A Perfect Stranger:

The Development of Margaret Cavendish's Natural Philosophy

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ABSTRACT

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The natural philosophy of Margaret Cavendish is a fragmented collection of texts and ideas. In this thesis, the multiple lenses of learning theory, writing theory, history and philosophy of science, and literary studies are employed to show the ultimate coherence of Cavendish's science. The mechanism of a taxonomy of cognitive processes is applied to explore the gradual evolution of her understanding of her material and ideas. Writing process theories further illuminate both the ways that her thinking develops as she composes and the ways that she comes to manipulate her texts in view of her changing relationship with her reading audience. Exploring the social and political influences affecting the development of early modern science further adds to an understanding of the opinions that Cavendish comes to hold. Finally, the literary and linguistic elements of her text, including their genre, structure, rhetorical devices and figurative language, contribute significantly to a full recognition of Cavendish's evolving scientific and epistemic beliefs. By examining her eight texts most concerned with natural philosophy as revelatory parts of a process rather than discrete meaning-entities, it is clear that Cavendish was responding to complex internal and external forces that simultaneously shaped her writing, her thinking, her social vision, her science, and her larger conception of nature and knowledge.

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Greatest thanks to Miles, for encouragement, understanding, and oceans of patience.

For Ellie

TABLE OF CONTENTS

ABBREVIATIONS

(Full bibliographical information is available in the list of Works Cited.)

BW: *The Description of a New World, Called the Blazing World.*

GNP: *Grounds of Natural Philosophy.*

LP: *Letters and Poems in Honour of the Incomparable Princess, Margaret, Dutchess of Newcastle.*

OEP: *Observations upon Experimental Philosophy.*

Orations: *Orations of Divers Sorts, Accomodated to Divers Places.*

PF: *Philosophicall Fancies.*

P&F: *Poems, and Fancies.*

PL: *Philosophical Letters.*

PPO55: *Philosophical and Physical Opinions.* 1st ed.

PPO63: *Philosophical and Physical Opinions.* 2nd ed.

SL: *Sociable Letters*

TR: *A True Relation of My Birth, Breeding, and Life.*

WO: *The Worlds Olio*

NOTES ON THE TEXT

In the original published versions of Margaret Cavendish's work, there is no consistent pagination of prefatory material. In this thesis, I have provided the titles of dedicatory verses, epistles to readers, and prefaces parenthetically in the text. In those works where a modern edition is used, I have provided both page numbers and the titles of prefatory material. In addition, page numbers in the original publications are sometimes incorrect and I have indicated where errors were made.

In the original publications, words are sometimes printed in capital letters or in italics for emphasis. However, as this is done with little consistency, I have standardized the appearance and used italics only when emphasis is clearly needed.

INTRODUCTION

In 1611, John Donne used the phrase "all coherence gone" in "The First Anniversary: An Anatomy of the World" to reflect the sense that the physical world was no longer as it had long been imagined (276). Scientific discovery and technological advances had put into question the geocentric conception of the universe, and all seemed to be confusion and chaos. By the 1650s, when Margaret Cavendish, then Marchioness of Newcastle, began to publish her work, the chaos was of an entirely different kind: the monarchy had been overthrown, the king was in exile, and traditional social order had been destroyed. Cavendish responded to this upheaval by writing—prolifically: philosophical poems, short essays, and narratives; letters, biography, and autobiography; plays, dialogues, and orations. The topics she broached were varied, but, like Donne, indicated a concern with making sense of the chaotic and disorderly universe in which she lived. To this end, several of her published works are overtly concerned with natural philosophy, matter and motion, and experimental science. Yet for the most part, none of her philosophical works strikes readers as especially orderly; within a twenty-page span, she is capable of discussing matter, motion, infinity, war, life, the senses, knowledge, creation, light, and the planets. In the early stages of her philosophical writing, when her world was in an uproar and she found herself in exile, Cavendish envisions a world of atoms as chaotic as her own. She offers no ultimate solution to this chaos; in fact, her early verse embraces the idea of willful, anarchic atoms. Later texts proclaim the ever-present possibility of disorder in the natural world: we are but a step away from chaos, confusion, and ignorance. But her texts are more than a simple reflection of her world at

war; over time, she develops a natural system in which chaos is as essential as order, and hierarchy is as present as individualism.

The concept of development is central here. Critical readings of Cavendish's science often focus on individual works, most notably the early atomic poems or her "science fiction," *Blazing World*. However, recent scholarship has shown increasing interest in the organization and language of her natural philosophy.[1] I propose to examine the evolution of the entire body of her major philosophical texts, from the earliest verses of *Poems, and Fancies* to the final statement of her natural philosophy in *Grounds of Natural Philosophy*. In her introduction to *Observations Upon Experimental Philosophy*, Eileen O'Neill hints at how these works are best approached; she states that "Cavendish's books of natural philosophy may appropriately be viewed as published notebooks, in which the features of her system of nature unfold at the same time as she develops as a philosopher" (xxxv). Judith Moore is more direct, declaring that "if Cavendish's publications are read sequentially and at length rather than in isolated excerpts, a considerable development does eventually emerge" (4). This suggests that these works are best examined as work-in-progress: a fifteen-year process of building an original scientific philosophy is manifested in the detailed written record of her acquisition, absorption, and synthesis of scientific knowledge. As the notion of 'evolution' implies, Cavendish's scientific works will be examined in the order they were written, with the eight principal texts grouped into pairs: first, *Poems, and Fancies* and *Philosophicall Fancies*, both published in 1653; then the two editions of *Philosophical and Physical*

[1]See for example Lisa T. Sarasohn, "*Leviathan* and the Lady"; Brandie R. Siegfried; Richard Nate, "'Plain and Vulgarly Express'd.'"

Opinions, appearing eight years apart in 1655 and 1663; next, *Philosophical Letters* and *Observations Upon Experimental Philosophy*, printed in 1664 and 1666 respectively; and finally *Blazing World*, the companion-piece to *Observations Upon Experimental Philosophy*, and *Grounds of Natural Philosophy*, her final work, printed in 1668.

The challenge of Cavendish's science is best engaged by an interdisciplinary approach integrating various interconnected strands of inquiry, and in this thesis, I have chosen to look most particularly to literary studies, history and philosophy of science, and various aspects of composition theory, including the study of cognition and of writing processes. In the mid-seventeenth century, the dividing line between literary and scientific discourse was yet to be fully established, and though her subject matter is 'scientific' and philosophical, these are essentially literary works which experiment with style and diction in order to entertain as well as inform. Along all those disciplinary avenues pursued in order to decipher Cavendish's writing, the specifically literary aspects of her work are central: the various genres she chooses sometimes to follow and other times to adapt or even subvert, as well as the syntactical, lexical, rhetorical, and figurative constructions she employs at different times and for different purposes. In recent years, the rhetorical and literary structure of scientific documents has attracted the interest of both students of literature and historians of science.[2] Work in the history and philosophy of science serves to illuminate her intellectual influences, the changing conditions in which she wrote, the central issues to which she responds, and the specific ways in which

[2] For studies of the rhetoric of science, see Charles Bazerman, *Shaping Written Knowledge*; Robert Markley; Richard Nate, "Rhetoric in the Early Royal Society"; Steven Shapin; Steven Shapin and Simon Schaffer; and Brian Vickers. For a modern version of the debate over the place of 'rhetoric' (and more specifically metaphor) in technical and scientific writing, see Jerome Bump. For studies which concern Cavendish's scientific rhetoric specifically, see Sylvia Brown; Steven Clucas, "Variation, Irregularity and Probabilism"; Sarah E. Moreman; and Richard Nate, "'Plain and Vulgarly Express'd'".

she responds. Exploring the social and historical context of her texts, we can come to see that the science she illustrates, analyzes, rejects or invents reflects key issues in the development of early modern science in the way problems were envisioned, interpreted, and eventually resolved. In addition, various aspects of composition theory, including studies of cognition and writing processes, provide insight into Cavendish's growing understanding of her ideas and how best to convey them. Finally, a pedagogical tool familiar to teachers offers an initial framework for organizing the discussion of a diverse body of work.

Cognitive Studies

Personal experience teaching science, literature and composition inspired me to look at Cavendish's scientific texts through the lens of Bloom's Taxonomy, a classification system ubiquitous if not always popular in pedagogical institutions. Though her formal education was patchy and she admits to having been an unenthusiastic pupil, Cavendish's natural philosophy evinces the development of skills that teachers seek to foster in their students. Her works of natural philosophy are paired here by more than just chronology: Bloom's Taxonomy suggests a preliminary organization of Cavendish's science into categories loosely defined by their dominant cognitive levels. The eponym for a systematic breakdown of educational objectives, or cognitive processes, Bloom's Taxonomy was first put forth in 1956 by Benjamin Bloom et al. and recently revised by Lorin Anderson et al. The Taxonomy comprises six hierarchical divisions, in order, *Knowledge*, *Comprehension*, *Application*, *Analysis*, *Synthesis*, and *Evaluation*. These six are further subdivided into types and skills, and it is assumed that students must to some

extent master the first levels before moving productively to the next.[3] When the Taxonomy was updated in 2001, the order of the highest classes was inverted to reflect the belief that the inductive component of synthesis is more complex than the deduction required in judgment or evaluation; moreover, creation is also felt to imply some form of judgment of the organic unity of the product.[4]

The Taxonomy was created for practical pedagogical purposes: classifying the goals of the educational system, helping educators discuss these goals with greater precision, providing constructive solutions for teachers, and analyzing kinds of learning (Bloom 3). It is the last of these that suggests the grounds for borrowing the Taxonomy to provide a rough framework through which we can begin to recognize the logic of Cavendish's work and acknowledge it as an intelligent and cognitively complex processing of information. Applying the revised Taxonomy is not meant simply to pigeonhole Cavendish's scientific texts; several if not all taxonomic levels are evident in each one. Often the seemingly 'higher' levels of creativity and judgment are more obvious than the basics of defining, explaining, and organizing, though her poetic creativity is significantly different from the systematic creation of "a coherent or functional whole" defined in the Taxonomy, just as her judgment is not the neutral and objective evaluation "based on criteria and standards" (Anderson 31). More useful is the degree to which different cognitive levels are represented in each work; it is this that first illustrates how the entire body of her scientific work builds in cognitive complexity. For

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[3] See Appendix A for a summary of the objectives in each version of the Taxonomy.

[4] In the revised Taxonomy, the category names were also altered from noun to verb form to reflect the way that educational objectives are framed as a student's active abilities. Thus, *Evaluation* becomes *Evaluate*, *Synthesis* becomes *Create*, etc. (Anderson 265). The authors also now suggest that the process categories are not exactly the cumulative hierarchy assumed in the first version.

example, the early work shows her recollection of concepts learned from her husband and brother-in-law, but little in-depth analysis or objective critique. Later works, on the other hand, show a more complete mastery of the sub-stages of understanding so necessary to analysis and synthesis, and in her final few works of natural philosophy, the critical analysis of the work of others shows yet more cognitive complexity.

An initial taxonomic 'tag' has been assigned here to each work based on structural and organizational elements of the documents as well as on Cavendish's diction, and in particular her choice of figurative language.[5] In the atomic poems, a wealth of similes, metaphors and analogies illustrates abstract or difficult concepts in an accessible way, enlightening as they entertain. Using the extensive elaboration of sub-classes and qualifiers in the revised Taxonomy, these figurative constructions can be broadly associated with various taxonomic stages. For instance, the extended metaphor of the war-like behavior of fire is an example of *representing* the action of fire, *illustrating* it with a metaphor, *comparing* the action to that of armies at war—all elements of *Understand*.[6] To some extent, this is an oversimplification, since it is also apparent that the war metaphor is *used* within Cavendish's theory of matter and that it reflects a certain *judgment* of nature and its capacity for random destruction.[7] In addition, the wealth of imagery in Cavendish's early texts points to the first stage of the advanced process category *Create*, which involves what Anderson et al. refer to as a "divergent phase in

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[5] Similarly, Darcy Haag Granello examines structural and organizational elements in her evaluation of the literature reviews of graduate students. This study is especially pertinent to the discussion in chapter 3 of this thesis.

[6] See Appendix A, table 2. The terms in italics correspond respectively to subcategories 2.1, 2.2, and 2.6 of the second process category (*Understand*).

[7] The terms in italics correspond respectively to subcategories 3.2 and 5.2. Notably, there is little evidence of process category 4 (*Analyze*).

which a variety of possible solutions are considered as the student attempts to understand the task" (85). Nonetheless, the distinctive feature of Cavendish's two earliest works, *Poems, and Fancies* along with *Philosophicall Fancies*, is their focus on imaginative illustration of her first thoughts on natural philosophy. Subsequently, the extensive lists of both the first and second editions of *Philosophical and Physical Opinions* (1655 and 1663) represent concerted efforts at classifying, differentiating and organizing, all together indicating Cavendish's increasing analytic skills. *Philosophical Letters* and *Observations Upon Natural Philosophy* are notable for their critical, even judgmental evaluation of scientific trends and ideas, while her final works, *Blazing World* and *Grounds of Natural Philosophy*, are very different renditions that both more fully represent synthesis.

Writing Theory

The Taxonomy serves to organize the discussion into chapters, but perhaps more importantly it leads to further explorations of cognition and knowledge creation. Since the field of cognitive studies is immense, the focus here will be on the area of composition studies concerned with the quite specific development of meaning within the written text, and even more particularly on how meaning and writing evolve in tandem. Bloom's Taxonomy helps approximate Cavendish's cognitive abilities at different stages of her writing, but it is in many ways a static model which identifies cognitive evidence in each text as if the text is an end in itself, which further implies that the knowledge it reveals is somehow discrete from that of the next work. To account for the growth of Cavendish's thinking and writing over time means to assume that her writing—any

writing, in fact—is dynamic. On the common premise that knowledge is created and not imminent, the cognitive development theories of Piaget and Vygotsky are often used as a starting point to link the development of knowledge with the evolving text. It is now a nearly unquestioned assumption in constructivist composition studies that writing is a process, moreover one far more multifaceted than the early "pre-write, write, re-write" model that emerged in the 1960s as a reaction to formalism.[8] Although she sometimes describes her writing as simply the product of purely intellectual contemplation, Cavendish's ideas evolve within and across texts, sometimes even within single (very long) sentences. Meaning does not leap directly out of her brain and onto the page; the transition from mental construction to textual inscription is a process more aptly described by recursion or cycles than by a narrow linearity. These ideas are briefly acknowledged in the revised Taxonomy, which mentions the cyclical nature of progression through the taxonomic levels, and in particular how "[the] process categories of *Understand*, *Analyze*, and *Evaluate* are interrelated and often used iteratively in performing cognitive tasks" (Anderson 80). However, Cavendish's fragmented, repetitive, convoluted and very clearly non-linear writing and thinking is better illuminated by those composition theories of the last forty years that begin with the premise of a "symbiotic relationship between cognitive complexity in writing and complexity in thinking" (Granello 302).[9]

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[8] Nystrand, Green & Wiemelt have written an especially useful and detailed overview of composition theory and its intellectual history going back to the mid-twentieth century. The discussion that follows includes necessarily brief references to the complexities that they explore.

[9] Some examples of such theories are Linda Flower and John R. Hayes, "The Cognition of Discovery" and "The Cognitive Process Theory of Writing"; Lee Odell, "The Process of Writing and the Process of Learning"; Donald M. Murray, "Writing as Process"; Kenneth Dowst, "The Epistemic Approach"; Janet Emig, "Writing as a Mode of Learning"; and Arthur N. Applebee, "Writing and Reasoning".

Research to better understand the "symbiotic relationship" between knowledge and writing has led to a variety of hypotheses concerning the entwined processes of writing and learning. In "Writing as a Mode of Learning," Janet Emig proposes that writing "serves learning uniquely because writing as process-and-product possesses a cluster of attributes that correspond uniquely to certain powerful learning strategies" (122). Stephen Judy acknowledges the importance of personal learning experiences, affirming that the structuring and organization of writing is learned as one shapes ideas and experiences, first, for oneself, and then for an audience; in essence, form grows from content (41). Similarly, Kenneth Dowst suggests that writing is the epistemic activity of making sense of an extremely complex set of personal perceptions and experiences of an infinitely complex world (66): to write is to compose understanding, meaning, and knowledge. Others have explored the intricacies of the process itself. By the late 1970s, the initial linear writing model was rejected in favor of far more complex sequences. Linda Flower and John R. Hayes suggest that advanced writers do not so much compose in discrete stages as they continually repeat the processes of planning, translating, and reviewing ("Cognitive Process Theory" 369). Embedded within these three processes are further sub-processes: generating, organizing, goal setting, evaluating, and revising. A key element in this cognitive process theory is its often-unpredictable iterative quality; reviewing can lead naturally to a new cycle of planning and translating, but generation, reevaluation, and revising of ideas can "interrupt any other processes and occur at any time in the act of writing" ("Cognitive Process Theory" 374). Donald Murray similarly describes a constant reiteration of the writing stages of rehearsing, drafting and revising and the variously competing forces of collecting, connecting, writing and reading that

affect writers at all times; furthermore, he cautions that writing is "a process of interaction, not a series of logical steps" ("Writing as Process" 4). In the same vein, Lee Odell concludes that the various conceptual activities that "writers need to engage in as they try to understand and write about specific sets of data" (43), do not take place in any "neat, sequential way" (44); instead, they recur throughout the composing process.

Such studies often have specifically pedagogical goals, yet the fundamental concepts are useful in elucidating Cavendish's natural philosophy: by examining the writing processes manifested in her work, her learning and thinking processes are also further revealed. Murray warns that one cannot infer process from product; however, I argue that the series of texts that make up the body of Cavendish's natural philosophy act as markers testifying to the evolution of both meaning and understanding.[10] Pierre-Marc De Biasi calls the individual rough draft "an essential link in the chain of transformations that [lead] from the project of the work to its definitive text" (27). In Cavendish's case, the draft often became the published work, both its own "definitive text" as well as "a crucial moment" in her larger *oeuvre* (27). Furthermore, the interrelated motifs of balance and cyclical recursion that she comes to use in her natural philosophy suggest an important link between her written work and writing process theories. Murray describes the writing process as a "sequence of balance and imbalance which takes place while the forces [of collecting, connecting, writing and reading] interact" ("Writing as Process" 11). A draft requires the tentative balance of the four forces; however, this balance is

[10] More precisely, Murray claims that "The process of making meaning with written language can not be understood by looking backward from a finished page. Process can not be inferred from product any more than a pig can be inferred from a sausage" ("Writing as Process" 3).

ephemeral. What Murray describes next resonates with a reader's experience of Cavendish's largely unedited work:

> The writer thinks the task is finished, that the balance will hold. But when the writer turns to read the page, it becomes apparent that the language is too stiff, too clumsy, has no flow. The reader will not follow it. Or, there is too much information; the writing goes off on tangents. Material has to be cut out and reordered. The writer may be able to help the piece of writing find its own meaning through a modest amount of rewriting and researching, reordering and rereading. But many times the imbalance gets worse ... New material has to be sought out and its order discovered. The piece of writing is severely out of balance and will be brought towards balance only by rehearsing.

Murray's point here is that writing is a "kinetic activity, a matter of instantaneous motion, action and reaction which is never still" (12). The imbalance is productive, if sometimes uncomfortable or frustrating.

Cavendish's writing illustrates this in many ways: in "imbalanced" and fragmented publications, in seemingly incomplete efforts at reordering and editing, in endless authorial interjections and apologies, but also, importantly, in her philosophy of natural balance and imbalance. Throughout her work, natural actions and physical health are often represented by images of tentative balance between opposing but interconnected forces: expulsive motions are (ideally) counterbalanced by digestive ones; excesses of heat in the body are resolved by cooling remedies; the death of organic matter provides

materials for a new production. At the same time, the order of nature is always at risk from the forces of disorder; 'irregular' motions are everpresent. In addition, what critics have most often defined as tiresome repetition in her writing is more accurately understood as manifestations of the cyclical composing—and cognitive—processes described by Murray, Flower and Hayes, Odell, and others. In the early stages of synthesizing her original philosophy of nature, Cavendish finds evidence of circular forms and motion everywhere: the circle is a fundamental figure of great importance to all natural productions, just as the quincunx was central to Thomas Browne. This figure is significant enough for Cavendish to structure parts of her 1663 edition of *Philosophical and Physical Opinions* as embedded spheres of discussion; her textual organization thus further calls to mind Flower and Hayes's embedded processes. Eventually, the simple circle evolves into the more complex idea of recursion: cycles of order and disorder, peace and war, stability and chaos. The motif permeates her writing; the philosophical implications of the cycle are illustrated in the figurative illustrations of her theory and more subtly reinforced in the organizational structures of the texts.

The process of writing and thinking does not exist in a social vacuum, and it is also important to look at the circumstances—personal, historical and cultural—in which Cavendish creates her texts. She begins to write for publication in the middle of the civil unrest that precipitated her exile from England and she continues through the further upheaval of the restoration of the monarchy; additionally, this is a formative period in the establishment of institutionalized scientific thinking. These influences are felt throughout her texts, yet constructivist cognition, which posits "individuals as more or less

autonomous agents of knowledge" (Kennedy 287), does not significantly take into account the social contexts affecting the eventual knowledge-product. Vygotsky's cognitive theory, however, includes an important social aspect; in positing that higher mental functions "emerge first in social interaction before they are internalized by the individual ... Vygotsky specifies *both* the social interaction and the internal processes of the individual" (Dias 287, emphasis added). The emergence of social constructionism in the 1980s and the more recent influence of Bakhtin's dialogism have also brought the social aspect of knowledge production into greater focus. Social constructionism "regards knowledge as socially negotiated and constituted in discourse, which registers shared assumptions and beliefs, in a socially emerging view of the world" (Dias 287), whereas Bakhtin views discourse "as a forum where the forces of individual cognition, on the one hand, and social ideology and convention, on the other, 'dialectically interpenetrate' each other" (Nystrand 295).

These perspectives on writing and discourse provide further insight into Cavendish's work. Though she often describes her writing as a solitary activity, she also openly acknowledges the influence of others on her understanding, first her husband and brother-in-law, later both extensive readings in natural philosophy and knowledgeable correspondents such as Huygens or Glanvill. Moreover, her texts are often set within learning communities—real or invented—from which Cavendish draws out the meaning of the natural world. Her ideas sometimes respond directly to the critique or theory of other philosophers, but even more often she creates fictional situations of debate: with an imaginary correspondent in *Philosophical Letters*, with the various beast-men in *Blazing*

World, and, in several works, with dissenting factions in her own brain. In addition, the unusual variety of genres Cavendish uses to convey her philosophical ideas demonstrates some of the tensions of "dialectical interpenetration." The conventions attached to the forms she chooses—verse, the prose essay, letters, or science fiction—create expectations which are both met and subverted in her work. Her light verse about atoms is amusing, but it also contains potentially radical social ideas; in the more conventional prose texts, information is accumulated and sorted to make sense of the natural world in new and unconventional ways; the epistles systematically clarify her theory while undermining dissenting opinions; her observations are as much commentary on human folly as on experimental science; and her fantastic tale is diverting entertainment combined with social commentary and philosophical treatise.

History and Philosophy of Science

In her prefaces, Cavendish often claims that her utmost desire is for fame and remembrance, yet the various ways in which she frames her ideas indicate that her agenda is far more involved. She also seeks to do more than put forward a viable theory of matter; an important concern throughout her writing is the very nature of knowledge, and her natural philosophy is significantly affected by her belief in the inaccessibility of absolute truth and the coexistence instead of innumerable and sometimes conflicting probabilities. Although they make only the briefest mention of the Duchess, Steven Shapin and Simon Schaffer's study of Hobbes and Boyle, *Leviathan and the Air-Pump*, contributes to our understanding of Cavendish's seemingly fragmented epistemology. Shapin and Schaffer claim that, in the mid-seventeenth century, solutions to problems of

knowledge were also seen as solutions to problems of social order. They specifically explore how questions surrounding Robert Boyle's air-pump were construed, especially by Hobbes, as issues of social order, and how the solutions suggested by men on both sides also functioned as solutions to political, religious and philosophical issues. Shapin and Schaffer's study is significant for Cavendish on two fronts. First, the authors examine not only the philosophical content of the air-pump debates, but the method of these debates. They argue that the *way* Hobbes and Boyle chose to correspond with and respond to one another—the language choices, the points of inclusion and exclusion, the organization of the responses—contributed to the establishment of the rules and conventions of modern science and helped found a new (experimental) social order among natural philosophers. Similarly, in Cavendish's work, her rhetorical approach to the material is as telling as the actual 'science' content. The structure of her texts, her various choices of figurative language, the wide selection of genres she attempts and the modifications she brings to these all address questions of knowledge and social order.

Equally importantly, Shapin and Schaffer frame their study as a "stranger's account" (4) of the debates surrounding the air-pump and experimental culture; in so doing, they deliberately reject "taken-for-granted perceptions of experimental practice and its products" and they "appropriate one great advantage the stranger has over the member in explaining the beliefs and practices of a specific culture: the stranger is in a position to *know* that there are alternatives to those beliefs and practices" (6). It is not only the authors who are "strangers" to the debates; Shapin and Schaffer quite convincingly present Thomas Hobbes as a stranger to experimentalism whose "objections

to the experimental programme seem plausible, sensible, and rational" (13). This role of the insightful outsider is remarkably appropriate to Cavendish, who throughout her life finds herself on the fringes of society as a woman, a political exile, and an opponent of increasingly-popular experimental science. Moreover, her texts repeatedly establish her estrangement. In the paratextual material, she frequently reflects on her preference for solitary contemplation over conversation; she also describes the various situations of social isolation which led her to write. Her desire for fame further sets her apart from others; she favors her singular opinions over the general consensus and repeatedly sets her ideas of matter, motion, medicine and knowledge in opposition to others through the rhetorical medium of debates, which sometimes take the form of ungentlemanly polemical attacks on named philosophers.[11] Her later works set up fictional relationships that seem only to emphasize her lack of real social contact: she creates an imaginary correspondent in *Philosophical Letters*, and writes herself into her *Blazing World* as a spirit befriended by the protagonist.

Following Shapin and Schaffer's lead, Eve Keller argues that Cavendish's *Observations Upon Experimental Philosophy* offers a stranger's account of the new science which displays the "epistemological problems and social pretensions in the claims of the experimentalists" (450). Cavendish's critique is insightful "precisely because it is spoken from outside the discursive and institutional forums it explores"; Keller adds that Cavendish holds "the paradoxically privileged position of the margins" (450). I suggest that this is true of all her natural philosophy. Cavendish is not only a

[11] On the social condemnation that such polemical attacks could entail, see Shapin, especially 114-19 and 307-09.

stranger to experimental philosophy but to theoretical atomism, mechanism, vitalism, and medicine; to contemporary intellectual debate; and even to her own land for the years of her exile. Her gender, her politics, her lack of formal education all contribute to her status as the "perfect stranger" to English natural philosophy: curious about natural philosophy but unable to fully participate in contemporary debates; as knowledgeable as many other virtuosi, and as limited; interested in innovation, but clinging to tradition; hoping for restored intellectual and political stability but also willing to take advantage of the social turmoil to 'speak out' in her writing. Cavendish's liminal, exiled, and alien position has made it difficult to see her work as plausible, sensible, and rational, but the alternatives she presents make it clear that the dominance of mechanism and experimental science were not the foregone conclusions we sometimes assume.

In the brief description of each chapter that follows, some detail of Cavendish's early life is provided to set out the specific context of her thinking and writing. The central theme and theoretical focus of each chapter is presented to facilitate the navigation through a multifaceted study of multifaceted works. Combining the fields of cognitive studies, writing process theory and history and philosophy of science with an overarching close literary reading helps give new perspective on Cavendish's philosophical texts and it also shows how interdisciplinary tools and methods can provide insight into such texts. The development of Cavendish's science illustrates the circuitous, fragmented and complex paths taken by writers and thinkers of any generation.

Chapter 1: *Poems, and Fancies* and *Philosophicall Fancies*

Margaret Lucas was born in 1623 to Elizabeth and Thomas Lucas of St John's, Essex.[12] The youngest of eight children, her early years were spent happily with her older sisters, the closest one six years older than Margaret; her oldest brother was a full twenty-five years her senior. Her formal education consisted of very basic tutoring in traditional areas as well as singing, music, and dancing. Painfully shy and possibly dyslexic, Margaret preferred quiet contemplation and writing above all else. Even as a young girl, she wrote prolifically, filling "sixteen large notebooks ... with observations and reflection, stories and poems" (Whitaker 18). After her marriage in 1645, Margaret took up her interest in writing again, likely with the encouragement of her husband William Cavendish, then Earl of Newcastle, himself the author of plays and verse and, later, a significant book on the breeding and training of horses. Her published work includes an impressive twenty-three volumes written between 1651 and 1671, of which eight are completely or significantly devoted to natural philosophy.[13]

She had been surrounded by political chaos since her late teens, and the civil war brought great adversity to her staunchly royalist family. Margaret fled England with Queen Henrietta Maria in 1644, not long after joining the court as a maid of honor. She was not to return until the Restoration in 1660. In 1653, however, she was in England to sue—unsuccessfully—for some of William's lands and monies. While awaiting an answer to her petition, she passed her time by writing what was to become her first

[12] This summary is drawn from the several interesting and insightful biographies of Cavendish, including those by Douglas Grant, Anna Battigelli, Kathleen Jones, and Katie Whitaker. Much of the information here draws on Whitaker's meticulously detailed biography.

[13] An explicit study of the philosophical parts of *Worlds Olio* was left out this thesis because her opinions are not representative of a specific natural theory like atomism or vitalism. However, I will point out where later works have drawn on opinions that are first expressed in *Worlds Olio*.

published work.[14] Margaret, now Lady Newcastle, first chose poetry as the medium for expressing her ideas about the natural world. *Poems, and Fancies* opens with fifty pages of verse exploring the idea of an atomistic universe where particles are endowed with a variety of human qualities, few of them positive: they are capricious, argumentative, vindictive and willful. The natural world is chaotic and unpredictable, much as her world is at this time. Even before this work was published, Cavendish turned to the prose essay and produced a series of very short, almost aphoristic essays entitled *Philosophicall Fancies*. The essays explore alternatives to Epicurean atomism in a preliminary effort to produce an original theory of matter and motion, but at this time there is no sense of an ultimate plan or a fully developed theory.

As both titles illustrate, Cavendish is at play here, with ideas, images, forms, and language. These early works show a central interest simply to create: documents to gain her remembrance and fame, verses to entertain, philosophical speculations to enlighten readers. She generates a wide variety of striking images and intriguing analogies, but the effect is of the haphazard juggling of new ideas that occurs in a brainstorming session; the imaginative connections and insights indicate a great curiosity about her subject matter but also that her understanding of science is limited and incomplete. Nonetheless, the 'fanciful' manipulation of ideas and images in these two texts has repercussions beyond simple entertainment. These works are the starting point for Cavendish's real interest in natural philosophy, the inspiration for her shift to vitalist philosophy, the source of the notions of balance and harmony central to her innovative theory of matter.

[14] Cavendish notes that "as for my Book entitled *The World's Olio*, I writ most part of it before I went into England" (*TR* 170). *The Worlds Olio* was not published until late 1654. Though the title page is dated 1655, Whitaker notes that it must have been available earlier (377n67).

It is through the figurations she initially employs to represent the natural world that she begins to formulate a new vision, one that is consciously at odds with the many systems from which it nonetheless draws its inspiration.

Chapter 2: *Philosophical and Physical Opinions*

Though it is in some ways a new and dramatically expanded draft of *Philosophicall Fancies*, the 1655 edition of *Philosophical and Physical Opinions* shows Cavendish just beginning to formulate a full world-view. She moves beyond imaginative sketches of atomic nature and begins to elaborate an animist natural philosophy founded on a hierarchical model of matter where reason and cooperation are highly valued, but where faction and disorder are still evident. The second edition builds on the first with added detail, clarification, organization and purpose: by 1663, her natural theory is more or less fully established. Subsequent works expand or explain, but rarely amend the basic ideas set forth in these treatises.

The availability of two very different editions of the same title offers a unique glimpse into the circuitous and reiterative processes of drafting and revising. In addition, the particular changes Cavendish brings to the content, organization, and diction show significant parallels between how and what is written. In these works, the range of images and metaphors is narrowed to a select few, all more closely related to ideas of balance and harmony, and the text develops a structure that further illustrates these ideas. Both editions of *Philosophical and Physical Opinions* reflect Cavendish's desire to expand her understanding, fit in with learned circles and distinguish her voice from others.

Accompanying the development of her scientific knowledge is a growing understanding of how to formulate a theory of matter that matches her social vision, and consequently she begins also to pass judgment of the ideas of her peers which fail to do the same. This continues in Cavendish's next philosophical works, where her need to have her ideas acknowledged is set against sometimes scathing criticism of those whom she would have accept her opinions.

Chapter 3: *Philosophical Letters* and *Observations Upon Experimental Philosophy*

In the relative peace of the mid-1660s, with new leisure to devote to reading and writing, Cavendish produces her most polemical works of natural philosophy. These two works include some new speculation, particularly on the subject of perception, but their major thrust is critical and judgmental. Figurative constructions are largely abandoned in favor of what appears to be a more objective stance; however, this has its own rhetorical implications. Her assessment of other philosophers also bespeaks a change in her relationship with her readers, and in *Philosophical Letters* she chooses a genre which specifically engages an outside reader, albeit an imaginary correspondent. In *Observations Upon Experimental Philosophy*, this spirit of dialogue and debate persists. The tone is more contentious than in the letters, but the critical style calls for some sort of response: Cavendish wishes both to defend her self-assigned membership among the community of natural philosophers and to force acknowledgment of her opinions.

Both texts evince Cavendish's growing difficulty in accepting the ideas of her scientific peers; they also indicate a higher level of cognitive learning in which her

analytical and critical skills become more obvious. Judgment is essential to the final synthesis of her natural theory, and the program of study in natural philosophy that she sets for herself allows her to develop more confidence in her own perspective on the natural world. There are interesting parallels to be drawn between these texts and the academic literature reviews produced by university students. By reviewing the literature pertinent to their project, students situate themselves in a scholarly tradition, and in the same way, Cavendish here seeks to situate herself in the world of natural philosophical debate from which she is inevitably excluded by gender above all else. As she examines the work of others, she reevaluates her own ideas, yet reading authors with conflicting opinions leads to the entrenchment of her own ideas.

Chapter 4: *Blazing World* and *Grounds of Natural Philosophy*

Cavendish achieved some of the recognition she so desired in the second half of the 1660s. In 1665, the couple rose to the heights of the aristocracy when William received his dukedom, and subsequently literary works and laudatory verses were dedicated to them.[15] Some of her hunger for philosophical fame was satisfied when her ideas were acknowledged (though disputed) in Joseph Glanvill's work on witchcraft.[16] Her most public moment, however, was her visit to the Royal Society in 1667, where Robert Boyle and Robert Hooke demonstrated objects and phenomena "designed to

[15] As patrons to the poet and playwright Richard Flecknoe, both William and Margaret were the subjects of many laudatory verses; Flecknoe dedicated some of his work to Margaret alone, and his play *The Damoiselles à la Mode* to the couple. Both John Dryden and Thomas Shadwell also dedicated work to the Duke and Duchess (Whitaker 320-21).

[16] Soon after reading *Philosophical Letters*, Glanvill had sought to communicate with Cavendish, wishing to defend the Platonic doctrine of Henry More; their correspondence continued for a few years. The later work of Ralph Cudworth also responds to Cavendish's views; in it, he "attacked her view that matter had free will as the most dangerous form of atheism" (Whitaker 319). Cudworth's *True Intellectual System of the Universe* was published in 1678, five years after Cavendish's death.

titillate the Virtuosi rather than satisfy scientific curiosity" (Jones 163). Her final two publications on natural philosophy do not, however, pursue the real-world engagement that was increasingly available to her. *Blazing World*, a fictional narrative written as a companion piece to *Observations Upon Experimental Philosophy*, retreats dramatically into a fantasy world where any philosophical debate takes place with creatures only half-human. Her last essays on natural philosophy, *Grounds of Natural Philosophy*, abjure open critique of other philosophies in favor of a simple and concise presentation of her theory of matter and motion.

Each one in its own way, these works culminate all that has come before. In *Grounds of Natural Philosophy*, her comprehension of the natural world and the various natural philosophies of her time is advanced enough for her to be able to finalize the creation begun with *Poems, and Fancies:* a new and wholly original world view that responds to and rejects these various philosophies and proposes in their stead a consistent and integrated model of a vital universe. In its fanciful and imaginative style, *Blazing World* also hearkens back to *Poems, and Fancies*. In addition, it takes up the challenge of *Philosophical and Physical Opinions*, that of finding structural and organizational means to illustrate her theory of balance, harmony, and variety in nature. Finally, it integrates her critiques of society, of experimental science, and of mankind in general. Following different paths, neither work arrives at an absolute end point; the cyclical nature of Cavendish's thinking excludes the very possibility. Instead, both works situate themselves as new beginnings. In these final presentations of her natural philosophy, Cavendish is consciously a creative *woman*. In *Blazing World* she is "Authoress of a

whole World" (*BW* 109), while in *Grounds of Natural Philosophy*, the restoring-beds that come at the close of two decades of philosophical writing are literal and figurative starting-points for new life, new conceptions, and new writing projects.

CHAPTER 1: "let Fancy have the upper place"[1]

Poems & Fancies and *Philosophicall Fancies*

From late 1651 to early 1653, Margaret Cavendish experienced a kind of multiple exile out of which her earliest attempts at natural philosophy emerged. Her life had already been dramatically marked by tragedy brought on by civil war. In the summer of 1642, her family home was invaded by local parliamentarians, the family was imprisoned, the house was plundered, and her brother John was imprisoned in the Tower of London.[2] Later in the war the house was largely destroyed and the family burial vault was desecrated; the mob of looters even broke open the tomb of Margaret's recently buried mother, Elizabeth. Soon after, her brother Sir Charles Lucas, a commander in the King's army, was executed by the Parliamentarian forces led by Lord Fairfax. Already in exile with her husband, who had been a general in the defeated royalist army, Margaret bitterly mourned the loss of her beloved mother. In 1651 she returned briefly to London, a stranger in her native land, isolated from her husband and friends in Antwerp, dispossessed and at the mercy of a parliamentarian government she felt had destroyed "not only the family I am linked to ... but the family from which I sprung" (*TR* 163). Her appeal for a proportion of William's estate was denied categorically, but she spent nearly eighteen months in England while her brother-in-law Charles sought to restore the family's financial security.[3] Lonely and suffering from insomnia, Margaret turned to writing to ward off her melancholy.

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[1] *P&F* 213.

[2] It is not clear, however, whether Margaret was with the family at the time (Whitaker 41).

[3] Margaret was denied the one-fifth entitlement the Parliament had allowed to the wives of traitors and delinquents because her marriage had taken place after William, already in exile at the time, had been

Early in 1653, she sent not one but two volumes to publication: first, *Poems, and Fancies*, and soon after, *Philosophicall Fancies*. In both texts, she claims that her central impulse is fundamentally creative. She wishes to produce documents that bring her remembrance and fame, verses that entertain, thoughts on natural philosophy that enlighten readers. She explores such notions as particulate motion, the vacuum, and the nature of disease, yet neither of these works of 'fancy' purports to be serious natural philosophy. The atomic verses of *Poems, and Fancies* are whimsical, naïve, and, by the author's own admission, not to be taken too seriously; the short essays in *Philosophicall Fancies* were composed quickly and, Cavendish claims, only for distraction. However, these texts evince far more than a lonely woman whiling away the hours. They illustrate the complex process of making rather than simply expressing meaning and knowledge. The fragmented nature of the atomic poems and the disconnected, almost haphazard organization of her first philosophical 'essays' suggest the unedited brainstorming of half-formed ideas; this in turn demonstrates her developing comprehension, assimilation and appropriation of complex concepts. In addition, the scientific content of her texts shows a rapidly growing understanding of the ideas of respected natural philosophers, both ancient and modern. Unable to participate more than tangentially in the sort of intellectual and philosophical debate open to her husband and brother-in-law, it is through her writing that Cavendish begins to make sense of many scientific topics. Initially drawing on her perception of the close correspondence between atomism and political anarchy, she anchors her understanding of the natural world in her observations of civil disorder. However, the process of articulating the chaos of atomism initiates a

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stripped of his estates (Whitaker 131, 134). Throughout her biography of Cavendish, Whitaker provides detailed descriptions of the family's complex financial maneuvers, including their income, debts, possessions, properties, and associated litigations.

significant shift in perspective: she ceases to see unruly nature as the root of social turmoil and instead begins to envision a natural order that foreshadows restored social harmony.

Philosophicall Fancies and the atomic verses in *Poems, and Fancies* are closely connected in time and topic, yet very different in genre and philosophical perspective. Together, these texts reveal the mutable, protean nature of Cavendish's first attempts at 'scientific' writing. This chapter will examine how her fragmented writing reflects the preliminary, even pre-textual aspects of the composing process; how the scientific content tests out possibilities rather than proclaiming a firm conviction; and how figurative language is used to explore evocative images and discover meaning through them. Though the atomism in *Poems, and Fancies* begins as a metaphor for society and *Philosophicall Fancies* is little more than a skeleton theory of matter and motion, it becomes clear that these two function heuristically to allow Cavendish to envision a far more comprehensive natural and epistemic theory.

(Pre-)Writing Processes

Giving free rein to her imagination, in *Poems, and Fancies* and *Philosophicall Fancies* Cavendish produces fragmented, exploratory texts, where any and all ideas, genres, rhetorical devices and associations are appropriate. The one hundred and five atomic verses unfold with no particular logical sequence. The most basic concept of matter is not defined until the seventy-sixth poem, and transitions from one topic to another appear arbitrary: verses on the element of fire are randomly scattered throughout,

and poems about physical illness are lumped together with verses about the Sun and others on motion. The atomic poems make up only a quarter of *Poems, and Fancies*, a book that also includes masques, elegies, orations, dialogues and moral discourses. Groups of poems experiment with different rhetorical devices such as simile, metaphor, and prosopopoeia.[4] The volume covers an extraordinary range of topics, from fame to fairies to fishes, hunting to honor to hope, prudence to pygmies to possets. Though devoted to natural philosophy alone, *Philosophicall Fancies* is also a very preliminary study. Each chapter is little more than a topic sentence introducing her first thoughts on matter, motion, the mind, the senses, natural phenomena, celestial bodies, and other subjects.

Especially in these early years of her writing career, she spent little time correcting or editing her work, preferring her ideas in their natural, unaltered state, and she had the social status, the means and the indulgence of her husband to publish her sprawling first thoughts.[5] As a result, these first texts are what Sandra Sherman describes as "a flagrant display of the author's mental processes and of the 'fancies' produced" (186).[6] They reveal aspects of the initial writing process that are usually invisible, taking place "within the writer's head or on scraps of paper that are rarely published" (Murray, "Write Before Writing" 381). One of these invisible aspects is an author's signal to write,

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[4] On the many genres and rhetorical devices used in *Poems, and Fancies*, see Hero Chalmers, "Flattering Division."

[5] On Cavendish's revision (or lack thereof), see James Fitzmaurice, "Margaret Cavendish on Her Own Writing" and "Front Matter." Whitaker points out that Cavendish risked her reputation by publishing *Poems, and Fancies*: "[modesty], silence, obedience, self-effacement—the central concepts of female virtue—would all be violated by publication, and women who printed their works risked shame and denunciation" (151). Also see Kathleen Jones 93-95.

[6] Sherman refers more specifically to *Poems, and Fancies*, *Sociable Letters* and *Blazing World*, but in this context, the description applies equally well to *Philosophicall Fancies*.

the "way of handling a diffuse and overwhelming subject" (378). Cavendish's prefatory comments indicate that the signal precipitating actual composing is not the scientific notion of the atom but the image of anarchy that atoms kindle in her mind. Both documents introduce her thoughts as unruly entities which she has indulgently allowed to roam freely. She tells her friend Elizabeth Chaplain that "[Nature] hath given us Thoughts which run wildly about, and if by chance they light on Truth, they do not know it for a Truth" (*P&F*; "An Epistle to Mistriss Toppe").[7] In *Philosophicall Fancies* Cavendish gives these wild thoughts voice in opening verses where they flout Reason's admonishments:

> Reason forebeare, our Study not molest,
> For wee do goe those waies that please us best.
> Nature doth give us liberty to run,
> Without a Check, more swift far then the Sun. ("Reason, and the Thoughts")

For once in her life, the chaos of the civil war is productive, channeled into a fruitful metaphor for her creative instincts.

Cavendish justifies the "general impression of wildness" of her book by privileging Fancy's abundant diversity above Reason's organization and method (Grant 127). She declares that, "Fancy goeth not so much by Rule, & Method, as by Choice" (*P&F*; "To All Noble, and Worthy Ladies"). Hero Chalmers argues that this first work demonstrates Cavendish's "poetics of 'variety'," a conscious espousal of chaos and

[7] As noted at the start of this thesis, the prefatory material is unpaginated and will be documented in the text by title.

fragmentation, but she also admits that the unrestrained flow of ideas gives rise to a structure that appears at best eclectic but at worst entirely chaotic—even "vertiginous" (123). Such representations call to mind the preliminary writing activities variously described by terms such as pre-text, *avant-texte*, pre-writing, brainstorming, generation, planning stages, free-writing, 'groping', or discovery drafts.[8] Some of these are also understood to be invisible processes, ones that mix elements of the written and spoken word. Rohman affirms that pre-writing happens "within the mind" (107). Witte suggests that pre-text is "a writer's tentative linguistic representation of intended meaning, a 'trial locution' that is produced in the mind" and eventually "transcribed as written text" (397). Murray uses the term "rehearsal" to describe how writers begin with verbal constructions, thinking aloud or discussing ideas with others; these eventually evolve into written form as "lists, outlines, titles, leads, ordered fragments, all sketches of what later may be written, devices to catch a possible order that exists in the chaos of the subject" ("Write Before Writing" 376-77). Both these definitions evoke the haphazard organization of Cavendish's texts in their allusions to the relative formlessness, even aimlessness of this part of the writing process.

However, the atomic poems and *Philosophicall Fancies* illustrate preliminary writing activities in more than their fragmented structure. In "Writing as Process," Murray further describes rehearsal as a "time for experiments in meaning and form, for trying out voices, for beginning the process of play which is vital to making effective

[8] Pierre-Marc De Biasi uses the term *avant-texte* to designate "the chain of writing operations that have preceded the appearance of the text proper" (38) and associates it with the critical readings practiced by literary geneticists. On brainstorming, pre-writing, discovery drafts and rehearsal, see Donald Murray, "Write Before Writing" 375-77. 'Pre-writing' is a term coined in 1965 by Gordon D. Rohman. Flower and Hayes describe generating ideas as a sub-process of planning ("Cognitive Process Theory" 372). Elsewhere, they explain that plans are "typically fragmentary" ("Images, Plans, and Prose" 124).

meaning" (5). Through these two explorations of natural philosophy, Cavendish creates an understanding of the natural world that is not what she had originally imagined or intended. Initially, she openly acknowledges her work as play, a diversion for both writer and reader. In *Poems, and Fancies*, she tells "All Noble, and Worthy Ladies" that her work consists of "harmlesse Fancies." She later adds that "I had nothing to do when I wrot it, and I suppose those have nothing, or little else to do, that read it" ("To Naturall Philosophers").[9] Cavendish does not expect her work to be taken too seriously and blithely admits that she "may be absurd, and erre grossely," yet continues, "if I do erre, it is no great matter; for my Discourse of them [atoms and motion] is not to be accounted Authentick: so if there be any thing worthy of noting, it is a good Chance; if not, there is no harm done, nor time lost." Even her choice of genre predicates play: she writes about science in verse because "Errours might better passe there, then in Prose; since Poets write most Fiction, and Fiction is not given for Truth, but Pastimes" ("To Naturall Philosophers").[10]

By *Philosophicall Fancies*, her outlook has changed, and her writing evokes the paradoxically aimless and essential search for purpose that Rohman associates with pre-writing. He explains that "writers set out in apparent ignorance of what they are groping

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[9] Amy Scott-Douglass suggests that in later works, because Cavendish wishes to present herself as a "self-crowned laureate" (35) rather than an amateur or professional writer, she is not "entirely comfortable approaching her writing as play" (45n11).

[10] A different view is found in Bronwen Price, "Feminist Modes of Knowing." Price argues that choosing verse to explore natural philosophy is Cavendish's conscious attempt to keep the form eccentric to the content. More than simply the practice of choosing the safety of acceptable female forms of discourse, this is a deviation from a passive to a 'textually active' role in which the masculine subject matter (natural philosophy) is explored through feminine discursive methods (verse).

for; yet they recognize it when they find it" (Rohman 107).[11] In her treatise, Cavendish is no longer indifferent to philosophical validity. Employing mostly prose, she no longer envisions her work as simply fiction or pastime. The content is set out in a more systematic way, starting with formal definitions before elaborating on matter and motion. She hopes that Nature will continue to provide her with "severall Fancies," but also "as good a Brain may make" (*PF*; "A Dedication to Fame"). In the prefatory verses, Thoughts and Reason are actors as prominent as Fancy. The play of imagination remains important, but Cavendish has begun to see knowledge and understanding as the central purpose of her philosophical musings. Though *Philosophicall Fancies* is brief and its topics lack elaboration, it both anticipates and paves the way for later philosophical projects, functioning, like Witte's pre-text, as a kind of prototype prepared before a writer commits to an extended written text (398).[12] Moreover, it is here that Cavendish begins to search, or 'grope', for alternatives to mechanical philosophy and atomism.

As Cavendish becomes interested in a more serious pursuit of natural philosophy, a certain anxiety begins to emerge in her writing that undermines her seemingly carefree stance. In *Poems, and Fancies*, she tackles natural philosophy with enthusiasm, all the while candidly professing ignorance "of any English Booke" on the topic and claiming that she has "not thoroughly reason'd on" the concepts of atoms or motion ("To Naturall Philosophers"). Her writing is presented as both innocuous pastime and work proper to a

[11] Rohman borrows the term "groping" from John Ciardi (107). Sylvia Bowerbank uses the same term when she sums up Cavendish's philosophical work: "Her work represents, in a whimsical way, a groping toward an alternative vision to Salomon's House with its pretence of finding certain and objective knowledge" (406). Elsewhere, a similar allusion is made by Flower and Hayes, who use the expression "rummaging for an idea" ("Images, Plans, and Prose" 126).

[12] Grant notes that *Philosophicall Fancies*, a duodecimo volume of less than a hundred pages, is "a pigmy among her extensive folios" (130). In contrast, *Philosophical Letters* exceeds five hundred folio pages.

noblewoman: alluding to the "spinster's respectable, domestic endeavours" (Rees, "Well-Spun Yarn" 173), Cavendish claims to have "chosen my Silke with fresh colours, and matcht them in good shadows, although the stitches be not very true" (*P&F*; "To All Noble, and Worthy Ladies").[13] Her authorial remarks in *Philosophicall Fancies*, however, are increasingly apologetic and regretful. She laments that she could not devote more time and thought to her work, and now she declares that the "false Stitches" are caused by the work being "huddl'd up in such hast." *Philosophicall Fancies* was written in less than three weeks because she wished to have it printed alongside *Poems, and Fancies*. She was obliged to cut short her observations and leave out many topics, yet "for all [her] hast, it came a weeke too short of the Presse" (*PF*; "To the Reader").[14] She declares more than once that her thoughts have outrun reason in the preparation of this work, and apologizes for her weak understanding:

> I wonder, Braine, thou art so dull, when there
> Was not a day, but Wit past, through the yeare ...
> But thou, poor Braine, hard frozen art with Cold,
> Words Seales, of Wit, will neither print, nor hold. ("An Epistle to my Braine")

[13] Emma Rees notes that at this time and in the context of women's lives, 'work' "refers almost invariably to 'needlework'." Pointing out the etymological link between textile and text (both deriving from the Latin verb *texere*), Rees suggests that Cavendish "identifies and seizes upon an opportunity to execute a literary transition from the occupation of needlework, or the creation of textiles, to the occupation of writing, that is, the creation of a text" ("Well-Spun Yarn" 172).

[14] In "Dismantling the Myth," Chalmers offers the more radical explanation that Cavendish's haste "reinforces the notion that the texts represent a form of political resistance in the face of royalist exile" (324).

Murray suggests that while an increasing concern for the subject is a powerful driving force for writers, it can be equally perturbing.[15] Towards the end of *Philosophicall Fancies*, the enormity of her project seems to strike Cavendish. She lists six pages of questions she *could have* explored, among them, "What Motions make Civil Wars, and whether the Aire causes it" (72); "Why the Sun should give light, and not the other Planets"; and "Why some have Haire, some Wool, some Feathers, some Scales, and some onely Skin" (74). The wandering thoughts that she had been pleased to let roam now cause her to "despaire of a finall Conclusion of my Booke; which makes my Booke imperfect, and my Fancies unsettled" (77).

Evolution of a Natural Theory

Just as her writing style changes as it begins to find its meaning, so does Cavendish's scientific outlook shift quite evidently from the atomic poems to *Philosophicall Fancies*. The swift evolution of her ideas has often been read as more evidence of the jumbled and confusing nature of her texts, leading critics either to ridicule Cavendish the author or simply dismiss her capacity for scientific thought and writing. After reading *Poems, and Fancies*, her contemporary Dorothy Osborne famously claimed "that there [were] many soberer People in Bedlam" (Temple 79). Virginia Woolf scathingly portrays Cavendish as a rambling and "riotous" writer, like "some giant cucumber [which] had spread itself over all the roses and carnations in the garden and choked them to death" (*A Room of One's Own* 59). She complains that Cavendish wished "to erect a philosophic system that was to oust all others," yet "[order], continuity, the

[15] Murray quotes Winston Churchill, who said, "Writing a book was an adventure. To begin with, it was a toy, and amusement; then it became a mistress, and then a master. And then a tyrant" ("Write Before Writing" 376).

logical development of her argument [were] all unknown to her" (*Collected Essays* 56, 54). More succinctly, Bowerbank calls her writing "muddled and indecisive" (406), while Sandra Sherman notes that "Cavendish's theories of the physical universe were so eccentric as to embarrass even committed atomists" (200n16). Scarcely more generous is her biographer, Douglas Grant, who claims that "her application of the [atomic] theory resembles nothing so much as a child playing with a meccano set, certain basic pieces being used to construct all manner of things" (116). At best, he adds, her theory is no more absurd than others.

Without question, Cavendish's exposition of scientific knowledge contains inconsistencies and contradictions that indicate that few of the theories she calls upon have been fully assimilated. She presents ideas attributable to such important philosophers as Aristotle, Epicurus, Gassendi, Descartes and Hobbes, yet in Jay Stevenson's words, she "ruminates rather than communicates, reiterating facts, ideas and opinions acquired from various sources" (529). Though Stevenson intends this as a critique, rumination, in its physiological sense of the sequence of partial digestions that eventually lead to complete absorption, is a strikingly apt metaphor for Cavendish's learning process. From the early days of her marriage, Margaret had been informally tutored by William's brother Charles, her "conversational companion, patron, protector, and intellectual mentor" (Whitaker 82).[16] The atmosphere of the household was one in which her interest in natural philosophy was able to flourish. In Paris, William and

[16] Margaret dedicates *Poems, and Fancies* to Sir Charles and also includes a dedicatory epistle to him in *Philosophicall Fancies*. Robert Kargon notes that Sir Charles was "a mathematician of some repute" and "an important ... figure in scientific circles of the mid-seventeenth century. The loss of the major part of his papers was indeed a great one for historians of science" (*Atomism* 40).

Charles had been in close contact with some of the most eminent thinkers of their time: Thomas Hobbes, Marin Mersenne, René Descartes, Pierre Gassendi, Sir Kenelm Digby, William Petty, mathematician John Pell and others.[17] Hobbes and Descartes were both occasional dinner guests, though Margaret was unable to converse with these men directly because of her shyness and her inability to speak French to Descartes. In *Poems, and Fancies* she draws on discussions with her husband and brother-in-law and subscribes to an atomism rooted in diversity. Moreman notes that early-modern atomism "developed within a context of intellectual ferment, involving combinations of the elements of ancient atomism, chemical atomism, the neoplatonic 'seminalism' of Paracelsus and Van Helmont, and the scholastic tradition of *minima naturalia*" (131).[18] Cavendish tackles natural philosophy with enthusiasm, all the while candidly professing ignorance "of any English Booke" on the topic and claiming that she has "not thoroughly reason'd on" the concepts of atoms or motion (*P&F*; "To Naturall Philosophers"). For the most part she follows Gassendi's version of Epicurean atomism, yet in some cases, she diverges: her fire atoms are long and piercing, unlike Gassendi's easily-moved spherical fire atom.[19] Robert Kargon suggests that her atomism is one of the first presentations of Gassendi's ideas in England (*Atomism* 77), though Battigelli cautions that "her volumes were not in any sense faithful expositions of any particular atomist system" (50).

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[17] William and Charles' Parisian salon is most often referred to as the Newcastle circle or Cavendish circle. Anna Battigelli notes that Charles also hosted an epistolary salon "through which he acquired, reviewed, and circulated new ideas, including those of Hobbes and Gassendi" (47). See Battigelli 45-49; Whitaker 92-94; Kargon, *Atomism* 63-76; Clucas, "The Atomism of the Cavendish Circle."

[18] Sarah Moreman's summary of the context of Cavendish's atomism (131-33) draws on Clucas, "The Atomism of the Cavendish Circle," who provides more detail on Cavendish herself (259-64) as well as thinkers with whom she would have been familiar, notably Gassendi, Charleton, Digby, and Hobbes. For other works specifically concerned with Cavendish's atomism, see Battigelli 39-61; and Sheehan and Tillery 8-13. For more on early seventeenth century atomism, see the work of Kargon; Christopher Meinel; and Lisa Sarasohn, "Motion and Morality."

[19] Clucas points out that the piercing fire atom is more like the 'stinging' aculeate Platonic atom ("The Atomism of the Cavendish Circle" 260).

In *Poems, and Fancies*, however, Cavendish's goal is not to present a coherent or comprehensive natural system. Initially she is attracted by atomism's capacity to reflect the chaos of the civil war: the potential wilfulness and volatility of atoms correspond to her sense of the world turned upside down. Her long-standing and ongoing concern with social order combines with an increasing interest in natural order to create what Murray describes as a centripetal force by which everything surrounding a writer becomes pertinent:

> The writer's perception apparatus finds significance in what the writer observes or overhears or reads or thinks or remembers. The writer becomes a magnet for specific details, insights, anecdotes, statistics, connecting thoughts, references. The subject itself seems to take hold of the writer's experience, turning everything that happens to the writer into material. ("Write Before Writing" 376)

What becomes clear throughout *Poems, and Fancies* and *Philosophicall Fancies* is the pervasive influence of the personal, social, and political on Cavendish's constitution of scientific understanding. Everything in her description of nature is tinged by war and disorder. Like Hobbes, Cavendish perceives society as a subset of nature. However, while Hobbes interpolates from natural laws to explain the commonwealth, Cavendish determines nature's rules by extrapolating from herself: she seeks to make sense of the natural world through her observations of phenomena like thunder and lightning, through her perceptions of social behavior, and through her experiences of civil war and political exile.

Philosophicall Fancies shows that Cavendish has begun to struggle with the difference between representing the natural world as a mirror of the chaos around her and as a macrocosm of her ideal society. The burgeoning anxiety evident in her authorial comments is matched by her doubts about the atomic world-view. This is made manifest in the way she re-conceives the natural world. To supplant the anarchy of atomism, she develops a hierarchical structure that, as Sheehan and Tillery suggest, "reconciles organicism and mechanism by positing that nature follows physical laws in a purposeful and sentient way" (13). Matter is described as a unified whole made up of an inanimate component controlled and manipulated by sensitive spirits, which are themselves controlled and manipulated by rational spirits.[20] Traces of Cartesian mechanism are retained in the way that "laws guide the action of the cosmos" (13); however, Cavendish breaks with mechanical theory, in which motion is external to matter and all action is the result of the collisions of lifeless particles. Motion is redefined as inherent in matter: a refined, 'thin' matter insinuates itself into inanimate matter and "makes solid Matter run" (*PF* 9).[21] Hobbes, in contrast, describes motion in terms of impact, force, and conquest of the strong over the weak; motion is the "continual relinquishing of one place, and acquiring of another."[22] As John Rogers argues, in such a mechanical system, the very rules of motion discriminate against Cavendish as a woman. She cannot accept a natural (and thus social) theory in which greater physical strength is equated with greater natural

[20] In her later works, these are called sensitive and rational *matter* rather than spirits.
[21] This concept may be drawn from Hobbes's early theory, dating to about 1630, which suggests that certain substances emit a corporeal effluvium allowing them to move. Hobbes refutes this theory by the 1650s in favor of an external impulse towards motion (*conatus*). He comes to claim that nothing moves by itself: motion is external to matter and must be induced by an external mover (Kargon, *Atomism* 55).
[22] Hobbes, quoted in Rogers 185. Descartes and Gassendi also posit an external mover: movement is bestowed upon matter by God, and the sum of all motions in the universe is constant.

(and thus political) power.[23] By appropriating only certain aspects of Cartesian mechanism and Hobbes' older theory of effluvia, Cavendish explains motion as the cooperative yet hierarchical interaction between material spirits, which retain the living characteristics and 'personalities' ascribed to atoms in *Poems, and Fancies*.

Envisioning Nature

The rejection of atomic and mechanical theories that emerges in *Philosophicall Fancies* indicates Cavendish's need to find solutions to the questions of nature that function equally well when applied to society as she wishes it to be. Her goals are perhaps more personal and self-interested than those of Boyle or Hobbes, who, according to Shapin and Schaffer, seek to justify or refute experimental methods in order to establish a safe space for intellectual dissent.[24] The vitalist hierarchy she begins to formulate not only gives hope for restored social order, it also gives hope of increased agency for Cavendish herself, not only as an exiled royalist, but also as a woman. The changes in imagery, the ways that Cavendish figures and refigures the physical world, reveal a powerful heuristic significance in the parallels she draws between society and nature. Images, metaphors and analogies help her both to represent the natural world and to create new meaning. Flower and Hayes explain that "[as] writers compose they create multiple ... representations of meaning" such as "imagistic" ones, which are translated and inscribed in text as current meaning ("Images, Plans, and Prose" 122). In *Poems, and Fancies*, Cavendish's fragmented verse sketches mirror the civil situation and exemplify

[23] For more on this topic, see Rogers 185-90.
[24] On the other hand, Shapin and Schaffer imply that Hobbes's 'philosophical' objections to restricting the experimental community to a closed group of acceptable members may have had a personal edge, since Hobbes himself was never made a member of the Royal Society; see 131-39.

her fancy running wild but these are also dynamic resources for her developing understanding of the natural world. Bazerman argues that a writer's "struggle with meaning, a dialectic between the language system and the writer's knowledge, experience, ideas, and impressions of his reader, is a deeply creative force, constantly remaking our creative world" (20). Disparate topics and thoughts are juxtaposed based on whatever connections spontaneously occur to Cavendish, sometimes with enlightening results. For example, by visualizing tidal motion, she is better able to define the difficult notion of the vacuum, picturing it as existing in the spaces left empty by the constant movement of atoms.[25] Admittedly, she sometimes selects images with tenuous or limited insight, as when consecutive images represent motion as a panderer and a baker in order to convey its constant desire "new Formes to get" (*P&F* 17). However, the conceit of free play of imagery and imagination is well-suited to the random, even capricious behavior of atoms. Through vivid and varied illustration of the protean, anarchic atomic world, Cavendish has found, to paraphrase Rohman, an arrangement that fits her subject to her and her to her subject (107). She is able to develop the parallels between fancy, nature and society while literally sustaining her objective to "please the Eye" of her readers (*P&F*; "To All Noble, and Worthy Ladies").

Yet her exploration of an atomic world is undeniably *guided*, however much she invokes the unruliness of fancy, by images anchored in her own reality. When Bowerbank suggests that Cavendish's lack of method "recreates pure nature" (396), she recognizes only one part of the equation. As the macrocosm of society at war, nature is

[25] See *P&F* 19-21, "Of Vacuum"; "Of the Motion of the Sea"; "Ebbing and Flowing of the Sea"; "Vacuum in Atomes"; and "Of Contracting and Dilating, whereby Vacuum must needs follow."

itself chaotic; as the constitutive particles of violent mankind, atoms themselves are aggressive and volatile. Even Chalmers somewhat understates the situation when she suggests that "Cavendish's poetic principles and practice reflect her cherished natural philosophy and carry with them resonances which touch on her historical predicament" ("Flattering Division" 123). More to the point is Stevenson's claim that Cavendish's jumbled writing is "a demonstration of the potential for disorder she [sees] in the social and natural universe" (541).[26] In a similar vein, Rogers argues that Cavendish is driven "to marshal images from natural philosophy as an organizational foundation for her beliefs about human society" (185). Yet the reverse is as often true: she marshals images of human society—initially as it is, and later as it *should* be—into the foundation of her theory of matter and motion.[27]

This interconnection of her political and natural vision is well illustrated in the changing ways motion is depicted in her first two works. In the atomic poems, Motion is one of Nature's powerful generals, independent of, and often in conflict with, Matter. Sometimes an ordering force, Motion is also often randomly violent in exerting its power over atoms. The results are quite literally earth-shaking:

> When Motion, and all Atomes disagree,
>
> Thunder in Skies, and sicknesse in Men bee.
>
> Earthquakes, and Windes which make disorder great,
>
> Tis when that Motion all the Atomes beate. (*P&F* 16)

[26] Stevenson goes on to identify intentionally concealed radical elements in Cavendish's natural philosophy. He claims that "her texts deny their own content" (527) and that by presenting her thoughts as independent and rebellious agents of her writing, she remains apart from her dangerously radical ideas.
[27] Rogers makes the point that Cavendish and others employ natural imagery in order to debate social conventions like woman's subordination to man: "The battle of the sexes could be waged, discursively, in the debates over the physical constitution of the natural world" (185).

In contrast to purely mechanical theories, Cavendish's atoms are not lifeless pawns to be manipulated by external forces. Like a mob of rebel ruffians, atoms often seem to be in command, even electing Motion to be a "Generall in their war" (16). At times Motion succumbs to atoms, for "Motions inconstancy oft gives such power / To Atomes, as they can Motion devoure" (17). The lawlessness and unpredictability inherent in this vision of nature does more than reflect the chaos of her world at the time; it also connotes both helplessness and hopelessness over any restoration of order. In *Philosophicall Fancies*, her reworked theory of motion suggests vitality rather than violence, order rather than anarchy. Functioning "Like Marrow in the Bones, or Bloud in Veines" (*PF* 9), motion simultaneously lives within matter and gives matter life. Motion may show power, but in a benevolent way, as "a God to the weaker." Innate matter, later called animate or self-moving matter, is like "an Infinite and Eternall Government" in which motions act as magistrates, controlling the masses but subject to the rule of the mayor, the king, and "some Higher power" (12).

These illustrations of motion only begin to show the full extent of the pessimism that gives way to hope for something more than meaninglessness and disorder. Even the imagery of anthropomorphized atoms wreaking havoc that dominates *Poems, and Fancies* is counterbalanced, at least to some degree, by more positive representations. However, the opening atomic verses set a bleak tone, implying the aptness of Hobbes' description of times of war, in which people live in "continuall feare, and danger of violent death," their lives "solitary, poore, nasty, brutish and short" (*Leviathan* 186). In Cavendish's creation story, Nature is under attack by Fortune, Time and Death, who

threaten her monarchy—to Cavendish, the only 'natural' ruling system. Disorder, chaos, conflict and dissent prevail. When Nature meets with her generals, Life, Motion, Form, and Matter, to debate the rebellion of Death, Life tells Nature, "[Death] cares for none of your commands, nor will / Obey your Lawes, but doth what likes him still; / He knowes his power far exceedeth ours" (*P&F* 2). The creation of the world is conceived as a military diversion tactic: continuing to build the world keeps Death busy undoing their work, rather than undoing Nature herself. There is no sense of fighting towards victory, but only of postponing inevitable defeat.[28] The imagery of random violence and war is carried through more than twenty poems on fire. Combative, militaristic fire atoms are a powerful metaphor for exploring many manifestations of conflict in the world. In flint, fire atoms are imprisoned by earth atoms until Motion sets them free as sharp and angry sparks which attack other figures and eat away at them like swarming insects. Coals are a tightly packed army of fire-atom soldiers who rush out to support their comrades in battle. Ashes are likened to the aftermath of an army's rout: their flat atoms, unbound from their original forms, are scattered about like bodies on a battlefield. Battlefield imagery further illustrates the increase and decrease of fire. Like scavenging crows feeding on a dead horse, fire atoms swarm their fuel and the fire increases. When the fuel, or carcass, is consumed, the fire-crows fly away and the fire diminishes. Even the quenching action of water is presented using the image of opposing armies: as ranks of

[28] Aside from the obvious allusions to England's civil upheaval, there is a sense of resignation permeating this first part that intimates Cavendish's despair in failing to regain her husband's lands and monies. A more blatant reference to Fortune as an enemy to her family is made in *Blazing World* (82-87), where the Duchess debates Fortune and is judged the victor, but Fortune "would not hearken to Truth's judgment, but went away in a passion" (86).

fire atoms attack, brave water atoms disperse the fire-army like cannons shot through a regiment on horseback.[29]

Other aspects of nature are presented using similarly violent imagery of collision, conflict, and struggle for domination. Sound is created by atoms crashing into one another, literally giving each other blows. The roaring of the sea is the loud clashing of spherical, hollow water atoms. Sickness arises from dissent among atoms in the body. Specific illnesses occur if one kind of atom dominates others: dropsy (edema) is an overabundance of water atoms; consumption (tuberculosis), an overabundance of dry fire atoms; colic an overabundance of air; and palsy or apoplexy an overabundance of earth atoms in the brain, which block the passage of blood. Even the fantastic worlds that Cavendish imagines are tinged by dissent and war. Her world contained in an earring has seas filled with fish, spice-islands, jewel and gold mines, cattle feeding in meadows and birds singing in gardens. However, the vision of pastoral beauty gives way to a more realistic world, with cities stricken by infection, plague, and battles. The sketch ends with annihilation: "A Lover dead, in a faire Ladies Eare," and the end of the world itself when the earring breaks, and "Lovers they into Elysium run" (46).

By representing these imaginary and invisible worlds as microcosms of her world at war, Cavendish adds to a natural vision already reflecting little hope for social order and stability. Yet the motifs of war, chaos and conflict are not always so bleak or

[29] Cavendish's references to horses as both carcasses and cavalry recall her husband's interest in equestrian training and husbandry. In addition, her brother Charles Lucas was "one of the outstanding cavalry officers" of the civil war, and he commanded the cavalry of William Cavendish's army in the North (Whitaker 42, 55).

pessimistic. Nimble and unruly atoms ricocheting around the brain are positively associated with the generative forces of fancy and imagination (*P&F* 10). Battles and demolition are frequently paired with architecture and construction, suggesting eventual balance between creation and destruction, life and death, order and chaos. The council of war in the opening verses moves quickly from discouraged debate to the practical and cooperative action of world-building, Matter providing materials, Motion carving out pieces, Figure drafting various forms, and Life organizing these forms appropriately. Though chaos may undermine their efforts to establish order, creation nonetheless emerges from the disorder and destruction they constantly face. The newly-created world is like a well-built house: its foundation is the sphere of earth, the oceans form the supporting walls, air pressure provides the mortar to seal everything together, and fire forms the roof over the world, "To keepe out raine, or wet, else it would rot" (3). Elsewhere, the architectural image is employed to show both that atoms work together to build our world and, conversely, that they dissent and undermine its solid construction. At times rogue atoms thrust themselves out of an otherwise solid construction and go off to create new worlds; more often, atoms form alliances and act peaceably, cooperating with one another, holding together solidly within their forms or, if necessary, moving about "As severall work-men serve each others turnes" (5). Alliances between atoms provide stability, giving the new, mixed figures strength and longevity: fire atoms consent among themselves to form the rotating sphere of the Sun; animals contain a mix of various closely-packed (and thus closely-allied) atoms; while "in Mankinde, the best of Atomes bee" (12).

Envisioned in the atomic poems is a universe whose fundamental units are dynamic and independent, but by the same token wholly unpredictable. Motion is at times like a shepherd who drives and organizes aimless and mindless atoms, "as Sheep and Kine" (12), but also a predatory wolf frightening the atomic herd. Atoms organize *themselves* into all aspects of nature, with or against the forces of Motion; it is merely by chance that they sometimes cooperate to do so in an orderly fashion. Though Nature is ultimately in command, her interest is in variety over systematic organization. These illustrations of the natural world create in Cavendish an understanding of the problematic social implications of atomism and begin to crystallize her vitalist vision of the natural world. When Cavendish abandons this disorderly world view in *Philosophicall Fancies*, random atoms are replaced by a hierarchy of rational, sensitive and inanimate matter. Matter is unified, not divided into discrete atomic particles. Though the different levels of matter have different responsibilities, all three are inextricably mixed in all things. She uses the idea of nested containers: "all sensitive Spirits live in dull Matter; So rationall Spirits live in sensitive Spirits" (*PF* 42). Despite its complete dismissal among the mechanists, she embraces the vitalist movement's concept of self-motion to what Rogers calls its "boldest" degree, imagining "the infusion of all material substance with the power of reason and self-motion"; "even nonorganic matter ... is thought to contain within it the agents of motion and change" (1-2).[30] Cavendish's version of animist materialism allows for individual agency without the anarchy inherent in atomic theory, since motion requires the voluntary cooperation of the animate parts of matter in "the initial exercise of the infinite wisdom and perceptive powers of rational matter, the

[30] Rogers uses the terms "vitalism" and "animist materialism' interchangeably. For more on the Vitalist movement, see especially Rogers 8-16; and Merchant 117-26.

demands of this rational matter on the laboring sensitive matter and, finally, the free consent of the sensitive matter to obey those demands" (Rogers 192). Self-moving matter becomes the fundamental concept in a theory of nature that allows for some individual freedom and choice, but which also restores the proper hierarchical order of things.

With chapters sometimes as short as a single sentence, *Philosophicall Fancies* contains far less figurative language than the atomic poems. Those metaphors and images that remain specifically fit Cavendish's re-ordered perception of a world in equilibrium. Bazerman suggests that this is a significant part of the process of making meaning: "[in] surveying the symbolic options, we find some more apt to our experiences and needs, and others less" (21). The imagery of cooperation and construction dominates Cavendish's redefinition of matter. The sensitive spirits are gatherers, builders, and destroyers, manipulating inert matter into soundly-built natural structures. These spirits are under the control of nature's architects, the more refined rational spirits who "choose the Materialls" and "direct the sensitive spirits in the management thereof" (*PF* 37). At the same time, rational and sensitive spirits are "Fellow-labourers that assist one another" (36). Like a man building a house or a cook baking a pie, the sensitive spirits must mold matter into various useful figures: thick beams or thin lathes of wood, fine pastry or cake batter, or (in the creation of man) bones, sinew, nerves and muscle. Growth and development are processes involving increasingly more workmen. Young plants and animals are weaker than mature ones because few spirits are at work. As time goes on, the spirit-workmen start to gather and bring in nourishment and eliminate waste. If these

spirits bring in poor materials, or take away essential ones, the resulting figure is flawed; if all goes well, "then the Figure is beautifull and well proportioned" (22).

Even when construction eventually gives way to destruction, a sense of order and purpose is maintained. Physical degeneration is illustrated using the analogy of the collapse of a house: the eyes, like old windows, grow dim; nerves and muscles, like old floorboards, grow loose and tremble; finally, the 'spring' of blood dries up, and the dust and rain of disease settles in. Part of a natural cycle of production and decay, death is simply the beginning of a new construction project involving recycled building materials: "as that Figure dissolves, the Spirits disperse about, carrying their severall burthens to the making of other Figures" (*PF* 24). Images of warfare still exist, but these are similarly presented as phases in the greater cycle of order and disorder. Cavendish envisions natural interactions as necessary battles for self-preservation, an ongoing "Naturall, or Sensitive War" (14); for example, the drive for food is both constructive (to satisfy an appetite and promote growth) and destructive (of the food figure). The constant division and reorganization of matter into new figures is a war between Motion and Figure, which are in a constant struggle for power. However, "there is not a Confusion in Nature, but an orderly Course therein" (10). Since "Eternall Matter is allways One, and the same" (10), she is stoic that all will be settled eventually, and there will be "an Equality in Infinite" (11). In the end, there is constant struggle in Nature, but ultimately there is also order.

Envisioning Knowledge

Having drawn parallels between the larger physical world and society as its microcosm, Cavendish goes on in both works to explore the inner world of the individual mind. To describe nature in a way that fully corresponds to her experiences, she must look to her mental experiences—thoughts, speculations, conjectures, and fancies. Roberto Bertuol suggests that Cavendish, like other post-Baconian thinkers, believed that "investigation of the world of things might open up the world of mind. The human body was seen as an anatomizable version of nature, and the brain, as the site of the mind-soul, was seen as a locally anatomizable version of the mind, even of the universal mind" (30). In the final pages of the atomic poems, the illuminating capacity of metaphor and imagery is incarnated in verses that specifically explore the mind as the site of meaning- and knowledge-production. Through a series of speculations about alternate worlds, Cavendish arrives at the image of nested boxes that, in a modified form, becomes central to her representations of both matter and knowledge in *Philosophicall Fancies*, and to her natural theory in all its future manifestations. A first epistemological contemplation puts into question the accuracy of the senses, and especially vision, which has implications for our means of procuring knowledge and understanding the world. She shows how sensory perception is subject to manipulation by the imagination, which has the power to make us perceive what is not there. Hunger can cause the nose to smell nonexistent meat; the sight of a thief makes us believe we hear the sound of the break-in; and hearing a tale "lively told, / The Braine strait thinks that the Eye the same behold." The verse concludes: "Imaginations just like Motions make, / That every Sense doth strike with the Mistake" (*P&F* 39). Comprehensive knowledge is impossible to gain through senses that are

nothing but weak or limited instruments. Uncertainty appears to go hand in hand with the unpredictability and unlikelihood of order in a random atomic world.

Reason, however, has more potential to guide us reliably. In "The Motion of Thoughts" she shows us a sight that becomes conflated with the site of her mind (Sherman 187). She climbs to the crest of a hill and sees a dazzling light, always in motion and yet fixed. The bright light is a union of "Knowledge, Power, and Might; / Wisdome, Justice, Truth, Providence, all one" (*P&F* 41). The light is its own center and circumference, yet has no outer boundary—it is infinite and eternal. Her rational thoughts discover themselves to be the same as the brilliant light, but only a tiny part of it, so that they are unable (until this point in time, presumably) to perceive or understand their origins. The implications are multiple. First, it points to the extent of human ignorance: we are limited in what we can know because we are simply a tiny part of what we seek to know. This is extended in later works to strong criticism of mankind's presumption of mental superiority. Secondly, it reinforces that the only truth that can ever be trusted comes from within our own minds, not from external sensory evidence. Experimental philosophy is thus flawed from the outset, a point she makes far more deliberately in *Observations Upon Experimental Philosophy.* Finally and more optimistically, Cavendish's conclusions suggest the infinite potential within the human mind, and *her* mind in particular. This perspective allows her to affirm the likelihood of other worlds. If our senses are flawed and our reason is limited by these flaws, then what seems impossible may not be so, for "Nature is curious, and such worke may make, / That our dull Sense can never finde" (44). Cavendish knows that people are quite willing to

believe what they cannot see, for example that loadstone is made up of hooked atoms or that incorporeal spirits exist; if so, then tiny, invisible worlds are also possible.[31] She reasons that since matter is infinite, it cannot be contained in our bounded physical world; there must be an infinite number of alternate worlds to accommodate this infinite matter.[32] She presents the possibility of "severall Worlds ... in an Eare-ring" (45) or others "so big, as none can swim [circumscribe], / Had they the life of old Methusalem" (46).[33] Having begun with her version of this world's creation, she ends by opening up infinite possible creations: infinite worlds, each as knowable and unknowable as our own.

After many descriptions of fantastical worlds in the atomic poems, *Philosophicall Fancies* presents only one, a long speculation about the various shapes that matter might take: she describes a world populated by "Deere of Oake" who shed acorns that become fawns, men of iron who need fear no weapons in war, grass made of silver strings that resonate in the wind (*PF* 57). The impetus for these fanciful imaginings is the vitalist concept that "Vegetables and Minerals may know, / As Man" (56). All matter has sense and reason, and in combination with self-motion, all matter also has some form of knowledge. It is an image from the atomic poems that best illustrates the connection, and furthermore links motion and knowledge to her tripartite division of matter. "Just like unto a Nest of Boxes round" (*P&F* 44), knowledge "lives in motion, as motion lives in matter" (*PF* 52). Thus quick and agile motion of the sun indicates its "great Knowledge"

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[31] Sandra Sherman explains it somewhat differently: "To the extent that the poet is her own creation, a possible world disconnected from discourse—that is, outside the contingent world subject to verdicts of 'dull Sense'—no one has the standing to judge the legitimacy of her creative acts (authorized by a whole universe of corresponding recessiveness)" (190).

[32] See *P&F* 30. Her initial discussion of these other worlds suggests a series of disjoint mathematical spheres: discrete planets, suspended in air, whose circumferences never cross.

[33] Foreshadowing *Blazing World*, Cavendish wishes she could enter these worlds "By Art of Navigation in a Ship" (*P&F* 46).

(69). Vegetables and minerals may not have animal knowledge, but they have their own sort of knowledge due to the motion of their rational spirits (54-55). Mankind is not alone in its rational abilities, but what is more, the individual's capacity to distinguish truth is intrinsically limited if animals, plants, and minerals have knowledge that we cannot recognize. The vitalism of *Philosophicall Fancies* does not eradicate Cavendish's skepticism; if anything, it reinforces it, but in a way that encourages further search for truth. We may not understand most of Nature's secrets, but the variety of Nature is neither random nor meaningless; rather, there is sympathy between parts of unified matter that is reassuring in its sense of orderliness and harmony.

The implications are not pursued any further at this time; in fact, the conclusion to the work suggests that mankind should trust in God and stop looking so hard for truth. Yet the 'certainty of uncertainty' that Cavendish comes to articulate is a force that drives her to continue to write about natural philosophy. It provides impetus for all the works that follow, just as her unruly imagination provides the initial generation of ideas from which her philosophy grows. Her playful manipulation of ideas and images in these two early texts is neither simple entertainment nor self-indulgence. Virginia Woolf's complaint of Cavendish that "[the] wildest fancies come to her, and she canters away on their backs" (*Collected Essays* 54) does not acknowledge the heuristic value of these mental (and textual) jaunts. Following her imagination and building metaphorical representations of the natural world provide Cavendish with an "analogical way of understanding and structuring reality" (Bertuol 25). In *Poems, and Fancies*, her initial desire to ground political turmoil in an atomist world-view evolves into a search for a

natural system that privileges order. *Philosophicall Fancies* is Cavendish's "discovery draft" of such a system. Her next philosophical works explore the "Worlds in the World" (*P&F* 44) more comprehensively, developing her vitalist ideas into a complete vision of both external and internal nature.

CHAPTER 2: "Writ according to my own Natural Cogitations"[1]

Philosophical and Physical Opinions

On her return to Antwerp, Cavendish continued to advance her literary career, initially compiling a number of unpublished essays into *The Worlds Olio*. This 'spicy stew' is like *Poems, and Fancies* in its imaginative scope, covering literary, social, political, historical, moral, natural and medical topics.[2] At the same time, her growing interest in science prompted the composition of more focused and much-expanded versions of her natural theory. She took on the ambitious project of completing the very preliminary work begun in *Philosophicall Fancies*, writing her first detailed philosophical treatise, *Philosophical and Physical Opinions*, published in 1655. This volume opens with the reprinted contents of the earlier text and goes on to expand the short pieces on matter and motion into significantly longer chapters; Cavendish supplements these with detailed reflections on diseases and remedies, likely inspired by her own troubled physical condition.[3] Written entirely in prose, the more serious publication was also given a title which no longer makes reference to fancy. Eight years later, a new edition was published under the same title; in it, Cavendish amends and rearranges her ideas substantially, overtly rejects atomism, and further solidifies her vitalism.

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[1] *PPO63* 456.

[2] Whitaker explains that 'olio' refers to a Spanish stew (*olla podrida*) popular at the time among the English aristocracy (163).

[3] Cavendish was unable to conceive, a cause of great concern in the early years of her marriage. Their efforts to treat her barrenness (and William's impotence) were the beginning of Margaret's near-obsession with her medical condition; throughout the years she continued to try various painful and possibly dangerous treatments, including laudanum cordials, purges, vomits and frequent bloodletting.

Together with *Philosophicall Fancies*, these two quite different working drafts offer a unique glimpse into the writing and thinking processes that underlie and shape her vitalist philosophy. The 1655 edition presents a wealth of information and imagery roughly organized into a natural theory that still draws on some of the ideas of atomism. The authorial commentary, textual organization, and scientific content all reflect a tentativeness which indicates the ongoing evolution of her natural philosophy through her writing. The 1663 edition reflects greater clarity, confidence and focus analogous to the return of domestic, social and political stability to her world—by 1663, Cromwell was dead, the monarchy was restored, and the Newcastles had returned to their peaceful country estates.[4] Cavendish is surer of her ideas as well as her ability to communicate them effectively and coherently, and by the end of the 1663 *Philosophical and Physical Opinions*, she has sufficiently confirmed and ordered her ideas to move on to the defense of her work before an audience of natural philosophers. Through these editions, the evolution of the scientific and medical content illustrates Cavendish's growing recognition of the complex ways in which structure and language intersect with her philosophical ideals. As she continues to explore the possibilities for political, social and natural order, the organization, prose style, wording and rhetorical choices in her writing develop to account for the essential interdependence and harmony she sees in the world.

Though the two editions share the same title, the differences between them are substantial and significant. In this chapter, Cavendish's editing processes come under close scrutiny in order to identify the actual changes and the cognitive, rhetorical or

[4] These are Welbeck, in Nottinghamshire, and Bolsover Castle, in Derbyshire. Whitaker notes that "[for] the rest of their lives, William and Margaret would leave Welbeck only rarely and for short periods" (238).

philosophical purposes they serve. The modifications brought to these texts include expanding and developing ideas, cutting unsuitable notions, reordering text elements, and amending terminology and descriptive language. However, revision is not a transparent, one-time process. It does not begin after a first draft is produced, but is "layered and organic", an integral and recursive part of composing (Carroll 71).[5] It is an ongoing sequence of changes "which are initiated by cues and occur continually throughout the writing of a work" (Sommers 380). Consequently, the specific changes brought to a text are often only to be inferred. Carroll in fact argues that, faced with a single text, ongoing revision "is impossible to identify since it has occurred in the act of composing, itself a massed, imagistic, chaotic 'clay' forever undergoing change" (71). Cavendish, however, provides us with two versions of the same work, as well as the very preliminary sketch of her theory in *Philosophicall Fancies*. These provide some access to a process of revision that extends over a series of drafts. From first edition to second, but also within each one, there is a simultaneous evolution of her relationship with her readers, her scientific opinions, and her preferred textual structures and elements. In order to separate these strands without masking their essential interconnection and reciprocal influence, this chapter first examines how Cavendish uses the prefatory material to frame, justify and validate her work. This is followed by an exploration of the ways in which her new understanding of science is developed, cut or reorganized. These preliminary discussions provide necessary background to understand the evolution of complex textual structures and the corresponding changes in terminology, diction, and figurative construction.

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[5] On revision as a recursive and ongoing process, see Carroll; Faigley and Witte; Sommers; the works of Flower and Hayes; and the works of Murray.

Setting the Stage

Both editions open with numerous and sometimes quite lengthy paratexts which provide insight by articulating Cavendish's analysis of how, what and why she has written.[6] These are markedly different in the two editions: in 1655, she validates her work through a combination of defensiveness and defiance, while the 1663 prefaces more systematically set out her purpose and methods. In both editions, her prefatory pieces manifest a "tension between self-clarification and normalization" (Carroll 70), and a new relationship with her readers is inferred. She no longer writes for diversion, but more plainly in aid of knowledge-creation—for herself as well as for others. Yet her relationship with her readers begins in controversy. Much to her dismay, from the time that *Poems, and Fancies* was first published, the authorship and originality of her works had been questioned. She briefly acknowledges such attacks at the end of *Philosophicall Fancies*, declaring herself not "so vaine-glorious, as to straine to build up a Fame upon the ground of another mans Wit" (85). By the time the 1655 edition of *Philosophical and Physical Opinions* was ready to publish, however, Cavendish felt she had to respond more fully to her critics.[7] In 1655 she does so with a great deal of defensiveness and anxiety, while in 1663 she shows more confidence and authority in her authorial comments.

Composed after the completion of the treatise—some, in fact, after it had been sent to publication—the sixteen prefaces, epistles and verses in the first edition of

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[6] A more precise term than paratext might be "peritext." Emma Rees uses the latter to refer specifically to "prefatory, dedicatory and titular components" (*Margaret Cavendish* 26). She draws the term from Gérard Genette, who divides paratext into the sub-categories of peritext and epitext, the latter including more distanced elements of the text such as conversations or private communications (47n9).

[7] For details of these attacks on her early work, see Whitaker 162-63 and 183-87.

Philosophical and Physical Opinions employ techniques which anticipate those in the main body of the work, for one, the repetitious accumulation of 'evidence' that stands for proof of her conjectures. The use of repetition as a rhetorical tool can tend to accord a sense of redundancy rather than argumentative weight to her reasoning, but in the prefaces it also serves to highlight Cavendish's outrage. In the twelve pieces preceding the text and four more addresses to the reader scattered through the text, the tone is even more defensive and tentative than in *Philosophicall Fancies*, and the playfulness of *Poems, and Fancies* is completely lost. Two indignant pieces by her husband are found at the very start, the first a dedicatory verse entitled "To the Lady Marquesse of Newcastle, On her Book intitled her Philosophicall, and Physicall Opinions" which criticizes learned men who "know not that we do know nothing right"; the second is self-explanatory in its title: "An Epistle to justifie the Lady Newcastle and Truth against falshood, laying those false, and malicious aspersions of her, that she was not Authour of her Books." Here, William responds systematically to the accusations that Margaret had 'borrowed' the terms of divinity, philosophy, physic, geometry, and astronomy, concluding that "here's the crime, a Lady writes them, and to intrench so much upon the male prerogative, is not to be forgiven." Margaret, too, answers at some length the objections that she lacked the necessary experience and education that her writing seems to imply. Clearly frustrated and firmly convinced that "ignorance and present envie will slight my book" (*PPO55* 53), she decries "this ill natured, and unbeleeving age" ("To the Reader"), complaining of the "over-weaning conceit men have of themselves" ("To the Two Universities") and condemning "the ignorant, and malicious, [who] do strive to disturb, and obstruct all

probable opinions, wittie ingenuities, honest industry, vertuous indeavours, harmlesse phancies, innocent pleasures, and honourable fames" ("To the Reader").

Her outrage is tempered by enough self-doubt to cause her to make and remake the same points: reiterations of her originality, apologies for previous errors, and justifications of her right to write. She repeatedly asks her readers for patience and open-mindedness, hoping that her "faint knowledge, and dim understanding" may be overlooked (*PPO55*; "An Epistle to my Honourable Readers"), begging "to be pardoned by reason somwhat of it was writ in the dawning of my knowledge, and experience, and not having a clear light I might chance to stumble in dark ignorance on molehills of error" and later entreating her reader "not to condemn me for an ideot" ("To the Reader"). Her anxiety is carried through the work in the form of interrupting epistles directed "to Condemning Readers" (26) or "Unbeleeving Readers" (51), and in the final preface, putatively meant to announce the content to follow, she implies that her work may be in fact nothing more than fancy, wondering if she will be thought "not a right begotten daughter of nature, but a monster produced by her escapes, or defects" ("The Text to my Natural Sermon").

In this first edition, Cavendish also uses repetition as a rhetorical means to defend and explain her work, continually invoking "natural reason" throughout her modest apologies and angry remonstrations. This simple expression has a deceptive complexity. In recalling the naturally wild and untutored style of *Poems, and Fancies*, it implies a lack of formal structure. Yet distinctly unlike this earlier work, the reference here is not

to fancy, but to more conservative and controlled reason, which is more prone to "walke in a beaten path" than "run ... in such strange phantastick waies" (*PF*; "Reason, and the Thoughts"). The two are not diametrically opposed. Natural reason is both free and orderly, and is, in fact, the source of natural fancy.[8] Natural reason is also innate, not dependent on formal academic training which Cavendish had never received; moreover, it is superior to the artificial means of reasoning taught in schools. She uses natural reason to define the unquestionably worthy source of her reasoning abilities, justifying her lack of formal education by building a glowing picture of herself as a writer ultimately indebted to none other than Nature for her gifts.[9] Since "natural reason was the first educator," it follows that "natural reason is a better tutor then education" (*PPO55*; "To the Reader"). Cavendish tells the reader that "natural Reason hath informed me of many things," and that "in natural things my natural reason will conceive them without being in any wayes instructed" ("To the Reader"). At the end of the first edition, she reminds her readers that "I had never any guide to direct me, nor intelligence from any Authors, to advertise me, but write according to my own natural cogitations" (171): fittingly, it is nature that controls the way she writes about Nature.

By framing her thoughts as the product of natural reason, Cavendish also draws attention to the greater sense of purpose informing her work, and these prefaces employ 'natural' analogies with significantly different implications than the random, capricious motion of thought-atoms. In her earlier work, Cavendish's prefatory acknowledgment of

[8] Cavendish also raises the connection between reason and fancy in the preface to the reader in *Blazing World* (5-6).
[9] As Scott-Douglass puts it, Cavendish asserts that she "is the child and heir of a teacher who is preferable to William Camden any day of the week: Cavendish's professor is Nature" (38).

the unruly and fundamentally irrepressible nature of her thoughts helped to define a 'naturally' fragmented style; like restless atoms, her wild fancies go where they please. In 1655's first expansion of her philosophy, natural reason is metaphorically associated with both honeybees at the hive and a river's current. The idea of ceaseless motion is retained in both of these illustrations of her thinking and writing, but it is motion channeled more productively. In the case of the honeybees, the final creation is even quite clearly textual. She tells the reader that her head

> is fully populated with divers opinions, and so many fancies are therein, as sometimes they lie like a swarm of bees in a round heap, and sometimes they flie abroad to gather honey from the sweet flowry rhetoric of my Lords discourse, and wax from his wise judgment which they work into a comb making chapters therein. (*PPO55*; "To the Reader")

Elsewhere, a combination of liberty and order is evoked in the image of a flowing stream, which she uses to describe both her brain and the discourse it generates. This representation continues to convey the atomic poems' sense of the wild freedom of her imagination but adds both a sense of direction and spatial delimitation. She had planned at one point to turn her atomic poems into prose; however, she found that she could not, because "[her] brain would be like a river that is turned from its natural course, which will neither run so smooth, swift, easie, nor free, when it is forced from its natural motion and course" ("An Epistle to the Reader, for my Book of Philosophy").[10] She also suggests that her discourse is not the "large river" of the ancient philosophers, which draws "from

[10] In "Images, Plans, and Prose," Flower and Hayes also mention the image of the stream as a model for thought (121). They suggest that images can "give flexibility, richness, and truth-to-experience to thought" (142), but, as Cavendish articulates in this passage, that imagistic representations of meaning are often difficult to translate into prose (130-33).

many several springs"; rather, her writing "onely flows in little Rivulets, from the natural spring in [her] own brain" ("An Epistle to my Honourable Reader"). By metaphorically containing her thoughts within the banks of a river, Cavendish indicates that the path of her thoughts and writing may be meandering and circuitous, but it nonetheless proceeds with an aim and an end.

In 1655, the journey through so many repetitive paratexts foreshadows and mirrors the sometimes tortuous character of the opinions that follow. In 1663, the path is more direct, much of the content of the revised prefatory material concerned with rules and conventions. Half as many prefaces provide substantially more practical information: definitions of terminology, corrections of previous errors, explanations of changes from the earlier edition, as well as references to her reading of philosophers, both ancient and modern. All together, these indicate greater attention to the overall coherence and comprehensibility of the work. The more systematic and pragmatic paratextual material in this edition predicts the similarly more sustained structure in the opinions that follow. In addition, the sense of defensiveness is gone; with seven published works, Cavendish no longer needed to justify or defend her writing so vehemently.[11] Her increased confidence is made clear even in her ironic acknowledgment of the text's imperfections. Cavendish tells her "Noble Readers":

> Although I have Indeavour'd in the Preface to hinder Objections which might be made, by Explaining some Terms which I use in this Work, yet I am Confident there will be more Senseless Objections made against it,

[11] By this time, aside from *Poems, and Fancies*, *Philosophicall Fancies*, the first edition of *Philosophical and Physical Opinions*, and *The Worlds Olio,* Cavendish had also published *Nature's Pictures* in 1656 as well as *Orations of Divers Sorts* and *Playes* in 1662.

> than there are real Faults in it, and this cannot be Avoided, for more Learned Works than mine have not escaped Censures. As for Terms, it cannot be expected but I must sometimes Err in the Proper Expression of them, since I have not Scholastical Learning; but although I may Err in Words, yet I am Confident, I do not Err in Sense and Reason, and dare Avouch to the World, that these my Philosophical Opinions have as much Sense and Reason as any that have been Written, as being Built upon the Ground of Sense and Reason. (*PPO63*)

She no longer feels that she stumbles in the dark, and, furthermore, she implies that the readers' struggles with the material are their own fault:

> every Several Chapter, like Several Rooms, have as Much and as Clear Lights as I can give them, and if any Part should seem Obscure to my Readers, I should be Sorry for't, for I can assure you, that all these Opinions seem Clear to my Conceptions, as also to my Sense and Reason, though I do not know how they will seem to your Understanding. ("An Epistle to the Reader")

She is even openly judgmental of certain "Learned and Studious men, which have been accounted the Sages of Former, Present, and it may also be Future times," and she proceeds to discount several "very Extravagant Opinions and Phantasms in Natural Philosophy" concerning such topics as tides, thunder, or the immaterial soul ("Another Epistle to the Reader"). Out of their proper place, these detailed critiques nonetheless show how much more confident Cavendish has become in her own thinking: she concludes this epistle by disparaging "our Modern Writers in Philosophy" and promoting

her method of "Contemplation and Observation" ("Another Epistle to the Reader"). This new self-assurance is carried through the main body of the work; it reflects not only the conviction that her natural philosophy is valid, but a developing willingness to take on anyone who argues otherwise, a stance which is carried into her two subsequent works.

Notable in the passages quoted above is the repetition of "Sense and Reason," a pairing as multifaceted as "natural reason" in the earlier edition. In this new expression, Cavendish reworks the framework of her opinions to better suit her hierarchy of matter, uniting its two 'living' aspects to emphasize both the animism of her theory and the interdependence of sensitive and rational matter. Looking ahead, the addition of "Sense" also points to her growing interest in perception and the physical senses, which becomes more central and significant in both *Philosophical Letters* and *Observations Upon Experimental Philosophy*. More immediately, where in 1655 her claim to innate natural reason had served to validate her writing *against* her critics, the use of Sense and Reason allows her instead to join their ranks. Cavendish assumes her membership among serious thinkers by presenting Sense and Reason as universals, shared by all and consequently beyond doubt. It is a rhetorical maneuver that has its weaknesses. Shapin notes that in the seventeenth century, a countervailing suspicion of vulgar errors meant that "nothing was deemed so likely to be in error as common opinion" (232). However, Cavendish's appeals are directed at an audience whose social status implies intrinsic sense and reason. In addition, she links the two terms into a single entity that is defined as the foundation, the "Essence," the "Ground or Principle" of her natural philosophy (*PPO63*; "An Epistle to the Reader", "To the Reader").

Just as rational animate matter is at the top of the hierarchy of matter, reason is understood to be superior to sense, and in affirming this, Cavendish also seeks to identify herself with the true philosopher, who "might be distinguished from the vulgar man precisely because the latter was a slave to his senses while the former was at liberty to disbelieve the immediate impressions of eyes and ears when his rational knowledge of the nature of things informed him of sensory error" (Shapin 207). Cavendish implies that, with the solid base of Sense and Reason, her theory should be widely accepted and recognized, if not as certainty, then at least as greatly probable. At the same time, she seems quite sure this will not happen: "I know very well, that my Opinions cannot be generally Received and Applauded, for as the Old Proverb says, So many Men so many Minds" ("Noble Readers"). However, Cavendish sets up Sense and Reason as more reliable judges than individual men; we are led to take for granted her authority to represent good common sense and knowledge.

While Cavendish's appeals to Sense and Reason give weight to her natural theory, they also point to a different kind of concern over the reception of her work. In 1655, her primary desire was that her work be seen as authentic; now, her concern is that it be "Received and Applauded" for its epistemic value. This is further evinced in the subtle shift in style that follows on her earlier, more drastic generic move from poetry to prose. From *Poems, and Fancies* to *Philosophicall Fancies*, she had abandoned the concept of exposing her scientific ideas purely in verse. In eliminating any mention of fancy in the title, *Philosophical and Physical Opinions* comes to abandon poetry altogether: though the first part of the 1655 edition is a reprint of *Philosophicall Fancies*, the long verse

speculation on alternate worlds is notably absent; in 1663, the text is entirely in prose.[12] When Cavendish chooses to draw inspiration from her reason rather than her fancy, she also chooses a new genre, one which requires clear sense to prevail over pleasing sound, but which also allows for repetition "to make my Readers to Remember, as also to Understand the Truth" (*PPO63*; "An Epistle to the Reader"). Over the many other prose forms she had employed in other works—allegory, aphorism, oration, dialogue—Cavendish selects the philosophical essay, a form closer to traditional scientific rhetoric. In so doing, she recognizes the social significance of genre, how it is "a social construct that regularizes communication, interaction, and relations" (Bazerman 62).[13] This treatise is still nothing like the systematic philosophy of Hobbes, but there is a concerted effort to follow a style and format that will be more readily acceptable to her readers. Immediately preceding the first chapter, she includes a lengthy preface under the similarly lengthy yet self-explanatory title, "A Preface Concerning the Rules of Art, and Explaning the Nature of Infinite, together with some other Terms, for the better Understanding of this Philosophical Work." In it, two of the problems of the earlier edition are tackled, if not altogether resolved, as she elucidates in some detail the tenets of her theory and the terminology to come. At times, her 'clarification' is of little help: for example, she tells the reader that "my meaning of Only matter is, the Infinite matter in Nature, as it is Matter, that is Considered in it Self, called Only matter, to Exclude all other Matter whatsoever" (*PPO63*; "A Preface Concerning the Rules of Art"). Once the punctuation of

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[12] See Appendix B for a detailed comparison of *Philosophicall Fancies* and the two editions of *Philosophical and Physical Opinions*.

[13] Bazerman looks more specifically at the genre of the experimental report as it develops from 1665 to 1800 in the *Philosophic Transactions of the Royal Society of London*. Even in the early years of the Royal Society, the "reportable business of natural philosophers was hardly restricted to experimenting or even theorizing" (65). Though Cavendish is not writing anything as precise as an experimental article, her scientific observations are of a kind with many of its precursors.

the sentence is conquered, one is left to wonder what "other Matter" she means to exclude; however, the very act of composing this explanatory preface illustrates greater attention to detail and method.

In 1663 she additionally describes the plainness of her writing, alluding to stylistic prescriptions popularly advocated for all natural philosophy. Thomas Sprat's is one of the best known formulations of these recommendations. In his *History of the Royal Society*, he writes of "a constant Resolution, to reject all the amplifications, digressions, and swellings of style: to return back to the primitive purity, and shortness, when men deliver'd so many *things*, almost in an equal number of *words* ... bringing all things as near the Mathematical plainness, as they can" (Sprat 113). Though Cavendish had little enthusiasm for mathematics, her words echo similar sentiments.[14] She describes her work as

> like an Unpolish'd Stone or Metall, a meer Rough-cast without any Gloss or Splendor ... It is Plain and Vulgarly Express'd, as having not so much Learning as to Puzle the Reader with Logistical, Metaphysical, Mathematical, or the Like Terms; Wherefore you shall onely find therein Plain Sense and Reason, Plainly Declared. (*PPO63*; "An Epistle to the Reader")

Her wish is to express herself fully, even if this requires repetition, while also bringing the work closer to the conventions of the New Science.

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[14] Her feelings about mathematics are ambiguous, often negative but sometimes positive. In *PPO55*, she states that "the Mathematicks brings both profit and pleasure to the life of man" ("An Epistle to the Reader, for my Book of Philosophy"). Though Cavendish had no formal training in mathematics, she does employ mathematical metaphors and allusions in her work, as discussed by Roberto Bertuol; and Stephen Clucas, "Variation, Irregularity and Probabilism."

Revisions of Science

In contrast to the prefatory material, in the first and second editions of *Philosophical and Physical Opinions* the fundamental scientific notions do not change substantially. Her opinions are instead subject to the extensive "developing, cutting, and reordering" that is brought on by a writer's revision of an existing text. Murray describes the process as if the text were a sentient being: "The writing stands apart from the writer, and the writer interacts with it, first to find out what the writing has to say, and then to help the writing say it clearly and gracefully" ("Writing as Process" 5). The first evidence of development is in the greatly expanded length of her philosophical work. Though she contends that her writing is simple and plain, Cavendish cannot claim it to be succinct. The 1655 edition is almost seven times the length of *Philosophicall Fancies*, and the 1663 edition is longer still. Both wordy editions share an almost Burtonian profusion of lists of all kinds. Often, modern readings have seen the excessive detail only as a great deal of redundancy, what Berthoff calls "the uninstructed writer's only means of emphasis" (746). Grant suggests, for example, that her "opinions may often exasperate by their silliness or their tedium."[15] However, the cataloguing of nature in both editions reflects a greater awareness of the intellectual context of her writing. In her efforts to write more conventionally about nature, Cavendish borrows from natural philosophy's sister-discipline, natural history, drawing on its tradition of classification and categorization.[16] In addition, the proliferation of lists points to new levels of cognitive processing, including experimentation with higher-order synthesis and theory

[15] Tempering this criticism, Grant follows by saying, "but much can be excused anyone who was illuminated by such ardour and capable of expressing it with such instinctive grace" (146).
[16] Natural history is understood here as "the collecting of true instances of natural things and events themselves" (Cook 400). Though his discussion focuses on medicine in the Scientific Revolution, Cook briefly examines competing opinions of natural history and natural philosophy in this time.

development. These works function at a significantly different level of understanding than her earlier natural philosophy. Gathering evidence into lists and catalogues allows Cavendish to verify the applicability and validity of self-moving matter; by extension, she also tests her skill at building a strong foundation for a cohesive theory of nature. Yet while generating these lists helps solidify her thinking about nature, indiscriminate accumulation of every plausible example still functions more like brainstorming than proof by evidence. This process continues through both editions; there is little editing of the lists from one draft to the next, and in fact the 1663 edition has more lists than the first. Moving beyond the natural historian's propensity for arbitrary collection will have to wait for a later publication.

The extensive classification of motions, figures, diseases and remedies illustrates another of the ways in which scientific understanding evolves through the composition of these texts. Cavendish experiments with both inductive and deductive techniques, and she also interjects with comments on the very processes she undertakes. According to Bloom's taxonomy, an important step in building understanding is the categorization of material, either through exemplifying or classifying. Exemplifying is deductive: starting with a general concept or principle, specific examples are drawn out. On the other hand, classification tends towards induction: by accumulation or conjunction, specific examples are recognized as illustrating a particular concept (Anderson 72). Illustrative of both inductive and deductive techniques, lists can thus be used to generate an abstract principle or to support an established one. In Cavendish's two editions, both processes are attempted. The reader can find inventories of fiery, airy, and watery motions; types of

liquid and light; forms of heat and cold; varieties of passions and thoughts; and kinds of sensory stimuli and perception. In the "physical" opinions, the humors are catalogued, as are the elements and motions from which each of the humors is derived; the 'natural maladies' of the body are enumerated and defined; many other diseases, including fevers, infections, colics, apoplexies and convulsions, are catalogued and explained; and the workings of medicines and various cures are explored. These lists at first appear to be deductive, their starting point a general statement or assumption about the structure of matter or the laws of nature. Figures are pigeonholed according to four fundamental shapes, reminiscent of the shapes of her atomic elements: circular, triangular, cubic and "Paralels" (*PPO55* 33; 100).[17] The three fundamental figures in every particular form are illustrated by examples: a man is, first, an animal (the local figure); second, made of flesh (not wood or water); and finally, specifically human flesh (not dog or bear flesh). The six "ground-motions" (33; 99) allow for the classification of a variety of "grosse exterior motions" (34) as well as the figures that these generate. Cavendish envisions a layered structure for most natural figures; for example, "first there is the figure of a man in bones ... then there is the figure of a man in flesh; thirdly there is a figure of the man in the skin, then there are many, different figures, belonging to one and the same figure" (44; 118). She goes on to list some of man's 'sub-figures':

> there is the brain, the pia mater, the dura mater, the soul, the nose, the eyes, the fore-head, the ears, the mouth, the lips, the tongue, the chin, yet all this is but a head; likewise the head, the neck, the brest, the arms, the hands, the back, the hips, the bowels, the thighes, the legs, the feet;

[17] Page numbers are given first for the 1655 edition of *Philosophical and Physical Opinions*. A second page reference after the semi-colon indicates that the same (or nearly the same) wording exists in the 1663 edition. Note that the capitalization is often different in 1663.

> besides, the bones, the nerves, the muscles, the veins, the arteries, the heart, the liver, the lights, the midrif, the bladder, the kidnies, the guts, the stomacke, the brain, the marrow, the blood, the flesh, the skin, yet all these different figurative parts make but the figure of one man. (44; 119)

The lists are not often so concentrated nor so long, but at times entire chapters are set out as an enumeration of interconnected items: types of motion and examples of each one; elemental figures and their manifestations; types of fevers and examples of their symptoms; causes of disease and their treatment.[18]

In the end, this sort of organization is neither clearly deductive, nor entirely inductive. A reader may infer the relationship between, for instance, different types of coughs, but any connection is most often the result of contiguity, not of any summing up of the general principle by the author. The systematic and coherent connections that are integral to analysis are only partially, even inadvertently, present. At times the lists have no logic at all: "gloomy" figures actually include a disparate collection of shining figures such as air, bright metals, water, and glossy-coated animals (80; 121). Cavendish is quite aware of the weaknesses of this classification project. She forges ahead in a way that evokes the process of discovery through writing in which a writer is advised "to assert whatever [he or she] can, accepting its partial and conflicting nature; and then to continue to formulate successive utterances, no matter how disorganized and rambling their sequence is. The result will be that new conceptual relationships (ideas), corresponding to the previously obscure area of conflict, will be externally formulated' (Galbraith 52).

[18] Two illustrative examples are "Of Motions" (32; 97) and "Of Apoplexies" (149; 375).

Cavendish even comments on the impossibility of exhaustive catalogues of nature. She believes there is too much variety in nature for this to be possible, because of nature's "millions of several motions" (131; 319), "infinite variety of motions" (33; 100), and "infinite sorts of figures" (40; 110). There is little tension between Cavendish's attempts to draw up lists and form categories and her insistence that the task is impossible. The contradiction is so unproblematic that it becomes part of the enumeration, as in this list of infinite 'low' motions: "Diving, dipping, mowing, reaping, or shearing, rowling, creeping, crawling, tumbling, traveling, running, and infinite the like examples may be given of the varieties of one and the same kinde of motion" (35).

Though the classification project may be impossible, the process is of value, providing a forum in which Cavendish can test and develop her knowledge. Similarly, she builds a better understanding of atomism in the very process of enumerating her reasons for rejecting it as a theory of matter. In *Poems, and Fancies*, atomism was less a philosophical conviction than a convenient vehicle for unrestrained speculation and play of images. In *Philosophicall Fancies*, Cavendish had already begun to doubt its validity, but had yet to abandon atomism's metaphorical value.[19] The 1655 edition of *Philosophical and Physical Opinions* still maintains a vestigial attachment to a particulate model, evidenced in her declaration that, at one time, she "would have turned [her] Atomes out of verse into prose, and joyned it to this book" (*PPO55*; "An Epistle to the Reader, for my Book of Philosophy"). Yet because Cavendish leads into the philosophical opinions of the first edition with "A Condemning Treatise of Atomes," the

[19] Anna Battigelli suggests in fact that although Cavendish "rejected atomism as a theory of matter in 1655, she retained it throughout her life as a metaphor for the body politic and for the mind, exploring both as troubled atomistic systems" (63).

continuing significance of atomism to her vitalist natural philosophy is often underestimated. Her apparent rejection of atomism has led many critics to segregate the earlier work in a "pre-animist" category, while conflating the 1655 and 1663 editions, with the implication that their theory is the same.[20] Sylvia Bowerbank even refers to the ideas of the second edition as only "supposedly revised" (396).

However, the "Condemning Treatise" attempts to be both a selective repudiation and a defense of atoms. Cavendish endeavors to rein in the wild particles of the atomic verses by a stricter delineation of the conditions under which atomism—and order—are possible. She wishes to retain the metaphorical impact of her atomic representations; her illustrations of elemental shape and action still make sense to her, and regardless of their potential for chaos, the individuality and active capacity of atoms continue to appeal to her. She thus maintains her "particular opinions of the figures":

> that the long atoms make air, the round water, the flat square earth; also that all the other figures are partly severed from those, also the measure, and the weight of atoms, of slime, flame, of burning, of quenching of fire, and of the several motions, compositions, and composers in their creating and dissolving of figures; also their wars and peace, their sympathies and antipathies, and many the like.

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[20] In fact, discussions of *Philosophical and Physical Opinions* often use only the 1663 edition unless making specific reference to the prefatory material. See for example Hutton, "Anne Conway, Margaret Cavendish and Seventeenth-Century Scientific Thought"; Grant; James; Sarasohn, "A Science Turned Upside Down"; and Stevenson. Blaydes differentiates between the two editions for the purposes of historical overview, but says nothing of the differences in philosophical content. In contrast, Moore's summary of Cavendish's scientific *oeuvre* uses the 1655 edition and only briefly mentions that it was "handsomely reprinted in 1663" (8). It is to be noted, however, that Cavendish later refers to *Grounds of Natural Philosophy* as the second edition of *Philosophical and Physical Opinions*, which suggests that she came to consider the 1655 and 1663 editions to be fundamentally identical.

What Cavendish can no longer accept is the mechanical definition of lifeless particles in which "infinite matter is onely a body of dust." The "wandring and confused figures" of dusty specks "blown about with winde" are socially, politically, and naturally problematic, suggesting to her only "infinite and eternal disorder." Inanimate atoms "could never produce such infinite effects; such rare compositions, such various figures, such several kindes, such constant continuance of each kinde, such exact rules, such undissolvable Laws, such fixt decrees, such order, such method, such life, such sense, such faculties, such reason, such knowledge, such power." To resolve this problem, she speculates that for matter to be made up of atoms, "every atom must be of a living substance, that is innate matter" ("A Condemning Treatise of Atomes"). The idea of individual living atoms making war on one another of their own volition is more acceptable than lifeless particles jostled around with no order or purpose. However, the subtlety of the difference undermines any sense that atomism has truly been reprieved, and in the end, Cavendish's initial attempt to narrow the scope of atomism lacks conviction.

By 1663 she is able to "give Better Reasons concerning Atoms" and explain more fully why her opinions have changed. In this time, has Cavendish come to see how much more adaptable vitalist thought is to her perception of the natural, social and political world. Her tone is no longer baffled and bewildered; instead, she claims confidently that "after I had Reasoned with my Self, I conceived that it was not probable, that the Universe and all the Creatures therein could be Created and Disposed by the Dancing and Wandering and Dusty motion of Atoms." Nominally based on her observation of natural

phenomena, her reasoning is in fact concerned with social order, to a far greater and more specific degree than in 1655. Then, she had made clear that *senseless* atoms could not combine by pure chance to form an ordered world. Now she judges that even individual *animate* atoms, each with equal power, life, knowledge, free will and liberty, would be in constant conflict: "they would hardly Agree in one Government, and as unlikely as Several Kings would Agree in one Kingdom, or rather as Men, if every one should have an Equal Power, would make a Good Government; and if it should Rest upon Consent and Agreement, like Human Government, there would be as many Alterations and Confusions of Worlds, as in Human States and Governments" ("Another Epistle to the Reader"). Simply put, atoms can't be dead, because dead things can't create an ordered living world; and atoms can't be alive and animate, because they would not cooperate to create an ordered living world.

In this more thorough denunciation of atoms, the recently re-established social order is a given that the premises of mechanism and atomism cannot properly account for. The laws of nature must first be proved in the subset of society; mechanical and atomic explanations are dismissed not because they cannot sufficiently explain natural phenomena, but because they no longer account for prevailing social and political behavior. Looking elsewhere for scientific models compatible with her social ideal, and with the eventual reality of the Restoration, Cavendish continues to elaborate a model wherein matter is imbued with harmonious vitality. Though she likes to claim that her "old opinions of atoms" have given way to "absolutly new opinions" (*PPO55*; "A Condemning Treatise of Atomes"), in their initial form, her vitalism is as much a

patchwork of various theories as were her atomic poems. She adopts only the ideas of Paracelsian vitalist theory homologous to her personal beliefs, maintaining that motion is inherent in matter, that matter is informed with rational and sensitive power, and that nature is self-knowing and perceptive, but dismissing the monist belief that matter and spirit are one and interconvertible. Like Hobbes, she rejects the idea of the incorporeal soul and also envisions thoughts as physical entities, "independent, self-moving beings engaged in a struggle, not for truth, but for representational preeminence within the kingdom or commonwealth of the brain" (Stevenson 529). The latter aspect is significantly different from the vitalists; Cavendish sees matter as often oppositional, disputatious, and even power-hungry instead of part of some happy holistic unity. The originality of her animist materialism lies in the infusion of vitalism with aspects of Hobbesian pessimism that reflect her belief in the *dis*harmony necessary in the larger harmony of all things.

With her expanded understanding of the science she explores, Cavendish also recognizes the need for clear and consistent terminology, and she begins to excise ambiguous or idiosyncratic expressions. With the exception of the material reprinted from *Philosophicall Fancies,* the very word 'atom' is almost entirely absent from the text of either edition of *Philosophical and Physical Opinions*. Where atoms are mentioned, the word means simply the tiniest, most insignificant specks of matter. For example, in arguing for the material nature of motion, Cavendish claims that it can no more be annihilated than can a figure, in which "every part and parcel, grain, and atome, remains in infinite matter" (*PPO55* 31; 96). She affirms that infinite matter "may be divided in it

self by Self-motion into Atoms," but this is only to declare that "in comparison of infinite Matter Man is but as an Atom" (*PPO63* 29). A greater obstacle to the coherence of her work is Cavendish's use of terms that, as Whitaker points out, are "neologisms whose meanings [can] only be extracted from her text with difficulty" (251): "innated" (*PPO55* 31) is used to describe the animate nature of rational and sensitive matter; "onely Matter" (30) appears to mean both 'unified' and 'fundamental' matter, with an implied contrast to particulate matter; and "transmigration" appears where either transformation or transmutation is meant. Adding to the confusion, certain basic concepts are expressed in more than one way. Having made no changes to the material from *Philosophicall Fancies*, Cavendish refers to the vital parts of matter as sensitive and rational "spirits" (12) throughout the first section of the 1655 edition, while in the newly-written sections thereafter she abandons the term for "matter" (33). Inanimate matter is variously called "immoving matter" (8), "grosse matter" (37) "dull matter" (46), or "the dull part of matter" (32).[21] In the revised work, she completely omits *Philosophicall Fancies*, appreciably normalizing the terminology, and even allotting over nine pages to definition and explanation, "for the better Understanding of this Philosophical Work" (n. pag.).

These changes point not only to a better understanding of her theory, but to Cavendish's growing awareness of how best to convey it in her writing. The organization of the two editions further illustrates this awareness. The 1655 edition, while more systematically arranged than her early work, is still a jumbled text. Its chaotic development evokes the kind of discovery through writing where a writer dives in to the

[21] A single instance is given for each of the various terms listed here, but all occur repeatedly throughout the 1655 edition.

composing process directly and allows ideas to evolve naturally (Galbraith 49). Though its meandering nature is presaged in the style of Cavendish's prefaces, in the last of the multitude of prefaces, "The Text to my Natural Sermon," she appears to set out a tentative plan of the work. However, this is presented in the vaguest of terms, declaring only that she will begin with matter and end with eternity. Further along the same page, she provides a little more detail, employing the visual format of verse for an odd and brief four-line statement that tells us only that:

> The first cause is matter.
>
> The second is Motion.
>
> The third is figure
>
> which produceth all natural effects. (*PPO55*)

Her inability to recognize the organization of her own work, even after its completion, indicates quite clearly that Cavendish entered into the composing process without formulating any real plan at all. Nor does Cavendish accomplish her plan to end with eternity: the last content chapter examines "The knowledge of diseases" (169), while the final numbered chapter, in which God is acknowledged as the source of infinite matter, is preceded by the comment that "it belongs to another book" (172).

The absence of a clear framework is partly due to Cavendish grafting new chapters onto old without any substantial revision. She uses the sequence of topics in *Philosophicall Fancies* as an initial organizational imperative, but the fragmented earlier work is a poor introduction to a theory that had evolved considerably over the two intervening years. Moreover, it creates unnecessary repetition and circuitousness:

especially in the second section (albeit the first 'new' one) of the 1655 edition, many chapters return to expand upon ideas previously presented only in brief form. After the two rambling philosophical sections enlarging the discussion of matter and motion, she proceeds with two sprawling sections of physical opinions. To link the philosophical and physical is not unusual; in this time, "physic" did not have the same meaning as "medicine," but implied an interest in nature and natural history.[22] Cavendish had written reflections on the body and its afflictions in both the atomic poems and *The Worlds Olio*, but in 1655 the discussion is far more fully-developed. In the end, the work as a whole has more structural and logical development than the scientific verses and "fancies," far though it may be from a methodical exposition of fact.

In contrast, in the 1663 *Philosophical and Physical Opinions* Cavendish literally begins anew, with a plan that echoes her theory; the very design of the text draws on its central philosophical ideas. The first three sections of the philosophical opinions open up like the nest of boxes in her atomic poems, unfolding as layered spheres that correspond to Cavendish's triumvirate of matter as well as to the three 'worlds' that most occupy her thinking: nature, society, and her own mind. Her intention is to move inward from "the Only and Infinite Matter, the Nature, Degrees, Motions, and Figures, and of Creation, or Production in general" (*PPO63* 27), to the specifics of man and then finally to the central core of the human psyche. The opening section begins at the outer sphere of matter, the largest 'box' that forms the base of the hierarchy: the intermixture of inanimate matter with its two animate components. Here Cavendish explains unified, infinite and eternal matter and motion, its infinite variety, its infinite (and thus unknowable) knowledge, and

[22] On the seventeenth-century meaning of 'physic', see Cook, esp. 398-406.

the infinite process of creation and production in nature. In other words, this is a general discussion of the entire natural universe. The middle degree of sensitive animate matter is quite literally 'characterized' in the second part of the treatise, which moves inwards to one particular creation: man. Cavendish's abiding concern for society and polity is evoked here. Finally, the third section, on human thought and knowledge, illustrates the most refined rational aspect of matter and this shrinks the focus to the paradoxically limitless internal world of Cavendish's own mind.[23]

At this point, the organizational momentum seems lost as the text meanders through various disconnected topics: equality, operation, fortune, chance, perpetual motion, time, incorporality, and divisibility. One might argue that the fragmentation here recreates the fertile but unsystematic mind that created *Poems, and Fancies* not so long before. However, some of these topics share an undercurrent that is related to human knowledge, albeit negatively: there is always infinite potential for confusion and misunderstanding. Man "is deceived" by fortune (*PPO63* 72); "Chances" are simply "Visible Effects" of causes we cannot comprehend (73); and some theories of division are so difficult that "it is beyond [her] Capacity to understand" (87). Cavendish reawakens her skepticism, though without engaging in any systematic epistemological reflection; as in 1655, her thoughts on this subject are scattered throughout the text. Beyond the third section, there appears to be a loss of editorial steam. The rest of the

[23] Whitaker proposes a very different interpretation of the arrangement of the text. She suggests that Cavendish had previously followed "the conventional ordering of Creation, proceeding from its lowest to its highest forms" (252), while in 1663, by placing creatures and mankind earlier in the treatise, Cavendish rejects the concept of man's supremacy. However, neither reading seems entirely persuasive. In 1655, the point is undermined by the inclusion of *Philosophicall Fancies* at the start of the treatise, in which mankind is discussed. Moreover, both editions end with sections on mankind, although these are more specifically on human ailments.

document is not very different from 1655; the editing process from this point on consists far more in revision than in rewriting. The remaining philosophical sections correspond more closely to the earlier edition, in concept if not in exact content. Part 4, on motion, is largely identical to the second section of the 1655 edition. In the fifth part, Cavendish makes substantial changes to the third section of the 1655 edition, but the thrust is still a categorization of elements and their motions. The original physical opinions remain virtually unchanged in the final two sections, though with considerable expansion and added detail.

The Language of Universal Balance

The gradual though incomplete development of an organizational superstructure is importantly mirrored in the evolution of the central figurative constructions that give force and structure to Cavendish's theory. The two editions of *Philosophical and Physical Opinions* primarily explore the symbol of the circle, in its multiple and often complex manifestations. As Bertuol explains, the circle is a manageable and beautiful abstraction. It is "the superordinate term for all round objects in reality" and its shape conveys the sense of the "harmonious whole" (31). It can evoke balance, since all points are equidistant from its center; it may suggest equality—even democracy—since no point has primacy. There are implications of both contrariety and cooperation: each point is diametrically opposed to another on the circumference but this separation incorporates the bond of a shared center and radius. Associating motion with the points on the circle generates a cycle, an image especially befitting representations of nature. Her process of making meaning is demonstrated further by tracing Cavendish's use of the circle image.

In 1655, through an accumulation of instances of circularity in nature, she once again comes to realize the significance of her rhetorical choices, eventually seeing in the circle the simplest manifestation of a more complex and dynamic cyclical metaphor. By 1663, she presents a more consistent and sustained vision of matter and motion in which the circle is used subtly and pervasively to represent universal balance, unity and harmony.

In addition, the changing ways that circularity is invoked also reflect a changing social perception. Where *Poems, and Fancies* is dominated by the imagery of war—arrows of fire, rebel atoms, watery cannon shot—in *Philosophicall Fancies*, Cavendish had already begun to 'marshal' her rhetorical troops into less bellicose representations that fit a reformed world view. The first edition of *Philosophical and Physical Opinions* identifies circular motions and forms without making any overt connection to the civil war, but with the shift of focus to cyclical harmony, the second edition more clearly presents the socio-political vision underlying her natural theory. It is a vision less hopeful than might be assumed given the restoration of the monarchy and the repeal of William and Margaret's exile. The harmony she finds in the greater natural world does not imply ultimate hope for peace and prosperity in the lesser social domain; rather, the inevitability of discord and division in society is a sign that disorder lurks in every part of matter, as a necessary diametric opposite to order and method.

Only the seeds of these ideas are present in 1655. Initially, the reader is bombarded with natural evidence of circularity, the weight of examples all that is provided to prove its importance. Motion is envisioned as acting within a circle:

attraction, retention and contraction draw in from the circumference, dilation and expulsion move out from the center, and digestion moves both ways. Heat and cold are then defined by their 'circular' dilation or contraction. Actions once associated with war are reinterpreted: the quenching of fire, illustrated in *Poems, and Fancies* as occurring when "Atomes round the sharp put to rout" (27) is now merely water's spherical form blunting and dispersing the fiery points. The circle is the basic form linked with metals as well as all things related to water. The latter is discussed at great length. Different forms of water are associated, sometimes obscurely, with circular figures: fresh water has a simple round form while salt water has a pointed form perhaps meant to evoke the angular construction of a (nearly circular) many-sided polygon. Even when externally altered, watery figures remain internally circular: hail is a contraction of water's circular form to a lump, snow a change to a triangular form, ice a square or cubic form, and frost a crackling or "surfling" form (*PPO55* 60). Anything that is "of the nature of water, as also oyls, vitrals, strong-waters, all juices from fruits, herbs, or the like, or any thing that is liquid and wet" (57) is essentially an alteration on a circular shape. Natural phenomena on a larger scale also involve circularity: the planets move in circular orbits due to their corresponding form; the circular nature of water "in [her] opinion is the reason of the ebbing and flowing of tides" (87); thunder and lightning are the result of circular shapes overextended to their breaking point (92); and as in *Poems, and Fancies*, the roar of wind and sea is the striking of hollow spheres of moisture.

Before the end of 1655's philosophical sections Cavendish tempers her unbridled enthusiasm and declares the limitations and internal inconsistencies of the circular model.

The unifying potential of the circle, she admits, is not necessarily unique: "as this world is of a spherical figure, so other worlds may be of other figures ... so may worlds differ for all we know, and if we should guesse by the several changse [sic], and variety in nature, it is very probable that it is so" (*PPO55* 97). In the physical opinions, the circle image is almost absent, with the exception of references to the arched shape of the skull, conducive to motions which amplify sound, clarify vision, or intensify taste and smell; and to the circular openings—pores, eyes, ears, nostrils, and mouth—which allow sense messages to enter the body. She does not abandon the imagery altogether, but reinterprets it to allow for a dynamic element: instead of reiterating examples of circularity, the physical opinions concentrate on notions of interaction and interchange that result in the physical cycles of health and harmony, illness and chaos. Even in *Philosophicall Fancies*, Cavendish had defined life and knowledge as changes in sensitive and rational motion that follow a perpetual cycle of growth and decay, and in 1655, the physical opinions reiterate this interaction of rational and sensitive faculties in the body. Numerous examples show how actions of the mind affect the body, and vice versa. Prosaically, she points out that an upset stomach is often accompanied by headache. Elsewhere, she claims that disorderly passions can affect both sense and brain; "the minde feeds as greatly on thoughts, as a hungry stomacke doth upon meat" (110). Conversely, the perfect interaction of rational and sensitive motions can produce illuminating dreams. The final section makes it clear that illness is the imbalance and chaos that is one half of the cycle that eventually gives way to restored harmony and health; moreover, "all diseases are cured by contrary motions" (162), motions, we recall, which she envisions working within a metaphorical circle.

The numerous examples of circular form and motion put forth in the first edition function heuristically to induce Cavendish's recognition of the common thread of balanced and harmonious interconnection. The circle, the natural cycle, and the notions of balance and harmony are all present in her first attempt, but it is the later edition that develops these ideas in a more comprehensive way. Overall, there is less figurative language in the 1663 edition; it is no longer necessary for Cavendish to point out every manifestation of the circle or cycle in nature, nor to draw on endless analogies of circular form or motion. She moves beyond simple recognition and enumeration of the static visual metaphor to the wider use of cyclical patterns in the organization and content of the text. The ideas of balance and harmony are introduced openly, from Cavendish's first revised definitions of matter. She states that any division in nature is eventually resolved, since "the Unity of the nature of Only and Infinite matter, maketh Concord out of Discord" (*PPO63* 11). Motion, "the Creator of Figures, doth make Warr," but "the Infinite and Eternal matter is Eternally in Peace" (10). Our universe, made of "One only Matter" and "One only Motion" (4), contains an infinity of contrasts—life and death, creation and dissolution, war and peace, dark and light—yet always finds balance in cycling through these contrasts: "one Creature [is] produced from another, so that the Dissolving of one or more Creatures or Figures is the way of the Creation of one or more Creatures or Figures, and must of necessity be so" (20). In the section on man, Cavendish follows the life cycle from gestation through birth, growth, decay and death. Chapters on the mind draw a parallel between the life cycle and the growth and decay of knowledge, and a link is made between the balanced interaction of body and mind, sense and reason.

When Cavendish calls on other images, such as the construction and destruction of a house, the ebb and flow of fluids, and the give and take of economic trade, they are interpreted in ways that emphasize unity, reciprocal interaction and balance. The analogy of construction is central to the initial discussion of animal, and more specifically human, creation and development. Though the construction of the body, or "Animal House" (*PPO63* 30), mainly involves sensitive matter working on its inanimate 'supplies', rational matter is nonetheless involved, "although not in the Building or Labouring, yet in the Ordering, Contrivance, and Designing like as Surveyers" (31). In the development of the mind, rational and sensitive matter are later described as "Fellow-Labourers that joyn in one Work, or as Fellow-Servants in one House" (44). This architectural image is not only illustrative and simple, but it also assumes the simultaneous hierarchy and cooperation of architect, laborer, and material. In addition, the new analogy of economic traffic and trade helps to highlight the interconnection of mind and body. Sense passages are highways on which various goods are transported in the interest of "Home-profit, which is Nourishment, Health, and Peace" (49). Expulsive motions in the body "[carry] out all Unusefull, Unprofitable and Hurtfull matter or substance, which is brought into the Figure" (34). Traffic back and forth between sense and reason is ongoing and the profit of this mental or bodily industry is reasoning and knowledge, love and desire, discovery and discourse, fighting and pain (50). The ebb and flow of blood in our body's closed circulation is also used to illustrate the balanced distribution of rational and sensitive matter: just as there is not always the same amount of blood in every part of the body, so are there not always the same quantities of animate matter in all parts, but any disproportion is naturally resolved over time.

In the boundless and unwieldy sphere of human thought, which Cavendish undertakes to explore in the third part of the 1663 edition, the diction is marked by allusions to interconnection and imitation rather than by the concrete imagery used elsewhere. She initially describes a fragmentation of human knowledge that appears difficult to reconcile with notions of unity, harmony, and balance. However, though she claims that "all Knowledge, both Sensitive and Rational is divided into Parts and Particles" (*PPO63* 64), Cavendish finds that segregation, independent action, and conflict nonetheless add to the complex interdependence of sensitive and rational matter. The various sense organs each have their own discrete ways of taking in information, which explains how "Sensitive knowledge lies in Parts" (64); similarly, "Rational Knowledge is confined in Parts ... for the Rational motions in one Figure are ignorant of the Rational motions in an other Figure" (68). As isolated as their knowledge may be, rational and sensitive aspects (along with the inanimate) are always linked in every part of matter, and there is "a strong Sympathetical Agreement, and Natural Unity between the Rational and Sensitive matter and motions in one and the same Figure and Creature" (75). The animate parts can act independently of one another, but there is essential similarity; for example, though imagination is a product of the rational matter acting alone, "it doth often move its Self, and Motion like to the Sensitive Objects" (62). Such imitation is beneficial. Rational motions will mimic the sensitive and then improve upon the products, "by which the Rational Animate matter and motions discover new Inventions, and when they have discovered or made new Inventions, those Motions declare them to the Sensitive motions, and the Sensitive motions put them into Arts" (64). Not all interaction is so positive; the rational and sensitive may also "intangle each other" and cause disputation (65) or "move

mixtly" and cause mistakes (66). In the end, however, the relationship between rational and sensitive matter is reciprocal and mutually beneficial: knowledge is created "by the assistance of each Part and Party" (77), wherein "the Sense and Reason doth Inform and Reform each other" (85). Like natural creatures, knowledge moreover follows a cycle of increase and decay; the development of "Strong and Long-lived Opinions, Subtil and Ingenious Inventions, Happy and Profitable Effects, and probable Conjectures, and Absolute truths" is inevitably accompanied by "obscurity of Particular Knowledges of particular Causes, Things, Creatures and Truths" (77).

Though the remaining philosophical opinions resemble the first edition more closely and lack any overriding scheme, the central notions of cycles, balance and harmony are a unifying feature, and additionally, the fragmentation of the next two parts of the treatise is diminished by virtue of following on the nested structure of the first three sections. The classification of motion and the importance of the circle as a fundamental shape take on new coherence, chapters on metamorphosis add evidence of natural cycles, and new discussions of ascent and descent further illustrate reciprocity. The fifth part starts with an assertion of the natural proportion of the elements in our world and then reorders the discussion in such a way that the reader knows what to expect from the start—or at least knows not to expect too much, since "there is so much Variety in every Kind and every Sort, and in one and the same Kind, and one and the same Sort, and in one and the same Creature, as it is impossible for any one Creature to describe the Infinite Varieties in Nature" (*PPO63* 152). In the final chapters of this section, Cavendish reiterates the "Intermixt" nature of all creatures (242) and follows

with a description "Of the Temper of the Four Seasons of the Year, as Spring, Summer, Autumn, and Winter" (243), ending the philosophical opinions with a final powerful image of the infinitely recurring cycles of time and nature.

By the end of her revised work, through both the language and structure of the philosophical opinions, Cavendish comes to convey a fundamental belief in the unity of self-moving matter, the complementarity of sympathetic and antipathetic motions, and the interdependence of mind and body. Yet she also shows her reader that discord and division are perpetual, even necessary: "the Infinite Compositions do Equalize or make an Unity with Infinite Divisions, for one Infinite doth Counterpoise an other Infinite, which makes Order and Method in Infinite Nature" (*PPO63* 88). It is in the physical opinions that we find the greatest emphasis on the negative side of balance and harmony—the discord, difficulty and disagreement in matter and motions that are as everpresent as cooperation and sympathetic action. This is manifested most clearly in the war imagery that continues to characterize the physical opinions. The body, a microcosm of society, is described as a war zone in which struggles for absolute power rage at almost all times. Sickness frequently afflicts the body in the form of "mutinous and rebellious humours, or the foreign enemy, as surfets, and the like"; these rebels and attackers must be "beaten out, killed, or taken prisoners" (*PPO55* 128; 308).[24] In the conflict between disordered animate matter and regular animate matter, "according as each party gets the better, the body is better or worse, and according as the siege continues, the body is sick, and according as the victory is lost or won, is life or death" (140; 338). The battle imagery is pervasive. The irregular motions of madness are an

[24] In *PPO63*, Cavendish uses "Cast out" instead of "beaten out".

army that advances with some troops far ahead of others. Diseases of the head are caused in the stomach, which "begins the war, sending up such an army of ill vapors, as many times they do not onely disorder the head, but totally ruinate it" (154; 392). Malignant infections are like "a foraign enemy, which enters into a peaceable country, which not onely disorders it, but makes havock and waste"; when bred in the body, "it is like civil war, where uproars are raised, and outrages are done, by inbred corrupt humors" (144; 346). An epileptic seizure is the body's struggle, like "a loyal people that would defend or release their natural and true born king, from being prisoner to a foraign enemy" (151; 379). The internal discord that can arise in the mind is also envisioned as civil war. When the senses rebel, "it is with the Animate Matter and motions as it is with Governours and Citizens, or Commons" (*PPO63* 278): the rational government is "so Disordered ... as it can neither Direct Prudently, nor Advise Subtilly, nor Order Methodically" (279).

These examples of the embattled body are followed, in both editions, by the methods that reinstate order to the body: purges, drugs, and cordials that "indeavour to Compose, Unite, and Strengthen the several Disordered, Dissevered, and Weakened Parts" (*PPO63* 426). There is hope for recovery. But just as often, medicines cause other problems and "turn from being assisting friends to assaulting enemies" (*PPO55* 162; 425). Moreover, in 1663 Cavendish adds the description of seasonal diseases, which imply a cyclical pattern in which illnesses pass only to be replaced by new ones.[25] Good health—and social order—require the proper balance and proportion of all things, but ultimately, all that is possible is the perpetual and irresolvable coexistence of regular and

[25] These first appear in *The Worlds Olio* 184-88. In a similar vein, the stages of ague are compared to the seasons: first is winter (cold and dry contracting motions), then spring (shaking, expulsive motions), then summer (hot and dry digestive motions), then summer/fall (sweating, dilative motions) (*PPO63* 354-55).

irregular motions, of order and chaos, of knowledge and ignorance. Neither a material hierarchy of rational, sensitive and inanimate matter, nor a restored political hierarchy can guarantee harmony; rather, Cavendish concludes that, as all matter and motion stem from God, "an infinite Deity" at the center of infinite moving matter, who "orders and disposes of all natures works" (172; 454), mankind needs to "seek no more, but in his greatness trust" (173; 455).

Following such an extensive and complex discussion of many issues, this conclusion, unaltered in the eight years between publications, may seem dissatisfying. Odder still are the final pages by William Cavendish, expounding in six pages the grounds of natural philosophy to which his wife has devoted over four hundred and fifty. At first glance, the blithe declaration that he means to "Play at this Philosophical Game" (*PPO63* 459) appears to demean her work, almost implying that what she has devoted years to completing could be done just as well in a few hours. Yet the image is more appropriate than it seems. The chaotic play of ideas and images in her early work is what allowed her to formulate her own natural theory. To Cavendish, the search for knowledge has always been more of an ongoing game than a purposeful quest. The 'game' can be quite practical, since in the search for absolute knowledge mankind gains experience and "[makes] use of our acquaintance [learning] to our own benefit" (*PPO55* 41; 112). Moreover, the outcome can be fortuitous, for even if "many went about to finde that which can never be found (as they said natural Philosophy is) yet they might finde in the search that they did not expect, which might prove very beneficial to them" (*PPO55* 53). Cavendish advises a combination of diffident objectivity and dedicated interest, searching

for knowledge without overestimating the value of what we discover. After all, she declares, "this Question of the Designs, Causes and Reasons ... Human sense and reason may guess at them, and may probably and happily light or chance on the Right and Truth of some of them, but Human sense and reason can never attain to a Perfect knowledge" (*PPO63* 131). We are nothing but figures of Nature that have a limited knowledge of other figures, for "as our knowledge comes slow, and in parts, and pieces, so we know but parts and pieces of every particular thing" (67; 192).

Underpinning her claims of man's intellectual limitations is implicit criticism, and in her two subsequent works this develops into a more specific critique of natural philosophers. Already in 1663 there is some evidence of this in the prefaces and in sporadic comments within the text. However, Cavendish has long been critical of man, who "thinks himself to have the Supreme knowledge," yet she also accepts this as inevitable: "he can but think so, for he doth not absolutely know it, for thought is not an absolute knowledge but a suppositive knowledge" (*PPO55* 40).[26] Both editions end showing how man's arrogance prevents him from recognizing the essential balance of the universe:

> Self love doth make him seek to finde, if he
> Came from, or shall last to eternity;
> But motion being slow, makes knowledge weak,
> And then his thoughts, 'gainst ignorance doth beat,
> As fluid waters 'gainst hard rocks do flow,
> Break their soft streams, & so they backward go:

[26] There is a similar discussion with quite different phrasing in *PPO63* (111-12).

Just so do thoughts, & then they backward slide,

Unto the place, where first they did abide;

And there in gentle murmurs, do complain,

That all their care and labour is in vain. (173; 455)

The ebb and flow of knowledge also means to Cavendish that there is no end to the process of thinking and writing. In the first edition of *Philosophical and Physical Opinions*, she sets out to justify a theory that is not yet fully developed; in elaborating the theory, she comes to see its flaws and modify her course. After editing, explaining, rearranging, organizing, and rewording, she tests the theory again. Through the medium of increasingly well-sustained analogies and metaphors, the images of harmony and balance are more consistently explored and presented, but the 1663 edition of *Philosophical and Physical Opinions* is still a draft version. Cavendish's thoughts flow on, though along a slightly different channel. Her next two works, *Philosophical Letters* and *Observations Upon Experimental Philosophy*, set her ideas squarely against those of other natural philosophers. She moves beyond personal knowledge-making to an active search for wider social acceptance for both her ideas and her right to assert them.

CHAPTER 3: "my Brain was like an University"[1]

Philosophical Letters and *Observations Upon Experimental Philosophy*

By 1663 Cavendish had had many years to reflect on her natural theory and, after 1661, a great deal more time to devote to her writing. She and her husband had chosen to live quietly at Welbeck, their country home in Nottingham, where Cavendish was able to devote much of her time to her writing. This is borne out by her prolific production in these years: *Playes* and *Orations* were published in 1662; the edited *Philosophical and Physical Opinions* in 1663; *Sociable Letters* and *Philosophical Letters* in 1664; and *Observations Upon Experimental Philosophy* and *Blazing World* by the end of 1666.[2] In this time, she also embarked upon a course of study in natural philosophy that included reading works by Hobbes, Descartes, Henry More, Jean Baptiste Van Helmont, Charleton, and Harvey. In addition, by 1666 she had read works by Robert Boyle, Henry Power, and Robert Hooke, and Thomas Stanley's *The History of Philosophy*, which summarizes the works of ancient philosophers. This is a radical change of direction for a writer who has frequently (and proudly) used her lack of formal education as a badge of honor.[3] Cavendish's new interest in reading in this time is a manifestation of her increasing willingness to look to outside sources for meaning and understanding. At the same time, it points to her growing belief in the epistemic value of her opinions and, correspondingly, her conviction that her voice should be heard. She brings no radical changes to her vitalist theory of nature in the two philosophical works of this period.

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[1] *PPO63*; "An Epistle to the Reader."
[2] Her plays were composed while in exile in Antwerp; once back in England, Cavendish made new copies, presumably edited and corrected, and only then sent the work to be published (Whitaker 243).
[3] See for example *P&F*, "To Naturall Philosophers"; and *PPO55*, "An Epilogue to my Philosophical Opinions." For further discussion of Cavendish's claims of ignorance, see Scott-Douglass 38-40.

Instead, *Philosophical Letters* and *Observations Upon Experimental Philosophy* summarize the strengths and weaknesses of established opinions and methods and consequently validate her own project. These texts are characterized by their wide-ranging engagement: the natural philosopher's wrestling with her own ideas and those of others; the writer's interaction with her earlier texts and the style of her peers; and the more personal communication of the author with her readers, imaginary and real, past and present.

In these two works, the scope of Cavendish's research is vast. She takes on the ambitious task of evaluating important thinkers of her generation and the even more colossal mission of refuting the experimental methods that still now dominate scientific inquiry.[4] Her first reaction is to question and reevaluate her ideas and revise her texts, but soon she turns to the analysis and critique of others. Both *Philosophical Letters* and *Observations Upon Experimental Philosophy* function as reviews of the literature pertinent to her natural philosophy: they examine the methodologies and approaches of other philosophers, identify controversies and potential problem areas, and thus provide an intellectual context for Cavendish's theory of matter. A certain amount of objective evaluation is necessary to formulate an understanding of the works she reads and to situate her own ideas in the scientific discourse of the day; however, Cavendish combines insightful criticism with contentious judgment that threatens to alienate her peers. Additionally, these works demonstrate a pervasive self-awareness. To negotiate their reception, Cavendish uses linguistic techniques that create a bond with her various

[4] The latter is perhaps only colossal in retrospect, since experimentalism had yet to become the primary and uncontestable scientific philosophy.

readers while at the same time establishing a distance that keeps her isolated and quite literally eccentric. In *Philosophical and Physical Opinions*, Cavendish had come to identify a coexistence and simultaneity of opposites in the universe. In their purpose, structure, content and language, the two texts examined in this chapter further reflect the contraries in Nature by encompassing both her desire to be included in the discourse of science and her wish to establish herself as an acknowledged authority.

A great variety of topics are broached in the nearly nine hundred pages of these two documents, but Cavendish gives the most attention to the broad subject areas of motion, perception, experimentalism, and immaterialism. *Philosophical Letters* is premised on a female correspondent's request for her more learned friend to comment on the theories of four famous men and to explain her theory of matter and motion. Cavendish's epistles examine and reject the ideas of various natural philosophers, but most notably Hobbes, Descartes, Henry More and Van Helmont. The first set of letters examines motion and perception as described by Hobbes in *Leviathan* and *Elements of Philosophy*, and Descartes in *Discourse on Motion* and *Discourse on Method.* Their works become a base from which to reaffirm self-moving matter and explain her theory of perception by patterning. She also responds to questions from her correspondent on topics such as rarity, density, breaking hard objects, invisible creatures, artificial life, and indivisibility. The second section examines Cambridge Platonist Henry More's *Antidote against Atheisme* and *Of the Immortality of the Soul.* Cavendish argues in favor of self-moving matter, which More's work tries to debunk, and against immaterial spirits and all they imply. She also briefly examines and rejects More's idea of perception, which, like

Hobbes' and Descartes', depends on force or pressure. The third group of letters examines three main areas of Van Helmont's esoteric work, *Oriatrike or Physick Refined*: his concept of matter, his concept of the soul, and his medical theory. Van Helmont's theories depend on a mix of experimental and supernatural proof, neither of which Cavendish believes to be valid. The final section of *Philosophical Letters* is a piecemeal commentary on various philosophers which examines Aristotle and the nature of fire; Harvey and concepts of generation; Galileo and circular motion, collision and pendulums; Charleton on atoms and the vacuum; Huygens on Rupert's drops; and Boyle's ingenious experiments. The range of topics is extraordinary, from inanimate matter and minima to the reason why kissing is pleasant; predestination and free will to the effect of a basilisk's gaze; types of respiration to the optimal length of a gun barrel. In the final letters in this collection, Cavendish responds to questions from her correspondent, in the process clarifying topics from her own *Philosophical and Physical Opinions* and reiterating her theories.

Published two years later, *Observations Upon Experimental Philosophy* is more focused. It is in an open and sometimes scathing critique of experimental science that targets in particular Robert Hooke's and Henry Power's work in microscopy. Her concrete discussion of specific microscopic observations inspires more abstract reflections on perception and the epistemic value of experimental philosophy, and she also comments on the nature of knowledge in general. The treatise is broken into three parts. The first works through the microscopic observations of Hooke and Power and the many experiments of Boyle on color, heat, cold, water pumps, and air pumps; she ends

with a summary of her own theory of matter and perception. Following this are "Further Observations,"[5] which include reflections on art, knowledge, the soul, chemistry and medicine. The final section contains only six chapters that systematically run through opinions of some ancient philosophers: Thales; Plato; Pythagoras; Epicurus; Aristotle; and the Sceptics, Heraclitus, Democritus and Protagoras.

The Review of Literature

The enormous breadth of information in these texts reflects a new determination on Cavendish's part. She had long maintained her compulsion to write; now we see a sustained drive to read. To some extent, it is the greater availability of "scientific" texts that makes this possible: the 1660 establishment of the Royal Society in London led to an increase in philosophical works written in English or translated from the Latin; furthermore, with the restoration of the family income, Cavendish had the means to purchase many of these. Whitaker suggests in fact that in 1664 the family ordered what might well have amounted to two hundred volumes from a bookseller in London (255n7). In studying the work of other natural philosophers and intellectuals, Cavendish embarked upon a course of information-gathering that was vital in shaping her philosophical writing in this period. She became subject to what Murray calls the forces of collecting, "the gathering of contradictory and unpredictable information which will force old meanings to adapt and new ones to be constructed" ("Writing as Process" 9). Consequently, the ambitious reading program initiated a revision process more intricate and complicated than that which had made the second edition of *Philosophical and Physical Opinions*

[5] The full title is "Further Observations upon Experimental Philosophy, Reflecting withal upon some Principal Subjects in Contemplative Philosophy" (*OEP* 195).

"more Intelligible for [her] Readers" (*PPO63*; "Another Epistle to the Reader"). She was inspired to thoroughly re-evaluate the clarity of her writing and the consistency of her views, but also to critically assess the writing and ideas of other philosophers: her reading motivated Cavendish to produce a kind of precursor to today's academic literature review.

However, she was also made more aware of her own failings, which rekindled some of the authorial anxiety evident in early works such as *Philosophicall Fancies* and the first edition of *Philosophical and Physical Opinions*. Cavendish recognizes her ignorance of other texts as a fundamental flaw. In *Philosophical Letters*, she admits having begun to write the details of her philosophical system too early, "so early, that I had not liv'd so long as to be able to read many Authors" ("A Preface to the Reader"). The point is reiterated at the start of *Observations Upon Experimental Philosophy*:

> I do ingenuously confess, that both for want of learning and reading philosophical authors, I have not expressed myself in my philosophical works, especially in my *Philosophical and Physical Opinions*, so clearly and plainly as I might have done, had I the assistance of art, and the practice of reading other authors. (11; "To the Reader")[6]

Her anxiety is increased by her struggles to decipher the difficult texts she has chosen to study. She tells the reader that "when I began to read philosophical works of other authors, I was so troubled with their hard words and expressions at first, that had they not been explained to me, and had I not found out some of them by the context and

[6] Though O'Neill's edition of *Observations Upon Experimental Philosophy* is paginated continuously, I will also provide the titles of prefatory material where appropriate.

connexion of the sense, I should have been far enough to seek" (11). Elsewhere she confesses "that since I have read the works of these learned men, I understand the names and terms of Art a little better then I did before; but it is not so much as to make me a Scholar" (*PL*; "A Preface to the Reader"). Yet ultimately her reading did not discourage Cavendish. She is confident enough to advise her readers to go back to *Philosophical and Physical Opinions*, "wherein is contained the Ground of my Opinions" (*PL*; "A Preface to the Reader"), and later adds that "I desire you to join my *Philosophical Letters*, and these *Observations* to them, which will serve as commentaries to explain what may seem obscure" (*OEP* 13; "To the Reader").

The intricacies of her analysis and evaluation are illuminated by drawing parallels with the modern-day literature review. A literature review accounts for the research and scholarship on a particular topic in forms as simple as a briefly-annotated bibliography or as complex as an integrated summary, analysis, and evaluation of primary sources. As graduate students use it, it is a way of showing an understanding of the significant ideas, theories, and controversies in one's field; of determining their application to one's own field of interest; of giving an evaluation of their accuracy and pertinence; and eventually, of forging a place for one's original research and ideas.[7] The essential elements of the review of literature—wide but focused reading, synthesis of crucial ideas, and evaluation of methods and conclusions—are all present in both *Philosophical Letters* and *Observations Upon Experimental Philosophy*. As she sought to absorb her reading, Cavendish had not only to discover meaning in the work of others, but integrate this new

[7] These defining aspects of the literature review can be found in academic writing guides as well as on most college and university websites.

knowledge with her own and so continue to discover meaning and coherence in her own texts. Moreover, this process would have been repeated each time new ideas were encountered, each time a new text was engaged. The difficulty of these tasks requires higher cognitive skills, and the processes of classifying, categorizing, and exemplifying that were so evident in *Philosophical and Physical Opinions* give way in *Philosophical Letters* and *Observations Upon Experimental Philosophy* to the more complex analytic processes of discrimination, integration, and deconstruction,[8] as well as the evaluative activities of judgment and critique.

Darcy Haag Granello draws a direct link between the literature review and Bloom's taxonomic levels in ways that resonate strongly with both of Cavendish's texts. Seeking to help graduate students improve the cognitive complexity of their writing, Granello suggests categorizing literature reviews based on their knowledge content and written format. Reviews are situated on a spectrum ranging from a cognitively immature list of authors and their ideas (corresponding to the *Knowledge* category) through the more complex thematic study of theories and their specific significance to a project (corresponding to *Evaluation*).[9] Granello's evaluative criteria offer a productive way of framing Cavendish's new approach in these works of natural philosophy. Like the graduate student, Cavendish uses *Philosophical Letters* and *Observations Upon Experimental Philosophy* to show her newfound knowledge of key issues relating to her

[8] These three are alternate terms (in noun form) for the subcategories of *Analyze*: Differentiating (4.1), Organizing (4.2) and Attributing (4.3). See Appendix A, Table 2.

[9] Though neither Bloom's categories nor the formal review of literature existed in her day, situating Cavendish's work along this spectrum is not entirely anachronistic. In *Observations Upon Experimental Philosophy*, she compares herself to "a young student, when first he comes to the university" and begins to prepare "to be master of arts" (12; "To the Reader"). In *PPO63*, Cavendish also describes her brain as "an University, Senate, or Council-Chamber" ("An Epistle to the Reader").

area of interest. Faced with a wide range of philosophical opinions, experimental accounts, and speculative treatises, she balances the potential chaos of an indiscriminate accumulation of information by reading both critically and selectively. Her central concern is the justification of her animist theory and in particular, questions of motion, perception, immaterialism and experimentalism. Therefore, she narrows the field of study, asserting that she "shall onely pick out the ground Opinions of the aforementioned Authors, and those which do directly dissent from [hers]" (*PL* 3). Arriving for example at sections of Hobbes' *Leviathan* which concern politics or geometry, she simply stops reading: "For ... being no Scholar, I shall not trouble myself withal" (47). Similarly, she freely admits that from Descartes, "I intend to pick out onely those discourses which I like best" (97). There are practical reasons for this selectivity: she declares that "neither the strength of my Body, nor of my understanding, or wit, is able to mark every line, or every word of their works, and to argue upon them" (3). Thus, she differentiates relevant from irrelevant information and ignores many points outside the scope of her particular topic. Similarly, in *Observations Upon Experimental Philosophy* she states, "I have taken upon me in this present work, to make some reflexions also upon some of our modern experimental and dioptrical writers"; her plan is to limit the defense of her speculative natural philosophy largely to arguments against the growing popularity of experimentation (10; "The Preface to the Ensuing Treatise"). Though her work continues to cover a great many topics, Cavendish clearly recognizes the need for focus in her reading and her responses.

Nevertheless, Cavendish has a great deal of new information to process, integrate, and articulate in some lucid form. To organize an analytical review of her reading, she begins to build systematic and coherent links among often disparate pieces of information (Anderson 81). Murray suggests that there is a point in the writing process where "[the] volume of material we gather—consciously and subconsciously—becomes so immense and is so diverse it demands *connecting*" ("Writing as Process" 8). Cavendish's engagement with so many diverse texts and ideas signals such connecting, a multifaceted activity which involves selecting significant information, identifying links to prior knowledge, discovering patterns, and consequently building meaning. Connecting can also highlight contradictions that need to be resolved and can lead a writer to seek out new information, and in this way it turns back onto the reading process that initiates it. The reading that is re-initiated need not be of new material; equally important is re-reading, both of source material and one's own writing. The intertwined processes of connecting and re-reading stimulate evaluative revision, again, both of the source material and one's own writing. As writers "become more critical, more orderly" ("Writing as Process" 11), they revise their texts and ideas for clarity; however, in a review of literature, judgment is also turned outward in order to formulate "objective critiques of the quality of the source information" (Granello 299). Cavendish's work includes both objective self-criticism and, at least in intention, unbiased assessments of other philosophers. In *Philosophical Letters*, she is careful to suggest that what appear to be attacks on her peers are merely points of friendly debate: "although I dissent from their opinions, yet doth not this take off the least of the respect and esteem I have of their Merits and Works" ("To His Excellency the Lord Marquis of Newcastle"). Similarly, in

Observations Upon Experimental Philosophy she assures the reader that she "[opposes] so many eminent and ingenious writers ... not out of a contradicting or wrangling nature, but out of an endeavour to find out truth" (9; "The Preface to the Ensuing Treatise").

While *Philosophical Letters* and *Observations Upon Experimental Philosophy* both employ techniques associated with a literature review, neither follows a format that Granello associates with the most cognitively complex literature reviews. *Philosophical Letters* is set out as a systematic analysis by author; there are direct and explicit links to Cavendish's particular concerns and she limits the parts that she is willing to comment upon, but the overarching structure seems to be imposed by the sources Cavendish happens to have read and not by her own thematic or topical interests. Under Granello's taxonomy, this suggests less complexity than the literature review arranged by theme, for "[sequential] organization represents a failure to accomplish synthesis" (298). The end result is a series of specific topics each associated with specific authors: Hobbes and Descartes on matter, motion and perception; Henry More on spirits and the soul; Van Helmont on physic and experiment. The most complex reviews of literature include thematic outlining, comparison and contrasting of sources, and evaluative comparisons. These are only fleetingly apparent in *Philosophical Letters*; while the structure of the letters suggests comparisons between More and Van Helmont, Hobbes and Descartes, ancients and moderns, Cavendish rarely draws specific conclusions from these largely implicit comparisons. Moreover, even when the same topic is explored in a different philosopher's work, there are few if any references back to her prior opinions of others. Instead, the reader is presented with Cavendish's own conception as the standard, the

more reasonable alternative. In a letter concerning More's *Of the Immortality of the Soul,* she tells her correspondent, "I have declared, Madam, my opinion concerning Perception in my former Letters" (*PL* 174). The only comparison made is to her own theories. Similarly, Van Helmont's views of the soul are not compared to More's, though Cavendish does once declare, "I perceive the difference betwixt your Authors opinion, and ... [that of] other Philosophers" (339), going on to distinguish Van Helmont's differentiation of the mortal and immortal soul of man from the more common belief in a rational human soul versus a sensitive animal soul. In the exceptional circumstances where she overtly compares philosophers, the purposes are critical of all involved: in her objection to Hobbes's differentiation of body and accident, she states that "these accidents seem to me to be like Van Helmont's Lights, Gases, Blazes and Ideas; and D[r] More's Immaterial Substances or Daemons, onely in this D[r] More hath the better" (54). Despite the nod to More, the implication is that all these concepts are largely unreasonable.

Observations Upon Experimental Philosophy has a more clearly thematic organization, with its central objective made evident in the title, and yet it is still constrained by the readings to which it responds. Cavendish's references to other philosophers are reasonably systematic, with a long series of chapters quite clearly progressing through Hooke's *Micrographia*, yet references to various other philosophers are intermixed as the argument requires, showing a greater overall focus on her strong

objections to experimental instruments, techniques, and conclusions.[10] This corresponds to a format that Granello identifies with the taxonomic level of *Synthesis*; information from source documents is spread throughout the review and applied based on her own organizational schema (298). However, the "organizational schema" of *Observations Upon Experimental Philosophy* is still quite tenuous. The first set of observations, largely concerned with microscopy, is separate from those chapters "Reflecting withal upon some Principal Subjects in Contemplative Philosophy" (*OEP* 195), yet this division may only indicate her more recent reading of Glanvill's work, *Scepsis Scientifica*, since references to this work are nowhere in the first part. These "Further Observations" have an internal logic reminiscent of *Philosophical and Physical Opinions*. The topics progress from natural matter and motion through sense and reason, the knowledge of man, the body of man, and diseases; however, none of these subjects is discussed comprehensively. Finally, the section on the "Opinions of some Ancient Philosophers" is, by Cavendish's own admission, a summary of a single source, Thomas Stanley's *The History of Philosophy*. In the end, though there is a central anti-experimental "theme," this text is also fundamentally controlled by the texts she has chosen to study.

Analysis of Science

In their structure and organization, *Philosophical Letters* and *Observations Upon Experimental Philosophy* may resemble the unsophisticated review of literature, yet an important element of the advanced review is the identification of "contradictions, gaps, and inconsistencies in the literature" (Granello 293), and in both of these treatises,

[10] Cavendish rarely identifies the philosophers by name, but Eileen O'Neill's edition of *Observations Upon Experimental Philosophy* provides invaluable references to the various philosophers to whom Cavendish refers in her individual chapters.

Cavendish identifies problematic aspects which she feels are all too frequent in the philosophy of her day. In her earlier works of natural philosophy, her main concern had been to formulate a cohesive understanding of the natural world and develop an original theory of self-moving matter. Now her focus shifts to understanding the central debates in natural philosophy and clarifying, defending and advocating her opinions to others. She shows an ability to assimilate and objectively evaluate readings that are often themselves widely divergent, and this also allows her to present clearer justifications for her animist materialism than in any of her previous works. In addition, her assessments of the flaws inherent in various scientific theories or methodologies are often insightful.[11] The mechanist world-view from which she dissents alone subsumes a number of conflicting perspectives, especially with respect to motion, perception, and the soul, and in *Philosophical Letters*, Cavendish works to make sense of these. *Observations Upon Experimental Philosophy* raises some of the same issues, though its central focus is the many contradictory beliefs and methods that play a part in the early stages of the institutionalization of experimentalism.

Mechanists variously posited an atomic or particulate system, the dualist separation of material body and immaterial mind, discrete inanimate matter and animate spirit, or a more complete materialism. While her early poems reveal a curiosity about both atoms and mechanical systems, Cavendish soon abandoned most of her Epicurean atomism and eventually rejected mechanism, recognizing the difficulties in its various manifestations, especially with regards to motion. In this she was not alone. Henry

[11] For more on this, see James, "Philosophical Innovations." In the areas of matter, perception, and change (or generation), James suggests that Cavendish had significant insight into the problems of the particulate and vitalist theories then in debate.

Power, though devoted to mechanism, nonetheless claimed that "the Speculation of Motion, and its Origin, [is], as I conceive one of the obscurest things in Nature" (n. pag.; "The Preface to the Ingenious Reader"). Though Gassendi posited atoms with internal energy, particulate matter was often described as lifeless, inert and moved by an external, immaterial agent. Descartes offers an ethereal substance, Power suggests material spirits, Charleton a 'faculty motive', while More and the Cambridge Platonists believe an immaterial spirit to be the principle of motion. In Hobbes' early materialism, motion depended on a fluid ether; later, he suggests the quasi-animist *conatus*, the impulse toward motion. Van Helmont's fully vitalist system also suggests an immaterial dynamic principle, the *archeus*.[12] Cavendish would have none of these. She believed in a unified, entirely material natural world. Taking Hobbes' ideas to their limit, the fully-material world has motion as an integral part of matter, material in itself.

Self-moving matter is both an original and more comprehensive alternative. What is more, it gives back to Nature the autonomy that is lost in mechanical systems, and to Cavendish, the premise that "Nature moveth not by force, but freely" is fundamental and inarguable (*PL* 23). If matter is self-moving, there is no need for external movers or internal, immaterial ones. Her justification of self-motion is articulated in the objections she directs, first, against Hobbes, whose concept of inertia implies that all motion (or lack thereof) is the result of external forces. To Cavendish, this position is untenable when applied to perception, memory, understanding, or dreams. Common sense tells us that bodies would simply collapse under the repeated strain of Hobbesian pressure, compulsion or impulsion: "the pressure of outward objects, pressing the sensitive organs,

[12] On the various ways motion was described in this period, see Merchant 121-22 and 201-09.

and so the Brain or interior parts of the Body ... would cause such dents and holes therein, as to make them sore and patched in a short time" (22). Nor can the concussion of particles account for the variety of nature. Instead of infinite diversity, the world would be made monstrous, since "those pressures would make a strange and horrid confusion of Figures, for not any figure would be distinct" (22). Her critique of Cartesian motion makes reference to the notion of the watch, an image central to the rhetoric of mechanical philosophy.[13] She rejects Descartes' definition of motion as "*onely a Mode of a thing, and not the thing or body it selfe*" (97).[14] Insisting that motion is material, Cavendish declares that "[a] Watch-maker doth not give the watch its motion ... for the motion of the watch is the watches own motion, inherent in those parts ever since that matter was" (100). Further problems arise with Descartes' suggestion that in the transfer of motion, one body gains the motion that the other body loses. If motion is a bodiless abstraction, asks Cavendish, "how can motion, being no substance, but onely a mode, quit one body and pass into another?" To argue "that neither Motion nor Figure should subsist by themselves, and yet be transferrable into other bodies, is very strange, and as much as to prove them to be nothing, and yet to say they are something" (98).

Her arguments concerning matter and motion serve to explain ideas she had established in works as early as *Philosophicall Fancies*, but in *Philosophical Letters*, Cavendish, for the first time, develops an original concept and defends it against potential

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[13] See for example Merchant 220-27 on the clock as the mechanistic symbol of cosmic order. Cavendish also briefly refers to the watch in her critique of Hobbes (*PL* 24).

[14] Cavendish uses italics to distinguish cited material from her own. Here she quotes from Descartes' *Principles of Philosophy*, pt. 2, art. 25. A modern translation reads, "I want to make it clear that the motion of something that moves is, like the lack of motion in a thing which is at rest, *a mere mode of that thing and not itself a subsistent thing*, just as shape is a mere mode of the thing which has shape" (Descartes 233, emphasis added).

opposition. In response to the inadequacy of mechanical explanations, her theory of perception depends on a concept of patterning. Just as Hobbesian pressure and force fail to describe motion in any reasonable way, Cavendish believes these to be insufficient explanations for perception. The onslaught of material sensory stimuli would eventually kill us: "the sentient by so many pressures in so many perceptions, would at last be pressed to death, besides the organs would take a great deal of hurt, nay totally be removed out of their places, so as the eye would in time be prest into the centre of the brain" (*PL* 60). Nature's way is far simpler, and "doth not use such constraint and force" (61). Descartes' suggestion that sensory perception reaches the brain by the medium of the nerves, as a blind man senses objects by touching them with the end of a stick, has equally unreasonable implications: either the motion along the sensory paths is material, in which case the object somehow loses some of its substance each time it is observed, or the "motion has no body, it is nothing, and how nothing can pass or enter or move some body, [she] cannot conceive" (117). Perception has nothing to do with the movement of particles or pressure on sense organs. In keeping with the essence of her world-view, it depends instead on a harmonious and balanced process: the production by our sensory organs of a corresponding or sympathetic copy of an object, followed by a second level of 'patterning' in the rational motions. Perceiving one's face reflected in a mirror, for example, requires "that the glass in its own substance doth figure out the copy of the face, or the like, and from the copy the sensitive motions in the eyes take another copy, and so the rational from the sensitive, and in this manner is made both rational and sensitive perception, sight and knowledg" (81). Thus perception is not limited to sense organs and

the brain, but is spread throughout the sensitive and rational parts. In essence, patterning is another kind of auto-kinesis, or self-motion.[15]

In *Observations Upon Experimental Philosophy*, she devotes even more attention to an extended explanation of all aspects of perception. Three long chapters elaborate a more comprehensive statement of her theory of perception, "a full declaration" of her opinions concerning "natural knowledge and perception ... [which are] the ground and principle, not only of philosophy both speculative and experimental, but of all other arts and sciences, nay of all the infinite particular actions of nature" (*OEP* 137).[16] This is the synthesized material of Granello's advanced literature review: Cavendish alludes to the various mechanists' accounts of sense transmission and perception, the scholastics' view, the theories of dioptrical writers, as well as Van Helmont's vitalist opinions; yet she uses her own concerns with perception as the "organizational schema to direct the flow of information" (Granello 299). Individual points of her own theory are presented in distinct numbered articles, much like the structure of works by Hobbes, More, or Charleton.[17] Though all other views are rejected in favor of her own, she tempers her claim "that all perception consists in patterning out exterior objects" (*OEP* 140), allowing for the infinite and unknowable variety of nature as well as the possibility of internal "voluntary acts of figuring" (170). Granello also suggests that the most advanced literature reviews "draw synthesized conclusions logically based on objective evaluations: therefore,

[15] Though Cavendish does not indicate that she knew of their discussion, More and Descartes had discussed something similar in 1649; Hobbes speaks of it in *De Corpore*, which Cavendish read in its 1656 translation.

[16] These three chapters from 35 to 37 (pp. 137-194) almost match the length of the previous thirty-four.

[17] See for example Hobbes, *Elements of Philosophy*; More, *The Immortality of the Soul*; and Charleton, *Physiologia Epicuro-Gassendo-Charltoniana*. Cavendish uses numbered points (or articles) in chapter 35 (pp. 137-38) and chapter 37 under "Q. 23" (pp. 191-93). In chapter 35, after twelve brief articles, the thirteenth continues without a clear break into over ten pages of more general discussion.

readers of these papers can feel secure in the quality of the conclusions reached" (299). This portion of *Observations Upon Experimental Philosophy* shows Cavendish as a writer with sufficient understanding of conflicting views to be able to compile and explain her own with clarity and conviction.

The neutral tone and methodical organization are found again in the final section of *Observations Upon Experimental Philosophy*, where Cavendish voices her objections to the ancient philosophers in brief and systematic chapters broken down into numbered points. Many of the ancients, whose ideas she explores through Stanley's overview in *The History of Philosophy*, make reference to immaterial substances. Cavendish rejects Thales' idea that God is the soul of the world, since the soul of nature is corporeal. Where Plato says the soul is self-moving, she believes natural matter is the same, and she rejects that which has no being; that matter has no form; and the immaterial soul of the world combined with material body of the world. In addition, she dismisses the Pythagorean distinction between body and the incorporeal. She concludes "that most of the ancients make a commixture of natural and supernatural; corporeal and incorporeal beings; and of animate and inanimate bodies" (*OEP* 275). Yet she does not wish "to revile or prejudice their wit, industry, ingenuity and learning, in the least." Rather she wants to demonstrate her originality, clarify her ideas, and "if possible ... find out the truth in natural philosophy" (250).

Cavendish also raises some valid points about the various experimental techniques and instruments that natural philosophers employ. Her principal objections

come from her belief that the instruments of experimentation are often flawed, the senses are not always reliable, the artificiality of experiment does not correspond to what happens in nature, and the presumption that experiment is infallible has set natural philosophy off in the wrong direction. She includes chemical experimentation in her criticism, declaring that "Fire and Furnaces do often delude the Reason, blind the Understanding, and make the Judgment stagger" (*PL* 281). Moreover, experimentation carries a high cost: "to become an Artist in Chymistry," means "my time vainly spent, my health rashly endangered, and my Noble Lords estate unprofitably wasted, in fruitless trials and experiments" (286). She speaks from some experience, for in Antwerp she had observed her husband and brother-in-law in the family laboratory, and had even been "involved in many of the experiments that most puzzled and fascinated contemporary philosophers" (Whitaker 114). In addition, the family owned a number of telescopes, and she had her own microscope (Whitaker 99, 229).

Her doubts about optical instruments like the microscope and telescope were not unfounded: there were no standards for their construction, lenses often distorted the periphery of objects, and lighting issues reduced the clarity of many observations. She remarks that "experimental philosophers confess themselves" that "the instrument [is] not very exact," and she insightfully predicts that "hereafter there may be many faults discovered of our modern microscopes which we are not able to perceive at the present" (*OEP* 60). Telescopes are equally problematic, for "if art be not able to inform us truly of the natures of those creatures that are near us; how may it delude us in the search and enquiry we make of those things that are so far from us?" (135). From the failure of the

instrument, it follows that the accuracy of any microscopic image is suspect. A further significant problem is that "there are so many alterations made by several lights, their shadows, refractions, reflexions, as also several lines, points, mediums, interposing and intermixing parts, forms and positions, as the truth of an object will hardly be known" (50). Far from being "the real body of the object" (51), the image is monstrous, misshapen, "hermaphroditical" (53)—a mix of natural and artificial, truth and lie. The same can be said of any artificial imitation of natural effects; these are as different as "chalk and cheese" or "artificial glass, and natural diamonds" (113). In the end, Cavendish believes that the best alternative is a return to deductive and speculative methods. Careful observation and, more especially, rational thinking will reveal as much truth as we can possibly achieve.

Even if she conceded that a magnified image was true to the external reality of the object, it would not follow that these instruments could reveal anything about the internal structure or nature of an object. Henry Power's explanation of magnetism by effluvia, for example, is unsupportable, since Cavendish "can hardly believe, that any microscope is able to show how those flowing atoms enter and issue" (56).[18] While it may be intriguing to observe the variety of shapes and surfaces of the seeds of corn violets, "it is impossible that the exterior shape and structure of bodies can afford us sure and excellent instructions to the knowledge of their natures and interior motions, as some do conceive; for how shall a feather inform us of the interior nature of a bird?" (70). Consequently, she strongly objects to all conclusions drawn about the interior nature of the object based on

[18] Yet Cavendish had once suggested that magnetic attraction was due to atoms "like to *Pincers* small" shooting out from the North and South Poles (*P&F* 24).

external appearances, asserting that the internal self-motion of creatures is not necessarily revealed by any external appearance or motion, and "neither is any art able to assist our sight with such optic instruments as may give us true information thereof: for what a perfect natural eye cannot perceive, surely no glass will be able to present" (*OEP* 59).

Cavendish insists that the senses are better than any lifeless, man-made instrument, for though the senses are more easily deluded than reason, art is more likely to distort than enlighten. In *Micrographia*, Robert Hooke claims that human error can be repaired by "*artificial instruments* and *methods*".[19] To Cavendish, this gives unwarranted power to a simple object. In *Philosophical Letters* she even tries to shift responsibility for magnification from the lenses of a telescope or microscope to the motions of the eye itself, which "double and treble their strength, making the Image of the object exceedingly large in the eye" (66). She believes that "much less will dioptrical glasses give any true information ... but they rather delude the sight; for art is not only intricate and obscure, but a false informer, and rather blinds than informs" (*OEP* 87). Convinced of the "deceitfulness" (135) and "delusion of the glasses" (136), she comes to imply that these instruments have some evil will to misrepresent reality: the observation of thousands of eyes in the fly is but "a deceit of the optic instrument" (59); and, recounting her observation of butterflies emerging from cocoons, she notes that she could not distinguish their gender, "except I had some microscope, but a thousand to one I might have been also deceived by it" (62).

[19] Quoted in *OEP* 48n21. O'Neill points out that Cavendish alters the beginning of Hooke's quote to read simply "By art there may be a reparation made..."

Microscopes and telescopes may deceive the natural philosopher, but worse to Cavendish is the prevalent belief in the supremacy of mankind over all other living creatures. In *Philosophical Letters* and *Observations Upon Experimental Philosophy*, as she reiterates her own sense that this is a limiting and deceptive intellectual bias, Cavendish illustrates an analytic "process of deconstruction" where "the intentions of the author of the presented material" are recognized and evaluated (Anderson 82). Her condemnation of these assumptions of man's superiority underpins her interpretation of almost every philosopher to whom she responds. When she reads in *Leviathan* that Hobbes believes man is the only creature subject to absurdity, Cavendish observes that "the Ignorance of Men concerning other Creatures is the cause of despising other Creatures, imagining themselves as petty Gods in Nature" (*PL* 41). To Henry More's claim of the preeminence of Man in *Antidote Against Atheisme*, Cavendish responds that "though he can build a stately House, yet he cannot make a Honey-comb; and though he can plant a Slip, yet he cannot make a Tree" (147). Van Helmont is reprimanded for his "presumption and arrogancy ... to make Man the chief over all Nature, and to believe Nature was onely made for his Sake; when he is but a small finite part of Infinite Nature, and almost Nothing in comparison to it" (279). The point is made even more strongly in *Observations Upon Experimental Philosophy*, where Cavendish decries the egotism and self-conceit that makes man "[think] himself the chief of all creatures, and that all the world is made for his sake; doth also imagine that all other creatures are ignorant, dull, stupid, senseless and irrational; and he only wise, knowing and understanding" (219). She further associates presumptions of superiority with the self-delusion that leads mechanical experimentalists to believe that they can manipulate nature into revealing true

causes and effects; she contends that "neither can natural causes nor effects be overpowered by man so, as if man was a degree above nature, but they must be as nature is pleased to order them; for man is but a small part, and his powers are but particular actions of nature, and therefore he cannot have a supreme and absolute power" (49).[20]

Critical Evaluation

Her open censure of the unstated assumptions informing many philosophical proposals represents a point at which analysis crosses over into evaluation and judgment, and while this indicates her accession to the highest cognitive levels, it also signals Cavendish's tendency to function outside the boundaries of civil interaction. In *A Social History of Truth*, Steven Shapin notes that, "[in] general, the practice of opposition was recognized as a serious threat to the good order of civil conversation. ... The corrosive effects of opposition and obstinancy were not worth the cause of truth for which they were allegedly enlisted" (116). In her critiques, Cavendish almost exclusively takes a dissenting position. Her analysis of various scientific notions and methods can be insightful, and she makes attempts to remain detached and impartial; however, she struggles to "present both sides of an argument with a minimum of researcher bias" (Granello 299), and the ways in which she engages in her critique repeatedly challenge the value-neutrality of her claims. The tone of her appraisals is at various times argumentative, belligerent, or cynical, and her attacks often seem to be personal rather than intellectual. She tends towards the dangerously uncivil *ad hominem* style, which, in gentlemanly circles, should "at all costs be avoided, for the risk ... of making foes out of

[20] This recalls Cavendish's declarations about man's presumption of "Supreme knowledge" in both *PPO55* (40) and *PPO63* (111).

mere dissenters" (Shapin and Schaffer 73). At a time when "[good] manners might be recognized as a sign of good intellectual matter" (Shapin 223), her uncivil and judgmental tone adds to the already-substantial impediments of her gender and admitted educational shortcomings. Though she believed in the value of her opinions and was determined to prove their merit, in the eyes of the philosophical community, Cavendish's contentious and "ungentlemanly" approach would have significantly undermined her evaluative commentary.

By arranging both texts, at least to some extent, as responses to specific individuals, Cavendish sets up a situation where even objective critique might be construed as personal attack; still, at times she is quite openly disparaging and discourteous. In *Philosophical Letters* this is most often clear in her discussion of the opinions of Henry More and Van Helmont. In *The Immortality of the Soul*, More claims that self-motion grants too much authority to "mere *Matter*" (65; bk. 1, ch. 12, art. 1); he derides ideas of self moving matter like Cavendish's as nothing but

> Absurdities ... so mad and extravagant, that a man would scarce defile his pen by recording them, were it not to awaken those that dote so much on *the power of Matter* (as to think of it self sufficient for all *Phaenomena* in the world) into due shame and abhorrence of their foolish Principle. (115; bk. 2, ch. 6, art. 6).

Cavendish chooses to respond by attacking *his* theories, declaring,

> my opinion of self-corporeal motion and perception, may be as demonstrable as that of Immaterial Natural Spirits, which, in my mind, is

> not demonstrable at all ... For how can that be naturally demonstrable, which naturally is nothing? (*PL* 177)

Though she shares with More a distaste for mechanical explanations of motion, she cannot accept his alternative of an immaterial "active Principle of *Motion*" (64; bk. 1, ch. 11, art. 8), and she is unequivocal in her opinions. It is beyond reason and common sense to believe that immaterial substances are capable of moving material substances. Finding self-moving immaterial spirits as absurd as More finds self-moving matter, Cavendish berates More and other philosophers like him who feel they do God a service by representing Nature as "stupid, ignorant, foolish and mad" (*PL* 163) and then see themselves as wise though they are part of "foolish" nature. Nature has no need for "some Immaterial or Incorporeal substance to move, rule, guide or govern her, but she is able enough to do it all her self, by the free Gift of the Omnipotent God" (194). According to More, since mankind is capable of far more than matter alone, man must be imbued with immaterial spirit, a natural soul which is incorporeal, indivisible, self-moving, able to penetrate, contract and dilate itself and also to move and alter matter. Cavendish is derisive in pointing out the flaws in More's reasoning. It is "absurd and ridiculous" to believe that immaterial substances are capable of moving material substances (198). Even more absurd is More's concept of the small soul that dilates as the body grows; it implies that a person who loses a limb has a diminished soul and "if a dwarf, the soul must be a dwarf also" (209). The immaterial is, quite simply, unnatural—or supernatural, in which case it is a subject for divinity and not natural philosophy. Cavendish, like Hobbes, posits instead a material soul, "not composed of rags and shreds, but ... the purest, simplest and subtillest matter in Nature" (180). She acknowledges that

"there may be supernatural spiritual beings or substances in Nature, without any hinderance to Matter or corporeal Nature" (225), but ideas of immaterial minds are nothing but "Hobgoblins to fright Children withal" (187).

Henry More is not her only target on this topic. Cavendish is equally critical of Van Helmont's natural theory, which is undermined by its immaterial foundations; not only does Van Helmont draw inspiration from gauzy "Visions, Apparitions, and Dreams" (*PL* 239), but his Ideas, Archeus, Gas, Blas and Ferment are all incorporeal "Non-beings" (242). She freely admits that his "obscure, intricate and perplex" (241) principles are confusing, but blames him for needless complication: "Nature is easie to be understood, and without any difficulty, so as we stand in no need to frame so many strange names, able to fright anybody" (238).[21] Cavendish adds to her critique by ridiculing his Ideal Entity, comparing it to a mechanical "Jack in a Clock" in its "admirable powers to put off and on Corporeality and Incorporeality, and to make it self Something and Nothing as often as it has occasion" (242).[22] In her discussion of his work, she continually returns to the fundamental problem of ascribing supernatural (and thus immaterial) causes to natural and material phenomena. Van Helmont claims spirits make up more than half the world; Cavendish wonders how bodiless spirits which "possess no place at all" can occupy half the world (320). Van Helmont suggests that diseases have a material existence, but life has no substance; Cavendish replies that "since he names Diseases the Thieves of Life, they must needs be poor Thieves, because they steal No-thing" (347).

[21] Especially in the first letters analyzing Van Helmont, Cavendish quotes more extensively from his texts than she does with other philosophers. Granello suggests that overreliance on quotation is a sign of a fundamentally weak comprehension of a text: "Students are unable to translate the ideas of the source authors into their own words and, thus, overuse quotes" (Granello 298).

[22] The Jack in the Clock, also called Jack o' the clock, clock-jack, or jacquemart, is a mechanical figure (automaton) that strikes the hours on the bell of a clock.

Van Helmont calls rainbows a divine mystery, thunder and lightning signs from the devil, and earthquakes a judgment from God. He includes biblical interpretation in his discussion of nature, stating for example that Adam "defloured [Eve] by force" (312), and that the consequence was the growth of animalistic facial hair. To Cavendish, these explanations ignore natural causes and indicate further the profound presumption on the part of philosophers, who are so "conceited with their own perfections and abilities ... as to make themselves God's privy Councellors, and his Companions, and partakers of all the sacred Mysteries, Designs, and hidden secrets of the Incomprehensible and Infinite God" (314).

Cavendish also makes stinging comments about the methodologies that natural philosophers employ in their writing and research. While in both texts her remarks are most often directed towards experimentalism, in *Philosophical Letters* she includes any form of philosophy other than deductive reasoning among her targets. She criticizes Hobbes for his demonstrations "done most by art"' (*PL* 95).[23] Later, she confesses to be baffled by mathematicians who wish to "inchant Nature with Circles ... as if she were ... mad," geometricians who measure nature down to the atom, natural philosophers who stuff Nature "with dull, dead, senseless minima's," chemists or alchemists who torture Nature into nothingness, and "natural Theologers ... for they make such a gallamalfry of Philosophy and Divinity, as neither can be distinguished from the other" (491). The reader is left to applaud her confessed ignorance of "their Scholastical Arts, as Logick, Metaphysick, Mathematicks, and the like" (490). However, her most extensive and

[23] This may refer to the many geometrical proofs in *Elements of Philosophy* or, more generally, to his rhetorical technique, which in her eyes is an 'artificial' means of argument.

concerted attacks are reserved for those philosophers who believe that great truths will be revealed by the media of instruments or by setting up artificial situations. At various times in *Philosophical Letters*, she characterizes Van Helmont, "the famous Philosopher and Chymist" (234), as rash, presumptuous, and even slightly dim, declaring that he "is so taken with Fire, that from thence he imagines a Formal Light ... but certainly, he had, in my opinion, not so much light" (281). While Cavendish was intrigued by the work of Harvey, Galileo, and Boyle, she nonetheless concludes that experimentalists, "with their penetrations, pressings, squeezings, and the like, make such holes in her [Nature], as they do almost wound, press and squeeze her to death" (489). True or "Pure" natural philosophers need only "natural sense and reason" (281). Despite their various instruments, glasses, tubes, engines and stills, experimentalists are merely artists, little better than workmen or laborers.

Practical experimentation, but more specifically experimental philosophers, are most powerfully disparaged in *Observations Upon Experimental Philosophy*. Targeting Hooke's *Micrographia* specifically, Cavendish belittles experimental devices by saying that at best, "artificial things are pretty toys to employ idle time" (*OEP* 105). Micrography has "intoxicated so many men's brains" that "all better arts and studies are left aside" (51). These men are "as boys that play with watery bubbles or fling dust into each other's eyes, or make a hobbyhorse of snow ... worthy of reproof rather than praise, for wasting their time with useless sports" (52). Aside from all other considerations, she wonders how "a fool [can] order his understanding by art" or how "a wise man [can] trust his senses ... if the sense be defective, either through age, sickness, or other accidents"

(49). Summarizing her profound suspicion of both experimental philosophers and their tools, she declares,

> But I observe, experimental philosophers do first cry up several of their artificial instruments, then make doubts of them, and at last disprove them; so that there is no trust nor truth in them, to be relied on: For, it is not an age since weather glasses were held the only divulgers of heat and cold, or change of weather; and now some do doubt, they are not such infallible informers of those truths. By which it is evident, that experimental philosophy has but a brittle, inconstant, and uncertain ground. And these artificial instruments, as microscopes, telescopes, and the like, which are now so highly applauded, who knows but they may within a short time have the same fate; and upon a better and more rational enquiry, be found deluders, rather than true informers. (98)

In her opinion, the inventors of optical instruments have done the world a great disservice. Those experimental philosophers taken with micrography, like Hooke or Henry Power, have become "unprofitable subjects to the commonwealth of learning"; their work has done nothing "for the better increase of vegetables and brute animals to nourish our bodies, or better and commodious contrivances in the art of architecture to build us houses, or for advancing of trade and traffic, or ... to make men live in unity, peace, and neighbourly friendship" (51). More generally, all experimental philosophy leads its followers astray, for after drawing faulty conclusions from "artificial trials," learned men too frequently "judge that all natural actions are made the same way" as that trial seemingly reveals (100). Cavendish suggests, in fact, that Nature has such a love of

variety that she will playfully misrepresent herself in artifice. There is no surety to be drawn from experimental results, since through Nature's whims these could be completely different one day to the next:

> Wherefore those that employ their time in artificial experiments, consider only nature's sporting or playing actions; but those that view her wise government, in ordering all her parts, and consider her changes, alterations, and tempers in particulars, and their causes, spend their time more usefully and profitable: and truly, to what purpose should a man beat his brains, and weary his body with labours about that wherein he shall lose more time, than gain knowledge? (*OEP* 105).

Ironically, she suggests that experiment is better suited to women, who have time on their hands and no responsibility to improve society's lot; "and then would men have reason to employ their time in more profitable studies, than in useless experiments" (105). The experimental "or mode philosophy" (99) has come to prevail in large part because men are unwilling to accept the limitations of their finite understanding of infinite nature; however, an understanding of nature's wise government is only accessible if the variety of nature's actions is acknowledged and if the pairing of sense and art is rejected in favor of sense and reason.

Dis/Engaging the Audience

In *Philosophical Letters* and *Observations Upon Experimental Philosophy*, as Cavendish develops her own version of the literature review, she moves between testing her opinions against other philosophies and judging other ideas, sometimes quite harshly,

in light of her own. The persistent consciousness of her audience with which she carries out her analysis is often ambiguous. Though her extensive reading drives her to look inwards in self-criticism, it also serves to renew and even increase her confidence in her own writing and the value of her ideas. She wishes to express her opinions "as other Philosophers do" (*PL*; "A Preface to the Reader") and she sets out to justify for herself a position within the realm of "eminent and ingenious writers" (*OEP* 9; "The Preface to the Ensuing Treatise"). Where her earlier concern was to present the natural world in a way that corresponded to her social reality—both civil war and restored political order—now the social reality that interests her is that of the intellectual community. Yet at the same time she presents her opinion as the external standard by which other theories are evaluated. In these texts, hers is a voice of authority, independent of any discourse or civil exchange of opinions.

These two works present Cavendish simultaneously reaching out to her audience while keeping her distance, forging a place for herself alongside her peers while risking their alienation. In order to manage her status within the written 'conversation' that she composes, Cavendish presents her work with profuse apologies, but also with forceful defenses of her right to dissent. She uses rhetorical techniques that reach out differently to both her philosophical audience and her common readership, all the while using diction and syntax that appear to disengage her from the opinions she propounds. She forges a sense of unity with her readers and yet also establishes for herself a removed position of authority. Finally, there is an ambiguity to Cavendish's engagement with the very opinions she elaborates: these are represented both as original products of her

unique mind and as the authoritative precepts of a universal reasoning power. This tension between her desire for engagement and her tendency to retreat into seclusion, between objective and contentious analysis, reveals the complexity of negotiating the waters of scientific discourse.

Realizing that her work often appears to be needlessly argumentative and anticipating the potential outrage of her readers, Cavendish apologizes in advance, but at the same time she makes clear her conviction that her methods are justified and her work is worthwhile. In *Philosophical Letters*, the spectre of the civil war still haunts her prefaces, in which dissent in philosophical discourse is associated with political rebellion. Her anxiety about causing offense is obvious when she writes to her husband, "I was afraid that your Lordship would be angry with me for Writing and Publishing this Book, by Reason it is a Book of Controversies, of which I have heard your Lordship say, That Controversies and Disputations make Enemies of Friends" ("To His Excellency The Lord Marquis of Newcastle"). However, she then tells her readers that "Contradictions are better in general Books, then in particular Families, and in Schools better then in Publick States" ("A Preface to the Reader"). In the opening epistle, she likens her fear of taking on so many illustrious philosophers to being "commanded ... to get upon a high Rock, and fling myself into the Sea, where neither Ship, nor Plank, nor any kind of help was near to rescue me" (1). Yet these thoughts give way to some hope: "on the other side I considered first, that those Worthy Authours, were they my censurers, would not deny me the same liberty they take themselves; which is, that I may dissent from their Opinions, as well as they dissent from others, and from amongst themselves" (2). In so asserting her

right to dissent, Cavendish finds justification for the argumentative approach of her letters. Furthermore, she points out the value of juxtaposing contrasting views: her philosophical opinions become all the more "perspicuous and intelligible by the Opposition of other Opinions, since two opposite things placed near each other, are the better discerned" (2). Her intention is not to ridicule other ideas to elevate her own, but rather to present opposing views in peaceful coexistence. It is to the ultimate profit of all that dissenting opinions be heard, "[for] as Lawyers are not Enemies to each other, but great Friends, all agreeing from the Barr, although not at the Barr: so it is with Philosophers, who make their Opinions as their Clients, not for Wealth, but for Fame, and therefore have no reason to become Enemies to each other, by being Industrious in their Profession" ("To His Excellency The Lord Marquis of Newcastle").

In *Observations Upon Experimental Philosophy*, Cavendish appears both more confident in her own ideas and more resigned to their dismissal. She justifies her "controversies" more assertively, claiming "[it] may be, the world will judge it a fault in me, that I oppose so many eminent and ingenious writers: but I do it not out of a contradicting and wrangling nature, but out of an endeavour to find out truth, or at least the probability of truth" (9; "The Preface to the Ensuing Treatise"). Ironically, given her own tendency to pick and choose, her reader is not so much requested as told to read her earlier works: "if you'll give an impartial judgment of my philosophy, read it all, or else spare your censures" (13; "To the Reader"). With both foresight and anxiety, she attempts to "hinder and obstruct as many objections as could be made against the ground of [her] opinions"; however, she realizes that it is impossible to anticipate the "endless

objections" that confront her (13). Her experiences have led her to believe that there is a great deal of folly and malice in the world, and now she merely hopes that her philosophy, though "slighted now and buried in silence ... may perhaps rise more gloriously hereafter ... [and] meet with an age where she will be more regarded" (12). There is a melancholic overtone in such declarations, yet Cavendish concludes that this is simply more evidence of the "poised and balanced" actions of nature (13). At its core, this justification is similar to what she offers in *Philosophical Letters*; Cavendish still believes in the productive tension arising from the coexistence of opposites, but acknowledges that balance may only occur across time.

However, more often in *Observations Upon Experimental Philosophy* her defense of her work amounts to an attack on the folly of other writers. After admitting how difficult she found her readings in natural philosophy, Cavendish turns and attacks the obtuseness of philosophical language, and by extension, its writers: "their hard words did more obstruct, than instruct me. The truth is, if anyone intends to write philosophy, either in English, or any other language, he ought to consider the propriety of the language, as much as the subject he writes of; or else what purpose would it be to write?" (*OEP* 11; "To the Reader"). The natural philosophers of her time, she complains, do nothing but "confuse truth and falsehood," and borrow so much from the ancients that they "are like those unconscionable men in civil wars, which endeavour to pull down the hereditary mansions of noblemen, to build a cottage of their own" (8). Moreover, their motives are suspect: "they will rather maintain absurdities and errors ... for, they would fain be above

nature, and petty gods" (112). Her concern with "gentlemanly" discourse is noticeably diminished.

This also proves to be true in Cavendish's use of the language of probability. On the surface, the frequent references to probability in *Philosophical Letters* appear to add a degree of civility to her arguments by associating her with the new institutionalization of natural philosophy, just as her claim to plain style had done in *Philosophical and Physical Opinions*. In both cases, she shows her awareness of the ways in which her writing is part of a social interaction. Employing the idea of probability in her texts indicates Cavendish's acknowledgement that there is "a way of formulating responses in certain circumstances" and also provides her reader with "a way of recognizing the kind of message being transmitted" (Bazerman 62). Shapin notes that in the seventeenth century, the meaning of "probable" shifted from its earlier sense of "opinion warranted by authoritative and respected sources" to "a quality of uncertain knowledge apportioned to the evidence available" (198). According to the gentlemanly code of the time, theoretical matters should be debated in terms of probability because "[it] was not to be expected that men could attain that certainty about theories that they could about facts" (Shapin 125). "Probable" was a term that allowed for dissent within the restrictions of civil interaction; as such, it was recommended by the Royal Society that natural philosophy be couched in terms of probability rather than certainty.

Yet Cavendish's particular use of the idea of probability, or more often, *im*probability, is to dismiss the ideas of other philosophers, and this adds to the conflict

between engagement and disengagement in her writing. She tells her correspondent that Hobbes's idea of vital motions "appears improbable if not impossible to me" (*PL* 45); More's suggestion that man can conceive of God is similarly "not probable" (141); Van Helmont's claim of the powers of the moon are "said without any probability of Truth" (266), and his concept of propagation "seems improbable to my reason" (329). Ultimately, Cavendish does not strengthen her link to her philosophical peers. In fact, she turns the notion of probability back on them, by using the very language of probability to criticize those who assume it increases the validity and credibility of their ideas. By *Observations Upon Experimental Philosophy*, references to probability are fewer. Cavendish appears to have abandoned hope of acceptance, for far more striking is her dismissal of scientific propositions as simply unbelievable. Forgoing the polite notion of probability to soften her dissent, Cavendish instead emphasizes that she "can hardly believe," "cannot approve," or "cannot admire" the ideas of others.[24] In so doing, Cavendish establishes an impassable chasm between herself and her philosophical peers; not only does she all but accuse them of lies, but in her negative diction she also seems to discount any possibility of compromise or assent.

In a similarly contradictory way, Cavendish reaches out to her general readership with appeals to their shared capacities and yet also distances herself by implying her intellectual superiority. By its epistolary nature, *Philosophical Letters* implies an intimacy between writer and correspondent. The parity between Cavendish and her reader is emphasized when, from the very beginning, she asks her correspondent for "the help and assistance of your Favour, that according to that real and intire Affection you bear to

[24] While these expressions are used repeatedly, see for example *OEP* 56, 57, 90.

me, you would be pleased to tell me unfeignedly, if I should chance to err or contradict but the least probability of truth in any thing" (4). In *Observations Upon Experimental Philosophy*, Cavendish invites the approbation of her "Courteous Reader" (13; "To the Reader"), and expresses her confidence that "the ingenuous reader" will be able to interpret "the true meaning" of her work (14). Additionally, in *Philosophical Letters*, as in the second edition of *Philosophical and Physical Opinions*, Cavendish repeatedly invokes a universal "humane sense and reason" (*PL* 11) to indicate that her judgments reflect a capacity shared by all readers.[25] In fact, she asserts that "if any one can bring more Sense and Reason to disprove these my opinions, I shall not repine or grieve" (*PL*; "A Preface to the Reader"). In *Observations Upon Experimental Philosophy*, the expression is used less frequently, but to similar effect: for example, Cavendish calls upon her reader to agree that "human sense and reason perceives, that the parts of the earth do undergo perpetual alterations" (*OEP* 132), or that "our sense and reason can perceive" that nature is a mix of animate and inanimate matter (157). These aspects of her texts invoke the readers' sense of their own intellectual potential and capacity to fairly judge the ideas before them. However, just as often, Cavendish situates herself as the authority who can enlighten less knowledgeable readers. *Philosophical Letters* is set up as a series of answers to questions from her correspondent; furthermore, within the letters, Cavendish frequently develops her discussion through a series of hypothetical questions to which she responds. Even the style suggests her superior reasoning abilities and thus her intellectual distance from the reader. She presents her correspondent's

[25] As noted in chapter 2 of this thesis, claims of common sense could be problematic, but Cavendish's gentle audience would be assumed to be generally immune to vulgar errors. In *Philosophical Letters*, examples of "sense and reason" alone are too numerous to list; however, for the modifiers "humane" or "common" sense and reason, see also 152, 160, 162, 165, 166, 230, 245, 317, 416, 417, 420, 434, 465, 481, 482, 488, 514, and 515.

misapprehensions by writing, "you may say..." and then authoritatively declares, "I answer..." before elucidating her opinions. This same style is used in *Observations Upon Experimental Philosophy*, and though the tone is friendly and the situation appears casually conversational, she creates doubt about whether the reader's 'common sense' is really of the same worth as her own.[26]

Perhaps most nebulous is Cavendish's affiliation with her own ideas. At times she vehemently claims ownership of her opinions, while at other times she defers to reason, embodied as a figure of authority. Both cases, moreover, can either link her to her readers or set her apart. In *Philosophical Letters*, when it is not common sense and reason that are invoked, it is often the authorial voice that qualifies the pair: "*my* sense and reason."[27] This has the effect of distinguishing her thinking from her audience's even as it invokes its agreement. In *Observations Upon Experimental Philosophy*, the frequency and forcefulness of the first-person pronoun asserts Cavendish's ownership of her ideas; expressions such as "I cannot approve the opinion," "I answer," "I grant," "I will add," and "I mean" abound.[28] Yet there is a double message behind this self-assured "I": it sets her out as an authority, but it also overtly declares opinions so personal and unique that they cannot be offensive to any reader, as they allow for the coexistence of an infinite variety of alternate opinions. At the same time, reason (or sense and reason) is also often represented as a commanding figure that Cavendish has judiciously chosen to consult;

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[26] Question and answer styles are found in *PL*, Section 1, letters 26, 27, 31, 32; Section 2, letters 2, 9, 13; Section 4, letters 2, 4, 11, 15, 17, 26, 27, 29, 30, 31, 33, 34, 36, and 44. In *OEP*, this style occurs in chapter 37 of the first part (pp. 155-94); chapter 20 of "Further Observations" (pp. 232-241); and sporadically throughout "Observations on the Ancients."

[27] *PL* 241, emphasis added. See also *PL* 227, 237, 280, 412, 419, 477, etc. On 237 alone, the possessive adjective is repeated four times.

[28] *OEP* 57; 87; 147; 155; 159; and many more instances.

this situates her alongside her readers by implying that, through their reading of her work, they are together seeking the wisdom of the same expert. When she "is not altogether capable to understand your Authors opinions in Natural Philosophy" (*PL* 275), or when she "cannot conceive" the logic of what she is studying, she claims that "my reason perswadeth me" (38). Her readers benefit together with her: she also declares that "if *we* observe well," then "sense and reason inform *us*" (147, 133; emphasis added). Reason is a figure that Cavendish sometimes identifies with, but sometimes simply channels. She makes claims "according to my reason" while dismissing others that "human sense and reason will contradict" (62, 166). In *Observations Upon Experimental Philosophy* she voices Reason's authority most openly: "I only endeavour to deliver my judgment as reason directs me" (136). Thus Cavendish does not claim her opinions alone; she is assisted by a greater authority, and so is exempt from ultimate responsibility for veracity.

In her natural philosophy, Cavendish has always acknowledged her readership, most obviously in extensive prefatory material. What distinguishes these two works under discussion is a complex engagement that goes far beyond prefaces and epistles to the reader. These two volumes reach out in sustained and significant ways, in their genre, structure, language, and content. The epistolary genre of *Philosophical Letters* connects her to outside readers through the intermediary of the imaginary correspondent; the rhetoric of debate in *Observations Upon Experimental Philosophy* similarly gives the reader a sense of an ongoing discussion with the author. Both texts are organized by a reasonably systematic interaction with various ideas, theories and methods, and consequently, the scientific content shows her far broader knowledge of her peers and

predecessors. In both works, Cavendish chooses a direct, plain style over the extended analogical constructions of earlier works; this brings her writing closer to the conventions of academic or philosophical writing.

In many ways, the final preface to *Observations Upon Experimental Philosophy* epitomizes everything she wishes to accomplish in both works; in fact, Cavendish gives it the subtitle, "Concerning some principal subjects in natural philosophy; necessary for the better understanding, not only of this, but all other philosophical works, hitherto written by the authoress" (23; "An Argumental Discourse"). It is a review, analysis, and assessment of philosophical ideas, all presented as a contentious discourse between different factions in her brain. In this "war in [her] mind," her "former conceptions" (23) generally triumph over the newly-formed "latter thoughts" (24), which indicates that, while she has reflected on contemporary arguments, Cavendish remains convinced of her established earlier opinions on self-moving matter, perception, immaterialism, and other topics. Moreover, the former thoughts have sufficient weight and value to sway their opponents in debate, just as Cavendish believes that her opinions can stand and even prevail against those of her philosophical peers. However, before this occurs in the "Argumental Discourse," the debate becomes sufficiently heated to require the assistance of an unbiased authority. Peace is restored when "some rational thoughts, which were not concerned in the dispute" (41) step in, yet rather than settle matters themselves, these thoughts propound "that the sensitive parts should publicly declare their differences and controversies, and refer them to the arbitration of the judicious and impartial reader" (42). This is an intriguing depiction of how Cavendish justifies her contentious texts and

negotiates their reception. Social order does not depend on quelling dissenting voices, but on allowing them a fair hearing. In addition, the burden of assessment is neither on her nor the philosophers she critiques; it is on the audience, who are implored to "be impartial in your judgment" and to "let regular sense and reason be your only rule, that you may be accounted just judges" (42).

At the same time, and as both *Philosophical Letters* and *Observations Upon Experimental Philosophy* have so frequently demonstrated, engagement and interaction always subsume some measure of disengagement and isolation. Though Cavendish envisions herself taking part in intellectual dialogue, by illustrating a discourse that takes place within her mind, she highlights her exclusion. Outside some correspondence with Huygens, Charleton, and Glanvill, her philosophical conversations are primarily internal. In the atomic poems, Cavendish had also represented herself withdrawing into the world of her thoughts, but "An Argumental Discourse" foreshadows the more thorough retreats apparent in her final two works of natural philosophy, *Blazing World* and *Grounds of Natural Philosophy*. Insofar as "An Argumental Discourse" stands in for *Philosophical Letters* and *Observations Upon Experimental Philosophy*, it comes to show that Cavendish may have been able to navigate a course through the seas of scientific discourse; however, after testing the waters in these two works, she goes in search of other shores.

CHAPTER 4: "For in her self so many Creatures be"[1]

Blazing World and *Grounds of Natural Philosophy*

One of the most frequently recounted events in Margaret Cavendish's life is her 1667 visit to the Royal Society. The Duchess was a figure of London gossip at the time, for her masculine pretensions to authorship, her outrageous dress, and her defiance of social conventions. She had recently appeared at a public playhouse in a costume which bared her breasts, suggesting "the heroic women of antiquity and heroic romances," and she had presented herself to the visiting Queen of Sweden accompanied by a female train-bearer, violating court etiquette which "allowed only the woman of highest status in a company to have a female train-bearer" (Whitaker 294, 296). In his diaries, Samuel Pepys, intrigued by her reputation, reports her behavior and appearance on numerous occasions, including some detail of the unprecedented visit to the recently-established Royal Society by such a notorious woman.[2] Cavendish's visit was unusual for reasons beyond gender or social infamy.[3] Her most recent publication openly criticized the Society's, and more pointedly, Hooke's, experimental techniques and results. Not only had she explicitly attacked the value of the microscope and other instruments, but *Blazing World*, the companion piece to *Observations Upon Experimental Philosophy*, included further mockery of the Royal Society's beliefs, aspirations and methods. Though some members of the Royal Society were hesitant to invite her, Walter Charleton and others

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[1] *SL* 10.

[2] Both Samuel Pepys (246) and John Evelyn (482-83) recorded their impressions of the day in their diaries. Samuel Mintz gives the most detailed modern account of Cavendish's visit to the Royal Society. See also Whitaker 299-300; Battigelli 110-13; and Jones 162-63.

[3] Cavendish's visit is especially unusual because women were excluded from the Royal Society for nearly three hundred years. In 1902, Hertha Marks Ayrton was the first woman to be nominated for membership, but she could not be elected on the grounds that she was married. The Royal Society did not admit women as members until 1945, when Kathleen Lonsdale and microbiologist Marjory Stephenson were elected.

spoke up in her defence, and the extraordinary visit took place. Cavendish viewed demonstrations of the cohesive forces between polished marble plates, of magnetic forces, and of the effects of acids; she saw how the air-pump could assist in measuring the weight of air; she was shown a louse under the microscope and various spectacular chemical reactions. At the end of it all, she declared only "that she was full of admiration, all admiration" (Pepys 246).

Her very public appearances at court and at the Royal Society seem to be fulfillments of her long-held desire for interaction and recognition, among her scientific peers as well as society as a whole, and it is tempting to regard this as a seminal event for Cavendish as a natural philosopher, a turning point that may have either entrenched or altered her views on experimentation. Yet on the day, as Pepys notes with great disappointment, Cavendish was essentially a silent observer. Moreover, her subsequent and final piece of natural philosophy, *Grounds of Natural Philosophy*, is without comment on the experience. Instead, this visit illustrates another of the diverse ways that she ambiguously combines engagement and display with exile and retreat. It also marks a period in which multiplicity is more completely synthesized in her writing and ideas. In their content, structure, and language, *Blazing World* and *Grounds of Natural Philosophy* demonstrate that the essence of her natural theory is multiplicity and variety. These two works manifest this through variations of synthesis, a term which implies the development of complexity and the simplification of form, the coalescence of prior constituents and the creation of new products. These texts are Cavendish's final works concerning natural philosophy, yet both suggest infinite possibility for more.

The Description of a New Blazing World, best known as *Blazing World*, and *Grounds of Natural Philosophy*, are possibly the two most dissimilar of Cavendish's texts. Initially published in 1666 as a companion piece to *Observations Upon Experimental Philosophy*, *Blazing World* has drawn more critical attention from Cavendish scholars than any of her other texts.[4] Cavendish describes it as "a work of fancy," paired with her serious natural philosophy in order to divert and delight both her readers and herself (*BW* 5; "To the reader").[5] It tells the story of a young lady kidnapped and taken to the ends of the earth, only to pass through to a parallel world in which she becomes Empress and eventually is able to return to protect the country of her youth. The story is not merely one of romance and adventure, however: set within the central narrative are several sub-plots in which scientific and philosophical notions figure importantly.[6] The first is a lengthy discussion between the newly-named Empress and her natural philosophers, astronomers, experimentalists, chemists, physicians, and mathematicians, framed as the Empress's verification of the progress made by "her new-found societies of the virtuosos" (21). The Empress embarks on a similarly elaborate conference with immaterial spirits on the topics of mysticism, divinity, self-motion, knowledge, and the soul, culminating in her decision to make a Cabbala. For this

[4] Critics whose work focuses specifically on *Blazing World* include Carrie Hintz, Sarah Hutton, "Science and Satire," Claire Jowitt, Rosemary Kegl, Lee Cullen Khanna, Marina Leslie, Kate Lilley, Nicole Pohl, Bronwen Price, "Journeys Beyond Frontiers," Elizabeth Spiller, Rachel Trubowitz, and Geraldine Wagner. Their discussions range through explorations of feminist allusions, utopian themes, innovations of genre, political subtext, rhetorical sources, and desire for fame. Others who examine *Blazing World* alongside other Cavendish texts include Sylvia Bowerbank, "The Spider's Delight"; Eve Keller, "Producing Petty Gods"; Linda R. Payne; Lisa T. Sarasohn, "A Science Turned Upside Down" and "*Leviathan* and the Lady"; and Sandra Sherman.

[5] Though Susan James's edition of *Blazing World* is paginated continuously, I will also provide the title of any paratextual material where appropriate.

[6] There are also significant political allusions; these are noted especially in James's edition of *Blazing World*, which also includes *Orations of Divers Sorts*.

purpose, she engages the soul of the Duchess of Newcastle herself as scribe.[7] The two women become great friends, "platonic lovers" in fact (70), and discuss the failings of various ancient and modern philosophers as well as exploring the possibility of alternate worlds.

In 1668, not long after her visit to the Royal Society, came *Grounds of Natural Philosophy*, Cavendish's only new volume of natural philosophy in the five years remaining before her death.[8] In stark contrast to the fantasy of *Blazing World*, this is a terse, summarized account of her earlier theories, far less polemical than her letters and comments on experimentation. She refers to *Grounds of Natural Philosophy* as the second edition of *Philosophical and Physical Opinions*, but though there are many topics in common, the altered title establishes a new solidity and permanence: these are fundamental concepts, basic truths, indisputable facts. The main text is divided into thirteen parts, progressing quickly through matter, creatures, productions, man, the mind, irregularities (both physical and mental), knowledge, elements, minerals and metals. This is followed by a lengthy appendix, divided into five parts, which examines immaterial spirits, and invisible, regular and irregular worlds. The final section of this appendix is organized somewhat differently: subdivided into fifteen parts, it is a discussion within her mind about the possibility of restoring-beds which allow for a rebirth of natural matter into a new form.

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[7] In the subsequent discussion of *Blazing World*, I will refer to the character of Margaret Cavendish, Duchess of Newcastle as "the Duchess," while the author herself is simply denoted as "Cavendish."
[8] In the same year, she had reprinted slightly amended versions of both *Observations Upon Experimental Philosophy* and *Blazing World*.

Synthesis and Creation

Though the appendix digresses from Cavendish's study of natural phenomena, the major part of *Grounds of Natural Philosophy* constitutes a synthesis of fifteen years of reflection on science. In it, she combines the theory of matter elaborated in *Philosophical and Physical Opinions* with the ideas she has read and evaluated through the years. Where *Philosophical Letters* and *Observations Upon Experimental Philosophy* detail the specific texts and philosophers under her scrutiny, *Grounds of Natural Philosophy* succinctly sums them up. Cavendish's analysis and evaluation of her sources is assimilated within the explication of her theory; the organizational principle of her text comes from her theory and not from external influences. This is the sort of integration of ideas that Granello associates with cognitively advanced writing (300-01) and that is widely recommended in academic writing guides.[9] In Anderson's Taxonomy, synthesis is presented as the culmination of all other stages; its product is "a coherent and functional whole" which assembles previous learning experiences into an organized presentation that is nonetheless greater than the sum of its parts (84). The product of synthesis may be both ingenious and imaginative, and in fact, when verbs replaced the noun forms of the original Taxonomy, the category of *Synthesis* was renamed *Create*. The result of the creative combination of prior knowledge into a new and original whole is what Anderson at one point calls "a novel structure" (85). Cavendish produces just such a structure in *Blazing World*, a work she refers to as a variation on the romance, the term which in French evolves into the *roman*, what we call the novel. *Blazing World* incorporates her scientific notions into a unique narrative that functions as more than any one of her individual earlier ventures in natural philosophy: it entertains, presents theories and

[9] See for example Ilona Leki; and York University's *Academic Writing Guide* website.

opinions, assesses and comments, and at the same time contributes to the emerging genre of utopian science fiction.[10]

Some form of synthesis had indeed occurred at every stage of Cavendish's writing; however, *Blazing World* and *Grounds of Natural Philosophy* stand on the shoulders of all her previous texts, encompassing their diversity by containing, compressing or alluding to all that came before. This involves processes both revisionary and transformative; it entails looking back and going beyond, following and subverting convention. *Blazing World* alludes to various works of romance and fantasy, but Cavendish makes significant changes to the models available to her. *Grounds of Natural Philosophy* is designated quite specifically as an edited version of *Philosophical and Physical Opinions*, but Cavendish amends her earlier work in more fundamental ways than she had done between 1655 and 1663. In both cases, the result is a text that reveals its sources while differentiating itself from them absolutely.

Blazing World explicitly amalgamates different styles of writing, drawing on Cavendish's earlier philosophical texts as well as on other works, "romancical" or "fantastical" (6; "To the Reader"). Though she initially indicates that *Blazing World* is pure entertainment meant to "divert [her] studious thoughts" and "delight the reader with variety" (6), it quickly becomes clear that the narrative emerges not only from its companion piece, *Observations Upon Experimental Philosophy*, but from Cavendish's earlier works of natural philosophy. Like *Poems, and Fancies*, it is a sustained work of

[10] Khanna, for example, suggests that *Blazing World* prefigures twentieth-century feminist utopian fiction. On other aspects of utopian science fiction, see also Leslie; Lilley; Trubowitz; and Salzman.

fancy with scientific overtones; however, this new piece of fiction replaces the central atomism of the poems by the hierarchical model of self-moving matter systematically developed through both editions of *Philosophical and Physical Opinions*. In addition, *Blazing World* continues to articulate the judgment of her peers Cavendish expresses in *Philosophical Letters*, and the philosophical digressions that form a lengthy portion of the tale often correspond directly to issues she addresses in *Observations Upon Experimental Philosophy*.

Cavendish also draws on external sources in *Blazing World*. The first part of the narrative appears to follow "the typical romance plot of disaster, exile and restoration" (Leslie 12): a young lady is stolen away from her home, her virtue is threatened, she comes near death in a raging storm, but she survives and is rewarded with great power and riches, both in the Blazing World and, later in the story, back in her homeland. Marina Leslie suggests that there are strong similarities with Shakespeare's *The Tempest*, a play that "had an obvious appeal for Restoration audiences with its story of the exile and return of lawful authority" (15).[11] Cavendish's "description of a new world" (*BW* 6; "To the Reader") also calls to mind similarly fantastical tales such as Joseph Hall's *The Discovery of a New World*, Ben Jonson's masque "News from a New World discovered in the Moon," John Wilkin's *The Discovery of a New World in the Moon*, Francis Bacon's *New Atlantis*, and Thomas More's *Utopia*. In the preface to the reader, Cavendish also explicitly mentions the work of Lucian and "the *French*-man's world in

[11] Around this same time, John Dryden produced a version of *The Tempest*, as did John Fletcher and Philip Massinger in their play *The Sea Voyage* (Leslie 15). On the romance elements in *Blazing World*, see Leslie 12-16; Pohl 60-61; Trubowitz 233 and 243n17; and Wagner, who examines the romance elements extensively and also explores the links between *Blazing World* and *The Tempest*.

the moon" (6), a reference to Cyrano de Bergerac's *Histoire comique contenant les États et Empires de la lune* (*Comical Story about the Empire of the Moon*), though she wishes to differentiate her work from these two.[12]

Consciously and deliberately, she designs a tale like no other in order to describe a world like no other, "a world of [her] own creating" (*BW* 6; "To the Reader"). Its mixed form embodies multiplicity but also hinders a clear understanding of the text's purposes. Insofar as genre functions as "a maker of meaning", the generic ambiguity of *Blazing World* prevents readers from knowing how to respond appropriately to the text (Devitt 580).[13] Cavendish resolves this problem somewhat by spelling out her intentions: she claims that since works of fancy help "to recreate the mind and withdraw it from its more serious contemplations," her imaginative combination of philosophy, romance and fantasy provides unique assistance in the difficult task of "rational search and enquiry into the causes of natural effects" (*BW* 6). *Blazing World* is not merely a mishmash. The modifications she brings to the genres from which she draws inspiration suggest purposes more complex than simple recreation, in particular, her desire to participate in intellectual discourse and be recognized as a valid (and valuable) contributor. The conventional romance plot is reworked in such a way that the female protagonist is both victim and hero. As Leslie points out, pursuing the parallels with Shakespeare's play suggests that the Empress also plays the powerful role of goddess or mage (15): like the magical

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[12] For a brief discussion of Hall's tale, published in 1605, see *BW* 7n7; and Leslie 9-10 and 22n7. On Jonson's masque, see *BW* 7n7. Whitaker mentions the work by Wilkins, published in 1638 (282). Connections with *Utopia* and *New Atlantis* are examined in Hutton, "Science and Satire" 165-70. On Lucian, see *BW* 6n3 and Hutton, "Science and Satire" 170-75. Susan James suggests that the reference to "the *French*-man" may be to Pierre Borel's 1657 work, *Discours nouveaux prouvant la pluralité des mondes* (*New Discourse proving the plurality of worlds*) (*BW* 6n3).

[13] See also Devitt 578 and Bazerman 62-63.

Prospero, she instructs and guides her subjects, consults with and commands spirits, and inspires religious awe by appearing before her congregation "like an angel" preaching "sermons of terror to the wicked" and "sermons of comfort to those who repented" (*BW* 50-51).[14] Cavendish gives her character the agency and authority she desires for herself.

Blazing World also re-envisions the utopian fantasy by allowing for the active involvement of a stranger—a woman—in a new land. This is a female utopia, but presented without the satire of works such as Hall's *The Discovery of a New World*, where the capital city of a land ruled by women is called Gospingoa (*BW* 7n7).[15] In addition, as James notes, "Cavendish departs from the standard device of describing an ideal world through the eyes of a visitor" (15n21). The Lady-made-Empress does far more than observe the Blazing World; she is a dynamic participant who, moreover, determines all civil order. She succeeds both in keeping the peace and in making war when it is necessary, ruling over her new land with "an absolute power" (15) and defeating the forces threatening her native country of EFSI.[16] Trubowitz suggests that Cavendish's revision of the utopian genre "creates a new generic space" where she can inscribe herself "as an autonomous and self-governing woman despite the cultural constraints thwarting her worldly ambitions" (237, 238). The character of the Duchess of Newcastle also has uncharacteristic authority in the worlds she visits. The Empress "willingly [follows] her advice" to dissolve the learned societies, "for 'tis better to be without their intelligences, than to have an unquiet and disorderly government" (88), and

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[14] See also Wagner, par. 20.
[15] Other place names include Tattlingen, Scoldonna, and Blubbertck (*BW* 7n7).
[16] EFSI refers to Charles II's full title: King of England, France, Scotland and Ireland (*BW* 100n180). Before she returns to the Blazing World, the Empress magnanimously makes the king of EFSI "the absolute monarch of all the world" (100).

in the battle for EFSI, the Duchess convinces the Empress "to abate her passion" during the war-council (95). The Duchess is, of course, Cavendish herself, and her active advisory role in the narrative points to the desire for engagement made so clear in the first half of the volume. To enable this engagement, Cavendish shatters the framework of fiction, allowing her characters to travel freely between real and imaginary worlds. The Empress and Duchess move between the Blazing World, the land of EFSI, and even England's court and the real domain of the Duchess in Nottinghamshire (Khanna 25). Leslie argues that Cavendish does not so much change as *enact* utopia as she "[writes] herself in" to the fundamentally male intellectual canons of literature and philosophy (9).[17] The critique in *Observations Upon Experimental Philosophy* was intended to provoke conversation; in *Blazing World*, she imposes herself as a full participant in all discourses.

In *Grounds of Natural Philosophy*, Cavendish principally draws on her own work; however, other sources are also implied, and, as in *Blazing World*, she amends or re-interprets all her source material to integrate it into the final, comprehensive statement of her natural theory. As such, *Grounds of Natural Philosophy* completes the task begun in *Philosophical Letters* and *Observations Upon Experimental Philosophy* of reviewing the literature pertinent to her natural philosophy. The relationship between *Grounds of Natural Philosophy* and Cavendish's earlier work is straightforward; not only does she acknowledge *Philosophical and Physical Opinions* as the "First Edition" of the present treatise (*GNP*; "To all the Universities in Europe"), but she also invokes her readers'

[17] Leslie notes, with a certain irony, that "insofar as it is the custom of utopian narratives to reject or transform their literary precursors, Cavendish is nowhere more orthodox a utopian than in her revisions of others' utopian models" (7).

knowledge of all her other philosophical works. She presents *Grounds of Natural Philosophy* as a final installment of her larger *oeuvre* of "Philosophical, Poetical, and Oratorical Works," which she leaves, "All ... and this especially," to the much extended audience of "all the Universities in Europe." This final treatise is significantly shorter than any of her full explorations of natural philosophy. Though Cavendish declares she has corrected her earlier work with "many Alterations and Additions" ("To all the Universities in Europe"), *Grounds of Natural Philosophy*, excluding the Appendix, is little more than half the length of the 1663 edition. In *Observations Upon Experimental Philosophy*, she admits to have "chosen rather to be guilty of prolixity and repetitions, than to be obscure by too much brevity" (155);[18] yet by 1668, she distills her theory to an essential core of ideas presented with concision, simple phrasing and little rhetorical flourish. In essence, her final treatise is the tip of the iceberg, the wealth of writing and knowledge lurking below the surface.

Comparing *Grounds of Natural Philosophy* to the two editions of *Philosophical and Physical Opinions* it claims as its drafts reveals Cavendish's efforts to write plainly and lucidly without all the while overlooking the potential complexity of her notions. She attempts to adhere to the rhetorical ideals of *perspicuitas*, identified with both truthfulness and clarity of expression, and *brevitas*, or "linguistic economy" (Nate, "Rhetoric" 222-23); "making" sense no longer requires elaboration, but abbreviation.[19] In *Grounds of Natural Philosophy*, Cavendish edits drastically, yet the process is not merely

[18] This recalls Boyle's intentional prolixity in his reports of experiment, which were highly detailed in order to create the sense of virtual witnessing (Shapin and Schaffer 62).

[19] While he suggests that her work lacks "conventional" brevity and perspicuity, Nate never refers specifically to *Grounds of Natural Philosophy*. See also Nate's more specific examination of Cavendish's rhetorical style, "'Plain and Vulgarly Express'd.'"

reductive. She also makes major changes to the philosophical content, reordering and rearticulating her ideas, as well as improving the overall organizational scheme in ways that will be examined later in this chapter. A few examples suffice to illustrate Cavendish's technique, the first concerning her explanation of the fundamental figure of the circle, the second involving her description of physical weakness, and the third regarding her theory of perception. The example of the circle demonstrates how slashing away large chunks of text can actually make meaning far clearer. For example, the following lengthy and confusing paragraph from the 1663 edition of *Philosophical and Physical Opinions* is reduced to its central idea in *Grounds of Natural Philosophy*; Cavendish writes:

> The Nature of Extensions and Dilatations strives or indeavours to get Space, Ground, or Compass, as also to Smooth, Plain, or Level, the Substance or Matter those Motions work on, and with, but the Nature of Contracting motions indeavours or labours to cast or thrust out Space, Place, Ground or Compass, labouring to draw and croud Substance Matter or Parts close together, and this is the reason that Circle-lines or Figures may be Contracted many several Ways, Forms or Figures, because Contraction flings out the Compass, and onely makes use of the Line or Circumferent circle, drawing and laying the Line into millions of several Works or Figures, without breaking or dividing the Exterior form, which is the Circle; and this is the reason, that when the Contractions are over-powered by Dilations, and that the Circle extends the full Compass, it returns to its Original form, which is a Round circle, without any

> alteration; and thus may a Circle-figure or Line Exteriously alter several ways by Contraction several times, and yet keep the Interior form, figure or nature; also Circle-Lines or figures may be Exteriously altered by Mixt Exterior motions, as for Example, when a Circle-line should be wound about a Round staff, or such like thing, the winding about the Pole or Staff is the Motion of Contraction, at least one way, as when the Compass is turned Inward, as towards the Centre, yet by winding one Line above another is Extenuation, and millions the like Examples may be given. (147)

In *Grounds of Natural Philosophy* only the central idea that a circle may be contracted or expanded without altering its fundamental nature is asserted.[20] In addition, she extends this notion to apply to "all such sorts of Figures that are (like Circular Lines) of one piece" (179), which further clarifies the earlier editions' vague reference to "all those Figures that are by Nature made of one Piece, without Distinct Parts and Several Tempered Substances" (*PPO55* 59; *PPO63* 149).

Concise statements are common in *Grounds of Natural Philosophy*, but Cavendish must often alter her original opinions more substantially to achieve clarity, as we see in the discussion of weakness. In the 1655 and 1663 editions of *Philosophical and Physical Opinions*, chapters entitled "Of Weakness" are identical with minor differences in spelling, capitalization and paragraphing. Despite the title, the chapters begin by defining "Swooning," only later specifying that "Weakness is caused by a too much

[20] Cavendish's discussion of the circle is found in *PPO55* 56; ch. 88; and 58; ch. 91; *PPO63* 146-49; pt. 4, ch. 33-34; and *GNP* 178-79; pt. 11, ch. 14. A full comparison of the 1663 and 1668 versions of the circle discussion is provided in Appendix C.

relaxing of sinews" (133; 322). This is followed by the analogy of sinews with the lathes of a house and an alternative explanation that weakness may be the result of "the sinews ... boyl'd too tender, as too much towards a jelly" (133; 323). In *Grounds of Natural Philosophy*, in a chapter half the length, Cavendish keeps to the topic announced in the title, foregoes the imagery of the house and omits any reference to boiled sinews. Her topic sentence supplies a summarized explanation of weakness much closer to what we might expect: "some Weakness proceeds from Age; others, through want of Food; others are occasioned by Oppression; others, by Disorders and Irregularities" (*GNP* 120).

Cavendish also adjusts her original theory of matter to include a more fully-evolved concept of perception. Neither edition of *Philosophical and Physical Opinions* had examined perception in great detail; it is in *Philosophical Letters* and *Observations Upon Experimental Philosophy* that she describes her notion of patterning, developed as an alternative to mechanical accounts of sense perception by pressure and force. However, in *Grounds of Natural Philosophy* perception truly functions as a "ground and principle" (*OEP* 137). Perception is mentioned in fifteen separate chapter titles alone, yet none of the discussions goes into the detail of the earlier works. Instead, the concept of patterning underpins other topics; it has been absorbed into Cavendish's overall theory, where it can be called on in a variety of situations. In the end, trimming, rewriting and redistributing the content of her earlier philosophical works helps to make the final text more concise, more comprehensible and more comprehensive.

The inclusiveness of *Grounds of Natural Philosophy* extends to an understated use of outside sources, indicating that her analysis and critique of other ideas is now fully subsumed in her own project. For the most part, the notions she had grappled with elsewhere—Cartesian dualism, Hobbesian motion, More's immaterialism, Van Helmont's "chymistry"—are resolved in her increasingly cohesive theory. Though she makes allusions that can be traced to specific thinkers, the text is stripped of references to named philosophers, who are lumped together into an undifferentiated mass of "some men" whose ideas clash with Cavendish's opinions (*GNP* 76).[21] This also indicates an increasing compliance with rhetorical prescriptions or expectations concerning philosophical discourse. Boyle declares that it is "accounted a more genteel and masterly way of writing, to cite others but seldom, and then to ... mention what they say in the words of him that cites, not theirs, that are cited" (qtd. in Shapin 117n223); similarly, "[disputes] should be about findings and not about persons" (Shapin and Schaffer 73). Nonetheless, at times her targets are reasonably evident. Her dismissal of the belief that witches may transform themselves into other creatures, for example, is clearly aimed at Henry More and Joseph Glanvill.[22] Glanvill, with whom she had been corresponding since 1667, had sent her at least one of his publications and while she never mentions either its title or the author explicitly, the Appendix is framed as a response to "the theological questions" raised in their debate (Whitaker 319). In addition, her correspondence with Glanvill may have influenced Cavendish's shift to a more restrained plain style. In 1665, when he republished *Vanity of Dogmatizing* under the new title *Scepsis Scientifica*, Glanvill included a disclaimer of the work's style, too full of "the

[21] At best, she refers to other philosophers as "the Learned" (*GNP* 35); more often, she writes "some may say" (99, 174, 179, 193), "some may ask" (99, 100, 192) or even "some may object" (143).
[22] See *GNP* 175-76. On Cavendish, More, and Glanvill's discussions of witchcraft, see Whitaker 317-19.

musick and Curiosity of *fine Metaphors* and *dancing periods*" to suit his "*present relish* and *Genius*," and he subsequently revised and shortened the work substantially.[23] At the least, both writers "demonstrate how strong the drift towards a stylistic standardization had become in the 1660s." By *Grounds of Natural Philosophy*, not only are Cavendish's judgments of others integrated seamlessly in her work; she has also assimilated the "rhetorical norms of the New Science" required for her voice to be heard (Nate, "'Plain and Vulgarly Express'd'" 417).

The Structure of Variety

Cavendish's final texts reveal and re-create their multiple sources, but they are also framed to reflect her sense of social order, her epistemology, and especially a dynamic natural philosophy of infinite, ongoing, cyclical change. Both illustrate what Chalmers calls a "formal and thematic commitment to variety ... inextricably connected to the natural philosophy that constitutes a central preoccupation in the text" ("Flattering Division" 126). While Chalmers is referring to earlier work, her words apply well to these two final works. As the fragmented *Poems, and Fancies* reflects the anarchy of atomism, and the nested spheres of the second *Philosophical and Physical Opinions* mirror her hierarchy of matter, so do the structures of *Blazing World* and *Grounds of Natural Philosophy* echo their content. *Blazing World* is arranged to reflect the narrative's movement across shifting borders between different worlds, while *Grounds of*

[23] Qtd. in Vickers 18. *Vanity of Dogmatizing* was originally published in 1661. Glanvill's final revisions were made in 1676, and Vickers notes that while Glanvill "evidently felt that the old style could no longer pass," the drastic cuts he made were at least in part made to reduce "a book to the length of an essay" (19). *Scepsis Scientifica* is not the text that Glanvill sent to Cavendish, but she had read it, for she refers to it in *OEP*. More probably he sent *Philosophical Considerations Concerning the Existence of Sorcerers and Sorcery* (1666), since in a letter dated April 22, 1667, Glanvill writes, "I am bold to beg Favour and acceptance for a Trifle of mine *that was designed for your Grace*" (*LP* 136; emphasis added). On July 8 he responds to "the particular's of your Grace's Letter" (137), and all the points made refer to witchcraft.

Natural Philosophy is organized in ways that suggest both the movement across the body and through the cycle of life. Both additionally invoke the image of nested worlds from *Poems, and Fancies*, reinforcing Sandra Sherman's claim that throughout her *oeuvre*, Cavendish is "always aware of and promoting an aesthetic of englobement" (188).

Of these two last works, *Blazing World* more openly acknowledges and pursues the affinity of its structure and ideas. Cavendish does not simply append it to *Observations Upon Experimental Philosophy*; the pair of philosophical and fanciful texts are joined "as two worlds at the end of their poles" (*BW* 6; "To the reader"). By this, she suggests a more than tangential link between two spheres; each one is, in fact, a passageway to the other. This intimates an essential link between philosophy and fiction, and though Cavendish is careful to point out that the "noble study" of natural philosophy is not merely "a fiction of the mind" (5), she goes on to show that fiction is in no way diametrically opposed to reason. Fiction proceeds from fancy, which, she asserts, is as much an action "of the rational parts of matter" as is reason; by extension, if fancy is a rational action, then fiction is but a variant of "serious philosophical contemplations" (5). The narrative itself then moves between romance, fantasy and philosophy, further indicating the essential likenesses and links between various genres. In addition, Cavendish further affirms that a comprehensive understanding of her natural philosophy is not complete without *Blazing World.* In the preface to *Observations Upon Experimental Philosophy*, her readers are forewarned of the interconnected nature of her writing when Cavendish dissuades them from reading "by parcels, here a little, and there a little"; she states that, "I have found it by myself, that when I read not a book

thoroughly from beginning to end, I cannot well understand the author's design, but may easily mistake his meaning; I mean, such books as treat of philosophy, history, etc. where all parts depend upon each other" (*OEP* 13; "To the Reader"). Readers may find the inter- and intra-textual generic transitions disorienting, but they are also compelled to recognize both the similarity and diversity of the many realms.

While readers may struggle with Cavendish's multiple spheres and styles, the characters of *Blazing World* move back and forth with ease. In the narrative, physical as well as spiritual entities cross boundaries: the young Lady who becomes Empress travels from her nation into the Blazing World and back again with an army of fantastic creatures; her spiritual servants move between her world and ours; and her soul also journeys with the Duchess's into all three. Yet *Blazing World* represents movement between worlds that are not only contiguous, but "englobed" in one another. Geraldine Wagner suggests that this text is another illustration of the nesting boxes of worlds within worlds (par. 9), where the outer limit is Cavendish's imagination, in which the whole document, containing the narrative, philosophical and fantastic sub-texts, is created.[24] The Empress and the Duchess are "sub-versions" of Cavendish herself, and both contain infinite imaginative universes in themselves.

Each world has a role to play, both in the creation of knowledge and of social order. Creatures of each land or world exercise their influence in another, suggesting that no one place is ideal. The Duchess's England, the lady's native nation and the Empress's

[24] Wagner describes the inner boxes as divided between parts of the narrative; however, it is not a simple split between Cavendish's first and second parts, but between the parts that explore "utopian aspirations" and the part that explores "self/self relations" (pars. 10-12).

dominion come to represent various possibilities, intellectual, social, and political. Moreover, when the Duchess and the Empress begin "making and dissolving several worlds" in their imaginations (*BW* 75), they increase the realms of choice infinitely. Nicole Pohl has suggested that Cavendish's "poetic creation of a 'heterocosmos' is not the simplistic blue-print of an alternative better world, but presents a range of speculative prospects" (52).[25] The Blazing World is not simply a perfect utopian realm on which to model our own. This is represented quite plainly by the dissenting academic societies that the Empress must eventually dissolve for the sake of civil order. She had hoped to learn something from all of them, but eventually tires of their inability to comprehend that "no particular knowledge can be perfect, by reason knowledge is dividable, as well as composable" (*BW* 48). Also "composable" is nature itself, as Cavendish proclaims in the voice of the Empress: "by the virtue of its self-motion, [nature] is divided into infinite parts, which parts being restless undergo perpetual changes and transmutations by their infinite compositions and divisions" (40). The pairing of philosophical and fictional works, the internal generic mix of the narrative, and the creation of infinite alternate worlds all combine to represent the infinite variety of nature that Cavendish has long maintained in her theory of matter.

Grounds of Natural Philosophy, for its part, is largely silent on the subject of its own structure, yet it is without question the most strictly arranged of Cavendish's philosophical treatises. It presents another representation, or more literally an

[25] Pohl identifies a different structural model in *Blazing World*, based on the "triangular discourse" of male, female and individual (54). However, she similarly argues that the text's design is a conscious choice reflecting Cavendish's "overall scientific and philosophical methodology and ... epistemology" (56).

embodiment, of interconnected variety: the text as anatomy.[26] In its most simple manifestation, an anatomized text is topically subdivided into component chapters or sections, and *Grounds of Natural Philosophy* is arranged into thirteen parts, almost double the seven of the 1663 edition of *Philosophical and Physical Opinions*. The notion of anatomy also suggests the surgical dissection that allows a subject to be examined from multiple perspectives, a kind of revelatory fragmentation. Dissection further implies the progressive movement through superimposed layers to arrive at a central truth, and this invokes the idea of nested boxes and spheres yet again. Like the 1663 edition of *Philosophical and Physical Opinions*, the arrangement of topics in the first half of *Grounds of Natural Philosophy* follows a progression of increasing specificity that also strongly suggests increasing importance, a movement towards an essential core. Cavendish begins with general definitions of nature, matter and motion; the focus is narrowed to creatures, corporeal motions, animals, and then man. In the sixth part she arrives at the core of the human mind, while the seventh, the arithmetic centre of the text, is concerned with the unconscious knowledge associated with sleep, dreams, and death. By narrowing the scope of each section, Cavendish presents the human mind as the ultimate point of convergence. Moreover, in death all disorder and strife are resolved: "in the last act of Human Life, all the Motions do generally agree in one Action" (*GNP* 99).

Though the first seven sections seem to encompass diminishing spheres, at the same time it is made clear that the compass of each topic is infinitely broad and varied, and the second half of *Grounds of Natural Philosophy* examines just some of these

[26] Chalmers also uses the notion of anatomy to describe how the material in *Poems, and Fancies* and *The Worlds Olio* is divided and subdivided in order to explore different aspects of a topic or to appeal to different tastes ("Flattering Division" 124).

variations. Three sections on the diseases of the body and mind are followed by a section on diversities of knowledge, motion, and change. The final two parts include a rather abrupt treatment of the remaining components of nature, which Cavendish justifies by claiming that "[to] treat of the Productions of Vegetables, Minerals, and Elements, is not so easie a Task, as to treat Animals" (179).[27] In any case, her purpose is not an exhaustive account; she is well aware of the inherent impossibility of anatomizing the infinitely varied body of nature.

While the principle of anatomy is evoked in the document's structure, it is brought to the forefront more directly in allusions to the human body and its life cycle. In her prefatory letter addressed "To all the Universities in Europe," Cavendish presents her work as the "beloved Child of my Brain." Extended to encompass the usual apologies for intellectual shortcomings, the metaphor is strikingly female: "I may be forgiven for spoiling This, in never putting it to suck at the Breast of some Learned Nurse ... but [I] would, obstinately, suckle it my self, and bring it up alone, without the help of any Scholar."[28] The text-as-child also suggests variety in its implication of endless cycles of birth, death and resurrection. Though Cavendish fears this "beloved Child" will be "buried in the hard and Rocky Grave" of disapproval, she nonetheless hopes "for its everlasting Life" (*GNP*; "To all the Universities in Europe"). The first half of *Grounds of*

[27] Most natural philosophers would feel that minerals and vegetables were easier to examine objectively, because rational thought would not be an issue; however, for Cavendish, all matter has rational thought. The reason animals are 'easier' is because we *are* animals and so we have self-knowledge that we cannot access in elements, minerals and vegetables.

[28] As indicated in chapter 1 of this thesis, in her writing, Cavendish frequently employs metaphors relating to typical female activities. In "Flattering Division," Chalmers points out that throughout *Poems, and Fancies*, many of these are specifically employed to symbolize diversity: the sumptuous banquet, the spicy stew or "olio," the harmonies of music, the mixed colors of fine needlework. Scott-Douglass notes, however, that Cavendish rarely uses the analogy of her books as children (30, 44n6).

Natural Philosophy goes on to illustrate the human life cycle: universal self-moving matter is transformed and quickens into the embryonic child who is born, grows to physical and rational maturity, and then dies. However, death is not the end; the penultimate chapter of the seventh part examines "Whether a Creature may be new formed after a general dissolution" (100). Cavendish's response is that creatures "can be repeated, and rechanged" (100), though the parts are likely to be reassembled differently. The topic is picked up again in the final part of the Appendix, "Concerning Restoring-Beds, or Wombs" (291). These two alternate names not only allude to restored political order, but very clearly unite the notions of birth, death and re-birth: the endless reiteration of the cycle of life. Nearly twenty pages are devoted to an internal discourse between parts of her mind over the existence, composition, function and location of such re-generators. Mirroring the earlier nested structure, her mind presents its conclusions with an increasingly narrow spatial focus:

> the Parts of my Mind did conceive, That the Center of the whole Universe, was the Sea; and in the Center of the Sea, was a small Island; and in the Center of the Island, was a Creature, like (in outward Form) to a great and high Rock ... compounded of Parts of all the principal Kinds and Sorts of the Creatures of this World, *viz.* Of Elemental, Animal, Mineral, and Vegetable kinds: and, being of such a nature, did produce, out of it self, all kinds and sorts of Restoring-Beds. (308)

The physical description of the rocky island, in retrospect, causes some wonder at Cavendish's fear for the untimely death of her textual offspring. The "Rocky Grave of

Displeasure" might well imply the transformation, renewal and renascence that are far preferable to "the soft and easie Bed of Oblivion" ("To all the Universities in Europe").

In positing not one but a multiplicity of these restoring wombs, Cavendish further underlines her belief in the central yet divided nature of reason and knowledge. A parallel is drawn between the variety of nature (re-)produced infinitely in restoring-beds at the center of the world and the infinitely productive capacity of the human mind, located at the core of all human parts. *Grounds of Natural Philosophy* reiterates once more the belief that "All Parts of Nature have Life and Knowledg" (6), and more specifically, "all Creatures ... must have a Sensitive and Rational Knowledg and Perception" (18). Self-moving matter is unified in its rational and perceptive capacities, but neither knowledge nor perception is limited to humankind. However, by extension, neither are they limited to physical organs such as the brain or the eye; these capacities are distributed among all human organs. As a result, "a Human Creature ... can have but a parted Knowledg, and a partial perception of himself: for, every different composed part of his Body, have different sorts of Self-Knowledg, as also different sorts of Perceptions" (55). In the end, the anatomical principles and metaphors in *Grounds of Natural Philosophy* reveal the inevitability of infinitely fragmented perspectives on truth and knowledge.

Multiplying Perspective

Blazing World and *Grounds of Natural Philosophy* add to the notion of fragmented perceptions on yet another level, in their deployment of multiple points of view which serve a range of discursive, didactic, persuasive, and epistemological

purposes. Many of Cavendish's texts have presented various standpoints or employed different voices. This is clear in her plays and hybrid works such as *Poems, and Fancies* and *The Worlds Olio*. *Orations of Divers Sorts* includes points of view multiplied far beyond the standard rhetorical practice of writing speech pairs defending opposing views on a topic; James explains that Cavendish "turns her verbal contests into many-sided debates as speakers answer one another back and forth" (*Political Writings* xxii).[29] In *Philosophical Letters* and *Observations Upon Experimental Philosophy*, the scientific texts in which Cavendish seeks most actively to engage in open discourse, she offers the perspectives of other philosophers in tandem with her own, though views that differ from hers are not always presented objectively. *Blazing World* builds on this aspect of its companion piece, exploding the intellectual dialogue into the multifaceted conversation that is an integral part of the narrative. The dialogue presents in turn the perspectives of its protagonist the Empress, the virtuosi, immaterial spirits, the character of the Duchess of Newcastle, and Cavendish as narrator. Each has a distinct contribution to make to the ongoing intellectual discourse, yet in the end the discourse turns in on itself and the range of points of view collapses into one. In *Grounds of Natural Philosophy*, the diversity of perspectives is more subtle. As her writing becomes more didactic than heuristic, dialogue becomes monologue; there is essentially only the voice of the author, communicating to a silent audience through a mix of statements of personal opinion, dispassionate declarations of fact, rebuttals of unspoken objections, and debates between parts of her own mind. The tension between singularity and multiplicity in these final

[29] James suggests that this introduces "the thought that there are sometimes more than two sides to a question" (xxii), which echoes Cavendish's belief that human knowledge can only ever be partial.

works continues to reveal Cavendish's ambiguous, even paradoxical relationship with her audience.

Animated debate is a central plot element of *Blazing World*, and in the multiple conversations and interchanges, the voice of authority constantly shifts between characters in ways that put into question the locus of ultimate knowledge. At times, the conversational relationships are patently hierarchical: when the Empress convokes her virtuosi, they answer her summons "with all the obedience and faithfulness befitting their duty" (*BW* 21). The Socratic question and answer tone of the Empress's interviews with her virtuosi, in which the Empress articulates Cavendish's natural philosophy, recalls the interaction in *Philosophical Letters* between Cavendish and her imaginary correspondent. However, in *Blazing World*, the discussion of natural philosophy is not an exchange between equals; the virtuosi are reverential before the Empress, a "goddess" who deserves "all the veneration and worship due to a deity" (15). Hers is the voice of cool reason and judgment that quells the incessant and ungentlemanly bickering of the virtuosi; they defer to her "great and able judgment in natural philosophy" (41). No matter how benevolent she is, the Empress is unquestionably the ultimate authority. Nonetheless, a second kind of exchange in the story inverts the social hierarchy and gives authority to the Empress's inferiors. In certain instances, Cavendish's theories and beliefs are presented through voices other than the Empress's: immaterial spirits, the soul of the Duchess of Newcastle, and at times even the much-maligned virtuosi. The bird-men, for example, explain the different appearances of the sun and moon using Cavendish's concept of patterning (23), and the worm-men hold Cavendish's view that color is an

intrinsic property of matter (36-37). When the immaterial spirits assert that "we spirits, being incorporeal, have no motion" (55), they defend Cavendish's belief that motion is inseparable from matter. The distribution of her opinions among many different individuals has the effect of granting her ideas greater probability; here, dispersed philosophical authority means greater authority.

In the discourse between the Empress and the Duchess, a balance is struck. The Duchess is unquestionably the Empress's subordinate, interacting with her by imperial command, and she refers to her friend at all times as "your Majesty" (*BW* 68). Yet like the virtuosi, the Duchess is called upon because of her specific expertise; she is "plain and rational writer" (68) and this imparts her voice with the authority of reason. Though she is summoned to be the Empress's scribe in her composition of a Cabbala, the Duchess quickly assumes a more significant advisory role; moreover, in their dialogue, the Duchess often takes the superior position of teacher and guide. She dissuades the Empress from embarking on religious, philosophical, moral, or political projects that would serve no practical advantage, or, worse, "would breed a confusion" and instead directs her friend "to make a poetical or romancical Cabbala" (69). Later, when the Empress becomes puzzled by the complexities of imagining a new world, the Duchess "[invites] the Empress's soul to observe the frame, order and government" of her own creation: an imaginary world "composed of sensitive and rational self-moving matter" (75). Her curiosity piqued, the Empress then asks to know more about her friend's native world. The Duchess leads her through England's cities and countryside, educating the Empress on social structure, government, religion, poetry and theatre-craft.

Despite the multiplicity of authoritative voices in the narrative, all these exchanges serve to relocate intellectual and philosophical authority in Cavendish the author, transparently represented by the Empress in her conversations with the virtuosi, and by the Duchess in her conversations with the Empress. Through them, Cavendish can express her opinions about social order and her judgments of knowledge communities. As in *Observations Upon Experimental Philosophy*, a cynicism about society in general and intellectual communities in particular becomes increasingly obvious. She illustrates her long-standing disapproval of certain kinds of scholars by associating them with emblematic animal species.[30] The logicians are represented as "magpie, parrot and jackdaw-men" (*BW* 46), and they incur the Empress's most violent condemnation; though she does not immediately dissolve their society, she banishes them from her presence, declaring, "I shall never take delight in hearing you any more" (48). The experimental philosophers annoy the Empress with their dependence on "false informers" like telescopes and microscopes (27), but Cavendish further mocks experimentalists by having them declare that they "take more delight in artificial delusions, than in natural truths" (28). Wagner suggests that by representing the experimental philosophers as bear-men, Cavendish is calling on the seventeenth-century belief in bears as "among the most ferocious but least intelligent of animals" (n23). When the Empress permits them to continue their pointless work, it is on the condition "that their disputes and quarrels should remain within their schools and cause no factions or disturbance in state or government" (*BW* 28). The Duchess later draws an even more direct association between political chaos and learned societies:

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[30] The virtuosi are amalgamations of man and beast who follow "such a profession as [is] most proper for the nature of their species" (*BW* 18). Other examples include bird-men astronomers, fly-, worm- and fish-men natural philosophers, ape-men chemists, goat-men physicians, and spider-men mathematicians.

> 'The truth is,' said [the Duchess], 'wheresoever learning is, there is most commonly also controversy and quarreling, for there be always some that will know more and be wiser than others. Some think their arguments come nearer to truth and are more rational than others; some are so wedded to their own opinions that they'll never yield to reason, and others, though they find their opinions not firmly grounded upon reason, yet for fear of receiving some disgrace by altering them, will nevertheless maintain them against all sense and reason, which must needs breed factions in their schools, which at last break out into open wars and draw sometimes an utter ruin upon a state or government.' (88)

The disorder imminent in knowledge communities is simply a reflection of the sad state of society.

Cavendish's own world—the Duchess's native world—is presented as a troubled and difficult place. The Duchess's comments hearken back to the civil war that so powerfully shaped Cavendish's life, and they also reflect the Restoration sensibility that "all free debate bred civil strife" (Shapin and Schaffer 290). When she visits England, the Empress finds society to be "ambitious, proud, self-conceited, vain, prodigal, deceitful, envious, malicious, unjust, revengeful, irreligious, factious, etc." (*BW* 76). Cavendish again shows her world as a place with little hope of peace, truth, or reason when the Duchess asks her friend the Empress to intervene in the long-standing disagreement between her husband and Fortune. Despite the best efforts of the two female souls, they cannot prevail upon Fortune to "hearken to Truth's judgment" (86). Soon after, the

Duchess advises the Empress to restore her realm to its former state: "one sovereign, one religion, one law, and one language" (87). In terms that powerfully presents Cavendish's dismay over the state of her own world, the Duchess presages dire consequences otherwise: the Blazing World will

> prove as unhappy, nay, as miserable a world as that is from which [the Duchess] came, wherein are more sovereigns than worlds and more pretended governors than government; more religions than gods and more opinions in those religions than truths; more laws than rights and more bribes than justices; more policies than necessities and more fears than dangers; more covetousness than riches; more ambitions than merits; more services than rewards; more languages than wit; more controversy than knowledge; more reports than noble actions and more gifts by partiality than according to merit. (87)

This reveals not only Cavendish's pessimism, but a potentially disastrous consequence of multiplicity.

Ultimately, the only authority Cavendish has is over her own creations, the only opinions permitted to coexist are those voiced by fictional self-representations, and the only 'conversation' that takes place is internal, within the fantastic world created in her imagination. However, the natural principle of variety is not renounced; Cavendish indicates rather that she has abandoned hope of participating in a discourse where such a perspective is acceptable. Resigned to the impossibility of achieving intellectual distinction anywhere but in her mind, she withdraws from 'real' debate and discourse and

retreats to a realm where multiplicity can be explored. Moreover, in all her various manifestations—as Duchess, Empress, and author—she forsakes any existent world where merit and fame might be achieved. Ambitious to become an empress herself, the Duchess is convinced by the immaterial spirits to forego the conquest of some material world and create a world within her own mind. This world is composed outside reality *and* discourse; it is "so curious and full of variety, so well ordered and wisely governed, that it cannot possibly be expressed by words" (75). Though she eventually returns to her actual world, she does so in the knowledge that she can, at any time, create infinite such places. The Empress also briefly returns to her native land but retires to her true home, the Blazing World, a location emblematic of knowledge and clear reason. The blazing stars which give this world its name produce "as much light in the sun's absence as in its presence." The Empress's residence is a place "always clear and never subject to any storms, tempests, fogs or mists." She not only has all the power and fame she could desire, but she can indulge in her "chief delight and pastime," which is "to discourse ... with the most learned persons of that world" (107). Finally, in the epilogue to the reader, the author herself states openly that her "ambition is not only to be Empress but authoress of a whole world." She no longer desires to debate scientific or philosophical notions with others; in fact, she declares that "concerning the philosophical world, I am Empress of it myself." The choice of "philosophical" to describe her imaginative dominion is telling: her need for approval, recognition, and interaction has clearly diminished. Readers are invited to join her world, but if they "cannot endure to be [her] subjects, they may create worlds of their own and govern themselves as they please" (109); she prefers her own company and conversation.

Cavendish's withdrawal from social and philosophical interaction by the end of the narrative is what ends the volume containing both *Observations Upon Experimental Philosophy* and *Blazing World*, and this signals her rejection of intellectual discourse in favor of an absolute entrenchment of her opinions. The consequence in *Grounds of Natural Philosophy* is a treatise in which discourse loses the implication of conversation and gains a sense of the professorial exposition of an academic lecture (Bazerman 86). The tone is didactic, the diction is impersonal and the syntax is passive. In the first thirteen sections, only a few chapters are organized as a dialogue. Some of these are internal debates which preclude any external voice,[31] while in the Appendix, all but the first part is structured as a debate between parts of her mind. The spiritual and religious topics in the Appendix are ones that she has long avoided as outside the purview of natural philosophy. Articulating these new reflections through dialogue as she had done in *Philosophical Letters* allows her to test her opinions. Yet by framing the debate entirely internally, Cavendish implies that the time has passed for the sort of engaged critique seen in this earlier work: the refinement of her "philosophico-religious" opinions will be done in her own mind (Whitaker 319). Elsewhere, the question-and-answer construction so prevalent in *Philosophical Letters* is modified into a less personal form: Cavendish writes, "Some may ask" or "the question is" rather than the more intimate "you may ask me" (*PL* 90).[32] The conversational nature of the discussion is lost, and while even in *Philosophical Letters* and *Observations Upon Experimental Philosophy* the informality often simply masks Cavendish's desire to demonstrate her superior reasoning skills, in *Grounds of Natural Philosophy*, all pretense is dropped.

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[31] See *GNP* 13-15, 94-95, 102-03, and 231.

[32] For question-and-answer syntax in *GNP*, see 21-22, 25, 76, 95-96, 99, 100-02, 105, 116, 120-21, 143, 160, 174, 179, 192-93, 218, 233, and 235.

Instead, Cavendish addresses her readers in ways that imply both a disinterested commitment to educate and an unquestionable expertise. She takes on a didactic stance that has similarities to the position of the Empress in relation to her virtuosi, but Cavendish is more than impartial judge and less than deity. She becomes the teacher "introducing students into a coherent and comprehensive understanding of a subject," and in the hierarchy of learning, the teacher is in a position of preeminence; as Bazerman explains, "[the] authoritative voice of the professor ... leaves little room for serious challenge" (86). Certain phrases are used repeatedly to remind her reader of notions already discussed: she writes "as I have declared," "as I have said," or "as I formerly proved"; these expressions occur over fifty times in this short volume.[33] These simple syntactical constructions achieve two goals: the argument is easier to follow, and Cavendish's authority is reiterated time and time again. In addition, by instructing her reader to review what she has previously declared, often simply a matter of going back to the beginning of a chapter, she also implies that the reader should look back to her other texts and thus subtly confirms the value of her entire body of work.

Where the phrase "as I have said" prompts a glance back, the phrase "it is to be noted" has different didactic overtones.[34] Though constructed as a directive, the passive voice removes any personal link between Cavendish and her audience and gives the author the disembodied voice of objectivity and truth. From this elevated position, Cavendish calls for her knowledge to be inscribed, literally and metaphorically 'noted,' just as students both reflect upon and write down new information during a classroom

[33] For example, see *GNP* 18, 26, and 235; other instances are too numerous to list.
[34] For examples of the passive "it is to be noted" see *GNP* 126, 164, and 191; other instances are too numerous to list.

lecture. Assuming that this prescription to register her opinions is followed, Cavendish's ideas are given additional permanence and solidity. Moreover, *Grounds of Natural Philosophy* is delivered to a wide, if nameless audience; where she had previously sent her work to Cambridge or Oxford only, this treatise is directed to all the universities in Europe. To urge so many more readers to note her ideas, especially students of natural philosophy, also implies that these have value for everyone.

Cavendish's professorial stance is not without ambiguities, however. Her passive syntax exists side by side with a personal, active voice that both emphasizes and undermines her authority. The union is problematic, as evidenced in her various reports of the act of observing. The expressions "it is to be observed" and "I observe" are used seemingly interchangeably, and while the former conveys objective factuality, the latter, contradictorily, communicates both potential idiosyncrasy and insightful perceptiveness.[35] Shapin and Schaffer argue that to the seventeenth century scientist, the testimony of a single witness to an event was open to doubt, while "[the] multiplication of witness was an indication that testimony referred to a true state of affairs in nature" (57).[36] Claiming that a phenomenon is *to be* observed implies this multiplication: all individuals will observe the same phenomenon as Cavendish. On the other hand, personal observations do not necessarily lack credibility. In fact, Shapin notes that, as a counter-maxim to the multiplicity of testimony, "truth itself was apt to be more solitary than sociable" and "the truth-speaker was always as likely to be recognized by the fact that a

[35] There are numerous examples of each expression. For a few examples of the passive expression "it is to be observed," see *GNP* 150, 182, 194; for the active "I observe," see 131, 151, 208.
[36] See also Shapin 213-15.

confederacy of dunces was leagued against him" (233).[37] However, the validity of Cavendish's observations comes into question with her frequent declarations that she presents *only* personal opinion: she claims that it is "in my opinion" that man's voice is more melodious than other animals (*GNP* 49), that perception functions by patterning (55), and that metals have circular motions (221). The ambiguity of her authority is heightened by the fact that these statements of opinion are sometimes parenthetical.[38] Brackets both draw attention to their content and mark it as removable, superfluous, or unimportant. Cavendish may wish to proclaim her ideas as true or probable, but she cannot help but admit that their plausibility may depend entirely on perspective.

There is a temptation to see synthesis as an end; more so when we consider that these two texts come so near the end of Cavendish's writing career. Yet had she not died so suddenly at the age of fifty, she may well have continued to write; there is evidence that she was working on various other projects, including a study of magnetism and a new book of poetry.[39] The publication of a text inevitably brings the process of writing to some kind of end: the document ceases to be edited, expanded, or rearranged and comes to exist in a finite and concrete form. As Donald Murray remarks, "[at] the end of the composing process there is a piece of writing which has detached itself from the writer" ("Writing as Process" 3). However, in Cavendish's collected philosophical works, severance is never complete. Previous texts are never far from her mind, and consequently never far from the next piece of writing. In this sense, synthesis also signals

[37] Additionally, claiming actively to observe suggests what Shapin and Schaffer call Boyle's "literary technology of virtual witnessing" (61). See also 55-79. Unlike Boyle, Cavendish is not meticulously recreating experimental procedures within her text, but her language hints at her awareness of Boyle's rhetoric and of its significance in scientific circles.

[38] For parenthetical use of "in my opinion" see *GNP* 49, 55, 65, 146, 163, 170, and 186.

[39] See Whitaker 338.

a beginning, as new lines of thinking develop and new approaches suggest themselves. We have seen this in each text: the capricious atomic verses of *Poems, and Fancies* inspire Cavendish to examine natural philosophy more closely in *Philosophicall Fancies*; its brief chapters grow into an extensive exploration of vitalism in *Philosophical and Physical Opinions*; and the relatively brief discussion of perception in the latter leads to greater investigation of the topic in both *Philosophical Letters* and *Observations Upon Experimental Philosophy*.

Both literally and figuratively, *Blazing World* marks an end: it completes the document that begins with *Observations Upon Experimental Philosophy* and it is also the end of Cavendish's overt critique of her peers. At the same time, it shows a renewed interest in fictional forms, one which prompted Cavendish to reexamine *Nature's Pictures* and *World's Olio* before her death. Perhaps more than any other text, it calls on the idea of ends as beginnings. In the narrative, the young lady passes through the geographical end of her own world to reach a new one, where she is reborn as Empress. Both the fictional Duchess and Cavendish as author are given new life in their imaginary realms, wherein both reinvent themselves as supreme rulers. In addition, the frequent speculative passages in the text—reflections on scientific phenomena, discussions of divine and supernatural forces, and, most obviously, the imaginative construction of various alternate universes—lead us to see Cavendish's thought processes as ongoing and ever-expanding. *Grounds of Natural Philosophy* is also significantly framed by images of birth and rebirth. Cavendish describes her writing as the child of her brain; its gestation and birth are the beginning of a life. As the volume closes with the discussion of restoring

beds which allow for a rebirth of natural matter into a new form, the reader is left with the sense of infinite possibility.

Epilogue

As Cavendish's natural philosophy evolved over this fifteen year span, fragments of ideas recur in new structures, figurations, and allusions. It is only when the full body of her scientific writing is read that these traces are recognizable, yet they provide a coherence that is absent in any single, discrete text. Mapping the internal and external influences on her thinking and writing gives insight into works often overlooked within her larger corpus. An interdisciplinary study is more than helpful in this; it is necessary. Cavendish's experiences of the English civil war, her exile to a country where eminent philosophical thinkers were gathered, her return to a native land in which order was restored yet no longer taken for granted, all fed her thinking about the greater world in which she lived. The debates occurring around her concerning civil order, intellectual practice and scientific method further affected her conceptions. Finally, the various ways in which she articulated, revised, and framed her thoughts and opinions over the years point to her progressively more complex understanding of these political, social, and philosophical influences. In the end, a complete sense of her development as a thinker and writer would require the inclusion of her plays, poems, letters, orations, biography and autobiography, as well as a fuller exploration of gender issues, psychology, rhetoric, and epistemology. The prospect is overwhelming, yet suitable for a writer as interdisciplinary as the Duchess of Newcastle, not so mad after all.

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APPENDIX A

Taxonomies of Educational Objectives

Table 1: Cognitive Domain Categories in the Original *Taxonomy of Educational Objectives* (1956)[1]

1. Knowledge
1.1. Knowledge of specifics **1.1.1.** Knowledge of terminology **1.1.2.** Knowledge of specific facts **1.2.** Knowledge of ways and means of dealing with specifics. **1.2.1.** Knowledge of conventions **1.2.2.** Knowledge of trends and sequences **1.2.3.** Knowledge of classification and categories **1.2.4.** Knowledge of criteria **1.2.5.** Knowledge of methodology. **1.3.** Knowledge of the universals and abstractions in a field. **1.3.1.** Knowledge of principles and generalizations. **1.3.2.** Knowledge of theories and structures.
2. Comprehension
2.1. Translation. **2.2.** Interpretation. **2.3.** Extrapolation
3. Application
4. Analysis
4.1. Analysis of elements. **4.2.** Analysis of relationships. **4.3.** Analysis of organizational principles.
5. Synthesis
5.1. Production of a unique communication **5.2.** Production of a plan, or proposed set of operations **5.3.** Derivation of a set of abstract relations
6. Evaluation
6.1. Judgments in terms of internal evidence. **6.2.** Judgments in terms of external criteria.

[1] Taken from Anderson 271-77.

Table 2: Cognitive Process Categories in the Revised Taxonomy (2001)[2]

Categories and Cognitive Processes
1. **Remember**: Retrieve knowledge from long-term memory.
1.1. Recognizing (Identifying) **1.2.** Recalling (Retrieving)
2. **Understand**: Construct meaning from oral, written, and graphic communication.
2.1. Interpreting (Clarifying, paraphrasing, representing, translating) **2.2.** Exemplifying (Illustrating, instantiating) **2.3.** Classifying (Categorizing, subsuming) **2.4.** Summarizing (Abstracting, generalizing) **2.5.** Inferring (Concluding, extrapolating, interpolating, predicting) **2.6.** Comparing (Contrasting, mapping, matching) **2.7.** Explaining (Constructing models)
3. **Apply**: Carry out or use a procedure in a given situation.
3.1. Executing (Carrying out) **3.2.** Implementing (Using)
4. **Analyze**: Break materiel into constituent parts and determine relations (part-to-part, part-to-whole).
4.1. Differentiating (Discriminating, distinguishing, focusing, selecting) **4.2.** Organizing (Finding coherence, integrating, outlining, parsing, structuring) **4.3.** Attributing (Deconstructing)
5. **Evaluate**: Make judgments based on criteria & standards.
5.1. Checking (coordinating, detecting, monitoring, testing) **5.2.** Critiquing (Judging)
6. **Create**: Put elements together to form a coherent or functional whole; reorganize elements into a new structure or pattern.
6.1. Generating (Hypothesizing) **6.2.** Planning (Designing) **6.3.** Producing (Constructing)

[2] Taken from Anderson 67-68.

APPENDIX B

Cross-Referenced Content of *Philosophicall Fancies* and Two Editions of *Philosophical and Physical Opinions*

The first set of charts compares the 1655 edition of *Philosophical and Physical Opinions* to both *Philosophicall Fancies* and the revised 1663 edition. Chapter titles refer to the 1655 edition; variants or comments are included parenthetically, next to the titles.

1655 Edition		*Philosophicall Fancies*[1]		Title/Comments
Pt.	**Chap.**	**Page**	**Chap.**	
1	1	1	1	Of Matter and Motion
	2	2	2	Of the Form and the Minde
	3	3	3	Eternal Matter
	4	4	4	Of Infinite matter
	5	4	5	No proportion in Nature
	6	5	6	Of one Kinde of Matter
	7	5	7	Of Infinite knowledge
	8	5	8	No Judge in Nature (also similar to 1663, pt.1, ch. 14)
	9	6	9	Of Perfection
	10	6	10	Of Inequalities
	11	7	11	Of Unities
	12	8	12	There is no Vacuity
	13	8	13	Of Thin, and Thick Matter
	14	9	14	Of Vacuum
	15	9	15	The Unity of Nature
	16	10	16	Of Division
	17	10	17	The Order of Nature
	18	11	18	Of War, and no absolute Power
	19	11	19	Of Power
	20	12	20	Similizing the spirits, or Innate Matter
	21	13	21	Of Operation
	22	14	22	Natural, or Sensitive War
	23	14	23	Of Annihilation
	24	15	24	Life
	25	20	25	Of Change
	26	21	26	Of Youth, or Growth

[1] In *Philosophicall Fancies*, 'chapters' are not numbered. I have provided page numbers, as well as provisional chapter numbers based on their sequence.

1	27	22	27	Of Increasing
	28	23	28	Of Decay
	29	24	29	Of Dead, and Death
	30	25	30	Of Local Shapes
	31	26	31	The Visible Motions in Animals, Vegetables, and Minerals
	32	27	32	Of the Working of several Motions of Nature
	33	30	33	Of the Minde
	34	31	34	Of their several Dances, or Figures
	35	33	35	The Sympathy, and Antipathy of Spirits
	36	36	36	The Sympathy of Sensitive, and Rational spirits in one Figure
	37	37	37	The Sympathy of the Rational and Sensitive Spirits, to the Figure they make, and inhabit
	38	38	38	Pleasure, and Pain
	39	38	39	Of the Minde
	40	41	40	Of Thinking, or the Minde, and Thoughts
	41	42	41	Of the Motions of the Spirits
	42	45	42	Of the Creation of the Animal Figure
	43	47	43	The gathering of Spirits
	44	49	44	The moving of Innate Matter
	45	52	45	Of Matter, Motion, and Knowledge, or Understanding (similar to 1663, pt. 1, ch. 15)
	46	54	46	Of the Animal Figure (similar to 1663, pt. 1, ch. 17)
	47	55	47	What an Animal is
	48	63	49[2]	Of the dispersing of the Rational Spirits
	49	64	50	Of the Senses
	50	65	51	Of Motion that makes Light
	51	65	52	Opticks
	52	67	54[3]	Of Motion, and Matter
	53	68	55	Of the Brain
	54	68	56	Of Darknesse
	55	69	57	Of the Sun
	56	69	58	Of the Clouds
	57	70	59	Of the Motion of the Planets
	58	71	60	Of the Motion of the Sea

[2] Note that the verses entitled "Of the Sense and Reason exercised in their different shapes" (pp. 56-63) are omitted in 1655.

[3] Note that the verses entitled "Of the flowing of the Spirits" (pp. 66-67) are omitted in 1655.

1655 Edition		1663 Edition		Title/Comments
Pt.	Chap.	Pt.	Chap.	
	59	3	10	Of Fortune
	60	3	13	Of Time and Nature
	61	4	1	Of Matter, Motion, and Figure
	62	4	2	Of Causes, and effects
	63	4	3	Whether motion is a thing, or nothing, or can be Annihilated
	64	4	4	Of Motions
	65	4	5	Many motions go to the producing of one thing, or to one end
	66	4	6	Of the six principal motions
	67			Of Exterior Motions produced from the six principal Motions
	68	4	7	Of double motions at one and the same time, on the same matter
	69	4	8	Of the several strengths
	70			The creation of Figures, and difference of Motions
	71	4	9	The Agilenesse of innated Matter
	72			Of external, and internal figures and Motions
2	73	4	10	Of repeating one and the same work, and of varieties
	74	4	11	Of creation, and dissolving of Nature
	75	4	11	Of Gold
	76	4	12/13	Of Sympathies, and Anitpathies, which is to agree, or disagree, to joyn, or to crosse (some variations in phrasing)
	77	4	14	Of different knowledge in different figures
	78	4	15	The advantages of some figures, some degrees of matter, and motions, over others
	79	4	16	Of the figurative figures
	80	4	17	Of the gloomy figures, and figures of parts, and of one piece
	81			Of the dull and innated matter
	82			An answer to an old question, what becomes of the shape, or figures, or outwards forms of the old figure, when the nature takes a new form
	83			Of Transmigrations (1663 title: "Of Transmutations")
	84	4	27	Of metamorphosing of Animals and Vegetables
	85	4	28	The Metamorphosing of the exterior forms, of some figures

1655 Edition		1663 Edition		Title/Comments
Pt.	Chap.	Pt.	Chap.	
	86			Earth Metamorphosed into water, water Metamorphosed to vapor, Aire and fire, at least into heat
	87	5	7	Of wetnesse (only some parts are used in 1663)
	88	4	33	Of Circles (similar but not identical)
	89	5	7	Of Softnesse (only some parts are used in 1663)
	90	5	7	Of Liquors (only some parts are used in 1663)
	91	4	34	The extention and contraction of circles (similar but not identical)
	92	5	39/40	Of congealed water (middle section of 1655 chapter only)
	93			Motion changing the figure from water to fire
	94	5	14	Of Oyl (similar but not identical)
	95	5	16	Of Metals (similar but not identical)
	96	5	26	Of the Load-stone
	97	5	27	Of the needle
	98			Of stone
	99			Of burning
	100			Of different burning
	101			Fires transformation
	102	5	10/17	Of such sorts of heating Motions, as cause burning, melting, boiling, Evaporating and rarifying (only some elements are the same)
	103	5	18	Of quenching of fire (similar but not identical)
	104	5	19	Of the quenching of fire, and evaporated water
3	105			Of a bright-shining hot, glowing, fire
	106			Of the drinesse of hot, burning, bright, shining fire
	107	5	3	Of moist colds, and moist heats, of dry colds, and dry heats & c. (longer in 1655)
	108	5	4	Of the motions of cold, and heat, drouth, and Moisture (longer in 1655)
	109			Of dry heats, and cold, and of moist heats and cold
	110			Of shining figures
	111			The motions that make natural air, and day light
	112			Of light
	113			The reflections of light
	114	5	20	Of light, and reflections (similar in one part only)
	115			Of some opinions of light, darknesse, and Death
	116	5	21	Of darknesse (much longer in 1655)
	117			The motions that make Darknesse
	118	5	22	Of Shadows (only first sentence is the same)
	119	5	23	Of shadows and airie figures
	120			Of a more probable opinion to me of light making several colours
	121	5	41	Of Colours (paragraph 2 similar to 1663 chapter)
	122	5	42	Of airy figures
	123	5	37	Of external figures, and internal forms (summarized in 1663)
	124			Earth, water, air, fire, cold, heat, light, darknesse

3	125	5	52	The motions of the Sun, and Planets
	126			Of the motions and figures of the four natural Elements
	127	5	28	The reason of the ebbing and the flowing of the sea thus
	128	5	29	Describing the tides
	229 (129)	5	30	Of double tides (same title, but different reasoning than in 1663)
	130	5	31	Of spring tides (different phrasing)
	131	5	32	The tide and stream flowing against each other (slightly longer in 1655)
	132	5	49	The difference of salt water and fresh water
	133	5	46	Of winde
	134	5	47	Of the noise of Tempest and storms
	135	5	48	Of thunder and lightning
	136	5	50	Of the alterations of motions
	137			Of different motions
	138	5	51	Of the local motions of water, air, and fire
	139			Explanations of onely Matter
	140			The differences and alterations of figures
	141			Of several Worlds

1655 Edition		1663 Edition		Title/Comments
Pt.	Chap.	Pt.	Chap.	
4	141	6	1	The Motion of the Bodie
	142	6	2	The frame of mans body
	143	6	3	Of natural self-tyrannie
	144	6	5	The two grand motions amongst the rational innate matter
	145	6	6	The two chief parts belonging to man, is the head, and the heart, wherein resides the rational spirits
	146	6	7	Whether the passions are made in the head or heart?
	147	6	8	Of different passions in one and the same part
	148	6	9	The affinity betwixt imaginations and passions
	149	6	10	Of the Brain
	150	6	11	Of the multitude of figures amongst the rational matter in the brain and heart
	151	6	12	Of thoughts
	152	6	13	Of thinking, or thoughts
	153	6	22	Of sleep and dreams
	154	6	23	Dreaming of living, and dead figures
	155	6	24	Of Local Dreames
	156			Of the senses, and the objects that pass through the senses
	157	6	26	Of figure presented to the senses, and figures together (different phrasing)
	158			Of objects, and the senses, something differing from the other Chapter
	159			Of the figure of the head
	160	6	27	Of Sight (1663 title: "Of the Several Senses")
	161	6	30	Of Light and Colours
	162			Of Blindnesse
	163	6	30	Of hearing
	164	6	28/29	Of Articular sounds, or sounds without distinction (same topic with different analysis in 1663)
	165	6	32	Of taste, touch, and smell
	166	6	33	Of Touch
	167	6	34	Of the pores of the body

1655 Edition		1663 Edition		Title/Comments
Pt.	Chap.	Pt.	Chap.	
	167[4]	7	1	The Natural Wars in Animal Figures
	168	7	5	Of the four natural Humours of the Body, and those that are inbred
	169	7	6	The five natural Maladies of the body (1663 title: "The Four Natural Maladies of the Body, and Two Unnatural Maladies, one in the Mind, the other in the Body")
	170	7	7	I will treat first of the motions that make sicknesse (1663 title: "Of the Motions that make Sicknesse")
	171	7	8	Of the motions which cause pains
	172	7	9	Of swimming or dissiness in the head
	173	7	45	Where the brain turns round, or not in the head
	174	7	46	Of the sound or noise in the head
	175	7	10	Of Weakness
	176	7	11	Of numb and dead palsies
	177	7	12	Of that we call a sleepy numbness
	178	7	47	Of the head feeling numb
	179	7	13	The manner of motion, or disorder in madness
	180	7	14	Of madness in the body and minde
	181	7	15	Madness is not always about the head
5	182	7	16	Musick may cure mad folks (1663 title: "Muscik may Cure those that are Mad in Mind")
	183	7	18	Of the fundamental diseases, first of fevours (1663 title: Of the Fundamental Diseases")
	185[5]	7	52	Of the infections of animals, Vegetables, and elements
	186			Of burning fevors
	187			The remedies of Malignant Diseases
	134[6]	7	4	Diseases caused by conceit, or cured (similar, but with different terminology in 1663)
	188	7	21	Of the expelling malignity to the outward parts of the body
	189	7	29	Of Sweating diseases
	190	7	41	Of Surfeits
	191	7	26	Of Consumptions
	192	7	28	Of dropsies
	193	7	35	Of apoplexies
	194	7	36	Of Epilepses, which is called falling-sicknesse
	195	7	38	Of shaking Palsies
	196	7	39	Of Convulsions, and Cramps
	197	7	40	Of Collicks
	198	7	44	Of the diseases in the head, and vapors to the head
	199			Of catching cold

[4] The 1655 edition has two consecutive chapters numbered 167 (pp. 125, 127).
[5] There is no chapter 184 in the 1655 edition.
[6] A second chapter numbered 134 appears between chapters 187 and 188 in the 1655 edition.

5	200	7	55	Of the several motions in an animal body
	201			Of the several tempers of the body
	202	7	59	The nature of purging medicines
	203	7	60	The motion of Medicines
	204	7	64	Agreeing, and disagreeing of humours, senses, and passions
	205	7	65	Of outward objects disagreeing with the natural motions, and humours in the body
	206	7	66	Of the inward sense, and outward sense, as the interior and exterior parts
	207	7	67	The sympathies and antipathies of sound to the minde and actions
	208	7	68	The knowledge of diseases
	209		p. 456	To my just readers
	210	7	72	The diatical Centers

This second set of charts compares the revised 1663 edition of *Philosophical and Physical Opinions* to the 1655 edition. Chapter titles refer to the 1663 edition; variants or comments are also included in this column.

1663 Edition		1655 Edition		Title/Comments
Pt.	**Chap.**	**Pt.**	**Chap.**	
1	1	1	6	Of Only Matter (minor similarities and references to 1655 ed.)
	2			Of the several Degrees of Only Matter
	3			Of the Degrees of that Part of Matter as is Animate
	4			Of the Intermixing of every Degree of Infinite and Only Matter
	5			Of Motion
	6	1	12/14	Of Vacuum
	7			Infinite Matter cannot have an Exact figure or form
	8			Of the Degrees, Changes, Parts, Divisions and Compositions in Infinite Matter
	9			Of the Grounds or Principles of Only Matter
	10			Of Varieties
	11			Of the Equality of several Degrees and Changes of Infinite Matter and Motion
	12			Motion causeth Disturbance, but the Nature of Only Matter keepeth Peace
	13			Of the Knowledge and Power of Infinite Matter
	14	1	8	There is not a Judge in Infinite Matter (similar only)
	15	1	45	Of Life, Knowledge, and Matter (similar only)
	16			Of Life and Knowledge
	17			Of the Sensitive and Rational Animate Matter
	18			Of Creations
	19			Of Productions
	20			Of the Producer, and the Produced
	21			That the Produced partakes of the Producer
	22			Of the several Creating Motions and Matter
	23			The Sensitive Animate Matter causeth the Inanimate Matter to help in Creations
	24			Of the Motion of Animate Matter

1663 Edition		1655 Edition		Title/Comments
Pt.	Chap.	Pt.	Chap.	
2	1			Of Creation, or Production
	2			Of the Quantity of Animate Matter, and Inanimate matter, in Creations of Men or Animal Kind
	3			Of Infancy, Youth, and Full Growth
	4			Of Decay or Age
	5			Of Death
	6			Of Local Motions and Shapes, as also of several Shapes amongst Animals
	7			Of the External Animal motions
	8			Of Man's particular Shape
	9			Of the Mind
	10			Of the Mind and Body of Man
	11			Of the Communication or Information between the Mind and Body, as between the Sense and Reason
	12			The Imitations between the Sensitive motions of the Body, and the Rational motions in the Mind
	13			Of the Various motions in the several Parts of Man
	14			Of the Coherence of several Motions in several Parts of a Man's Body
	15			Of the Ebbing and Flowing of Animate matter
	16			Of the Motions in the Head, and other Parts of a Man's Body
	17			The Rational Figures, as Thoughts, made in the Head
	18			Of the Rational motions in the Heart, or such Lower Parts
	19			The Desire of Fame

1663 Edition		1655 Edition		Title/Comments
Pt.	Chap.	Pt.	Chap.	
3	1			Of Imagination or Conception
	2			Of Conjectures and Probabilities, Inventions, Arts, and Sciences
	3			What makes Arguing and Disputing, both with a Man's Self, or Others, or with the Sense and Reason
	4			The different Degrees of Man's Knowledge
	5			Of Rational Knowledge in Parts
	6	1	11	Of Unities or Equalities (1655 version is in verse)
	7			Of Influence
	8			Of Operation
	9			Of the Procreation of Thoughts, and of Faith
	10	2	59	Of Fortune
	11			Of Chance
	12			The Restlessness of Creatures
	13	2	60	Of Time and Nature
	14			A Sympathetical Agreement and Indeavour between the Rational and Sensitive motions in one Creature, for Safety and Defence
	15			Of the Increase and Decay of Knowledge
	16			Objections against some Opinions of Incorporality
	17			Objects: Sense doth not Judge
	18			Of one Object working Different Effects upon the several Senses
	19			All Thoughts and Senses and Objects are Substances
	20			Of Divisible or Dividings
	21			Of Notions
	22			Of the Notions or Thoughts, of Deafness, Dumbness, Blindness, Lameness, Baldness, Absence, Death and Sin

1663 Edition		1655 Edition		Title/Comments
Pt.	Chap.	Pt.	Chap.	
4	1	2	61	Of Matter, Motion, and Figure
	2	2	62	Of Causes and Effects
	3	2	63	Whether Motion be a Thing or Nothing, or can be Annihilated
	4	2	64	Of Motions
	5	2	65	Many Motions go to the Producing of one Thing, or to one End
	6	2	66	Of the Six Principal Motions
	7	2	68	Of Double motions at one and the same Time, on the same Matter
	8	2	69	Of several Strengths
	9	2	71	The Agility of Animate matter
	10	2	73	Of Repeating one and the same Work, and of Varieties
	11	2	74/75	Of Creation and Dissolving of Nature
	12	2	76	Of Sympathy, and Anitpathy, which is to Agree or Disagree, Joyn or to Cross (some changes in phrasing)
	13	2	76	There's no Supreme Knowledge (some changes in phrasing)
	14	2	77	Of Different Knowledge in Different Figures
	15	2	78	The Advantages of some Figures, and some Degrees of Matter and Motions over others
	16	2	79	Of Figures in Figures
	17	2	80	Of the Gloomy Figures, and Figures of Parts, and one Piece
	18			Of Round and Square Figures, and their Motions
	19			Of Heavy and Light Bodies
	20			Of Bodies, that are apt to Ascend or Descend
	21			Why Heavy bodies Descend more easily and freely than Light bodies Ascend
	22			The Observations of Human sense and reason
	23			Of Change
	24			Of the Variety of one and the same Sort of Shapes and Motions
	25			The Different Degrees of one and the same Kind or Sort of Degrees of Matter, and Changes of Motions
	26	2	83	Of Transmutation (1655 title: "Of Transmigrations")
	27	2	84	Of Metamorphosing of Animals and Vegetables
	28	2	85	The Metamorphosing of the Exterior Form of some Figures
	29			Of Fixed and Loose Elements
	30			Of Loose Humors and Elements
	31			The Change of Motions
	32			Of Lines
	33	2	88	Of Circles (similar but not identical content)
	34	3	91	Of the Extension and Contraction of Circle-Figures or Circle-Lines (very similar with some sections omitted in 1663)

1663 Edition		1655 Edition		Title/Comments
Pt.	Chap.	Pt.	Chap.	
	1			Of the four Worlds, of Fire, Air, Water, and Earth
	2			Of different Motions and Creatures
	3	3	107	Of Moist colds and Moist heats, of Dry colds and Dry heats, and of Hot and Cold motions in general (shorter in 1663 edition)
	4	3	108	Of the Motions of Cold and Hot, Drought and Moisture (summary of 1655 chapter)
	5			Of Earth
	6			Of Water
	7	3	87/89/ 90	Of the Wetness of Water, and other Sorts of Liquors (combines elements of all three chapters from 1655)
	8			Of the Interior Figure and Motions of Bright-shining Hot-burning Fire
	9			Of the Interior and Exterior motions of Bright-shining Hot-burning Fire
	10	3	102	Of the Exterior motions of several Sorts of Fire (some elements only)
	11			Of the Sort of Fire that is named a Dead fire, and the Difference betwixt that, and Bright fire
	12			Fire produced by Exterior motions
	13			Of Hot and Burning motions and of Burning figures
5	14	3	94	Of the Nature, Motions, and Figure of Oyl (similar but not identical)
	15			Of the Division of several Liquors
	16	3	95	Of the Interior Figures and Motions of Metal (very similar but not identical)
	17	3	102	Of the Exterior Motions of Heat and Fire (similar opening only)
	18	3	103	Of the Power of Water on Fire, as the Quenching out Fire (similar but not identical)
	19	3	104	Of the Dissolving of Water (middle section is rephrasing of 1655 chapter)
	20	3	114	Of the Motions that make natural Air and Natural Light (similar in one part only)
	21	3	116	Of the Motions that make Darkness (longer in 1655)
	22	3	118	Of Shadows (only first sentence the same)
	23	3	119	Of Shadows and Aery Figures
	24			Of Stone
	25			Of Transparent Stones
	26	3	96	Of the Load-stone
	27	3	96 (97)	Of the needle (chapter 97 is incorrectly numbered in 1655)
	28	3	127	Of the Different Motions and Figures in the Tides, as Flowing and Ebbing of the Waters (1663 introduction is different)
	29	3	128	Describing of Tides

5	30	3	229 (129)	Of Double Tides (chapter 129 is incorrectly numbered in 1655; though the titles are the same, the reasoning is quite different)
	31	3	130	Of Spring-tides. (different phrasing in 1655)
	32	3	131	Of Tides and Streams Flowing against each other (1655 version is slightly longer)
	33			Whether the Sea run thorow the Veins of the Earth
	34			Of Nilus
	35			Of the Divided parts of Water, and several External motions
	36			Of Rain
	37	3	123	Of External Figures and Internal Forms (longer in 1655)
	38			Of Metamorphosed Elements
	39	3	92	Of those Motions or Figures that turn Water to Snow, Hail, Ice and Frost (similar to the middle section of 1655 chapter)
	40	3	92	Why Snow is Rougher and Lighter than Ice and Hail (similar to middle section of 1655 chapter)
	41	3	121	Of Colours (middle section in 1663 is similar to 1655 chapter)
	42	3	122	Of Aery Figures
	43			Of several Sorts of Vapors
	44			Of the Agreement and Disagreement of Fire and Wind
	45			The Difference of Cold and Hot Winds and Vapors
	46	3	133	Of Wind
	47	3	134	Of the Noise of Tempest and Storms
	48	3	135	Of Thunder and Lightning
	49	3	132	The Difference of Salt and Fresh water
	50	3	136	Of the Alteration of Motions
	51	3	138	Of the local motions of Water, Air, and Fire
	52	3	125	The Motions of the Sun and Planets
	53			All Heat is not only Inherent in the Sun
	54			Of the Sun
	55			Of the Moon
	56			Of the Planets
	57			All Creatures are Intermixed or Joyned or Have Commerce with each other
	58			Of the Tempers of the four Seasons of the Year, as Spring, Summer, Autumn, and Winter
	59			Motions doth not Work in all Creatures exactly

1663 Edition		1655 Edition		Title/Comments
Pt.	Chap.	Pt.	Chap.	
6	1	4	141	Of the Motion of the Body
	2	4	142	Of the Frame of Man's Body
	3	4	143	Of Natural Self-tyranny
	4			Of the Understanding, Sense, and Reason
	5	4	144	The two Ground motions in the Rational Animate matter
	6	4	145	The two Chief parts belonging to Man, are the Head and the Heart, wherein Reside the Rational Spirits
	7	4	146	Whether the Passions are made in the Head or Heart
	8	4	147	Of Different Passions in one and the same Part
	9	4	148	The Affinity betwixt Imaginations and Passions
	10	4	149	Of the Brain
	11	4	150	Of the Multitude of Figures in the Rational matter, in the Brain, and Heart
	12	4	151	Of Thoughts
	13	4	152	Of Thinking or Thoughts
	14			The Cause why a Man hath not his usual Knowledge, Sense, and Reason, in a Swoon or Trance
	15			Of Sense and Knowledge in Dead and Living men
	16			Of the Motions of the Rational and Sensitive matter
	17			The Power of the Rational motions over the Sensitive
	18			Of the Regular and Irregular motions of the Rational and Sensitive Animate matter
	19			Of Sleep
	20			Of the Disturbance of some Parts, causing a Disturbance in the Whole, as to hinder from Repose or Sleep
	21			The Difference between Sleeping and Waking
	22	4	153	Of Sleep and Dreams
	23	4	154	Dreaming of Living and Dead Figures
	24	4	155	Of Local Dreams
	25			The rational and Sensitive motions do not at all times take a general Notice or Knowledge of their own Body and Mind
	26	4	157	Of the Figures presented to the Senses (different phrasing)
	27	4	160	Of the Several Senses (1655 title: "Of Sight")
	28	4	164	Of Hearing, Seeing, and the other Senses (similar in general content)
	29	4	164, par. 3	Of particular Objects entring into several Men's particular Senses
	30	4	161	Of Light and Colours
	31	4	163	Of Hearing
	32	4	165	Of Taste, Touch, and Smell
	33	4	166	Of Touch
	34	4	167	Of the Pores of the Body

1663 Edition		1655 Edition		Title/Comments
Pt.	Chap.	Pt.	Chap.	
7	1	5	167[7]	Of Natural Warrs in Animal Figures
	2			Of the Motions of the Blood
	3			Of the several Ways of Bleeding Physically
	4	5	134[8]	Of Diseases caused by Conceit or Imagination (similar, but not identical)
	5	5	168	Of the four Natural Humors of the Body
	6	5	169	The Four Natural Maladies of the Body, and Two Unnatural (1655 title: "The five natural Maladies of the body")
	7	5	170	Of the Motions that make Sickness (1655 title: "I will treat first of the motions that make sicknesse")
	8	5	171	Of the Motions which cause Pain
	9	5	172	Of Swimmering or Dissiness in the Head
	10	5	175	Of Weakness
	11	5	176	Of Numb and Dead Palsies
	12	5	177	Of that we call a Sleepy Numbness
	13	5	179	The Manner of Motion, or Disorder in Madness
	14	5	180	Of Madness in the Body and Mind
	15	5	181	Madness is not always in the Head
	16	5	182	Musick may Cure those that are Mad in Mind (1655 title: "Musick may cure mad folks")
	17			Of Natural Fools or Ideots, also of Deaf and Dumb Men
	18	5	183	Of Fundamental Diseases (1655 title: "Of the fundamental diseases, first of fevours")
	19			Of the Spotted Feaver, especially the Spotted Plague
	20			Of the Small Pox and Measles
	21	5	188	Of Expelling the Malignity to the outward Parts of the Body
	22			Of Hectick Feavers
	23			Of ordinary Feavers
	24			Of feavers in the Blood
	25			Of Agues
	26	5	191	Of Consumptions
	27			Of Coughs
	28	5	192	Of Dropsies
	29	5	189	Of Sweating Diseases
	30			Of Gangrenes
	31			Of Cancres and Fistulas
	32			Of the Gout

[7] The 1655 edition has two chapters numbered 167 (pp. 125, 127). Here, the reference is to page 125.
[8] This chapter is incorrectly numbered; it falls between chapters 187 and 188 (*PPO55* 142).

	33			Of hard white Swellings
	34			Of the Stone
	35	5	193	Of Apoplexies
	36	5	194	Of Epilepsies
	37			Of Lethargy
	38	5	195	Of Shaking Palsies
	39	5	196	Of Convulsions and Cramps
	40	5	197	Of Colicks
	41	5	190	Of Surfeits
	42			Of Unnatural Purging and Fluxes
	43			Several Causes of the Flux, of Purging or Vomiting
	44	5	198	Of Diseases in the Head, and Vapors to the Head
	45	5	173	Whether the Brain turns Round in the Head
	46	5	174	Of the Sound or Noise in the Head
	47	5	178	Of the Head feeling Numb
	48			Of the Winter, and the Diseases therein
	49			Of the Season of the Spring, and the Diseases most Frequent therein
	50			Of the Season, and the Diseases of the Summer
	51			Of the Autumn, and the Diseases most Frequent therein
	52	5	185	Of the Infections of Animals, Vegetables, and Elements
7	53			Of the Superfluity of the Humors, , as Phlegm, Choler, Melancholy and Blood
	54			Of those Parts of the Veins which draw Nourishment into the Body
	55	5	200	Of the several Motions in an Animal Body
	56			Of the Animal or Radical and Vital Spirits in Animal Bodies
	57			Of Cordials and Opium
	58			Of Pleasure and Pain
	59	5	202	The nature of Purging Medicines
	60	5	103 (203)	The Motion of Medicines (chapter 203 is incorrectly numbered in 1655)
	61			Of Purging
	62			The reason why one and the same Quantity of Physick shall Purge some Bodies to Death, and not Move other Bodies, or at least not to that Degree
	63			The Agreeing and Disagreeing of Food, as also Physick and Cordials
	64	5	204	The Agreeing, and Disagreeing of Humors, Senses, and Passions
	65	5	205	Of Outward objects Disagreeing with Natural Motions, and Humors in the Body
	66	5	206	Of the Inward and Outward Senses and Parts of the Body
	67	5	207	The Sympathies and Antipathies of Sound to the Mind and Actions
	68	5	208	The Knowledge of Diseases
	69			Of Diseases in General
	70			The reason why Animals are Hot whilst they Live, and Cold when Dead
	71			A Conclusion of this Part, of Diseases
	72	5	210	The Deitical Centre

APPENDIX C

An Example of Cavendish's Editing Processes

In the 1655 edition of *Philosophical and Physical Opinions*, Cavendish discusses the figure of the circle in several chapters, but most specifically in chapters 88 and 91. In 1663, a discussion of approximately the same length occurs in two consecutive chapters, 33 and 34, in the fourth part of her treatise. The two editions are similar but not identical in phrasing. By 1668, in *Grounds of Natural Philosophy*, the discussion of the circle is cut by more than two-thirds. Comparing the 1668 and 1663 versions shows how much more substantially Cavendish edited and rewrote her original opinions.

Phrasing from the 1663 edition that is similar or retained verbatim in 1668 is indicated in bold print. Portions cut from the 1663 edition are shown with strikethrough. New additions are in bold italics.

From *Philosophical and Physical Opinions* (1663), Part 4, Chapter 33, "Of Circles":

A Circle is a Round figure without Ends, ~~having a Circumference, and a Centre,~~ **and the Figure of a Circle may, more aptly alter the Exterior form than any other Figure** ~~can~~; **for a Circle-line may be *drawn*** ~~Contracted~~ **many several ways,** ~~and after divers forms or fashions, but it cannot be Dilated but after one manner of way, which is to Dilatate, and so to inlarge the Circumference, and the Parts from the Centre by an equal Dilatation to the Circumference; for if a Circle be extended in part, and not in whole, as it Extends or Dilates one way, it Contracts in another way, whereas a Parallel line may be Dilated or Extended in Parts, without a General alteration, but a Circle-line cannot, for as one part stretches out, another part draws in; but, to conclude, a Circle figure may be Dilated and Contracted, and be Changed into many several Exterior figures or forms, and yet keep the Interior figure or form; also a circle may move Interiously, as also Exteriously several ways, as to move from the Centre to the Circumference, and from the Circumference to the Centre; as also to move Circle-ways according to the Figure, as to move Round.~~

From *Philosophical and Physical Opinions* (1663), Part 4, Chapter 34, "Of the Extension and Contraction of Circle-figures, or Circle-lines":

~~The Nature of Extensions and Dilatations strives or indeavours to get Space, Ground, or Compass, as also to Smooth, Plain, or Level, the Substance or Matter those Motions work on, and with, but the Nature of Contracting motions indeavours or labours to cast or thrust out Space, Place, Ground or Compass, labouring to draw and croud Substance Matter or Parts close together, and this is the reason that Circle-lines or Figures may be Contracted many several Ways, Forms or Figures , because Contraction flings out the Compass, and onely makes use of the Line or Circumferent circle, drawing~~ ~~and laying the Line~~ **into millions of several Works or Figures, without breaking or dividing** ~~the Exterior form, which is~~ **the Circle;** ~~and this is the reason, that when the Contractions are over-powered by Dilations, and that the Circle extends the full Compass, it returns to its Original form, which is a Round circle, without any alteration; and thus may a Circle figure or Line Exteriously alter several ways by Contraction several times, and yet keep the Interior form, figure or nature; also Circle Lines or figures may be Exteriously altered by Mixt Exterior motions, as for Example, when a Circle line should be wound about a Round staff, or such like thing, the winding about the Pole or Staff is the Motion of Contraction, at least one way, as when the Compass is turned Inward, as towards the Centre, yet by winding one Line above another is Extenuation, and millions the like Examples may be given. But to draw towards a conclusion of this Chapter, a Circle may be Drawn or Contracted~~ ***also, it may be contracted or extended into a less or wider compass; and drawn or formed into many several sorts of Figures, or Works; as*** **into a Square figure, and into a Triangular figure,** ***or Oval, or Cylinder or like several sorts of Flowers, and never dissolve the Circular Line*** ~~and into a Cube figure, and into a Parallel figure, the Parallel is made by drawing the Circle long-ways; but all those several Figures, and many other Figures, made partly of each figure without dividing the Circle; also Circle-lines may be very Different, and yet not different in the compass or Circle,~~ ***But this is to be noted, that there may be several sorts of Circular Lines;*** **as some** ~~Circles may be~~ **Broad, some Narrow, some Round, some Flat, some** ***Ragged or*** **Twisted, some Smooth,** ~~some Rough~~**, some Edged, some Pointed,** ***and numbers of the like; and yet the compass be exactly round.*** ~~for though the Compass may be evenly Round, yet the Matter of the Circle may be uneven; and though the Figure of a Circle is to be but one intire figure in and of it self, yet the Substance, or Matter of the Circle may be different; but as for the Figure of a Circle,~~ ***But*** **some may say, that a Circle is not a circle, when by several motions it is made Square** ~~or Triangular~~**; I answer that it is circle squared, but not a Circle broken,** ***or divided*****; for** ~~if the Circle be whole, as not broken or divided,~~ **the Interior nature is not Dissolved** ~~or Destroyed~~**, howsoever the Exterior**

figure or form is changed or altered, it is a Natural ~~or Perfect~~ **circle still, although it** ~~Exteriously~~ **should be put into a Mathematical Square** ~~or other figure~~**. But, to conclude,** ~~(for I have digress'd) it is to be observed,~~ ***I*** **say that all those Figures that are** ***(like Circular Lines)*** ~~by Nature made~~ **of one Piece,** ~~without Distinct parts and Several Tempered substances,~~ **their Exterior forms or shapes may be changed and re-changed without any alteration of their Interior proprieties,** ~~forms or natures, whereas those creatures or Figures, that are made into several Distinct parts, and composed of several Tempered substances or Matter, could not be so changed without an Interior Destruction, besides the alteration of Different parts and Different composures or temperaments, would cause a Confusion of Several Motions in their Transformations.~~

From *Grounds of Natural Philosophy* (1668), Part 11, Chapter 14, "Of CIRCLES":

A Circle is a Round Figure, without End; which Figure can more easily and aptly alter the Exterior Form, than any other Figure. For example, A Circular Line may be drawn many several ways, into different and several sorts of Figures, without breaking the Circle: also, it may be contracted or extended into a less or wider compass; and drawn or formed into many several sorts of Figures, or Works; as, into a Square, or Triangle, or Oval, or Cylinder, or like several sorts of Flowers, and never dissolve the Circular Line. But this is to be noted, that there may be several sorts of Circular Lines; as, some Broad, some Narrow, some Round, some Flat, some Ragged or Twisted, some Smooth, some pointed, some Edged, and numbers of the like; and yet the compass be exactly round.

But some may say, that, When a Circle is drawn into several Works, it is not a Circle: As for example When a Circle is squared, it is not a Circle, but a Square.

I answer: It is a Circle squared, but not a Circle broken, or divided: for, the Interior Nature is not dissolved, although the Exterior Figure is altered: it is a Natural Circle, although it should be put into a Mathematical Square. But, to conclude this Chapter, I say, That all such sorts of Figures that are (like Circular Lines) of one piece, may change and rechange their Exterior Figures, or Shapes, without any alterations of their Interior Properties.