The Architectures of Knowledge:
Spatial Metaphors in Seventeenth-Century Science

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Abstract

This thesis sets out to explore the connections between scientific space and natural philosophical writing in seventeenth-century England. Though recently scholarly accounts have paid increasing attention to the spaces that housed the 'new science', very little attention has been paid to the ways in which these spaces were replicated on the page. This thesis will remedy that oversight by tracing the rich nexus of interconnections that linked natural philosophy, books and spaces of scientific investigation in seventeenth-century writing.

Following an introduction in which the work and residence of Francis Bacon illustrate the rich multiplicity of ways in which architectural rhetoric shaped early modern epistemologies, each subsequent chapter explores the analogical and metaphorical resonances of one of the spaces Bacon recommends for philosophy in his *Gesta Grayorum* (1594-95). Chapter One uses Thomas Browne's *Garden of Cyrus* (1658) to show how the structures associated with particular scientific spaces could provide formal and aesthetic frameworks for texts. Highlighting the material and conceptual connections between gardens and early modern books, it explores how spatial analogies could work in extra-verbal ways, relying on shared cultural understandings and material histories to suggest methods of reading and knowing. Chapter Two examines the metaphor of 'Nature's Closet' in Margaret Cavendish's *Poems, and Fancies* (1653), illustrating how a multiplicity of real spaces might coalesce in the archetypal space of metaphor, and examining how sites of knowledge-making could be used both to formulate and express ideas about the nature of knowledge itself. Chapter Three surveys how the metaphorical laboratory worked across a wide range of natural philosophical texts as an explanatory figure for digestion. It interrogates what it means for a space so emblematic of empirical discovery and practical experiment to be used as an analogical trope and suggests how spatial analogies might transform as well as communicate developments in scientific theory.

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Declaration

I declare that this is a presentation of original work and I am the sole author. This work has not previously been presented for an award at this, or any other, University. All sources are acknowledged as references.

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A shorter version of Chapter Two is currently under preparation for publication in the book *The House in the Mind*, a selection of articles based on the conference of the same name held at Wadham College, Oxford, published by Palgrave Macmillan (forthcoming).

Introduction

Building the House of Philosophy

Science is built up of facts, as a house is built of stones; but an accumulation of facts is no more a science than a heap of stones is a house.[1]

Natural Philosophy: A Brick House?

In Thomas Shadwell's satirical play *The Virtuoso* (1676) a comic aside hints at a pervasive truth. The eponymous virtuoso, Nicholas Gimcrack, has just announced his latest discovery: dust motes, he claims, are actually tiny living creatures. Awed by his friend's skill, Sir Formal Trifle suggests the allure of natural philosophy for its disciples. 'Talk of use?' he blusters, rebuking any in the company who might be skeptical about the utility of this new finding, '[t]hese are the mysteries of nature's closet'.[2] For Sir Formal, knowledge is an end in itself. All mysteries beg to be solved, and locked rooms or boxes—as an early modern 'closet' would denote— have been tempting curious onlookers since Pandora. The metaphor of nature's closet, which evokes the cabinet of curiosities so fashionable at the time, is just one of many spatial metaphors that were used to conceptualise natural knowledge in the early modern period. Trifle, however, is known for his ridiculous oratory, and his lofty rhetoric is quickly torn down by his love-rival, Bruce. Scoffing at the notion that the philosophical pretensions of Trifle and Gimcrack have any 'use' at all, he snipes: '[t]his foolish *virtuoso* does not consider, that one bricklayer is worth forty philosophers'.[3]

Bruce's brutal aside has extra bite because Shadwell adopts the rhetoric of construction beloved by many natural philosophers in order to demolish their grandiose pretensions. His productive bricklayer feeds off an implied comparison with the common trope in which knowledge is depicted as something that can be 'built'. But where philosophers build castles in the air, bricklayers have something tangible to show for their labours. Contrasted with the solidity of a brick house, the work of these hapless philosophers, who struggle to open even an imaginary cabinet,

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[1] Henri Poincaré, *Science and Hypothesis* (London: Walter Scott Publishing Co., 1905), 157.
[2] Thomas Shadwell, "The Virtuoso," in *The Sensational Restoration*, ed. H. James Jensen, (Indianapolis: Indiana University Press, 1996), 427.
[3] Ibid.

looks very flimsy indeed. Gimcrack's futile philosophising is exposed as vain self-interested nonsense when compared with the ethically, socially and materially productive labour of construction.

Shadwell's assertion of the utility of building was not merely a way of denigrating natural philosophy. Though building work must have been commonplace in seventeenth-century towns and cities as urban populations grew, a cataclysmic event saw construction in the capital skyrocket in the later part of the century.[4] In 1666 the Great Fire of London had destroyed great swathes of the City; the rebuilding that followed was an extraordinary project that took decades and shaped much of London as it still is today. Shadwell's satire was first performed ten years after the Fire, while major rebuilding work was ongoing, and opened in the Dorset Garden Theatre, a playhouse that had been built on the grounds of a building destroyed by the blaze. The prominent position held by Robert Hooke, the virtuoso most prominently singled out for Shadwell's mockery, on London's influential rebuilding committees—he was Surveyor to the City of London and Christopher Wren's right-hand man—made the criticisms particularly pointed.[5] Virtuosi might dabble in architecture as well as anatomy, but London needed the practical honest work of bricklayers much more than it required fanciful observations about microscopic eels in vinegar or bottled air.

This thesis sets out to explore the complex relationship between the built environment—in particular spaces of scientific activity—and English natural philosophical writing in the seventeenth century. Metaphors of philosophical place abound throughout the rich prose of this period. But as Shadwell's satire indicates, they are often laced with tension: between empirical and analogical forms of knowledge-making; objectivity and subjectivity; place and page; language and matter.

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[4] On population growth in cities, see: Lena Cowen Orlin, "Introduction," in *Material London, ca. 1600*, ed. Lena Cowen Orlin (Philadelphia: University of Pennsylvania Press, 2000): 1-14.

[5] Hooke realised that audiences, understanding him to be the inspiration for Gimcrack, were laughing at him when he attended a performance of *The Virtuoso*, writing in his diary: 'Damned Dogs. *Vindica me Deus*. People almost pointed.' *The Diary of Robert Hooke*, eds. Henry W. Robinson and Walter Adams (London: Taylor & Francis, 1935), 2 June 1676: 235. See also: Tita Chico, "Gimcrack's Legacy: Sex, Wealth, and the Theater of Experimental Philosophy," *Comparative Drama* 42, no. 1 (2008): 29-49; John Shanahan, "Theatrical Space and Scientific Space in Thomas Shadwell's *Virtuoso*," *Studies in English Literature* 49, no. 3 (2009): 541-571. On Hooke's architecture, see Michael Cooper, *A More Beautiful City: Robert Hooke and the Rebuilding of London after the Great Fire* (Stroud: Sutton Publishing Ltd, 2003). Though the design of the Dorset Garden Theatre has traditionally been ascribed to Wren, it is possible that Hooke was the architect, which would bring the comparison between natural philosophical and architectural work into even sharper relief. See: Diana de Marly, "The Architect of Dorset Gardens Theatre," *Theatre Notebook* 29 (1975): 119-224.

While these texts stand as monuments to a perceived new era of rationality, their use of figurative language betrays a lingering alliance to older ways of knowing. Attempting to reconcile these analogical approaches with the work of the new science, this thesis will explore the interactions between the real and metaphorical manifestations of spaces for scientific activity in a range of texts, highlighting the many ways in which philosophical work could occur on the space of the page.

Offering a sense of the variety of these evocative connections between place, page and philosophy, this introduction will trace some of the ways architecture and the natural philosophical project were connected for Francis Bacon, an author whose works feature architectonic metaphor and allusion very prominently, and who served as a formative influence and model for many natural philosophers of the later seventeenth-century, especially those developing the foundational logic of the Royal Society. Brian Vickers has noted that one of the 'major motifs' and sequences of imagery running through Bacon's works is 'the building of new structures of knowledge, which involves clearing the ground of previous edifices, designing the plans, collecting the materials, carrying the building through, and finally "removing the scaffolding and ladders out of sight."'[6] And yet, despite this recognition, very little critical attention has been paid to the metaphorical spaces of early modern science, either in Bacon's work or beyond it. By examining Bacon's work alongside the existing scholarship on the spaces and literary strategies of early modern natural philosophy, I will highlight key aspects of the relationship between architectural spaces, natural philosophy and the book that deserve further consideration and critical attention: namely, the overlap between scientific spaces and sites of domestic, artisanal and mechanical practice; the importance of imagined spaces and spatial metaphors in early modern philosophical texts; and the complex interconnections which exist between spaces, books, and knowledge.

Space for Science

Ironically, Shadwell's enthusiasm for buildings was likely one that most virtuosi would rally behind; even before the Fire, scientists were increasingly developing and

[6] Brian Vickers, "Introduction," in *Francis Bacon: The Major Works*, ed. Brian Vickers (Oxford: Oxford University Press, 2008), xxxi.

building specialised spaces for scientific work. Following sixteenth-century developments in mainland Europe, in the seventeenth century universities and institutions in England began to develop more extensive and specific facilities for scientific practice and teaching, from anatomy theatres and botanic gardens to dispensaries and laboratories. Increasingly, natural philosophy was regarded as a discipline with a place.[7]

This is abundantly clear in the work of Francis Bacon, whose dreams of ideal scientific space are well-documented in his writings. In the 'Device for the Gray's Inn Revels' (the *Gesta Grayorum* of 1594-1595) the importance of physical space to the natural philosophical project is made explicit. Advising the monarch on how to excel in natural philosophy and achieve 'the conquest of the works of nature; […] the searching out, inventing, and discovering of all whatsoever is hid and secret in the world', the Second Counsellor recommends an ambitious program of construction for spaces conducive to the understanding of nature. In a moment which Paula Findlen identifies as the moment that Bacon 'beg[ins] to fantasize about the locations for knowledge', the monarch is advised of the importance of suitable spaces in which to the philosophise.[8] A wish-list for the development of a philosophical property is swiftly put together:

> First, the collecting of a most perfect and general library, wherein whatsoever the wit of man hath heretofore committed to books of worth, be they ancient or modern, printed or manuscript, European or of other parts, of one or other language, may be made contributory to your wisdom. Next, a spacious, wonderful garden, wherein whatsoever plant the sun of divers climates, out of earth and divers moulds, either wild or by the culture of man brought forth, may be with that care that appertaineth to the good prospering thereof set and cherished: This garden to be built about with rooms to stable in all rare beasts and to cage in all rare birds; with two lakes adjoining, the one of fresh water, the other of salt, for like variety of fishes. And so you may have in small compass a model of universal nature made private. The third, a goodly huge cabinet, wherein whatsoever the hand of man by exquisite art or engine hath made rare in stuff, form, or motion; whatsoever singularity chance and the shuffle of things hath produced; whatsoever Nature hath wrought in things that want life and may be kept; shall be sorted and included. The fourth such a still-house, so furnished with

[7] See: Paula Findlen, "Anatomy Theaters, Botanical Gardens, and Natural History Collections," in *The Cambridge History of Science* vol. 3, eds. Katharine Park and Lorraine Daston (Cambridge: Cambridge University Press, 2006): 272-289; Andrew Cunningham, "The Kinds of Anatomy," *Medical History* 19, no. 1 (1975): 1-19.
[8] Findlen, "Anatomy Theaters," 272.

> mills, instruments, furnaces, and vessels, as may be palaces fit for a philosopher's stone.[9]

A library, a garden, a cabinet, and a stillhouse or laboratory: these, for Bacon, are the essential facilities required to understand the natural world. Findlen remarks that these spaces 'represented a full elaboration of science as an activity that removed nature *from* nature in order to study it better. Bacon's remarkable array of unique spaces for science mirrored the variety of possible experiences that one could have of nature, isolating all natural objects and processes'.[10] And yet, these spaces, the metaphorical forms of which constitute the focus of my thesis, together and individually constitute microcosmic arenas, entire worlds realised in miniature. While Bacon's fantasy project removes nature from itself, his ideal project also reconstructs it.

The *New Atlantis* (1627), Bacon's posthumously published utopia, indicates how enduring Bacon's dreams of a series of specifically-designated spaces for intellectual labour were. But if *Gesta Grayorum* offered a theoretically attainable blueprint by which the macrocosmic world might be microcosmically rendered within the grounds of a house, the fictional city of *New Atlantis* is a philosophical complex on an altogether different scale. The philosopher's mansion, offered as a proposal (however light-hearted) to a monarch, was potentially realisable, at least in a curtailed form. In Bensalem, his private, utopian fantasy, however, Bacon allows his imagination to run riot, expanding his wish-list for scientific space until a city almost entirely dedicated to science emerges. As he details an entire industrial infrastructure dedicated to the production of knowledge, the urban topography—and the narrative of Bacon's text—are dominated by spaces specifically for scientific investigation. But while the exhaustive (and exhausting) list of spaces for philosophical experimentation, material production and speculation in the utopian society of Bensalem features a number of impossible spaces, such as the chamber in which the movement of meteors is mimicked, the buildings around Solomon's House also gesture towards the extraordinary variety of real places that could accommodate natural philosophical labour in the early modern period; Bacon's fantastic theme park for science includes caves, observational towers, medicinal dispensaries, textile

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[9] Francis Bacon, "A Device for the Grays Inn Revels," in *The Major Works*, ed. Brian Vickers (Oxford: Oxford University Press, 2002), 54-55. All following references to Bacon's works will be to this edition, unless stated otherwise.
[10] Findlen, "Anatomy Theaters," 273.

workshops, furnaces, insulation chambers, 'perspective houses' for optical experimentation, orchards and gardens, kitchens, breweries, bakeries, collections of stones and clocks, engine houses, perfumeries, and galleries of inventions.[11] Bacon's detailed imaginary geographies make the importance of an extraordinary range of locations to the project of the 'new' science abundantly clear; natural philosophy, in this vision, was a cosmopolitan project to which everyone, everywhere, could contribute. But historical narratives have traditionally depicted scientific knowledge as emerging almost entirely from the *minds* of a few great men. How was it that the places of science, so prominent for Bacon, came to be lost?

The Repugnant Kitchen

It seems astonishing, considering how compulsively one of the founding fathers of the so-called 'Scientific Revolution' discussed them, that the spaces of science were largely ignored in scholarship until the late 1970s.[12] As Bruno Latour has vividly put it, historians and philosophers of science until that time tried to 'avoid the world of the laboratory, that repugnant kitchen in which concepts are smothered with trivia.'[13] In part the lack of attention given to scientific space was a problem of evidence; the material and archaeological remains of seventeenth-century sites for scientific investigation have rarely been preserved.[14] But given the breadth of texts referring to the sites of science in one form or another, the limited scholarship seems primarily to have been the result of an ideological resistance to considering the ways in which scientific knowledge was locally formed and culturally determined.

Latour has described how traditionally '[e]pistemologists and sociologists of knowledge explained truth through its congruence with natural reality, and falsehood through the constraint of social categories, epistemes, or interests. They were asymmetrical.'[15] This notion of science as a purveyor of universal and objective

[11] Bacon, "New Atlantis," 479-87.
[12] On the problematic nature of the term 'Scientific Revolution', see Steven Shapin, *The Scientific Revolution* (Chicago: University of Chicago Press, 1996), which begins 'There was no such thing as the Scientific Revolution, and this is a book about it': 1.
[13] Bruno Latour, *We Have Never Been Modern*, trans. Catherine Porter (Cambridge: Harvard University Press, 1993), 21.
[14] See R.G.W. Anderson, "The Archaeology of Chemistry," in *Instruments and Experimentation in the History of Chemistry*, eds. Frederick L. Holmes and Trevor H. Levere (Cambridge: MIT Press, 2000): 5-34.
[15] Latour, *Never Been Modern*, 94.

truths unblemished by sociocultural factors blossomed within traditional grand narratives of the Scientific Revolution and the development of 'modern science', which have privileged accounts of individual genius and discussed scientific truth as geographically and historically universal. Science, accordingly, has often been perceived and depicted as non-geographical, transcending any obvious setting or locality.[16] Robert E. Kohler has illustrated how important this idea of 'placelessness' has been in laboratory history, enabling us to conceive of laboratories as homogenous and uniform spaces capable of the production of universally legitimate knowledge, regardless of local or historical context, noting that '[p]lacelessness marks lab-made facts as true not just to their makers but to everyone, anywhere. It marks the lab as a social form that travels and is easy to adopt, because it seems rooted in no particular cultural soil but, rather, in a universal laboratory.'[17] This 'universal' space flattens the localised, material specificities of the cultures and places in which science occurs. Revealing such posturing as an 'artfully constructed yet highly potent and useful social fiction,' Kohler prompts us to look at what—or perhaps more pertinently, *where*—lies behind it.[18] What might appear to be 'neutral stages for experiment,' he suggests, will, upon closer comparison, be revealed 'as cultural spaces that actively shaped what went on inside them.'[19]

Recognising the rich potential in such studies, in recent decades, historians of science have attempted re-locate the discipline. This has provoked a re-evaluation not only of the sites that were used in the manufacture of knowledge, but also a slew of questions about the nature of knowledge itself. Adi Ophir and Steven Shapin have asked what it means if knowledge 'has an irremediably local dimension' and 'possesses its shape, meaning, reference, and domain of application by virtue of the physical, social, and cultural circumstances in which it is made, and in which it is used.'[20] Knowledge has been re-characterised as the product of a subjective and mutually transformative interaction between an individual and their environment; theorists including Peter Galison have argued that 'the built world helps define how scientists see themselves. Architecture can therefore help us position the scientist in cultural space; buildings serve both as active agents in the transformation of

[16] Adi Ophir and Steven Shapin, "The Place of Knowledge: A Methodological Survey," *Science in Context* 4, no. 1 (1991): 4.
[17] Robert E. Kohler, "Lab History: Reflections," *Isis* 99, no. 4 (2008): 766.
[18] Ibid.
[19] Ibid., 762-63.
[20] Ophir and Shapin, "Place of Knowledge," 4.

scientific identity and as evidence for those changes.'[21] Recognising that it was not only buildings that shaped scientists, but also that scientists' manipulations of space reflected the cultural conditions in which they worked and helped to constitute them, Galison has articulated the complex and multidirectional web of interactions between buildings, things and people that resulted in the production of culturally and historically situated forms of knowledge. Arguing that particular forms of spatial organisation lie at the heart of this mutually-constitutive environment, Galison suggests that '[i]t is through appropriation, adjacency, display, and symbolic allusion that space, knowledge, and the construction of the architectural and scientific subject are deeply entwined.'[22] The kinds of actions that Galison foregrounds, which relate to the organisation and spatial placement of things, play an especially important role in early modern science. Shapin, for example, has illustrated 'how the stages of experimental knowledge making mapped onto physical and symbolic patterns of movements within the rooms of a house, particularly the circulation between private and public places', indicating the ways in which social and spatial customs could affect the shape that knowledge took, as well as directing how it entered into the world.[23]

Shapin's work on the residences and laboratories occupied and used by Robert Boyle, the Royal Society, and Robert Hooke, is a compelling study of the intricate dance that produced knowledge and networks of credibility among the intellectual and institutional elites. But it reflects a wider tendency in the scholarship on early modern scientific space towards privileged groups and exceptional locations, such as the island castle of Danish royal astronomer Tycho Brahe, the gardens and anatomy theatres of elite European universities, or the grand collections of Italian noblemen.[24] In part this is a reflection of the fact that it was these elites that were most able to designate or build specific spaces for their philosophical work, and who, through their status and social networks, were able to produce and circulate

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[21] Peter Galison, "Buildings and the Subject of Science," in *The Architecture of Science*, ed. Peter Galison and Emily Thompson (Cambridge: MIT Press, 1999), 3.
[22] Ibid.
[23] Steven Shapin, "The House of Experiment in Seventeenth-Century England," *Isis* 79, no.3 (1988): 374. These are issues that Shapin has explored at length: cf. Steven Shapin and Simon Schaffer, *Leviathan and the Air-Pump: Hobbes, Boyle, and the Experimental Life* (Princeton: Princeton University Press, 2011); Steven Shapin, *A Social History of Truth: Civility and Science in Seventeenth-Century England* (Chicago: University of Chicago Press, 1994).
[24] See, for example, Owen Hannaway, "Laboratory Design and the Aim of Science: Andreas Libavius versus Tycho Brahe," *Isis* 77, no. 4 (1986): 584-610; Paula Findlen, "Masculine Prerogatives: Gender, Space and Knowledge in the Early Modern Museum," in *The Architecture of Science* eds. Peter Galison and Emily Thompson (Cambridge: MIT Press, 1999): 29-57.

experimental findings. It also reflects the bias of the archive, which is far more likely to preserve documentary evidence relating to the work of great or wealthy men. But a renewed focus on the ways in which place affects knowledge has prompted a reassessment of the scientific ecosystem of the seventeenth century, and with it our understanding of the diversity of people and places involved in scientific labour. The knowledge coming out of the Royal Society or Uraniborg might have been strictly regulated, but a whole range of spaces were producing a glut of natural knowledge, each according to their own rules.

While they have attracted a huge proportion of the critical attention, the well-off virtuosi and polymaths that made up the membership of London's scientific societies represented just a fraction of the people actively involved in natural philosophical work at the time.[25] By considering the broad range of practices, interests and applications encompassed by early modern philosophical activity, a clearer picture of just how widespread such practice was emerges. The natural philosophical enquiry of a dilletantish virtuoso might have been presented as frivolous and devoid of use by Shadwell, but scientific labour and investigation permeated an astonishing range of early modern industries. Dyers, brewers, apothecaries, goldsmiths, blacksmiths and distillers for example, were all involved in chemical work in spaces that would have been recognised by their contemporaries as laboratories.[26] Navigators were deeply invested in mathematics, astronomy and physics in the attempt to solve the longitude problem. A range of medical providers, from physicians and barber-surgeons down to midwives and quacks pursued findings in anatomy and physiology, while botany was a subject of interest not only for natural historians but also to gardeners supplying the latest exotic plants, and medicine makers. Artists were also scholars of nature, studying anatomy and natural objects in order to improve their own draughtsmanship, while also making many of the iconic images that illustrated the tomes of early modern science.[27]

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[25] Even within the intellectual elite, a vast amount of the technical and manual labour that went into producing natural philosophical findings was performed by 'invisible actors', skilled laboratory technicians of a lower class. See: Shapin, "House of Experiment," 395.

[26] Ursula Klein, "The Laboratory Challenge: Some Revisions of the Standard View of Early Modern Experimentation," *Isis* 99, no. 4 (2008): 770.

[27] On the visual culture of early modern science, see: Matthew C. Hunter, *Wicked Intelligence: Visual Art and the Science of Experiment in Restoration London* (Chicago: University of Chicago Press, 2013); Sachiko Kusukawa, *Picturing the Book of Nature: Image, Text, and Argument in Sixteenth-Century Human Anatomy and Medical Botany* (Chicago: University of Chicago Press, 2012).

Coffee houses provided vibrant and accessible spaces in which many of these interests might be shared, attracting a wide range of people and interests Larry Stewart, for example, has shown how the Atkinsons, a middle-class early modern family, used their coffee house as the epicentre of a range of diverse business interests, all of which pertained to natural philosophy: they 'published navigational texts, many of them decades old, and ran a coffee-house in Southwark from which they apparently also peddled scientific instruments.'[28] But these kinds of natural philosophical work occurred everywhere from public marketplaces to residential neighbourhoods and debtor's prisons: in a distinctly Latourian account, Deborah E. Harkness has even suggested that the entire city of London functioned as an extended laboratory.[29] The spaces and practices of science in the capital were so diverse, she suggests, as almost to make Bacon's utopian project a reality: while 'Bacon put all of these [diverse scientific] activities within a single, hierarchical institution overseen by a single, well-educated man', she notes, '[i]n all other respects […] Salomon's House already existed in the City of London'.[30] As Harkness adroitly notes, London was a more expansive and inclusive scientific site than Bacon's deeply ingrained prejudices could allow even a utopia to be.

Chief among the sites of early modern science was the household, and an increasing number of studies have demonstrated the many and varied overlaps between domestic and experimental space and practice.[31] Even Bacon, who longed

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[28] Larry Stewart, "Other Centres of Calculation, or, Where the Royal Society Didn't Count: Commerce, Coffee-Houses and Natural Philosophy in Early Modern London," *The British Journal for the History of Science* 32, no. 2 (1999): 149.

[29] Deborah E. Harkness, *The Jewel House: Elizabethan London and the Scientific Revolution* (New Haven: Yale University Press, 2007), 7. Latour suggests that the external world can only reflect and accept the discoveries of the modern laboratory 'if the same laboratory conditions are extended there beforehand', thus collapsing the boundaries between laboratory and 'external' world: Bruno Latour, "Give Me a Laboratory and I Will Raise the World," in *Science Observed: Perspectives on the Social Study of Science*, eds. Karin Knorr-Cetina and Michael Mulkay (London: Sage, 1983): 155.

[30] Harkness, *Jewel House*, 8.

[31] See: Simon Werrett, "Recycling in Early Modern Science," *British Journal for the History of Science* 46, no. 4 (2013); Deborah E. Harkness, "Managing an Experimental Household: The Dees of Mortlake and the Practice of Natural Philosophy," *Isis* 88, no. 2 (1997); Wendy Wall, *Recipes for Thought: Knowledge and Taste in the Early Modern English Kitchen* (Philadelphia: University of Pennsylvania Press, 2016); Elaine Leong, "Making Medicines in the Early Modern Household," *Bulletin of the History of Medicine* 82, no.1 (2008) and "Collecting Knowledge for the Family: Recipes, Gender and Practical Knowledge in the Early Modern English Household," *Centaurus* 55, no. 2 (2013); Elizabeth Spiller, "Recipes for Knowledge: Maker's Knowledge Traditions, Paracelsian Recipes and the Invention of the Cookbook, 1600-1660," in *Renaissance Food from Rabelais to Shakespeare: Culinary Readings and Culinary Histories*, ed. Joan Fitzpatrick (Farnham: Ashgate, 2010) and "Printed Recipe Books in Medical, Political, and Scientific Contexts," in *The Oxford Handbook of Literature and the English Revolution*, ed. Laura Lunger Knoppers (Oxford Oxford University Press, 2012); Sara Pennell, "'Pots and Pans History': The Material Culture of the Kitchen in Early Modern England," *Journal of Design History* 11, no. 3 (1998) and *The Birth of the English Kitchen, 1600-1850* (London: Bloomsbury Academic, 2016); Elaine Leong and Sara Pennell, "Recipe Collections and the Currency of Medical Knowledge in the Early Modern

for the institutionalisation of science, reluctantly recognised the essential nature of domestic spaces to natural philosophy, remarking '[t]here is a strange Reluctance, and kind of Loathing in the Mind, with regard to *mechanical Experience*, and the homely Observations of the *Kitchen,* the *Dairy*, the *Cellar*, servile Arts, and the like: and yet the most necessary, and serviceable part of all *Naturall Philosophy*, must be derived from such Observation.'[32] Despite Bacon's distaste for domestic activity and space, he recognised that the discoveries of the household had valuable information to offer the natural philosophical project.

Though scholars such as Paula Findlen have illustrated how many spaces of science were often deliberately gendered, they have also demonstrated that the location of scientific work in the household necessarily involved women in that work, and that these theoretically gendered boundaries, embedded in Renaissance architectural ideals and societal norms, often broke down in practice.[33] As well as the development of household spaces such as closets and libraries specifically for scholarly work, experimentation often took place in kitchens, using culinary equipment. Though this could sometimes generate tension, as experimental work impinged on the order of the household, Harkness has argued that 'as long as natural philosophy was practiced in the home, women were not only present, but influential.'[34] But women did not just assist in experimental work, or negotiate the work of the household around it: traditional women's work, including culinary activities, caring for the health of the household, and distilling also frequently drew upon and also helped to develop ideas at the cutting edge of science, making women a key component in the continuum of scientific practitioners.

The domestic setting of natural philosophy changed the essential character of the kind of work that was being done, making new kinds of empirical observation possible. 'The resituation of natural philosophy […]to the household,' Harkness has argued, 'generated new scientific practices, as mundane domestic events were subjected to scientific observation and documentation.'[35] The house might have been transformed by the natural philosophical practices imported within its walls, but natural philosophy too, was transformed because it took place in the house.

'Medical Marketplace'," in *Medicine and the Market in England and Its Colonies, c.1450-c.1850* eds. Mark S.R. Jenner, and Patrick Wallis (Basingstoke: Palgrave Macmillan, 2007).

[32] Francis Bacon, *The Philosophical Works of Francis Bacon, Bacon of Verulam*, ed. Peter Shaw, vol. 3 (London: J.J. Knapton, P.D. Midwinter, A. Ward et al., 1733), 12.

[33] Findlen, "Masculine Prerogatives," 30; 32.

[34] Harkness, "Mortlake," 257.

[35] Ibid., 262.

Though these accounts have provided us with a valuable sense of the variety of locations and participants involved in scientific activity in seventeenth-century England, they have often focused on people rather than place. But the stream of material culture studies that have permeated disciplines including literary studies, architectural history and science studies in recent decades have reasserted the importance of objects and physical spaces in producing knowledge. After all, scientific spaces are material, and constructed not just from bricks and mortar, but also from the furnishings, instruments and architectural features that occupy them. These things were essential tools for philosophical work, and scientific spaces were often specifically built or designed to accommodate them. In *The Advancement of Learning,* his great manual on how knowledge ought to be built, Bacon stressed the necessity of 'instrumentals' such as 'spheres, globes, astrolabes, maps, and the like', annexed 'gardens for simples of all sorts' and 'dead bodies for anatomies' in addition to and 'as well as' books in scientific spaces designed for the 'deep, fruitful, and operative study of many sciences, specially natural philosophy and physic'.[36] Sociocultural infrastructure can be materially embedded as well as embodied; it is expressed, circulated and constructed in, by and with objects and constructed environments as well as people.

Recent work on material culture has emphasised 'how variously things knit together matter and meaning' and revealed the 'dynamic and mutable nature of things as well as their representations and meaning'.[37] Scholars have sought to show how meaning is both socioculturally and historically embedded, but also materially and technically situated and made, considering how objects might materialise knowledge, and exploring how far such objects can be understood as autonomous while recognising that they are constructed, utilised, and studied in historically- and culturally-specific networks. As Gaston Bachelard has noted, '*Les faits sont faits*'—

[36] Francis Bacon, *The Advancement of Learning, Book Two*, 172.
[37] Lorraine Daston, "Introduction: Speechless," in *Things That Talk: Object Lessons from Art and Science*, ed. Lorraine Daston (New York: Zone Books, 2004), 10; Paula Findlen, "Early Modern Things: Objects in Motion, 1500-1800," in *Early Modern Things: Objects and Their Histories, 1500-1800*, ed. Paula Findlen (London: Routledge, 2012), 6.

facts are fabricated.[38] To understand how knowledge is made, we must also understand the contexts of making in which it was produced.

The crossover between domestic or artisanal labour and experimental practice is now reaching the forefront of critical consciousness. Larry Stewart, expressing a more widely-held notion, has blithely stated that during the mid- to late-seventeenth century, '[p]hilosophers and craftsmen inhabited unique worlds, with different customs and distinct attitudes to material production.'[39] This view, however, dangerously oversimplifies the evidence, belying the content even of his own article, which details the mutual exploitation of one other's resources by the guilds and the Fellows of the Royal Society. Ursula Klein has argued that laboratories were explicitly 'sites of material production' and not exclusively scholarly institutions, but also industrial and artisanal workplaces, documenting the overlapping methods, tools, interests and architectures that all of these spaces shared.[40] By indicating how the artisanal and academic are intertwined in the products of laboratories, Klein prompts an important consideration of how artisanal and academic values might be complicit in the way these spaces were perceived and represented by their contemporaries. She asserts forcefully that 'the early modern laboratory produced not only knowledge[…] but also artifacts and things'.[41]

Recent developments in literary studies have extended our understanding of how knowledge might be made to the realm of the book, illustrating how the craft of literature might produce knowledge that intertwines textual and scientific strategies. Compelling work by Frédérique Aït-Touati, Mary Baine Campbell, Elizabeth Spiller and Howard Marchitello has explicated the many productive crossovers of scientific and literary writing during the early modern period, aiming to unseat the false perception of a clean divide between the arts and science at this time. Instead they highlight ways in which scientific practices were 'understood as imaginative, creative and literary', and art was understood as a 'knowledge practice'; Marchitello has described how the literary and the scientific elements of Bacon's work, especially in the *Gesta Grayorum*, were 'mutually informing and mutually sustaining'.[42] Rayna Kalas

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[38] Gaston Bachelard, cited by Latour, *Never Been Modern*, 18.
[39] Larry Stewart, "Science, Instruments, and Guilds in Early-Modern Britain," *Early Science and Medicine* 10, no. 3 (2005): 394.
[40] Klein, " Laboratory Challenge," 778; 774.
[41] Ibid., 779.
[42] Howard Marchitello, *The Machine in the Text: Science and Literature in the Age of Galileo* (Oxford: Oxford University Press, 2011), 1; 29; 27. See also: Elizabeth Spiller, *Science, Reading and Renaissance Literature: The Art of Making Knowledge, 1580-1670* (Cambridge: Cambridge University Press, 2011); Frédérique

has shown how the links between literary, conceptual and material modes exposed Renaissance poetic imagery 'as a material practice and a technical craft', construing 'the work of the imagination' as 'comparable to any other artisanal skill.'[43] This thesis will build on such approaches, treating the literary, the scientific *and* the architectural as coterminous forms of knowledge-making in an attempt to show that the spaces of everyday scientific practice were not only places in which knowledge was produced but also, in themselves, conceptual tools, which helped to shape and communicate new forms of natural knowledge.

Bacon's insistence on the necessity of practical tools and spaces for carrying out primary investigation alongside the received knowledge provided by books or globes stresses the ways in which natural knowledge can be made through things. Gardening, for Bacon, is a mode of learning just as essential as reading or writing. Bacon's work reflects how *episteme̅* and *techne̅* often coexisted in early modern spaces of empirical investigation, with knowledge 'the outcome of a long tradition in which innovative forms of labor, technical expert knowledge, and text-based philosophies developed in tandem.'[44] Peter Dear has noted that unlike other intellectual disciplines including astronomy, medicine and music, which were built on a close pairing of *theorica* and *practica*, natural philosophy was theorised until the early seventeenth century as 'essentially and solely speculative because it was about understanding things, not doing things'.[45] However, as numerous critics have indicated, this traditionally posited 'hand-mind' divide in early modern science was not, in fact, a clean binary: instead, the practical and the philosophical overlapped in ways that made it hard to keep them artificially distinct.[46] Lissa Roberts and Simon Schaffer, for example, have celebrated 'the mindful hands and handy minds that collaboratively engaged in inquiry and invention between the late Renaissance and early industrialisation.'[47] Dear suggests that one of the most notable developments of

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Aït-Touati, *Fictions of the Cosmos: Science and Literature in the Seventeenth Century*, trans. Susan Emanuel (Chicago: Chicago University Press, 2011); Mary Baine Campbell, *Wonder & Science: Imagining Worlds in Early Modern Europe*, (Ithaca: Cornell University Press, 1999).

[43] Rayna Kalas, *Frame, Glass, Verse: The Technology of Poetic Invention in the English Renaissance* (Ithaca: Cornell University Press, 2007), ix; xvi.

[44] Ibid., 780.

[45] Peter Dear, "What is the History of Science the History of? Early Modern Roots of the Ideology of Modern Science," *Isis* 96, no. 3 (2005): 394.

[46] For further information on the hand/mind divide and the distinction between the theory and artisanal practice in early modern natural philosophy, see *The Mindful Hand: Inquiry and Invention from the Late Renaissance to Early Industrialisation*, eds. Lissa Roberts, Simon Schaffer and Peter Dear (Amsterdam: Koninkliijke Nederlandse Akademie van Wetenschappen, 2007); Harkness, *The Jewel House*; Stewart, "Science, Instruments and Guilds"; and Shapin, *Scientific Revolution*, 32.

[47] Lissa Roberts and Simon Schaffer, "Preface," in *The Mindful Hand*, xv.

the Scientific Revolution was 'a restructuring of natural philosophy', transforming it into a discipline where 'works[…] could act as testimony to philosophical truth and where the production of works was advertised as a major moral justification for natural philosophy'.[48] He traces the foundations of this view back to Bacon's *Advancement of Learning*, which divides natural philosophy into the production of speculative and operative effects. Bacon's rhetorical register, which emphasises the built and handcrafted nature of knowledge, supports Dear's claim at least insofar as Bacon was key to promoting the notion that physical works and philosophical truth may go hand in hand, though he was far from the first writer to employ such metaphors.

For Roberts and Schaffer, place is essential to this conjunction of material and knowledge making. They reflect on a process where localisation is essential: 'what is now called scientific knowledge is made in local and mundane ways[…] and tends often to be embodied in ingenious and artful labour. Its production requires and reinforces specially organised places where this labour is performed and between which it is distributed.'[49] Pamela Long, however, has suggested the complexities of this relationship between theory and practice. While arguing that linked traditions of handwork and the mechanical and technical arts range back as far as the ancient world, Long notes that the seventeenth century was the period in which the division between technical and epistemological traditions deepened—at least in rhetorical terms. She suggests that seventeenth-century experimental philosophers 'often distanced themselves from specific architectural, practical, and technical traditions' in order to 'enhance[…] the status of experimental knowledge by placing it in a special preserve, cordoned off from the practical concerns of architecture, technology, and practice as well as from the arena of political power.'[50] Long identifies a seventeenth-century trend whereby, despite an increasingly public dependence upon technologically sophisticated equipment, 'experimental philosophy became legitimized as valid "disinterested" knowledge of the world. Architecture, technology, and other practices came to be seen as separate and often derivative[…] but distinct from the new edifice of knowledge about the natural world.'[51] Long

[48] Dear, "History of Science?," 394.
[49] Ibid., xii-xiii.
[50] Pamela O. Long, "Openness and Empiricism: Values and Meaning in Early Architectural Writings and in Seventeenth-Century Experimental Philosophy'," in *The Architecture of Science*, ed. Peter Galison and Emily Thompson (Cambridge: MIT Press, 1999), 94.
[51] Ibid.

argues that having methodologically borrowed from the bricklayers, philosophy tried to disguise its links to technical craft.[52]

This thesis questions not only how effective this disguise was, but also whether there really was any such disguise in the first place. It is this fluid relationship between natural philosophy and architectonics, between epistemological and craft-based, material practices, that my work seeks to unpick. It is my contention that we can find both ends of this broad spectrum within the texts of the empirical sphere. After all, if labs make things and make knowledge, books, as mentally and materially crafted objects, seem perfect receptacles for their work.

Reading Buildings

Despite the impressive work that has been done there are still significant gaps in scholarship at the intersection of architecture and the history of science. Both Findlen and Carla Yanni have called for a stronger transdisciplinary approach, foregrounding the importance of literary and book history in furthering our understanding of scientific architecture and architectural science. Acknowledging that the history of scientific spaces is not only material, but also textually bound, Yanni recognises that '[m]uch architectural knowledge was mediated through the printed word, through journals and books', suggesting that '[c]lose attention to the history of the book and to the reception of architectural theory might be a profitable approach to seminal works [of architectural history]'.[53] Yet we might usefully push further than Yanni, who fails to address how books or text might be integrated into scientific and architectural histories apart from as documentary records. She neglects to consider the conceptual links between text and space, which might illuminate how these spaces might themselves *be* textual, and how the textual can be spatial.

Findlen, apparently writing in response, argues that historians have begun 'to consider why buildings matter in understanding not only what people did in places, but how they used space to organize and interpret their world.'[54] And yet she urges us to go further. Calling for accounts of immaterial or imagined spaces as well as real

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[52] Ibid.
[53] Carla Yanni, "History and Sociology of Science: Interrogating the Spaces of Knowledge," *Journal of the Society of Architectural Historians* 64, no. 4 (2005): 423.
[54] Paula Findlen, "History of Science: How Buildings Matter," *Journal of the Society of Architectural Historians* 65, no. 1 (2006): 7.

ones, Findlen argues that '[e]very generation has its memory theater in which it deposits its best projects. We should do our best to recapture these moments not simply as intellectual projects[…] but as meditations about the use of space.'[55] Putting the focus back on both the spatial and the imaginary, and asking about the multidirectional influence between our understandings of the world and the spaces we create, both materially and imaginatively, Findlen significantly complicates how we might want to think about scientific spaces. But she also sounds a note of caution: like physical buildings over time, in the translation from physical entity to the page, and through different periods of historical change, '[r]epresentations of things also migrate. Retracing their itinerary helps us to understand the production of meaning that frequently has a separate life from the object in question.'[56] Meanings generated through representations can be important, but they do not necessarily align with the meanings assigned to the things that they represent.

Through accounts primarily based on records of real spaces, scholars have provided some compelling accounts of the ways in which architectural space could both shape and reflect modes of thought. As Frances Yates has shown in her influential study of memory theatres, buildings can be at once conceptually and physically rooted, and, as Findlen notes, important cultural repositories for modes of thought.[57] Buildings, whether real or imagined, could be dialectical and rhetorical, showcasing and facilitating social and philosophical ideologies. Owen Hannaway and William R. Newman have demonstrated the symbolic potential of both real and imagined buildings, showing how philosophical concepts might be read and inscribed in architectural structures full of 'textual elements.'[58] Buildings, in either their plans (real or ideal) or their archaeology can be, as Jole Shackelford has conceded, 'treated as ideological documents' and 'presented for rhetorical purposes.'[59]

This is certainly true of many features in Bacon's own house, which were clearly conceived as spaces to be read. The Baconian crossover of the architectural

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[55] Ibid.
[56] Paula Findlen "Early Modern Things: Objects in Motion, 1500-1800," in *Early Modern Things: Objects and their Histories, 1500*-1800, edited by Paula Findlen (London: Routledge, 2012), 20.'
[57] Frances A. Yates, *The Art of Memory* (London: Pimlico, 1992).
[58] William R. Newman, "Alchemical Symbolism and Concealment: The Chemical House of Libavius," in *The Architecture of Science*, ed. Peter Galison and Emily Thompson (Cambridge: MIT Press, 1999), 64, 72; Hannaway, "Laboratory Design."
[59] Jole Shackelford, "Tycho Brahe, Laboratory Design, and the Aim of Science: Reading Plans in Context," *Isisi* 84, no. 2 (1993): 221.

and the natural philosophical was not merely conceptual. It was also realised materially in the stained-glass windows that Bacon commissioned for his house at Gorhambury.

Figure 1. The remains of Francis Bacon's residence at Old Gorhambury, near St. Albans. The property is now cared for by English Heritage.

Visitors to Old Gorhambury House today will find Bacon's statements on the power of words and the power of architecture vindicated: while Bacon's writings have been celebrated over centuries, and many early editions of his books still survive, his house now stands in ruins, barely recognisable as the manor complex that Bacon delighted in retreating to (Figure 1).[60] An English Heritage noticeboard, however, hints at a fragment of this building which is still legible. The stained-glass windows that adorned the gallery during Francis Bacon's residence are preserved in the 'new' eighteenth-century palladian Gorhambury House just a few hundred metres away.

The vibrant, highly decorative set of three stained glass windows seem to have attracted little analysis, but they were clearly a significant and memorable part of the building. Upon his visit to Gorhambury in 1656, John Aubrey remarked on the 'stately Gallerie, whose Glasse-windowes are all painted: and every pane with severall figures of beest, bird, or flower: perhaps his Lordship might use them as Topiques for Locall memorie.'[61] Aubrey's comment is illustrative, indicating how

[60] In a statement we will return to, Bacon remarks: 'We see then how far the monuments of wit and learning are more durable than the monuments of power or of the hands. For have not the verses of Homer continued twenty-five hundred years or more, without the loss of a syllable or letter; during which time infinite palaces, temples, castles, cities, have been decayed and demolished?' *The Advancement of Learning, Book One*, 167.

[61] Aubrey is cited by Michael Archer, '"Beest, Bird, or Flower": Stained Glass at Gorhambury House I,' *Country Life*, June 3, 1976: 1451.

places, or *topoi*, of knowledge, here in the form of stained-glass images, are not simply imagined, but embedded in the fabric of the building. Bacon's metaphorical architectures of knowledge are literally housed here: built into the frame of his main residence, the 'severall figures of beest, bird or flower' on these evocative windows reflect Bacon's particular interests in natural history.

Catherine Drinker Bowen's biography has imagined the influential power these beautiful windows might have had on the intellectual development of a young Francis Bacon:

> [i]n Sir Nicholas Bacon's new gallery at Gorhambury House were windows of colored glass, depicting flowers and birds and beasts from this new India: the tobacco plant, strange fishes, a savage with a baby slung in a furred hood upon her back. To young Bacon it must have been obvious that the humble artisan who painted Gorhambury windows knew more of plants and people, of their anatomies and properties, than did any Cambridge don.[62]

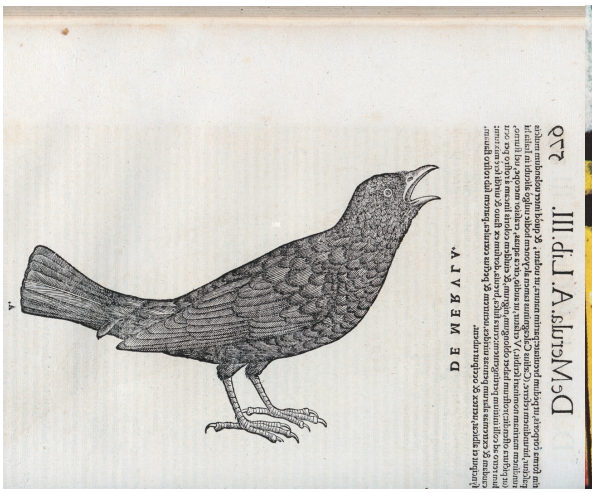

Figure 2. Blackbird. Illustration from Conrad Gesner, *Historiae Animalium* (Tigvri: Froschovervm, 1551-1587) vol. 3 (1555), 579. Zentralbibliothek Zürich, VD 16 G 1730, Vischer C 505. Image reversed and rotated.

Figure 3. Detail of panel from stained-glass windows originally installed at Old Gorhambury, c. 1615-1626. Image taken from Michael Archer, "'Beest, Bird, or Flower': Stained Glass at Gorhambury House I," *Country Life,* 3 June 1976, 1453.

While Drinker Bowen's account is suggestive of the imaginative power of the window, showing how it might have reflected Bacon's interests as well as his ideas about how natural philosophy should be done (the work of artisans reporting from the field was an essential first step in this process), she is almost certainly wrong in asserting that the window could have had such an early influence on Bacon. Michael

[62] Catherine Drinker Bowen, *Francis Bacon: The Temper of a Man* (London: Hamish Hamilton, 1963), 36. This follows Bowen's assertion that to a young Francis, 'Gorhambury was Eden' (32).

Archer has argued convincingly with the reference to the engravings copied on the panes and the pattern of the window frame that while the gallery was added to Gorhambury in the 1570s by Nicholas Bacon, the windows were commissioned and constructed during the tenure of Francis, between 1615 and 1626.[63] Drinker Bowen's comments, though, do not lose their pertinence: though Bacon was not inspired to draw up his scientific scheme by youthful interaction with the windows, he most likely commissioned them to reflect his ideals and interests, constructing a daily visual reminder of the epistemological schema he was attempting to advance.

The windows are irretrievably bookish: Archer lists a number of mostly Dutch sources for the engravings.[64] Using published sources as inspiration for decorative motifs was common in the sixteenth and seventeenth centuries, and the illustrations of natural history books often provided templates for emblems which featured in the décor of wealthy households, from tapestries to painted ceilings (see, for example Figure 4 and Figure 5).[65] But the natural imagery in Bacon's windows, which includes detailed illustrations of plants as well as animals, is particularly fascinating. Archer suggests that the panels in the windows have been re-arranged, and that the material evidence suggests that 'entire groups, for instance of birds or flowers, were originally together'.[66] This offers an enticing hint about the extent to which these windows might originally have been performing natural philosophical labour, perhaps spatially cataloguing the species they depict, slotting them in taxonomies according to similar qualities. By using engravings from natural history books as sources for the window images, Bacon's own dwelling becomes like a book: a space which can be read, and in which knowledge can be both created and communicated.

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[63] "'Beest, Bird, or Flower'," 1452-54. This time period was well into the ownership of Francis, who moved into Gorhambury in 1601. Archer's precise dating is based on the windows' use of printed sources: the pattern for the glazing is unusual, and apparently copied from a *Booke of Sundry Draughtes* produced for glaziers by Walter Gedde in 1615. This earliest possible date is confirmed by the use of Crispin van de Passe's *Hortus Floridus* (1614) as the source for some of the flower paintings.

[64] Images for a set of birds were derived from illustrations by A. Collaert in *Avium Vivae Icones*; fishes were copied from J. Sadeler in *Piscium Vivae Icones*; flowers came from sets by Sadeler in *Florae Deae* and Crispin van de Passe's *Hortus Floridus* (1614). Animals were copied from Conrad Gesner's *Icones animalium* (1560); A. Collaert and M. Gerardo's *Animalium Quadrupedum*; and Tempesta's fighting animals (1600). "'Beest, Bird, or Flower'," 1452-54.

[65] See: M.R. and W. Norman Robertson Apted, "Two Painted Ceilings from Rossend Castle, Burntisland, Fife," *Proceedings of the Society of the Antiquaries of Scotland* 104 (1972): 222; Michael Bath, *Renaissance Decorative Painting in Scotland* (Edinburgh: National Museums of Scotland, 2003); and Katherine Acheson, "'The Picture of Nature': Seventeenth-Century English Aesop's Fables," *Journal for Early Modern Cultural Studies* 9, no. 2 (2009): 30.

[66] "'Beest, Bird, or Flower'," 1454.

Figure 3. Wading bird. Fragment from the Oxburgh hangings, made by Mary Queen of Scots and Bess Talbot, Countess of Shrewsbury, c. 1570-1585. Victoria & Albert Museum, London, T.33Y-1955.

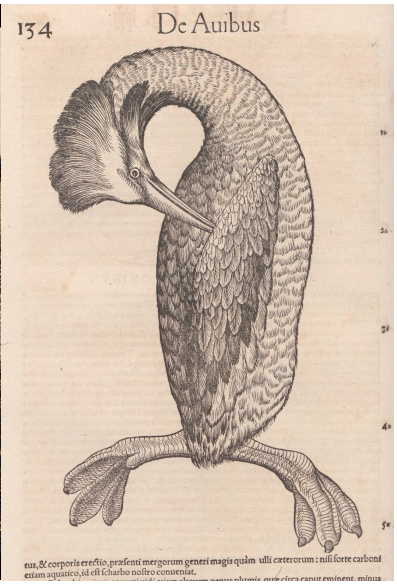

Figure 2. Loon or Grebe. Illustration from Conrad Gesner, *Historiae Animalium* (Tigvri: Froschovervm, 1551-1587) vol. 3 (1555), 134. Zentralbibliothek Zürich, VD 16 G 1730, Vischer C 505.

This seems to have been especially true of households with avid and active natural philosophers, who enjoyed the textual crossovers between buildings and books, and made little distinction between their walls and their emblem, commonplace and notebooks, covering their walls not only with images but also with text.[67] These inscriptions could be astonishingly self-reflexive, reflecting the work which was undertaken in those spaces in ideological and allegorical but also very literal ways: Uraniborg, for example, Tycho Brahe's castle-observatory, not only boasted a ceiling painted with the stars in the sky, but also a grandiose mural quadrant, which was at once a representation in the most literal terms of Tycho's labours, featuring a large portrait of Tycho at work, and simultaneously a functional astrological instrument, containing a cross-sectional depiction of each of the storeys of Uraniborg and the labour which happened within them.[68] Clearly the purpose of some of these features went beyond decoration, becoming elucidations of natural and educational

[67] See: Adi Ophir, "A Place of Knowledge Re-Created: The Library of Michel de Montaigne," *Science in Context* 4, no. 1 (1991): 173; Paula Findlen, *Possessing Nature: Museums, Collecting and Scientific Culture in Early Modern Italy* (Berkeley: University of California Press), 43.
[68] Hannaway, "Laboratory Design," 594-97; Findlen documents how Ulisse Aldrovandi 'commissioned several artists, most of whom were already employed as natural history illustrators in his museum to complete a cycle completing the life of Ulysses in the great hall and to fill three smaller rooms with emblems that transformed the best and most dramatic objects in his museum into moral allegories about the life of a humanist encyclopedist,' "Masculine Prerogatives," 42.

philosophies as well as aesthetically pleasing demonstrations of wealth, skill and taste.

Reflecting the dreams of the *Gesta Grayorum*, Bacon was clearly invested in recreating the natural world within his house: like his windows, the garden, featuring ponds enlivened with ceramic fish and ornate railings ordained with images of plants, clearly also played on the ability to construct a microcosmic world through representation.[69] But it was his windows, perhaps more than any other facet of Bacon's house, that speak most eloquently of the particular and peculiar nexus in which natural philosophical knowledge was made. Rayna Kalas has highlighted the potential of thresholds to bring together a number of disciplines, claiming that the Derridean frame 'works to suture boundaries between disciplinary practices and idioms: between poetry and painting, and between aesthetics and reason'.[70] As she notes, glass is especially potent and transformative, both materially and metaphorically: '[u]sed as metaphors, frames and glass did not link the word to an imaginary picture so much as they demonstrated the integration of visual technologies and with figurative invention, and of techne with poeisis.'[71] Bacon's windows, as Kalas suggests, demonstrate their own, hybrid forms of knowing. Physically occupying the boundaries between the external natural world and the constructed environment and displaying the ways in which natural knowledge is captured both through artisanal labour and within books, their structure literally illuminates how Baconian natural knowledge grows out of a convocation of these varied qualities that the window holds together. If Bacon's notions of natural knowledge were architectural, the space in which he lived and worked only served to reinforce the man's ability to frame the world in architectural terms.

Bacon's windows point towards the number of productive ways in which we might read spaces of knowledge, which are often explicitly verbal as well as pictorial, and material as well as textual. While the windows at Gorhambury suggest the legibility of buildings, and the myriad ways that natural philosophical and literary modes of interpretation and expression might intertwine when played out across a

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[69] Paula Henderson, "Sir Francis Bacon's Water Gardens at Gorhambury," *Garden History* 20, no. 2 (1992): 122. On the tradition of water gardens featuring representations of natural features and creatures, see Roy Strong, "Sir Francis Carew's Garden at Beddington," in *England and the Continental Renaissance: Essays in Honour of J.B. Trapp*, ed. E. Chaney and P. Mack (1990), 223.
[70] Rayna Kalas, *Frame, Glass, Verse*, 48. Kalas discusses Jacques Derrida, *The Truth in Painting [Vérité En Peinture]*, trans. Geoff Bennington and Ian McLeod (Chicago: University of Chicago Press, 1987).
[71] Kalas, *Frame, Glass, Verse*, 48.

structural backdrop, they are just one such instance of the close and intertwined relationship between the book, natural philosophy and architecture.

The Place of the Book

Though scholars have paid close attention to the textual features of architectural spaces, they have often looked past the architectural features within texts. If, both materially and conceptually, building and plans can be read as text we ought more often to consider not only the rhetorical and aesthetic strategies of place but also the architectural strategies of the page.

The technology of print was essential to the dissemination and development of natural philosophy in the early modern period. Adrian Johns, whose magisterial work on the subject has detailed the material and phenomenological effects of the book in early modern science, has stressed the importance of reading and writing as natural philosophical activities. In particular, he has illustrated the socio-cultural forces that construct the book, arguing that 'a book is the material embodiment of, if not a consensus, then at least a collective consent[…] a printed book can be regarded as a nexus conjoining a wide range of worlds of work.'[72] While Johns is not overly concerned with specific individual sites of knowledge making, he is attuned to the importance of location in the dissemination of knowledge, and particularly aware of the networks through which this occurred. Johns asserts 'texts, printed or not, cannot compel readers to react in specific ways, but[…] they must be interpreted in *cultural spaces* the character of which helps to decide what counts as a proper reading'.[73]

Johns extends earlier ideas about the apparent placelessness of scientific 'truth' to argue that 'print and science share a rather intimidating characteristic. Both appear to transcend place.'[74] But Johns asserts that, on the contrary, much like scientific facts, print must be conceived of as 'an achievement, warranted and maintained by situated labors,' and advocates a detailed, localised approach 'in order to show how print, like scientific truth, attains the level of universality—by the hard,

[72] Adrian Johns, *The Nature of the Book: Print and Knowledge in the Making* (Chicago: University of Chicago Press, 1998), 3.
[73] Ibid., 20; emphases my own.
[74] Ibid., 41.

continuous work of real people in real places.'[75] Discussing the vital exchange and distribution of printed and textual objects between sites of knowledge making, Johns describes how it was not only natural philosophical practices, facts and techniques that were transmitted through the book. He also reminds us that '[r]hetoric, however persuasive, came into being and achieved its effects only when incarnated in such objects.'[76] Cultural attitudes and philosophical modes are embodied in textual objects which both circulate through and proliferate in the spaces of natural philosophy in the early modern period.

If we shift our focus to the ways in which texts are rhetorically and figuratively situated, what will we find? Early modern books frequently situate natural philosophy in a figurative landscape filled with architecture. Architectural metaphors and analogies are used to structure the ways in which knowledge is produced, to provide ideological frameworks for philosophical texts, and as explanatory conceits for complex, often abstract or invisible, theories. They shape the ways we interact both with books and with the world around us. And yet, despite the renewed scholarly interest in scientific place and in the literary forms of scientific texts, these architectural metaphors, which are often fleeting or derivative and draw on a wide cultural tendency to compare books, knowledge and buildings, have received little detailed attention. Perhaps it is precisely because of the ubiquity of architectural metaphor that they escape our notice and remain unexcavated.

In an attempt to move toward a more nuanced understanding of the cultural arena of early modern science the real, theoretical and conceptual architectures of that supported it all require closer scrutiny, as do the complex ways in which these different manifestations of scientific space interrelate. Alongside the material architectures of scientific spaces and books, the imaginary architectonics of science—the imagined, metaphorical or figural spaces which draw upon their real counterparts, and perhaps also help to shape them—warrant further attention. The remainder of this introduction will explore the architectural framing of Francis Bacon's epistemologies in order to illustrate both the prevalence and the epistemological and explanatory power of architectural analogy in natural philosophical texts.

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[75] Ibid.
[76] Ibid., 45.

Pyramid Schemes

In a key moment of Bacon's famous account of knowledge, *The Advancement of Learning*, natural philosophy is depicted as a great monument, built from the study of natural history, physics, and metaphysics:

> For knowledges are as pyramides, whereof history is the basis. So of Natural Philosophy the basis is Natural History; the stage next the basis is Physics; the stage next the vertical point is Metaphysic. As for the vertical point, 'Opus quod operatur Deus a principio usque ad finem', the Summary Law of Nature, we know not whether man's inquiry can attain unto it.[77]

For Bacon, if natural philosophy is a knowledge that can be built, its completion, at least in this instantiation of the metaphor, is uncertain. He invokes natural philosophy as a magnificent monument, like an Egyptian pyramid. The classical allusion here is clearly not unfounded: much of *The Advancement of Learning* discusses our ability to build on, but also to transcend and further ancient learning, particularly that of the Greeks and Romans.[78] This image is crucial to depicting the type of inductive hierarchical system Bacon imagines the production of reliable natural philosophical knowledge to take, proceeding from a mass of particulars and assistants to a pinnacle at which the most advanced (and socially appropriate) philosopher might draw from all of these singular observations in order to make broad conclusions about the universal laws of nature. This is a hierarchy of types of knowledge (individual observations of natural history, for example, are less reliable forms of knowledge than the axioms drawn from them), a social hierarchy (those formulating the axioms are intellectually superior to those providing the observations) and also a hierarchy from the mundane towards the divine. Each of these is reflected in the increasing elevation of the pyramid as it narrows towards its apex.

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[77] Francis Bacon, *Advancement of Learning, Book Two*, 197. Bacon quotes Ecclesiastes, 3:11: 'God hath made everything beautiful in his time: also he hath set the world in their heart, so that no man can find out the work that God maketh from the beginning to the end': 622, n. 197.

[78] On the reception of Ancient Egypt, including discussions of the pyramids, in the Renaissance, see: Brian A. Curran, *The Egyptian Renaissance: The Afterlife of Ancient Egypt in Early Modern Italy* (Chicago: University of Chicago Press, 2007); John Michael Archer, *Old Worlds: Egypt, Southwest Asia, India, and Russia in Early Modern English Writing* (Stanford: Stanford University Press, 2001); Karl H. Dannenfeldt, "Egypt and Egyptian Antiquities in the Renaissance," *Studies in the Renaissance* 6 (1959): 7-27.

The architectural rhetoric which suffuses so much of Bacon's work congregates strongly around his theories of natural philosophy and natural history. The architectonic mode is clearly key to Bacon's modes of imagining and understanding the world—a trait which he intimates might be a particularly human way of conceiving of the world around us. Despite wryly noting that had God only a more human disposition, 'he would have cast the stars into some pleasant and beautiful works and orders, like the frets in the roofs of houses', Bacon continues to imagine the whole of nature as constructed, formed on an architectural masterplan.[79] In one passage, for example, Bacon employs a suggestive and apparently common metaphorical topography to describe the body as a grand mansion and its surrounding estate:

> to say that the hairs of the eyelids are for a quickset [hedge] and fence about the sight; or that the firmness of the skins and hides of living creatures is to defend them from the extremities of heat or cold; or that the bones are for the columns or beams, whereupon the frames of the bodies of living creatures are built […] or that the solidness of the earth is for the station and mansion of living creatures, and the like, is well enquired and collected in Metaphysic.[80]

Bacon applies architectural analogy not only to the bodies of animals, but also to man, an idea which has origins in the Renaissance tradition of sympathies, but also in the Vitruvian tradition which aligns the forms of architecture with those of the human body.[81] But Bacon's interest is not so much in human anatomy as the human mind and the forms of knowledge which we pursue. If the human anatomy constitutes a physical frame, and perhaps even a temple, Bacon reminds us that 'the Body[…] is but the tabernacle of the mind,' and once more utilising the metaphor of the ceiling and framed building, discusses the 'three beams of man's knowledge'.[82] A contemporary, much-abridged summary of the *Novum Organum*, translates Bacon's description of his project: 'we do not build or dedicate a Capitol or Pyramid to the Pride of men, but we found an holy Temple for the worlds pattern in humane

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[79] Bacon, *Advancement of Learning, Book Two*, 228.
[80] Ibid., 198.
[81] Ibid., 208. On the Vitruvian tradition which posits man as the basis for architectural forms, see *The Architecture of Science* eds. Peter Galison and Emily Thompson (Cambridge: MIT Press, 1999); in particular Adrian Forty, "'Spatial Mechanics': Scientific Metaphors in Architecture," 213-31; and William R. Newman, "Alchemical Symbolism and Concealment: The Chemical House of Libavius," 59-79: 64.
[82] Bacon, *The Advancement of Learning, Book Two*, 215; 205.

Understanding.'[83] While the apparent denouncement of the pyramid here may seem at odds with Bacon's earlier statements, it is not the structure but its purpose he objects to: it is pride, and not the pyramid, that he finds problematic. In fact, Bacon's buildings of knowledge—temples and pyramids—share similar features. These ancient structures both have religious significance, and are designed to house precious contents, whether the funerary hoards of the dead Pharaohs or the shrines and relics to which temples are dedicated.

While pyramids and temples hint at the theological purpose of this knowledge project—that the pursuit of natural knowledge might be, in and of itself, a form of worship—Bacon also more explicitly incorporates his philosophical project in the Christian theological tradition in another passage that relies on architectural metaphor. Characterising knowledge as a 'rich storehouse, for the glory of the Creator and the relief of man's estate,' Bacon suggests that the proper end of knowledge is a space for worship, furnished with the treasures of natural knowledge that help to make God visible on Earth. This is contrasted with various other structures which appear to be for the benefit, comfort, or pleasure of man alone. Bacon talks of the dangers of 'mistaking or misplacing of the last or furthest end of knowledge,' which ought to be the veneration of the divine Creator, in consistent spatial terms. He writes disapprovingly of those who simply seek comfort or diversion in knowledge:

> as if there were sought in knowledge a couch, whereupon to rest a searching and restless spirit; or a terrace, for a wandering and variable mind to walk up and down with a fair prospect; or a tower of state, for a proud mind to raise itself upon; or a fort or commanding ground, for strife or contention; or a shop, for profit or sale; and not a rich storehouse, for the glory of the Creator and the relief of man's estate.[84]

Knowledge, according to Bacon, ought not simply to entertain idle curiosity, or be pursued for purposes of self-promotion or profit. Ultimately, Bacon claims, knowledge ought to be employed in order to forward the glory of God and enable man to transcend himself through access to the divine.

This metaphorical connection between building and knowledge, which is so persistent throughout not only Bacon's work but also early modern writing more

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[83] Francis Bacon, *The Novum Organum of Sir Francis Bacon… Epitomiz'd, for a Clearer Understanding of his Natural History*, trans. M.D. (London: printed for Thomas Lee, 1676), 15.
[84] Bacon, *The Advancement of Learning,* Book One, 148-149.

broadly, has cultural resonance far beyond renaissance Europe. Anthropologists have placed metaphor at the heart of many accounts of knowledge, and entire ontologies have been constructed around spatial metaphors. Like George Lakoff and Mark Johnson, Daniel Miller has argued that our use of spatial metaphor reflects widely-held and deeply-rooted systems of cultural value. For example, he describes the Western '*depth ontology*'—where depth and interiority are prized, while 'shallow' or surface-based behaviours are denigrated—as culturally-specific, rooted in as well as perpetuated by metaphorical language.[85] Miller foregrounds the powerful ways in which material and spatial metaphor can affect, and be affected by our interactions with the world. The material cultures which surround us 'unconsciously direct our footsteps, and are the landscapes of our imagination, as well as the cultural environment to which we adapt.'[86] However, corroborating Galison's suggestion that scientific metaphors in architectural theory are used 'in ways so familiar to us as to be practically invisible,' Miller notes that we 'constantly fail to notice' the ways in which our actions and cognition are shaped by our environment.[87] Equally I suggest, with the metaphorical connection between architecture and knowledge still so culturally ingrained, we have remained blind to the scientific and architectural metaphors which proliferate among the texts of seventeenth-century natural philosophy.

Miller and Galison's comments provide a rationale for why the architectures of early modern literature have remained under-examined, and they simultaneously act as a prompt to redress this. By bringing attention back to the ways in which early modern people interacted with both the real and figurative spaces in which they moved, worked and read, as well as the stuff that these spaces contained and produced, we will be able to gain a better understanding of the assumptions and structures that underpinned early modern knowledge projects. This thesis aims to examine the extensive scale over which these metaphors range, arguing that this is not only a verbal, but also a visual and material analogical register. As the range of uses to which they were put illustrates, architectural metaphors in natural philosophical texts were used to demonstrate a whole host of desired and real

[85] Daniel Miller, *Stuff* (Cambridge: Polity Press, 2010), 16; George Lakoff and Mark Johnson, *Metaphors We Live By* (Chicago: University of Chicago Press, 1980).
[86] Ibid., 53.
[87] Galison, "Buildings and Science," 9; Miller, *Stuff*, 155.

similarities and dissimilarities. By consciously inspecting them, we might open our eyes to new interpretations of natural philosophical culture.

Architexts

As Anne M. Myers has shown, architectural analogy populated an extraordinarily broad range of seventeenth-century texts and was employed in an astonishing variety of ways.[88] An entire genre—country house poetry—played on the connections between architectural and poetic form to provide verse accounts of the social and material infrastructure of great houses, and disciplines from chorographic history to devotional poetry deployed architectural tropes liberally. William H. Sherman has noted that the connections 'between books and buildings—and, more generally, between cognitive activity and physical space—have a very long history, stretching back through the Middle Ages into classical antiquity. The book-as-building may well sit alongside the book-as-body as the longest-serving and widest-ranging metaphorical repertoire.'[89] Describing how this interplay between words and architecture affected 'cogitation, meditation, and communication', Sherman unearths the powerful nexus which ties architecture, knowledge and books together through a shared language.[90] And yet architectural analogy was not always explicitly textual: some of the most effective expressions of architectural analogy occur in the likeness between buildings and the physical book.

In framing the book as a building, architectural analogy is often concentrated at the boundaries of a work: in its prefaces, frontispieces or even on its covers. As Sherman has remarked, 'early modern textual thresholds were understood in spatial—and often specifically architectural—terms.'[91] Paratextual material has always been theorised in architectural terms–though Gérard Genette calls paratexts 'threshold[s]' he also expresses a fondness for Borges's description of prefaces as 'vestibule[s]'—and it is also within these liminal spaces of the book that spatial

[88] Anne M. Myers, *Literature and Architecture in Early Modern England* (Baltimore: John Hopkins University Press, 2013).
[89] William Sherman, "On the Threshold: Architecture, Paratext and Early Print Culture," in *Agent of Change: Print Culture Studies after Elizabeth L. Eisenstein*, ed. Sabrina Baron, Eric Lindquist and Eleanor Shevlin (Amherst: University of Massachusetts Press, 2007), 79.
[90] Ibid.
[91] Ibid., 70-71, 72.

metaphor is most explicitly foregrounded.[92] Though their common confinement to the fringes of texts has perhaps made these architectural analogies seem unimportant in relation to body of the work, I argue that these early interactions with spatial analogy can instead colour and frame the way in which a reader engages with the rest of the text. If the preface is a porch through which the reader enters the book, then it can help open our eyes to the presence of the structure beyond it.

In the preface of Bacon's posthumously published *Sylva Sylvarum* (1627), William Rawley elaborates on the metaphor of building a philosophy, depicting Bacon as a would-be architect of the enterprise. Having initially imagined himself as the author-architect of a natural history, Bacon, Rawley suggests, was dismayed by the discovery that, without a willing set of participants to work under him, he had to oversee every aspect of the natural philosophy he was constructing. He became brickmaker, layer, foreman and architect all in one, making, collecting and recording the basic observations and facts which would, he hoped, eventually provide the foundation for the more analytical work of others. Rawley states:

> to write such a Naturall History, as may be Fundamentall to the Erecting and Building of a true Philosophy: For the Illumination of the Understanding; the Extracting of Axiomes; and the producing of many Noble Works, and Effects. For he hopeth, by this meanes, to acquit Himselfe of that, for which hee taketh Himselfe in a sort bound; And that is, the Advancement of all Learning and Sciences. For having in this present Worke Collected the Materialls for the Building; And in his Novum Organum (of which his Lordship is yet to publish a Second Part,) set downe the Instruments and Directions for the Worke; Men shall now bee wanting to themselues, if they raise not Knowledge to that perfection, whereof the Nature of Mortall men is capable. And in this behalfe, I have heard his Lordship speake complainingly; That his Lordship (who thinketh hee deserveth to be an Architect in this building,) should be forced to be a Work-man and a Labourer; And to digge the Clay, and burne the Brick; And more then that, (according to the hard Condition of the Israelites at the latter end) to gather the Strawe and Stubble, over all the Fields, to burn the Bricks withall.[93]

This metaphor of author-as-architect is not only used *about* Bacon, but also used *by* him, particularly when describing knowledge projects. By extracting Bacon's

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[92] Gérard Genette, *Paratexts: Thresholds of Interpretation*, trans. Jane E. Lewin (Cambridge: Cambridge University Press, 1997), 2. On paratexts see also: *Renaissance Paratexts* eds. Helen Smith and Louise Wilson (Cambridge: Cambridge University Press, 2011); and Helen Smith, "Paratexts," in *The Printed and the Built: Architecture, Print Culture and Public Debate in the Nineteenth Century* eds. Mari Hvattum and Anne Hulsch (London: Bloomsbury Visual Arts: 2018): 251-258.

[93] William Rawley, 'To the Reader', in Francis Bacon, *Sylva Sylvarum: Or A Naturall Historie* (London: printed by John Haviland and Augustine Matthews for William Lee, 1627), [A1v] - A2[r].

architectural metaphor from the text, and relocating it in the preface, Rawley not only engages a traditional prefatory trope, but also primes the reader to understand Bacon's philosophy in architectural terms.

For Bacon, the material reality of the book is crucial to its metaphorical significance. Writing after the fall of the great ancient civilisations he so ambivalently admires and the iconoclastic destruction of the Reformation, Bacon is acutely aware of the transience of buildings and monuments. While the *Gesta Grayorum* recommends that the monarch should present 'the visible memory of himself in the magnificence of goodly and royal buildings and foundations,' in another court entertainment, 'Of Love and Self-Love' (1595), presented for the Queen's accession day later in the same year, Bacon ultimately recognises that monuments will not stand the test of time.[94] Instead, he privileges the written word as the most durable mode of preserving a legacy, writing that: '[t]he monuments of wit survive the monuments of power: the verses of a poet endure without a syllable lost, while states and empires may pass many periods.'[95] This is a sentiment that Bacon expands on in *The Advancement of Learning*:

> We see then how far the monuments of wit and learning are more durable than the monuments of power or of the hands. For have not the verses of Homer continued twenty-five hundred years or more, without the loss of a syllable or letter; during which time infinite palaces, temples, castles, cities, have been decayed and demolished?[96]

This statement is more elusive than it appears at first sight. While Bacon frames his project as a type of building, a monument, he also uses these self-same monuments—temples, palaces and statues—as symbols of decay. But just as architecture occupies a complex position in Bacon's materialisation of knowledge, the book correspondingly occupies a curious niche in Bacon's metaphorical ecosystem. It is both superior to the built environment, and a tool within it. As the physical records of our knowledge, books become the buildings of our philosophy; the temples and storehouses of what we know, designed to carry words from one setting to another. But if the likeness between books and decaying buildings seems to point to the material fragility of the page, Bacon also suggests the ways in which

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[94] Bacon, "Device", 55.
[95] Bacon, "Of Love and Self-Love", 62.
[96] Bacon, *Advancement of Learning, Book One*, 167.

texts are not bound to their substrate, evoking the power of words to transcend their fragile containers to illustrate how texts might outlive the places they describe.

For Bacon the book and its technologies constitute an analogy for nature as well as a mode of collecting and organising knowledge about it. Just as Bacon conceives of nature as architectural, he also conceives of it as textual. Utilising the traditional metaphor of the book of nature, which conceived the world as a source of divine knowledge analogous to Scripture, Bacon argues that no man 'can search too far or be too well studyed in the book of God's word or in the book of God's works; divinity or philosophy; but rather let men endeavour an endless progress or proficience in both'.[97] Real and metaphorical books, words and things, were equally important ways of gaining knowledge and moving closer to God. In another example Bacon's metaphysics is explained through a potently textual metaphor. Arguing that, ultimately, only a small number of qualities such as motion and colour constitute the 'essence' of a particular thing, he write that these qualities, 'like an alphabet are not many.'[98] This metaphor gestures to how a small number of distinct qualities can make a multiplicity of things; the twenty six letters of the alphabet, joined in various combinations, can make an almost infinite number of words and meanings. Following the example of Lucretius, Bacon's building blocks of nature are not only architectural but also textual.[99]

These self-referential metaphors, which drew on the material apparatus of print, were very influential in early modern conceptual philosophy. Daniel Selcer has illustrated how these 'figures of material inscription' functioned in the work of philosophers including Leibniz, Spinoza and Bayle.[100] Espousing a 'conviction that

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[97] Ibid., 126. On Francis Bacon and the book of nature, see *The Book of Nature in Early Modern and Modern History*, eds. Klaas van Berkel and Arjo Vanderjagt (Leuven: Peeters, 2006), esp. Peter Harrison, "The 'Book of Nature' and Early Modern Science:" 1-26; and Edward B. Davis, "The Word and the Works: Concordism in American Evangelical Thought:" 195-208.

[98] Bacon, *Advancement of Learning, Book Two*, 196.

[99] Lucretius's philosophy self-reflexively considers the way that combinations of letters from the same limited alphabet can make up an infinite variety of words, using this as an analogy for atomism:

> Furthermore, all through these very lines of mine, you see
> Many letters that are shared by many words - and yet
> You must confess that words and lines from this one alphabet
> Have sundry sounds and meanings. Letters only have to change
> Their order to accomplish all of this - and still the range
> Of possibilities with atoms is greater. That is why
> They can create the universe's rich variety.

Lucretius, *The Nature of Things [De Rerum Natura]*, trans. A.E. Stallings (London: Penguin, 2007): Book I, ll. 823-829.)

[100] Daniel Selcer, *Philosophy and the Book: Early Modern Figures of Material Inscription* (London: Continuum, 2010), 194.

the material, technological, and historical situation in which early modern texts were produced both shaped their rhetorical contours and constituted a reservoir of imaginative or metaphorical forms,' Selcer suggests these figures and metaphors do more than just support, elaborate, or visualise the philosophies they are used to describe: they also affect their contents.[101] Selcer's notion of the 'ontology of the page' is a compelling illustration of the complex overlaps between conceptual and material realms in early modern philosophy. By expanding his focus on figures of material inscription to also consider other instruments and spaces used in the manufacture of knowledge, we can see that the influence of the material environment on the structures of knowledge is much more extensive than Selcer indicates.

This congruence between the metaphorical and material architectures of the book is perhaps best manifested in *The Advancement of Learning*. Bacon questions why it is that 'a few received authors stand up like Hercules's Columns, beyond which there should be no sailing or discovering?'[102] The pillars of Hercules, the symbolic depictions of the promontories flanking the Straits of Gibraltar, were often invoked at this time to mark the limits of the known world; no one knew what lay beyond them. Imagining ancient authors and the classical books which they synecdochically represent as columns, ancient books are metaphorically rendered as both monuments of learning and barriers to discovery. But Bacon argues that we must move beyond the wisdom of the ancients to develop new forms of knowledge.

This metaphor is strikingly illustrated in the frontispiece to *Of the Advancement and Proficience of Learning*, the posthumous English translation of Bacon's *De augmentis scientiarum* (Figure 4), which elaborates on the earlier title pages for *Instauratio magna* (1620) and *Sylva sylvarum* (1627). Depicting Bacon's architectural rhetoric in magnificent detail, the columns of Hercules frame the engraving, inscribed with the names and shields of England's two universities, 'Oxonium' and 'Cantabrigia'. If you look closely, these triangular columns, intriguingly, do not immediately rest on stone plinths but on books; these are, in fact, Bacon's own, with each of the six representing a division of his *Instauratio magna*. Sat atop the disciplinary divisions of 'Scientiæ' and 'Philosophia', this engraving seems to be suggesting, none too subtly,

[101] Ibid., 18.
[102] Bacon, *The Advancement of Learning, Book Two*, 169.

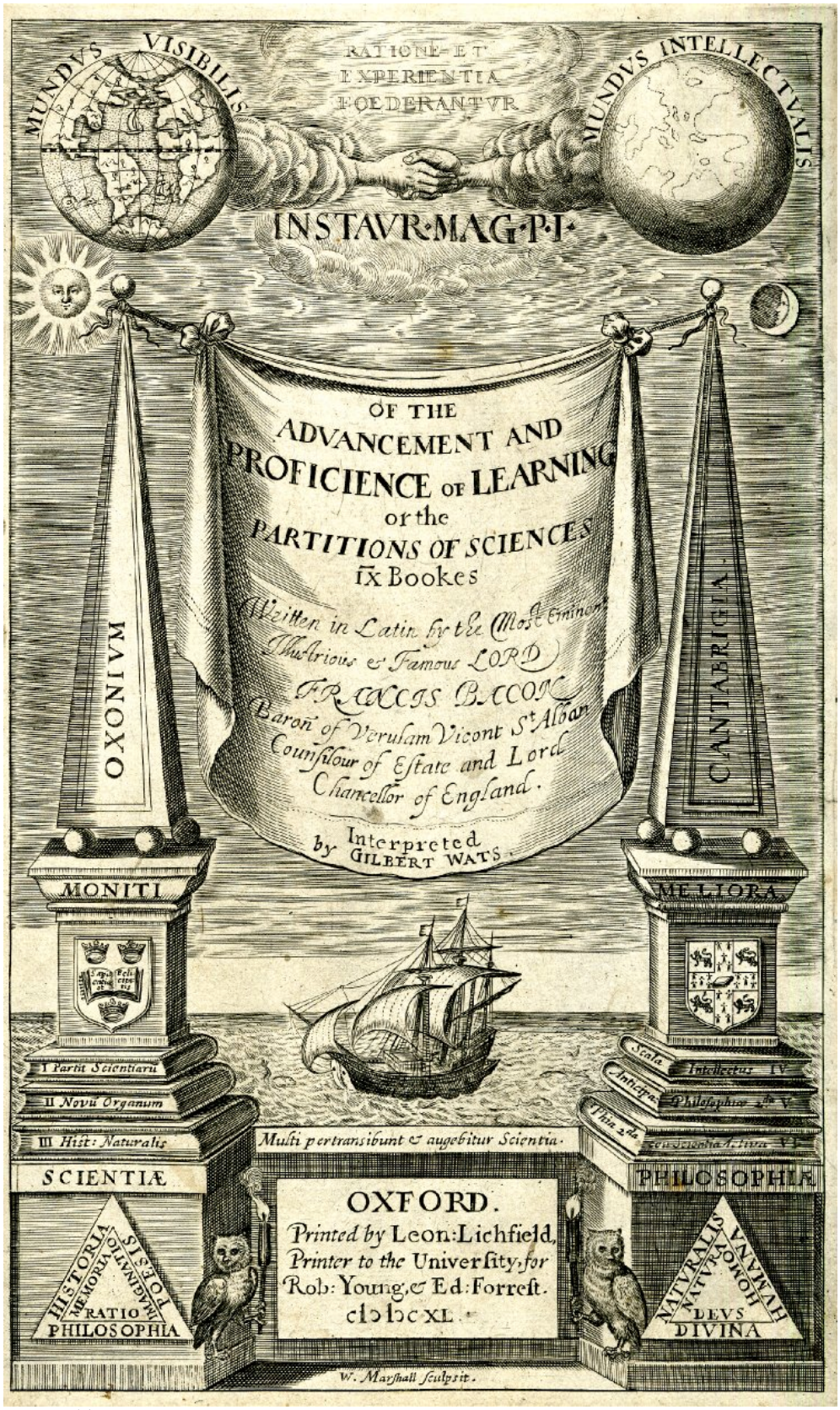

Figure 4. Title page engraving by William Marshall in Francis Bacon, *Of the Advancement and Proficience of Learning*, trans. Gilbert Wats (London: 1640). BM 1868,0808.3225. Image © Trustees of the British Museum.

how Bacon's own method might help to build a new kind of knowledge; a knowledge on which England's universities can stand tall, reaching towards the pinnacle of what can be known.

Bacon's ambitions extend even further. Like the books of received wisdom he describes, the columns of Hercules that are depicted are monumental, but in reflecting the *limits* of knowledge, they also represent a potential obstruction in the path of the new natural philosophy. But in this engraving, Bacon's project sails beyond these bounds and into unknown waters. Ironically Bacon's philosophy is not represented as an architectural figure but instead as a boat; perhaps imagined in the guise of one of the 'certain little boats for Philosophy, gallant enough for Art and structure' that Bacon imagines, in his *History of Winds*, might be constructed 'after a copious, and faithful History of Nature and Arts is gathered and digested, and as it were set, and laid open before mens eyes.'[103] We can imagine the jaunty engraved ship sailing off into the distance, weaving its way through and beyond the pillars that define knowledge as it currently stands. Bacon's vision of modernity and modern understanding is relentlessly positive; Bacon discusses the pillars of Hercules in *The Advancement of Learning* to explicitly stress how the motto of the current time, '*plus ultra*' ['further yet'], must overtake the 'ancient *non ultra*' ['no further'].[104] Using words that echo those inscribed on the ornate, engraved frontispiece frame, he goes on to describe how, through constant and earnest intellectual labour, we might expect 'the further proficience and augmentation of all sciences'. Citing Daniel, 12:4, 'Plurimi pertransibunt, et multiplex erit scientia' ('Many shall pass to and fro, and knowledge shall be increased'), Bacon gestures to the Biblical prophecy that we might surpass the learning of both the Greeks and the Romans in the present time. But the image does more than visually replicate Bacon's verbal metaphor. The careful use of perspective ensures that the reader is aligned with the boat, projected forward past the bounds of the known world, and sailing into the depths of new knowledge as they turn the pages and begin to read.

Building a Home for Philosophy

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[103] Francis Bacon, *The Natural and Experimental History of Winds*, trans. Robert Gentili (London: printed for Anne Moseley and Thomas Basset, 1671): [A3v]-[A4r].
[104] Bacon, *The Advancement of Learning*, *Book Two*, 184; translations are Vickers's: see 616, n. 184. The motto 'Plus ultra,' which in Bacon's time was used by Emperor Charles V, would later be adopted by the Royal Society.

This introduction has traced the rich nexus of interconnections between the natural philosophical, the textual, and the architectural in the early modern period, using examples from the work (and residence) of Francis Bacon to suggest the fertile ground on which this study might build. Arguing that knowledge is manufactured in a way that is closely keyed to cultural contexts, I highlight the ways in which early modern experiences of scientific space could provide structural frameworks for natural philosophical ideas, texts and epistemologies, and show that architectural analogy did not only reflect scientific theory, but also helped to shape it, ultimately transforming the spaces in which natural philosophical labour occurred.

The rest of this thesis will examine the complex ways in which analogies between place, page and practice interact and unfold across both the textual and architectural spaces of seventeenth-century literature. Arguing that the architectural metaphors of natural philosophical texts are commonplace, deeply nuanced and deserving of further exploration, this thesis will examine metaphors of place within natural philosophical writing. Many of these metaphors rely on the common trope of knowledge as something that must be constructed, an idea which was commonplace in scientific texts and theories of knowledge during the early modern period. But though these metaphors of building form an essential context for understanding the figural landscape in which spatial analogy works, they will not be the focus of my attention here.

Instead, the rest of my thesis will focus on more specific and self-reflexive metaphors of scientific place. Each chapter will focus on one of the spaces that Bacon identifies as necessary for natural philosophy in the *Gesta Grayorum*—gardens, cabinets and laboratories—examining the figural and analogical forms that these spaces take in natural-philosophical texts. These specific metaphors, occasionally noted, but rarely considered in detail in their scientific context, can each show us much about the realities of seventeenth-century scientific space, as well as illustrating the wide utility of spatial metaphor in scientific work, a topic which has largely been neglected. By drawing on a wide range of practitioners and historical spaces, I hope to illustrate that spatial metaphors reflected the diversity of experience among practitioners of natural philosophy, being utilized for a range of functional purposes in a variety of ways.

Chapter One takes the idea of the garden as a structural framework and explores how this explicitly local image might form the basis for a type of knowledge that can elucidate ideas far beyond the purview of the garden. Following the quincuncial planting patterns endorsed in Thomas Browne's *Garden of Cyrus*, a close reading of the text probes the nature of Browne's knowledge, arguing that it tempers empirical observation with an imaginative spatial poetics. By considering not only the formal but also the material ways in which the book reasserts its analogy to the garden, it argues that this somewhat buried framework ultimately gestures to a more sublime and mystical knowledge than Browne's reputation as a physician and experimentalist might suggest.

Margaret Cavendish's *Poems, and Fancies* is the focus of the second chapter, which explores the metaphor of nature's closet in detail. Outlining the numerous types of cabinet that were present in early modern households, this chapter seeks to illustrate how a metaphor might draw on a multiplicity of real spaces in order to configure a complex and multifaceted figurative arena. It explores how the figure of the cabinet provided a means of grappling with complex theories about cognition, mirrored in the modern theory of cognitive ecology, and the boundaries between self and world. But it also attempts to explicate how the invocation of household architecture enables Cavendish's construction of a defiantly female, deeply unconventional philosophy in which poetical imagination is asserted as a valid philosophical strategy.

Chapter Three shifts direction to interrogate the metaphorical laboratory—a later incarnation of the stillhouse that Bacon recommends. Exploring how laboratories were understood in early modern culture, it unpicks what it means for a space so emblematic of empirical discovery and practical experiment to be used as an analogical trope. Focusing on laboratory metaphors used in texts primarily about digestion, it will stress the explanatory power of such a trope. By tracing the history of the metaphor, I will suggest how such analogies might transform as well as communicate developments in scientific theory, before hinting at how physiological commonplaces can also be borrowed to theological ends.

The library is the first site that Bacon recommends in the *Gesta Grayorum*, and though conspicuously without a chapter of its own, it is ultimately never far from the surface of this thesis. Though a detailed analysis of the metaphorical library is sacrificed here for reasons of brevity, the library is also the place of Bacon's that has

received the most critical attention in its role as an epistemological metaphor and cultural space.[105] As the locale which wears its structural functions most evidently upon its sleeve, and also the space which, in the current day, remains the most structurally and conceptually similar to its early modern counterpart, the metaphorical library needs less explication than its counterparts. The most common early modern form of the metaphorical library is also the most general of the metaphorical spaces examined here. Utilised as an expansion of the trope of the book of nature, the metaphor of the library of the world also encoded the natural world as something which can be read; an analogue of Scripture which teaches the grace of God through the display of Creation. Offering a greater sense of volume and variety than the book of nature, the library of creation, a trope popularised by St Anthony of Egypt, was often invoked as a commonplace illustrating how God might be found anywhere, and also suggested the depth of knowledge that might be found in any living creature, as each could be conceived of as a book.[106] But though it provided a rationale for natural philosophy as a devotional activity, this metaphor was seldom used in an explanatory capacity, and more often served as a prompt to reflect on the glory of nature than as a means of explicating complex theoretical ideas or epistemological paradigms.

Seventeenth-century England was full of people studying in the library of the world. This thesis examines a wide range of texts by a wide range of practitioners, from physicians to noblewomen and laboratory technicians to radical religionists. Though some texts have more explicit interests in natural philosophy than others, all seek to understand the world around them. Often this is accompanied by a hope of gaining proximity to God through a better understanding of his Creation; sometimes it is in an effort to increase knowledge for purposes of social utility (for example,

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[105] See, for example: Ophir, "Place of Knowledge"; Selcer, *Philosophy and the Book*, esp. "Infinite Mechanism and the Allegorical Library," 22-57; Nicolas Barker, "Libraries and the Mind of Man," in *A Potencie of Life: Books in Society* ed. Nicolas Barker (London: British Library, 2001):179-194; *The Meaning of the Library: A Cultural History* ed. Alice Crawford (Princeton: Princeton University Press, 2015); Roger Chartier, *The Order of Books: Readers, Authors and Libraries in Europe between the Fourteenth and Eighteenth Centuries* (Cambridge: Polity Press, 1994); Alberto Manguel, *The Library at Night* (New Haven: Yale University Press, 2006).

[106] Samuel Purchas offers a fairly typical example of the trope in the introduction to his book on insects: 'The Creatures are the Book of Nature, as said *Anthony* the Hermite, who being demanded by a Philosopher,* how he could possibly spend his time in the Wilderness, seeing hee was destitute of Bookes? answered, My Book, O Philosopher, is the nature of all things created by God, which when I please, I can peruse and read. The world is Gods Library, God manifested and drawn out; and all the creatures as Glasses, in which wee may see, and as Scaffolds and Ladders, by which we may ascend and draw nearer to him.' *A Theatre of Politicall Flying-Insects* (London: printed by R.I. for Thomas Parkhurst, 1657), A2[r]-[A2v].

better healthcare); sometimes the pursuit of knowledge is seen as its own reward. But all of these authors share exuberance in their attempt to build a sturdy house for philosophy. As Bacon's work illustrates, the construction might be difficult, but the rewards can be magnificent.

Chapter One

Experimenting with 'Garden Discourse'

nor till the poets among us can be
"literalists of
the imagination"—above
insolence and triviality and can present
for inspection, "imaginary gardens with real toads in them,"
shall we have
it.[1]

Hortulan Saints

Despite protestations that he was 'never master of any considerable garden,' Thomas Browne had a lifelong passion for botanical study.[2] The Norwich physician, who had achieved intellectual and literary renown with his 1643 volume of spiritual meditations, *Religio Medici*, and his 1646 encyclopaedic compendium of popular errors, *Pseudodoxia Epidemica*, spent much of his childhood hunting for medicinal plant specimens in simpling expeditions around Cheapside.[3] During his studies at Montpellier, Padua, and Leiden, he had access to some of the best-established and most innovative botanical gardens of the time. By the 1640s, Browne was sending information, seeds and plants to a wide-ranging correspondence network of fellow botanical enthusiasts, while at home he compiled herbaria with his children (see Figure 5); he advised his son Thomas, while travelling, to '[t]ake notice of such plants as you meet with ether upon the Spanish or African coast & if you knowe them not, putt some leaves into a booke, though carelessly, and not with that neateness as in your booke at Norwich.'[4] Virtuoso gardener and Royal Society

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[1] Marianne Moore. "Poetry (longer version)," in *The Complete Poems of Marianne Moore* (Harmondsworth: Penguin, 1982), 266.
[2] Thomas Browne, "Garden of Cyrus," in *The Major Works*, ed. C.A. Patrides (Harmondsworth: Penguin, 1977), 319. Hereafter *GoC*. Unless otherwise stated, all subsequent references will be to this edition.
[3] Claire Preston, *Thomas Browne and Writing of Early Modern Science* (Cambridge: Cambridge University Press, 2005), 196.
[4] Letter from Browne to Thomas Browne the younger, February, 1667, in Thomas Browne, *The Works of Sir Thomas Browne*, ed. Geoffrey Keynes, (London: Faber & Faber, 1964), vol. 4: 21. Herbaria compiled by (the elder) Thomas Browne and his son Edward are preserved in the collections of the Natural History Museum, London as manuscripts *Hortus Siccus* 107 and *Hortus Siccus* 108. See Brent Nelson, "The Browne Family's Culture of Curiosity," in *Sir Thomas Browne: The World Proposed*, eds. Reid Barbour and Claire Preston (Oxford: Oxford University Press, 2008), 86.

founder John Evelyn thought so highly of Browne's advice on his monumental garden project, *Elysium Britannicum*, that he proposed him as one of his 'hortulan saints.'[5]

Figure 5. A page of Browne's herbarium. Natural History Museum, London, *Hortus Siccus* 107.

Botany is a persistent interest in Browne's writing, from *Pseudodoxia Epidemica*'s investigation of 'sundry tenents concerning Vegetables' and the posthumously published tracts, 'Observations upon Several Plants mention'd in Scripture' and 'Of Garlands and Coronary Plants,' to the experiments diligently recorded in his notebooks.[6] Browne's 1658 essay *The Garden of Cyrus* initially appears

[5] Letter from John Evelyn to Browne, 28 January 1660, in Browne, *Works*, ed. Keynes, vol. 4: 275.
[6] Browne, *Pseudodoxia Epidemica* ed. Robin Robbins (Oxford: Clarendon Press, 1981); *Certain Miscellany Tracts* (London: Charles Mearne, 1684). For examples of Browne's prolific botanical note-taking, see *Works*, ed. Keynes, vol. 3, which features 'Miscellaneous Notes and Observations in Natural History' (361-373); 'Observations and Experiments on the Natural History of Plants' (374-400); and notes from

to bear the fruit of these interests. Printed as a companion tract to *Hydriotaphia,* an essay that starts with the excavation of funerary urns and ascends to a rhapsodic reflection on mortality, *The Garden of Cyrus* begins with meditations on long-lost gardens of biblical and classical significance. The prefatory letter is packed with horticultural language and references, and even seems to play on the close connections between literature, botany and Browne's hometown of Norwich, a city described by Evelyn as 'very much addicted to the flowry part.'[7] Addressing his text to Nicholas Bacon (1623-1666), who he calls the 'flourishing branch of that Noble Family,' Browne perhaps makes a reference to Ralph Knevet's pastoral drama *Rhodon and Iris*, which was devised for the florist's feast in Norwich in 1631 and featured an allegorical plot revolving around the application of botanical knowledge.[8] The printed playtext of *Rhodon and Iris* was dedicated to Nicholas Bacon of Gillingham (d. 1641)—seemingly the father of Browne's dedicatee— in a letter that explicitly links the powers of botanical and literary discernment.[9] Whether conscious of this or not, Browne's own text draws together similar interests, playing with the early modern propensity to graft together gardens and books.

Books were materially and metaphorically botanical in the early modern period. This chapter uses *The Garden of Cyrus* to illustrate how the often self-conscious links between books and gardens could operate in epistemologically significant ways. It argues that Browne's repeated positioning of his book as a garden creates a productive model for aesthetic, theological and scientific experimentation and innovation. The framework of the garden constructs a space in which the foremost, apparently contradictory, models of knowledge associated with the seventeenth-century garden—the analogical approach of the doctrine of signatures and the empirical approach associated with the 'new science'—can coexist.

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commonplace books including reflections on the woodcuts of the herbal *Hortus Malabarus*—'the largest and fairest cutts of any Herball I have seen' (275); a conceit imagining a garden in the terms of men's fashion (277); speculation about what makes meadows look yellow (277); the discovery of plants in different countries, (289-290); queries about thistle apples (296); and the flowers of verbascum (300).

[7] Letter from Evelyn to Browne, 28 Jan 1660, in *Works*, ed. Keynes, vol. 4: 275-76.

[8] *GoC*, 321. Browne likely knew of Knevet's work and moved in similar social circles. In a similar instance of overlap, Knevet dedicated a poem to 'Sir Charles Le Gross'—almost certainly Browne's patient Charles Le Gros and the father of *Hydriotaphia* dedicatee, Thomas Le Gros. See 'The King of Pyrrhus shewd the Muses nine,' in Ralph Knevet, *The Shorter Poems of Ralph Knevet: A Critical Edition*, ed. Amy M. Charles (Columbus: Ohio State University Press, 1966), 97; and Browne, "Hydriotaphia," 263. fn. 1.

[9] Ralph Knevet, *Rhodon and Iris: A Pastorall as It Was Presented at the Florists Feast in Norwich, May 3, 1631* (London: [J. Beale], 1631). Knevet writes to Bacon: 'Considering your true affection to Poesy, which (no doubt) proceeds from your singular perfection in that art; seeing also how fervently you are addicted to a speculation of the virtues and beauties of all flowers; I could not but choose but present you with the patronage of this dramatical piece,' A2[r].

Extrapolating from the book of nature to suggest the inherently discursive and rhetorical forms of Browne's knowledge as well as its limitations, the chapter concludes by proposing a new spatial model for this kind of coterminous literary and experimental approach: the *elaboratory*.

Browne's explicit prefatory claim that gardens are the 'subject' of *The Garden* has proved thorny.[10] From the outset, Browne admits that he 'write[s] no Herball' and scholars unravelling the horticultural language of the preface have noted, not unfairly, that this amorphous text is not really *about* gardens at all; as Kevin Killeen has remarked, '[w]hat might be a treatise on gardens[…] turns out to be a work of "arithmetical divinity", whose sweep takes in its collateral subject matter by the merest of connections, some more and some less tangible.'[11] Browne's discussions of garden history and plant generation rapidly diverge into explorations and explanations of topics including windows, military formations, etymology, chess, the anatomy of sea creatures and the pyramids. Tentatively threading these diverse ideas together is the figure of the quincunx; a malleable five-pointed symbol in the shape of the five dots on a dice, which tessellates outward in a diamond pattern. Initially alighting on the quincunx as an important ancient planting pattern, Browne sees the shape everywhere, identifying it in artificial and natural objects, as well as more abstract iterations, for example in typography and numerology. Utilising what Juliet Odgers has described as a permissively 'loose' definition of the shape, Browne uses the quincunx to trace the signature of divine creation, gesturing to the harmonious and orderly design that underpins the natural world.[12]

Confronted with these ever-shifting interests, Kathryn Murphy, Claire Preston and Anne Cotterill have all moved away from the text's titular 'garden-ness' to develop compelling readings which foreground issues of language, rhetoric and reading alongside political, philosophical and scientific concerns.[13] Murphy and Preston, in particular, astutely identify Browne's underlying interest as a veiled,

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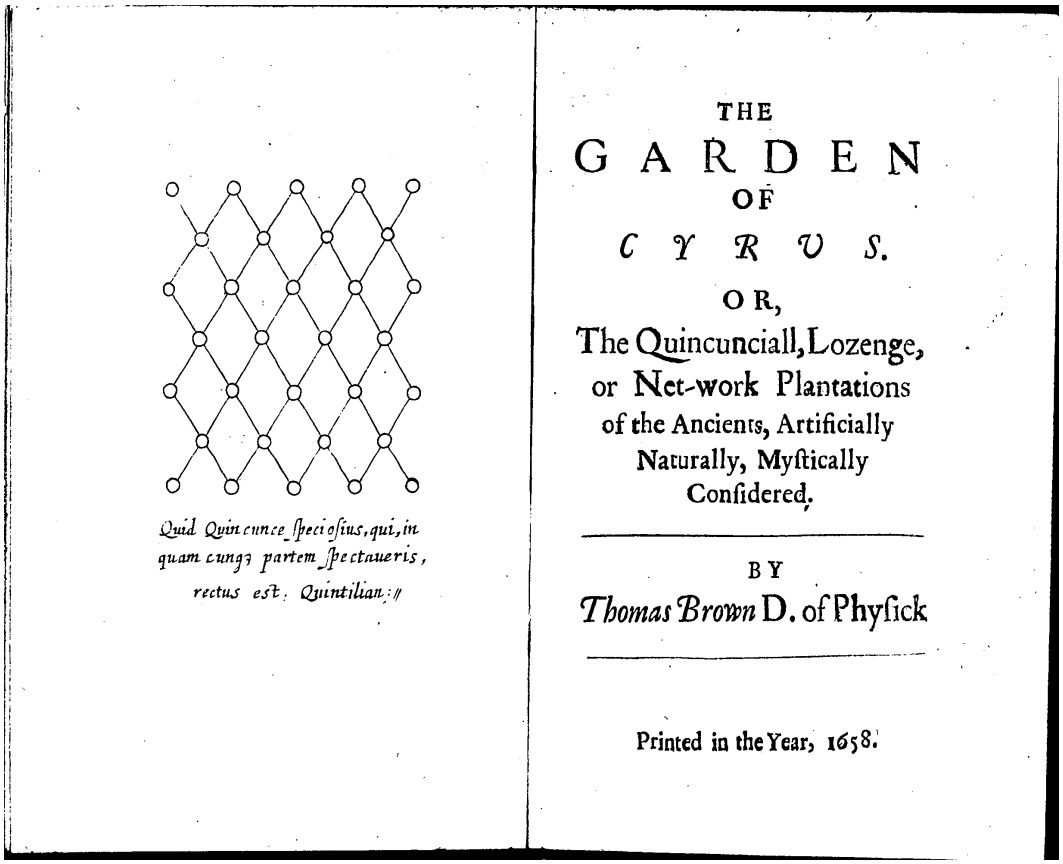
[10] *GoC*, 319.
[11] Kevin Killeen, "Introduction," in *Thomas Browne: Selected Writings*, ed. Kevin Killeen (Oxford: Oxford University Press, 2014), xv.
[12] Juliet Odgers, "Resemblance and Figure in Garden and Laboratory: Gaffarel's Influence on John Evelyn," in *Jacques Gaffarel: Between Magic and Science*, ed. Hiro Hirai (Rome: Serra, 2014), 95.
[13] Anne Cotterill, *Digressive Voices in Early Modern English Literature* (Oxford: Oxford University Press, 2003); Kathryn Murphy, "Plato's Timaeus in the Garden of Cyrus," in *Sir Thomas Browne: The World Proposed*, eds. Reid Barbour and Claire Preston (Oxford: Oxford University Press, 2008), 242-57; Claire Preston, *Thomas Browne and Early Modern Science*, esp. Chapter 6, 'The Epitome of the Earth: *The Garden of Cyrus* and Verdancy,' 175-210; and *The Poetics of Scientific Investigation in Seventeenth-Century England* (Oxford: Oxford University Press, 2015)., esp. Chapter 1, 'Orlando Curioso: The Lapsarian Style of Thomas Browne,' 34-67.

humanly unattainable theosophy, in which an opaque knowledge of the Divine might be intuited through the patternings of the text. But while Browne's focus undoubtedly meanders beyond the garden gate, the garden nevertheless constitutes an essential structural paradigm for his text. The repeated positioning of the text itself *as* a garden—a positioning achieved through the title and reinforced through the language, subject matter, textual structure and materiality of the book—creates a productive epistemological environment in which analogical and empirical approaches can not only coexist but also collaborate, yielding fertile ground for understanding.



Quid Quincunce ſpecioſius, qui, in quam cunq; partem ſpectaueris, rectus eſt. Quintilian.

THE
GARDEN
OF
CYRUS.
OR,
The Quincunciall, Lozenge,
or Net-work Plantations
of the Ancients, Artificially
Naturally, Myſtically
Conſidered.

BY
Thomas Brown D. of Phyſick

Printed in the Year, 1658.

Figure 6. Title page of Thomas Browne's *Garden of Cyrus* (London: H. Brome, 1658), with facing illustration of the quincuncial lattice. BL E.1821.(3.)

The Changing Shape of Gardens

The importance of the garden as a structural framework for Browne's text is made clear in his preface. While Browne is acutely aware that his 'Garden Discourse' has a tendency to wander off-topic, it is precisely by adopting the seventeenth-century philosophical garden as his model that he justifies his departure from this central

locus. He formally aligns his omnivorous digressions with the deliberate variety of a space that was understood as a microcosm for the whole of nature:

> That in this Garden Discourse we range into extraneous things, and many parts of Art and Nature, we follow herein the example of old and new Plantations, wherein noble spirits contented not themselves with Trees, but by the attendance of Aviaries, Fish Ponds, and all variety of Animals, they made their gardens the Epitome of the earth, and some resemblance of the secular shows of old.[14]

In a passage which directly echoes Francis Bacon's description of the 'spacious, wonderful garden' recommended for philosophy in the *Gesta Grayorum* (1595)—Bacon's garden is 'in small compass a model of universal nature made private', featuring wild and cultivated plants, 'rooms to stable in rare beasts and to cage in all rare birds' and lakes housing a 'variety of fishes'—Browne asserts the philosophical garden as the 'example' and structural paradigm for his own text.[15]

The remarkable botanical gardens in which Browne studied undoubtedly had a lasting impact on his ideas about what gardens could and ought to do. John Dixon Hunt has suggested that during the early modern period the garden shifted from being a site of symbolic order, invested in the doctrine of signatures, to a site of empirical investigation.[16] Describing this transition using two of the most potent symbols of Foucault's esoteric and empirical epistemes, he claims 'the garden as laboratory was the true descendant of the garden as cabinet of curiosities.'[17] This shift involved physical, as well as intellectual, transformations of gardens. Noting that '[t]he changing shape of the botanical garden during its first century of existence reflected a tension between older encyclopedic, analogical and symbolic ideals of the garden and newfound ideas about empiricism,' Paula Findlen has documented how the circular and labyrinthine designs used to symbolise the worlds of knowledge made microcosmically available were disrupted and gradually replaced by rectangular plans, which were more accessible and practical for plant development

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[14] *GoC*, 321.
[15] Bacon, 'Gray's Inn Revels,' 54-55.
[16] The doctrine of signatures, promoted in the sixteenth and seventeenth centuries by scholars including Paracelsus, Giambattista della Porta and Jakob Böhme, was a belief that God inscribed resemblances in the natural world to reveal essential connections between natural beings. These connections often had divine purposes, particularly curative ones. For example, walnuts were believed to relieve head injuries because of their resemblance to the brain.
[17] John Dixon Hunt, *Garden and the Grove: The Italian Renaissance Garden in the English Imagination: 1600-1750* (London: J.M. Dent & Sons, 1986), 80. See also Michel Foucault, *The Order of Things: An Archaeology of the Human Sciences [Les Mots Et Les Choses]*, trans. Tavistock Publications (London: Routledge, 2001).

and observation, and favoured by practitioners with an increasingly investigative, empirical approach.[18]

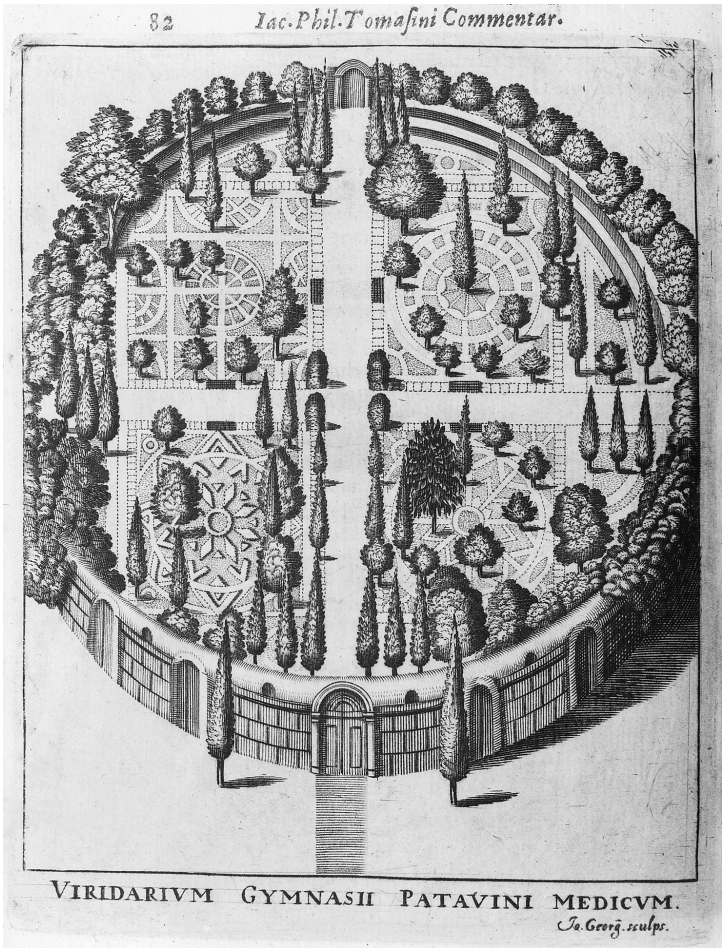

Figure 7. Engraving of the botanical garden at Padua in Giacomo Filippo Tomasini, *Gymnasium Patavinum* (Udine: 1654), 82. Image © Wellcome Collection.

These conflicting ideas about what a garden should do played out across the institutions where Browne studied, which also embedded their specific epistemological and pedagogical principles in their garden designs (see Figure 7). Montpellier's garden emphasised the importance of human artistry in opening up of the natural world for investigation; Padua's complex symbolic designs emphasised the harmony of nature; and Leiden advocated the integration of pragmatic study within a rigorous moral and theological framework.[19] These concerns suffuse the textures of Browne's prose and *The Garden of Cyrus* echoes the epistemological aims

[18] Paula Findlen, "Building the House of Knowledge: The Structures of Thought in Late Renaissance Europe," in *The Structure of Knowledge: Classifications of Science and Learning since the Renaissance*, ed. Tore Frängsmyr (Berkeley: University of California Press, 2001), 33.
[19] Reid Barbour, *Sir Thomas Browne: A Life* (Oxford: Oxford University Press, 2016), 116-17, 70, 94. On the significance of botanical gardens, see Findlen, "Anatomy Theaters."

as well as the physical structure of these gardens. But where botanical gardens sometimes struggled to reconcile their circles and decussations, Browne's quincunx yokes these differing epistemes together. Crucially, the garden paradigm allows Browne to unify two apparently conflicting types of logic.

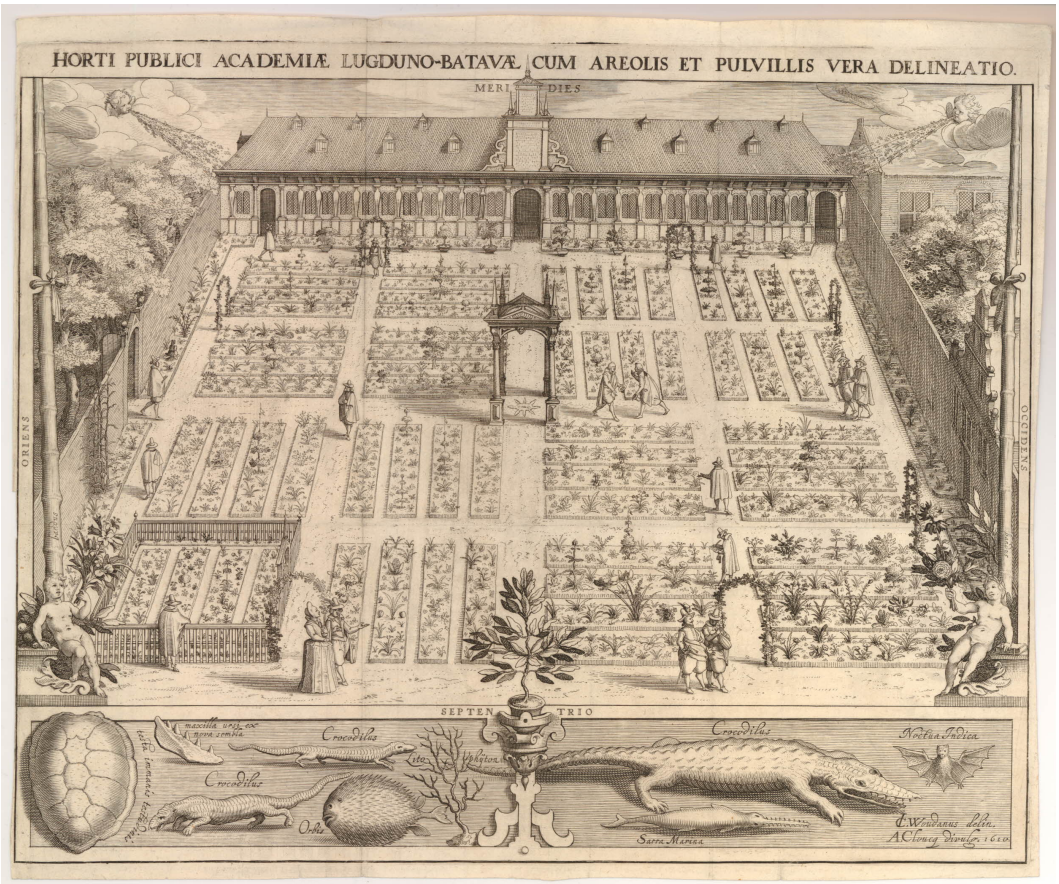

Figure 8. Willem Swanenburgh after Jan Cornelisz Woudanus, etching of the botanical garden at Leiden, 1610. BM 1875,0814.739. Image © Trustees of the British Museum.

In *The Garden of Cyrus*, written during this period of epistemological shift, the empirically-minded laboratory and the analogically functioning cabinet of curiosities coexist. Browne's textual garden captures this tension within its quincuncial structure; presented in five connected chapters, the textual shape of *The Garden* is governed by the planting pattern he observes everywhere. But Browne finds space to integrate both types of knowledge in a text that, as Preston has noted, 'work[s] at the intersection of the literary-linguistic (with its imaginative hinterland) and the empirical (with its distinctive observational and investigative practices).'[20] Vacillating between his fascination with circular and spherical forms, and the

[20] Preston, *Poetics of Investigation*, 38.

perpendicular lattice-grid, the quincunx is a figure that allows Browne to indulge both of these approaches.

As I argued in the introduction to this thesis, the project of recovering the ideal and real architectures of natural philosophy has been critical in developing our understanding of the roots of modern science, and these analogies with the physical and symbolic structures of botanical gardens are vital illuminating contexts for *The Garden of Cyrus*. However, as Frédérique Aït-Touati has suggested, at this time '[s]cience as such did not yet have its own place, and its discourse had no fixed form; it made its appearance across a heterogeneous range of texts and domains.'[21] To unearth the full significance of the garden structure, which cultivates the full range of Browne's natural-philosophical, esoteric, scholastic, theological and philological interests, a multi-generic approach is required. The early modern garden was not only a space for science, but simultaneously a nexus for poetry, philosophy and politics.

As we have already seen, a compelling body of recent scholarship has demonstrated the inherent hybridity of attempts to understand the world in the early modern period, challenging the false dichotomy later constructed between scientific and literary work. While Howard Marchitello and Elizabeth Spiller have highlighted the ways in which literary-scientific writing might be considered a hybrid form of making, Preston and Aït-Touati have documented the narrative, aesthetic and rhetorical strategies used to describe and understand the natural world.[22] Aït-Touati's model of 'cosmopoetics'—an 'association of aesthetics, cosmology and poetics' used to advance scientific hypotheses when scientific and sensory instruments prove inadequate tools—is an instructive example of the integrated forms of knowledge used at this time.[23] Such approaches are essential to understanding the literary-philosophical hybrid of *The Garden of Cyrus*. By nurturing the cultural, philosophical, material, and linguistic links between books and gardens, I argue, Browne allows his *Garden* to bloom as a heterotopic site where poetic and philosophical innovation and investigation can grow in harmony.[24]

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[21] Aït-Touati, *Fictions of the Cosmos*, 5.
[22] Marchitello, *Machine in the Text*, 1, 29; Spiller, *Science, Reading and Renaissance Literature*; Aït-Touati, *Fictions of the Cosmos*. On the coterminous literary-scientific approach of *The Garden of Cyrus*, see Preston, *Poetics of Investigation*, 34-67.
[23] Aït-Touati, *Fictions of the Cosmos*, 1.
[24] Michel Foucault, "Of Other Spaces [Des Espaces Autres]," *Diacritics* 16, no. 1 (1986).

The Book of Nature and the Natural Book

The roots of the connection between gardens, books and writing run old and deep. From the Edenic foundation myth to Virgil's *Georgics* and Marianne Moore's famous early twentieth-century formulation of authentic poems as 'imaginary gardens with real toads in them', gardens have provided fertile conceptual ground for literature.[25] Horticultural metaphors for the processes of reading, editing and composition have a long history, and by the time Browne was writing *The Garden of Cyrus*, the metaphorical garden was ubiquitous.[26] In addition to the highly developed renaissance tradition of botanical allegory, which drew from diverse textual sources including the Bible and its apocrypha, classical mythology, natural histories and husbandry manuals, herbals, Christian exegesis and popular folklore, the millenarian rhetoric, political turmoil and physical destruction surrounding the British Civil Wars resulted in a proliferation of garden metaphors.[27] Andrew Marvell's famous desire for 'a green thought in a green shade' and a return to the prelapsarian 'happy garden-state' has become a touchstone for scholars seeking to highlight the importance of the garden for mapping out political, theological, social and philosophical tensions in the mid-seventeenth-century imagination.[28] Concern about the knowledge lost in the Garden of Eden permeated a range of genres, while the garden, depicted as an isolated idyll or fruitful space of communal labour, became a fiercely charged literary trope among the resurgent poetics of retirement and idealistic schemes for reparatively productive public spheres.[29]

Gardens and books were linked commercially as well as conceptually, and early modern plant- and print-cultures were tightly intertwined. The growth of

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[25] Moore, 'Poetry,' in *Complete Poems*, 267.

[26] Randall L. Anderson traces botanical analogies for literary activity through the early literary cultures of Japan and Muslim Spain as well as Renaissance Europe and the ancient Greek and Roman empires in "Metaphors of the Book as Garden in the English Renaissance," *The Yearbook of English Studies* 33 (2003).

[27] Mirella Levi D'Ancona, *Garden of the Renaissance: Botanical Symbolism in Renaissance Painting* (Firenze: Olschki, 1977), 11-13.

[28] Andrew Marvell, 'The Garden,' in *The Poems of Andrew Marvell* ed. Nigel Smith (Harlow: Longman, 2006), 158. On the significance of the garden in early modern literature, see *Culture and Cultivation in Early Modern England: Writing and the Land*, eds. Michael Leslie and Timothy Raylor (Leicester: Leicester University Press, 1992).

[29] Jim and Scott Mandelbrote Bennett, *The Garden, the Ark, the Tower, the Temple: Biblical Metaphors of Knowledge in Early Modern Europe* (Oxford: Museum of the History of Science, 1998). The *Garden* is described as alluding to but ultimately 'very distinct from the two garden traditions' promising plenitude and introspection: Preston, *Thomas Browne and Early Modern Science*, 182.

international trade networks and consumer spending increased the circulation and sales of plants and books alike, while also nurturing an appetite for books about gardens, including gardening and husbandry manuals, herbals, and books of botanical science.[30] Subject to a mutually productive analogy, books were conceived of in terms of the garden, while gardens were established as spaces that might be read.

This early modern concatenation of books and gardens was most philosophically and theologically powerful in the concept of the 'book of nature,' theorised by medieval and early modern theologians as an analogue to scripture—both were seen as works of God's creation for our interpretation and instruction.[31] If the book of nature imagines the natural world as a site that can be read, then the early modern book is a site where we might, in literal ways, do this reading. Joshua Calhoun has pointed to early modern readers' sensory awareness of the 'natural history of the book,' where traces of organic matter such as flax and linen were still visible in the paper.[32] As Leah Knight has observed, contemporary botanists drew attention to these material origins, writing in herbals, for example, about the use of hyacinth bulbs in glue for paste-downs. 'Plants and pages were thus quite literally bound together,' she notes: 'even ordinary readers and writers may have been familiar with the interface between paper and plants in this now quite unfamiliar way.'[33] Herbaria, like those compiled by Browne's family, were perhaps the ultimate expression of the organic book. Key instruments of botanical study, they directly incorporated dried and pressed plant specimens on the page, illustrating how pieces of nature might literally, as well as descriptively, be inked, wrapped, glued, sewn and pulped into the printed codex. The connection between books and gardens was not only registered in the cerebral modes of metaphor, allusion or etymology, but was also perceptible in objects of reading.

Books shared a visual and verbal terminology as well as a material origin with the garden. Pages were known as folios and leaves, stamped with printer's 'flowers' and decorative 'borders'. While Juliet Fleming has warned against unquestioningly correlating these arabesque forms with their botanical counterparts, citing their

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[30] Rebecca Bushnell, *Green Desire: Imagining Early Modern English Gardens* (Ithaca: Cornell University Press, 2003), 35.
[31] See: Harrison, "Book of Nature and Early Modern Science."
[32] Joshua Calhoun, "The Word Made Flax: Cheap Bibles, Textual Corruption, and the Poetics of Paper," *PMLA* 126, no. 2 (2011): 328, 331.
[33] Leah Knight, *Of Books and Botany in Early Modern England: Sixteenth-Century Plants and Print Culture* (Farnham: Ashgate, 2009), xi.

'associative burdens,' she nevertheless concedes that some sixteenth-century books deliberately 'engage the floral connotations of their own type-ornament.'[34] While the first page of the first edition of *The Garden of Cyrus* utilises only slender rows of printed flowers, distinctly floral forms, with round, five-petalled rose shapes marshalled tightly between thick, hedge-like bands of foliage clearly demarcate the textual space as the 'Garden' of the title printed directly beneath.[35] The physical book reasserts the importance of the garden as a visual and conceptual frame, and the simple presence of printers' flowers on the page reminds us that nature might be read as a text, reinforcing the sense that natural forms might have semiotic functions, and that meaning can be imputed by combinations of forms, whether they are strings of letters or natural motifs.

Self-consciously playing throughout his work on the many literary and material conventions likening books to gardens, Browne has been suggested as the seventeenth-century author who 'most elaborately developed' the trope of the book of nature.[36] His explicit discussion of the book of nature in *Religio Medici* provides a compelling model for approaching his later work:

> there are two bookes from whence I collect my Divinity; besides that written one of God, another of his servant Nature, that universall and publik manuscript, that lies expans'd unto the eyes of all; those that never saw him in the one, have discovered him in the other: This was the Scripture and Theology of the Heathens; the naturall motion of the Sun made them more admire him than its supernaturall station did the Children of Israel; the ordinary effect of nature wrought more admiration in them, than in the other all his miracles; surely the Heathens knew better how to joyne and reade these mysticall letters, than wee Christians, who cast a more carelesse eye on these Common Hieroglyphicks, and disdain to suck Divinity from the flowers of nature.[37]

Browne evokes the book of nature as a garden from which access to the divine might be extracted. Imagining the heathen reader, literate in the patterns of nature,

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[34] Juliet Fleming, "How Not to Look at a Printed Flower," *Journal of Medieval and Early Modern Studies* 38, no. 2 (2008): 347; and "Changed Opinion as to Flowers," in *Renaissance Paratexts*, eds. Helen Smith and Louise Wilson (Cambridge: Cambridge University Press, 2011), 49.
[35] Thomas Browne, *Hydriotaphia, Urne-Buriall, or, a Discourse of the Sepulchrall Urnes Lately Found in Norfolk. Together with the Garden of Cyrus, or the Quincunciall, Lozenge, or Net-Work Plantations of the Ancients, Artificially, Naturally, Mystically Considered* (London: Henry Brome, 1658). This first edition does seem to play on the representational nature of the ornaments; while the borders at the top of the first pages of *Hydriotaphia* and *The Garden* are identical, the ornamentation of *Hydriotaphia*'s prefatory letter uses regal *fleurs-de-lys*, a notable contrast to the ornamentation of *The Garden*'s prefatory letter, which look like flowers in vases.
[36] Bushnell, *Green Desire*, 101.
[37] Browne, "Religio," 78-79.

as able to interpret the book of nature in such a way as to 'suck Divinity from [its] flowers,' Browne adapts a longstanding classical and humanist pedagogical tradition that depicts the diligent, commonplacing student as a bee collecting nectar. In the influential educational manual *De Copia* (1512), Erasmus similarly described how 'our student will flit like a busy bee through the entire garden of literature, will light on every blossom, collect a little nectar from each, and carry it to his hive.'[38]

For Browne, interpreting nature, like creating commonplace books, is a multifaceted process. It involves identifying things worthy of admiration, observing them closely, and then learning how to 'joyne and reade' them. This passage indicates the different activities Browne perceives as essential to understanding the natural world. On the one hand, close and careful (as opposed to 'carelesse') observation is required, with as much value ascribed to the quotidian as the extraordinary: the 'publik manuscript, that lies expans'd unto the eyes of all' is found in the everyday motions of the sun. On the other, we must simultaneously 'read' and reinterpret what we see: the 'mysticall letters' and 'Hieroglyphicks' of nature suggest a symbolic meaning in need of decoding. This model of double reading, in which careful and literal observation must lie alongside a more mystical and creative interpretation, lies at the heart of Browne's natural philosophical hermeneutics.

Re-ploughing the Field of Knowledge

If *Religio Medici* castigates the careless reading tendencies of the Christian, *The Garden of Cyrus* offers instruction in how we might 'joyne and reade these mysticall letters' that have been divinely inscribed into nature, with Browne promising an 'Artificially, Naturally, [and] Mystically Considered' examination of the quincunx in his subtitle. It is no coincidence that Browne, who so clearly sets up the book of nature as a conduit to both divine and sensible, theological and philosophical knowledge, explicitly names his tract after a 'garden,' a site where nature and artistry are traditionally held in tension, and a symbolically overloaded space where man's knowledge of the creation was once most complete, and then lost.

[38] Desiderius Erasmus, *De Copia/De Ratione Studii*, eds. R.A.B. Mynors, et al., vol. 24, *Collected Works of Erasmus* (Toronto: University of Toronto Press, 1978), 639. On the roots of the metaphor, see Anderson, "Book as Garden," 249, fn. 2.

However, Browne's work is no conventional garden book. The slender octavo volume of *Cyrus* and *Hydriotaphia* differentiates itself in form and content from the weighty tomes of herbals and botanical works fashionable at the time:

> we write no Herball, nor can this Volume deceive you, who have handled the massiest thereof: who know that three Folio's are yet too little, and how New Herbals fly from America upon us, from preserving Enquirers, and old in these singularities, we expect such Descriptions.[39]

Browne ironically exposes the latest herbals as lacking in innovation, describing his experienced readers as 'old in those singularities' of the herbals, and 'expect[ing] such Descriptions' as the novelties they afford. In this extensively covered 'Field of knowledge', he notes, it is 'hard to spring anything new'. And yet, Browne proposes to do exactly that, claiming: 'Of old things we write something new, If truth may receive addition, or envy will have anything new'. By proposing to 'spring' or cultivate 'something new' from the old in this 'Field of knowledge,' Browne invokes the notion of the plough, which turns over exhausted soil to create a new and fertile landscape for germination; in doing so, he stakes out his ambitions to redraw the space of the botanical book.[40]

Summoning the massy pages of the herbals in order to deny them, Browne's paralipsis reassigns the garden book as a frame that he can simultaneously utilise and efface. It becomes a template he can re-plough, in which a new kind of knowledge might be sown and harvested. If the text's main interest is the fragile, shadowy efforts of human knowledge, it is nevertheless the figure of the garden that provides the frame upon which such intangible notions might grow, and in which the hybrid approach needed to read the Book of Nature can flourish.

Bruno Latour has described the process of negotiating the movement of knowledge from its site of production to the external world as inherently discursive and rhetorical: a sort of 'metaphorical drift' which 'is the source of all innovations.'[41] Latour's description of the essential nature of '[t]he technology of inscribing' in the communication of knowledge from an originary source to a wider audience is revealing, and can be extended usefully beyond the laboratory to other sites of knowledge production.[42] Positing his text not as a traditional herbal but as a 'Garden

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[39] *GoC*, 319.
[40] *GoC*, 319.
[41] Latour, "Give Me a Laboratory," 153, 154.
[42] *GoC*,162.

Discourse,' Browne signals the importance of language, legibility and inscription in the transmission of natural knowledge, recognising the garden as a space in which rhetorical and scientific experimentation and innovation can go hand in hand.[43]

The importance of literary arts as an essential methodological tool of natural philosophy is suggested throughout *The Garden* in Browne's alignment of the creative manual arts of humanity and the divine creation of nature. Refusing the visual power of illustrations, on several occasions Browne utilises textual images that convey the creative powers of God in terms of craftsmanship and manual artistry, describing 'the orderly hand of nature' and how 'the needle of nature delighteth to work, even in low and doubtful vegetations.'[44] In the early modern world, practices of writing, needlework and gardening were understood as analogous forms of creative and manual work: the knots of the garden and the needle were closely linked with visual and literary artistry, and possessed similar symbolic capacities. Gardening, embroidery and writing all created surfaces and 'textures'—a favourite word of Browne's—which could, in some fashion, be 'read.'[45] These metaphors reinforce Browne's notion of nature as a text that might be read and deciphered in a movement towards the divine, while also reinscribing Browne's own book and the book of nature as gardens, creative spaces where nature can be cultivated and nurtured through craft, whether divine or human. Invoking the legible book of nature, and, as Murphy has described, sending the reader on a 'course in reading: construing not just Browne's essay, but also the world,' Browne uses the garden to model the diverse ways in which we might move closer to successful understandings of our relationship with God and the natural world he has authored.[46]

The Anthological, Analogical Garden

[43] *GoC*, 321.
[44] *GoC*, 361, 44.
[45] On links between needlework, gardening and writing, especially for women, see Jennifer Munroe, *Gender and the Garden in Early Modern English Literature* (Aldershot: Ashgate, 2008), 12, 91-120. John Evelyn describes how the patterns of knots, frets, and parterres in careful garden design can 'appeare like a glorious embrodery', describing the ability of the 'exquisite hand' of the artist-gardener to 'compose *Impresses, Mottos, Dialls, Escutchions, Cyphers* and innumerable other devices with wonderfull felicity & effect,' John Evelyn, *Elysium Britannicum, or the Royal Gardens* (Philadelphia: University of Pennsylvania Press, 2001), 123.
[46] Murphy, "Plato's Timaeus," 252-53.

The anthology or commonplace book provides a key epistemological frame for Browne's work. Humanist educational manuals drew on a classical tradition which described pedagogy in botanical terms, and various iterations of the commonplace book were etymologically as well as figuratively linked to the garden.[47] The literary *florilegium* derives its name from the Latin for 'flower-culling', and is a literal rendering of the Greek root of 'anthology', *ἀνθολόγιον*.[48] Short excerpts of advice, knowledge, poetry, and rhetorical ornament were characterised as flowers, and printed commonplace-style books styling themselves as 'gardens' for pleasure and profit were popular across a range of genres.[49] It was not only literary commonplace books which encouraged the gathering of fragments of knowledge: Preston has described the 'scientific *copia*' that was 'a fundamental feature of the intellectual universe [Browne] and his colleagues constructed for their investigative and observational writing and thinking.'[50] Considering the centrality of these garden metaphors to texts specifically designed to aid learning it is no wonder that the book, the plant and the processes of knowing came to be synonymous.

The commonplace book's encouragement of *copia*, and collection of discrete facts and rhetorical devices, resonates with the sheer variety and restlessness of Browne's prose. At least a part of *The Garden of Cyrus* was a product of this commonplacing culture; as Jeremiah S. Finch has noted, the first chapter of the text is like a 'patchwork of borrowed material', developed from sections of Browne's own notebooks that closely copy passages from Curtius's *Hortorum Libri Triginta* and della Porta's *Villæ.*[51] Browne's 'range into extraneous things' also bears formal and structural resemblance to commonplace books, grouping observations according to common themes such as textile arts, surface patterning in anatomy, or the direction of plant growth, and lighting on a topic for anything from a few words to an extended paragraph before diverging to something different.[52] Browne's liberal use

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[47] See Rebecca Bushnell, *A Culture of Teaching: Early Modern Humanism in Theory and Practice* (Ithaca: Cornell University Press, 1996).
[48] 'Florilegium, n.' and 'anthology, n.,' *OED*.
[49] Some typical titles include: Henry Peacham, *The Garden of Eloquence conteyning the Figures of Grammer and Rhetorick, from Whence Maye Bee Gathered All Manner of Flowers, Coulors, Ornaments, Exornations, Formes and Fashions of Speech,* (London: H. Jackson, 1577); *Floures for Latine Speakyng Selected and Gathered Oute of Terence* (London: 1544); Thomas Hunt, *Abecedarium Scolasticum or the Grammar-Scholars Flower-Garden* (London: Obadiah Blagrave, 1681); Hugh Plat, *The Floures of Philosophie with the Pleasures of Poetrie Annexed Vnto Them* (London: Frauncis Coldocke and Henry Bynneman, 1581); *A Garden of Spirituall Flowers. Planted by Ri. Ro. Will. Per. Ri. Gree. M.M. And Geo. Web.* (London: R. B[adger], 1635).
[50] Preston, *Poetics of Investigation*, 38.
[51] Jeremiah S. Finch, "Sir Thomas Browne and the Quincunx," *Studies in Philology* 37, no. 2 (1940): 282.
[52] *GoC*, 321.

of scriptural, classical, historical and philosophical reference, often embedded in his printed marginalia, also gives an impressionistic sense of the commonplace book.

In contrast to the precise classificatory logic of differentiation that directs the phytologies from which Browne distances himself, the linked modes of analogy, similitude and digression that dictate the doctrine of signatures play major structural roles in *The Garden*.[53] Similitude permeates the text not only in conventional forms of figurative language, but also as a mode of yoking together separate reflections, facilitating Browne's shifts from one concern to the next, as, for example, in the simple movement from the discussion of lattice shapes on birds' legs to examinations of similar patterns in fish scales and leather.

Analogy also dictates the overarching structure of the work. Because Browne's book is imagined as a garden, it is structured according to the logic of the quincunx, his archetypal symbol for garden design. On a simple level, this means, as already noted, that the text is divided into five chapters; more significantly, it also means Browne's text spans exponentially outwards, using the bonds of similitude to recreate the latticework woven by the quincunx, expanding from point to point in a web of fast-moving connections. These links often, but never exclusively, rely on tracing the quincuncial structure through a series of objects, forms and ideas. However, on occasion Browne also springs from one subject to the next based on an alternative criteria, such as word repetition or the development of an alternative theme, creating a permissive, digressive, and dynamic network of links.

A sense of this transverse movement can be captured with a summary of the final passage of Chapter 3, which begins, ironically, with the prefix 'Lastly.'[54] Across a series of paragraphs, Browne discusses theories of vision; refraction through windows and convex glasses; ancient anatomies of the optic nerve; the architecture of whispering chambers; echoing sound waves; Bovillius's model of sensory perception; hallucinations; Ancient Egyptian spiritual beliefs; the figure 'X' and its pictorial origins as a stork; the Platonic motions of the souls of world and man; Justin Martyr's mistaking of 'X' for 'T'; and finally—truly 'lastly'—the possibility that 'X' might have been brought into Greek culture by Cadmus.

Browne's musings are bound together by the common conceptual thread of the quincunx, but they also trace its connective, macromolecular logic. One notion

[53] *GoC*, 319.
[54] *GoC*, 376.

leads organically to the next, but often with little apparent direction: the text frequently returns to interests it seems to have diverged from several paragraphs earlier. The value of this digressive texture lies not in the careful documentation of a precise hieroglyph but in the potentially infinite scale of the resulting network; Browne's analogical mode attempts to comprehend the mystic connectedness of everything to everything in divine creation. The connective logic of digression enables Browne to formally enact the expansive nature of the quincuncial lattice, speaking to the impossible magnitude of Divine creation while also unearthing novel connections that might 'venially admit of collaterall truths'.[55] Murphy has argued astutely that 'If God is author, then Browne becomes the appreciative critic, tracing and communicating God's intention in the world, rousing his reader's admiration and wonder at his artistry.'[56] The quincuncial garden, with its fertile *copia* and pious integration of *dulce* and *utile* provides the pattern required to capture and communicate this astonishing artistry.

Nevertheless, while Browne insists within the space of two paragraphs that 'Studious Observators may discover more analogies in the orderly book of nature' and that we 'cannot overlook the orderly hand of nature,' Browne's copious text can gesture to, but never achieve that order.[57] Browne is necessarily distracted and enabled by his habits of digression and paralipsis, finding his own innovation precisely within their rhetorical disorderliness.[58] Paradoxically locking a chaotic plethora of *varietas* within the apparently well-ordered and confined structure of the quincunx, Browne's attempts to muster variety into harmonious order in fact indicate the inadequacy of human artistry to recreate the orderly and divine book of nature; the arbitrary frame of the quincunx often struggles to hold against the unwieldy energy of Browne's spiralling, expansive interests.

Conclusion

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[55] *GoC*, 320.
[56] Murphy, "Plato's Timaeus," 256.
[57] *GoC*, 320.
[58] Contemporary rhetorical texts describe the figures of *paralipsis* and *digressio* in similarly dynamic terms of moving beyond or journeying away from a topic. George Puttenham describes *paralipsis* as 'the Passager' and *digressio* as 'the straggler' in George Puttenham, *The Arte of English Poesie* (London: Richard Field, 1589), 194-95. Thomas Blount describes digression as 'a departing, a changing of purpose, a straying from the matter, a swerving from', while *præteritio* (another term for *paralipsis*) is a 'going over, a passing by or beyond, a surpassing,' in *Glossographia, or, a Dictionary Interpreting All Such Hard Words of Whatsoever Language Now Used in Our Refined English Tongue* (London: Tho. Newcombe, 1661), [Ii2v].

Much of the *Garden*'s emotive and intellectual power derives from the dizzying series of rhetorical and logical connections that hold the text's delicate tissue of ideas together: these joyous and oblique movements gesture toward the ingenuity of a divine maker. Certainly *The Garden* is a site of formal and literary experimentation, where Browne tests the limits of how far his esoteric learning and superlative wordplay can take him. But if Browne's analogical, hermetic logic seems outdated in 1658, his garden-text also draws on his familiarity with gardens as sites where the critical work of the 'new science' was being performed, where empirical investigation and observation was encouraged in the plant beds as well as laboratories. The encouragement of intricate scientific experimentation alongside grandiose philosophical meditation was deeply ingrained in the design of an ideal garden: in *Elysium Britannicum*, Evelyn imagines a 'philosopho-medicall' garden replete with an 'Elaboratory', offering the 'roome and opportunities for new & rare experiments for enfranchising strange plants & civilising the wild & rude' while also enlarging the possibilities for the 'contemplation of Nature & the accomplishment of our Elysium.'[59] Artistry in the garden could also be investigative.

Preston has persuasively argued that *The Garden of Cyrus*, particularly in its discussion of seeds and generation, shows 'Browne in his most rigorously scientific mode,' and so 'might with justice have been called *The Laboratory of Cyrus*.'[60] At a number of points in *The Garden*, Browne advances the importance of scientific tools and espouses the kinds of close and careful empirical observation which were encouraged in natural histories and herbals and taught in the integrated complexes of laboratories, gardens and anatomy theatres of Europe's great medical schools. In one instance, he notes: 'He that would exactly discern the shop of a bees mouth, needs observing eyes, and good augmenting glasses; wherein is discoverable one of the neatest peeces in nature, and must have a more piercing eye then mine'.[61] In another, he describes an experiment he performed by setting mint and scordium stalks upside down in water, to see which way the leaves would grow.[62]

Browne's observations are not confined to his workrooms, and *The Garden* records his observations in the field, too:

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[59] Evelyn, *Elysium Britannicum*, 403-4. Evelyn lists many of the gardens in which Browne had studied, including Leiden and Montpellier, as appropriate models for his own design.
[60] Preston, *Thomas Browne and Early Modern Science*, 175, 191.
[61] *GoC*, 356.
[62] *GoC*, 366.

> in the orderly and rarely disposed cels, made by flyes and insects, which we have often found fastened about small sprigs, and in those cottonary and woolly pillows, which sometimes we meet with fastened unto leaves, there is included an elegant net-work texture, out of which come many small flies. And some resemblance there is of this order in the egges of some butterflies and moths, as they stick upon leaves, and other substances; which being dropped from behinde, nor directed by the eye, doth neatly declare how nature geometrizeth, and observeth order in all things.[63]

In many senses nature *is* Browne's laboratory: it is the space in which he makes a great number of his observations. However, Browne's conclusion here, that 'nature geometrizeth, and observeth order in all things,' should alert us to a critical difference. His findings are neither neutral nor discrete as the products of a laboratory claim to be; instead, intertwined with his reading of the rest of the book of nature, his hypotheses, linked together in the connective network of his text, collectively 'declare' universal conclusions.[64]

While such observations speak of the divine order that Browne traces with such zeal, they do not come without due warning. Having cautioned against 'carelesse' readings of the book of nature in *Religio Medici*, in *The Garden* Browne repeatedly warns that human senses might provide imprecise, or, even worse, distorted images of nature. He denigrates his own eyes as inadequate optical instruments and reflects that in a Bovillian model of sensory perception, a malfunctioning perceptive geometry might produce 'irregular apprehensions of things.'[65] While empirical observation is an essential tool for reading the book of nature for Browne, like all other kinds of reading, it carries a potentially heretical risk of misinterpretation.

Robert E. Kohler has noted that while often 'assumed to be little more than neutral stages for experiment[…] [i]t is in labs that cultural boundaries—for example, between the realms of nature and of religion and politics—are made visible.'[66] Latour highlights this paradoxical coexistence of the human and the natural in his paradigm of the Boylean laboratory, which emerged in the mid-seventeenth century,

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[63] *GoC*, 356.
[64] On the appearance of 'neutrality' that laboratories create, see: Robert E. Kohler, "Lab History: Reflections," *Isis* 99, no. 4 (2008); and Bruno Latour, "Give Me a Laboratory and I Will Raise the World," in *Science Observed: Perspectives on the Social Study of Science*, eds. Karin Knorr-Cetina and Michael Mulkay (London: Sage, 1983).
[65] *GoC*, 377.
[66] Kohler, "Lab History," 762-63.

and whose metaphorical and bodily affordances I trace in Chapter Three. He argues that 'within the artificial chamber of the laboratory', while 'facts are mute[…] scientists declare that they themselves are not speaking; rather, facts speak for themselves[…] they testify to each other that they are not betraying but translating the silent behaviour of objects.'[67] The early modern laboratory was a place where art might master or challenge nature within a controlled environment.[68] This tension was also true of the garden, a place where nature is manipulated by human artifice but can also resist this deliberate shaping.

This complex and contentious relationship lies at the heart of Browne's text, which uses the figure of the garden to highlight the human artistry involved in producing knowledge. Claiming that such 'bye and barren Themes' as his rehearsals of garden history may prove the place for 'most fit for invention', Browne replicates the work of the laboratory, applying imaginative rhetorical artistry to natural subject matter in an attempt to expand knowledge.[69] Combining the artificial, natural and mystical modes of inquiry alluded to in his title, Browne forms his work in the model of a heterotopic text-laboratory-garden hybrid, which combines older scholastic and mystical forms of knowing with more contemporary empirical forms of investigation, and where the imaginative connections forged by the author might make as prominent a contribution to the 'Field of knowledge' as experimental data.

While Browne's objects of interest certainly speak to him, and 'declare' conclusions and connections not only for themselves but 'for all things,' Browne leaves us under no illusion as to the extent to which his own voice, and his own imagination, play a key role in weaving together the fabric of his findings. To a greater degree perhaps than the ideal of the empirical laboratory, the spaces of the garden and the page both enable humans to manipulate nature to fit their own design or 'order'. If Boyle's experiments seem to speak for themselves, Browne's suggestion that '[s]tudious observators may discover more analogies in the orderly book of nature, and cannot escape the elegancy of her hand in other correspondencies' plays evocatively on the similarity between *correspondency* as likeness and epistolary *correspondence* as mail to suggest that natural philosophy occurs in discourse with nature, as a collaborative process of observing, reading and

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[67] Latour, *Never Been Modern*, 29.
[68] See Pamela H. Smith, "Laboratories," in *The Cambridge History of Science*, ed. Katharine and Lorraine Daston Park (Cambridge Cambridge University Press, 2006).
[69] *GoC*, 320.

interpreting nature's missives or 'correspondencies', before being re-written in his own hand.[70] Browne is no disguised ventriloquist for his objects, but overtly shapes them; his expansive garden, unfurling outwards in its latticed grids might be seen to anticipate Latour's description of 'nature-culture', manifested in 'networks [that] are *simultaneously real, like nature, narrated, like discourse, and collective, like society*.'[71] Browne's quincuncial network is all of these things: embedded in nature, discursively and rhetorically shaped, and collectively connected in its lattice forms.

While Browne's text records the results of the kinds of observation and experimentation we might justifiably associate with the laboratory, I want to propose, in the spirit of Browne, a modification of Preston's terminology when she describes '*the Laboratory of Cyrus*'. As we have already seen from John Evelyn's garden plans, an early form of the word 'laboratory' was *elaboratory*, which appeared in the mid-seventeenth century in publications such as *Philosophical Transactions*.[72] Though according to the *Oxford English Dictionary*, *laboratory* and *elaboratory* possess the same meaning—both are 'place[s] where chemical operations are performed, or where medicines are compounded'—they have distinct etymologies. While the now-standard *laboratory* derives from the Latin *laboratorium* or 'workplace,' the *elaboratory* has origins in *elaborare* and the verb 'to elaborate' —to speak further on something. By the sixteenth-century elaboration was already associated with rhetoric, artistry and craft; a contemporary definition of 'elaborate' was simply 'accomplished style.'[73] Playing on the idea of the rhetorical flower, Juliet Fleming has suggested that printed flowers 'are used, in their turn, as metaphors, to evoke that which is embellished, ornamented or otherwise marked as being at the height of excellence.'[74] We might see Browne's emphatic garden signposting, as well as his own printers' and rhetorical flowers, as similarly elaborate gestures, pointing not only to the verdant riches of his own prose, but also to the unfathomable beauties of divine creation.

Following these etymological trails allows us to construct a new model of the elaboratory as a space where concerns of style could be entwined with scientific work, and where the epistemological patternings of the garden might be rendered textually on the page. This new model of the elaboratory by no means coincides

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[70] *GoC*, 360.
[71] Latour, *Never Been Modern*, 6.
[72] Evelyn, *Elysium Britannicum*, 404; 'Laboratory, *n.*' and 'elaboratory, *n.*,' *OED*.
[73] [Anon.], *The Academy of Pleasure Furnished with All Kinds of Complementall Letters, Discourses and Dialogues* (London: printed for John Stafford...and Will. Gilbertson, 1656), [G7v].
[74] Fleming, "Changed Opinion," 50.

with actors' terms and requires further elaboration of its own. But it might go some way to providing a word for what we find on Browne's pages: a space where a heightened aesthetic might not only coexist with but also support empirical and experimental attention to the natural world. *The Garden of Cyrus* embodies the peculiar polysemousness of this elaboratory. Making its digressive style a productive aspect of its natural philosophy, Browne's book is a place both for the scientific work of empirical observation and for the elevation of nature and divine creation through style, using imagination, metaphor and observation in tandem to explore and test the boundaries of the world, and of what can be known in and of the garden.

Chapter Two

Nature's Cabinets Unlocked

Nothing [is] esteem'd in this lunatique age, but what is kept in Cabinets.[1]

Nature's Cabinet Unlock'd

In 1657, *Nature's Cabinet Unlock'd,* a natural philosophical work promising to lay bare the secrets of the natural world from the properties of metals and stones to the processes of human anatomy and gestation, was published. Its title page made two clear bids for commercial success. First, its (false) attribution of authorship to Thomas Browne was a clear attempt to profit from the popularity of his previous works, *Religio Medici* and *Pseudodoxia Epidemica*.[2] The inclusion of the epigraph 'All things are Artificial, for Nature is the Art of God' on the title page, a phrase lifted directly from Browne's *Religio*, attempted to reinforce the impression that, as with Browne's other books, the buyer of *Nature's Cabinet Unlock'd* would be receiving a work not only of scholarly accuracy but also of literary and philosophical merit.[3]

Second, the title was carefully calculated to seduce a would-be reader. The simple metaphor, 'Nature's Cabinet Unlock'd', tantalisingly promises the whole world opened up for the inquisitive reader to inspect. The lure of curiosity—of accessing the contents beyond a locked box or door—transcends historical specificity; this temptation can be traced right back to Pandora and classical mythology. But while the promise of a locked box has proved universally attractive throughout the ages, the metaphor of Nature's cabinet, in which the anthropomorphised goddess Nature holds the key to a cabinet or closet containing the contents of the world, occupied a special place in seventeenth-century thought, particularly in natural philosophical writing.

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[1] Michael Drayton, *Poly-Olbion* (London: printed for M. Lownes, I. Browne, I. Helme, I. Busbie, 1612), A[1r].

[2] Anon. [attrib. Thomas Browne], *Natures Cabinet Unlock'd* (London: printed for Edw. Farnham, 1657). Both *Religio Medici* (first published in an unauthorised version in 1642) and *Pseudodoxia Epidemica* (first published in 1646) went into multiple print editions during Browne's lifetime. The claim of Browne's authorship of *Natures Cabinet Unlock'd* was denounced by his stationers in his next book: see *Hydriotaphia,* (London: Henry Brome, 1658): 'The Stationer to the Reader', [O6r-O6v].

[3] *Religio Medici* ([London]: printed for Andrew Crooke, 1642), 29.

Cabinets were ubiquitous in the seventeenth century. A trend for collecting, and the growth of mercantile trade in the early modern period had resulted in an avalanche of stuff that needed to be stored somewhere, whether it was invoices and documents, household linens, or luxury goods such as tea, jewellery and curiosities. The storage capacities and architecture of early modern homes developed accordingly. Closets, small private rooms which were often ante-chambers to bedrooms, were built into upper- and middle-class homes, providing space for a range of private activities such as study, business and prayer, and for storing treasured items, from books, accounts and family records, to rich textiles or silver plate.[4]

Figure 9. Pieter de Hooch, *Interior with Women beside a Linen Cupboard*, 1663, oil on canvas, 70 x 75.5 cm, Rijksmuseum, Amsterdam. Image © Rijksmuseum, Amsterdam.

Freestanding cabinets, from small trinket boxes to large linen chests (see Figure 9), also proliferated. Dora Thornton has stressed the decorative and functional

[4] Lena Cowen Orlin has stressed that while aristocratic cabinets have left a disproportionate amount of documentary evidence and have received an accordingly disproportionate amount of critical attention, cabinets were as much a feature of houses of the urban elites and the 'middling sorts' in *Locating Privacy in Tudor London* (Oxford: Oxford University Press, 2007), 296-326.

continuities between the freestanding cabinet and the closet room in the early modern period, describing the difference as 'primarily one of scale, and not function'.[5] The words 'cabinet' and 'closet' were used interchangeably to describe freestanding or built-in structures, and both enabled the private and secure storage, organization and display of documents, books, and objects. Both types of cabinet employed similar decorative techniques, often mimicking architectural facades and utilising skilled woodwork, with elite examples decorated with fine marquetry from exotic wood veneers or even *pietra dura* marble effects.[6] From private ascetic studies, to trinket boxes, trunks and ornate spaces for the display of valuable art works, these versatile and intimate spaces were imagined as a continuum.

Perhaps the most significant type of cabinet in the development of the trope of nature's cabinet was the collector's cabinet, in particular the *Wunderkammer*. For natural philosophers, the whole world had been opened up by global trade, and natural specimens from the far-flung corners of the globe were in high demand. *Wunderkammern* represented an attempt to recreate the macrocosmic world on a microcosmic scale using objects from the natural world. Literally 'wonder chambers', these collections were intended to invoke the fascination of the viewer, and often relied on curious and exotic specimens to do so. Yet the *Wunderkammer* could also provoke intrigue through the variety and sheer number of objects they exhibited. In the grandest, and most renowned examples, occupying their own, dedicated spaces (see Figure 12), a huge variety of things including natural specimens and human-made objects were displayed in a manner that attempted to replicate the world's natural hierarchies and puzzle out taxonomies. Coral, for example, might be positioned in between plants and rocks, indicating its apparently 'hybrid' nature. The crocodile on the ceiling might mediate between reptiles and fish, apparently displaying features of both.

These worlds-in-miniature encompassed a bricolage of collections we would now consider natural historical, anthropological, technological and historical, attempting to weave them together into a holistic picture of the universe. Museological *Wunderkammern* were both renowned and popular, particularly for their more unusual objects, which could include such items as unicorn horns or mermaid

[5] Thornton, *Scholar in His Study*, 74.
[6] Ibid., 53. See also: Glenn Adamson, "The Labor of Division: Cabinetmaking and the Production of Knowledge," in *Ways of Making and Knowing: The Material Culture of Empirical Knowledge*, eds. Pamela H. Smith, Amy R.W. Meyers and Harold J. Cook (Ann Arbor: University of Michigan Press, 2014).

tails.[7] Many collections were private, and restricted their visitorship to the members of the philosophical elite, with invites relying on introductions through Europe's tangled networks of scientific correspondence. But others were more freely accessible; 'Tradescant's Ark', the South Lambeth collection of middle-class plantsman and explorer John Tradescant the elder, became one of the 'must-see' attractions of mid-seventeenth-century London, recommended as an educational and entertaining experience for everyone from foreign visitors to northern grammar-school pupils.[8]

Figure 10. Woodcut of a Wunderkammer from Ferrante Imperato, *Dell'historia Naturale… Libri XXVIII* (Naples: 1599), Wellcome Collection 9530940. Image © Wellcome Collection.

On a more modest scale, inquisitive hobbyists collected their own rare and curious items in small cabinets (see Figure 11). The cabinet of John Bargrave, a canon of Canterbury Cathedral, for example, contained the mummified finger of a Franciscan

[7] Even as zooanatomical knowledge increased, mythological terms continued to be used in the description of certain animals and their body parts. The catalogue of the Royal Society Repository, for example, lists 'The Horn of the Sea-Unicorne', noting the creature is known as a narwhal in Iceland, and a fossilised specimen Grew calls 'Dragons Teeth'. Nehemiah Grew, *Musæum Regalis Societatis, or, A Catalogue and Description of the Natural and Artificial Rarities Belonging to the Royal Society* (London: printed for Tho. Malthus, 1685), 83-84; 257.
[8] Swann, *Curiosities*, 28.

monk, a dried chameleon, an 'escaping handle' used to aid controlled descent down a rope, lodestones, an anatomical model of the human eye, a coral, a commemorative pilgrimage ribbon, two Chinese books, a piece of hippopotamus tooth rumoured to protect against poison, and a Native American necklace, all in a small wooden box of drawers.[9]

Amid this trend for microcosmic cabinets of curiosity that attempted to recreate the natural world in miniature, it was easy, and perhaps almost instinctive, for scientific practitioners to comprehend and envision the natural world by imagining it within a cabinet.

Figure 11. Domenico Remps, *Cabinet of Curiosities*, c. 1689, oil on canvas, 99 x 137cm, Museo dell'Opificio delle Pietre Dure, Florence.

Playing on a notion that was essential to the operation of metaphor in natural philosophy, Browne's epigraph, adoped by his pirate, claimed that 'All things are Artificial, for Nature is the Art of God'—ironically stressing the inherent artificiality of nature. Early modern spaces for science, including cabinets of curiosity, often

[9] Bargrave's catalogue of his cabinet's contents is included in John Bargrave, *Pope Alexander the Seventh and the College of Cardinals, with a Catalogue of Dr Bargrave's Museum*, ed. James Craigie Robertson (London: Camden Society, 1867), 113-40. Claire Preston has made a compelling argument that Bargrave's collection was the inspiration for Thomas Browne's 'spoof' collection, *Musæum Clausum*, in *Thomas Browne and Early Modern Science*, 169.

functioned according to a similar logic; Paula Findlen has suggested that scientific spaces such as anatomy theaters, botanical gardens and cabinets of curiosities worked by 'remov[ing] natural artifacts from their original locations, [and] placing them inside new spaces for the specific purpose of studying them in order to improve natural knowledge'.[10] And yet, as I hope to illustrate in this chapter, poetry could also operate in an analogous mode, taking natural objects and bodies and reconfiguring them, through language, in order to re-place them in the world, and in the reader's understanding.

In this chapter, I will use Margaret Cavendish's 1653 work, *Poems, and Fancies*, as a case-study of how the metaphor of nature's cabinet could work, arguing that her comparisons of the body and the book to cabinets produce both localised and general frameworks that help to structure our understanding of her work, and provide insights into the natural world around us. Suggesting that Cavendish's text reflects, and indeed relies upon, a variety of the spaces that an early modern 'cabinet' or 'closet' might denote, and that she mirrors the structural functions of such cabinets in her poetic strategies, I will argue that the metaphor of nature's cabinet is key to comprehending the eccentric natural philosophy of *Poems, and Fancies*, a work that has sometimes been written off as frivolous and immature, but which in fact engages with the world around it using philosophical modes that were commonplace in their time. In particular, I will explore how the model of the cabinet influences Cavendish's theories of cognition, enabling her to promote an epistemology that stresses both the interconnectedness of the body within its environments and the validity of using the poetic imagination as a tool for natural philosophical investigation. First, I will provide brief context as to the development and use of the trope, before outlining the interactions Cavendish herself would have had with cabinets. I will then examine how these experiences impacted on the use of the metaphor of nature's cabinet in *Poems, and Fancies*, exploring how it provides us with a model of cognition that is more broadly developed by Cavendish throughout the volume. Finally, I will examine how Cavendish's descriptions of her poetics, and the physical make-up of the book itself, encourage us to consider her fanciful and imaginative strategies as legitimate forms of knowledge-making, resulting in a natural philosophy that is imaginatively, and poetically, infused.

[10] Findlen, "Anatomy Theaters," 273.

The metaphor of nature's cabinet first began to appear in print in the late sixteenth-century, with its usage growing steadily until the 1650s. This decade saw an explosion in the trope's use, which quickly declined again across the rest of the century.[11] Nevertheless, when *Natures Cabinet Unlock'd* appeared in 1657 at the height of the metaphor's fashionability, the book's bold titular promise to open up the secret inner workings of nature to the reader was still regarded as provocatively ambitious.

The extensive claim implied by the title is supported by the synopsis of the contents offered on the title page. The book makes a claim for itself as a volume which will reveal:

> The natural Causes of Metals, Stones, Precious Earths, Juyces, Humors, and Spirits, The nature of Plants in general; their Affections, Parts, and Kinds in Particular. Together with A Description of the Individual Parts and Species of all Animate Bodies, Similar and Dissimilar, Median and Organical, Perfect and Imperfect. With a compendious Anatomy of the Body of Man, As also the Manner of his Formation in the Womb.[12]

Offering such a huge wealth of knowledge for sale went beyond the standard applications of this metaphor. While nature's closet often alluded to a similarly vast wealth of knowledge, many philosophers believed such in-depth knowledge of nature, and in particular, natural causes, was not possible.

As we have seen, the commonly held notion that God's creation must remain a mystery to humanity was both theologically and philosophically contested in the era, and different uses of the metaphor of nature's cabinet reflected this debate. Natural knowledge, even when presumed obtainable, was considered prone to misinterpretation, and accordingly, nature's closet or cabinet was often invoked as an opaque and mysterious container, difficult or impossible to access. Descriptions often stressed philosophers' active pursuit of nature's 'Inscrutable Secrets' in the

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[11] This analysis has been primarily undertaken using EEBO keyword search and the 'EEBO-TCP Key Words in Context' function of the 'Early Modern Print' project, authored by Anupam Basu © Digital Humanities Workshop at Washington University in St Louis. https://earlyprint.wustl.edu/toolwebgrok.html. Though there are clear limitations to such an approach, including the number of texts not yet digitized or translated into searchable html text, and the multiple forms in which a concept such as a metaphor may appear, pursuing such an approach does offer enough evidence to give a clear sense of the rise and fall in usage over time.

[12] *Natures Cabinet Unlock'd*, title page.

cabinets; the cabinet itself, as well as the search for its contents, was frequently characterised as 'abstruse'.[13] This word provides the double-sense on which the metaphor operates; the 'contents' of Nature's cabinet are inaccessible, both in the sense that they are, by virtue of their position in the metaphorical closet, '[c]oncealed, hidden; secret'; but also because they are '[d]ifficult to understand; obscure, recondite.'[14] Few authors were bold enough to make such forthright claims of access to the contents of nature's cabinet as Browne's plagiarist; instead, for most, the contents of nature's cabinet were either unobtainable, or something to be pursued with considerable difficulty and virtuous diligence.

Natures Cabinet Unlock'd was subsequently denounced by Thomas Tenison as 'a dull worthless Book[…] A Plagiary so ignorant and so unskilful.'[15] Though Tenison was a partisan commentator—a relative of Browne, he also edited his posthumous papers—his criticism was pointed, executed with the righteousness of a distinguished church figure and the vituperation of a fellow author.[16] The inaccurate claims of the title were singled out for particular criticism, with Tenison expressing outrage that despite the inaccurate and plagiarised contents, 'yet he [the unknown author] had the confidence to call this Scribble, *The Cabinet of Nature unlocked*: An arrogant and fanciful Title, of which his [Browne's] true Humility, would no more have suffer'd him to have been the Father, than his great Learning could have permitted him to have been the Author of the Book.'[17] Tenison assures the reader of Browne's comparative humility by noting that 'as he is a Philosopher very inward with Nature, so he is one who never boasts of his Acquaintance with her.'[18] Implying that boasting about possessing the keys to nature's cabinet is a grave impropriety,

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[13] Edward Reynoldes, *A Treatise of the Passions and Faculties of the Soule of Man with the Severall Dignities and Corruptions Thereunto Belonging* (London: printed by R. H[earne and John Norton] for Robert Bostock, 1640), 499. See, for example; Henry Nollius, *Hermetical Physick: Or, the Right Way to Preserve, and to Restore Health*, trans. Henry Vaughan (London: printed by Humphrey Moseley, 1655), 3; Renodaeus, *A Medicinal Dispensatory, Containing the Whole Body of Physick, Trans. And Revised by Richard Tomlinson* (London: printed by Jo. Streater and Ja. Cottrel, 1657) 674-75; James Hart, *Klinike, or the Diet of the Diseased* (London: printed by John Beale for Robert Allot, 1633), 19; Massarius, *De Morbis Foemineis, the Womans Counsellour: Or, the Feminine Physitian*, trans. R.T. Philomathes (London: printed for John Streater, 1657), 3; Nathaniel Wanley, *The Wonders of the Little World, or, a General History of Man in Six Books* (London: printed for T. Basset, R. Cheswel, J. Wright, and T. Sawbridge, 1673), 16-17.
[14] 'Abstruse, *adj*.,' *OED*.
[15] Thomas Tenison, "An Account of All the Lord Bacon's Works," in *Baconiana, or, Certain Genuine Remains of Sr. Francis Bacon* (London: printed by J.D. for Richard Chiswell, 1679), 76-77.
[16] Though Tenison had vested interests, the later repeat of the complaint, ironically almost word for word, by Anthony Wood lends credence to the severity of our unknown author's abuse of title. See: Anthony Wood, *Athanæ Oxonienses* (London: printed for Thomas Bennet, 1692), 536; William Marshall, "Tenison, Thomas (1636-1715)," in *ODNB*.
[17] Tenison, "Account of Bacon's Works," 77.
[18] Ibid.

Tenison sees the misused metaphor not only as an inaccurate portrayal of the contents of the work but also as a poor reflection of the author's character. As his critique illustrates, the cabinet metaphor relies on assessments of interior natures—both in terms of the cabinet's contents and the subjective self. Being 'inward' might help one to develop a knowledge of both nature and oneself, but opening up such contents to the spectatorship of others must be done with caution and humility: the flamboyant unlocking of nature's cabinet by Browne's plagiariser exposes the moral flaws of the compiler as well as its stolen and faulty contents.

The metaphor of nature's cabinet can be complex; like Pandora's box, though alluring, it can reveal the flaws of the opener, as well as its treasures. The inwardness and sacred character of the cabinet, which seems to belong at once to God and to an anthropomorphised Nature, are emphasised across a number of works, often in connection with the suggestion that the precious contents of Nature's cabinet must remain unknowable. For example, Robert Fludd claims that 'there are many thousand things more that are hidden in the secret closet of nature, then commonly man doth know; or can at first discerne,' and that 'there are an infinity of invisible and internal actions performed by God, in the closet of Nature; which falleth not into the spheare, or capacity of the sensuall or naturall man; but are onely by faith to bee beleeved.'[19] Further suggesting the seriousness of Tenison's claims, some accounts even suggest that claims to know the secrets of the cabinet of nature do not only overstate their abilities; they are also dangerously heretical. Edward Reynoldes, for example, argues that '[t]o soare after Inscrutable Secrets; to unlocke and breake open the closet of Nature, and to measure by our shallow apprehensions the deep and impenetrable Counsels of Heaven which we should with a holy, fearfull, and astonished Ignorance onely adore, is too bold and arrogant sacriledge, and hath much of that Pride in it, by which the Angels fell.'[20] The hubris of natural philosophy, he warns, can have catastrophic theological consequences.

Among others, however, the search into the closet of nature was characterised as not only productive, but even virtuous. Discussing the work of physicians, Renodaeus describes 'men of approved skill, learning, and knowledge; who, given to the study of the abstruser Sciences, seek the more secret Closets of Nature, and finde the more miraculous vertues of Creatures: who make

[19] Robert Fludd, *Doctor Fludds Answer Unto M. Foster or, the Squeesing of Parson Fosters Sponge* (London: printed for Nathanael Butter, 1631), 42.
[20] Reynoldes, *Treatise of the Passions*, 499.

Medicaments after several manners[…] that in small quantity they have much vertue.'[21] The physician not only gains knowledge through his grasp of the more abstruse contents of nature's cabinets, but can virtuously adapt his discoveries in the cause of God's work: healing the sick. Renodaeus was a physician and his translator an apothecary; both had a vested interest in marketing their medicines as virtuous and godly products emanating from professional ingenuity. And yet, the pursuit of natural knowledge was legitimately regarded by many as an act of devotion: by pursuing the contents of nature's cabinet practitioners might develop practical and benevolent medical tools, but they might also find themselves moving closer to God.

Reflecting Lena Cowen Orlin's assessment that all kinds of closets and cabinets were fundamentally defined by their 'secure storage of valuable goods' and their ability to be 'safely kept locked,' the metaphor of nature's cabinet consistently alluded to the same essential notion—that the inner workings of nature could be imagined as valuable treasures, difficult to access.[22] However, the different responses to how, and if, we should attempt to open nature's cabinet, and what we might find there, reflect the wide range of genres, opinions, authors and readers associated with the texts in which it appeared. 'Nature's cabinet' was found chiefly in natural philosophical works or books containing practical medical advice, but it was also, like many of these metaphors of philosophical space, invoked in theological works and printed sermons. It would be convenient to presume that the religious works stress the unfathomable aspect of divine creation, while works interested in natural philosophy occupy a more active stance towards exploring the contents of the cabinet, but the textual evidence offers no simple conclusion: a range of attitudes are exhibited across all genres, and the accessibility of the closet, as well as the desirability of exploring it, varies from text to text.

The range of ways in which the metaphor of nature's cabinet or closet is put to use in the early modern period reflects the variety of physical settings and objects to which the terms refer. Most commonly, the metaphorical cabinet of nature is conflated with the cabinet of curiosities; both were associated with attempts to describe the variety of the natural world in microcosmic form. This chapter, however, will elaborate on how different types of cabinet could also inform the ways in which the metaphor was constructed and read, and consequently, affect the ways

[21] Renodaeus, *A Medicinal Dispensatory*, 674-75.
[22] Orlin, *Locating Privacy,* 8.

the world was understood. As Amanda Lillie has suggested, the material reality of objects might help us to understand textual form just as much as documentation might help us understand objects: Lillie has argued that '[r]ather than assuming that literary texts can explain buildings, it may be more helpful to turn the argument round and discover whether buildings and their physical environment can shed light on the construction of literary models'.[23] By examining the how the many forms of cabinet that Cavendish inhabited find their way into the figural architectures of *Poems, and Fancies,* I hope to show how Cavendish's philosophy adopts the plural semantics of the cabinet in a productive and coherent manner.

Cavendish's Closets

Cabinets and closets would have been ubiquitous for Cavendish throughout her life. Growing up in one of the wealthiest families in Essex, she would have been surrounded by a range of them, from personal closet rooms to freestanding furniture, from a very early age. Her autobiography details her childhood preference for clothes and fashion accessories over her 'closets or cabinets of toys,' and biographical evidence suggests that in her younger years she probably shared a closet with her youngest sister Catherine, who used it for her prayers.[24] Cavendish's time as a maid of honour to Henrietta Maria in Oxford and Paris ensured her fluency in the demarcations of public and private space that governed movement through the realms of the elite, including closets richly adorned with valuable *objets d'art* and paintings.

After her marriage, the scientific interests of her husband, William, and brother-in-law, Charles, who hosted renowned philosophical salons, make it almost certain that Cavendish was aware of the major cabinets of curiosity. Though it is unlikely that she visited the most famous collections herself—Paula Findlen has documented the attempted cultural construction of early museums as exclusively male spaces—she knew many who had, and had probably seen the impressive engravings of the most prestigious *Wunderkammern*, such as those of Ulisse

[23] Amanda Lillie, "The Humanist Villa Revisited," in *Language and Images of Renaissance Italy*, ed. Alison Brown (Oxford: Clarendon Press, 1995), 214-15.
[24] Catherine and Margaret shared a bedroom, making it likely they also shared the closet. See: Katie Whitaker, *Mad Madge: Margaret Cavendish, Duchess of Newcastle, Royalist, Writer and Romantic* (London: Vintage, 2004), 24.

Aldrovandi and Olaus Worm (Figure 12). This style of collection was likely emulated by William and Charles, who were keen collectors.[25] William's play, *The Varietie*, satirised the craze for collections, with one character exclaiming: 'Oh fie, you must buy a Cabinet. What's here? a Toad stone, two Turkies, sixe thumb-rings, three Aldermens seales, five Gemmals, and foure Deaths-heads; these are Alehouse ornaments—Yet these Diamonds are tollerable, and these Pearles will make a half Chaine'.[26] But he shared his character's obsession, with Margaret writing sadly in her biography of William that his 'several Curiosities of Cabinets, Cups and other things' were pillaged from Welbeck Abbey during the Civil Wars, ironically by his own Royalist brothers-in-arms.[27] The description, and the theft, implies these were collections of a smaller, more portable scale, kept in freestanding cabinets (see Figure 11), and during the Cavendishs' return from exile there seems to have been a conscious effort to rebuild their collections; Richard Flecknoe's post-restoration poem 'On *Welbeck*, the Duke of *Newcastle*'s House,' written in the tradition of country house poetry, notes that 'every where their *Rarities* were sought / By *Land* and *Sea*, and unto *Welbeck* brought'.[28]

Cavendish's own closet at Welbeck Abbey, which she 'sometimes did not leave for weeks on end,' was also immortalised in verse by Flecknoe, being one of the few of his verse portraits to offer such a clear sense of place.[29] Flecknoe's epigrams about women tended to emphasise stereotypically 'feminine' virtues, such as beauty, good grace, and kindness. The setting of 'On the Dutchess of *Newcastles Closet*', however, allows Flecknoe to foreground the philosophical and authorial skills of his subject:

> What place is this! looks like some *Sacred Cell*,
> Where Holy *Hermits* antiently did dwell,
> And never ceast importunating *Heaven*,

[25] On the designation of *Wunderkammern* as gendered spaces, see Findlen, "Masculine Prerogatives." Charles and William Cavendish had experimental laboratories at Bolsover during the 1630s and undertook scientific research at Welbeck Abbey. They possessed prestigious collections of scientific books and instruments as well as impressive networks of philosophical contacts, many of whom, including John Evelyn, travelled widely to visit notable collections during the Interregnum: Whitaker, *Mad Madge*, 68, 101-103.
[26] William Cavendish, *The Country Captaine and the Varietie, Two Comedies Written by a Person of Honour* (London: printed for Hum. Robinson and Hum. Hoseley, 1649), 51.
[27] Margaret Cavendish, *The Life of the Thrice Noble, High and Puissant Prince William Cavendishe, Duke, Marquess and Earl of Newcastle* (London: printed by A. Maxwell, 1667), 105.
[28] Richard Flecknoe, *Euterpe Revived, or Epigrams Made at Several Times* (London: 1675), 46.
[29] Lisa T. Sarasohn, "A Science Turned Upside Down: Feminism and the Natural Philosophy of Margaret Cavendish," *Huntington Library Quarterly* 47, no. 4 (1984): 299.

Till some great Blessing unto *Earth* was given!
Is this a *Lady-Closet* ! 't cannot be,
For nothing here of *vanity* you see,
Nothing of *curiosity*, nor *pride*,
As all your *Ladys Closets* have beside.
Scarcely a *Glass,* or *Mirrour* in't you find,
Excepting *Books*, the *Mirrours* of the mind.
Nor is't a *Library*, but only as she,
Makes each place where she comes a *Library*,
Carrying a living *Library* in her brain
More worth then *Bodleys* or the *Vatican*.
Here she's in *Rapture*, here in *Extasy*,
With studying high and deep *Philosophy*.
Here those clear *Lights* descend into her *Mind*,
Which by Reflection in her *Books* you finde;
And those high *Notions* and *Ideas* too,
Which none before, but she, did ever know:
Whence shee's her Sexes Ornament and Grace
And Glory of the Times, hail Sacred Place!
To which the world in after-times shall come,
As unto *Homers* Shrine, or *Virgils* Tomb,
Honouring the walls wherein she made aboad,
The air she breath'd, & ground whereon she tro'd.
So *Fame* rewards the *Arts*, and so agen,
The *Arts* shall honour her who honour'd them,
Whilst others who in other hopes did trust,
Shall after death, lie in forgotten dust. [30]

Depicted as a place for philosophical contemplation, Cavendish's cabinet, in Flecknoe's depiction, is an author's sanctuary. Rendered a place of worship through her philosophical activity, the closet is configured as a 'Sacred Place', both because it contains the panegyrically virtuous Cavendish, who, placed on a pedestal alongside Virgil and Homer, is imagined as a writer worthy of veneration, and because it is the site of Cavendish's own, philosophical acts of worship: imagined like a nun or anchorite, overcome by the 'Rapture' and 'Extasy' of her philosophical pursuits, her closet is a 'Sacred Cell', where her mind is enlightened. This vision of a holy, philosophical closet plays on the original function of such rooms, which, as Lucy Worsley remarked of the Welbeck Abbey closet of William's first wife Elizabeth—likely the same room depicted here—originally privileged worship as a primary function. 'Closets had originally been identical to oratories, places used for prayer as

[30] Richard Flecknoe, *A Farrago of Several Pieces Being a Supplement to His Poems, Characters, Heroick Pourtraits, Letters, and Other Discourses Formerly Published by Him* (London: 1666), 13-14. A shortened and altered version of this poem, completely omitting the lines about books and libraries, is printed in Flecknoe, *Euterpe Revived*, 39.

much as writing,' she notes, '[t]heir character as private chapels has been eroded with the passage of time and replaced with the idea of a room for solitary study and the assembly of precious objects'.[31] And yet Flecknoe, through his comparison of Cavendish's closet with others, gives us a glimpse of different closets; whether filled with looking glass 'mirrours' or books which are 'the mirrours of the mind', cabinets can be homes for the tools of vanity, whether intellectual or superficial. But they are also spaces for intense self-reflection. Cavendish does not need her cabinet to act as a library because her own intelligence, according to Flecknoe's flattering verse, out-equals the best libraries of the age.

This is echoed in a contemporary engraving of Cavendish (Figure 12), apparently in her closet, in which the inscription notes: 'Her library on which she looks/ It is her Head her Thoughts her Books.'[32] Surrounded by rich textiles, Cavendish is seated at her writing desk with standish, pen and bell for summoning servants. The chapel-like railing once more reinforces the notion that this is a sacred space.[33] But instead of walls flanked with books or trinkets, cherubs pull back the wall hangings, revealing what Worsley has suggested is 'not a wall but the wide strange spaces of Margaret's imagination'.[34] While the image itself is frustratingly bereft of detail beyond the curtain, these readings cohere with both the inscription and Cavendish's own conflation of cabinets and minds in *Poems and Fancies*, a conceit that this chapter will examine closely. Both the engraving and Flecknoe's poem post-date *Poems, and Fancies*; Cavendish had not yet visited Welbeck. But these sources give us a glimpse of the kinds of spaces she habitually occupied; while writing *Poems, and Fancies*, her residences included Rubens' house in Antwerp, which boasted its own museum and gallery, and a Covent Garden mansion in London, where she stayed while petitioning for the return of her husband's estates which had been confiscated by the Commonwealth, which likely provided similar closet spaces in which she could read, write and think.[35]

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[31] Lucy Worsley, *Cavalier: A Tale of Chivalry, Passion and Great Houses* (London: Faber & Faber, 2007), 69.

[32] This plate seems to have been bound in the front of some of Cavendish's works, notably *The World's Olio* and *The Life of William Cavendish*, though apparently inconsistently; it is not present in all copies: Worsley, *Cavalier*, 218-19. James Fitzmaurice notes that there is 'little pattern to the way in which frontispieces appear in [Cavendish's] books: that is, virtually any book may be found with any of the three frontispieces or with none at all.' James Fitzmaurice, "Fancy and the Family: Self-Characterizations of Margaret Cavendish," *Huntington Library Quarterly* 53, no. 3 (1990): 202.

[33] Fitzmaurice, "Fancy and the Family," 202.

[34] Worsley, *Cavalier*, 218.

[35] Whitaker, *Mad Madge*, 137, 12; Worsley, *Cavalier*, 176, 67-70, 172-73, 218.

Figure 12. Pieter Louis van Schuppen after Abraham Diepenbeeck, *Margaret Cavendish (neé Lucas), Duchess of Newcastle Upon Tyne*, late seventeenth century, line engraving, 27.4 x 15.9cm, National Portrait Gallery, London. NPG D30185. Image © National Portrait Gallery, London.

The insistence of these depictions on the interiority of Cavendish's thinking in her closet, and the configuration of her mind as a library echo Cavendish's own analogization of the brain as a cabinet, which, as we will see, similarly envisages the cognitive faculties as contiguous with the designated material spaces in which intellectual activity occurs.

But it was not only luxurious, private studies that influenced Cavendish's depiction of nature's cabinet. In her everyday existence, Cavendish clearly encountered a large variety of closets and cabinets, from private studies to linen chests to small cabinets full of exotic treasures. Considering this range of cabinets will be critical when examining the metaphor of nature's cabinet and the modes of cognition it promotes in *Poems, and Fancies*, where the domestic realities of the housewife's cabinet are overlaid with experiences of the cabinet as a decorative object for storing treasures, and the cabinet is at once an intimate space for writing, imagination and thought, and a space where nature can be displayed. These layers of real space activate the metaphorical space to support, structure and enable an idiosyncratic and imaginative natural philosophy. For Cavendish, the cabinet is not a straightforward place of order, but also of working things out, where juxtaposition, rearrangement and imagination might yield new insight into the wider macrocosm.

Cognition and Cabinets

Poems, and Fancies, Cavendish's first printed work, was published in London in 1653, and, now little studied, it seems odd to modern eyes. An anthology of various verse writings, the work opens with an allegorical poem detailing Nature's creation of the world, followed by an extensive series of poems in heroic couplets explicating an atomistic theory. An apparently bewildering array of later poems includes descriptions of nature and natural forces, allegorical moral dialogues, a series of 'similizing' poems or conceits which compare one thing to another, poems about the hunting of animals, a 'Register of Mournfull Verses,' and a series of poems discoursing on fairies and the supernatural. This accumulation of poetic forms and topics initially seems haphazard. About halfway through the work, however, at the very beginning of the section entitled 'Fancies', two poems seem to provide a key to unlocking the work as a whole. '*The Severall* Keyes *of* Nature*, which unlock her Severall* Cabinets' and '*Natures Cabinet*' provide us with a framework from which we can begin to comprehend the work, opening up a structural paradigm, that, by mirroring

the contents and spatial arrangements of cabinets, provides a way of understanding the world it seeks to depict.[36]

Books and cabinets had always been conceptually linked; from the closet's earliest origins, it was conceived of as a place for the study and storage of books, and where images, objects and texts became interchangeable and equally legible.[37] Not only could an order or pattern be 'read' in the placement and display of objects, but texts often stood in for objects, too, with books used to fill material gaps in the collections of *Wunderkammer*, either providing illustrations and descriptions of rare or perishable natural specimens, or offering knowledge of intangible phenomena.[38]

Indicating the permeable nature of these boundaries between words and things, the encyclopaedic spirit of Renaissance collection frequently found its way onto the page, from catalogues recording the artefacts of major collections, to collections of recipes, poetry, and jokes. This use of the book as a substitute cabinet became a characteristic feature of Renaissance writing. As Margaret Hodgson has suggested, noting the tendency of natural philosophers to construct textually-based linguistic collections as well as material collections of natural specimens, 'obviously not all collections, ethnological or otherwise, lent themselves to containment in "closets," in the shallow trays and narrow pigeonholes of cabinets, or even to suspension from the ceilings and walls of galleries. The collecting impulse, wayward as it was, began early to spread into areas of interest for which the printed page in the bound book was the only conceivable means of record and safekeeping.'[39] William H. Sherman has suggested that there is a longstanding connection between buildings and books, and between 'cognitive activity and physical space'; undoubtedly this link is sustained in the relationship between the book and the cabinet.[40]

Cavendish is clearly fascinated by the motions, structures, and productions of thought in *Poems, and Fancies*, and her cognitive model, outlined partly through the metaphor of nature's cabinet, lies at the heart of her natural philosophy. About

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[36] Margaret Cavendish, *Poems, and Fancies Written by the Right Honourable, the Lady Margaret Newcastle* (London: printed by T.R., for J. Martin and J. Allestrye, 1653), 126. Hereafter, *PaF*.
[37] Stephen J. Campbell argues that '[a] room designated as *studiolo* defines its owner—however otherwise identified as merchant or prince, male or female, contemplative or connoisseur—as a reader, and even the space for the housing of a personal art collection is simultaneously identified as a space for personal reading.' *The Cabinet of Eros: Renaissance Mythological Painting and the Studiolo of Isabelle d'Este* (New Haven: Yale University Press, 2004), 11.
[38] See: Swann, *Curiosities and Texts*; Findlen, *Possessing Nature*; and *The Paper Museum of Cassiano Dal Pozzo: A Catalogue Raisonné*, (London: Harvey Miller, 1997).
[39] Margaret T. Hodgson, *Early Anthropology in the Sixteenth and Seventeenth Centuries* (Philadelphia: University of Pennsylvania Press, 1998), 123.
[40] Sherman, "On the Threshold," 79.

halfway through the volume, a series of poems describes an anthropomorphised Nature's household arrangements. The first poem of the 'Fancies' section is a poem titled '*The Severall* Keyes *of* Nature, *which unlock her Severall* Cabinets':

> A *Bunch* of *Keyes* which hung by *Natures* Side,
> *Nature* to unlock these her **Boxes* try'd.
> The *first* was *Wit,* that *Key* unlock the *Ear,*
> Opened the *Brain*, to see what things were there.
> The *next* was *Beauties Key*, unlockt the *Eyes*
> Opened the *Heart*, to see what therein lyes.
> The *third* was *Appetite*, that *Key* was quick,
> Opens the *Stomack,* meat to put in it.
> The *Key* of *Sent* opens the *Braine*, though hard,
> For of a *Stink* the *Nose* is much afeard.
> The *Key* of *Paine* unlocked *Touch*, but slow,
> *Nature* is loath *Diseases* for to shew.[41]

Cavendish describes Nature as a housemistress with a bunch of keys dangling from her belt, which can be used to unlock five different boxes symbolizing the five senses. The reader is provided with their own key to the poem in the form of a marginal note which specifies: '**The* five Senses *are* Natures Boxes, Cabinets: *The* Braine *her chiefe* Cabinet.'[42] Privileging the brain as the most important cabinet of nature, Cavendish positions the human mind as a space in which nature's secrets might be both contained and explored. But for Cavendish, the contents of nature's cabinets cannot be understood by the brain, or the wit of the words that open it, alone. These provide only partial access to what lies within. Instead, Cavendish depicts a number of aesthetic and sensory keys external to, or on the periphery of, the human body, which work in tandem to access and display the full contents of nature's cabinets, which are dispersed across a number of boxes. Cabinets and minds have long been linked.

Studies of cabinets have become deeply intertwined with accounts of cognition, and closets have often provided emblems for current and historical scholarly epistemes. The *Wunderkammer* is often used as an emblem of the Foucauldian narrative of epistemic shift from a voraciously curious early modern world-view governed by sympathies to a mathematicized Enlightenment phenomenology concerned with tables of classification, and has since been employed to critique the advance of the object-centred discourse of 'new new

[41] *PaF*, 126.
[42] *PaF*, 126, marginal note.

historicism'.[43] Meanwhile, the closet has frequently been aligned with psychology in early modern as well as contemporary scholarship, featuring in neo-Burckhardtian narratives of emerging subjectivity and the 'invention' of privacy in the Renaissance.[44] While actual cabinets may provide material means for understanding the self and the world as well as spaces and cases for philosophical activity, this chapter will suggest that one of the best methods of understanding this correlation is through metaphor. George Lakoff and Mark Johnson have noted the importance of metaphor in conceiving of the mind, suggesting that '[i]t is virtually impossible to talk about the mind in any serious way without conceptualizing it metaphorically'; they also note, however, that in conceptualizing the mind we use a variety of inconsistent and conflicting metaphors.[45] This is certainly the case with Cavendish's text, where different valences of the cabinet take simultaneous effect.

Cavendish provides a model of cognition which challenges traditional scholarly narratives in which the cabinet is straightforwardly perceived as both a retreat for isolated rational contemplation and the exercise of the interior mind. According to Cavendish, we experience and understand nature not only in the

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[43] See: Foucault, *Order of Things*; Jan C. Westerhoff, "A World of Signs: Baroque Pansemioticism, the Polyhistor and the Early Modern Wunderkammer," *Journal of the History of Ideas* 62, no. 4 (2001); Jonathan Gil Harris, "The New New Historicism's Wunderkammer of Objects," *European Journal of English Studies* 4, no. 2 (2000).

[44] The link between the history of the cabinet with theories of the development of interiority and the emergent self has been much discussed: see Kimberley Skelton, "Redefining Hospitality: The Leisured World of the 1650s English Country House," *Journal of the Society of Architectural Historians* 68, no. 4 (2009); and Campbell, *Cabinet of Eros*, 39. Thornton has described the study as a response to a 'need for psychological space', developing from the tradition of the Christian monastic cell which privileged solitude as necessary to moral and intellectual reflection and study: *Scholar*, 9; these monastic roots for the study are also discussed in Shapin, "Science and Solitude"; and Smith, *Key of Green*, 2. A number of critics have challenged the link that has been made between the study of interiors, particularly cabinets, and the development of 'interiority', arguing that real and textual closets offered a performative kind of 'public privacy': see Patricia Fumerton, *Cultural Aesthetics: Renaissance Literature and the Practice of Social Ornament* (Chicago: University of Chicago Press, 1991), 69; Mary Thomas Crane, "Illicit Privacy and Outdoor Spaces in Early Modern England," *Journal for Early Modern Cultural Studies* 9, no. 1 (2009): 5; Alan Stewart, *Close Readers: Humanism and Sodomy in Early Modern England* (Princeton: Princeton University Press, 1997), esp. 'Epistemologies of the Early Modern Closet', 161-88; Marta Straznicky, "Reading the Stage: Margaret Cavendish and Commonwealth Closet Drama," *Criticism* 37, no. 3 (1995); and Julie Crawford, "Wroth's Cabinets," in *Feminisms and Early Modern Texts: Essays for Phyllis Rackin*, eds. Rebecca Ann Bach and Gwynne Kennedy (Selinsgrove: Susquehanna University Press, 2010). Lena Cowen Orlin has argued that privacy and solitude may not have been as desirable—or attainable—in the early modern period as we believe: see *Locating Privacy*. In modern culture, the closet has remained a potent psychological symbol: Emily Apter, for example, has drawn comparisons between fin-de-siècle 'cabinet fiction', an 'archival psychiatric genre' detailing disturbing case histories, and the physical space of domestic cabinets, while the closet has played a prominent role in popular culture and queer studies, see: Apter, "Cabinet Secrets: Fetishism, Prostitution, and the Fin de Siècle Interior," *Assemblage* 9 (1989): 9; and Eve Kosofsky Sedgwick, *Epistemology of the Closet* (Berkeley: University of California Press, 1990).

[45] George Lakoff and Mark Johnson, *Philosophy in the Flesh: The Embodied Mind and Its Challenge to Western Thought* (New York: Basic Books, 1999), 235.

cabinet of the brain, but also through our hearts, stomachs, and our ability to feel pain. The totality of nature can only be accessed by unlocking the eyes, the nose, the ears, the appetite, and our sense of touch; it demands that barriers between the interior self and exterior world be broached and suggests that bodies gain knowledge by interacting with and being in and of the world. Cavendish's cabinets also disrupt our sense of the boundary between body and environment. The body's barrier, the skin, equated with the outside of these cabinets (the eyes and ears are the locks on the surface of the cabinets just as they are openings on the skin) is metaphorically opened up to the surrounding environs when the cabinets are unlocked.

This porousness of cognition across the boundaries of the body, environment and page is a descriptive commonplace that Cavendish keeps returning to. In a poem called 'The *Motion* of *Thoughts*', for example, she describes how 'My *Feet* did walke without *Directions* Guide, / My *Thoughts* did travel farre, and wander wide'. Working as an extension of her body, her thoughts are depicted as climbing, looking, and running in the landscape she occupies, returning with a deeper understanding of the divine nature of creation.[46] In 'Similizing *Thoughts*', she describes how '*Thoughts* as a *Pen* do write upon the *Braine*,' describing how different types of thought come together to paint a complex landscape, with melancholy thoughts creating shadows broken through by the sunlight of lighter fancies.[47] In the first 'Claspe' verse, Cavendish describes the process of writing *Poems, and Fancies*, telling of the wild-running thoughts she had in the process. Her thoughts are distinctly corporeal; she walks furiously until her '*Thoughts* run out of *Breath*' and declares that 'Sometimes I kept my *Thoughts* with a *strict dyet*, / And made them *Faste* with *Ease*, and *Rest*, and *Quiet* / That *they* might run agen with swifter speed'. But though these thoughts can be managed bodily, they are also separate material entities which can be expelled from the body and onto the pages of her book: Cavendish concludes that 'now *they're* out, my *Braine* is more at ease.'[48]

Defining cognition not simply as rational process, but also reclaiming for it an affective dimension, Evelyn Tribble and John Sutton have proposed that cognition occurs not simply within the individual but across a wider 'cognitive ecology' which includes complex social structures and the material environments of

[46] *PaF*, 40-41.
[47] *PaF*, 145-146.
[48] *PaF*, 47.

particular cultures.[49] For Cavendish as well as twenty-first century scholars, the cabinet has clear significance as the kind of 'cognitive artifact' that helps to structure how we perceive the world.[50] Tribble and Sutton argue that 'objects and artifacts must be seen as integral to a model of cognitive ecology' and that '[b]odies, spaces, artifacts, and environments are all co-ordinated in a cognitive ecological model, and agents both shape and are in turn shaped by their manipulation of objects.'[51] While Cavendish's theory of cognition is rendered in whimsical poetry, her work in *Poems, and Fancies* clearly articulates serious questions and theories about how cognition occurs that anticipate the theory of 'cognitive ecology' in no uncertain terms.

The application of cognitive science in early modern studies has been critiqued for its anachronism, with justifiable questions about whether the same frames of cognition might have existed in the early modern period as do for us. But while Bruce Smith has paid heed to these objections, his cultural history of colour, *The Key of Green,* adopts a similar but period-specific methodology, built around physiological and Aristotelian understandings of cognition present in the early modern period. He argues that this approach places the focus back onto '[a]esthetic response, sense experience, and emotion' as essential modes of cognition, following what has been called the '[a]ffective turn' in cultural studies.[52] Similarly Mary Thomas Crane has shown how the 'extended mind' and 'distributed cognition' models of cognition help to highlight similar early modern modes of conceiving the world. Citing Gail Kern Paster's account of the humoral body as a porous, semi-permeable container 'capable of absorbing and being physically altered by the world around it', Crane argues that a 'sense of "exteriority" or even "outdooriority" of the self [as opposed to interiority] is not as far-fetched as it might initially sound, since it takes into account such pervasive early modern concepts as the placement of the human subject as microcosm within a natural macrocosm'.[53] While Crane refers specifically to the formation of the self in the outdoors—particularly gardens—her notion of

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[49] Tribble and Sutton build on the work of Edwin Hutchins and Andy Clark. See: Tribble and Sutton, "Cognitive Ecology as a Framework for Shakespearean Studies," *Shakespeare Studies* 39 (2011): 96; Edwin Hutchins, *Cognition in the Wild* (Cambridge: MIT Press, 1995); Andy Clark, *Being There: Putting Brain, Body and World Together Again* (Cambridge: MIT Press, 1997).

[50] Tribble has identified 'an expanding repertory of cognitive artifacts, including printed books, maps, and diagrams, objects such as astrolabes and perspective glasses, and new cognitive environments such as purpose-built theatres,' "'The Chain of Memory": Distributed Cognition in Early Modern England," *Scan* 2 (2005) <scan.net.au>.

[51] Tribble, "Cognitive Ecology as Framework," 99.

[52] Smith, *Key of Green*, 5.

[53] Gail Kern Paster, *The Body Embarrassed: Drama and the Disciplines of Shame in Early Modern England* (Ithaca: Cornell University Press, 1993), 13; Crane, "Privacy and Outdoor Spaces," 17.

'exteriority' as a mode in which 'the self is not enclosed, but rather porous, open to the natural world' seems suggestive of how all environments external to the body (including internal ones) might affect the formation of the self, and the self's understanding of the world around it; her gesture to early modern micro- and macrocosmic understandings of the self suggests how influential the cabinet, often portrayed as similarly microcosmic, might be as a space in which the self can be both opened to and incorporated in an understanding of the world around it.[54] The various and interconnected porous boundaries of nature's cabinet suggest that Cavendish envisages the self and cognition as very much influenced by its surroundings.

Cavendish's cabinets of nature, laid over the perceptive human anatomy, clearly privilege the human interior as one of the most important objects of our knowledge in nature, but simultaneously as providing tools which are essential to gaining that knowledge—human emotion, psychology, and physiology are both opened up for inspection and configured as instruments for understanding nature in this metaphor. Nature is both enclosed within man-as-cabinet, and positioned without him, ready for integration within the human self through the lockable conduits of the senses. These metaphorically blurred boundaries between the cabinet self, the human anatomy, its cognitive and sensory powers, and the natural world, exhibit an uncanny similarity between Cavendish's conception of cognition and the extended mind theory. Nature's cabinet, for Cavendish, is not an empty metaphor, but illuminates the complexities of what natural knowledge can be, and how we might grasp it.

The Poetics of Housewifery

If Cavendish's frameworks for thought rely on the body's analogies with the microcosmic *Wunderkammer*, she articulates and frames her theories by relying on a very different type of cabinet. Cavendish is preoccupied with her own poetics, and throughout the work aligns the creations of nature and her own poetic making through the figure of the housewife. In a prefatory epistle Cavendish's writing is figured as a substitute for her domestic duties, written, she sombrely declares,

[54] Crane, "Privacy and Outdoor Spaces," 17.

because with no children, and in exile with no estate to run, she has '*nothing for* Huswifery, *or thrifty* Industry *to imploy my selfe in*'.[55] Instead, her compulsive poetic making is depicted as traditional women's work: a '*Spinning* with the *Braine*'.[56] The work of Nature, depicted as the mistress of a substantial estate, is depicted throughout the volume in terms which echo those used to refer to Cavendish's poetic making. In 'Nature calls a Councell', for example, Nature summons the figures of Motion, Life, Form and Matter to assist her in the creation of the world, instructing the Fates 'in huswifery to spin'.[57] The series of poems immediately following '*The Severall* Keyes *of* Nature' and '*Natures Cabinet*', which include '*Natures* Dresse', '*Natures* Cook', '*Natures* Oven', '*A* Posset *for* Natures Breakfast', 'Meat *drest for* Natures Dinner; *an* Ollio *for* Nature', '*A* Bisk *for* Natures Table', '*A* Hodge-Podge *for* Natures Table' and '*Natures House*', continue the configuration of Nature as a woman in charge of a household. The common anthropomorphization of Nature in the early modern period as a female muse or deity with a classical garb and character has been extensively documented. But while this often explicitly feminist scholarship rightly draws attention to the brutal, coercive and misogynistic terms in which male authors wrote about their attempts to, often literally, pin down nature, Cavendish does something very different.[58] Cavendish's Nature is a defiantly modern housewife, with her own agency, responsibilities and power. *Natures* Grange', describes how '*Nature* in this *Housewifry* doth take / Great pleasure, the *Cloath of Life* to make: / And every *Garment she* her selfe cuts out, / Disposing to her *Creatures* all about.'[59] Described in terms that might also describe the reality of Cavendish's own (sometime) domestic duties and which are also used to describe her poetic endeavours, we are encouraged to read Cavendish and Nature's acts of creation interchangeably; if Nature is joyously making worlds, then Cavendish is re-creating those worlds in words.

The description of Nature as the mistress of a substantial estate speaks to Cavendish's reality, both growing up in the wealthy Essex estates of the Lucas family, and her luxury-rich but cash-poor experience of exile in Paris and Antwerp. But it also speaks to Cavendish's experience of making poetic worlds; as she becomes

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[55] *PaF*, [A7r].
[56] *PaF*, A2[r].
[57] *PaF*, 1.
[58] See: Londa L. Schiebinger, "Feminine Icons: The Face of Early Modern Science," *Critical Inquiry* 14, no. 4 (1988); Carolyn Merchant, *The Death of Nature: Women, Ecology and the Scientific Revolution* (London: Wildwood, 1982) and *Nature's Body: Gender in the Making of Modern Science* (Boston: Beacon Press, 1993).
[59] *PaF*, 136.

aligned with Nature the Housewife, Cavendish the Housewife-Poet creates creatures and makes garments too, and like Nature, she enjoys it, constructing a poetics of housewifery capable of making knowledge of the natural world.

To many of Cavendish's male contemporaries, nature's cabinet was touted as an object to be rapaciously forced open, or an attractive but dangerous temptation; like Eve's apple or Pandora's box, women promising access to unlimited knowledge could be deemed particularly threatening. Cavendish reversed the gendered subtexts of the metaphor, presenting a figurative household ecology in which holding the key to nature's cabinet was just another duty in the daily work of a woman. This perhaps more accurately reflects the more flexible gender relations at work in seventeenth-century cabinets and productions of natural knowledge than ideas promoted by the men of science's patriarchal institutions: though renaissance architectural theorists, including Leon Battista Alberti, explicitly designated the cabinet as an exclusively masculine domain, Orlin and Findlen have shown the reality of everyday experience to be otherwise, citing anecdotal evidence which 'suggests that neither the English closet nor early modern gender roles were as thoroughly coercive as was imagined by Alberti', and showing that men's studies were frequently used and cared for by women.[60] But women frequently had their own cabinets too, which were understood in their own gendered terms.[61] As Thornton has noted, the plethora of household books titled 'closet' or 'cabinet' addressed to women illustrates that 'closets were spaces for housewives or for housewifely tasks', but women's closets, especially in wealthy households, were also conceived as private and intimate spaces closely associated with writing and reading.[62] Critics have linked poetic form and the enclosed space of the cabinet in early modern women's writing, and noted that the lady's cabinet was also a literary commonplace for a repository of poetry. The literary closet, then, was regarded as not only 'emblematically female' but also

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[60] Women were often central participants in the labour of men's cabinets, whether philosophical or mercantile, and were often left in charge of their security and contents when their husbands were away, or when they died: Findlen, "Masculine Prerogatives,"; Orlin, *Locating Privacy*, 312.

[61] See: Thornton, *Study*; Campbell, *Cabinet of Eros*, 59; and Carolyn Sargentson, "Looking at Furniture Inside Out: Strategies of Secrecy and Security in Eighteenth-Century French Furniture," in *Furnishing the Eighteenth Century: What Furniture Can Tell Us About the European and American Past*, eds. Dena Goodman and Kathryn Norberg (New York: Routledge, 2007), 96-97.

[62] Thornton, *Study*. On women's closets as spaces for literary activity, see: Bernadette Andrea, "Pamphilia's Cabinet: Gendered Authorship and Empire in Lady Mary Wroth's "Urania"," *ELH* 68, no. 2 (2001); Katherine R. Larson, "Reading the Space of the Closet in Aemilia Lanyer's Salve Deus Rex Judaeorum," *Early Modern Women: An Interdisciplinary Journal* 2 (2007); and Mary Ellen Lamb, *Gender and Authorship in the Sidney Circle* (Madison: University of Wisconsin Press, 1990). Sargentson argues that the link was compounded by developments in cabinet-making which made reading and writing materials more portable: 'Furniture Inside Out', 205.

emblematic of the contained and contradictory position of the Renaissance woman writer: '[s]he may write, but only from the limits of her own room; she may preserve her writing, but only within the confines of her own mind'.[63] But if the mind and the closet were confined spaces the possibilities of writing made them paradoxically expansive.

Instead of offering straightforward comparisons in which the sensory organs provide access to the senses, Cavendish's more detailed imaginings of the keys to nature's cabinet suggest how her poetics interweave with her natural philosophy. While pain unlocks touch, appetite unlocks the stomach, and scent fairly straightforwardly unlocks the brain via the nose, Cavendish also emphasises the importance of wit and beauty as keys to our cognitive centres. Wit acts on the brain through the ears, and the heart is accessed through the eyes, which are unlocked by the key of beauty. Crucially, both wit and beauty are qualities prized in Cavendish's self-conscious poetics, and Cavendish sees poetry as a naturally feminine craft.[64] While the metaphorical link between closets, architecture and anatomy was commonly employed in the early modern period, and Cavendish's keys do correspond to the senses, her insistence that wit and beauty might open up nature's cabinets pose poetry, alongside sensory perception, as a legitimate mode of accessing both the human mind and knowledge of nature. Furthermore, their use to open the heart as well as the brain strongly suggests that the type of emotional, affective knowledge proposed by Tribble and Sutton as a natural part of cognition might be achieved by poetic effects.[65] Helping us to rationalise the coexistence of the moral, allegorical, and traditionally philosophical elements in *Poems, and Fancies*, which is concerned not just with the workings of the natural world, but also with the worlds of the mind and the heart, with our emotions and morals and how they might interact with our environment, this bold model situates emotion as a key element of anatomy in Nature's cabinet. In utilising these keys, the poem suggests, we can construct a model of knowing in which nature is not only contained and displayed, but also elucidated by a feminine poetics.

Poems, and Fancies certainly poses itself as an emblematically female space. Cavendish's address to women readers at the beginning of the book, as well as the

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[63] Andrea, "Pamphilia's Cabinet," 335. See also Larson, "Reading the Closet"; Lamb, *Gender and Authorship*..

[64] Cavendish writes that '*Poetry,* which is built upon *Fancy*, *Women* may claime as a *worke* belonging most properly to themselves,' *PaF*, A3[r]

[65] Tribble, "Cognitive Ecology as Framework," 96.

relationship with her close companion and maid Elizabeth Topp displayed through a prefatory epistolary exchange, reconstruct the book as a place of female interaction and withdrawal. When Cavendish describes her poetry as a substitute for housewifery, she simultaneously invokes two archetypically female types of cabinet. Bonded together alongside the other types of cabinet she invokes, from *wunderkammer* to jewellery box, under the unifying terms of 'cabinet' or 'closet', these varied spaces, experiences and expectations become contiguous and fluid; the multiplicity of cabinets Cavendish imagines and implies reinforces the idea that the book itself should be read *as* a cabinet, while allowing it to operate, at different times, according to the various different logics or cultural expectations they imply. Henri Lefebvre has described 'representational space' as 'the domain of everyday intimate experience where space is activated by memory and imagination' which 'overlays physical space, making symbolic use of its objects'.[66] Campbell has suggested that Lefebvrian representational space 'necessarily involves[…] the operations of imagination and even of the unconscious, to uncover structures and patterns which spokesmen of the culture itself are less likely to have perceived and articulated in such a conscious manner.'[67] Examining the representational space of Cavendish's cabinet of nature unveils a similarly multi-layered and innovative way of thinking. Both the cabinet and the world that Cavendish describes involve observations of real space transformed and mediated by the colours of imagination and fancy. The realities of everyday spatial and sensory experience are integrated with associative structures of knowing and poetic fancy to present a powerful and enhanced model of understanding.

Nature's Trinket Box

The poem '*Natures Cabinet*,' which describes the chief cabinet of the brain, further legitimises this feminine, playful aesthetic as a mode of comprehending nature. While the series of boxes described in Cavendish's first poem addressing nature's cabinets might be any kind of cabinets—their only defining features are their locks—in '*Natures Cabinet*,' the poem which immediately follows, the brain is

[66] Henri Lefebvre, *The Production of Space*, trans. Donald Nicholson-Smith (Oxford: Oxford University Press, 1991): 38-46.
[67] Campbell, *Cabinet of Eros*, 34.

described as a ladies' trinket box. Alongside narratives of interiority, the emergent self of the cabinet has also been connected to the proliferation and display of things; Richard Goldthwaite has suggested that if selfhood was transformed in the Renaissance this was 'because man attached himself in a dynamic and creative way to things, to material possessions.'[68] But while Cavendish describes, in her prefaces, 'how I busie my Thoughts, when I thinke upon the Objects of the World,' the world is also recreated for Cavendish in and by the imagined objects of the mind.[69] It is not just the self that is configured in relation to things, nor the cabinet of nature, but also the powers of cognition, which she imagines as fashion accessories. 'In *Natures Cabinet*, the *Braine,* you'l find/ Many a fine *Knack*, which doth delight the *Mind*,' Cavendish writes, before listing a string of cognitive attributes imagined as fashionable items: '*Colour'd Ribbons* of *Fancies* new', '*Masques* of *Imaginations'*, '*Fans* of *Opinion'*, '*Gloves* of *Remembrance*,' and '*Veiles* of *Forgetfulness*'.[70] Despite the proliferation of these accessories of the mind, Cavendish presents us with a clear warning: the heavy '*Pendants* of *Understanding*' are not available to everyone; some can only adorn themselves with '*Black Patches* of *Ignorance*'.[71] This persistent association of ladies' fashion accessories with mental functions constructs a cognitive model in which the whole treasure chest of the brain's faculties is posited as central to understanding Nature.

Cavendish's prefaces, which are full of self-effacing rhetoric—including her assertion that she writes poetry because it is more suitable for errors and her emphasis on the importance of fancy—have led some to assume that *Poems, and Fancies* is an immature work of philosophy not meant to be taken seriously. On the contrary, fancy is a serious and integral part of a coherent natural philosophy for Cavendish; as Lisa T. Sarasohn recognises, 'Cavendish, at least in her early works, felt that there was a continuum between imagination, or what she calls fancy, and reason and that women were particularly suited to explore the connection.'[72] Cavendish's comparison of her writing to fashion accessories was not an act of trivialisation: she

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[68] Richard Goldthwaite, *Wealth and the Demand for Art in Italy, 1300-1600* (Baltimore: John Hopkins University Press, 1993), 255.
[69] *PaF*, A4[v].
[70] *PaF*, 126.
[71] *PaF*, 126. Ironically Cavendish was renowned for wearing these black or silk velvet patches, which were often shaped as stars or hearts, on her face; this was a fashion used by women to hide blemished skin. See Whitaker, *Mad Madge*, 297.
[72] Lisa T. Sarasohn, *The Natural Philosophy of Margaret Cavendish: Reason and Fancy During the Scientific Revolution* (Baltimore: John Hopkins University Press, 2010), 17.

found genuine pleasure in fashion, and regarded her appearance with careful calculation.[73] Crucially, there is no discrimination made in this cabinet between the creative powers of fancy and imagination so essential to Cavendish's poetics and other, apparently more rational, cognitive attributes such as opinion; both exist in the brain, and have the same relationship to the pendants of understanding. Elsewhere in the volume, the same semantic field of fashion is used to defend the 'garments' of Cavendish's poetry.[74] Cavendish indicates that she might *make*, through her poetry, the kinds of cognition essential to understanding nature, and in doing so she will also produce something aesthetically pleasing, writing in her preface:

> *Poetry*, which is built upon *Fancy*, *Women* may claime, as a *worke* belonging most properly to themselves: for I have observ'd, that their *Braines* work usually in a *Fantasticall motion*: as in their *severall*, and *various dresses*, in their many and singular choices of *Cloaths*, and *Ribbons*, and the like.[75]

Configuring her poetry as women's work, Cavendish stresses the fanciful and idiosyncratic nature of women's craft and women's thought. But this is not a denigration of women's philosophical powers: comparing her poems to the 'many *Curious* things [women] make, as *Flowers, Boxes, Baskets* with *Beads, Shells, Silke, Straw* or any thing else[…] thus their *Thoughts* are imployed perpetually with *Fancies*,' Cavendish imagines her poems in the same terms as she imagines the powers of understanding.[76] According to Cavendish's overarching figurative logic, though the products of women's making, whether material or literary, might be inherently fantastical, they all belong in the dressing room of the brain: the cabinet of nature which is so crucial to understanding and appreciating the world around it. The pendant of understanding, itself a product of Cavendish's fanciful poetry, illustrates the lack of prejudice with which Cavendish integrates the imagination into her cabinet's collection of cognitive faculties. Taking objects such as beads, shells and straw, and transforming them, through poetry, into the flowers, boxes and baskets which accompany such fashionable attire, Cavendish illustrates that women's creative interactions with natural objects can stock the cabinet of nature with new forms of knowledge. Sarasohn has suggested that in her later work, 'Cavendish materialized

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[73] Whitaker notes that 'dress was to be the only conventional female concern that engaged [Cavendish's] interest and enthusiasm', *Mad Madge*, 24.
[74] *PaF*, 121.
[75] *PaF*, A3[r].
[76] Ibid.

the faculties of the intellect and will and then transformed them into a stylistic aesthetic,' but this is more than just a stylish aesthetic—it is also a radical cognitive model.[77]

Poetry, for Cavendish, has the power to illuminate the contents of nature's cabinets. This is made clear by her exploration of the phenomena and structures she emphasises in her nature's cabinet poems throughout the rest of *Poems, and Fancies*. Cavendish's cabinets of nature are described as consisting of and accessed by the eyes, ears, brain, the stomach, smell, and disease; anatomical and epidemiological subjects that are discussed in a number of the verses in *Poems, and Fancies*. The first poem about the creation of the world discusses the construction of the brain and eye, and substantial sequences of poems explore how a variety of diseases might be caused by atoms, how sensory perception, cognition and the passions are interlinked, and the workings of organs.[78] The poetic 'keys', wit and beauty, which provide access to nature's cabinets are also examined, for example in '*A* Dialogue *betwixt* Wit, *and* Beauty,' and *'The* Mine *of* Wit.'[79]

Just as recent trends in the history and philosophy of science have moved away from the explication of scientific theories and toward considering how, particularly through modes of representation, knowledge was *made* in the early modern period, so Cavendish's poetics must be considered not simply as feminine frivolities, but also as a form of philosophical inquiry through literary craft.[80] The kind of poetic labour that Cavendish performs is perceived as itself making the kinds of treasures and accessories that we might find in nature's cabinet, the brain. This allows us to perceive Cavendish's poems not only as treasures but also as the contents of nature's cabinet, displayed for the reader's inspection. In agreement with Howard Marchitello and Elizabeth Spiller, scholars including Lorraine Daston and Katherine Park have noted that 'some forms of early modern art and literature were

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[77] Sarasohn, *Natural Philosophy of Cavendish*, 18.

[78] *PaF*. On the brain and eye, for example, see '*Nature calls a Councell*,' 1-4; on disease: '*What* Atomes *cause* Sicknesse,' '*What* Atomes *make a* Dropsie,' '*What* Atomes *make a* Consumption,' '*What* Atomes *make the* wind Collick,' '*What* Atomes *make a* Palsey, *or* Apoplexy,' and '*In all other* Diseases *they are mixed*, *taking* parts, *and* factions,' 15-16; on sensory perception, cognition and the passions see '*Of* Light, *and* Sight,' '*The* Objects *of every* Sense*, are according to their* Motions *in the* Braine,' '*According as the* Notes *in* Musicke *agree with the* Motions *of the* Heart, *or* Braine, *such* Passions *are produced thereby*,' '*The* Motion *of* Thoughts,' and '*The Reason why the* Thoughts *are onely in the* Head', 39-42; on the organs, see: '*A* Heart *drest*,' 'Head, *and* Braines,' '*Similizing the* Braine *to a* Garden,' and '*Of two* Hearts,' 131, 136, 140-141.

[79] *PaF*, 81-82, 153-154.

[80] See: *Ways of Making and Knowing: The Material Culture of Empirical Knowledge* eds. Pamela H. Smith, Amy R.W. Meyers and Harold J. Cook (Ann Arbor: University of Michigan Press, 2014).

also so tightly intertwined with coeval natural inquiry that it is more accurate to treat them as expressions of a common endeavor.'[81] In this metaphor of nature's cabinet, the literary cannot be separated from the philosophical.

Worlds Within Worlds

Discussing Cavendish's closet drama, Marta Straznicky notes that 'Cavendish portrays enclosed spaces as most admirable when they include rather than reject "the world." The solitude of one's study, far from shutting out the external world, is the ideal space in which to engage with it.'[82] The metaphorical cabinet and the real cabinet overlap for Cavendish as sites not only of engagement with the world, but also of worldmaking. As the eponymous Lady Contemplation notes in Cavendish's play, 'though the World draws not my Minde to wander up and down, yet my Minde draws the World to it, then pensils out each several part and piece, and hangs that Landskip in my Brain, on which my thoughts do view with Judgements eyes. Thus the world is in my Minde, although my Minde is not in the world.'[83] The mind—the chief cabinet of nature—remakes the world within it through artistry.

While Cavendish's poetic recreation of the world enables our understanding of it, the precise relation of the world that Cavendish describes to our own world is complex. As Sarasohn has noted, discussing *The Blazing World*, '[i]n creating other worlds, Cavendish defined a space where her fancy could discover and envision nature'.[84] Playing on the microcosmic logic of the *Wunderkammer*, *Poems, and Fancies* describes a proliferation of worlds-within-worlds, ranging from the metaphorical to the fanciful, the apparently real to the hypothetical. Each, however 'fictional', produces insights or comparisons that might help us to comprehend our own world.

In *Nature's Cabinet*, 'understanding', as we have seen, is figured as heavy pendant earrings ('*Nature* hangs them not in every *Eare*', Cavendish warns).[85] These

[81] Lorraine Daston and Katherine Park, "The Age of the New," in *The Cambridge History of Science*, eds. Katharine and Lorraine Daston Park (Cambridge: Cambridge University Press, 2006), 12; Spiller, *Science, Reading and Renaissance Literature*; Marchitello, *Machine in the Text*.
[82] Straznicky, "Reading the Stage," 377.
[83] Margaret Cavendish, "The Lady Contemplation," in *Playes Written by the Thrice Noble, Illustrious and Excellent Princess, the Lady Marchioness of Newcastle* (London: printed by A. Warren for John Martyn, James Allestry, and Tho. Dicas, 1662), 229.
[84] Sarasohn, *Natural Philosophy of Cavendish*, 35.
[85] *PaF*, '*Natures Cabinet*,' 126.

earrings undoubtedly allude back to a vivid image from a series of poems earlier in the volume, which consider how understanding might be connected to poetical world making through a reflection on the possibility of '*A* World *in an* Eare-Ring'. Referring once more to the earrings as 'Pendents', Cavendish imagines each jewel as a microcosm, hypothesising that '*Ladies* well may weare / A *World* of *Worlds*, as *Pendents* in each *Eare*'.[86] Turning synecdoche inside out to describe how entire gold mines can be worn in each ear, Cavendish imagines this world in miniature, detailing its agriculture, gardens, animals, elemental weather, stars, sun and entire zodiac, as well as its plagues, cities, and churches.[87] Cavendish repeatedly insists that despite all the noise, storm, fury and action of the world in the earring, none of this might be discerned by the earring's wearer, forcing us to conclude that this world might only be accessed through the imagination. The evolution of optical glasses, in particular microscopes, had alerted people to worlds that lay beyond the perception of the human eye. Extrapolating this notion to suggest that worlds might exist that cannot be perceived even with the assistance of optical prostheses, Cavendish, through the later positioning of earrings within the cabinet of the brain, proposes that worlds might be contained within the imagination. By suggesting that this world within the earring, with its duels, balls and plagues, can be best accessed through the powers of the mind, Cavendish helps to justify her attempts to understand her own world, which is so similar to the earring world, through the powers of imagination and fancy.

The model of the world-within-a-world offers a potentially daunting level of insight. This Russian-doll effect of worlds containing yet further worlds has been described by Daniela Bleichmar as a specific effect of the information overload of cabinets of curiosities, 'so that what appeared like excess turns out to be restraint, and the unrestricted outpouring of so many things onto the page, which seemed to imply that nothing was being held back, actually reminds the viewer that there is still more (and more!), that the cabinet does not show it all as much as reveal through careful looking.'[88] Cavendish's potentially infinite worlds promise an impossible amount of information to the viewer, reinforcing that this work truly be considered as Nature's cabinet, encoding, if not explicitly displaying, the whole of the

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[86] *PaF*, '*Of many* Worlds *in this* World,' 45.
[87] *PaF*, '*A* World *in an* Eare-Ring,' 45-46.
[88] Daniela Bleichmar, "Seeing the World in a Room: Looking at Exotica in Early Modern Collections," in *Collecting across Cultures: Material Exchanges in the Early Modern Atlantic* eds. Daniela Bleichmar and Peter Mancall (Philadelphia: University of Pennsylvania Press, 2011), 28.

macrocosm in miniature. Like the cabinet of curiosities, Cavendish's fancies suggest more than they actually show. In a provocative sequence, Cavendish imagines precisely this dizzying proliferation of worlds within worlds. She conceives of these worlds, critically, as nesting boxes, a popular component of early modern carpentry: '[j]ust like unto a *Nest* of *Boxes* round, / *Degrees* of *Size*, within each *Boxe* are found. / So in this *World*, may many *Worlds* more be.'[89] Gesturing forward to the multiple boxes that she imagines as Nature's Cabinet, Cavendish suggests the potentially infinite layers of worlds we might explore. If Nature's chief cabinet is the brain, and among her others are the human senses, then they enable humankind both to comprehend worlds without them and to construct worlds within them.

Worlds which are interpreted simultaneously as both 'real' but imperceptible to the normal methods of human sensory perception, are deemed accessible only through the cognitive powers of nature's cabinets. Cavendish notes that '*Nature* is curious, and such *worke* may make, / That our dull *sense* can never finde, but scape. / For *Creatures*, small as *Atomes*, may be there.'[90] This microscopic world is invisible to our eyes, Cavendish hypothesises, but it need not be to our minds:

> If foure *Atomes* a *World* can make,* then see,
> What severall *Worlds* might in an *Eare-ring* bee.
> For *Millions* of these *Atomes* may bee in
> The *Head* of one *small,* little, *single Pin.*
> And if thus *small,* the *Ladies* well may weare
> A *World* of *Worlds*, as *Pendents* in each *Eare.*[91]

For Cavendish, the senses do not, on their own, provide a full picture of the natural world. Instead, she uses both the poem, and footnote, which reads '*As I have before shewed they do, in my* Atomes,' to explicitly tie this proposition to the atomic theory she has already propounded.[92] Cavendish repeatedly emphasises that the atomic world is inaccessible to the senses, but demonstrates how an imaginative approach might provide ways of understanding it. For example, Cavendish notes, alluding to the relatively recent discovery of magnetism, that there are aspects of the natural world that our senses cannot comprehend:

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[89] *PaF*, '*Of many* Worlds *in this* World', [44]-45.
[90] Ibid., [44].
[91] Ibid., 45.
[92] Ibid.

For many things our *Senses dull* may scape, […]
So in this *World* another *World* may bee,
That we do neither *touch, tast, smell, heare, see*.
What *Eye* so *cleere* is, yet did ever see
Those *little Hookes*, that in the *Load-stone* bee,
Which draw *hard Iron?* or give *Reasons*, why
The *Needles point* still in the *North* will lye.[93]

Cavendish proposes a world made up of atoms in four primary shapes: round, straight, sharp, and square.[94] In a number of her atomic verses she describes how sharp atoms might be bent into hook or pincer shapes—magnetism, she suggests, can thus be understood as a consequence of these hooks.[95] This analogy not only rationalises her controversial atomistic theory with visible examples, but also integrates her atomism into her fanciful poetics of world-making.

The conflation of poetics, atomic theory, world-making and Cavendish's own person within the project of *Poems, and Fancies* is cemented in Cavendish's description of her anxieties about the reception of the volume. Despite the propensity of poets for fiction, she fears her atomistic theory will be censured. She claims that despite the microscopic size of her atoms, her 'desire that they should please the *Readers*, is as big as the *World* they make', and her ambition for her atoms, and her poetry, is 'such, as I would either be a *World*, or nothing.'[96] The book and Cavendish are both proposed as hopeful sites for an atomistic world.

Cavendish's poetic modes of understanding are not always imaginative elucidations of unknowable worlds. She also relies on more conventional poetic techniques to enhance natural knowledge in a series of conceits that we might term her 'similizing' poems. These more-or-less elaborate reflective analogies—for example, comparing fancy to a gnat, gold to the sun, and birds to a ship —highlight the logic of comparison that underlies nearly all of Cavendish's poetic work in *Poems, and Fancies*. As well as displaying the playful style of feminine salon culture, these juxtapositions replicate the 'associative, rather than exclusive' logic of the

[93] *PaF*, '*It is hard to beleive, that there are other* Worlds *in this* World,' 43.
[94] *PaF*, '*The foure principall* Figur'd Atomes *make the foure* Elements, *as* Square, Round, Long, *and* Sharpe,' 6-7.
[95] See: *PaF*, '*The* Attraction *of the* Poles, *and of* Frost,' 24; '*The* Attraction *of the* Earth,' 21.
[96] *PaF*, [A6r].

Wunderkammer, which would place objects in spatial proximity to each other in order to emphasise their similarities or differences.[97]

Cavendish's similizing, however, is far more than just a game: it is used to uncover truths which underpin her philosophical method, her understanding of cognition, and her poetical making. This becomes particularly clear in '*Similizing the* Head *of* Man *to the* World', which highlights how the world also exists in and through thought. The poem opens with a strong statement of likeness:

> The *Head* of *Man* is like the *World* made round,
> Where all the *Elements* in it are found.
> The *Braine*, as *Earth*, from whence all *Plants* do spring,
> And from the *Womb* it doth all *Creatures* bring.[98]

Cavendish goes on, in the poetic convention of blason, to detail the topographical nature of facial features, likening the forehead and nose to hill, the hair to trees, and cheeks to flowery banks. Importantly, the 'brain' is imagined as protean and fertile earth, the base for our round planet and everything that occurs upon it. Intangible fancies and imaginations are imagined like the orbs of planets and twinkling of the stars, appearing in the brain as they might in the sky, and thoughts are like the signs of the zodiac, to which Cavendish attributes great wisdom. Wit too, is imagined as a nebulous celestial influence, 'the *Suns* bright *Spheare*'.[99] But if the cognitive processes are imagined as celestial actions, the solid matter of the brain is terra firma: Cavendish encourages us to compare '[t]he *Braine*, unto the *Solid Earth*, / From whence all *Wisdome* hath its *Birth*.'[100]

Elizabeth Spiller has offered a model of *poeisis* as 'worldmaking' which spans both poetics and natural philosophy in the Renaissance. For Spiller worldmaking is not 'hypothetical or counterfactual', and 'not an escape but a more powerful and more meaningful engagement with reality than can be found in the world at large.' In this model, 'art (fiction, experiments) grounds [the practitioner's] ability to claim to produce knowledge'.[101] Extrapolating from Spiller's theory, John Shanahan notes that that poetic making could be 'empirical, practical and proto-scientific', creating—just

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[97] Whitaker notes that Cavendish's writing was heavily influenced by the emphasis on wit, wordplay, and the literary games of female salon culture, a style which prized striking, far-fetched comparisons. *Mad Madge*, 125; See also: Andrea, "Pamphilia's Cabinet," 347.
[98] *PaF*, 148.
[99] Ibid.
[100] *PaF*, 149.
[101] Spiller, *Science, Reading and Renaissance Literature*, 16.

like cabinets of curiosity—the artificial conditions in which knowledge can be produced.[102] *Poems, and Fancies* adopts precisely this approach.

Books and Cabinets

While the metaphor of nature's cabinet is prominent in *Poems, and Fancies*, it occurs roughly halfway through the volume. If we really can read it as a key to the work, it requires a reconfiguration of what has already been read, presuming that the reader approaches the work sequentially. But while many of the more abstract, structural allusions to *Wunderkammer* could be regarded as oblique, the book self-consciously signals that it might be 'read' like a cabinet in other ways, too: not least through its material form.

The rise of the metaphor of nature's cabinet in texts from the 1650s coincided with an increasing fashion for freestanding cabinets as *objets d'art* as well as functional objects, and with mid-seventeenth-century developments in cabinetry techniques.[103] The parallel seems not to be wholly coincidental. As cabinets became smaller and more portable, they became more visually bookish in size, materials, and decor. By the mid-sixteenth century continental cabinets had become luxuriously decorated objects for display as much as for use, and they began to employ similar decorative techniques to bookbinding, including painted lacquer imitations and inlaid mother-of-pearl panels.[104] For the less wealthy, the use of leather on both book bindings and cabinets likewise announced the similarity between these two 'containers'. Some artisans played consciously with the haptic similarities; as an ornate, perfectly book-sized box decorated with tooled leather and displaying a drawing from the V&A collection illustrates, boxes and books can provoke very similar interactions for users in the ways they are opened, perused and perhaps even stored as well as sharing an aesthetic (see Figures 15-17). As these techniques and trends gradually reached England, the prominence of these parallels between cabinets and books probably precipitated the rapid rise in the number of books alluding to themselves as 'cabinets' or 'closets' in their titles in the 1640s and 1650s.

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[102] John Shanahan, "Ben Jonson's "Alchemist" and Early Modern Laboratory Space," *Journal for Early Modern Cultural Studies* 8, no. 1 (2008): 54.
[103] See: Adamson, "Cabinetmaking and Production of Knowledge."
[104] Thornton, *Scholar in His Study*, 72.

Figure 13. Box displaying drawing, made by Francesco Chinello, c. 1632, leather, 5 x 33.4 x 24.9 cm, V&A, London. V&A 103-1882. The top and back side of the box (corresponding to the external front cover and spine of a book) also feature tooled leather panels. The patterns, as well as the techniques closely mirror those used on ornate book bindings (see Figure 17). Image © Victoria and Albert Museum, London.

Figure 15. Top of box made by Francesco Chinello (V&A 103-1882). Image © Victoria and Albert Museum, London.

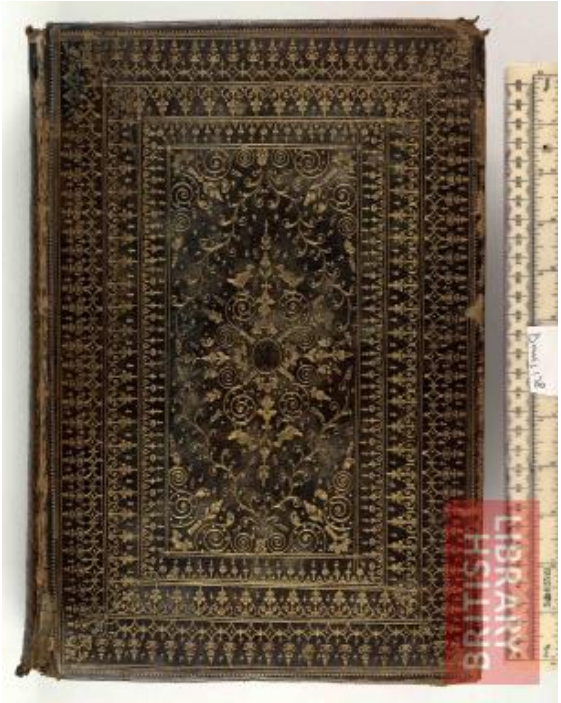


Figure 14. *The Booke of Common Prayer* bound with Bible and Psalms, (London: 1633), goatskin tooled in gold, bound by Lord Herbert of Cherbury's binder. BL Davis 178. Image © The British Library Board.

Figure 16. Frontispiece to Margaret Cavendish, *Poems, or, Several Fancies in verse with the Animal Parliament in Prose* (London: 1668), Henry E. Huntington Library 120159. The same etching was used in the 1652 edition of *Poems, and Fancies*.

Though bindings tended to be applied by individual owners and were therefore out of the control of the author, they could make the parallels between cabinets and books more visible, both in a physical and a conceptual sense. Furthermore, the contents of *Poems, and Fancies* reinforces the various logics of the cabinet conceptually embedded in the work. Espousing the 'sense of spatial and metaphorical play' that Sherman has shown to be common to early modern

paratexts, Cavendish's paratextual, as well as textual, allusions subtly guide the reader to consider the volume of *Poems, and Fancies* as itself analogous to the cabinet of nature.[105] The frontispiece of *Poems, and Fancies* (Figure 16) ascribes to the shared architectural aesthetic of both the cabinet and the book in the seventeenth century.[106] Like freestanding cabinets (see Figure 17 and Figure 18), the frontispieces of books often featured prominent architectural decorative motifs; *Poems, and Fancies* depicts Cavendish positioned as a statue in an architectural niche between two caryatids. Surrounded with Palladian columns, the image evokes the elaborate cabinets of the era which were often designed to emulate classical buildings in miniature.[107]

Figure 17. Ulrich Boas, cabinet featuring architectural detail and figures in niches, c. 1605-1610, ebony with silver and silver gilt mounts, 38 x 36.8 x 29.3 cm, V&A, London. V&A M.511 to K-1956. Image © Victoria and Albert Museum, London.

Throughout the book, this paratextual gesturing to cabinets continues. Thornton notes that 'silver mounts and fittings, and with elaborate locks and lockplates', often visually and functionally similar to book clasps, were fitted to

[105] Sherman, "On the Threshold," 70-71. On early modern paratexts, see: *Renaissance Paratexts*.
[106] See: Larson, "Reading the Closet," 81; Thornton, *Scholar in His Study*, 70; and Smith, *The Key of Green*, 20.
[107] On architectural frontispieces, see Sherman, "On the Threshold."

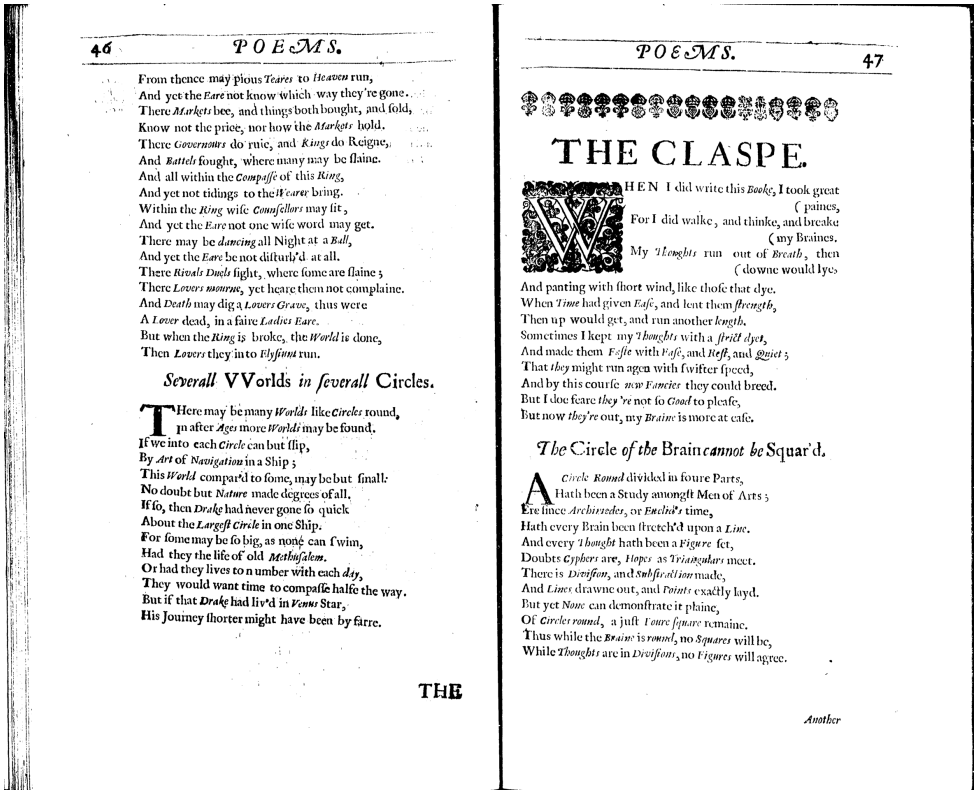
cabinets.[108] While the addition of bookclasps or binding decoration would have been left to individual owners, the divisions of Cavendish's text emphasise how cabinet-

Figure 18. Domenico Benotti and Francesco Fanelli, 'The John Evelyn Cabinet', 1644-1646, veneered ebony on pine and oak inlaid with *pietra dura* panels and bronze mounts, V&A W.24:1 to 24-1977. Commissioned by the diarist, who was close to the Cavendishes at this time in Paris, it features a central architectural panel surrounded by motifs from natural history rendered in *pietra dura*, four miniature figures nestled in niches on columns, and a series of locked drawers. Image © Victoria & Albert Museum, London.

like the book really is in print. Divided into four sections called 'claspe[s]', these subtitles, clearly and boldly marked out in large type, and using decorative borders of printer's flowers in three out of four instances, declare an implicit comparison with cabinets (see Figure 19). While clasps most frequently referred to the clasps on bookbindings, clasps were also an essential feature of cabinets, chests and closets both as fasteners and hinges. In both guises they held the structure of cabinets and books intact, and they held the contents of the cabinet and book together. The connective nature of the clasp sections in *Poems, and Fancies*, serves to hold together and create clearly visible, artificial links between the apparently disparate contents of sections of the work.

[108] Thornton, *Scholar*, 69.

This connection is also rendered in material form. Catchwords, particularly for section titles, such as the catchword 'FANCIES', printed in large type on what appears to be its own printing block, perform the function of a hinge or clasp



46 POEMS.

From thence may pious *Teares* to *Heaven* run,
And yet the *Eare* not know which way they're gone.
There *Markets* bee, and things both bought, and fold,
Know not the price, nor how the *Markets* hold.
There *Governours* do ruie, and *Kings* do Reigne,
And *Battels* fought, where many may be slaine.
And all within the *Compasse* of this *Ring*,
And yet not tidings to the *Wearer* bring.
Within the *Ring* wife *Counsellors* may sit,
And yet the *Eare* not one wife word may get.
There may be *dancing* all Night at a *Ball*,
And yet the *Eare* be not disturb'd at all.
There *Rivals Duels* fight, where some are slaine;
There *Lovers mourne*, yet heare them not complaine.
And *Death* may dig a *Lovers Grave*, thus were
A *Lover* dead, in a faire *Ladies Eare*.
But when the *Ring* is broke, the *World* is done,
Then *Lovers* they in to *Elysium* run.

Severall VVorlds *in severall* Circles.

THere may be many *Worlds* like *Circles* round,
In after *Ages* more *Worlds* may be found.
If we into each *Circle* can but slip,
By *Art* of *Navigation* in a Ship;
This *World* compar'd to some, may be but small:
No doubt but *Nature* made degrees of all.
If so, then *Drake* had never gone so quick
About the *Largest Circle* in one Ship.
For some may be so big, as none can swim,
Had they the life of old *Methusalem*.
Or had they lives to number with each *day*,
They would want time to compasse halfe the way.
But if that *Drake* had liv'd in *Venus* Star,
His Journey shorter might have been by farre.

THE

POEMS. 47

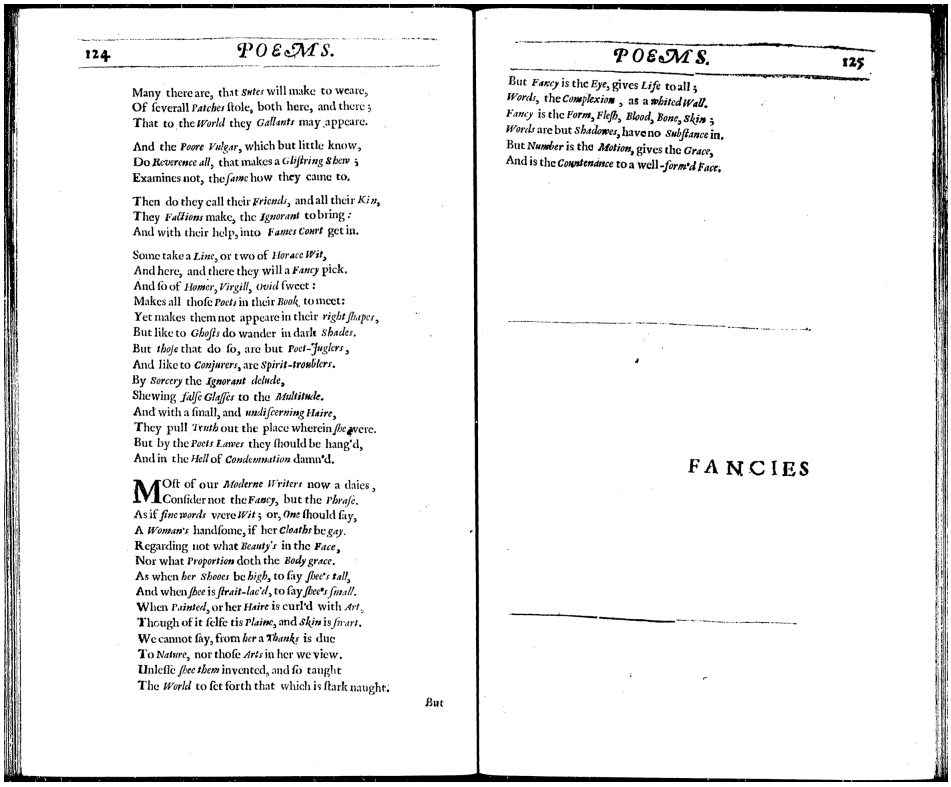
THE CLASPE.

WHEN I did write this *Booke*, I took great (paines,
For I did walke, and thinke, and breake (my Braines.
My *Thoughts* run out of *Breath*, then (downe would lye
And panting with short wind, like those that dye.
When *Time* had given *Ease*, and lent them *strength*,
Then up would get, and run another *length*.
Sometimes I kept my *Thoughts* with a *strict dyet*,
And made them *Fast* with *Fast*, and *Rest*, and *Quiet*;
That *they* might run agen with swifter speed,
And by this course *new Fancies* they could breed.
But I doe feare *they're* not so *Good* to please,
But now *they're* out, my *Braine* is more at ease.

The Circle *of the* Brain *cannot be* Squar'd.

A *Circle Round* divided in foure Parts,
Hath been a Study amongst Men of Arts;
Ere since *Archimedes*, or *Euclid's* time,
Hath every Brain been stretch'd upon a *Line*.
And every *Thought* hath been a *Figure* set,
Doubts *Cyphers* are, *Hopes* as *Triangulars* meet.
There is *Division*, and *Subdivision* made,
And *Lines* drawne out, and *Points* exactly layd.
But yet *None* can demonstrate it plaine,
Of *Circles round*, a just *Foure square* remaine.
Thus while the *Braine* is *round*, no *Squares* will be,
While *Thoughts* are in *Divisions*, no *Figures* will agree.

Another



124 POEMS.

Many there are, that *Sutes* will make to weare,
Of feverall *Patches* ſtole, both here, and there;
That to the *World* they *Gallants* may appeare.

And the *Poore Vulgar*, which but little know,
Do *Reverence all*, that makes a *Gliſtring Shew*;
Examines not, the *ſame* how they came to.

Then do they call their *Friends*, and all their *Kin*,
They *Factions* make, the *Ignorant* to bring:
And with their help, into *Fames Court* get in.

Some take a *Line*, or two of *Horace Wit*,
And here, and there they will a *Fancy* pick.
And ſo of *Homer*, *Virgill*, *Ovid* ſweet:
Makes all thoſe *Poets* in their *Book* to meet:
Yet makes them not appeare in their *right ſhapes*,
But like to *Ghoſts* do wander in dark *Shades*.
But *thoſe* that do ſo, are but *Poet-Juglers*,
And like to *Conjurers*, are *Spirit-troublers*.
By *Sorcery* the *Ignorant deludes*,
Shewing *falſe Glaſſes* to the *Multitude*.
And with a ſmall, and *undiſcerning Haire*,
They pull *Truth* out the place wherein *ſhe* were.
But by the *Poets Lawes* they ſhould be hang'd,
And in the *Hell* of *Condemnation* damn'd.

MOſt of our *Moderne Writers* now a daies,
Conſider not the *Fancy*, but the *Phraſe*.
As if *fine words* were *Wit*; or, *One* ſhould ſay,
A *Woman's* handſome, if her *Cloathe* be *gay*.
Regarding not what *Beauty's* in the *Face*,
Nor what *Proportion* doth the *Body grace*.
As when *her Shooes* be *high*, to ſay *ſhee's tall*,
And when *ſhee* is *ſtrait-lac'd*, to ſay *ſhee's ſmall*.
When *Painted*, or her *Haire* is curl'd with *Art*,
Though of it ſelfe tis *Plaine*, and *Skin* is *ſwart*.
We cannot ſay, from *her a Thanks* is due
To *Nature*, nor thoſe *Arts* in her we view.
Unleſſe *ſhee them* invented, and ſo taught
The *World* to ſet forth that which is ſtark naught.

But

POEMS. 125

But *Fancy* is the *Eye*, gives *Life* to all;
Words, the *Complexion*, as a *whited Wall*.
Fancy is the *Form*, *Fleſh*, *Blood*, *Bone*, *Skin*;
Words are but *Shadowes*, have no *Subſtance* in.
But *Number* is the *Motion*, gives the *Grace*,
And is the *Countenance* to a well-*form'd Face*.

FANCIES

Figure 20. The catchword 'FANCIES' occupies its own printblock in Margaret Cavendish, *Poems, and Fancies* (London: 1653), 124-125. Henry E. Huntington Library 120141.

(Figure 20).[109] Carried across adjacent pages, and, particularly in this case, connecting together the two titular sections of the book, these catchwords provide not only a technical means for the printer to correctly print and assemble pages, but also provides a visual means for the reader to construct a continuity between the 'poems' and the 'fancies' that Cavendish presents.

Conclusion

While claims that Cavendish's philosophical methods can be elucidated by the common figurative threads that run through *Poems, and Fancies*—of housewifery, of poetical making, of fancy, and of the frame of the cabinet—may seem tentative, Cavendish herself encourages us to read her fragmented work as a unified whole. At the end of her address 'To Poets' midway through the volume she explicitly warns her reader 'to observe very strictly every word they read; because in most of these Poems, every word is a Fancy. Wherefore if they loose, by not marking, or skip by

[109] *PaF*, 125.

too hasty reading, they will intangle the Sense of the whole Copy.'[110] Our comprehension of every poem depends on our comprehension of every other poem; the whole copy of the work can only be understood as a coherent and unified theory underpinned by fancy. Cavendish suggests that we might 'know in *generall*, as of the *Effects* [of nature], but to know the *Cause* of any one thing of *Natures* workes, *Nature* never gave us a *Capacity* thereto.'[111] It is these *effects* of nature that Cavendish seeks to capture through the curious mixture of observation and fancy that governs her poem, an artificial arena which might enable us to understand them. The integration of Cavendish's whimsical poems within a more philosophically credible atomistic theory is achieved through a number of cross-references, similitudes and the thorough integration of her poetics and her philosophy. In this philosophy, all things are interconnected: the passions and thoughts, the nature of man and the nature of animals and matter, all have a bearing on each other—and all are affected as creations of Nature, and as creations of Cavendish.

Cavendish's use of the metaphor of nature's cabinet provides a critical point around which key aspects of her philosophy converge. The creations of nature, traditional housewifery and poetry collide, and reason and fancy come together. Glenn Adamson has described the increasing 'cabinetization of knowledge' that occurred during the seventeenth century as 'an ongoing process of division' and 'compartmentalization' that governed the cultural work of the cabinet.[112] Increasingly subdivided and categorized, he tracks the specialisation of the cabinet's contents into discrete objects, and, by the eighteenth century, the separation of collecting practices 'into scientific and aesthetic effects.'[113] The cultural work of *Poems, and Fancies*, however, tells a very different story. Cavendish's cabinet works within the rubric that Adamson suggests the freestanding cabinet unit left far behind, in which science and aesthetics coexisted, and a plethora of differing objects could be assembled in a web of allusive and overlapping connections. As Adamson notes, the contents of this cabinet can hold both aesthetic and scientific significance; '[a] specimen in this environment could be both an object of regard and a piece of information.'[114] Nature's cabinet in *Poems, and Fancies*, opened up, offers up both recreations of the world around us for philosophical use and poetical delight.

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[110] *PaF*, 123.
[111] *PaF*, A4[r].
[112] Adamson, "Cabinetmaking," 248-49.
[113] Ibid.
[114] Ibid., 266.

Chapter Three

Laboratory Oratory: Digesting Metaphors

They may be small, but new lab-grown miniature human stomachs could one day help researchers better understand how the stomach develops, as well as the diseases that can strike it. […]"It was really remarkable to us how much it looked like a stomach," said researcher Jim Wells, a professor of developmental biology at Cincinnati Children's Hospital Medical Center.[1]

Researchers can use human gastric organoids as a new discovery tool to help unlock other secrets of the stomach […] Until now, a major challenge to addressing these and other medical conditions involving the stomach has been a relative lack of reliable laboratory modeling systems to accurately simulate human biology.[2]

The Human Laboratory

On 6 June, 1822, Alexis St Martin, a French-Canadian soldier serving in the US army, was shot in Michillimackinac, Michigan. The attending army surgeon found a part of his patient's left lung protruding from the wound and 'a portion of the stomach, lacerated through all its coats, and pouring out the food he had taken for his breakfast, through an orifice large enough to admit the forefinger'.[3] After a substantial period of treatment in which he overcame fever, abscess and a rib amputation, St Martin eventually recovered, 'with the exception', his doctor noted, 'of the aperture in the stomach and side[…]. The perforation was about two and a half inches in circumference, and the food and drinks constantly exuded, unless prevented.'[4] After several months of using bandages to prevent the contents of his stomach from oozing out, a small fold grew on the interior of St Martin's stomach lining, forming a valve-like structure that prevented leaking. Though this fistula could be pressed open with a finger, the stomach perfectly retained whatever St Martin had consumed. This peculiar wound presented a unique opportunity in medical history: it

[1] Laura Geggel, "Tiny Human Stomachs Grown in Lab," www.livescience.com, https://www.livescience.com/48519-miniature-human-stomachs.html.
[2] Cincinnati Children's Hospital Medical Center, "Scientists Generate First Human Stomach Tissue in Lab with Stem Cells.," Science-Daily, www.sciencedaily.com/releases/2014/10/141029145615.htm. For the original research that inspired this and Geggel's article, see: Kyle W. McCracken, Emily M. Catá, Calyn M. Crawford et. al., "Modelling Human Development and Disease in Pluripotent Stem-Cell-Derived Gastric Organoids," *Nature* 516 (2014).
[3] William Beaumont, *Experiments and Observations on the Gastric Juice, and the Physiology of Digestion* (Edinburgh: Machlachlan & Stewart, 1838), 8.
[4] Ibid., 15.

was a window onto the interior workings of one of the most complex and vital human organs, the stomach.

Not one to overlook such a serendipitous gift, St Martin's surgeon, William Beaumont, reported that he 'commenced [a] series of gastric experiments with him'.[5] Beaumont's gesture toward collaboration—of experiments 'with', rather than 'on' his patient—overplayed St Martin's enthusiasm for being an experimental subject; two years after the experiments began, St Martin ran away from Beaumont's household. Unwilling to abandon his experimental goldmine, Beaumont assiduously tracked his subject down to Canada and lured him back, persuading St Martin to become a convenient mixture of domestic servant, 'chopping wood, carrying burthens, &c. with little or no suffering or inconvenience from his wound', and human laboratory: '[f]or the last four months, he has been unusually plethoric and robust', Beaumont remarked of his guinea-pig, 'though constantly subjected to a continued series of experiments on the interior of the stomach; allowing to be introduced or taken out at the aperture different kinds of food, drinks, elastic catheters, thermometer tubes, gastric juice, chyme &c. almost daily, and sometimes hourly'.[6]

Beaumont's experiments were a milestone in the science of digestion, with *in vivo* and *in vitro* work using the materials and setting of St Martin's body to definitively prove that stomachical digestion was primarily a chemical rather than a mechanical process.[7] Naming Beaumont's work one of his 'Great Scientific Experiments', Rom Harré notes that 'it seems to have suddenly dawned on Beaumont that in St Martin and his peculiar injury there was an ideal laboratory for an experimental study of digestion'.[8] While Beaumont himself, keen to paint his relationship with St Martin in a benevolent light, seems not to have explicitly referred to his patient as a laboratory (at least in print), he clearly considered him as such, referring to his stomach as a site to be prodded, tested and filled with a variety of tools and substances. Historians of science have drawn this comparison more explicitly, referring to St Martin as a 'walking apparatus', a 'living laboratory', a

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[5] Ibid., 18.
[6] Ibid., 20-21.
[7] It should be noted that there *are* several important mechanical aspects of digestion, including mastication and peristalsis, but to produce chyme, food in the stomach must be subjected to the action of digestive enzymes and hydrochloric acid as well as the mechanical digestion that the stomach muscle performs.
[8] Rom Harré, *Great Scientific Experiments: Twenty Experiments That Changed Our View of the World* (Oxford: Oxford University Press, 1981), 41.

'human laboratory' and a 'laboratory animal'.[9] This specific characterisation crystallises around the unique ways in which St Martin's stomach became both the site and the subject of experimentation. But though St Martin's stomach was framed as a site of innovation, a laboratory the likes of which the medical world had never seen before, the notion that stomachs were like laboratories had a long and distinguished heritage. The metaphorical stomach-laboratory, I will argue, was as important to digestive science as St Martin's actual stomach-laboratory, shaping the hypothetical understandings of the digestive process which were eventually tested, and largely confirmed, in Beaumont's experiments.

The metaphor of the stomach-as-laboratory caught the zeitgeist in the latter half of the seventeenth-century, gaining a cultural credence that helped to articulate and define positions in the vibrant debates over digestive science. Despite its proliferation and expressive power, this metaphor, and its theoretical and practical consequences, have drawn little consideration from scholars. Using a range of textual sources, this chapter will examine how and why the metaphor rose to prominence. It will consider what the metaphor of the stomach-as-laboratory can tell us about early modern laboratories and stomachs, and how the material realities of laboratory space and the figurative histories of digestive theory fed into the trope. It will also probe some more far-reaching implications, examining how the stomach-as-laboratory trope worked as a tool for theological debate and as an indicator of the eclecticism of early modern epistemologies. By examining the work of a range of writers including Walter Charleton, Henry Power, Everard Maynwaring, Thomas Tryon, Denis Papin, and Robert Ferguson, I hope to illustrate the spread and reach that such metaphors could achieve; the stomach-laboratory was employed by a variety of practitioners with a range of audiences. Though many of these writers moved in the networks surrounding London's scientific institutions, their different philosophical, political and theological agendas saw the trope turned to the service of popular works on health and wellbeing, chemical medicine, utilitarian invention, and religious debate as well as to explore complex physiological hypotheses. Though a seemingly

[9] Ibid.; John Carey, "The Man with a Lid on His Stomach," in *Eyewitness to Science*, ed. John Carey (Cambridge: Harvard University Press, 1995), 68; Simon Singh, "Serendipity: In a Soldier's Stomach," *The Independent*, 14 March 1999; Ruth Hannon, Charlotte Pooler and Carol M. Porth, *Pathophysiology: Concepts of Altered Health States* (Philadelphia: Lippincott, Williams & Wilkins, 2009), 855; John Duffy, *From Humors to Medical Science: A History of American Medicine*n(Chicago: University of Illinois Press, 1993), 109; Richard Selzer, "Alexis St Martin," in *Confessions of a Knife* (New York: Simon & Schuster, 1979), 127.

specific image, much of the power of the metaphorical laboratory lay in its versatility.

The Laboratory: Modernity and History

The 'laboratory' is often regarded as a space at the vanguard of progress; the home of futuristic developments in technology and science, it is a space of 'doing', where people in white coats grow 'tiny human stomachs' outside of the human body.[10] Narratives of the scientific revolution have credited the emergence of the 'modern' laboratory with a key role in bringing forth the characteristic paradigm shift of the 'new science', already extensively discussed, from mystical forms of knowledge reliant on symbolism and analogy to the empirical pursuit of objective facts, derived from testing and observation. For example, summarising the history of the early modern laboratory, Pamela H. Smith writes that '[b]y the end of the seventeenth century,[…] the laboratory had become one of the hallmarks of the new science—the site where theories and hypotheses were purportedly tested by experiment and from which discoveries and useful knowledge emerged.'[11] But touted as a totemically 'modern' institution, the laboratory has sometimes struggled to find its place in history; Owen Hannaway opined in the 1980s that '[t]he history of the laboratory is an important but neglected aspect of early modern science,' pointing to a limited historical understanding of what these spaces were actually like.[12] Though relatively little material and archaeological evidence remains, luckily, in recent decades, our understanding of the early modern laboratory has expanded.

The Oxford 'laboratory boom' of the 1650s heralded a dramatic shift for laboratories in England.[13] Prior to this, English universities had lagged behind their European counterparts in providing practical facilities for experiment. Most English laboratories belonged either to private individuals, such as alchemists, or in the form of artisanal workshops belonging to tradesmen such as apothecaries, goldsmiths, or dyers. By the 1670s the influence of the Oxford experimentalists (a group including

[10] Geggel, "Tiny Human Stomachs."
[11] Pamela H. Smith, "Laboratories," in *The Cambridge History of Science*, ed. Katharine Park and Lorraine Daston (Cambridge: Cambridge University Press, 2006), 292.
[12] Hannaway, "Laboratory Design," 585. This sentiment is echoed in Kohler, "Lab History," 761.
[13] Emily Booth, *'A Subtle and Mysterious Machine': The Medical World of Walter Charleton (1619-1707)* (Dordrecht: Springer, 2005), 9; see also Andrew Cunningham, "The Kinds of Anatomy," *Medical History* 19, no. 1 (1975).

figures such as Robert Hooke, Robert Boyle and Christopher Wren), the Hartlib Circle, and the newly-founded Royal Society, had precipitated a public growth of enthusiasm for the experimental method. The most notable and documented laboratories were those of the kind Smith describes: purpose-built, highly specialised spaces, fitted with bespoke equipment and designed for use by institutional and intellectual elites, the academic laboratory had flourished.[14] But as Smith herself has illustrated, the full spectrum of early modern laboratories was considerably more diverse. In many instances, laboratories were highly mobile and contingent spaces, varying in appearance, character and purpose. The development of the laboratory as a professional and specialised space for science was neither sudden nor uniform, and throughout the century the term applied to a range of diverse and often makeshift spaces where scientific labour occurred.

Though the use of the word 'laboratory' to refer to a space for scientific investigation increased rapidly during and after the 1650s, it had a much longer history. The word evolved from the medieval Latin term for a workplace, a *laboratorium*, the name given to medieval monastic spaces for distilling and medicinal production.[15] By the mid-sixteenth century *laboratoria* could be found in a range of places including personal residences, educational establishments and artisanal workshops.[16] The English term, referring specifically to a space for science, was in use by the later sixteenth-century; though the *OED* attributes the earliest example of usage to John Dee in 1592, Timothie Bright's *Treatise of Melancholie* describes the digestion as the work of a 'naturall Chymist' even more industrious than the 'artificiall Chymist[…] in his laboratorie' as early as 1586.[17] This early alliance of the laboratory with chemistry is characteristic: examining the actor's term as it evolved in England, Ursula Klein has shown that up to the eighteenth century, 'laboratory' described any artisanal workshop in which 'chemical operations' occurred, including 'apothecaries' shops, foundries, assaying shops, mints, arsenals and gunneries, dyeing

[14] On the material, social and technological aspects of elite chemical and alchemical laboratories, see Cunningham, "Kinds of Anatomy"; Shapin, "House of Experiment"; Hannaway, "Laboratory Design"; Shackelford, "Aim of Science.". Though these laboratories were often designed for and by wealthy, upper-class virtuosi, much of the work done in them was actually performed by skilled laboratory technicians of lower social standing: see Steven Shapin, *A Social History of Truth: Civility and Science in Seventeenth-Century England* (Chicago: University of Chicago Press, 1994), especially Ch. 8, 'Invisible Technicians: Masters, Servants, and the Making of Experimental Knowledge', 355-408.
[15] Smith, "Laboratories," 294; 'laboratory, *n.*,' *OED*.
[16] Smith, "Laboratories," 299.
[17] Cf. 'laboratory, *n.*,' 1.a., *OED*; Timothie Bright, *A Treatise of Melancholie: Containing the Causes Thereof, & Reasons of the Strange Effects It Worketh in Our Minds and Bodies* (London: Thomas Vautrollier, 1586), 3.

manufactories, porcelain manufactories, chemical factories, distilleries, and perfumeries'.[18] Klein argues that 'there was a strong correspondence between the material culture of academic-chemical and artisanal laboratories, including their architecture, instruments, vessels, materials, and manipulative techniques'; domestic and commercial establishments existed on a continuum with the sites of academic experimentation that commonly dominate historical discussion of the laboratory.[19]

Kitchens, breweries and stillhouses, which existed in a wide array of settings to distil and produce culinary, medicinal and household substances were some of the earliest, and most common 'laboratory' sites of the early modern period.[20] The distillation of alcoholic spirits gained popularity and 'was a flourishing business' by the early seventeenth-century, resulting in the foundation of the Company of Distillers in 1638 by Royal Physician Theodore de Mayerne.[21] While the traditional knowledge of stillhouses was becoming commercialised, domestic endeavours were simultaneously adopting and developing cutting-edge experimental techniques and knowledge. As Wendy Wall, at the forefront of a wave of recent scholarship, has noted, domestic, mainly women's work including '[t]he tasks of making cordial waters, omelets, and preserved fruits required a foray[…] into botanical, herbal, medicinal, anatomical and chemical knowledges. Domestic work also involved techniques, equipment and objects of study that overlapped with those engaged in the more recognizable experimentation conducted by members of the Royal Society.'[22] Deborah Harkness and Simon Werrett have compellingly illustrated how laboratories did not simply adopt culinary technology and materials; kitchens were often physically co-opted for scientific work with the borrowing of stoves or windowsills for experimentation, and often there was no distinction made between the 'domestic' work of the kitchen and 'scientific' practice of the superimposed lab.[23]

This porous boundary between the domestic and the scientific resulted in a shared inventory of tools, instruments, and practices. Werrett describes a domestic culture of 'making do'—a 'careful stewardship of materials and artefacts in the face

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[18] Klein, "Laboratory Challenge," 770. On the artisanal roots of the laboratory, see Smith, "Laboratories"; and Nummedal, "Words and Works," 331.
[19] Klein, "Laboratory Challenge," 774.
[20] Smith, "Laboratories," 290.
[21] O.M. Lloyd, "The Royal College of Physicians of London and Some City Livery Companies," *Journal of the History of Medicine* 11, no. 4 (1956): 415-16; on Mayerne see Hugh Trevor-Roper, *Europe's Physician: The Various Life of Sir Theodore De Mayerne* (New Haven: Yale University Press, 2006).
[22] Wall, *Recipes for Thought*, 211.
[23] Harkness, "Mortlake"; and *The Jewel House*; Werrett, "Recycling."

of expense and scarcity'—which was mirrored among natural philosophers, 'extending practices from the household, artisanal practice and waste trades into the new science.'[24] On the flipside, Elaine Leong has noted that parallels between the tools and processes of early modern kitchens and laboratories meant that it 'would not have required a great deal of either additional learning or acquisition of equipment' for the early modern housewife to prepare medicines in the same way as an apothecary or physician.[25]

Just as domestic and philosophical skills and spaces were fluid and adaptable, the texts that addressed them also had to be. This is nowhere better encapsulated than in women's receipt books, which collected together instructions for making foodstuffs, remedies and general household substances such as cleaning products from sources including contemporary medical and pharmaceutical texts as well as consultation with medical practitioners and recommendations from friends and family; these recipes, once trialled, were often validated with an empirical '*probatum est*' ('it is proven').[26] Wall has stressed that 'scientific and domestic communities were not just analogous but *overlapping* communities, with recipes providing a shared medium of communication among reformers, ladies, gentry, tradesmen, housewives, and servants'; she has pointed out that '[t]heir working practices formed corollary, analogous, and sometimes intersecting communities with those inhabited by the "new philosophers" of the late seventeenth century'.[27]

Even specialised pieces of equipment such as alembics and *bain maries*, required for distilling, were commonly found in middle-class households.[28] This crossover is visually encapsulated in the frontispiece to Hannah Woolley's 1670

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[24] Werrett, "Recycling," 628. On the use of household items such as playing cards and scraps of waste in the organisation of knowledge, see Ann Blair, *Too Much to Know: Managing Scholarly Information Before the Modern Age* (New Haven: Yale University Press, 2010); and Elizabeth Yale, "With Slips and Scraps: How Early Modern Naturalists Invented the Archive," *Book History* 12 (2009). On remaining archaeological and textual evidence of the material culture of early modern laboratories, see Anderson, "Archaeology of Chemistry."

[25] Leong, "Making Medicines," 162.

[26] See: Wall, *Recipes for Thought*; Leong, "Making Medicines"; Spiller, "Recipes for Knowledge: Maker's Knowledge Traditions, Paracelsian Recipes and the Invention of the Cookbook, 1600-1660," in *Renaissance Food from Rabelais to Shakespeare: Culinary Readings and Culinary Histories*, ed. Joan Fitzpatrick (Farnham: Ashgate, 2010); and "Printed Recipe Books in Medical, Political, and Scientific Contexts," in *The Oxford Handbook of Literature and the English Revolution*, ed. Laura Lunger Knoppers (Oxford Oxford University Press, 2012); Pennell, "Pots and Pans History" and *Birth of the English Kitchen*; Leong, "Collecting Knowledge"; Leong and Pennell, "Recipe Collections in the 'Medical Marketplace'."

[27] Wall, *Recipes for Thought*, 211-12.

[28] Wendy Wall, "Distillation: Transformations in and out of the Kitchen," in *Renaissance Food from Rabelais to Shakespeare: Culinary Readings and Culinary Histories*, ed. Joan Fitzpatrick (Farnham: Ashgate, 2010); Leong, "Making Medicines," 162.

household manual, *The Queen-like Closet* (Figure 21), which shows women at work, cooking and distilling, surrounded by an array of equipment and spaces that bear a striking resemblance to early modern depictions of laboratories in use (Figure 22).

Figure 21. Frontispiece, Hannah Woolley, *The Queen-like Closet* (London: 1672), BL C194.a.1292.

Laboratories in the seventeenth century existed in a broad range of spaces for a diverse population of workers. The 'instruments and apparatus', indeed the 'things' that Trevor H. Levere and Frederic L. Holmes have posited as central to the

development of chemistry, were derived from, and used in, a wide range of applications and environments.[29] While the isolated, bespoke-equipped, single-purpose space we now recognize as a 'laboratory' was certainly being developed by the most wealthy individuals and institutions, very different types of 'labs' were still accessible to a whole range of citizens, from consumers of cheap medicines or producers of common household goods to theoretical scientists at elite institutions and societies.

Literary Laboratories

As well as sharing tools and technical strategies with a wide range of their predecessors from kitchens to alchemists, laboratories also inherited distinctly textual traditions. Klein suggests that the early modern laboratory was intrinsically textual as well as practical: it 'was the outcome of a long tradition in which innovative forms of labor, technical expert knowledge, and text-based philosophies developed in tandem.'[30] Arguing against the tendency for historians of science 'to distance alchemy from laboratory science', Lawrence M. Principe has noted that some of the obscure allegorical language of alchemy, an explicitly symbolic discipline, including metaphorical *Decknamen,* was rooted in universally observable experimental phenomena. In this sense, laboratory work might *decode* the text: 'the admittedly culturally influenced metaphorical clothing, no matter how externally bizarre, may (in more than a few cases) cover a solid body of repeated and repeatable observations of laboratory results. The common source for these sometimes extravagant images is neither the unconscious psychic state nor the merely literary but rather the experimental'.[31] As Tara E. Nummedal has noted, 'Simultaneously bookish, experiential, and experimental, alchemy stubbornly resists any attempt to separate out the histories of reading, writing, making, and doing.' The same 'alchemical

[29] Trevor H. Levere and Frederic L. Holmes, "Introduction: A Practical Science," in *Instruments and Experimentation in the History of Chemistry*, eds. Frederick L. Holmes and Trevor H. Levere (Cambridge: MIT Press, 2000), vii-viii.
[30] Klein, "Laboratory Challenge," 780.
[31] Lawrence M. Principe, "Apparatus and Reproducibility in Alchemy," in *Instruments and Experimentation in the History of Chemistry* eds. Frederick L. Holmes and Trevor H. Levere (Cambridge: MIT Press, 2000), 69, 70-71. On the 'astonishingly well-developed experimental techniques' of alchemy, see also: Principe, "Alchemy Restored," *Isis* 102, no. 2 (2011): 310.

marriage of words and works' persists in the products of the early modern laboratory.[32]

Figure 22. Follower of David Teniers the younger (1610-1690), *An Alchemist in his Laboratory*, date unknown, oil on wood, 40.7 x 32.5 cm, Wellcome Library 45109i. Image © Wellcome Collection.

This intrinsic connection between laboratories and words is exemplified in the most famous engraving from Heinrich Khunrath's *Amphitheatrum Sapientiae Aeternae* (1609), depicting the 'Oratory Laboratory' (Figure 23). As Peter Forshaw has illustrated, Khunrath saw the work of (the) oratory—both a site of worship, and a form of rhetorical strategy—and the laboratory as fundamentally linked.[33] He believed that the book of nature, just like scripture, could be interpreted on a number of

[32] Nummedal, "Words and Works," 331, 332.
[33] 'Oratory, *n.*': 'A place of prayer; a room or building for private worship, *esp.*, in the Christian Church, a small chapel or shrine in or attached to a house, monastery, church etc.,' I.1.a.; 'the formal art of speaking eloquently or persuasively, esp. according to set rules; rhetoric,' II.1.a., *OED*.

exegetical levels and 'passionately exclaim[ed] against those who "utterly un-Philosophically separate *Oratory* and *Laboratory* from each other."'[34]

Figure 23. Engraving from Heinrich Khunrath's *Amphitheatrum Sapientiae Aeternae* (Hanover: 1609), BL 30.e.5.

The image condenses the arenas of worship, language and experimentation onto one another: aphoristic phrases billow from a smouldering apparatus which could be an incense burner or a steaming crucible and words festoon the laboratory fireplace as well as the religious canopy, tying the three pursuits of faith, hermeneutics, and science together.

Given the early alchemical dependence on literary techniques, it is little surprise that laboratories found a home in early modern literature. Laboratories were

[34] Peter J. Forshaw, "Vitriolic Reactions: Orthodox Responses to the Alchemical Exegesis of Genesis," in *The Word and the World: Biblical Exegesis and Early Modern Science*, eds. Kevin Killeen and Peter J. Forshaw (Basingstoke: Palgrave Macmillan, 2007), 119.

culturally recognisable entities: this much is apparent from their appearance in popular works such as broadside ballads and plays. But their presence on-stage was often decisively non-material, embedded and signalled in the language of the laboratory rather than its stuff.

In Ben Jonson's popular play *The Alchemist*, the laboratory remains resolutely offstage. Referred to only once in the play, the space in which the conmen Face and Subtle claim to ply their trade is almost as elusive as the philosopher's stone they promise to their gullible mark, Mammon. Warning him not to disturb their fictional workspace, Face tells his credulous client to quieten down and redirects him to a different area of the house:

> Sir, you are too loud. I hear you, every word,
> Into the laboratory. Some fitter place:
> The garden, or great chamber above.[35]

This is a pragmatic attempt to clear Mammon out of the way before the next arrival in an ever more frantic series of scams; instead of disturbing alchemical work, Mammon's excitable proclamations threaten to derail the other cons the tricksters are brewing. The laboratory never appears on stage because it doesn't exist, at least not as a physical space which can be put to profitable or authentic use. As John Shanahan and others before him have noted, 'From the perspective of the audience, Subtle's "laboratory" is no more than the words used to evoke it'.[36] Like its promised treasures, the laboratory is just another lie, fed to a greedy and unquestioning audience.

Face warns against the disruptive intrusion of language into the laboratory, suggesting that words are fitter elsewhere. But like everything he says, this statement shouldn't be taken at face value. Paradoxically his words highlight the power of laboratory language as a tool, used to mislead, distract and deceive those gullible enough to buy into it. This is established early on, when Subtle beguiles Mammon with a speech displaying his apparent expertise in alchemical practice. Instructing his

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[35] Ben Jonson, "The Alchemist (1610)," in *The Cambridge Edition of the Works of Ben Jonson*, eds. David Bevington, Martin Butler and Ian Donaldson (Cambridge: Cambridge University Press, 2012), 4.1.170-172. References are to act, scene and line.

[36] Shanahan, "Jonson's "Alchemist" and Laboratory Space," 36. See also R.L. Smallwood, ""Here in the Friars": Immediacy and Theatricality in the Alchemist," *Research in English Studies* 32, no. 126 (1980); and Edward Partridge, *The Broken Compass: A Study of the Major Comedies of Ben Jonson* (New York: Columbia University Press, 1958).

accomplice with a complex and jargon-laden set of instructions, he directs him to slowly reduce the heat of the 'aludels', the pots used in sublimation, and then

> Infuse vinegar
> To draw his volatile substance and his tincture,
> And let the water in glass E be filtered
> And put into the gripe's egg. Lute him well
> And leave him closed in *balneo*.[37]

While this studied and obscure language borrows carefully from the actual language of alchemical practice ('glass E', for example, subtly satirises the careful manner in which diagrams are annotated alphabetically in chemical texts) the effect quickly distorts into the grotesque, with an amalgamation of substances from ambiguous vessels co-opting 'calcined' faeces and 'menstrue' into a pelican.[38] To the seasoned reader of chemical recipes, these instructions sound legitimate; Boyle's chemical experiments, for example, frequently deploy spirit of urine, a substance that would sit comfortably among Jonson's distillates. But the opacity of the language here serves only to hide a text entirely empty of meaning. If the invocation of Ulen Spiegel, the German trickster hero of sixteenth-century chapbooks, does not alert us to the deception being performed, Surly's assessment of this 'brave language[…] next to canting' points the finger squarely at the con: as well as conjuring up the song-like chanting employed in religious and magical ritual, or suggesting the jargon so freely deployed, 'canting' also refers to the dialect of the early modern underworld, and the coded language associated with the vagabonds and con artists, who, like Jonson's protagonists, had become popular antiheroes in cheap pamphlets and plays.[39] Language is the only means through which the laboratory of *The Alchemist* is conjured into existence—and yet laboratorical language, despite all its professional glimmer, remains deeply untrustworthy. As Claire Preston notes, the laboratories in Thomas Shadwell's *The Virtuoso* and Aphra Behn's *The Emperor of the Moon* are similarly '*virtual*' spaces, distinguished either by verbal catalogues of objects, or never featured on-stage at all.[40]

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[37] Jonson, *The Alchemist*. 2.3.35-41.
[38] Ibid. 2.3.63, 72.
[39] Jonson, *The Alchemist*. 2.3.32, 42. On the idiolect of con artists in early modern literature, see *Rogues, Vagabonds & Sturdy Beggars: A New Gallery of Tudor and Early Stuart Rogue Literature* (Amherst: University of Massachusetts Press, 1990).
[40] Claire Preston, *Thomas Browne and Early Modern Science*, 107. Emphases Preston's own.

Jonson was consistently scathing of laboratory language—in his 1615 court masque *Mercurie Vindicated from the Alchemists at Court,* the dancing Mercury rails against the tortures he is subjected to by alchemists, objecting to how they 'pretend under the specious names of Geber, Arnold, Lully, Bombast of Hohenheim, to commit miracles in art and treason again' nature; and as if the title of philosopher, that creature of glory, were to be fetched out of a furnace'.[41] Mercury's indignation continues along linguistic lines, with his harsh treatment epitomised in the various verbal forms he is contorted into: 'I am their crude and their sublimate, their precipitate and their unctuous, their male and their female, sometimes their hermaphrodite; what they list to style me', he begins, before launching into a torrent of the chemical processes he has been subjected to.[42] But if Jonson rails against this misuse of language in the laboratory, the author's own admirers construed his literary efforts in alchemical terms. In 1662, it was suggested that 'Ben the onely true Alchymist converts all metalls into Gold by the advantage of the Laboratory, of whose Braine the wisdom of Greece and Rome the Riches of all Ages became tributary to ours, and inriched the English tongue.'[43] The power of the laboratory, according to these literary sources, lay in its position as the source of beguiling, transformative language, and the impact of this language on the imagination.

Despite these close links between oratory and laboratory, laboratory language has received relatively little critical attention. Though fictional, and especially utopian depictions of laboratories have been researched by scholars keen to understand the (often unattainable) ideals of early modern science, the laboratory as a metaphorical trope has passed largely unstudied.[44] While writers like Jonson illustrated how the imagined laboratory could be abused, for a different set of early modern writers, the imagined laboratory and its language had immense descriptive and explanatory utility. This remainder of this chapter will use one popular example, the metaphor of the stomach-laboratory, to explore how the laboratory functioned as a metaphorical trope in non-fiction, and especially scientific prose. By tracing the permeation this metaphor alongside the spaces in which it was used and developed, I hope to illustrate that the work of figural and physical laboratories was closely intertwined

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[41] Ben Jonson, "Mercurie Vindicated from the Alchemists at Court (1615)," in *The Cambridge Edition of the Works of Ben Jonson*, eds. Martin Butler, Ian Donaldson and David Bevington (Cambridge: Cambridge University Press, 2012), 435.
[42] Ibid.
[43] J.C., *A Short Treatise of the Epidemical Diseases of These Times* (London: R. Vaughan, 1662), 21.
[44] See, for example: Preston, *Poetics of Investigation*, esp. Ch. 3, '"A Blessing in the Wilderness": Fictions of Polity and the Place of Science', 90-157.

and mutually reinforcing, feeding an epistemology that not only drew from experimental observation, but also from the analogical understanding that the metaphorical laboratory could offer.

Inside the Anatomy Theatre

In March 1679, Walter Charleton (1619-1707), a prominent physician and natural philosopher, was chosen to deliver the Gulstonian Lectures at the Royal College of Physicians. This was an especially prestigious occasion, marking the opening of the new Cutlerian anatomy theatre, the flagship structure of the College's rebuild following the Great Fire of London.[45] Designed by the Royal Society's Curator of Experiments, Robert Hooke (1635-1703), and providing state-of-the-art facilities of the kind the institution had recently been lacking, the Cutlerian placed the Royal College of Physicians back on the map as a centre for anatomical study and education, grandly asserting the status of the College after a period that had been fraught with financial and reputational insecurity.[46] Like a phoenix rising from the all-too-real flames, Hooke's technically innovative theatre promised a new home for a wide range of people from London's scientific communities, which had become distinctly itinerant in nature, to gather, debate, and learn.[47]

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[45] On the Cutlerian Theatre see Matthew Walker, "Architecture, Anatomy, and the New Science in Early Modern London: Robert Hooke's College of Physicians," *Journal of the Society of Architectural Historians* 72, no. 4 (2013); and "Architectus Ingenio: Robert Hooke, the Early Royal Society, and the Practices of Architecture" (PhD, University of York, 2009), esp. Ch.4, 'Experimental Philosophical Architecture: Hooke's College of Physicians,' 200-247.

[46] In the seventeenth century London's institutions boasted a wider and more structured range of anatomical lectures than Oxford and Cambridge, where the relative importance of dissection could be sidelined during medical study: see Cunningham, "Kinds of Anatomy." Due to a lack of documentary evidence it is unclear whether the pre-Fire complex of the College of Physicians also housed an anatomy theatre: Walker, "Architectus Ingenio," 212. On the mid-century disputes between the Royal College of Physicians and other medical guilds and practitioners, including the Barber-Surgeon's Company and the Society of Apothecaries, see Lloyd, "Physicians and Livery Companies"; George Clark, *A History of the Royal College of Physicians*, vol. 1 (Oxford: Clarendon Press for the Royal College of Physicians, 1964), 286; Harold J. Cook, *The Decline of the Old Medical Regime in Stuart London* (Ithaca: Cornell University Press, 1986), 124-32; Margaret Pelling, *Medical Conflicts in Early Modern London: Patronage, Physicians, and Irregular Practitioners, 1550-1640* (Oxford: Clarendon Press, 2003); Elizabeth Lane Furdell, *Publishing and Medicine in Early Modern England* (Rochester: University of Rochester Press, 2002), 1-28.

[47] The 1660s and 1670s were difficult decades for London's best-known scientific institutions; the Royal Society had struggled to find a permanent home since its foundation and Gresham College (the Society's initial location), along with the Royal College of Physicians, the Society of Apothecaries and the Barber Surgeons' Hall, all sustained significant damage in the Great Fire of 1666. See Walker, "Architectus Ingenio," 202; Shapin, "House of Experiment," 381; Clark, *History of the RCP*, 327. On the technological innovations employed by Hooke to secure optimal viewing conditions for

Funding for the project came from John Cutler, a financier and patron of the sciences who had already endowed a weekly lecture series delivered by Hooke at the Royal Society.[48] The gift resulted in some very public back-bending from the Physicians; their preferred site for the theatre, within the planned herb garden, was overruled by the donor's insistence that the theatre was built at the front of the College site, 'presumably', as Matthew Walker has observed, 'so that the plaque bearing his name was visible from the street'.[49] The Physicians' gratitude for Cutler's gift was inscribed in print as well as stone in the published version of Charleton's inaugural lectures, which were prefaced with an engraving of the new hall (Figure 24) and a dedicatory epistle singing the praises of the magnanimous benefactor, describing the talks as 'born in Your Magnific Theatre'.[50] But Charleton's praise for the anatomy theatre extends beyond the usual hyperbole of admiration for a patron and his projects. The opening of the anatomy theatre provided Charleton with an occasion to reflect, at length, on the parallels between architecture and anatomy. Understanding the proliferation of these parallels, which grow beyond a panegyric trope to seem a fundamental part of Charleton's understanding of the body, is essential when placing his later discussion of the stomach in context. Buildings are placed centre-stage alongside bodies in a long preface framing the lectures, which argues that 'the most useful inventions of the first of Historical times, were Medicine and Architecture'.[51] The comparison between bodies and buildings that allowed Charleton to imagine his work as the progeny delivered of a newly-built body also allowed him to describe his 'Subject'—human anatomy. The body, he writes, is:

> a System of innumerable smaller *Machines* or Engines, by infinite Wisdom fram'd and compacted into one most beautiful, greater *Automaton*[…] yet all ordain'd and adjusted to one common End, namely, to compose a Living *Ergasterium* or Work-house, in which a *Reasonable* and *Immortal Soul* may, not

spectators in the theatre, see Walker, "Architectus Ingenio," 225-30; and "Architecture, Anatomy and the New Science," 489-96.

48 Walker, "Architecture, Anatomy and the New Science," 488. On Hooke's Cutlerian Lectureship, see Michael Hunter, "Science, Technology and Patronage: Robert Hooke and the Cutlerian Lectureship," in *Establishing the New Science : The Experience of the Early Royal Society* (Woodbridge: Boydell Press, 1989), 279-338.

49 Walker, "Architecture, Anatomy and the New Science," 489. A statue of Cutler was erected on the outside of the anatomy theatre above an inscription that read 'Omnis Cutleri cedat labor amphitheatro', which was later removed after Cutler's executors insisted that his money was a loan, not a gift, and must be repaid. Ibid., 501., fn. 81.

50 Walter Charleton, *Enquiries into Human Nature, in VI. Anatomic Prælections in the New Theatre of the Royal Colledge of Physicians in London* (London: M. White, 1680), [a1v].

51 Ibid., [B4r].

> only commodiously, but also with delight, exercise all her divine Faculties, to her own felicity, and to the praise and glory of her *Omnipotent Creator*.[52]

The full extent of this quotation is telling. As Booth has noted, many historians of science have mistakenly extrapolated from the first half of this passage to declare Charleton an unwavering supporter of mechanistic philosophy.[53] But while Charleton is undoubtedly interested in mechanism, exploring and explaining its implications though never committing to the full extent of its conclusions, he is equally interested in a metaphor which posits agency in the body, imagining it as both a product of creation and a creator itself. Charleton's lectures, unusually for the time, presented a non-committal synthesis of contemporary anatomical theory; he offered the latest—sometimes conflicting—scientific hypotheses for the judgement of his audience, sometimes combining apparently incompatible philosophies with an 'eclectic acceptance of a range of alternative theories'.[54] His twofold metaphor allows for a similarly ambivalent and yet contiguous stance. For Charleton, the body is not only a machine, but also a great factory (*ergasterium*) or workshop, a productive site under the direction and oversight of a maker, and a place of transformation, where, as in the laboratorical workshops of a range of early modern artisans, chemistry might transmute certain types of substance into others. Charleton finds divinity in the precision, ingenuity and bespoke nature of human anatomy, but he admires not only how it works but also its capacity for creation and life: this is not simply a mechanical automaton, but a site occupied by a creative, feeling soul. And if the body is a workshop for divinity, then the anatomy theatre, as a place where that creation could be dissected and displayed in all its intricate glory, could also be a site of worship.

This notion was echoed in Charleton's response to the fabric of the anatomy theatre. Charleton described the Cutlerian, helpfully fronted with an evocative classical Ionic portico and a spired and domed roof reminiscent of church architecture, as 'a Temple of Natural Theology, where the Perfections of God are studied in the Works of His hands, and His Praises celebrated with Understanding'.[55]

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[52] Ibid., B[1r]-[B1v]; the italics, which primarily highlight key metaphorical figures, are from the original text.
[53] Booth, *Subtle and Mysterious Machine*, 139.
[54] Ibid., 3, 164.
[55] Charleton, *Enquiries*, [a3r]. Walker notes that domed roofs were often used over French chapels, and that Hooke's spire-like conical lantern seems to have been inspired by Sebastiano Serlio's designs for an octagonal church: Walker, "Architecture, Anatomy and the New Science," 490-92. Similar designs had been proposed in England and it was mooted that the steeple of Old St Pauls' should be

Walker has noted that the Cutlerian was conceived as a materially significant symbol of the connection between buildings and scientific endeavour: 'at the time of its completion no other building in London could be said to have better represented the intellectual frontier between architecture and the new science.'[56] Religion, however, could easily be added to make this a triad of interwoven interests. The body, for Charleton, is a site of 'Divine Architecture', displaying 'infinite Wisdom' in its 'design and construction', and the introduction to his lectures hammers home the connection between architecture and anatomy with a blunt exactitude, discussing the 'fabric' and 'structure' of both the body and the building from which he works, and stressing that both the anatomy theatre and the body are sites from which Divine design might be investigated, understood, and witnessed.[57] This was more than just a linguistic comparison: positing practical links between the study of architecture and anatomy, Charleton directs his readers to the works of artists and architects including Dürer, Da Vinci and Vitruvius as well as anatomists like Spigelius and Vesalius if they want to excel in understanding the human body.[58]

As Matthew Walker has noted, during this time, 'the boundary between the sciences and architecture' was 'excessively blurred'; he even goes so far as to stress the 'epistemic entwinement' of the disciplines.[59] In Charleton's vision, architecture and anatomy are conflated as necessary partners within the same discipline; both are required to fully appreciate the majesty of God.

But while the anatomy theatre is a lofty temple for the elevation of the mind and soul, Charleton's discussion of the minutiae of nutrition and digestion reflected a messier, more corporeal reality, all too starkly on show in the live dissection that accompanied his lectures. While the more indecorous aspects of digestion might seem to demand a bathetic deflation of Charleton's grandiose descriptions of the theatre and the body, he registered no such shift, instead returning to the notion of

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replaced with a cupola as early as May 1666, before the Great Fire, in a project Hooke was closely involved with as surveyor and engineer: see Lisa Jardine, "Monuments and Microscopes: Scientific Thinking on a Grand Scale in the Early Royal Society," *Notes and Records of the Royal Society of London* 55, no. 2 (2001).

[56] Walker, "Architecture, Anatomy and the New Science," 476. Walker describes the Cutlerian Theatre as the 'crescendo' of a 'larger story of architectural one-upmanship that took place in the London medical world over the seventeenth century': 475.

[57] Charleton, *Enquiries*, [C1v, C3v]. 'Fabric' was a word that was closely entwined with scientific endeavour for Charleton, as the subtitle of his *Physiologia Epicuro-Gassendo-Charltoniana* implies: *Physiologia Epicuro-Gassendo-Charltoniana, or, a Fabrick of Science Natural, Upon the Hypothesis of Atoms* (London: printed by Tho. Newcomb for Thomas Heath, 1654).

[58] *Enquiries*, [D1v].

[59] Walker, "Architectus Ingenio," 8-9.

the body as a kind of workshop, in which are things are made, combined and crafted. The laboratory, after all, evolved from the *laboratorium* or workshop in both etymological and practical terms. If the body is an architectural fabric, then even its most crudely functional parts could be assimilated within Charleton's analogy. The godly workshop of the human body boasted no unworthy structures, only the products of divine ingenuity, in which the consummate design of Creation was borne out. The digestive system was just such a site of perfect design for Charleton, and this is encapsulated in the ways in which his lectures explicitly imagine the stomach as a kitchen, generously feeding the rest of the body, and as a laboratory, a site of chemical transmutation, discovery, and creation.

Figure 24. Frontispiece from Walter Charleton, *Enquiries into Human Nature in VI Anatomic Prælections in the New Theatre of the Royal Colledge of Physicians in London* (London: Robert Boulter, 1680), BL C.31.i.5.

Charleton's subject for the initial three of his six lectures, all delivered on the first day of a series which took place over the course of a week, was nutrition and the digestive system. Introducing his discussion of the physiological structure and workings of the stomach, Charleton explicitly referred to the stomach as a laboratory:

> let us in the next place convert our contemplation upon the principal Organ of Chylification, wherein, as in a publick Kitchin, nourishment for the whole body is praepar'd, viz. the STOMACH.
>
> This common Receptacle of all our meat and drink, and Laboratory in which all the profitable parts of both are, by the inimitable Chymistry of Nature, converted into a certain whitish liquor somwhat resembling barly cream, and call'd Chyle; hath been by the Antient Graec Physicians describ'd under three divers names.[60]

Charleton's lectures, which seem to have been intended to provide 'overviews to introduce readers to the field' for non-specialist audiences as well as physicians, needed to utilise images that were capable of expressing complex ideas with clarity.[61] The metaphor of the stomach-as-laboratory was clearly employed for this reason.

The premises under which Charleton's metaphor functions are simple, making it a perfect introductory figure for the 'lay' audience, with an interest, but little or no expertise in anatomy or medicine.[62] First, and most importantly, the analogy establishes the kinds of transformation that occur within the stomach as primarily chemical in nature; as we have seen, early modern laboratories were designated as places where chemical processes occur. This was significant because the idea of digestion as a chemical process was still contentious at the time of Charleton's lectures; depicting the stomach as a laboratory from the outset explicitly positions this understanding of digestion within the Paracelsian tradition of reframing bodily processes in terms of chemical change. Processes such as fermentation and distillation, which were thought to take place in the stomach, would have been widely recognisable to a range of practitioners from elite academic scientists to brewers and housewives, and easily intuited through the laboratory

[60] Charleton, *Enquiries*, 33.
[61] Booth, *Subtle and Mysterious Machine*, 48.
[62] Ibid., 50.

trope. Secondly, the laboratory metaphor suggests that the stomach consisted of specialised, well-designed bodily equipment. Charleton was keen to stress that like the alembics, flasks and furnaces that characterised early modern laboratories in the popular imagination, the stomach was formed of well-designed structures, divinely fitted for particular chemical and physiological purposes. Finally, the laboratory, serving as a shorthand for modernity and the transformations of the new science, was a self-reflexive figure suggesting the transformations that digestive science itself was undergoing.

Nevertheless, despite its allusions of modernity and the obvious similarities between processes occurring within laboratories and stomachs, invoking the laboratory as an analogical tool for understanding digestion produces an inherent tension with the traditional narrative of the rise of experimental science. Invoking the very emblem of empiricism—the laboratory—as an explanatory metaphor ironically seems to undermine the story of the Scientific Revolution, in which practitioners, particularly Royal Society members like Charleton, were characterised as turning away from analogy or similitude, and instead promoting plain, 'objective' language, privileging the apparently neutral findings of the laboratory as the keys to a new kind of knowledge.

Charleton's lectures, not least the figure of the stomach-as-laboratory, make a nonsense of any such binary concept of how knowledge worked. Charleton was a noted experimentalist, particularly in the early years of the Royal Society: he performed a number of dissections in an attempt to verify anatomical hypotheses, including one on a boy who had been killed by lightning, performed splenectomies on animals, planned experiments on skin grafts with Robert Boyle, and even risked the wrath of the Society for stealing a precious poison which had been gifted to them in order to test its effects on dogs at his home.[63] But Booth has convincingly argued that the tendency of scholarship to focus on Charleton's experimentalism has led to a skewed understanding of his epistemology which fails to capture the truly eclectic nature of his philosophy, in which analogy and scholarly authority play a major role. Booth argues that the impetus placed by modern scholars on Charleton's own experimental activities is not borne out in his writing, especially in his medical lectures, which have received very little attention, noting that they 'rarely referred to experimental evidence, and far more frequently invoked analogic demonstrations or

[63] Ibid., 120, 18, 25.

rational proofs.'[64] But while Booth is right to stress the importance of analogy for Charleton, and is certainly correct in describing his lectures as more within the scholastic tradition in their reliance on printed sources, whether ancient or contemporary, she neglects to consider how much of Charleton's analogical '*demonstration*', as Booth presciently has it, is infused with experimental tools and images. His analogies are not fundamentally different from experimentation, but rather rely on an understanding of experimental process and equipment. A listener, or reader, needs to understand how processes in the laboratory work in order to understand Charleton's chemical analogies; either through personal practice or by reading accounts (often both) they will themselves have been 'witness', in either a first-hand, literal sense, or in Shapin and Schaffer's famed 'virtual' sense, to the work of experimental equipment and procedures.[65] The 'experimental evidence' that Booth finds lacking is thus an essential and necessary aspect of Charleton's practice, even if it figures (literally) at a remove.

This was true not only of Charleton's work, but physiological science more broadly: Barbara Orland has also argued that despite the development of new 'knowledge tools' (not least experimental tools including the microscope) during the seventeenth century, 'analogies continued to serve as epistemic instruments. Old theories and new insights overlapped, and contemporary knowledge assimilated past ideas.'[66] She stresses that 'the choice of new knowledge tools continued to leave space for older ways of reasoning.'[67] But where Booth is astute to highlight the 'powerful explanatory role' of analogy in Charleton's philosophy, her suggestion that Charleton's examined hypotheses 'through rational and analogic rather than experimental criteria' fails to fully consider the importance of analogic demonstrations, which rely on those very instruments and spaces of experimentation to function: these figures, such as the stomach-laboratory, provide a kind of hybrid knowledge for Charleton in which both experimentation and analogy are distilled into a single form of understanding.[68]

The metaphor of the stomach-as-laboratory illustrates how empirical and analogical modes of understanding the world could not only co-exist, but also

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[64] Ibid., 133.
[65] On virtual witnessing, see: Shapin and Schaffer, *Leviathan and the Air-Pump,* 60-65.
[66] Barbara Orland, "The Fluid Mechanics of Nutrition: Herman Boerhaave's Synthesis of Seventeenth-Century Circulation Physiology," *Studies in History and Philosophy of Biological and Biomedical Sciences* 43 (2012): abstract.
[67] Ibid., 358.
[68] Booth, *Subtle and Mysterious Machine*, 33, 75.

commingle, enabling natural philosophers not only to comprehend observations from their own laboratories, but also to understand the workings of imagined laboratory-like spaces such as stomachs. The ability to project actual laboratory findings or processes onto the stomach in order to understand its inner workings, and to apply insights gleaned from observations of the stomach in laboratory work made this a circular and productive way of comprehending a range of natural and artificial processes. Charleton's is an instructive example of how the metaphor of the stomach-laboratory worked in the later-seventeenth century. Using language typical of the trope, this particular instance indicates how the metaphor functioned, while the context in which it was delivered gestures towards the wide and public dispersal of the idea, suggesting its broad efficacy as an explanatory concept. Situating the metaphor in its particular physical and verbal surroundings, further illustrates how, viewed *in situ*, the communicative power of Charleton's trope was heightened.

The Kitchen Laboratory

Charleton's metaphor illuminates another important truth about the nature of seventeenth-century laboratories. Despite Charleton's careful use of illustrative analogy, his description of the stomach initially seems to point in two separate directions. In the same instance he describes the stomach as a laboratory, he also declares the stomach 'a publick Kitchin, [where] nourishment for the whole body is praepar'd'.[69] As the overlapping of the metaphors (including the reference to 'barly cream' produced by the laboratory) indicates, this is not a poetic amplitude of figures. Charleton's doubled-over image, which identifies the stomach as both kitchen *and* laboratory, may seem confused to modern readers but instead reflects the realities of the more ambiguous and versatile locations of seventeenth-century science that have already been discussed.

Charleton had used and adapted metaphors of equipment that are simultaneously domestic and experimental tools in a number of his works, arguing, for example, that chyle was transmitted to the venae lactae by 'percolation' through the stomach's parenchyma as if through a 'streiner', and using bellows to explain the

[69] Charleton, *Enquiries*, 33.

process of respiration in the lungs.[70] Similar metaphors could also be pointedly self-reflexive for Charleton, for example when he imagines his work as a 'distillation of the essence from consulted texts', passing through 'the Alembic of our Pen'.[71] While Charleton's metaphors of equipment could be physiologically demonstrative, they could also illuminate his own hybrid epistemology. Wall has illustrated the crossover appeal of processes such as distillation, explaining that alchemy and distillation shared both aims and explanatory rhetoric: '[d]omestic distillation shared with alchemy the translation of solids into liquid and vaporous forms through alternate heating and cooling, often using alcohol as the medium for achieving this action. The goal was the separation of the essence from waste matter, often figured as a corporeal residue.'[72] Distillation, figured as a separation of nutritious, spirituous liquids from waste matter, was clearly a process that was understood as analogous to digestion whether it occurred in the kitchen or the laboratory, once more illustrating the harmonious understanding between the two spaces that underlay Charleton's metaphor.

It seems likely that the conflation of kitchen, laboratory and workshop would have seemed perfectly natural and palatable to Charleton's audience, who would have been familiar with such multifunctional, less rigidly defined spaces. His metaphor mapped common chemical procedures such as fermentation and distillation, which were closely associated not only with laboratories and experimentation but also with kitchens and food preparation, directly onto the processes that occur in the stomach during digestion. Though the demographic of the audience for Charleton's lectures, some of the most prestigious in London's calendar, was undoubtedly narrow—likely restricted to upper- and middle-class, educated men involved in the web of scientific networks that populated London—they were at least extra-collegiate, open to a 'lay' audience with little expertise or knowledge of anatomy or medicine.[73] Written in the vernacular, Booth notes that Charleton's printed medical lectures 'seem to be far more diverse in their expected

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[70] Ibid., 139-140; Walter Charleton, *Natural History of Nutrition, Life, and Voluntary Motion Containing All the New Discoveries of Anatomist's and Most Probable Opinions of Physicians, Concerning the Oeconomie of Human Nature* (London: printed for Henry Herringman, 1659), 111, 130-135, 139. Charleton refers to the 'streiner' of the parenchyma six times in three paragraphs, apparently borrowing the figure from Jean Pecquet's *Dissertatio Anatomicæ* (1654), while the bellows metaphor is reworked from Aristotle. See Booth, *Subtle and Mysterious Machine*, 53, 98.
[71] Walter Charleton, *The Darknes of Atheism Dispelled by the Light of Nature a Physico-Theologicall Treatise* (London: printed by J.F. for William Lee, 1652), c[1r].
[72] Wall, "Distillation," 91.
[73] Booth, *Subtle and Mysterious Machine*, 50.

readers' than other Latin medical texts, and 'address[…] a mixture of relatively unlearned and highly learned individuals'.[74] They also circulated widely in print.[75] Charleton's lectures encompass the idea of the stomach in figurative terms that those new to the subject or excluded from his lectures (women, the working classes, and those outside of London) might understand, even if his subsequent, more detailed explication of the intricacies of digestion is more exclusive, with its recourse to Latinate anatomical terms and reference to the work of other physicians.[76]

Charleton's metaphors were perhaps one of the many attempts being made to make medical knowledge more universally accessible. As Barbara Orland and E.C. Spary have noted, the range of people interested, invested in and investigating digestion and digestive health in the seventeenth century was broad, and growing. They argue that from 1650 onward, 'physicians no longer ruled unchallenged. Other groups—anatomists, chemists, pharmacists, physiologists, grocers, cooks, distillers, and consumers—were entering the debate over the fundamental nature of food and the mechanism by which it entered the body to integrate itself into the latter's fabric.'[77] As Elizabeth Spiller has shown, recipe books full of medicinal remedies and Paracelsian practices were addressed chiefly to women, and Nicholas Culpeper's translation of the *London Dispensatory* (the *Pharmacopoea Londinensis*) into the vernacular seems to have had the aim of spreading such knowledge for general use, particularly among women, who most often took responsibility for the health of the

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[74] Ibid., 50, 144. On anatomical lectures and dissections in early modern England, see Cunningham, "Kinds of Anatomy." Walker notes that at least some of the College's lectures were open to non-members, attracting figures including Hooke and John Evelyn, but that it was 'unclear exactly who could attend the Gulstonian lectures': Walker, "Architecture, Anatomy and the New Science," 488; "Architectus Ingenio," 214. There is debate over precisely how open these occasions were: Walker suggests they were 'not "public"' in the manner of continental anatomies, but likely invitation-only events, whereas Robert G. Frank describes the seventeenth-century Lumleian and Gulstonian lectures as 'public occasions' for the College; cf. Walker, "Architectus Ingenio," 220; Robert G. Frank, "Viewing the Body: Reframing Man and Disease in Commonwealth and Restoration England," in *The Restoration Mind*, ed. W. Gerald Marshall (Newark: University of Delaware Press, 1997), 89.

[75] The ESTC indicates a large number of surviving copies of the printed text of Charleton's lectures, *Enquiries into Human Nature* (1680) still extant in institutional libraries across Europe and the Americas, suggesting a large initial print run, with a second edition printed in 1697, suggesting that two decades after Charleton gave his lectures they were still considered useful texts on the anatomy of the digestive system.

[76] While documentary evidence of middle-class women reading books by authors like Charleton is limited (as is most evidence of non-elite women's reading in this period), elite women were reading his works, and the relationship between Margaret Cavendish and Walter Charleton has been well-documented: see L.E. Semler, "The Magnetic Attraction of Margaret Cavendish and Walter Charleton," in *Early Modern Englishwomen Testing Ideas*, ed. Jo Wallwork and Paul Salzman (Farnham: Ashgate, 2011).

[77] Barbara and E.C. Spary Orland, "Introduction to Assimilating Knowledge–Food and Nutrition in Early Modern Physiologies," *Studies in History and Philosophy of Biological and Biomedical Sciences* 43, no. 2 (2012): 320.

household.[78] Digestive health was an issue for everyone, and '[b]y the early modern period readers could acquire the dietetic knowledge which they applied to themselves, from cookbooks and encyclopædias to medical treatises and lectures, from servants and relations to manuscript family receipt books or newspapers'.[79] A number of the recipe books which gained popularity in the mid-seventeenth century positioned themselves in the amorphous space of the still-house, which was part-closet, part-kitchen, and part-laboratory.

Indeed, the universality of digestion as a process, and of the metaphors used to describe it, may have been brought home in more than one way for Charleton's listeners: with the first three lectures, all discussing the workings of the stomach, given on a single day, Booth has suggested that '[t[he audience had an intermission for a meal between the dissection of the stomach and gullet and the explanation of the action and use of the stomach!'[80] Whether or not that meal was served up by the 'publick Kitchin' of the Physicians' College, it is not difficult to imagine how Charleton's metaphor, stacked up alongside his physical demonstrations, might have taken effect during this lunch break.[81] Social dining seems to have been a common accompaniment to anatomical lectures, but must have provided particular food for thought on this occasion.[82] The viscerality of such dissection-led lectures can sometimes be sidelined, but the sensorial attributes were likely striking; Andrew Cunningham has noted that a medieval order of dissection, popularly followed during early modern whole-body dissections, involved tackling the belly first, according to 'the practical sequence of the order of corruption'.[83] Examining the 'publick Kitchin' of a dead man's stomach shortly before being served food from an

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[78] Spiller, "Printed Recipe Books," 520; and "Recipes for Knowledge."
[79] Orland, "Introduction, Assimilating Knowledge," 318.
[80] Booth, *Subtle and Mysterious Machine*, 227. The Royal College of Physicians were allotted the corpses of four convicts a year for dissection. There is some uncertainty as to whether a dissection did take place during Charleton's Gulstonian lectures; Cunningham suggests it was 'unlikely that dissection took place', while Booth has made a compelling case based on textual analysis and the order and timing of the lectures that the first three of Charleton's lectures, given on the same day, accompanied a dissection. As the opening of the anatomy theatre was a particularly prestigious occasion it seems probable that a body was secured so that the architectural innovations of Hooke's theatre could be demonstrated. Cf. Cunningham, "Kinds of Anatomy," 19 fn. 94; *The Anatomist Anatomis'd: An Experimental Disciple in Enlightenment Europe* (Farnham: Ashgate, 2010), 30; Booth, *Subtle and Mysterious Machine*, 137, 50 fn. 54, 227.
[81] Kitchens were built as part of the College's redesign: Walker, "Architectus Ingenio," 210.
[82] Walker notes the seemingly common provision of food at such events, citing diary accounts of anatomy lectures from this period which casually mention dining arrangements, displaying what has often been seen as 'the surprising social normativity of the occasion', ibid., 215-16; Cunningham records that a 'ceremonial dinner' was held after the annual dissections at the Barber-Surgeons' Hall, "Kinds of Anatomy," 11.
[83] Cunningham, "Kinds of Anatomy," 5.

actual public kitchen to supply your own would likely merit a particularly introspective and vivid reflection on the ways in which the stomach provided nutrition for the rest of the body.

And yet, Charleton's doubled-up images, which relish the notion of the stomach as *both* a chemical laboratory, able to transform and 'convert' an array of substances into the uniform substance of chyle, but also of the stomach as a 'publick Kitchin', a site of hospitality, warmth and nutrition, reveal not just the multiple and ambivalent states of the seventeenth-century laboratory-kitchen, but also reveal a great deal about the state of the digestive debate at this moment in the history of science, and about Charleton's position within it. His use of the laboratory-kitchen metaphor, perhaps one of the more obvious culminations of the association between anatomy and scientific sites, while significant in terms of its public-facing authority, was not original. Describing the stomach as a laboratory had become common during the advent of the Royal Society, as debates about digestion began to hot up among English philosophers, and Charleton, as he had done so often elsewhere, likely lifted the idea from his wide reading.

Digestive Metaphors: A Potted History

As any student of renaissance literature knows, a whole host of metaphors were used to describe the body in the early modern era.[84] Analogy had long been a powerful epistemological tool, providing the means for conceptualising how (and why) one thing—like, in whatever sense, to another thing—might work. But why was it that Charleton picked *this* metaphor—of the stomach as both a laboratory and a kitchen—to explain digestion in later seventeenth-century England?

The print history of the trope provides some clues. The laboratory was increasingly used as a metaphorical figure by the 1650s and 1660s. Just as the 'cabinet of nature' was beginning to dwindle in English printed texts, the use of the metaphorical laboratory began to increase in frequency. The 'laboratory of nature' became an increasingly common phrase, perhaps reflecting the shifting realities of philosophical and scientific space during this time, as the experimental method

[84] On the body in renaissance literature, see for example, Jonathan Sawday, *The Body Emblazoned: Dissection and the Human Body in Renaissance Culture* (London: Routledge, 1995).

secured its stronghold on early modern science and increasingly specialised resources were deployed in order to test theories about the laws of nature. But it was in relation to the stomach that the metaphorical laboratory seems to have become most widely used, and its link with the kitchen seemed equally secure as the metaphor was redigested through a number of texts.

In part, this was because the notion of the laboratory-kitchen was uniquely suited to the purpose that Orland ascribes to analogy: it had a physical, philosophical and literary heritage that was exceptionally well-suited to assimilating old theories into new models of digestion. While the laboratory-kitchen was an apposite figure for theories of digestion in the later-seventeenth-century, the evolution of the stomach-as-laboratory image can be traced right back to the ancients. From the earliest documented understandings of digestion, it has been common to compare the work of the digestive system to cooking. As Justin E.H. Smith has shown, the process of nutrition, understood as assimilating food matter into the human body, 'has been conceived on the model of cooking'.[85] The two processes were perceived to be so interlinked that digestion was even posited as the model for the development of essential cooking processes; William Newman has noted that Seneca reported (with characteristic scepticism) a theory that 'bread was discovered when a philosopher decided to imitate the workings of the teeth, throat, and stomach': the teeth being like the mill for the grain; the saliva from the throat like water in the mixing of dough, and the oven cooking the bread like a stomach.[86] Ancient medicine had firmly cemented this analogy between digestion and cooking. As Mark Grant has noted, Hippocratic medicine theorised that '[t]he innate heat of the body cooked foods[…] the more foods had been processed and cooked in the kitchen, the more easily they could be digested in the body.'[87] Galen himself had influentially imagined digestion as a kind of cooking, a meaning encapsulated by *pepsis,* describing the heat of the stomach as the essential element of the digestive process, which was increased by the 'adjacent viscera' of the digestive system, 'like a lot of burning hearths around a great cauldron'.[88]

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[85] Justin E.H. Smith, "Diet, Embodiment, and Virtue in the Mechanical Philosophy," *Studies in History and Philosophy of Biological and Biomedical Sciences* 43 (2012): 338.
[86] William R. Newman, *Promethean Ambitions: Alchemy and the Quest to Perfect Nature* (Chicago: University of Chicago Press, 2004), 15.
[87] Mark Grant, "Introduction," in *Galen on Food and Diet* (London: Routledge, 2000), 7.
[88] Galen, *On the Natural Faculties*, trans. A.J. Brock, vol. 71, Loeb Classical Library (Cambridge: Harvard University Press, 1916), III.vii.255.; on the history of digestive vocabulary, see Raffaele Passarella, "The Vocabulary of Digestion in Latin Medical Texts," in *Body, Disease and Treatment in a*

Unsurprisingly, the prevalence of Galenic theory provoked a continuation of the trope of digestion as cooking in anatomical texts of the early middle ages. In the twelfth century, the physician and scholar Nicholas of Salerno (also known as Magister Nicolaus or Master Nicholas, fl. c. 1150) directly drew on Galen's own imagery to describe the digestive organs as a kitchen: the stomach, he writes, 'has the liver below it like a fire underneath a caldron [sic]; and thus the stomach is like a kettle of food, the gall-bladder is the cook, and the liver is the fire.'[89] Nicholas' account of the Galenic anatomy is deeply attentive to language, paying particular attention to the etymological origins of anatomical terms. He uses a wide range of spatial metaphors, exploring the links between architectural analogy and anatomical nomenclature and function.[90] There is careful consideration behind Nicholas's metaphorical terminologies. His kitchen metaphor is not a single-use figure, but a continuing semantic field, using kitchen implements as illustrative paradigms for specific parts of the digestive system, and even remarking on the intrinsic similarities and shared linguistic roots of colons and colanders: '[t]he colon is called "colander" because the feces are strained there', he states.[91] While spatial metaphors are by no means the only kinds of figurative language used in a descriptive sense by Nicholas, perhaps unsurprisingly, given the associations between stomachs, food and eating and the popular Galenic notion of the stomach as a site powered by heat, he emphasises the connections between digestive systems and kitchens. Even his depiction of the mouth as 'working in the manner of a mill[…]; in the same way that the grain is cast by the hand of the miller under the grindstones (molares) to be ground, so is food cast by the tongue beneath the molar teeth to be masticated', echoing the story reported by Seneca, cements the comparison between the domestic work of food preparation and the work of the digestive system.[92]

The Galenic model of digestion espoused by Nicholas was intimately linked with humoral theory, in which, as the metaphors of stoves and strainers indicate, heat and mechanics were key. According to Galenic theory, digestion worked in the

Changing World: Latin Texts and Contexts in Ancient and Medieval Medicine, ed. David and Brigitte Maire Langslow (Lausanne: Éditions BHMS, 2010).

[89] Master Nicolaus, "Anatomia Magistri Nicolai Physici," in *Anatomical Texts of the Earlier Middle Ages*, ed. and trans. George W. Corner (Washington: Carnegie Institute, 1927), 79.

[90] For example, Nicholas notes that the vulva is named 'from volo vis, or from volvendo, or from valva, which is a door, for it is the portal of the uterus,' and his metaphors frequently draw on spaces or architectural features of the elite domestic home or residential institutions such as monasteries or colleges: ibid., 85.

[91] Ibid., 80.

[92] Ibid., 78.

same way as cooking: food would be broken down, pummelled, heated and sieved into its nutritive and waste parts, aided by a variety of environments within the digestive organs, from the dry and cold surface of the inner stomach, which helped to concentrate nutrients, to the warm and moist lower orifice of the stomach, which aided the absorption of nutrients. However, as the work of Paracelsus and his followers began to overturn the Galenic views that had dominated medical teaching for centuries, ways of depicting and understanding the digestive system began to subtly shift. By the early sixteenth century, Paracelsus was moving out of the metaphorical kitchen and into the laboratory, promoting the practice of chemical medicine. If the cauldrons and kitchens of the Galenic body seem to be curiously without a cook, Paracelsus places the alchemist squarely at the heart of his philosophy, ascribing vital bodily functions, including nutrition and growth, to a spirit substance called the 'Archeus', which is located in the stomach. This 'internal alchemist' separates the nutritious parts of food from the harmful ones in the process of digestion, conceiving, for the first time, of digestion as an essentially chemical process:[93]

> When thus the food reaches the stomach, the alchemist is ready and eliminates that which is not conducive to the well-being of the body. This the alchemist conveys to a special place, and the good to where it belongs. This is as the Creator ordained it. In this manner the body is taken care of so that no harm will befall it from the poison which it takes in by eating, the poison being eliminated from the body by the alchemist without man's co-operation. Of such a nature are the virtue and power of the alchemist in man.[94]

The kinds of workshop that Paracelsus himself used were clearly identifiable as 'laboratories', even when that terminology, in English at least, was not available to describe them. Likewise, the analogy of the stomach-as-laboratory preceded direct usage of the word in English but was still compelling and clear; with Paracelsus explicitly figuring the Archeus as alchemist, the digestive system is clearly his laboratory. [95]

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[93] Antonio Clericuzio, "Chemical and Mechanical Theories of Digestion in Early Modern Medicine," *Studies in History and Philosophy of Biological and Biomedical Sciences* 43, no. 2 (2012): 330-31.
[94] Paracelsus, *Volumen Medicinae Paramirum*, trans. K.F. Leidecker (Baltimore: The John Hopkins University Press, 1949), 29.
[95] As Principe and Newman have illustrated, even at the beginning of the eighteenth century alchemy and chemistry were rarely, if ever, distinguished from one another, with the words, and their cognates 'used largely interchangeably' in Western languages. William R. Newmanand Lawrence M. Principe, "Alchemy vs. Chemistry: The Etymological Origins of a Historiographical Mistake," *Early Science and Medicine* 3, no. 1 (1998): 32. See also: Principe, "Alchemy Restored," 306.

But the Paracelsian reimagining of the stomach as a laboratory was an evolution of, rather than a clean-cut departure from, earlier kitchen models for digestion. The imprecise transformation of the ancient kitchen metaphor into a laboratory metaphor is evident in Paracelsus' description. Still concerned with food and poisons, he observes that the metaphorical alchemist ('der Alchimist'), in the translation by K.F. Leidecker, 'resides in the stomach, which is his instrument wherein he boils and labors'.[96] The original German emphasises the links between the work of the kitchen and the laboratory even more forcefully: 'darin er kocht und arbeitet' can even more straightforwardly be translated as 'wherein he *cooks* and works'—the verb *kochen* functions in both, interrelated, senses of cooking and boiling.[97] Cooking and boiling, working and labouring are all activities which are interchangeable in the realm of the kitchen-laboratory.

Nouvelle Cuisine: Modernising Digestive Science

The multiple meanings of these linguistic dualities reflect the material and functional overlaps we have already identified between the kitchen and the laboratory and are deeply embedded in the heritage of the stomach-kitchen-laboratory metaphor, as well as its relevance. But while the metaphorical depiction of the stomach offered some continuity, playing on the connection between laboratories and kitchens, it also reflected the shifting theories of contemporary digestive science.

The development of sixteenth- and seventeenth-century chemical and anatomical sciences had provoked a reassessment of how the body functioned. The Cartesian mechanistic philosophy began to recalibrate ideas about how the body worked, comparing it to an engine or a machine, and explaining its functions with recourse to matter, motion, and mechanical law. But around the same time as mechanistic philosophy was taking hold, a Paracelsian renaissance was also taking place in England, with iatrochemists stressing the importance of understanding the workings of the body in terms of chemical reactions, offering a new set of solutions for the treatment of digestive, as well as other illnesses.[98] Two major anatomical

[96] Paracelsus, *Volumen Medicinae Paramirum*, 29.
[97] Paracelsus, *Volumen Paramirum Und Opus Paramirum* (Jena: Eugen Diederichs, 1904), 34; alternative translation my own.
[98] Antonio Clericuzio, "The Internal Laboratory: The Chemical Reinterpretation of Medical Spirits in England (1650-1680)," in *Alchemy and Chemistry in the Sixteenth and Seventeenth Centuries*, eds. Piyo

discoveries, William Harvey's theory of the circulation of the blood and Gaspar Aselli's discovery of the lacteal veins, the lymphatic capillaries that absorb fats in the small intestines, also helped to transform the landscape of digestive science.[99]

As theories about the precise workings of the digestive system evolved, they not only responded to new physiological models but also became instructive in how such models developed—and many philosophers of digestion, including Charleton, quickly began to develop a physiological model that combined these chemical and mechanistic understandings of the body. As Antonio Clericuzio has deftly illustrated, there was much more overlap between iatromechanistic and iatrochemical approaches in the seventeenth century than has previously been appreciated; he argues that, especially among English physiologists, 'the prevailing tendency was to combine mechanical and chemical theories.'[100] Even Descartes, the figurehead for mechanist philosophers, acknowledged the importance of chemical reactions within the digestive process, theorising that in addition to mechanics, the actions of digestive liquors could only be explained with recourse to two chemical reactions: the reaction of quicklime with water to release heat and the action of *aqua fortis* (a solution of nitric acid) in dissolving metals.[101] Likewise, iatrochemists in the Paracelsian and Helmontian tradition paid close attention to the importance of the various mechanical actions of digestion, from the grinding of the food by teeth, to the circulation of nutritive substances through the vascular system.

This more accommodating model of digestion, in which chemical and mechanistic models worked cooperatively, seems to have in turn helped to influence how human physiology more broadly was conceived. This is reflected in the metaphorical register of Boyle, when he wrote:

> I look not on a Human Body, as on a Watch or a Hand-mill, *i.e.*, as a Machine made up only of Solid, or at least Consistent, Parts; but as an Hydraulical, or

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Rattansi and Antonio Clericuzio (Dordrecht: Springer, 1994), 51. On Paracelsianism in recipe books, see Spiller, "Recipes for Knowledge"; on the English revival of Paracelsian theory, see Allen G. Debus, *The English Paracelsians* (London: Oldbourne, 1965). Iatrochemistry specifically denoted the medical domain of chymistry—the prefix, *iatros*, comes from the Greek for physician: Newman, "Alchemy vs. Chemistry," 42.

[99] The *vena lacteæ* correspond to the modern lacteal veins and were perceived to carry 'chyle'—the milky white fluid produced by the action of pancreatic juice on the chyme. See: Thomas Gibson, *The Anatomy of Humane Bodies Epitomized* (London: printed by T. W. for Awnsham and John Churchill, 1697), 71-73; Barbara Orland, "Why Could Early Modern Men Lactate? Gender Identity and Metabolic Narrations in Humoral Medicine," in *Medieval and Renaissance Lactations: Images, Rhetorics, Practices*, ed. Jutta Gisela Sperling (Abingdon: Routledge, 2016), 50.

[100] Clericuzio, "Chemical and Mechanical Digestion," 334.

[101] Ibid., 333.

> rather Hydraulo-pneumatical Engine, that consists not only of Solid, and Stable parts; but of Fluids, and those in Organical Motion. And not only so, but I consider that these Fluids, and the Liquors and Spirits, are in a living Man so constituted, that in certain Circumstances the Liquors are dispos'd to be put into a Fermentation or Commotion, whereby either some Depuration of Themselves, or some Discharge of hurtful Matter by Excretion, or both, are produc'd, so as, for the most part, to conduce to the Recovery or Welfare of the Body.[102]

Part machine subject to the laws of motion, part chemical apparatus, Boyle's view expressed an increasingly common viewpoint among mid-century English philosophers: though the body's actions were partly governed by physical phenomena, they were equally governed by chemical phenomena, with vital anatomical processes often occurring, at least in part, as a result of the chemical *and* material transformations of substances within the body. As attested by Boyle's adjustment of the classic mechanistic metaphor, according to this model the human body is understood not simply as a piece of clockwork, a plain 'machine', but something also in possession of a transmutative power; it is not just an engine, but a 'hydraulo-pneumatical' one, subject to the actions of spirits, ferments and distillations.

Boyle's conception of digestion was similarly nuanced, and 'put special emphasis on fermentation as the key to the understanding of human physiology and, notably, of digestion'.[103] Nevertheless, his account of the process in *The Usefulnesse of Experimental Philosophy* (1663) shows an understanding of the diverse forces at work within the digestive system, describing digestion as a primarily (though not, as Clericuzio suggests, a 'purely') chemical process:

> it seems a mistake to imagine (how many soever do so) that Heat must needs be the Efficient of all the changes the matter of our Aliments may happen to undergoe in a humane body: where there are Streiners, and Solvents, and new Mixtions, and perhaps Ferments, and diverse other powerfull Agents, which by successively working upon the assumed matter, may so fashion and qualifie it, as, in some cases, to bring the more disposed part of it to be not unlike even fossile Salts or other mineral substances.[104]

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[102] Robert Boyle, *A Free Enquiry Into the Vulgarly Receiv'd Notion of Nature; Made in an Essay, Address'd to a Friend* (1686) in *The Works of Robert Boyle*, vol. 10 (2000), 540. This passage is also discussed by Clericuzio in "Chemical and Mechanical Digestion," 334; and "Mechanism and Chemical Medicine in Seventeenth-Century England: Boyle's Investigation of Ferments and Fermentation," in *Early Modern Medicine and Natural Philosophy*, ed. B. Goldberg. P. Distelzweig, and E. Ragland, (Dordrecht: Springer, 2016), 274-5; and by Orland in "Fluid Mechanics of Nutrition," 365.
[103] Clericuzio, "Chemical and Mechanical Digestion," 335.
[104] Robert Boyle, *Some Considerations touching the Usefulnesse of Experimentall Naturall Philosophy, The Second Part* in *The Works of Robert Boyle*, vol. 3 (1999), 319.

Using terms that—like Charleton's more explicit metaphor—are clearly redolent of the laboratory (the 'solvents', 'ferments' and 'mixtions') and the kitchen (the 'streiners' and 'ferments' again), Boyle's words indicate the varied myriad of ways that seventeenth-century philosophers thought digestion occurred.

English physiologists were particularly influenced by the work of Jan Baptiste van Helmont, whose *Ortus Medicinae* (1648) has been described by Clericuzio as a 'turning point in the development of iatrochemistry'.[105] Van Helmont, whose work was translated into English by Charleton, had rejected the Galenic view that digestion was actively caused by heat, instead ascribing it chiefly to an acid ferment in the stomach, which he designated just one of six stages in digestion, each of which required a specific form of fermentation.[106] But while some common principles emerged among philosophers investigating digestion during the latter half of the seventeenth century—most, for example, were agreed that some form of fermentation occurred within the stomach, transmuting food into chyme and then chyle, a milky-white substance that was eventually incorporated into the blood, and separating these nutritious substances out from the waste to be excreted—there was still substantial scope for differences of opinion. The specifics of the process were disputed, from the precise route digested material took through the body, to the validity of acid-alkali theories and differing understandings of what, precisely, a ferment *was*.[107]

As the seventeenth-century understanding of digestion became clearer, its obvious affinity with the laboratory became self-evident. The processes that occur in

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105 Clericuzio, "Chemical and Mechanical Digestion," 332: Pietro Castelli and Joannes Walaeus had already suggested that digestion might be caused by fermentation before this, with Castelli arguing that 'if heat were responsible for the alteration of food into chyle, then one should be able to duplicate the process of digestion in a cooking pot, yet hitherto, nobody had ever been able to produce chyle by these means.'

106 In 1650, Charleton translated three Helmontian tracts which were printed under the title *The Ternary of Paradoxes* and a text by van Helmont which drew lengthy attention to stomach complaints and the role of medicine in treating them, *Deliramenta Catarrhi*. See: *A Ternary of Paradoxes: The Magnetick Cure of Wounds, Nativity of Tartar in Wine, Image of God in Man. Written Originally by Joh. Bapt. Van Helmont, and Translated, Illustrated, and Ampliated by Walter Charleton, Doctor in Physick, and Physician to the Late King.* (London: printed by James Flesher for William Lee, 1650); and *Deliramenta Catarrhi: Or, the Incongruities, Impossibilities, and Absurdities Couched under the Vulgar Opinion of Defluxions. The Author, That Great Philosopher, by Fire, Joh. Bapt. Van Helmont, &c. The Translator and Paraphrast Dr. Charleton, Physician to the Late King* (London: printed by E.G. for William Lee, 1650).

107 van Helmont, for example, understand ferments as 'psycho-physical agents' which 'dispose matter to receive the idea, or the first shape of individual objects', according to a divine plan; other accounts described ferments in 'chemical and corpuscular terms': Clericuzio, "Mechanism and Chemical Medicine," 280-282; on the acid-alkali theory, see: Orland, "Fluid Mechanics," 365.

the stomach, within the process of digestion, map directly onto the kinds of process that were being instigated and investigated by the practitioners of the early modern chemical laboratory or stillhouse: fermenting, acid dissolution, volatilisation, and transmutation of more or less specific kinds are all staples of the early modern experimental—and often alchemical—toolbox. It is both this shared theoretical and material heritage that makes the stomach so easily both the kitchen *and* laboratory that Charleton imagines. The kitchen not only gestures to the nutritive functions of digestion but, like the laboratory, can also provide physical and process-based analogues for the digestive system. Both spaces work together within a combined figurative architecture, in part because they were so frequently coalesced in the seventeenth-century home. But perhaps most importantly, the coexistence of kitchen and laboratory within this metaphor offered a temporal trajectory, charting a course through different models of thought in order to reach a figure which could encapsulate the complexities of digestive science as a process and a historical construct.

Regurgitating the Stomach Laboratory

Charleton, as we have already mentioned, was not the only person to seize on the illustrative qualities of the laboratory metaphor when describing digestion. The stomach-as-laboratory analogy was clearly considered an effective mode of communicating vital information about the digestive process by many of his contemporaries, who regurgitated it in a number of educational and didactic texts. Tracing the laboratory metaphor through the work of Everard Maynwaring, another physician and a proponent of chemical medicine, offers some sense of the proliferation of the trope, its cultural relevance, and its apparent well-suitedness for its subject. During a lengthy discussion of digestion in his 1665 treatise on scurvy, the connections between the stomach and the laboratory are made clear:

> Meat being received into the stomack, must suffer a transmutation there in the first laboratory and preparatory Office, for nutrition of the body: The principal agent in this work, is the stomachical ferment; this ferment by its incisive acidity penetrates, rarefies & volatiseth the food, and transmutes it into Chyle, or white juce: That which before was fixed, gross, hard or tough, is made Volatile, rare and fluid, which having obtained that praevious

> digestion and perfection proper for that place, the lower orifice of the stomack opens and gives it emission, sending it to the next Office of digestion for a new impression.[108]

Maynwaring repeated this analogy numerous times in several works over the next quarter of a century. Re-using his own phrasing, he refers to the stomach as 'the great Office and Laboratory to prepare Aliment to supply and maintain the whole Body' in a work of 1679 discussing sicknesses of the stomach, and calls the stomach 'this Laboratory and prime office of digestion' when describing the dangers of excessive alcohol consumption in *Vita Sana & Longa* (1669), and the updated editions of the same work printed in 1683 and 1687.[109] The number of editions of this text alone, which was marketed as a general guide to health and longevity, indicate the substantial readership that must have encountered Maynwaring's metaphor, but his writings were also repeated in a number of other texts. His comments on alcohol, including the reference to the stomach as 'Laboratory and prime office of digestion', were reprinted in John Hancock's compilations of writing about tobacco and other similarly addictive substances, *Two Broad-Sides Against Tobacco* (1672), and the neatly repackaged, almost identical work *The Touchstone, or Trial of Tobacco* (1676), as well as Samuel Ward's *A Warning-piece to All Drunkards and Health-drinkers* (1682).[110] Sections from the third impression of Maynwaring's work on scurvy in which tobacco is described as 'noxious to the Stomach (the first grand Laboratory of the Body)' were also reprinted in *Broadsides* and *Touchstone.*[111] The reprinting of these passages in such popular compilations gives some sense of how useful the stomach-as-laboratory metaphor was considered as an explanatory device, not only for elite scholars of anatomy, but also for less educated audiences, and how quickly the trope became a commonplace for English science writers, likely becoming familiar to a readership from a range of occupations and social classes.

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[108] Everard Maynwaring, *Morbus Polyrhizos Et Polymorphæus: A Treatise of the Scurvy* (London: R.D., 1665), 18-19.
[109] Maynwaring, *The Frequent, but Unsuspected Progress of Pains, Inflammations, Tumors, Apostems, Ulcers, Cancers, Gangrenes, and Mortifications, Internal.* (London: J.M., 1679), 85; *Vita Sana & Longa: The Preservation of Health and Prolongation of Life Proposed and Proved* (London: J.D., 1669), 80; *The Method and Means of Enjoying Health, Vigour, and Long Life* (London: J.M. for Dorman Newman, 1683), 132; *The Method and Means of Enjoying Health, Vigour, and Long Life.* (London: J.M., 1687), 132.
[110] *Two Broad-Sides against Tobacco* (London: John Hancock, 1672), 25; *The Touchstone, or Trial of Tobacco, Whether It Be Good for All Constitutions* (London: John Hancok, 1676), 25; Samuel Ward, *A Warning-Piece to All Drunkards and Health-Drinkers Faithfully Collected from the Works of English and Foreign Learned Authors of Good Esteem* (London: 1682), 71.
[111] Everard Maynwaring, *Morbus Polyrhizos & Polymorphaeus* (London: H. Eversden, 1669), 73; *Two Broadsides against Tobacco*, 14; Hancock, *Trial of Tobacco*, 14.

While Maynwaring's proliferative analogy may seem a simple one, its importance extended beyond simplifying a complicated structure for the comprehension of a wide readership. Maynwaring and Charleton's analogies also offered a distinct take on their medical ideologies, bolstering their position in a fiercely raging contemporary debate. Both Maynwaring and Charleton were strongly allied with the iatrochemical schools of thought that blossomed in the mid-seventeenth-century in England. Their adoption of the laboratory metaphor indicates their support for chemical medicine, signalling their position within contemporary debates around medicine and digestion, and signposting not only an adherence to a Paracelsian viewpoint that conceived of the body's most important functions as essentially chemical in nature, but also a promulgation of the importance of experimental practice in understanding the world around us.

Maynwaring, a controversial figure in the medical establishment, was a prominent follower of the Helmontian theory and a keen champion of chemical medicine—also known as iatrochemistry—who maintained a strong belief in the importance of physicians developing practical chemical skills and experimental experience of their own.[112] A supporter of the Society of Chemical Physicians, he authored polemics against apothecaries and was strongly invested in the notion that physicians should prepare their own medicines. While Charleton, by the time of his Gulstonian lectures, was regarded as less radical, bolstering his reputation with prestigious positions in the Royal College of Physicians, his earlier career had been similarly influenced by chemical medicine: he was first exposed to iatrochemical theories when he acted as assistant to the senior royal physician, Theodore de Mayerne, a leading exponent of chemical medicine and 'one of the most influential Paracelsian physicians in the first half of the seventeenth century'.[113] Mayerne, who was instrumental in the foundation of the Company of Distillers and the Society of

[112] For biographical detail on Maynwaring, see Antonio Clericuzio, "Maynwaring, Everard (b. 1627/8)," *ODNB*.
[113] Clericuzio, "Chemical and Mechanical Digestion," 331; on Mayerne, see John Henry, "Charleton, Walter (1620-1707)," *ODNB*; Trevor-Roper, *Europe's Physician*. On the early intellectual development of Charleton, see Nina Rattner Gelbart, "The Intellectual Development of Walter Charleton," *Ambix* 18, no. 3 (1971).

Apothecaries, clearly had a formative influence on Charleton, whose earliest works in print were the first translations of van Helmont into English.[114] These activities publicly established Charleton at the forefront of the iatrochemical movement, leaving him open to hostility from his more conservative medical colleagues during the early decades of his career.

Clericuzio has noted that '[d]espite its relevance for the history of medicine, the iatrochemists' contribution to the understanding of digestion has received relatively little attention from historians.'[115] While Clericuzio has gone some way to amend this, it is clear that the success of chemical medicine in the later seventeenth century is closely allied to its perceived applications for digestive ailments, and that this is closely reflected in the language that practitioners such as Charleton and Maynwaring employed to describe the functioning of the digestive apparatus. The laboratory was essential to the medical practice of those who aligned themselves with the iatrochemical movement, and Maynwaring spent much of his own time within the laboratory, or exhorting, through his texts, that others should too. The emphasis that Maynwaring places upon practical skill and experiment in medicine is clear in the introduction to his book *The Catholic Medicine* (1684) which somewhat optimistically argues that the production of a 'Universal Preservative, or Catholick Curing Medicine, may happily be the Prodigy of our Present Time.'[116] He argues that:

> the Apothecary-Doctor is not like to do the Business, so long as he makes Medicines by guess, with Pen and Ink upon a piece of Paper only: he must take a little more pains than in reading and writing: this is no Book Medicine; he must operate in the Laboratory too, if ever he will gain the Catholic Medicine. We must find out another, that is long experienced in the Preparation of Medicines, a diligent Operator, striving earnestly to purchase something Excellent, by various Tryals and Experiments beyond Book Reading; such a Man may happily find out this great Arcanum.[117]

Maynwaring notes that it is only through practice that the physician comes to truly understand and create effective medicines, and this practice is necessarily chemical in nature. He writes:

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[114] Lloyd, "Physicians and Livery Companies," 415.
[115] Clericuzio, "Chemical and Mechanical Digestion," 330.
[116] Everard Maynwaring, *The Catholic Medicine and Soverain Healer* (London: J. Gain, 1684), 3.
[117] Ibid., 5.

> You cannot design a Medicine rightly, nor aim at any Disease judiciously and certainly, but from the knowledge you have gained in *Pharmacopoeitick* operations and tryals of Medicines; for, by *correcting, digesting, fermenting, distilling, subliming, volating, fixing &c.* are Diseases known, by these artificial imitations of Nature, and does lay open the mystery of Curing.[118]

For Maynwaring and Charleton, this understanding of the chemical nature of digestion was more than just explanatory. It had practical application. By understanding the kinds of processes that occurred in the stomach—acid ferments, volatilisation, dissolution, and so on—practitioners could also begin to understand how digestion might falter. Digestive problems, it was theorised, could be remedied with medicines designed to fix deficiencies in these processes: Maynwaring lays a range of diseases at the door of poor 'Chylification', suggesting medicines that 'assist and *acuate* the stomachical ferment' and prescribing '*volatile*' solutions that 'discharg[e] its radiants or fulminating (yet friendly) power instantaneously; and awake[…] the *dormant* and *sluggish Archeus* of the stomach, exciting to a vigorous action and duty'.[119] Normally an autonomous laboratory of its own making, when, through bad diet or sheer bad luck, the alchemist of the stomach is outwitted, then the products of the laboratory in the outside world can reinvigorate the chemical processes in the stomach to help restore natural order and wellness. In comparing the stomach to the laboratory, Maynwaring also suggests that the best place from which to repair the stomach might be the laboratory itself.

While the laboratory works as a very clear comparison for communicating the effects and the problems of digestive process, it also acts, for Maynwaring as for Charleton, as an indication of the particular modernity of his knowledge. As we have seen, the laboratory was, in many respects, an emblem of the 'new' philosophy, a site where ancient knowledge could be put to the test, and, when necessary, challenged and revised. Maynwaring's description of the stomach reflects his empirical attitude, displaying his concern with correcting the falsehoods of ancient wisdom.[120] Immediately following his description of the stomach as the prime

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[118] Maynwaring, *Praxis Medicorum Antiqua & Nova the Ancient and Modern Practice of Physick Examined, Stated, and Compared* (London: printed by J.M., 1671), 12.
[119] Maynwaring, *The Pharmocopœian Physician's Repository* (London: 1669), 26; italics present in original text.
[120] Maynwaring was attacked, alongside Robert Boyle and Christopher Merret, for being an enemy of learned medicine and the Royal College of Physicians in an anonymous pamphlet, likely from 1668. All three were powerful voices in the call for an increasingly empirical approach to medicine. See: Clericuzio, "Everard Maynwaring."

laboratory and office of digestion, he declaims the outdated ancient theory that bodily heat is the chief cause of digestive processes. He claims:

> Contrary to this doctrine have the ancient Physitians asserted, and built upon, as a sure foundation, that heat is the principal efficient cause of digestion; being induced to this opinion, from the similitude of artificial concoctions and digestions: And finding humane bodies to be actually hot, supposed by increasing of natural heat, to fortifie the digestions; and that the difference of digestions in several persons, or the same person at several times, did depend and vary, from the degrees of heat, its debility and fortitude, but upon a due examination you will find it otherwise.[121]

While the ancients draw on the analogy between 'artificial concoctions' and digestive processes, using another implicit architectural metaphor for knowledge Maynwaring implies that the house of reason they have built stands on unsteady foundations. This line of argument threatens the premise from which his own metaphor proceeds—that we might understand the digestion through analogy and similitude, which Maynwaring of course does with regard to the laboratory. However, it is not drawing analogies between digestive and artificial processes, such as cooking, that is the cause of the ancients' fallacy. Instead their error derives from a failure of specific and detailed observation; a 'due examination' or empirical witnessing of the facts, Maynwaring concludes, will lead the reader to share in his findings. This methodical approach not only results in a more precise and effective laboratory analogy but also involves the empirical skills Maynwaring describes as essential to success in the laboratories of chemical medicine: close observation, a refinement of approach in accordance with results, and a willingness to truly test received wisdom when it is proffered without evidence.

While he admits that the temperature of the body can affect the type of digestion that occurs, Maynwaring argues that heat is primarily effective in the digestive process not within the human anatomy but instead through the pre-digestion of food, especially meat, before it enters the body. Heat is effective, he argues, 'in rosting, boyling, baking, &c. but not in the natural digestions of the body'.[122] Instead he argues that digestion within the stomach occurs primarily through the action of 'vital principles', which include the transformation of food into chyle through a 'ferment', a 'vital principle endowed with a transmutative

[121] Maynwaring, *Treatise of the Scurvy*, 19.
[122] Ibid., 20.

power'. But this transmutative power, so expressive of change, is ultimately governed by analogy, occurring 'by way of similitude astral or influential'.[123] While the process of digestion for Maynwaring is chemically transformative, it is physically determined and best communicated through analogy.

The Digester and the Fermenter

It was not only physical and functional similarities that made kitchens, laboratories, their occupants and their tools work so well as analogies for the digestive system. There was practical utility in the link, which worked multi-directionally: the intricacies of digestion were both closely studied in laboratories, and the insights and practical applications that occurred from these advances in knowledge were also put to work there.

Thomas Tryon, a writer who was a merchant, a religious radical, and an early advocate of vegetarian clean-eating provides a further example of how understanding the stomach as analogous to an experimental laboratory could provide practical solutions to common digestive problems. Tryon was particularly concerned about the effect of artificial sugars upon the diet (a particular problem, he warns, for women and children, their chief consumers). He uses observations on the functions of the stomach, which he calls 'Natures Laboratory', as an example from which lessons for the kitchen can be learnt. Giving the example of stale beer laced with sugar, Tryon notes that while sugar may allay the initial roughness of the beer on the palate:

> when it comes into the Stomach (Natures Laboratory) where she makes separation, then this Saturnine and Martial harshness will again appear in its own Form, and heat the whole Body, and generate the Gravel or Stone, if it find suitable matter: The same is to be understood in Foods; what Stomach will be satisfied after a whole Meal only of Gooseberry-Tarts made of young green Gooseberries made pallatable with Sugar? and so of all other things that are either unripe or unequal in their parts, and the reason is at hand, viz. because two Extreams, through never so cunningly joyned, cannot produce a thing of a middle Nature or equal Operation, and agreeable to Nature.[124]

[123] Ibid., 22-23.
[124] Thomas Tryon, *The Good House-Wife Made a Doctor* (London: 1692), 141-42.

Tryon provides practical dietary advice, designed for the avoidance of stomach upset. Added sugars might make sour things taste better but they cannot make them digestible, he reasons: this is evident from the poor health results witnessed after drinking sweetened stale beer. But he also extrapolates from similar observations to offer conclusions with a broader practical utility. In a second, similar example, Tryon explicitly uses analogy as a mode of understanding natural and chemical processes: likening the process of cider brewing to the first run-off of malt in brewing, Tryon argues that 'Natures Operations are uniform [and] he that rightly understands one Link will easily comprehend the whole Chain.'[125] He continues, once more with recourse to the laboratory of the stomach:

> For if you observe, you shall find, that any sort of Fruits will, when any violence is offered to them, first give forth their more sweet Vertues and pure spirituous Qualities, as if you bite a piece of Apple, will not the sweeter and more pleasant Juices be extracted first? And so by degrees yield that which is harsher and more unpleasant? The astringent Properties of Saturn and the hot bitter harsh Qualities of Mars are the first and last in all Vegetations: The same we find in the Stomach (Nature's Laboratory) does not she separate and extract all the Balsamick and good Vertues first, to the supply of Nutriment for all parts of the Body? As you may perceive if you give your Stomach any occasion of Casting, if it be within an hour or two after you received your Food or Drink, then it will be somewhat sweet, very tollerable, and come up easie, but if this Puking happen long after, as seven, eight or ten hours, then it will be very nauseous, bitter, sour, and of various Colours, as Yellow, Green, and the like, whereby 'tis evident that the bitter parts are drawn away first.[126]

The actions of the stomach in separating off sweet juices first, proven through timely vomiting, test and verify the evidence of taste. But these auto-experimental observations have a surprisingly appetising conclusion: they are put to use in relation to cider-making, where a soft and gradual pressing of the apples, Tryon asserts, will result in a better-tasting, better-digested and better-travelling cider. He concludes:

> So if Apples be pressed hard, there is forced out an hard, harsh, astringent, sour Property, which may cause such Cyder to ripen sooner, and be thereby fit to drink in a shorter time, but it will also cause it to fret, or become of a keen sharp Nature, and often causes it to sour, more especially if such Cyder shall be put on a fresh ferment by Carriage; either by Land or Sea.[127]

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[125] Ibid., 196.
[126] Ibid., 197-98.
[127] Ibid., 197-98.

From the laboratory of the stomach, Tryon derives the best advice for the kitchen (or brewery) and for the maintenance of digestive health. What we learn from the ferments which occur within the stomach, he suggests, could inform the way we ferment outside of it, ensuring a better fermentation within the stomach itself when we then consume the products of our own artificial fermentations.

The work of Huguenot physician Denis Papin, who was Boyle's laboratory assistant, offers an even more compelling example of the applications to which the new digestive science could be put. Having invented the prototypical pressure cooker, which he called a 'digester', Papin published a brochure detailing how to build and refine his machine, as well as testing how it works on a huge range of more- and less-expected materials. Despite usually being considered by historians of science for its role in the development of physics, Spary and Orland have noted that the text advertising his digester 'bears a strong resemblance to a cookbook in its recipes and the range of experimental materials trialled in the digester.'[128] Papin's pamphlet is a treasure chest of examples illustrating the range of experimentation surrounding digestion at the time as well as the hoped-for variety of applications that this science could develop. In its attempt to work out how to make cheap cuts or currently unusable parts of meat digestible, and thus affordable for the poor, Papin's text deftly combines ideas about food economy and social utility with the culinary objectives of the kitchen and the mechanical and observational expertise of the laboratory.

Papin's publications about his digester offer a clear sense of the benefits he expected such a machine to have, and both cookery and chemistry feature prominently. The title page promises a 'Description of its Make and Use in these Particulars: viz. Cookery, Voyages at Sea, Confectionary, Making of Drinks, Chymistry, and Dying', while the preface, addressed to the Royal Society, notes that while some of the experiments relevant to the digester were printed in Boyle's 1680 edition of physico-mechanical experiments, that was written in Latin and did not fully describe the engine or how to use it safely—factors which were prohibitive to the audience Papin imagines adopting his device.[129] Instead, he writes his own work in 'the vulgar Tongue for the use of such Housekeepers and Tradesmen as may have

[128] Orland, "Introduction: Assimilating Knowledge," 320.
[129] Denys Papin, *A New Digester or Engine for Softning Bones* (London: J.M. for Henry Bonwicke, 1681), title page.

occasion for this', and hopes that it 'may fall into the hands of divers persons that would never read the History of the Royal Society, nor Mr. *Boyle*'s Book about the Usefulness of Experimental Philosophy.'[130]

But Papin's experimental work, while focused on its social and practical applications, also sheds light on the conditions that might affect digestion within the stomach. He uses his machine to show, for example, that 'inward pressure is a great help to advance coction', and while his primary interest is the artificial digestion taking place within his machine, his insights are equally applicable to the digestive science of the human body.[131] In another section he notes that scurvy likely occurs among sailors due to the 'gross and terrestrial' blood which occurs as a result of eating salt meat, deprived of the 'volatile and spirituous parts' it would naturally have contained.[132] Papin argues that the products of his digester offer a solution: 'that Gellies being made of volatile parts, and easie to be digested, would be apt to correct the defect of the salt meat; but they use to be so dear and so hard to be made, that it is rarer to get any at Sea: this made me believe that it would be a good thing to find a way how to make them every where easie and cheap.'[133] Indicating the broad range of expertise that existed on digestive science, in one of his jelly-making experiments, he seeks the opinion of a female acquaintance (who remains unnamed), who, as an expert jelly-maker, is deemed an appropriate authority to judge the relative nutritional value of traditional jellies compared to Papin's supercharged versions. He writes that he offered his pressure-cooked jelly 'to a person that makes such Gellies pretty often, and she said that there must be something more in this than in hers, because this had both smell and taste pretty strong.' Papin theorises that this additional fecundity results from the sealed pressure cooker better retaining the spirits and volatile salts, and notes that 'from thence, it is very probable, that this new gelly hath much more virtue in it.'[134] Papin refers to the 'virtue' of this jelly in both a practical and moral sense; as Justin E.H. Smith has noted, the science of digestion

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130 Ibid., Preface [n.p.]; Papin refers to Robert Boyle, *Experimentorum Novorum Physico-Mechanicorum Continuatio Secunda* (London: printed by Milo Flesher for Richard Davies, 1680); Thomas Sprat, *The History of the Royal-Society of London, for the Improving of Natural Knowledge* (London: printed by T[homas] R[oycroft] for J. Martyn and J. Allestry, 1667); and Robert Boyle, *Some Considerations Touching the Usefulnesse of Experimental Natural Philosophy*, 2 vols. (Oxford: printed by Hen[ry] Hall for Ric[hard] Davis, 1663; 1671).
131 Papin, *A New Digester*, 12.
132 Ibid., 21.
133 Ibid., 21-22.
134 Ibid., 20.

could be a moral, as well as a scientific affair, and the question of how best to nourish the human body was never far from the grasp of scholars of digestion.[135]

Having observed the variety of properties among the gelatinous substances and glues produced by different animals, Papin gestures to the wider effects that similar experimentation might have:

> seeing our bodies are but congealed liquors, it is likely, that if people would go on with this tryal and draw Gellies from several parts of the same Animal, and from several Animals of the same kind, but of different ages, and from several kinds of Animals that live a great deal longer one than the other, as from Harts and Rabbets; and then if they would compare all the several proprieties of these Gellies with one another, it is likely, I say, that it would be a great help towards making a better Theory than hitherto we have about the causes of the lastingneß of our life: and such a Theory would, it may be, prove of more consequence than many people are apt to believe.[136]

Papin projects far-reaching ambitions for both the practical and theoretical products of his digester experiments. While his ambitions for life-extending jellies may seem far-fetched, the excitement at the possibilities this extracorporeal digester offered was very real. Though many of his contemporaries thought of stomachs as nature's laboratories, Papin's digester was a laboratorical reimagination of the stomach, adapted to pre-digest what humans could not. In the process, Papin's digester, and subsequent versions of it, also enabled investigations into a diverse array of physical forces and inspired major mechanical innovations, including the steam engine.

Stomach Spirits

The use of the stomach-laboratory metaphor not only reveals a great deal about seventeenth-century theories of digestion, but also influenced other aspects of physiological debate, in particular, theories of the vital and animal spirits. The laboratory was a place that had the potential to produce or refine many types of 'spirit', a polysemous word which could refer (among many other meanings) to holy spirit, the soul, physiological 'spirits' or life-forces, the essences of particular materials, and refined substances, particularly liquids (including alcohols) that had

[135] Smith, "Diet, Embodiment, and Virtue in the Mechanical Philosophy."
[136] Papin, *A New Digester*, 28.

been subjected to particular chemical processes including distillation and fermentation.[137] For Henry Power, another natural philosopher and physician, the digestive process could involve all of these types of spirit, and understanding the production of spirits in the laboratory provided a model for comprehending the invisible actions of spirits within the body.

Power's *Experimental Philosophy* (1664), nominally divided into sections of microscopical observations and 'mercurial' and 'magnetical' experiments, showcases not only Power's broad range of natural philosophical interests, but also what Adrian Johns has termed his 'rich prose style' and 'eagerness to draw elaborate imaginative analogies across the natural order.'[138] These qualities, perhaps unsurprising in a protégé of Thomas Browne, are nevertheless notable in a work that forthrightly proposes itself as a book of experimental methods and findings. Now chiefly recognised as the first English work about microscopy in print, Power's *Experimental Philosophy* was devoid of the magnificent illustrations of Hooke's *Micrographia*, and instead relied on the verbal prostheses of figurative language to draw for the minds' eye what only the artificial prostheses of optical glasses could show.[139] Power's frequent focus on the 'Architecture' and 'fabrick' of both human and animal bodies, and of the natural world more generally, provides an architectonic context for understanding the body, and like Charleton and Maynwaring, Power also endowed architectural metaphor with epistemological importance.[140] His preface cites Francis Bacon's passage requiring that successful experimentation must be a solid 'Foundation' on which a 'wary Builder' may cautiously construct hypotheses, and Power himself evokes the common trope of philosophy-as-house, declaring that the 'rotten Buildings' of ancient philosophy need to be demolished, making way for the 'new Foundation of a more magnificent Philosophy, never to be overthrown: that will Empirically and Sensibly canvass the Phænomena of Nature, deducing the Causes of things from such Originals in Nature, as we observe are producible by

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137 'Spirit, *n.*,' *OED*.
138 Adrian Johns, "Power, Henry (*c.* 1626-1668)," *ODNB*.
139 Samuel Pepys, for example, buys himself a microscope in order to learn how to use it from Power's work: *The Diary of Samuel Pepys*, vol. 5 (London: Harper Collins, 1995), 240-41: Aug 13, 14 & 16, 1664.
140 Henry Power, *Experimental Philosophy, in Three Books* (London: T. Roycroft, 1664), 7. Originating from French and Latin roots describing a skilled craftsperson, 'fabric' in its earliest iterations in English referred to an edifice or a building, before expanding to refer to any product of skilled workmanship. By the early seventeenth-century it was used to denote engines, frames and structures, and by the mid-century was used to describe anatomy. Power uses the word as a neat bridge term, allowing him to work across this allusive range of interconnecting meanings. See 'fabric, *n.*,' *OED*.

Art[…]to build a true and permanent Philosophy'.[141] This provided a vital figurative landscape in which Power's laboratory metaphor could flourish; while the laboratory-stomach was an essential part of the human body, the laboratory was also, in Power's epistemological scheme, part of the foundations of a successful house for philosophy.

For Power, these deft and sweeping uses of architectural analogy, which while most prominent in his paratexts percolate throughout his experimental observations, are neither distractions from objectivity nor decorative distortions of 'truth' but instead legitimate modes of comprehending and communicating the mysteries of nature. Like Charleton, Power considered both analogy *and* experimental observations as valid pathways to knowledge if applied correctly; he argued, for example, that without the aid of optical glasses Adam could only know of the world beyond natural vision 'what he might ingeniously ghess at by the Analogie of things in Nature, and some other advantageous Circumstances.'[142] For Power, then, scientific equipment, like the microscope, is a sure route to better understanding the natural world around us. But another way of comprehending it, when those artificial aids are unavailable to us, is the 'Analogie of things in Nature'—those sure signs and signatures that have been left behind by a divine creator.

But while Power compared the body to a machine, his wider analogies reflected that his philosophy was in fact the 'creative appropriation of both Paracelsian and Cartesian principles' that we have already discovered to be common among English physiologists, especially in the understanding of digestive science.[143] He balances out his mechanist trope with an explicitly Paracelsian metaphor which imagines the whole of man as a laboratory, with the soul as the alchemist at work in the stomach:

> Now the Spirits that are lodged in all the meats and drinks we receive, being more or less fixed therein; What does the Soul, but (like an excellent Chymist) in this internal Laboratory of Man, by a fermentation of our nourishment in the stomach and guts, a filtration thereof through the Lacteae, a digestion in the Heart, a Circulation and Rectification in the Veins and Arteries: what does she, I say, by these several Physico-Chymical operations, but strive all this while to unfix, exalt, and volatilize the Spirits conteined in our nutriment, that so they may be transmitted to the Brain, and

[141] Robert Boyle, *Certain Physiological Essays Written at Distant Times, and on Several Occasions* (London: printed for Henry Herringman, 1661), 10, cited by Power, *Experimental Philosophy*, [C4r-C4v].
[142] Power, *Experimental Philosophy*, [a3v].
[143] Johns, "Henry Power," *ODNB*.

> its divarications, and in that reconditory kept and reposited for her use and service.[144]

Power's 'soul', which, gendered female, adopts the role conventionally played by the anthropomorphised 'Nature' dictating the actions of the body, casts light on one of the more complicated aspects of digestive theories during the seventeenth century.[145] The 'soul' described here echoes Paracelsus's *archeus*—the 'incorporeal agent' that acted, like an alchemist, to separate pure parts of food matter from impure waste for the nourishment of the human body.[146] And just as the chemist in the laboratory might use processes such as fermentation and filtration to distil spirits—which, whether alcoholic or otherwise, were perceived as purified essences of the substances from which they were distilled—it is the extraction of vital spirits with which this chemist 'soul' is primarily concerned.

For many early modern physiologists, vital spirits were innate to animal matter, and requisite for the life-giving processes of growth, generation and sensation. While spirits and souls may seem intrinsically religious to modern readers, they were not always conceived as such by early modern scholars. In many accounts, even those in which they were infused with divine power, the vital spirits were more explicitly understood as gaseous or liquid chemical spirits. According to many accounts, the fermentation that occurred during the digestive process was essential in separating out the vital spirits from food, exciting them into a state of increasing volatility and purity until they were drawn off from both food matter and the thicker parts of the blood and circulated throughout the body via the blood, lymph and nervous systems.[147] The specifics of how exactly the spirits were separated out from food and moved through the body, as well as their precise function, were subject to a huge range of variant theories, however many English Paracelsians shared the view that '[t]he substances chemists distilled in their laboratories were considered identical with those contained in human blood and as the source of life in animals.'[148] This resulted in distilled substances becoming increasingly important to medicine as

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144 Power, *Experimental Philosophy*, 65.
145 On the anthropomorphisation of Nature as a female deity, see Carolyn Merchant, *The Death of Nature: Women, Ecology and the Scientific Revolution* (London: Wildwood, 1982); Londa L. Schiebinger, "Feminine Icons: The Face of Early Modern Science," *Critical Inquiry* 14, no. 4 (1988); *Nature's Body: Gender in the Making of Modern Science* (Boston: Beacon Press, 1993).
146 Clericuzio, "Chemical and Mechanical Digestion," 331.
147 Clericuzio, "The Internal Laboratory: The Chemical Reinterpretation of Medical Spirits in England (1650-1680)," 59-60.
148 Ibid., 53.

practitioners attempted to use artificially distilled spirits to correct illnesses that they considered to be imbalances of the spirits or caused by faults within the mechanisms that drew the spirits out from foods and distributed them across the body.[149] Power was one of many who believed that there was a direct comparison to be drawn between the work of chemists in the laboratory and the processes that occurred within the body, particularly digestion, believing that the processes made visible in the laboratory could shed light on those occurring within the stomach.[150]

He noted this explicitly in a manuscript work named *Analogia Physico-Chymica*. Introducing a numbered table several pages long that compiles examples of analogous 'Chymicall' and 'Naturall' processes (see Figure 25), he argues that the processes which enabled nutrition in the body were best 'demonstrated' through the power of 'chymicall Analogy':

> Whoseoever hath seene the admirable and almost incredible effects of chymistry, wrought by their severall progressive operations of Maceration, fermentation, putrefaction, Digestion Circulation, Rectification, cohabation, and the like, will easyly conclude [that] all the operations of Nature within us, are most emphatically expressed, and indeed are practiced by the chymists without us, & therefore the great and mysterious works of Concoction, chylification, Sanguification, assimilatio & c. are most powerfully demonstrated by chymicall Analogy. For Nature the Protochymist Acts in this Internall Laboratory of Man (the Body) as the Hermeticall Practitioners doe externally in their Furnaces & Operatoryes as wee. Shall most powerfully evince & demonstrate by these ensuing Physico-chymicall Analogyes.[151]

Power's case here is clear: the processes which occur in the stomach can also be enacted by chemists in the laboratory. Nature the 'Protochymist' was, in many ways the first chemist, and the human body was her laboratory: chemists working in their laboratories simply rendered visible processes in the external world that had already been perfected in the closed laboratory of the body. But though Power's position was a common one, there was serious debate about the validity of comparing vital, bodily spirits with spirits, especially liquors, that were extracted by chemical distillation.[152] While Power appeals to chemistry as a form of *demonstrative* proof for

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[149] Some, including the English Helmontian school, argued that the vital spirits were themselves a volatile alkaline salt, a substance which could be obtained by distilling both human urine and blood: Ibid., 63.
[150] Clericuzio, "Chemical and Mechanical Digestion," 331: 'Paracelsians identified [the vital spirits] with the spirits extracted by distillation.'
[151] Henry Power, *Analogia Physico-Chymica* (1657), BL Sloane MS 1393, fol. 38[r].
[152] Clericuzio, "The Internal Laboratory," 61.

processes within the stomach, configuring it as an empirical, as well as analogical evidence, many were less convinced. For some, this was about the imprecision of the language that seemed to so directly map chemical processes onto bodily ones. Boyle, who actually adopted the Helmontian notion of spirits as alkaline and acidic volatile salts and performed research on the chemical components of the vital spirits, argued that word 'spirit' was used so broadly, and with such a range of meanings, that any attempt to analogise it was futile:

> As for what the Chymists call spirits, they apply the name to so many differing things, that this various and ambiguous use of the word seems to me no mean proof that they have no clear notion of the thing. Most of them are indeed wont to give the name of spirit to any distilled volatile liquor, that is not insipid, as is phlegm, or inflammable, as oil. But under this general term they comprehend liquors that are not only of a differing, but must be, according to their principles, of a quite contrary nature.[153]

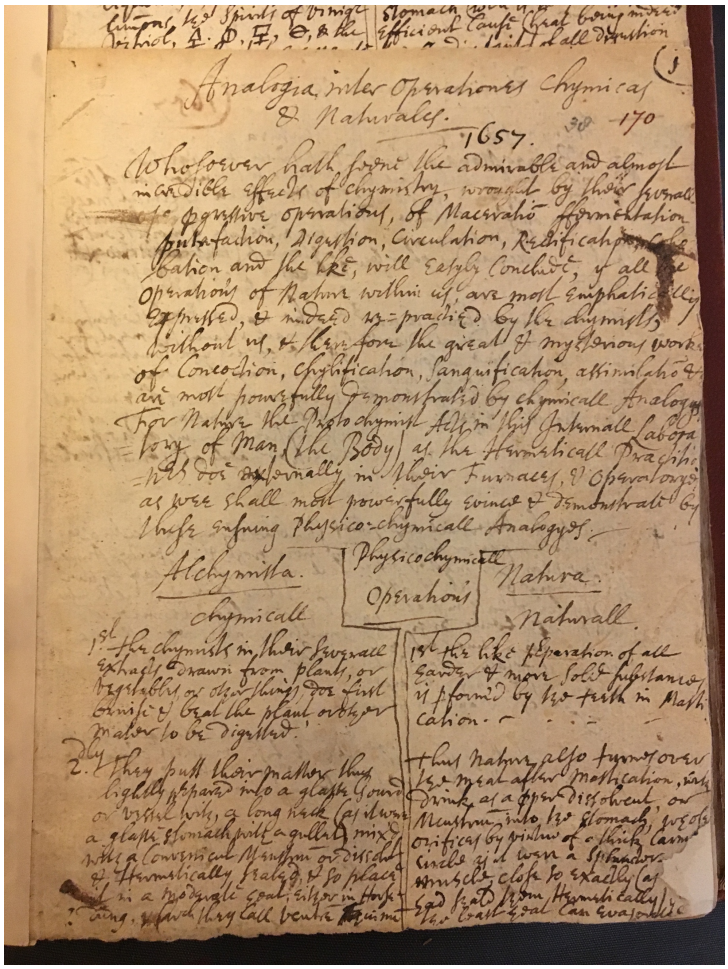

Figure 25. Henry Power, *Analogia Physico-Chymica* (1657), BL Sloane MS 1393, fol. 38[r].

[153] Robert Boyle, *Experiments and Notes about the Producibleness of Chymical Principles*, in *The Works of Robert Boyle*, vol. 9 (2000), 52.

But though the validity of analogy as a mode for understanding digestion was hotly contested, it was nevertheless central to digestive debates, and invoked to disprove, as well as to prove certain theories. Charleton, who in *Enquiries* espouses his own doubts about the existence of the spirits alongside those of influential anatomists George Ent and William Harvey, turns laboratorial analogy to his own ends when expressing his scepticism that the brain might be the final dispensary of the spirits:

> And truly if any man shall seriously, and without prejudice consider the great bulk, cold temperament, various parts, fabrick and texture of the Brain; he will at length find but little reason to believe, that Nature hath framed it chiefly for a Laboratory of Spirits. They tell us, that these spirits are made of the most subtile, most refined, and volatilized parts of the arteriose blood, by way of sublimation. But can a part so dense, so cold, so clammy, and to like a bogg, as the brain seems to be, be thought an instrument fit for sublimation or rectification of a spirituose substance? What Chymist hath at any time attempted to rectifie spirit of wine in a vessel whose head was stuffed with damp raw silk, or other the like villose matter, more apt to repercuss and condense, than to refine it?[154]

Charleton here defends the laboratory metaphor from misuse, insisting that while laboratory equipment can illustrate to us how the stomach works to separate nutritious, possibly spirituous matter from waste, it can also demonstrate that the brain—an organ of completely different structure and texture—would be ill adapted for such a purpose. The clammy, boggy matter of the brain provides neither the right equipment nor the right environment for the distillation of the purest of spirits, as the equivalent experimental set-up, with the brain's flesh mimicked in raw damp silk, illustrates. If the brain is indeed a laboratory, Charleton argues, it is better equipped for condensation than distillation. The metaphor is ruled inadequate by Charleton, but the consequences of the poor analogy have significantly greater consequence, producing a sceptical re-evaluation of physiological theory as it was most often proposed. Tested against the laboratory metaphor, the brain, as a stillhouse for the spirits, did not produce results concordant with the hypotheses.

This type of analogy, which focused on parallels between anatomical structures and particular pieces of laboratory or kitchen equipment lay at the heart of metaphors involved in explaining the refinement and passage of vital spirits through the body. Clericuzio has posited that the difference between Descartes'

[154] Charleton, *Enquiries*, 515-16.

mechanist model and Thomas Willis's chemical model is best explained through their choice of metaphors: while Descartes' model of the removal of the spirits from baser food matter is a mechanical one, 'analogous to that of sifting' (he uses the plural form of the verb *cribler,* 'criblant', meaning 'to sift'), Willis 'compared the brain to an alembic and saw the genesis of animal spirits as chemical distillation'. And while Willis theorises that the animal spirits are distilled from the blood in the cortex of the brain, he does not imagine that all the blood in the brain is distilled: instead some of the blood vessels provide the heat needed for distillation, acting, Willis argues, as a *bain marie*.[155]

Power's own theories draw explicitly on this premise. His 'Digression of the Animal Spirits' in *Experimental Philosophy* provides a detailed impression of how he perceived animal spirits to function. Power hypothesises that spirits are 'universally diffused throughout all Bodies in the World' and produce fermentation and concretion in mineral substances; vegetation and maturation in plants; and life, sense and motion in animals.[156] They exist in three possible states: in the state of fixation they are locked firmly within larger particles of matter; in the state of fusion they are becoming volatile and loosening themselves from the matter they are fixed to (Power includes fermenting vapours and liquors in this category); and in the state of volatility, spirits 'overcome' and break free from the particles of matter which they are attached to, as if 'upon wings, and ready to fly away': examples include wine at the height of its fermentation and parts of the arterial blood as spirits diffuse around the body.[157]

It is within this model that Power develops his model of the body as a 'this internal Laboratory of man' and the soul (and later Nature, and the divine creator) as an 'excellent Chymist'.[158] The spirits—substances understood to be literally at the heart of alchemical and chemical laboratory work at this time—undergo a series of processes in the body which might also be performed using the specialised technologies of the laboratory. This series of 'Physico-Chymical operations' is undertaken by the body to 'unfix, exalt, and volatilize the spirits conteined in our

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[155] Clericuzio, "The Internal Laboratory," 68, cites Thomas Willis, "The Anatomy of the Brain [Cerebri Anatome]," in *Dr. Willis's Practice of Physick Being the Whole Works of That Renowned and Famous Physician* (London: printed for T. Dring, C. Harper and J. Leigh, 1684), 72-73; and René Descartes, Letter to Newcastle, April 1645, in *Oeuvres De Descartes*, 12 vols., vol. 4 (Charles Adam & Paul Tannery, 1897-1913), 191.
[156] Power, *Experimental Philosophy*, 61.
[157] Ibid., 62.
[158] Ibid., 65.

nutriment', fermenting the nutritious material within the stomach and guts, filtering it through the lacteals, and purifying the spirits through volatilisation during their circulation through the blood system, the heart and the brain.[159] Power's analogies are detailed, and draw on his own experimental experience to explain and conceptualise the progress of the spirits through the body. For example, he describes the veins, arteries and nerves which he believed to be central to distributing the spirits around the body as 'infinitely small filaments and vessels […] all tubulous and perforated'.[160] These 'capillary threads or pipes' with their 'Coats and Cylindrical Membranes' are described in many of the same terms used to describe Power's experimental equipment, particularly that of his Torricellian experiments.[161] Power had access to state-of-the-art experimental technologies, expertise and equipment, from furnaces and weather glasses, glass cruets, tubes, siphons and vials to quicksilver, and though many of his experiments took place in the field, others most likely occurred in a purpose-built laboratory space at Towneley Hall.[162] Power's description of the body as 'instrumentally contrived, and preparatorily designed', in the manner of a custom-made laboratory full of bespoke, perhaps self-made equipment, expressed his understanding of the intricacy and precision of the body in terms with which both he and other members of his intellectual sphere, would have been intimately familiar. As an accomplished laboratory practitioner, it is unsurprising that Power describes the various chemical and mechanical ('Physico-Chemical') processes of the body—fermentation, filtration, circulation and volatilisation—as occurring within the 'internal laboratory' of the body; a body made to standards even more exacting than those of bespoke experimental equipment can only be read as a sign of divine design. But it also renders that design comprehensible, making the blueprint of the

[159] Ibid., 65.
[160] Ibid., 66-67.
[161] For example, listing items necessary for mercurial experiments, Power describes the need for a range of equipment, including 'Several Glass-Trunks, or Cylindrical Glass-Tubes', and 'Glass-Syphones, Weather-Glasses of several right and crooked shapes, &c. the more to advantage the Experiments': ibid., 88.
[162] It is likely that Power was in dialogue with Ralph Greatorex, 'one of the most celebrated London instrument makers' and later co-constructor of Boyle's air pump with Robert Hooke; it was Greatorex who informed Samuel Hartlib about Power's experiments. Richard Towneley, Power's experimental partner was also technically adept, having been 'associated with the rain-gauge [and] the improvement and publication of the details of Gascoigne's micrometer'. See: C. Webster, "The Discovery of Boyle's Law, and the Concept of the Elasticity of Air in the Seventeenth Century," *Archive for History of Exact Sciences* 2, no. 6 (1965): 459, 470. Many of the thinkers working on digestion and fermentation, including Power, Charleton, Ent, Glisson and Boyle were involved in these experiments on air pressure.

body legible by casting it in terms that are logical and decipherable, subject (largely) to the same laws that the scientist works with in his laboratory.

For Power, the soul is the chemist directing these processes, extracting and delivering the nutritive spirits around the body as required. His understanding of the animal spirits only serves to reinforce his framing of the body as a laboratory, and the notion that, so perfectly designed, it reflects the ingenuity of a divine creator:

> So that it seems, this Cottage of Clay, with all its Furniture within it, was but made in subserviency to the Animal Spirits; for the extraction, separation, and depuration of which, the whole Body, and all the Organs and Utensils therein are but instrumentally contrived, and preparatorily designed. Just as the Chymical Elaboratory with all its Furnaces, Crucibles, Stills, Retorts, Cucurbits, Matrats, Bolt-heads, Pelicans, &c. were made for no other end by the ingenious Chymist, than for the extraction and depuration of his Spirits and Quintessences (which he draws from those Bodies he deals with) in the obtainment of which he hath come to the ultimate design of his indeavours.[163]

Directly comparing the ability of the body and the chemist to extract and purify the most pure spirits or essences of other materials, Power emphasises the range of specialised equipment required for such operations. Power is less interested in the specifics of mapping specific bodily parts onto particular pieces of equipment than his contemporaries, however, instead finding more value in the *bespoke* nature of the equipment. Where other anatomists use the laboratory metaphor to explain particular physiological processes, Power is more interested in the digestive equipment as a proof of God's great design; ultimately, it has a theological, rather than a philosophical purpose. The humble clay cottage exterior of the human body, no doubt a reference to the earth from which humans are made in Genesis, is contrasted with the wildly sophisticated interior mechanics of man, equipped with all of the modern, high-tech and complex apparatus of the elaboratory.[164] The 'ingenious Chymist' who has conceived of this lab is not only the soul, but, in this imagination, God manifest within man, who, in the intricacy of the workings of the human anatomy, has 'come to the ultimate design of his indeavours'.

Power's *Experimental Philosophy* frames the discipline of philosophy as a legitimate striving towards a complete understanding of God's design. For Power, this is an intrinsically achievable, if ambitious goal, and it too can be achieved

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[163] Power, *Experimental Philosophy*, 66-67.
[164] Genesis 2:7: 'And the Lord God formed man of the dust of the ground.'

through the bodily laboratory, with the fermentation of the soul as well as the spirits. The soul, the rational outpost in Power's anatomy, can be fermented, rarified and loosened from its fleshy prison. And with the fermentation of the soul comes important consequences for the rest of philosophy. In his conclusion, Power looks forward to an era of unparalleled progress in scientific knowledge and attitudes. '[T]his is the Age wherein all mens Souls are in a kind of fermentation, and the spirit of Wisdom and Learning begins to mount and free it self from those drossie and terrene Impediments wherewith it hath been so long clogg'd, and from the insipid phlegm and Caput Mortuum of useless Notions, in which it has endured so violent and long a fixation', he says.[165] The process of knowing, for Power, becomes a process akin to that of digestion, with potentially divine consequences. But just as digestive complaints, caused by a malfunction in the fermentations of the stomach, were commonplace, knowledge could be similarly diseased. Power laments the lack of curiosity and reason in so many of his fellow human-kind, claiming that:

> There is a world of People indeed, and but a few Men in it; mankind is but preserv'd in a few Individuals; the greatest part of Humanity is lost in Earth, and their Souls so fixed in that grosser moity of themselves (their Bodies) that nothing can volatilize them, and set their Reasons at Liberty.[…] 'tis by the favour of a Metaphor, we call them Men, for at the best they are but *Des-Cartes's Automata* or *Aristotle's* Μιμήματα ἀνθρωπίνης ζωῆς, but the moving frames, and Zanies of men, and have nothing but their outsides to justifie their titles to Rationality.[166]

Luckily, true philosophers of nature ferment their knowledge perfectly, and this fermentation of the soul is what confirms them as humans, who are more than just machines. Men without curiosity are just soulless automata, dummies and puppets. The (chemical) reactions of the mind are both literally and metaphorically, for Power, what gives men spirit—and soul.

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[165] Power, *Experimental Philosophy,* 192.

[166] Ibid., 184. Many thanks to Carla Suthren who helped me with the transcription and translation of the Greek in this passage. Though Marie Boas Hall translates Power's term as 'least-men-like animals', leaning on the Aristotle to which he refers: 'πολλὰ ἂν θεωρηθείη μιμήματα τῶν ἄλλων ζῴων τῆς ἀνθρωπίνης ζωῆς' ('one may observe many imitations of human life in the other animals'), Suthren's translation of Power's Greek, 'things that are counterfeiting human life', offers a cleaner sense of Power's intentions. Cf. Marie Boas Hall, *Nature and Nature's Laws: Documents of the Scientific Revolution* (New York: Walker, 1970), 127; Aristotle, *History of Animals*, trans. D.M. Balme, vol. 3 (Cambridge: Harvard University Press, 1991), Bk VIII (IX), 250-251.

While the trend towards understanding the animal spirits as volatile salts in the latter half of the seventeenth century resulted in a move away from viewing the animal spirits as the corporeal agents of the soul, as Power's work has illustrated, the link between ideas about spirit and religion, which was a core aspect of the Paracelsian reformation of medicine, remained strong. The deeply religious nature of Paracelsian reforms was strongly influenced by philosophers of natural magic such as Marsilio Ficino who emphasised the theological aspects of the vital spirits; Owen Hannaway has remarked that 'Paracelsus's whole life's work was an endeavor to implement Ficino's ideal of the priest-physician.'[167] Allen Debus has noted that for Paracelsus, even divine creation was explicitly conceived of as a chemical separation of matter into constituent parts. According to Paracelsian theory, 'nature in a sense became a vast chemical laboratory' with almost every natural process from the formation of the earth's crust to thunder and lightning explicable with resort to chemical processes and equipment.[168] This image of the world as a chemical laboratory served only to reinforce God's greatness. As the ultimate alchemist, God could create anything and the intricacy and ingenuity of his work was astounding.

But while God's creation could be conceived of broadly as the products of a divine laboratory, the link between digestion and the laboratory seemed to wield particular power, even in theological matters. Power was far from the only writer for whom understanding digestion as a form of laboratory equipment had consequences beyond physiological understanding. Not only was the Paracelsian account of Creation analogous to their explication of digestion, in which matter was purified and separated through chemical means, but digestion itself became an extension of creation, with excretion just another stage in the separation of matter into its constituent parts, ultimately returning to 'the original prime matter.'[169]

While the work of the digestive system was mainly likened to the work of the laboratory in order to achieve physiological or gastronomical insight, then, the likeness could also be used to probe more abstract hypotheses, including issues of theology. Robert Ferguson, the religious radical and political conspirator, did just

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[167] Owen Hannaway, *The Chemists and the Word: The Didactic Origins of Chemistry* (Baltimore: John Hopkins University Press, 1975), 126.
[168] Debus, *The English Paracelsians*, 25; 29.
[169] Ibid., 26.

this. Clearly a friend to controversy, Ferguson was ejected from the Presbyterian ministry in 1662 and turned to Independency in the 1670s, before playing a prominent role in a series of major Jacobite and Whig plots from the 1680s onward.[170] Despite a print dispute involving allegations of extensive plagiarism from authors including Royal Society founder-member and cleric Joseph Glanvill, Ferguson's prolific output displays relatively little interest in natural philosophy as a discipline, focusing on theological and political polemic.[171] In the preface to *The Interest of Reason in Religion* (1675), Ferguson notes that while philosophy can 'be very useful both to promote Faith and Obedience in our selves', it is instead often a 'great Nuisance […] encumbring our Minds with insignificant Terms and idle Phantasms, & the deflouring [of] our Virgin Intellects by absurd Dogm's, that too many, instead of commencing either solid Scholars, or being prepared to be good and humble Christians, come abroad into the World, either Disputatious Whistlers, or sworn Enemies to Evangelical Grace.'[172] But as Melinda Zook has noted, Ferguson was nevertheless 'a collector and distiller of ideas,' who 'successfully fused arguments from history, reason, natural law and ancient constitutionalism' for his own means as a Whig pamphleteer.[173] When, in the same work, he borrows the natural philosophical trope of the stomach as a laboratory of nature, instead of being employed in its capacity for physiological illustration, it was harnessed to Ferguson's cause in a theosophical dispute.

Split into three extensive chapters, Ferguson's text first proclaims the importance of rationality in religion, before moving on to discuss the importance of scriptural metaphor and the nature of the union between Christ and his believers. As the second chapter, devoted to 'the Import and Use of Scripture-Metaphors', illustrates at length, Ferguson is deeply concerned with language, its power, and the ways in which it can be used and abused in theology. He mounts a rigorous defence of the non-conformist use of figurative language, including metaphors, similitude, allusions and allegory, noting the hostility with which this is treated by the 'sober

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[170] Melinda S. Zook, "Turncoats and Double Agents in Restoration and Revolutionary England: The Case of Robert Ferguson, the Plotter," *Eighteenth-Century Studies* 42, no. 3 (2009): 364. See also: Zook, "Ferguson, Robert (d. 1714)," *ODNB*.

[171] Sherlock accused Ferguson of prolific plagiarism, stating: 'I can scarce open an English author of any account, without making some new discoveries of Mr. *Ferguson*'s pilfering humour.' William Sherlock and Joseph Glanvill, *An Account of Mr. Ferguson, His Common-Place-Book in Two Letters* (London: printed by Andrew Clark for Walter Kettilby, 1675), 28.

[172] Robert Ferguson, *The Interest of Reason in Religion; with the Import & Use of Scripture-Metaphors* (London: 1675), A4v-A5r.

[173] Zook, "Turncoats and Double Agents," 367; 370.

Christians of the Church of England', promoting their self-proclaimed 'plain and intelligible Terms'; statements which undoubtedly echo the claims of many promoting apparently objective prose within the Royal Society at this time.[174] Though Ferguson appears to sympathise with writers like Sprat proclaiming the necessity of plain language in scientific writing, he sets a different rhetorical standard for theological writing, where he deems metaphors not only more appropriate but often necessary, stating he could:

> well allow that in Philosophy, where the Quality and Nature of things do not transcend and over-match words, the less Rhetorical ornaments, especially the fewer Metaphors, providing still that the phrase be pure and easie, the better. But in Divinity, where no expressions come fully up to the Mysteries of Faith, and where the things themselves are not capable of being declared in *Logical* and *Metaphysical* Terms: Metaphors may not only be allowed, but are most accommodated to the assisting us in our conceptions of Gospel-mysteries.[175]

Ferguson, who is also anxious to also warn against inappropriate metaphorical readings where they occur, goes on to argue that a countless number of historical church doctrines have been 'subverted and overthrown' by this 'new artifice of crying out Luscious and rampant Metaphors'.[176] Having set out his stall in favour of the appropriate usage of figurative language, when, in his final chapter, Ferguson employs the trope of the stomach laboratory, we must imagine its placement to be

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[174] Ferguson, *Reason in Religion*, 278. Though Ferguson paraphrases Sherlock's argument rather than quoting from it, Sherlock does use the word 'plain' excessively to describe forms of demonstration, argument or language. He also uses the phrase 'plain and intelligible' in relation to scripture. This echoes Sprat's stated objectives for the new science, which sought 'Mathematical plainness' in language, and information collected 'by the plainest Method, and from the plainest Information', recorded in 'as few words as are sufficient to signifie them intelligibly and plainly'. Cf. William Sherlock, *A Discourse Concerning the Knowledge of Jesus Christ* (London: printed by J.M. for Walter Kettilby, 1674), 390; Sprat, *History of the Royal Society*, 113; 257; 179. On the context surrounding debates of style between Anglicans and nonconformists, including the Anglicans' persistent attacks on 'nonconformists' cloudy vocabulary' see John Spurr, "Style, Wit and Religion in Restoration England," in *The Nature of the English Revolution Revisited*, ed. Stephen Taylor and Grant Tapsell (Woodbridge: 2013), 245. On debates around seventeenth-century 'plain style', see: Richard F. Jones, "Science and English Prose Style in the Third Quarter of the Seventeenth Century," *PMLA* 45, no. 4 (1930); "Science and Language in England of the Mid-Seventeenth Century," *The Journal of English and Germanic Philology* 31, no. 3 (1932); *Seventeenth-Century Prose: Modern Essays in Criticism*, (New York: Oxford University Press); Paul G. Arakelian, "The Myth of a Restoration Style Shift," *The Eighteenth Century* 20, no. 3 (1979); Roger Pooley, "Language and Loyalty: Plain Style at the Restoration," *Literature and History* 6 (1980); Isabel Rivers, *Reason, Grace, and Sentiment: A Study of the Language of Religion and Ethics in England, 1660-1780* (Cambridge: Cambridge University Press, 1991).
[175] Ferguson, *Reason in Religion*, 280.
[176] Ibid., 279.

carefully considered, judged not only appropriate but also beneficial to his audience by the author.

Having established his linguistic principles, it is unsurprising when metaphor becomes a key aspect of Ferguson's dispute with fellow religious controversialist and Anglican clergyman, William Sherlock. In a wrangle over theological issues raised by the writings of Independent John Owen, much of Ferguson's text is devoted to the rebuttal of arguments in Sherlock's *A Discourse Concerning the Knowledge of Jesus Christ* (1674).[177] Sherlock had criticised the belief of some theologians, including Owen, that over and above a knowledge of Christ through scripture, a bodily knowledge of Christ was necessary for salvation: that 'an acquaintance with the Person of Christ […] is the only fountain of saving knowledge.'[178] Sherlock argued that this diminished the gospel to an imperfect source of divine knowledge, implying that a believer 'may thoroughly understand whatever is revealed in the Gospel, and yet not have a clear and saving knowledge of these things, unless [they] gain a more intimate acquaintance with the Person of Christ.'[179] According to this position, a rational understanding of scripture is not sufficient to gain God's grace. Rather, a more embodied, corporeal knowledge of Christ is the only thing which can grant salvation. Scornful of this theory, Sherlock declaims Owen's approach an 'unsafe way of arguing'.[180]

But if Sherlock finds Owen's modes of argument unsatisfactory, Ferguson returns the favour. Arguing that Sherlock, insufficiently handling complicated philosophy, presents only a 'weak & sophistical' case, Ferguson in turn proceeds to dismantle Sherlock's logic by utilising the stomach-as-laboratory trope.[181] The fundamental point at stake here, he argues, is one not only of theology, but also of philosophy. Owen states that the believer must undergo some kind of corporeal union with Christ, a hypostatical conjoining that is more powerful than any rational understanding can be. Citing John 15:5 ('I am the true vine, ye are the branches, he that abideth in me, and I in him, the same bringeth forth much fruit, for without me ye can do nothing'), Sherlock argues that such unity is impossible: 'for it is not very intelligible', he says, 'how we can be or abide in the Person of Christ, and it is more

[177] On this dispute, see Zook, "Turncoats and Double Agents," 367. Owen and Ferguson were, at times, close—Ferguson had been Owen's assistant, preaching alongside him, and received a bequest from his will. See Zook, "Robert Ferguson."
[178] Sherlock, *Discourse*, 37.
[179] Ibid., 39.
[180] Ibid., 40.
[181] Ferguson, *Reason in Religion*, 530.

unintelligible still, how we can be in the Person of Christ, and the Person of Christ at the same time be in Us; which is a new piece of Philosophy called Penetration of dimensions'.[182] The philosophical problem Sherlock refers to here had in fact passed through Scholastic teaching and into mechanical philosophy from Aristotle, with the theory that bodies were impenetrable and that two bodies could not therefore exist in the same space at the same time, opening up a wide range of questions, including the existence of the void.[183] But while most seventeenth-century philosophers were agreed that multiple material bodies could not naturally occupy the same space, in the early modern period exceptions were granted to divine power; Edward Grant argues that 'scholastics would readily have conceded that God could, if He wished, create two or more bodies in the same place simultaneously'.[184] Disregarding even this get-out clause, Ferguson finds another problem in Sherlock's application of this philosophy:

> it seems to have been an apprehension of the Non-conformists owning a Personal Union with Christ, which influenced Mr. Sherlock to tell the World that it is not very intelligible how we can be or abide in the Person of Christ, and that 'tis more unintelligible still, how we can be in the Person of Christ, and the Person of Christ at the same time be in us, which is a new piece of Philosophy, called Penetration of Dimensions. […] the Medium by which he assaults the thing supposed, viz. A personal Union, is weak & sophistical. For as the preexisting Corpuscles of Matter do without any Penetration, or without ceasing to be entitavely [*sic*] as distinct as they were before, come to constitute one Physical Body meerly by being copulated together, and brought into a Continuity; and as the meat which we eat being concocted in the Stomach, that Laboratory of Nature, doth incorporate it self with the previous Corpuscular Particles which constitute our Organical Body, without the coexistency of two or more of them in one and the same Individual place, which is that we style penetration of Dimensions: So I see not but that a Hypostatical Union of Christ with Believers might be easily defended, if Penetration of Dimensions were all the inconvenience it were liable to.[185]

Ferguson does not take issue with Sherlock's conclusions, but with his poor interpretation of the gospel and even weaker philosophical sophistry, arguing that he applies the philosophy of the penetration of dimensions erroneously. It is clear that

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[182] Sherlock, *Discourse*, 147.
[183] On the philosophy of the impenetrability of dimensions, see Edward Grant, "The Principle of the Impenetrability of Bodies in the History of Concepts of Separate Space from the Middle Ages to the Seventeenth Century," *Isis* 69, no. 4 (1978); Roger Ariew and Alan Gabbey, "Body and the Physical World: The Scholastic Background," in *The Cambridge History of Seventeenth-Century Philosophy*, ed. Daniel Garber and Michael Ayers (Cambridge: Cambridge University Press, 1998), 435-36.
[184] Grant, "Impenetrability of Bodies," 553.
[185] Ferguson, *Reason in Religion*, 529-30.

Ferguson considers this an example of when philosophy can be a 'great Nuisance[…] encumbring our Minds with insignificant Terms and idle Phantasms, & deflouring our Virgin Intellects by absurd Dogm's'.[186] Ferguson argues that Sherlock deploys the philosophy of 'Penetration of Dimensions' inappropriately. Adopting a particulate matter theory, Ferguson instead points to physiological examples of the assimilation of one type of corporeal matter within another to disprove his intellectual rival. Ferguson shows that the integration of one substance into another can be, and is, achieved through the processes of procreation, growth and nutrition, without violating the law of the impenetrability of bodies. The human body, he notes, is a single entity made up of multiple distinct and yet unified parts or corpuscles of matter, from different sources. The example of digestion in particular illustrates how parts of a foreign body, in this case food, might become a part of the human body, resulting in the union of different types of matter in the same body without implying that two separate bodies must simultaneously occupy the same space. The capacity of the human body for 'incorporation'—literally the inclusion of one body within another—is clearly demonstrated by the process of digestion.

The laboratory image that is used to depict the stomach is critical in gesturing towards the kinds of compound substances which are so easily made without violating any philosophical tenets of impenetrability. Laboratories were places where different substances were commonly combined and transformed; the image accordingly draws on the idea of chemical activity to indicate the ways in which separate bodies might be joined to and alter one another, including the integration of spirits and aethers with solid and liquid materials. The laboratory could make the ways in which certain types of matter could be incorporated within others visible: theories like Power's, holding that spirits could be contained within denser bodies and released through volatility, gained sway in part because the tools of the laboratory had enabled practitioners to demonstrate processes such as sublimation and distillation, where one substance could in fact be revealed to be made of different constituent parts.

In particular, by drawing on the example of digestion, Ferguson brought the topic of assimilation, which was key to both physiological and theological accounts of digestion in the seventeenth century, to the fore. As with Ferguson's own concerns about religious knowledge, assimilation—the 'process of converting

[186] Ibid., A4v-A5r.

"other" matter into "self'"—had long been understood in terms which bridged the bodily and the epistemological.[187] As Shadi Bartsch, Orland and Spary have shown, the links between assimilating matter through digestion and assimilating knowledge, especially through the scholarly activities of reading, studying and commonplacing, also had a strong classical heritage.[188] For Ferguson, the pilfering collator of other people's arguments, assimilation is used as a counterargument, with digestion used to illustrate the fallacy of another man's philosophising. But it is also, as it is for so many authors, a rhetorical strategy. The stomach-as-laboratory is just one of the ideas assimilated by authors in order to explain their own ideas, and harnessing the power of the laboratory as a signal of its own contemporaneity, it becomes a particularly powerful literary technique, a shorthand gesturing to an argument embedded with reasoning from the latest scientific theories. If, for Ferguson, the laboratory is an almost mystical place of transformation, it is also a site of novel discovery and cutting-edge science.

Ferguson's interest in digestion and assimilation extends beyond its disputational power. Earlier passages in the same chapter discuss different doctrines about the incorporation of Christ in the human body through the Eucharist. Since the earliest years of the Protestant Reformation, digestion, and the transformation of digested substances had been key aspects of the debates around the Eucharist. In particular, Ferguson's description of impanation—a kind of hypostatical union in which the elements of the bread and wine become united with, but are not replaced by, the real body and blood of Christ—becomes a model for conceiving of the kind of bodily union between Christ and man that Owen proposes.[189] This presence of Christ within the wafer or the wine is not dissimilar to the presumed presence of vital spirits within food; as Ferguson's subsequent characterisation of the stomach as a laboratory implies, separated off from the remaining waste matter of the wafer and wine, which the body will discard, the holy spirit is a substance which could be extracted and united with the human body through fermentation in the stomach and transference into the circulatory system, where it might combine with the soul.

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[187] Orland, "Introduction, Assimilating Knowledge," 319.
[188] Shadi Bartsch finds particularly detailed analogies between classical theories of digestion and poetic consumption, mapping the process of reading Persius's satires onto the stages of Galenic digestion: *Persius: A Study in Food, Philosophy and the Figural* (Chicago: Chicago University Press, 2015), 49-50; Orland, "Introduction, Assimilating Knowledge," 319.
[189] Ferguson, *Reason in Religion*, 510.

For Ferguson, the workings of the digestive system are also central to disproving Roman Catholic doctrine on transubstantiation—the notion that the wine and bread *are replaced by* the body and blood of Christ—and the Eucharist as a source of divine Grace. Arguing that transubstantiation privileges the carnal eating and drinking of the host, and thus places Christ, in the most literal sense, in the stomach of the receiver, Ferguson suggests that through this model 'not only sincere Believers, but the most obdurate sinners, providing only they receive the Eucharist, should be united to Him.'[190] But this model, in which, Ferguson implies, Christ becomes not only the rarified spirits contained within the bread and wine, but also the excretable mass of their consumable matter, has a very considerable flaw. 'I neither see of what advantage Faith is to one Communicant, nor of what damage Infidelity can be to another,' Ferguson notes, 'but that the whole of both their securities depends upon this, that their Stomacks be not queasy, and that they have a strong digestion.'[191] He continues: '[e]ither Pauls assertion of some mens eating damnation to themselves is false, or else the Popish Notion of our being united to Christ by the eating of his Flesh under the Species and Accidents of a white Wafer, is so; and which of these is most likely to deserve that Brand, I leave to the umpirage of all Christians.'[192] Clearly privileging the gospel over papal doctrine, he even goes so far as to argue that the Catholic idea of 'cohesion to Christ' is 'lubricous' (a deftly-picked adjective meaning slippery or uncertain); such a union, he argues, 'continues no longer, than till the Form, Figure, and other Accidents of the consecrated Wafer dissolve and vanish. So that instead of an abiding conjunction with Christ, a little time unties the knot, and the incorporation of Christians with Him comes to nothing.'[193] While Ferguson lacks the scatological forthrightness of earlier Reformation pamphleteers, the direction of his argument is clear: according to the Catholic theory of transubstantiation, our union with the divine can last only as long as the wafer does in the digestive tract—and its remainder must then be evacuated from the body. Salvation, in this scenario, would depend on metabolic rate, not morality. Using a classic Reformation argument, Ferguson goes on to note that under

[190] Ibid., 517.
[191] Ibid., 517-18.
[192] Ibid., 518. Ferguson refers to 1 Corinthians 11:29: 'For he that eateth and drinketh unworthily, eateth and drinketh damnation to himself, not discerning the Lord's body.'
[193] Ibid., 519.

these circumstances 'I do not see but that Mice and Rats, &c. may come to be united to Him as well as Believers', should a neglectful priest leave stray wafers about.[194]

The process of digestion, for Ferguson, is a powerful method of conceptually testing the tenets and consequences of theosophical doctrines about the unity of the believer with Christ. If, as Power's work so neatly illustrates, there is a 'physiology of the soul', then physiology can play a valuable role in theological understanding.[195] Nevertheless, while Ferguson redresses Sherlock for his poor sophistry, he fundamentally agrees with his opposition to the notion that a person could really know God through the bodily senses.[196] Ferguson alludes to the sordid nature of such mystic philosophy, decrying it as 'a tattle of an Intime Union with God, whereby the soul becomes Deified.'[197] Nevertheless, despite his own opposition to the notion of bodily union with Christ, Ferguson's rebuttal of Sherlock's penetrability of dimensions theory offers an elegant proposal for the possibility of such a union. In its own way displaying the intelligence and beauty of divine creation in the human body, Ferguson's depiction of the stomach-laboratory—as a sophisticated assimilator and integrator of different types of matter—is a compelling analogical argument, gesturing to how body, soul and spirit might coexist in a productive partnership. As Diarmaid MacCulloch has said, the Eucharist, from the earliest days of the Church, 'has been a way to break down the barrier between the physical and the spiritual, between earth and heaven, death and life.'[198] It was not only the fact that the Eucharist was consumed but also the sense that digestion negotiated this complex boundary between the physical and the spiritual—releasing spirituous matter from food matter, and supplying essential, nutritive spirits for the human body—that made digestion such a powerful analogical and literal tool for probing spiritual, as well as bodily matters.

In Ferguson's calibration, the laboratory of the stomach is also a plausible laboratory of the soul—an example of a site in which the body might be transformed, through the presence of Christ, to a soul possessing true grace. This was a far cry from the laboratories that had graced the stage and page of much early modern literature, which had often seemed to house deception, ridiculous antics, or

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[194] Ibid., 520. See, for example, "The First Examination of Mistress Anne Askew before the Inquisitors. 1545.," in *Foxe's Book of Martyrs: Select Narratives*, ed. John N. King (Oxford: Oxford University Press, 2009), 24.
[195] Orland, "Introduction, Assimilating Knowledge," 319.
[196] Ferguson, *Reason in Religion*, 524.
[197] Ibid., 525.
[198] Diarmaid MacCulloch, *Reformation: Europe's House Divided, 1490-1700* (London: Penguin, 2003), 10.

hellish, dangerous pursuits. Ferguson was not the only one to capture the power of such an image: in a much reprinted sermon influential cleric Jeremy Taylor depicted the laboratory as a site of redemptive and divine alchemy, depicting suffering as 'that Laboratory and Crysable in which God makes his Servants vessels of honour to his glory', and writing that salvation exists only for those 'are fellow-workers with God in the laboratories of salvation'.[199] The laboratory's transformative power offered hope of religious redemption, forged in the fires of God, to the masses.

Conclusion

While the laboratory was a versatile part of the imaginary for those involved in an array of scientific endeavours during the latter half of the seventeenth-century, its most significant deployment was in the repeated tendency to describe the stomach as a laboratory. These metaphors drew precision from the wide but specific array of tools and procedures utilised in the early modern laboratory, but also served to illustrate the various nature of the early modern laboratory, in particular the longstanding overlap between the lab and the kitchen, and the varieties within the debates in digestive science it was used to explain. A symbol of modernity both in the seventeenth century and now, the metaphorical laboratory gestured towards the contemporaneity of the knowledge it alluded to, acting as a shorthand for the cutting edge of scientific and philosophical understanding. But by virtue of its own metaphorical nature, it also embedded modern theories, tools and approaches within more traditional epistemological ecosystems, which integrated empirical evidence alongside analogical forms of understanding, and put newly developed knowledge in the service of much older debates. The laboratory is fundamentally a site of transformation, but the forms of knowledge it produces have altered less over time than we might presume.

[199] Jeremy Taylor, *A Sermon Preached in Christ-Church, Dublin: At the Funeral of the Most Reverend Father in God, John, Late Lord Arch-Bishop of Armagh, and Primate of All Ireland*, (London: printed for John Crooke, 1663), 31; and *The Worthy Communicant, or, a Discourse of the Nature, Effects, and Blessings Consequent to the Worthy Receiving of the Lords Supper and of All the Duties Required in Order to a Worthy Preparation* (London: printed by T.R. for J. Martyn, J. Allestry, and T. Dicas, 1667), 5. Taylor's sermon for John Bramhall, Archbishop of Armagh, was reprinted widely, running through several editions and reproduced in numerous compilations of Taylor's work.

Conclusion

A Multiplicity of Metaphors

If the library in the morning suggests an echo of the severe and reasonably wishful order of the world, the library at night seems to rejoice in the world's essential, joyful muddle.[200]

In 2012, the metaphorical cabinet resurfaced in a very unlikely place when it was wheeled into the centre of a US patent court during a multi-billion-dollar lawsuit fought between two giants of the tech world. Oracle America, the license owners of the Java programming language, were suing Google for using 37 Java APIs without permission in Android, the astronomically successful mobile operating system, which powers smartphones all over the globe.[201]

There was more at stake than the gargantuan $9 billion Oracle sought in damages. Ironically billed as a case on which the 'future of programming' would depend, with the capacity to 'create a radical shift in how software is developed worldwide' and 'upend[…] the economics of software,' the world's technology reporters have followed, eagle-eyed, as the Jarndyce & Jarndyce of the digital age has dragged on for over eight years, that future slowly wasting away before it.[202] At the heart of the case, is the attempt to describe what an API is, and whether one can be copyrightable at all.

An API, or Application Programming Interface, is a term used to describe a group of pre-programmed functions that a software developer can use to allow independent pieces of software to communicate with each other. For example, if a

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[200] Manguel, *Library at Night,* 14.

[201] Though my analysis will focus on reports from the technology media, there has been significant academic interest in this case. For substantial legal analysis of the case to date and its consequences, see: Peter S. Menell, "Rise of the API Copyright Dead? An Updated Epitaph for Copyright Protection of Network and Functional Features of Computer Software," *Harvard Journal of Law & Technology* 31 (2018).

[202] See Klint Finley, "The Oracle-Google Case Will Decide the Future of Software," *Wired* (23 May 2016), https://www.wired.com/2016/05/oracle-google-case-will-decide-future-software/, and Joe Mullin, "Second Oracle v. Google Trial Could Lead to Huge Headaches for Developers," *Ars Technica* (8 May 2016), https://arstechnica.com/tech-policy/2016/05/round-2-of-oracle-v-google-is-an-unpredictable-trial-over-api-fair-use/. Mullin quotes Mitch Stoltz, an attorney for the Electronic Frontier Foundation. In March of 2018, having had judge *and* jury verdicts of a district court successfully appealed twice by the federal circuit, and declined a hearing by the Supreme Court, the case was kicked back down to the district court for a third trial, which is still pending. See: Sarah Jeong, "Federal Circuit Sends Oracle V. Google Back for Third Trial," *The Verge* (27 March 2018), https://www.theverge.com/2018/3/27/17169064/federal-circuit-oracle-v-google-third-trial-java-android.

developer wanted the calendar app she was designing to display live train times, she might use an API. The API provides a shortcut to a pre-fabricated piece of 'implementation' or 'source' code that (in this case) will retrieve the latest train times from another program, and return that information, via an interface, to the user. In this scenario, the developer does not need to know *how* the code to retrieve the train times works, or what it is. She simply needs to know the API will 'call' or access it. Using the API saves the developer a vast amount of time—she does not have to write that function from scratch herself—and potentially improves her program's interoperability, ensuring a smooth interaction with different apps, software languages and programs.

As my attempt at a technical description has no doubt illustrated, an API is a difficult concept to explain; they have been compared to breakfast menus, power plugs, collections of aphorisms, the layout of a QWERTY keyboard, and yoga positions.[203] Alienatingly intangible and abstract, confined to cyberspace and legible only to those fluent in the requisite code, a physical correlate is considered necessary to render it comprehensible to technology's 'laypersons'.[204] This was also deemed true for the juries in Oracle v. Google, who were bombarded with a panoply of metaphorical explanations. Google set the tone with their filing cabinet. Introducing the cabinet in court with what reads humorously like veneration, Google's attorney, Robert Van Nest, remarked:

> And now I actually created -- excuse me, your Honor. I'm going to approach the cabinet. I actually created a cabinet to illustrate this because, again, I think it's important for everybody to understand what we're talking about when we say structure and organization of an API.[205]

The cabinet sat, spectre-like, in the court through several weeks of testimony, an omnipresent visual reminder for the jury of one of the key points of Google's case.

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[203] See for example: Sarah Jeong, "In Oracle v. Google, a Nerd Subculture is on Trial," *Motherboard* (12 May 2016), https://motherboard.vice.com/en_us/article/mg77dy/in-google-v-oracle-the-nerds-are-getting-owned; "In a $9 Billion Trial, Google's Secret Weapon Is a Filing Cabinet," *Motherboard* (11 May 2016), https://motherboard.vice.com/en_us/article/yp33dy/googles-lawyers-tried-to-explain-apis-to-a-jury-using-a-physical-filing-cabinet; "Bikram Yoga Can't Be Copyrighted. Neither Should APIs," *Motherboard* (9 October 2015), https://motherboard.vice.com/en_us/article/nze8qm/bikram-yoga-cant-be-copyrighted-neither-should-apis; Sherwin Siy, "One Reason You Might Still Be Paying $120 for a Ti-89 Calculator: Copyright," *Motherboard* (14 October 2015), https://motherboard.vice.com/en_us/article/wnxeqb/one-reason-why-youre-still-paying-120-for-a-ti-89-calculator-copyright.

[204] Jeong, "Secret Weapon".

[205] Transcript of Proceedings, "Oracle America, Inc. v. Google Inc.," No. C10-3561 WHA (Northern District of California, 17 April 2012), 263.

Google argued that like a filing cabinet, an API was simply a way of organising content. American copyright law distinguishes between functional and creative expression; only the latter is considered copyrightable. Software code, enshrined as 'literature' in law, is subject to copyright. But an API, a structure which both organises and is code, occupies an uneasy legal position. Google's filing cabinet analogy stressed the functional, and thus non-copyrightable, nature of an API. Arguing that an API amounted to the cabinet, its drawers, and the labels on the files inside, but not the contents of the files themselves, Google argued it had simply utilised a technology of organisation. Organising Android's cabinet with the same folder and drawer names as Java's just made it easier for developers to find the thing that they needed. The content of the folders—in this analogy, the Android sourcecode—had been written from scratch by Google engineers, a point Google's lawyers stressed by waving around empty folders in court to illustrate that Google had in effect stolen 'nothing' from Java.[206] In closing arguments, Google's lawyer used repetitive rhetoric to emphasise the cabinet as the best, and perhaps only, way of truly understanding an API. Trying to surmise what precisely Oracle claimed was copyrighted, he declared:

> It's not the language. It's not the names. It's not the implementing code, because that's original […] So what is it? It's only the system of organization. That's what they're trying to protect. The system of organization. And yes, what's that? My file cabinet. My file cabinet. I'm not going to apologize one minute for this because it's the only way I can understand what structure, sequence and organisation are.[207]

Oracle, in later portions of the trial, responded with their own analogy. Opening their briefing documents to the appeals court, they wrote:

> Ann Droid wants to publish a bestseller. So she sits down with an advance copy of Harry Potter and the Order of the Phoenix[…]. She verbatim copies all the chapter titles—from Chapter 1 ("Dudley Demented") to Chapter 38 ("The Second War Begins"). She copies verbatim the topic sentences of each paragraph, starting from the first (highly descriptive) one and continuing, in order, to the last, simple one ("Harry nodded."). She then paraphrases the

[206] Jeong, "Secret Weapon". Google claimed to have implemented a 'clean room' version of Java's APIs. This meant that all of their source code was reverse-engineered or open source, so although it performed the same operations as Java's source code, the code itself was different. Apart from nine infamous lines of identical source code, a function called 'Rangecheck', which was ruled to be insignificant by Judge Alsup, the only identical lines of code in the case were 'declaration' or 'header' lines, which described the functions of the source code.
[207] Transcript "Oracle v. Google," C10-3561 WHA (30 April 2012), 2532.

> rest of each paragraph. She rushes the competing version to press before the original under the title: Ann Droid's Harry Potter 5.0. The knockoff flies off the shelves.
>
> J.K. Rowling sues for copyright infringement. Ann's defenses: "But I wrote most of the words from scratch. Besides, this was fair use, because I copied only the portions necessary to tap into the Harry Potter fan base."
>
> Obviously, the defenses would fail.[208]

Oracle's analogy stressed the creative nature of the copied content. Like Google, they referred to a physical object, one they could bring into court and demonstrate to the jurors. Like Google, they used the metaphor to indicate the place of the copied content in the hierarchy of code. But for Oracle, the copied content was not just labels and titles, but extended to narrative, an overarching, fundamentally creative logic; the content that Google reverse-engineered was equated with the plot of the books. Mark Reinhold, an engineer for Oracle, argued that as well as drawing on the books' titles, chapter names and starting sentences, copying an API also aped 'the connections between the characters[…] Three books later, there are all these deep connections. It's intensely creative,' he continued, 'Like writing a book, you have to keep a lot of stuff in your head, and the end result is rich and complex. A lot of it is about figuring out what structures you want.'[209] The analogy of the API as fictional series offered a framework for understanding its structure as creative, complex, and infinitely more self-referential and expansive than a simple hierarchy. This analogy imagined the API more like a quincuncial lattice; as Douglas Schmidt later claimed in court, an API could represent an 'intricate web of relationships.'[210]

A third interpretation of an API was offered by the presiding Judge William H. Alsup, a proficient software engineer who learnt Java to better understand the technicalities of the case.[211] He wrote:

> An API is like a library. Each package is like a bookshelf in the library. Each class is like a book on the shelf. Each method is like a how-to-do-it chapter in a book. Go to the right shelf, select the right book, and open it to the chapter that covers the work you need.[…] [T]he Java and Android libraries

[208] Opening Brief and Addendum of the Plaintiff-Appellant. "Oracle America, Inc. v. Google Inc.," No. 2013-1021, 1022 (United States Court of Appeals for the Federal Circuit, 11 February 2013), 13.
[209] Joe Mullin, "Oracle Java Architect Conscripts Harry Potter in Making the Case against Google," *Ars Technica* (17 May 2016), https://arstechnica.com/tech-policy/2016/05/round-2-of-oracle-v-google-is-an-unpredictable-trial-over-api-fair-use/.
[210] Joe Mullin, "Java Architect." Mullin quotes Douglas Schmidt, an expert witness for Oracle.
[211] Sarah Jeong, "The Judge's Code," *The Verge* (19 October 2017), https://www.theverge.com/2017/10/19/16503076/oracle-vs-google-judge-william-alsup-interview-waymo-uber.

> are organized in the same basic way but all of the chapters in Android have been written with implementations different from Java but solving the same problems and providing the same functions. Every method and class is specified to carry out precise desired functions and, thus, the "declaration" (or "header") line of code stating the specifications must be identical to carry out the given function.[212]

Finding APIs to be a system of structure and organization, and therefore not subject to copyright, Alsup's metaphor was widely considered (as might be expected from a non-partisan commentator) the most accurate of the three, providing the clearest sense of the order and hierarchy of an API, as well as its organisational capacity. [213] It also gave a clear and immediate sense of how such a system might be replicated without the theft of intellectual property. For example, you might be able to find books on stone carving in the same place in two different libraries, but only if they are both using the Dewey decimal system, and identical labelling conventions.

This very modern legal case is an unlikely correlate to seventeenth-century natural philosophical writing. The prose certainly bears no comparison. But it shines a light on our continuing reliance on spatial metaphor. If an unlucky time-traveller from seventeenth-century England found themselves in this North Californian courthouse the technology under dispute might astound them. But the discourse—metaphors of books, libraries, cabinets, and even webs of connections—would be unnervingly familiar. For almost as long as the written word, humans have used metaphors to explain difficult or abstract ideas. Oracle v. Google proves that no matter how scientifically advanced we consider ourselves, and no matter how high the stakes, we still rely on analogy in order both to model and explain complex theoretical notions. Science and technology, arenas that we like to consider objective, rational, and mathematical, remain fertile ground for the analogical imagination, especially as our explorations move beyond the visible world. Like so many of the ideas that early modern writers used spatial metaphors to explore—the interior of

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[212] William H. Alsup, Order re: Copyrightability of Certain Replicated Elements of the Java Application Programming Interface, "Oracle America, Inc. V. Google, Inc.," No. C10-03561 WHA (Northern District of California, 31 May 2012), 5.

[213] This ruling was later overturned by the US Court of Appeals, in a decision that was heavily criticised, appearing to many commentators as if the appeal judges did not accurately understand what an API was. See for example, Jeong, "Nerd Subculture on Trial". The decision also drew criticism from the legal academy: see Michael R. Mazzellla III and R. Harrison Dilday, "Copyrightability of Application Programming Interfaces and a Fair Use Defense: Oracle America, Inc. V. Google Inc.," *Georgetown Law Technology Review* 62 (2016); Peter S. Menell, "API Copyrightability Bleak House: Unraveling and Repairing the Oracle v. Google Jurisdictional Mess," *Berkeley Technology Law Journal* 31, no. 3 (2016); Pamela Samuelson, "Three Fundamental Flaws in CAFC's Oracle v Google Decision," *European Intellectual Property Review* 37, no. 11 (2015).

the living human body, the cognitive process, the structure of the world, even divine knowledge—an API is theoretical rather than readily graspable. Material objects and spaces provide us with a means of comprehending such intangible ideas; their physical counterparts allow us to touch, see, feel, smell, taste and intuit them.

Modern cognitive science has shown that we learn in relation to the world around us; our recall can be enhanced by smell or colour-coded notes. But writers have known this forever: long before Proust's madeleines became an icon of sensory cognition, for as long, almost, as the written word, writers have been explaining ideas using the spaces and objects that surrounded them. Like so many disciplines, software relies on architectural metaphors to express hierarchies and structures of knowledge, as well as its own endeavours: it is no coincidence that software is often referred to as architecture; its designers are not just programmers but 'engineers' and 'architects'. Of course, these metaphors change with time; despite the uncanny resemblances drawn between an API and the philosophical spaces invoked in Bacon's *Gesta Grayorum*, the metaphors used in Oracle v. Google rely on modern cultural contexts. The filing cabinet is not a place of wonder, but deliberately redolent of dull office infrastructure; we are used to libraries organised according to uniform cataloguing systems, not the idiosyncratic arrangements of the early modern bookshelf. But like our forebears, we cultivate communal spaces in the cultural imagination, drawing on a multiplicity of places and experiences to provide powerful images that are at once particular and universal; and these spaces, like an API, provide metaphorical spaces in which we can communicate with one another.

As I hope to have shown across this thesis, the metaphorical architectures of seventeenth-century literary and scientific texts supported a rich cross-section of society and a wealth of philosophical positions and ideas. In a highly stratified society, in which access to many of the most well-recognised scientific spaces were overseen by a wealthy and exclusive intellectual elite, the page was not only an accessible location around which a broad church of natural philosophers might congregate, from housewives to laborants, medical students to dyers, but also a space for philosophy that they could help to construct.

For many of those involved in early modern philosophy, their knowledge was indelibly shaped by both the physical and metaphorical spaces in which it was made. The shapes and structures of these spaces provided epistemological and formal frameworks for texts and engagements with the world; but the way in which

these spaces were constructed, decorated and organized also reflected the ideological and methodological aims of science. The objects and tools which characterised these spaces could not only be used in the physical production of knowledge, but also became the 'cognitive artifacts,' that, used in an explanatory or symbolic capacity on the page, enabled the transmission of knowledge from one person to another. The book was the place where these real and imaginary architectures met and were encoded, engendering a rich, culturally-inflected landscape. Extended beyond the covers of any single book, the imagined spaces of the page provided a place in which innovative forms of knowledge might be built and occupied.

In his *Gesta Grayorum*, Bacon advocated the building of a philosophical complex. Libraries, gardens, cabinets and stillhouses, he suggested, would provide you with the facilities required to 'bend the excellency of your spirits to the searching out, inventing, and discovering of all whatsoever is hid and secret in the world.'[214] But as we have seen, for early modern people with an interest, however tangential, in natural philosophy, the spaces and places of everyday life already provoked such actions. Though the specialised spaces of early modern science might provide specific and particular forms of knowledge, their imagined structures also meant that an understanding of the natural world could come from anywhere. This sentiment was notably enshrined by Robert Boyle, in his *Occasional Reflections*, when he remarked:

> whereas Men are wont, for the most part, when they would Study hard, to repair to their Libraries, or to Stationers Shops; the Occasional Reflector has his Library always with him, and his Books lying always open before him, and the World it self, and the Actions of the Men that live in it, and an almost infinite Variety of other Occurrences being capable of proving Objects of his Contemplation; he can turn his Eyes no whither, where he may not perceive somewhat or other to suggest him a Reflection.[215]

This metaphor of the library of the world expresses the complex interconnections of space, thought, text and imagination in early modern philosophy. Intrinsically textual and imaginative, knowledge in the early modern period always reflected the real and imagined spaces in which it was built.

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[214] Bacon, *Grays Inn Revels*, 54.
[215] Robert Boyle, *Occasional Reflections Upon Several Subjects, Whereto is Premis'd a Discourse About Such Kind of Thoughts* (London: pinted by W. Wilson for Henry Herringman, 1665), 15.

Note on the Text and Abbreviations

When using early modern sources, I have retained original spelling, though for ease of reading I have silently altered orthographical conventions such as 'i/j', 'u/v', 'vv/w' and the long 's'. Italics and capitalisation are as given in the original text unless noted otherwise. I have omitted information from colophons about printshop and booksellers' locations for reasons of space; this can easily be found on the *ESTC* if required. When working with early modern texts, I have provided page numbers where possible. In cases of no pagination, I have reverted to signatures. All bible citations refer to the King James Version.

A Note on 'Science'

I have used the word 'science' liberally and largely without comment in this thesis to suggest the interests of natural philosophy and its allied disciplines, including, for example, medicine, physiology, botany and physics. Though this is an anachronistic term, and I do not mean to impute its use or meaning to seventeenth-century authors or practitioners, it serves as a useful umbrella term when describing the wide range of pursuits and interests undertaken in their attempts to understand—and manipulate—the natural world.

While some historians of science have used the word 'science' to designate a rationalist and 'modern' approach defined by empirical, quantifiable and replicable observation, my use of the word in relation to the early modern period makes no such positivist assumptions, instead allowing the word to reflect the full range of epistemological approaches that were adopted in attempts to understand the world at this time, from mysticism to mathematics.

Abbreviations

The following abbreviations have been used:

BL British Library

BM	British Museum
EEBO	Early English Books Online <www.eebo.chadwyck.com>
ELH	English Literary History
ESTC	English Short Title Catalogue <www.estc.bl.uk>
GoC	Thomas Browne, *Garden of Cyrus*. In *The Major Works* ed. C.A. Patrides, 317-88. Harmondsworth: Penguin, 1977.
ODNB	Oxford Dictionary of National Biography <www.oxforddnb.com>
OED	Oxford English Dictionary <www.oed.com>
PaF	Margaret Cavendish, *Poems, and Fancies*. London: printed by T.R. for J. Martin and J. Allestrye, 1653.
PMLA	Proceedings of the Modern Language Association
V&A	Victoria and Albert Museum, London

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