.

Eliot, T. S. *After Strange Gods: A Primer of Modern Heresy*. London: Faber and Faber, 1933.

—. *Collected Poems: 1909-1962*. New York: Harcourt Brace & Company, 1968.

—. "Commentary." *The Monthly Criterion* VI (October 1927): 289-291.

—. *For Lancelot Andrewes: Essays on Style and Order*. Garden City: Doubleday, 1929.

—. *Knowledge and Experience in the Philosophy of F. H. Bradley*. New York: Farrar, Straus and Company, 1964.

—. *The Letters of T. S. Eliot*. 5 vols. Ed. Valerie Eliot and John Haffenden. London: Faber and Faber, 2009.

—. *The Sacred Wood: Essays on Poetry and Criticism*. Gloucester: Dodo Press, 2009.

—. *Selected Essays*. New York: Harcourt, Brace and Company, 1950.

—. *Selected Prose of T. S. Eliot*. Ed. Frank Kermode. San Diego: Harcourt, 1975.

—. *The Waste Land: A Facsimile and Transcript of the Original Drafts*. Ed. Valerie Eliot. San Diego: Harcourt Brace & Company, 1971.

Empson, William. *Seven Types of Ambiguity*. New York: New Directions, 1966.

Epple, Moritz. "An Unusual Career between Cultural and Mathematical Modernism." *Jews and Sciences in German Contexts*. Ed. Ulrich Charpa and Ute Deichmann. Tübingen, Germany: Mohr Siebeck, 2007.

Euclid. *The Thirteen Books of Euclid's Elements*. Vol. I. Trans. Thomas L. Heath. New York: Dover Publications, 1956.

Ewald, William, ed. *From Kant to Hilbert: A Source Book in the Foundations of Mathematics*. Vol. 2. Oxford: Clarendon Press, 2005.

Frege, Gottlob. *The Foundations of Arithmetic: A Logico-Mathematical Investigation into the Concept of Number*. Trans. Michael Beaney. *The Frege Reader*. Ed. Michael Beaney. Malden: Blackwell, 1997.

—. "Frege Against the Formalists." Trans. Max Black. *Translations from the Philosophical Writings of Gottlob Frege*. Ed. Peter Geach and Max Black. Oxford: Basil Blackwell, 1960.

—. *Grundgesetze der Arithmetik*. Vol II. Appendix. Trans. Peter Geach. *Translations from the Philosophical Writings of Gottlob Frege*. Ed. Peter Geach and Max Black. Oxford: Basil Blackwell, 1960.

—. "On *Sinn* and *Bedeutung*" ["On Sense and Reference"]. Trans. Max Black. *The Frege Reader*. Ed. Michael Beaney. Malden: Blackwell, 1997.

Froula, Christine. *Virginia Woolf and the Bloomsbury Avant-Garde: War, Civilization, Modernity*. New York: Columbia University Press, 2005.

Frye, Northrop. *Anatomy of Criticism*. Princeton: Princeton University Press, 1957.

Gordon, Lyndall. *T. S. Eliot: An Imperfect Life*. New York: W. W. Norton & Company, 1999.

Gray, Jeremy. "Modern Mathematics as a Cultural Phenomenon." *The Architecture of Modern Mathematics*. Ed. J. Ferreirós and J. J. Gray. New York: Oxford University Press, 2006.

—. *Plato's Ghost: The Modernist Transformation of Mathematics*. Princeton: Princeton University Press, 2008.

Greenberg, Marvin Jay. *Euclidean and Non-Euclidean Geometries: Development and History*. 4th ed. New York: W. H. Freeman, 2007.

Handley, William R. "War and the Politics of Narration in *Jacob's Room*." *Virginia Woolf and War: Fiction, Reality, Myth*. Ed. Mark Hussey. Syracuse: Syracuse University Press, 1991.

Hanrahan, Mairéad. "Literature and Mathematics: The Difference." *Journal of Romance Studies* 7 (2007): 7-25.

Hardy, G. H. *A Mathematician's Apology*. Cambridge: Cambridge University Press, 1992.

—. "Mathematical Proof." *Mind* 38 (1929): 1-25.

Hasse, Helmut. *Höhere Algebra*. Vol I. Berlin: Walter de Gruyter & Co., 1926.

Henderson, Linda Dalrymple. *The Fourth Dimension and Non-Euclidean Geometry in Modern Art*. Princeton: Princeton University Press, 1983.

Henry, Holly. *Virginia Woolf and the Discourse of Science: The Aesthetics of Astronomy*. New York: Cambridge University Press, 2003.

Hilbert, David. "Axiomatic Thought." Trans. William Ewald. *From Kant to Hilbert: A Source Book in the Foundations of Mathematics*. Vol. II. Ed. William Ewald. Oxford: Oxford University Press, 2005.

—. *Foundations of Geometry*. Trans. Leo Unger. La Salle: Open Court: 1971.

—. "The Foundations of Mathematics." Trans. Stefan Bauer-Mengelberg and Dagfinn Føllesdal. *From Frege to Gödel: A Source Book in Mathematical Logic, 1879-1931*. Ed. Jean van Heijenoort. Cambridge: Harvard University Press, 1967.

—. "Neubegründung der Mathematik. Erste Mitteilung." *Abhandlungen aus dem Mathematischen Seminar der Hamburgischen Universität* 1(1922): 157-77.

—. "The New Grounding of Mathematics, First Report." Trans. William Ewald. *From Brouwer to Hilbert: The Debate on the Foundations of Mathematics in the 1920s*. Ed. Paolo Mancosu. New York: Oxford University Press, 1998.

—. "On the Infinite." Trans. Erna Putnam and Gerald J. Massey. *Philosophy of Mathematics: Selected Readings*. Ed. Paul Benacerraf and Hilary Putnam. Englewood Cliffs: Prentice-Hall, 1964.

Hilbert, David, and Wilhelm Ackermann. *Principles of Mathematical Logic*. Trans. Lewis M. Hammond, George G. Leckie, and F. Steinhardt. New York: Chelsea, 1950.

Hussey, Mark. *The Singing of the Real World: The Philosophy of Virginia Woolf's Fiction*. Columbus: Ohio State University Press, 1986.

Hylton, Peter. "The Theory of Descriptions." *The Cambridge Companion to Bertrand Russell*. Ed. Nicholas Griffin. New York: Cambridge University Press, 2003.

Jakobson, Roman. "Two Aspects of Language and Two Types of Aphasic Disturbances." *On Language*. Ed. Linda Waugh and Monique Monville-Burston. Cambridge: Harvard University Press, 1995.

Kant, Immanuel. *Critique of Pure Reason*. Trans. Paul Guyer and Allen W. Wood. Cambridge: Cambridge University Press, 1998.

Katz, Jerrold J. "What Mathematical Knowledge Could Be." *Philosophy of Mathematics: An Anthology*. Ed. Dale Jacquette. Malden: Blackwell Publishers, 2002.

Kenner, Hugh. *The Pound Era*. Berkeley: University of California Press, 1971.

King, Julia, and Laila Miletic-Vejzovic, compiled and ed. *The Library of Leonard and Virginia Woolf: A Short-title Catalog*. Pullman: Washington University Press, 2003.

Leibniz, G. W. *Leibniz: Selections*. Ed. Philip P. Wiener. New York: Charles Scribner's Sons, 1951.

Levine, Caroline. *Forms: Whole, Rhythm, Hierarchy, Network*. Princeton: Princeton University Press, 2015.

Lewis, Wyndham. *Tarr*. New York: Jubilee, 1973.

MacHale, Desmond. *Comic Sections: The Book of Mathematical Jokes, Humour, Wit and Wisdom*. Dublin: Boole Press, 1993.

Majumdar, Robin, and Allen McLaurin, ed. *Virginia Woolf: The Critical Heritage*. Taylor and Francis e-Library, 2003.

de Man, Paul. "Semiology and Rhetoric." *Diacritics* 3 (1973): 27-33.

Mancosu, Paolo. *The Adventure of Reason: Interplay between Philosophy of Mathematics and Mathematical Logic, 1900-1940*. New York: Oxford University Press, 2010.

—, Ed. *From Brouwer to Hilbert: The Debate on the Foundations of Mathematics in the 1920s*. New York: Oxford University Press, 1998.

—. "The Mathematical Practice of Definitions by Abstraction from Euclid to Frege." Unpublished manuscript.

Marinetti, F. T. "Destruction of Syntax—Radio Imagination—Words in Freedom." Trans. Lawrence Rainey. *Futurism: An Anthology*. Ed. Lawrence Rainey, Christine Poggi, and Laura Wittman. New Haven: Yale University Press, 2009.

—. "Geometrical and Mechanical Splendor and the Numerical Sensibility." Trans. Lawrence Rainey. *Futurism: An Anthology*. Ed. Lawrence Rainey, Christine Poggi, and Laura Wittman. New Haven: Yale University Press, 2009.

—. "Technical Manifesto of Futurist Literature." Trans. Lawrence Rainey. *Futurism: An Anthology*. Ed. Lawrence Rainey, Christine Poggi, and Laura Wittman. New Haven: Yale University Press, 2009.

—. *Selected Poems and Related Prose*. Ed. Luce Marinetti. Trans. Elizabeth R. Napier and Barbara R. Studholme. New Haven: Yale University Press, 2002.

Mehrtens, Herbert. "Modernism vs. Counter-modernism, Nationalism vs. Internationalism: Style and Politics in Mathematics 1900-1950." *L'Europe Mathématique: Histoires, Mythes, Identités*. Ed.

Catherine Goldstein, Jeremy Gray, and Jim Ritter. Paris: Maison des sciences de l'homme, 1996.

—. *Moderne, Sprache, Mathematik: Eine Geschichte des Streits um die Grundlagen der Disziplin und des Subjekts formaler Systeme*. Frankfurt: Suhrkamp, 1990.

Minow-Pinkney, Makiko. "Virginia Woolf and December 1910: The Question of the Fourth Dimension." *Contradictory Woolf: Selected Papers from the Twenty-First Annual International Conference on Virginia Woolf.* Ed. Derek Ryan and Stella Bolaki. Clemson: Clemson University Press, 2012.

von Neumann, John. "Zur Prüferschen Theorie der idealen Zahlen." Acta Scientiarum Mathematicarum (Szeged) 2 (1926): 193-227.

Otter, Samuel. "An Aesthetics in All Things." *Representations* 104 (2008): 116-25.

Pater, Walter. *The Renaissance: Studies in Art and Poetry*. Mineola: Dover, 2005.

Peano, Giuseppe. "The Principles of Arithmetic, Presented by a New Method." Trans. Hubert C. Kennedy. *Selected Works of Giuseppe Peano*. Toronto: University of Toronto Press, 1973.

Perloff, Marjorie. *The Futurist Moment: Avant-Garde, Avant Guerre, and the Language of Rupture*. Chicago: University of Chicago Press, 2003.

—. *The Poetics of Indeterminacy: Rimbaud to Cage*. Evanston: Northwestern University Press, 1981.

Poincaré, Henri. *The Foundations of Science*. Trans. George Bruce Halstead. New York: The Science Press, 1929.

Porter, Theodore M. "Rigor and Practicality: Rival Ideals of Quantification in Nineteenth-century Economics." *Natural Images in Economic Thought: "Markets Read in Tooth and Claw."* Ed. Philip Mirowski. New York: Cambridge University Press, 1994.

Pound, Ezra. *ABC of Reading*. New York: New Directions, 1987.

—. "Affirmations, II: Vorticism." *The New Age* XVI (January 14, 1915): 277-8.

—. "Affirmations, IV: As for Imagisme." *The New Age*, XVI (January 28, 1915): 349-50.

—. "The Approach to Paris, V." *The New Age* XIII (October 2, 1913): 662-4.

—. *The Cantos*. New York: New Directions, 1998.

—. "Cavalcanti." *Literary Essays of Ezra Pound*. New York: New Directions, 1968.

—. "In a Station of the Metro." *Poetry* II (April 1913): 12.

—. *A Memoir of Gaudier-Brzeska*. New York: New Directions, 1974.

—. *Personae*. New York: New Directions, 1990.

—. "The Serious Artist." *Literary Essays of Ezra Pound*. New York: New Directions, 1968.

—. *The Spirit of Romance*. London: J. M. Dent & Sons, 1910.

—. "Status Rerum." *Poetry* 1 (1913): 123-7.

—. "Vorticism." *Fortnightly Review* 102 (1914): 461-71.

—. "The Wisdom of Poetry." *Selected Prose: 1909-1965*. Ed. William Cookson. New York: New Directions, 1973.

Quigley, Megan M. "Modern Novels and Vagueness." *Modernism/Modernity* 15 (2008): 101-29.

Raman, Shankar. "Specifying Unknown Things: The Algebra of The Merchant of Venice." *Making Publics in Early Modern Europe: People, Things, Forms of Knowledge*. Ed. Bronwen Wilson and Paul Yachnin. New York: Routledge, 2010.

Ransom, John Crowe. *The New Criticism*. Norfolk: New Directions, 1941.

Read, Forrest. "The Mathematical Symbolism of Ezra Pound's Revolutionary Mind." *Paideuma* 7 (1978): 7-72.

Recorde, Robert. *The Whetstone of Witte*. 1557. *Internet Archive*. Web. 1 June 2013. <http://archive.org/details/TheWhetstoneOfWitte>.

Reese, Judy S. *Recasting Social Values in the Work of Virginia Woolf*. Selinsgrove: Susquehanna University Press, 1996.

Richards, I. A. *The Philosophy of Rhetoric*. New York: Oxford University Press, 1936.

Ruotolo, Lucio P. *The Interrupted Moment: A View of Virginia Woolf's Novels*. Stanford: Stanford University Press, 1986.

Russell, Bertrand. *A Critical Exposition of the Philosophy of Leibniz*. Cambridge: Cambridge University Press, 1900.

—. *Introduction to Mathematical Philosophy*. London: George Allen & Unwin, 1919.

—. "Introduction to the Second Edition." *Principia Mathematica to *56*. Alfred North Whitehead and Bertrand Russell. Cambridge: Cambridge University Press, 1997.

—. "On Denoting." *Mind* 14 (1905): 479-93.

—. *Mysticism and Logic*. Garden City: Double Day, 1957.

—. *Principles of Mathematics*. New York: W. W. Norton and Company, 1996.

—. "The Study of Mathematics." *Mysticism and Logic*. London: George Allen & Unwin, 1963.

de Saussure, Ferdinand. *Course in General Linguistics*. Ed. Charles Bally and Albert Sechehaye, with Albert Reidlinger. Trans. Wade Baskin. London: Peter Owen, 1959.

Shoenfield, Joseph R. *Mathematical Logic*. Boca Raton: CRC Press, 2010.

Sim, Lorraine. *Virginia Woolf: The Patterns of Ordinary Experience*. Farnham: Ashgate, 2010.

Snaith, Anna. *Virginia Woolf: Public and Private Negotiations*. New York: St. Martin's, 2000.

Spurr, Barry. *'Anglo-Catholic in Religion': T.S. Eliot and Christianity*. Cambridge: The Lutterworth Press, 2010.

Spurr, David. *Conflicts in Consciousness: T.S. Eliot's Poetry and Criticism*. Urbana: University of Illinois Press, 1984.

Stephen, Leslie. "What is Materialism?" *An Agnostic's Apology and Other Essays*. London: Smith, Elder, & Co., 1903.

Stein, Gertrude. *Stein: Writings, 1903-1932*. Vol. 1. New York: Library of America, 1998.

Taussky, Olga. "Prof. David Hilbert." Obituary. *Nature* 152 (1943): 182-3.

Urbas, Joseph. "ABC of Ezra Pound's Science." *Revue française d'études américaines* 71 (1997): 89-104.

Valéry, Paul. *Œuvres*. Vol. I. Ed. Jean Hytier. Paris, 1957.

von Waltershausen, W. Sartorius. *Gauss zum Gedächtniss*. Leipzig: Verlag von S. Hirzel, 1856.

Weir, Alan. "Formalism in the Philosophy of Mathematics." *Stanford Encyclopedia of Philosophy*. Fall 2011 Edition. Ed. Edward N. Zalta. <http://plato.stanford.edu/archives/fall2011/entries/formalism-mathematics/>.

Weyl, Hermann. *Philosophy of Mathematics and Natural Science*. Trans. Olaf Helmer. Princeton: Princeton University Press, 1949.

Whitehead, Alfred North. *The Concept of Nature*. San Bernardino: CreateSpace Independent Publishing Platform, 2013.

Whitehead, Alfred North. *Introduction to Mathematics*. New York: Henry Holt and Company, 1911.

—. *Science and the Modern World.* New York: The Free Press, 1967.

Whitehead, Alfred North, and Bertrand Russell. *Principia Mathematica.* Merchant Books, 2009.

Whitworth, Michael H. *Einstein's Wake: Relativity, Metaphor, and Modernist Literature*. Oxford: Oxford University Press, 2001.

Williams, Raymond. *Keywords.* New York: Oxford University Press, 1983.

Wise, M. Norton, Ed. *The Values of Precision*. Princeton: Princeton University Press, 1995.

Wittgenstein, Ludwig. *Tractatus Logico-Philosophicus*. New York: Routledge, 1981.

Woolf, Leonard. *Beginning Again: An Autobiography of the Years 1911-1918*. London: The Hogarth Press, 1964.

—. *Sowing: An Autobiography of the Years 1880-1904*. New York: Harcourt, Brace & Company, 1960.

Woolf, Virginia. "Craftsmanship." Radio Broadcast. *Collected Essays*. Vol. II. New York: Harcourt, Brace & World, 1967. 245-51.

—. "De Quincey's Autobiography." *The Second Common Reader*. Ed. Andrew McNeillie. San Diego: Harcourt, 1986.

—. *The Diary of Virginia Woolf.* Vols. 1-2. Ed. Anne Olivier Bell. New York: Harcourt Brace, 1977-8.

—. *Jacob's Room*. New York: Harcourt, 1978.

—. *Letters of Virginia Woolf.* Vols. 1-3. Ed. Nigel Nicolson and Joanne Trautmann. New York: Harcourt, 1977.

—. "Modern Fiction." *Collected Essays*. Vol. II. New York: Harcourt, Brace & World, 1967.

—. "Mr. Bennett and Mrs. Brown." London: Hogarth Press, 1924.

—. *Mrs. Dalloway*. San Diego: Harcourt, 1981.

—. *Night and Day*. New York: Oxford University Press, 2000.

—. *A Room of One's Own*. New York: Harcourt, 1989.

—. "A Sketch of the Past." *Moments of Being*. San Diego: Mariner, 1985.

—. *To the Lighthouse*. San Diego: Harcourt, 1981.

—. *The Waves*. San Diego: Harcourt, 1978.

Yan, Song Y. *Number Theory for Computing*. Berklin: Springer, 2002.

Young, Anne L. *Mathematical Ciphers: From Caesar to RSA*. Providence: American Mathematical Society, 2006

Zalta, Edward N. "Gottlob Frege." *The Stanford Encyclopedia of Philosophy*. Winter 2013 ed. <http://plato.stanford.edu/archives/win2013/entries/frege/>.