The Most Versatile Scientist, Regent, and VOC Director of the Dutch Golden Age: Johannes Hudde (1628-1704)

The person in whom science, technology, and governance came together

Michiel van Musscher, *Painting of Johannes Hudde, Mayor of Amsterdam and mathematician*, Amsterdam, Rijksmuseum (1686).

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Introduction

In the period between 1600 and 1800, 'perhaps the most profound transformation of European, if not human, life' took place.[1] It was a period wherein Descartes' 'new' philosophy was established, Copernicanism gained more ground, and analytical geometry was introduced. Furthermore, in Amsterdam, Spinoza published his controversial *Tractatus*, the most complex waterworks project in the Dutch Republic was completed, and the Dutch East India Company (VOC) made the city one of the commercial centres of the world.[2] All these developments are connected via one of the most extraordinary erudite regents of the seventeenth century: Johannes Hudde (1628-1704). Hudde was seen as one of the greatest scholars by his contemporaries, although today he is nearly forgotten.[3] Professor Eric Jorink even wrote that 'Hudde … is an intriguing person, of whom too little is known', while in the eighteenth century, the poet Thomas Arents wrote: 'Lord Hudde's name shall live until the end of times.'[4] What happened to one of the most gifted mathematicians and scholars of his time, mayor of Amsterdam, and director of the VOC?[5]

This thesis represents an excavation of Hudde's life, and is an attempt to answer the question 'Who was Hudde as a natural philosopher, and how can we characterize him as a versatile scientist, regent and director of the VOC?' In the search for an answer, we will not only explore the life of one of the most interesting scholars of the Dutch Golden Age, but also receive an insight into the dynamic Dutch Republic on topics such as technological and scientific inventions, Bible criticism, (natural) philosophy, governance, politics, and the underexposed history of Amsterdam after the Disaster Year (1672). Since Hudde operated on the borders of 'science', technology, and governance, investigating his life is eminently interdisciplinary, which is precisely what characterises him. Therefore, this thesis is not only a description of Hudde's life, but also analyses the mathematical and philosophical framework from which he operates. Moreover, he is placed in context, through which we can evaluate to what extent Hudde was part of a wider current, or unique in his kind.

Since Hudde has never been the subject of comprehensive research, this is the first time that he has been analysed from an inter-disciplinary perspective.[6] In current historiography, Hudde is

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1 See: Alan Charles Kors, *Birth of the Modern Mind: The Intellectual History of the 17th and 18th Centuries* (1998).

2 Jaap Evert Abrahamse, *De grote uitleg van Amsterdam. Stadsontwikkeling in de zeventiende eeuw* (Amsterdam 2010) 308.

3 'Johannes Hudde: veelzijdige wetenschapper en regent', (2017) National Library of the Netherlands, consulted at 12 October 2017, https://www.kb.nl/nieuws/2017/johannes-hudde-veelzijdig-wetenschapper-en-regent.

4 Thomas Arents, *Mengel poezy* (1724) 80. Eric Jorink, 'In the Twilight Zone. Isaac Vossius and the Scientific Communities in France, England and the Dutch Republic' in: Eric Jorink and Dirk van Miert (ed.), *Isaac Vossius (1618-1689) Between Science and Scholarship* (Leiden 2012) 119-156, especially, 153. Zie ook: A.J. van der Aa, *Biografisch woordenboek der Nederlanden*, vol. I (Haarlem 1852) 350-351.

5 Gottfried Wilhelm Leibniz to Johan Bernouilli, 23 February 1697, in: C.I. Gerhard (ed.), *Leibnizens Mathematische Schriften*, vol. III (Halle 1855) 369-371, especially, 370.

6 A collection of essays is expected in the summer of 2018 by the contributors of the symposium about Hudde held on June 1, 2017. See footnote 3.

generally mentioned in several lines as a mayor of Amsterdam or a brilliant mathematician.[7] Only a few researchers have conducted detailed studies of single aspects of Hudde's life. The most significant contributions have been made by professor Rienk Vermij, who wrote on Hudde's life in the 1650s and 1660s, with a strong emphasis on dioptrics and the pamphlet war.[8] Furthermore, Cornelis de Waard (1879-1963), whose work can be seen as the point of departure for every study on Hudde, wrote a short and accurate summary on Hudde's life and merits.[9] This was further supplemented by J. MacLean, who gathered together some sources about Hudde that he analyses briefly and not always very accurately.[10] Along with Hudde's work on dioptrics, his correspondence with Spinoza and Locke and his merits in mathematics have been the best studied. Karlheinz Haas wrote a dissertation on Hudde's mathematical works, while the Dutch philosopher and Spinoza specialist Wim Klever carried out a reconstruction of Hudde's question about God's uniqueness.[11] On these three topics, I only discuss matters that remain underexposed or are of vital importance for this work.

Besides the established historiography, more researchers have devoted attention to Hudde since the symposium organised by the Koningklijke Bibliotheek (National Library of the Netherlands) in 2017, such as Fokko Jan Dijksterhuis, Eric Jorink, and Huib Zuidervaart.[12] However, Hudde is only a part of their research, rather than the main subject.[13] Nevertheless, some researchers who demonstrated their research at the symposium joined forces to publish a collection of essays on Hudde to put him back on the research agenda. Since then, new source material on Hudde has been found which provides us with more information about one of the most interesting scholars and most influential governors of the end of the Dutch Golden Age. Furthermore, it provides the opportunity to

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7 Peter Jan Knegtmans, *Amsterdam. Een geschiedenis* (Amsterdam 2011). Fokko Jan Dijksterhuis, 'Moving Around the Ellipse. Conic Sections in Leiden, 1620-1660' in: Sven Dupré, Christoph Lüthy (ed.), *Silent Messengers. The Circulation of Material Objects of Knowledge in the Early Modern Low Countries* (Berlin 2011) 89-124. Klaas van Berkel, 'Johannes Hudde', in: ibidem (ed.), *The History of Science in the Netherlands. Survey, Themes and Reference* (Leiden/Boston 1999) 476-478.

8 Rienk Vermij, 'Bijdrage tot de bio-bibliografie van Johannes Hudde', *Gewina*, vol. 18, no. 1 (1995) 25-35. Ibidem, 'Instruments and the Making of a Philosopher. Spinoza's Career in Optics', in: *Intellectual History Review*, vol. 23, no. 1 (2013) 65-81. Ibidem, *The Calvinist Copernicans. The reception of the new astronomy in the Dutch Republic, 1575-1750* (Amsterdam 2002) 281-294. Ibidem & Eisso Atzema, 'Specilla circularia: an Unknown Work by Johannes Hudde', *Studia leibnitiana*, vol. 27, no. 1 (1995) 104-121.

9 Cornelis de Waard, lemma 'Hudde' in: Molhuysen, P.C. & Fr. K.H. Kossmann (ed.), *Nieuw Nederlands Biografisch Woordenboek*, vol. I (*NNBW*) (Leiden 1911) 1171-1176.

10 J. Mac Lean, 'De nagelaten papieren van Johannes Hudde', *Scientiarum Historia*, vol. 13 (1971) 144-162, especially, 146. For example: it is blunt to state that Hudde became mayor because he favoured William III.

11 Wim Klever, 'Hudde's question on God's uniqueness; A reconstruction on the basis of Van Limborch's correspondence with John Locke', *Studia Spinozana: An International and Interdisciplinary Series*, vol. 5 (1989) 327-358. Ibidem, *John Locke (1632-1704). Vermomde en miskende Spinozist* (Vrijstad 2008). Ibidem, 'Een curieuze kwestie: Hudde in discussie met Spinoza, Van Limborch, Locke, en De Volder', (originally published on: benedictusdespinoza.nl 2009). Karlheinz Haas, *Die Mathematische Arbeiten von Johannes Hudde* (Dissertation at the University of Tübingen, Copenhagen 1956).

12 See footnote 3.

13 Dijksterhuis, 'Moving Around the Ellipse', 89-124. Jorink, 'In the Twilight Zone', 119-156. Huib J. Zuidervaart & Veerle Beurze, 'Samuel Carolus Kechel ab Hollenstein (1611-1668). Wiskundige en astronoom in de marge van academisch Leiden', *Leids Jaarboekje* (2014) 25-58. Huib J. Zuidervaart & Douglas Anderson, 'Antony van Leeuwenhoek's microscopes and other scientific instruments: new information from the Delft archives', *Annals of Science*, vol. 73, no. 3 (2016) 257-288.

study the world of which Hudde was a part. He was in a sense a *homo universalis* who operated in the disciplines we would currently call (applied) science, technology, governance, and philosophy. This makes it not only interesting to study Hudde for his own sake, but, as I shall argue, he is of vital importance in understanding Dutch history in the final phase of the seventeenth century.

Who was Hudde and which aspects of his life will be highlighted? Throughout his life, Hudde worked and corresponded with scholars such as Gottfried Wilhelm Leibniz (1646-1716), Baruch Spinoza (1632-1677), Johan de Witt (1625-1672), Christiaan Huygens (1629-1695), and Frederik Ruysch (1638-1731), and was educated by the Cartesian-inspired Johannes de Raeij (1622-1702) and Frans van Schooten, Jr. (1615-1660). From his birth until he was admitted to Leiden University in 1653, we know almost nothing about him. Since he was 25 years old at that time, he probably had been educated at a Latin school like his brother Jonas (ca. 1623-1653).[14] His brother Hendrick (1619-1677) was already graduated in law at that age.[15] Moreover, it is likely that Hudde had already received some education in Cartesian philosophy before enrolling to live and study with the natural philosopher De Raeij, who taught physics at Leiden.[16]

We do, however, know something about the world Hudde lived in before he went to university. From an intellectual perspective, René Descartes published his *Discours de la méthode* (1637), *Meditationes* (1641), and the *Principia philosophiae* (1644), while Galileo Galilei (1564-1642) published his *Dialogo* (1632). Both scholars had a tremendous impact on the early modern world due to their questioning of Aristotle's authority, especially in natural philosophy. Galileo pointed out that one's state of uniform motion is undetectable in principle by using the example that is known as Galileo's ship.[17] Galileo used this argument against his Aristotelian opponents, who maintained that if the Earth moved (around the sun or its axis) we would notice, because we would then be left behind. Hudde used a similar argument against the theologian and Aristotelian Jacobus du Bois (1607-1661) in the section on the pamphlet war in this thesis. However, Galileo's work was the first signal that the concept of motion (and thus the notions of space and time) may not be what they seem. Observing that the stars turn around us need not mean that the stars are in fact turning around us: it may just as well mean that we are turning ourselves. Today Galileo's notion is known as Galilean invariance or the principle of relativity.

Descartes is even more important in the framework of this thesis. The philosopher abandoned Aristotle's idea of a finite universe, which makes it difficult to define both position and motion. However, a solution for this was the invention of the Cartesian coordinates, which leads to algebraic

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14 Stadsarchief Amsterdam/City Archives Amsterdam (SA), Collectie Stadsarchief Amsterdam: personalia [access number 30579], Hudde, Jonas, inv. nr. 882.

15 G. du Rieu, *Album Studiosorum Academiae Lugduno Batavae 1575-1875* (The Hague 1875) 348.

16 Universiteitsbibliotheek Leiden/University Library Leiden, Archieven van Senaat en Faculteiten 1575-1877 (ASF), *Volumina inscriptionum 1645-1662*, vol. X, fol. 380: '1 May [1654]. Johannes Hudde, Amstelodamensis, annorum 25, medicina studiosus, apud d. de Raeij'.

17 Julian B. Barbour, *The Discovery of Dynamics. A study from a Machian point of view of the discovery and the structure of dynamical theories* (Oxford 2001) 352-450.

or numerical representation of geometrical objects; geometry was, therefore, no longer separated from algebra, which is of fundamental importance when discussing Hudde's commentaries on Descartes' *Geometria*.[18] Moreover, Descartes' definition of motion, expressed in his *Principia*, states that motion is fundamentally relative to other bodies, which was extremely influential for the conceptual analysis of motion, especially for Hudde's correspondents, Leibniz, and Huygens.[19]

Against this background and the rise of Cartesian philosophy as opposed to the scholastic tradition, the first three chapters will be discussed. In the first chapter I investigate the clash between the two worldviews. On the one hand is Cartesianism, represented by Hudde's teacher with whom he lived in Leiden, the philosopher De Raeij. On the other hand is Aristotelianism, represented by the Utrecht theologian Gisbertus Voetius (1589-1676). The clash between these two worldviews also had a strong political and theological component that is discussed extensively by for example Rienk Vermij and Theo Verbeek.[20] However, I restrict myself to the experiences of De Raeij, defending his beliefs as opposed to the dominant convictions of scholasticism. Moreover, I discuss De Raeij's *Clavis philosophiae naturalis* (1653), in which De Raeij provides a justification for Descartes' natural philosophy, in some detail since Hudde lived with De Raeij while he wrote it. In short, the section on Hudde's teacher provides an insight into the culture in which Hudde was educated and gives the context for the next chapter, in which it is not De Raeij, but Hudde himself who becomes involved in the conflicting worldviews.

Chapter Two investigates the pamphlet war of 1656, with a focus on Hudde and Du Bois, who argued for heliocentrism and geocentricism respectively. In Chapter Three Hudde's merits in mathematics are discussed, in which the meeting point of practical and theoretical mathematics is represented by his teacher, Van Schooten. This mathematician was a friend of Descartes and was also trained in the 'new' French mathematics represented by the philosopher as well as the scholars François Viète (1540-1603) and Pierre de Fermat (1601-1665). Hudde's merits lay in analytic geometry, and especially his improved method for solving complex equations, which can be seen as a step towards the differential calculus.[21]

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18 Frans van Schooten (ed.), *Geometria à Renato Descartes* (Amsterdam 1659). See for more detailed information on the history of geometry and the development since Josephus Justus Scaliger, François Viète, Pierre de Fermat, René Descartes, Franciscus van Schooten, Gottfried Wilhelm Leibniz and Isaac Newton: Henk J. M. Bos, *Redefining Geometrical Exactness. Descartes' Transformation of the Early Modern Concept of Construction* (New York 2001) 119-158, 167-182, 205-428. Ibidem, 'Tradition and modernity in early modern mathematics: Viète, Descartes and Fermat', in: Catherine Goldstein, Jeremy Gray, & Jim Ritter, *L'Europe mathématique. Histoires, Mythes, Identités* (Paris 1996) 183-204. Ibidem, 'Descartes en het begin van de analytische meetkunde', in: J.W. de Bakker (ed.), *CWI Syllabus – Centrum voor Wiskunde en Informatica. Vakantiecursus 1989. Wiskunde in de Gouden Eeuw* (Amsterdam 1998) 79-98. Jan P. Hogendijk, 'The Scholar and the fencing master: The excanges between Joseph Justus Scaliger and Ludolf van Ceulen on the circle of quadrature (1594-1596)', in: *Historia Mathematica*, vol. 37 (2010) 345-275.

19 Barbour, *The Discovery of Dynamics*, 406-497.

20 Vermij, *The Calvinist Copernicans*. Theo Verbeek, *La Querelle d'Utrecht. René Descartes et Martin Schoock* (Paris 1988). E.G.E. van der Wall (ed.), *Een richtingstrijd in de Gereformeerde Kerk. Voetianen en coccejanen 1650-1750* (Zoetermeer 1994).

21 Jeff Suzuki, 'The Lost Calculus (1637-1670): Tangency and Optimization without Limits', *Mathematics Magazine*, vol. 78, no. 5 (2005) 339-353.

Chapter Four is concerned with lenses and the invention of the microscope. Experimental philosophers such as Hudde, Huygens, and Robert Hooke (1635-1703) made a world visible that was once hidden from view.[22] Hudde, therefore, was part of a wider current of natural philosophers who were interested in lenses and the study of light. However, Hudde's lenses were to a certain extent unique, since instead of grinding, he melted glass into small globules that functioned as lenses. His model of a single lens microscope led to significant scientific discoveries in the hands of Nicolaas Hartsoeker (1656-1725), Antoni van Leeuwenhoek (1632-1723), and Jan Swammerdam (1637-1680).[23] Aside from his practical work, Hudde's recently discovered printed edition of the *Specilla Circularia* (1656), in which he provides a theoretical justification for the practical operation of lenses, is also discussed in this chapter.[24]

The fifth chapter can be seen as the background for the second part of the thesis, which investigates Hudde's achievements in public service and as director of the VOC. This chapter is concerned with Hudde's personal beliefs, which he discussed in utmost secrecy from 1666 to 1698. The chapter investigates a controversial matter in which Hudde sought advise from Spinoza and John Locke (1632-1704). It concerns Hudde's quest for proof that only one God exists, rather than multiple gods. The detailed analysis of Hudde's correspondence with the two philosophers provides an insight into the Cartesian framework from which Hudde operated and clarifies why he made certain decisions in the period he held public office. Furthermore, it situates Hudde in a wider network of philologists and Bible critics, such as Spinoza, Locke, and Jean LeClerc (1657-1736). Their work, and philology in general, eroded the authority of Scripture as a univocal guide to moral conduct in society; many *adiaphora* had to be abandoned through the Church in favour of the central moral message of Christ.[25]

The second part of the thesis discusses the road Hudde took after his return from the Grand Tour in 1659. He returned to Amsterdam, where at first he worked on series expansion and probability with Spinoza and Johan de Witt, and also on the practice of making lenses, as is discussed in the chapter on microscopy.[26] In 1667, he became a regent of Amsterdam and obtained public office. The sixth chapter is concerned with Hudde's road to becoming mayor, whereby the city of Amsterdam and the States-General benefitted from his expertise in practical and theoretical mathematics. Furthermore,

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22 Vermij, 'Instruments and the Making of a Philosopher', 67. Fokko-Jan Dijksterhuis, *Lenses and Waves. Christiaan Huygens and the Mathematical Science of Optics in the Seventeenth Century* (Dordrecht 2004). Robert Hooke, *Micrographia or Some Physiological Descriptions of Minute Bodies made by Magnifying Glasses with Observations and Inquiries thereupon* (London 1665). Luuc Kooijmans, *Gevaarlijke kennis. Inzicht en angst in de dagen van Jan Swammerdam* (Amsterdam 2008). Zuidervaart & Anderson, 'Antony van Leeuwenhoek's microscopes'.

23 Ibidem, 260-262. See also: H.L. Houtzager, 'Johannes Hudde en zijn vergrotende glazen bolletjes', *Scientiarum Historia*, vol. 31 (2005) 155-163.

24 'Specilla Circularia, Johannes Hudde over telescopen', (2017) National Library of the Netherlands, consulted at 12 October 2017, https://www.kb.nl/themas/boekgeschiedenis/specilla-circularia-johannes-hudde-over-telescopen.

25 Dirk van Miert, *The Emancipation of Biblical Philology in the Dutch Republic, 1590-1670* (Oxford 2018). [Baruch Spinoza], *Tractatus Theologico-Politicus* (Amsterdam 1670). John Locke, *An Essay Concerning Human Understanding* (London 1689). Jean LeClerc, *Ars critica, in qua ad studia linguarum Latinæ, Græcæ & Hebraicæ via munitur* (Amsterdam 1697).

26 De Waard, lemma 'Hudde', 1173. Ian Hacking, *The Emergence of Probability. A philosophical study of early ideas about probability, induction and statistical interference* (Cambridge 1975) 111-121.

this chapter discusses the internal politics in the Republic and Amsterdam. It demonstrates the power of family networks in the consolidation of power in the Golden Age in line with Luuc Kooijman's work *Vriendschap* (2016).[27]

From a cultural perspective, I proceed as a book historian into the world of controversial publications. I investigate Hudde's role as a patron for authors who were under attack from the ecclesiastical authority, especially from the Voetian camp. The works that I will address are Spinoza's *Tractatus Theologico-Politicus* (1670), Gregorio Léti's (1630-1701) *Critique historique* (1697), and Balthasar Bekker's (1634-1698) *De Betoverde Weereld* (1691). In combination with the chapters on the pamphlet war and the existence of one God, this section provides a new insight into book censorship during Hudde's term as mayor. Furthermore, it ties into to Jonathan Israel's thesis on the Radical Enlightenment, in which I will argue that the role of Spinoza's *Tractatus* is overstated.[28]

In the last two chapters, governance, science, and technology come together. Hudde's role as a mayor is investigated based on street lighting; fire prevention; and the quantity, quality, and availability of water. First, this chapter is an exposition of Hudde's technological innovations for the city of Amsterdam, which provided him with great honour and everlasting influence. Second, Hudde symbolises a more general tendency in which mayors without a university degree or graduated in law were replaced by highly educated scholars (in natural philosophy). This resulted in more sustainable solutions in public matters and a new governing style that was manifested after the Disaster Year of 1672.[29]

The final chapter proceeds along a similar line, but focusses on Hudde's role as director of the VOC. He worked together with Huygens on a marine clock to calculate longitudes at sea, and was supervisor of a project that aimed to make ships self-sufficient in producing their own drinking water. Through the distillation of seawater into drinking water, Hudde thought that he could improve the health and well-being of the sailors and reduce the costs of illness and death. In addition, his insistence on keeping a company history helped to prevent errors and mistakes by the directors. This chapter argues in favour of the claim that as a mayor and company director, Hudde searched for sustainable solutions for the greater good.

Throughout this thesis, I hope to provide some insight into Hudde's complex life, so that the reader can have an idea of who Hudde was and especially how he was related to the more profound changes surrounding him. Therefore, investigating Hudde's life is not solely valuable for the biographical content it provides, but it also offers a window through which to study to one of the most interdisciplinary scholars of the early modern period. After all, this was a period in which scholars worked in both the humanities and the natural sciences, often while holding public office and serving as directors of large companies. Modern scholars could certainly learn from their example.

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27 Luuc Kooijmans, *Vriendschap en de kunst van het overleven in de zeventiende en achttiende eeuw* (Amsterdam 2016).

28 Jonathan I. Israel, *Radical Enlightenment. Philosophy and the Making of Modernity 1650-1750* (Oxford 2001).

29 Abrahamse, *De grote uitleg van Amsterdam*, 198.

Chapter 1

Hudde as a student of the Cartesian philosopher Johannes de Raeij

The master as student

On May 1st, 1653, Johannes Hudde enlisted himself as a medical student at Leiden University and a resident in the house of professor Johannes de Raeij.[30] De Raeij, who was graduated in philosophy and medicine, was known as a Cartesian and a friend of René Descartes. In his younger years, he himself was a student of the Cartesian Henricus Regius (1598-1679).[31] Under Regius' professorship, De Raeij was an active student. In 1641, he publicly defended Cartesian propositions, which were part of Regius' work. Regius wanted to publish a Cartesian-inspired philosophical work that year, but Descartes advised him against it.[32] Therefore, Regius translated his philosophical work into a series of theses that were defended by his students in April and May. These works promoted the 'new philosophy' of Descartes and were critical of the scholastic tradition that was dominated by Aristotelian philosophy and taught by Regius' colleagues.[33] Regius' commentaries on Aristotle were not appreciated by his colleagues, especially not by the rector of Utrecht University and professor theology Gisbertus Voetius (1589-1676).[34]

These events took place in the same year that Regius read Descartes' unpublished work *Le Monde*.[35] The natural philosophy of *Le Monde* rejected scholastic forms and qualities as philosophical entities that contributed nothing to an explanation of natural phenomena.[36] In the eyes of Voetius, Regius and Descartes undermined the philosophical foundation of Calvinism as it was taught in Utrecht. Regius and Descartes tried to defend their position against Voetius through physical laws and natural phenomena.[37] In February 1642, Regius sent a treatise stating his viewpoint to Rector Voetius, which had the result that a month later, Regius was not allowed to teach natural philosophy and was

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30 University Library Leiden, ASF, vol. X: *Volumina inscriptionum 1645-1662*, fol. 380: '1 May [1654]. Johannes Hudde, Amstelodamensis, annorum 25, medicina studiosus, apud d. de Raeij'. For more information on De Raeij see: Wiep van Bunge (ed.), *The dictionary of seventeenth and eighteenth-century Dutch philosophers*, vol. II (Bristol 2003) 813-815.

31 G.C.B. Suringar, 'Invloed der Cartesiaansche Wijsbegeerte op het natuur- en geneeskundig onderwijs aan de Leidsche Hoogeschool', in: *Nederlands Tijdschrift voor Geneeskunde*, no. 8 (1864) 153-170, especially, 153. See for more information about Regius: M.J.A. de Vrijer, *Henricus Regius. Een "Cartesiaansch" hoogleraar aan de Utrechtsche Hoogeschool* (The Hague 1917). For the entire conflict read: Verbeek, *La Querelle d'Utrecht*, especially, 149-167. For more information on De Raeij: Theo Verbeek, 'Tradition and Novelty: Descartes and Some Cartesians', in: Tom Sorell (ed.), *The Rise of Modern Philosophy. The Tension between the New and Traditional Philosophies from Machiavelli to Leibniz* (Oxford 1993) 167-196, especially, 188-196.

32 Ibidem, 157.

33 See for example the disputation of Regius' student Henricus van Loon on 8-12-1641. He argues for Descartes' dualism that the human spirit and body are two separated substances. See: 'Henricus Regius', (2015) *Stanford Encyclopedia of Philosophy*, consulted on: 1 April 2018, https://plato.stanford.edu/entries/henricus-regius/.

34 Edward G. Ruestow, *Physics at seventeenth and eighteenth-century Leiden. Philosophy and the new science in the university* (The Hague 1973) 36.

35 Theo Verbeek, 'The invention of nature. Descartes and Regius', in: Stephen Gaukroger (ed.), *Descartes' Natural Philosophy* (London 2000) 149-167, especially, 152-162.

36 Charles Adam & Paul Tannery, *Oeuvres de Descartes*, vol. XI (Paris 1909).

37 Ibidem, *Oeuvres de Descartes*, vol. III (Paris 1899) 505. René Descartes to Henricus Regius, 3/4 February 1642 in: Erik-Jan Bos, *The Correspondence between Descartes and Henricus Regius* (Utrecht 2002) 113-118.

therefore restricted to teaching medicine. Moreover, with the approval of the municipality, the University Senate ruled that teaching Cartesian philosophy was prohibited. [38]

Thereafter, De Raeij decided to complete his education in medicine and philosophy at Leiden University under the supervision of the Cartesian-inspired professor Adriaan Heereboord (1614-1661). Descartes wrote to Alphonse Pollot (1602-1668), chamberlain of the Prince of Orange (1584-1674) and friend of Elisabeth of the Palatinate (1618-1660), that 'Heereboord cited him [Descartes] with greater praise than Regius had ever done', meaning that De Raeij was tutored by perfervid Cartesians.[39] On July 15th, 1647, De Raeij received his doctorate in philosophy under Heereboord, and the day after in medicine under Adolf Vorstius (1597-1663).[40]

After receiving his degrees, De Raeij started his career at Leiden University as a private tutor. However, only a year later, he disturbed the promotion of one of Adam Steuart's (1591-1654) students, which resulted in a fight. Steuart complained to the curators about the 'Cartesians' Heereboord and De Raeij, who disrupted the promotion.[41] De Raeij was summoned by the curators to answer for his actions. He managed to soften the allegations; however, for a short time he was not allowed to teach in public and was bound to the philosophy of Aristotle.[42] Heereboord's punishment was more severe: in the following years, he could not act as a promoter or teach in metaphysics.[43]

Five years later, a similar situation occurred.[44] However, this time it was not De Raeij, but Hudde who as a student was part of a controversy between his teacher and his opponents that would teach him important lessons for his later life. In the period during the 1650s that Hudde resided with his professor, De Raeij taught medicine and physics at Leiden University.[45] Therefore, it is not unlikely that as a medical student, Hudde received lessons in both disciplines. Moreover, in the year Hudde lived with him, De Raeij wrote and published his natural philosophical work *Clavis philosophiae naturalis*.[46]

In this book, De Raeij made an attempt to justify his epistemological foundation for his version of Cartesian philosophy by associating it with the philosophy of Aristotle. Since Hudde would have observed his professor writing the *Clavis* at home and at the university, it is essential to elaborate

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38 Suringar, 'Invloed der Cartesiaansche Wijsbegeerte', 157.

39 René Descartes to Alphonse Pollot, 8 January 1644 in: Charles Adam & Paul Tannery, *Oeuvres de Descartes*, vol. IV (Paris 1901) 76-78, especially 77.

40 Van Bunge (ed.), *The dictionary*, II, 813.

41 P.C. Molhuysen (ed.), *Rijks Geschiedkundige Publicatiën. Bronnen tot de geschiedenis der Leidsche universiteit 1574-1811*, vol. III (The Hague 1918) 10, 16, 13.

42 Ibidem, 15-17.

43 Ibidem, 16, 28, 40-41. Wiep van Bunge, *From Stevin to Spinoza. An Essay on Philosophy in the Seventeenth-Century Dutch Republic* (Leiden 2001) 34-64. For more information on the Utrecht and Leiden crisis, read: Theo Verbeek, *Descartes and the Dutch. Early Reactions to Cartesian Philosophy, 1637-1650* (Carbondale 1992) 13-51.

44 Molhuysen (ed.), *Leidsche universiteit*, III, 76.

45 Ibidem, 54, 76, 153-154 en 157-159.

46 Johannes de Raeij, *Clavis philosophiae naturalis, seu introductio ad contemplationem naturae Aristotelico-Cartesiana* (Leiden 1654).

on this work. Multiple ideas explicated in this book left their marks on Hudde, traces of which will be identified in later chapters.

Descartes' natural philosophy in De Raeij's Clavis

Physics in the seventeenth century was part of the discipline of philosophy, in which an epistemological foundation was necessary to be taken seriously.[47] The Cartesian foundation can be found in Descartes' metaphysics and his method: hyperbolic doubt. Descartes' methodological scepticism is a method he used to question his assumptions and to arrive at 'certain' knowledge.[48] Everything starts with the perception 'I doubt,' resulting in the phrase: '*cogito, ergo sum*,' or 'I think, therefore I am,' in which a 'thinking' substance is supposed.[49] Descartes observes that '*cogito*' is known only from the fact that it is 'clearly and distinctly' perceived by the intellect.[50] Hence, he sets up clear and distinct intellectual perception, independent of the senses, as the mark of truth.[51] On the base of his dualism – thinking and extended substance – Descartes proves that God exists. Since God is not a deceiver, He is the source of all the truth, like the clear and distinct ideas that are perceived by humans.[52]

The basis of Descartes' metaphysics is explained in his *Meditationes* and the first part of the *Principia philosophiae* (1644). His mechanics are presented in the second part of the latter book, which is fundamental for De Raeij's *Clavis*. In this section, Descartes states that God is the cause of all movement, whereby the total amount of motion in the universe stays the same. This results in Descartes' principle of the conservation of motion.[53] From this principle, three natural laws can be derived, which can be perceived by humans and seen as secondary causes of change. Only the first two laws, which result in the principle of inertia, will be discussed here. The first law states that only an external cause can change the movement of a substance. The second law contains the principle of uniform rectilinear motion.[54]

From the three laws, De Raeij derived various principles that he called *præcognita*. These *præcognita* provide detailed *a priori* knowledge of the physical world. According to De Raeij, this is philosophical knowledge as opposed to empirical knowledge, which is useful but unreliable. The philosopher's wisdom derives from knowledge of the 'first cause', which is lacking among the 'common' people.[55] A similar distinction between the knowledge of the philosopher and that of the

47 For more information about Descartes' physics see: Barbour, *The Discovery of Dynamics*, 406-450. Dennis G.B.J. Dieks, 'Descartes en de fysica', in: Willem Koops (ed.), *Née Cartésienne/Cartesiaansch Gebooren. Descartes en de Utrechtse Academie 1636-2005* (Assen 2005) 70-82.

48 Charles Adam & Paul Tannery, *Oeuvres de Descartes*, vol. VII (Paris 1904) 17-23.

49 Ibidem, 140.

50 Ibidem, 35.

51 Ibidem, 35, 62, 73.

52 Ibidem, 52-90.

53 Ibidem, *Oeuvres de Descartes*, vol. VIII (Paris 1905) 61-62.

54 Ibidem, 62-65.

55 De Raeij, *Clavis philosophiae*, 31-32.

people can be found in Aristotle's *Metaphysics*. Aristotle argues that the 'wise' know why something is as it is, while the people are only capable of determining that something is as it is.[56] However, a significant difference between Aristotle and De Raeij is that for De Raeij, philosophical knowledge relates to rational knowledge and empirical knowledge relates to the people, while Aristotle values empirical knowledge as real knowledge.[57] Through this statement, De Raeij criticised people who are devoted to Aristotle, since he argues that 'they', his colleagues, only have ordinary knowledge rather than philosophical knowledge. True knowledge can only be obtained through the *præcognita*, i.e., Cartesian physics.[58]

In the *Clavis*, De Raeij makes a distinction between four *præcognita*, which he details in one or two chapters. In his second *præcognitum*, for example, he ties his first *præcognitum* to Descartes' first natural law.[59] De Raeij tries to justify this *præcognitum* by appealing to Aristotle's *Metaphysics*, as criticising his work. De Raeij refers to *Metaphysics* book 12 wherein the Greek philosopher argues that matter cannot move from itself.[60] For Descartes this is similar to his first principle, whereby an external stimulus is necessary to change the position of a certain piece of matter. This is contrary to Aristotle's notion of movement, which is 'change' in general. Movement for Aristotle is not only caused by *causa efficiens* but also by *cause finales*. An apple does not only fall from the tree through the wind, but also because it is on the ground at 'rest'. De Raeij concludes his argument with a rhetorical trick, by stating that it is evident that substance can only be moved by an external cause, and that he cannot believe that people could doubt or deny this.[61]

Every *præcognitum* is outlined via a similar method of justifying Cartesian principles through Aristotle's philosophy. During this process, De Raeij criticises his colleagues trained within the boundaries of Aristotelianism by declaring that they argue from ordinary knowledge instead of philosophical knowledge. In his *epistola*, De Raeij declares that he can appeal to Aristotle's work on the one hand, and criticise it on the other hand. He argues that the supporters of Aristotle did not go back to the original sources, but to the commentaries of Averroes/Ibn Rushd (1126-1189), who based his work on poor translations of Aristotle. De Raeij even argues that if Aristotle were still alive, he would not recognise himself in these commentaries.[62] The followers of the Greek philosopher were, in De Raeij's eyes, nothing more than blind sheep who used poor translations instead of thinking critically.[63] Therefore, the philosophy of Aristotle is valuable, according to De Raeij, but it had to be

56 Aristotle, *Metaphysics*, translated by: Hugh Tredennick (London 1933) book I.
57 Ibidem.
58 De Raeij, *Clavis philosophiae*, 23.
59 Ibidem, 107.
60 Aristotle, *Metaphysics*, book XII.
61 De Raeij, *Clavis philosophiae*, 60.
62 Ibidem, viii.
63 Ibidem, x.

studied from the point of view of a purer philosophy, i.e., Cartesian philosophy. This 'new' philosophy could purify the classical philosophy and restore its honour.[64]

As we have seen, De Raeij was a Cartesian, but this does not mean that he adopted Descartes' philosophy completely. The main difference between the two is that De Raeij restricted himself to Descartes' physics. However, both Aristotle and Descartes used their metaphysics to build and justify their epistemological foundations. This is not the case with De Raeij; for him, it was evident that the phrase 'I think, therefore I am,' is true, as mathematical axioms are. Since these axioms are self-evident, the laws of physics are also self-evident and true.[65] He derives this from the idea that, in principle, there are no differences between mathematical axioms and the *præcognita* of physics.[66] De Raeij's epistemology is therefore structured horizontally instead of being built on a metaphysical foundation. From this we can conclude that De Raeij's principles of Cartesian physics were not founded on an empirical source, nor on divine revelation; therefore, a Platonic notion of innate knowledge remains.[67]

Although De Raeij's argument is plausible to a certain extent, his rhetorical trick of claiming that certain explanations for phenomena are evident, like a substance can only be moved by an external cause, presents a problem for his philosophy. By using the word 'evident', he implies that evident knowledge is available to everyone, while he maintains the distinction between philosophical and ordinary knowledge. Through his reference to Aristotle's *Topica* in the *Organon*, he proved that evident knowledge does not have to be accessible for everyone. Only those with a healthy spirit can access evident knowledge.[68] Through another reference to Aristotle's *Ethica Nicomachea*, De Raeij defines a healthy spirit as one that is free of 'assumptions and errors'.[69] Therefore, De Raeij argues by referring to Aristotle that only the Cartesian philosopher can access evident knowledge.

As we have seen, both Descartes and De Raeij strive to acquire 'true' knowledge of physical principles without relying on sensation. However, their methods for avoiding unjustified assumptions are significantly different. Descartes uses his methodological scepticism to argue that knowledge from sensations is unreliable. On the contrary, for De Raeij, assumptions play a key role in his investigation to true knowledge. By questioning ordinary knowledge, the philosopher can determine what true knowledge is and which assumptions he must avoid.[70] For Descartes, hyperbolic doubt results in a kind of 'new beginning' from which Cartesian metaphysics provides Cartesian philosophy with a new foundation. For De Raeij, examining unjustified assumptions is a critical investigation of existing

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64 Ibidem, xi.
65 Ibidem, 40.
66 Ibidem, 41-42.
67 Charles Adam & Paul Tannery, *Oeuvres de Descartes*, vol. V (Paris 1903) 146. For more information see also: Van Bunge, *From Stevin to Spinoza*, 71-73 and Theo Verbeek, *De Vrijheid van de filosofie. Reflecties over een Cartesiaans thema* (Utrecht 1994) 1-23.
68 De Raeij, *Clavis philosophiae*, 38.
69 Ibidem, 39.
70 Ibidem, 6.

knowledge and to dismantle the unjustified assumptions. Because of this, the knowledge that remains can be supplemented and improved. Thus, classical philosophy does not have to be rejected, but only needs to be revised from a Cartesian perspective.[71]

Due to his combination of two philosophical traditions, De Raeij cannot be seen as solely a Cartesian. He was a philosopher who, like many others, tried to incorporate Descartes' methodological scepticism into the scholastic tradition based on Aristotle's philosophy. Nevertheless, De Raeij tried (with significant effort) to read Descartes' physics into Aristotle's work. Therefore, the two philosophical traditions are not given equal footing in the *Clavis*. De Raeij clearly prefers the 'new' philosophy. However, it is difficult to investigate to what extent De Raeij used Aristotle as a means to get his work published, or whether he genuinely wanted to combine the two philosophies.

After the publication of his work, De Raeij dedicated it to the curators of Leiden University, for which he received an honorarium of one hundred guilders.[72] However, after they read the *Clavis*, and because of the protests of the theologians, De Raeij had to alter the name Cartesius in the remaining prints, after which he received fifty instead of a hundred guilders.[73] In the following years De Raeij especially taught at the faculty of medicine, where he asked the curators to promote him to ordinary professor in 1661. Instead, the curators promoted him to *professor ordinaris* at the faculty of philosophy.[74] Seven years later, the regents of the *vroedschap* of Amsterdam approved installing De Raeij as a professor at the Athenaeum Illustre with a threefold greater salary of 3,000 guilders.[75] This was made possible through a member of the *vroedschap* of that year, De Raeij's former student Johannes Hudde.[76]

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71 Ibidem, xxviii, 39, 43.

72 Molhuysen (ed.), *Leidsche universiteit*, III, 93

73 Ibidem, 107.

74 Ibidem, 171.

75 Peter Jan Knegtmans, *Professoren van de stad. Het Athenaeum Illustre en de Universiteit van Amsterdam, 1632-1960* (Amsterdam 2007) 58.

76 Suringar, 'Invloed der Cartesiaansche Wijsbegeerte', 153-170.

Chapter 2
Does the Earth move?

The pamphlet war between Hudde and Du Bois

As a student and resident of De Raeij, Hudde, like his teacher, was an active admirer of Descartes from an early age. Hudde probably lived with his professor for three years when he became involved in a pamphlet war against the Leiden minister Jacobus du Bois. In this war, Hudde sided with the physician and philosopher Lambertus Velthusius (Lambert van Velthuysen) (1622-1685) who, like De Raeij, had studied under Regius. It is therefore unlikely that Hudde participated in the debate on his own. As we can see in his pamphlets, in barely three years, Hudde managed to develop himself as a trained scholar in Cartesian philosophy, physics, and astronomy. Since his professor was a follower of Descartes and taught physics and medicine at Leiden University, it is likely that Hudde received support from De Raeij during the public debate.

It was 1655 when Du Bois published the treatise *Naecktheyt van de cartesiaensche philosophie* in Velthusius and Voetius' hometown and addressed to Velthusius. The pamphlet unleashed a war that ended in 1661.[77] Du Bois' treatise was an answer to Velthusius' *Bewys, ... der sonne stilstandt, en des aertrycks beweging niet strydich is met Godts-woort*.[78] Velthusius, later the correspondent of Hudde, Leibniz, and Spinoza, made an attempt in this work to argue that both Copernican and Cartesian notions are not incompatible with Calvinism.[79] This statement was opposed to theologians such as Du Bois and Voetius, who argued that the Bible should always be interpreted literally, except when God's word implies otherwise.[80]

Velthusius, who studied theology, philosophy and medicine at Utrecht University, was an orthodox (Cocceian) Calvinist himself.[81] Nevertheless, he made a distinction between sections in the Bible that should be taken literally and those that should be interpreted figuratively. His fight against the Voetians (followers of Gijsbertus Voetius) should not be seen as a battle against Calvinism, but rather as an opposition to the practices and political ambitions of some Reformed ministers. Velthusius was convinced that the Bible conveyed a moral message, but not natural philosophy. For Velthusius, bending an astronomical debate into a dispute about Biblical exegesis was a bridge too far. That

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77 Jacobus Du Bois, *Naecktheyt van de cartesiaensche philosophie, ontbloot in een antwoort op een cartesiaensch libel* (Utrecht 1655).

78 [Lambertus van Velthuysen], *Bewys, dat het gevoelen van die genen die leeren der sonne stilstandt, en des aertrycks beweging niet strydich is met Godts-woort* (1655).

79 Ibidem.

80 Jacobus du Bois, *Dialogvs theologico-astronomicvs, in quo ventilatur quæstio astronomica, an terra in centro vniversi quiescat* (Leiden 1653) 21, 32.

81 Van Bunge (ed.), *The dictionary*, II, 1017.

theologians (especially from the Voetian camp) could not accept Copernican and Cartesian notions was due primarily to their ignorance of physics and hermeneutics rather than their Christian piety.[82]

It is remarkable then that Velthusius and Hudde's opponent Du Bois received lessons from the private tutor of mathematics and astronomy and curator of astronomical instruments at Leiden University, Samuel Carolus Kechel ab Hollestein (1611-1668).[83] As a minister, Du Bois had a significant interest in astronomy, as we can see in his *Oude-tyds tyd-thresoor ende kerkelikke historie*. This book on chronology contained various calculations to determine when the new moon would occur according to the Julian calendar.[84] Moreover, it shows that Du Bois was a supporter of the Tychonic system, in which the sun moved around the earth. Du Bois elaborated on this notion in the *Dialogus theologico-astronomicus* (1653) followed by his *Veritas et authoritas sacra* (1655). In both works, Du Bois attacked Copernican and Cartesian notions of the universe in which he found proof for 'an error in [Cartesian philosophy] which is so immense that I [Du Bois] that from embarrassment you would abandon the false spirit of that philosophy and return to your own spirit.'[85] Velthusius answered Du Bois' reaction to the theologian and Cartesian, Christophorus Wittichius (1625-1687).[86] However, it was Hudde who in 1656 provided an overwhelming attack against the minister's 'silliness'.[87]

Current historiography lacks a detailed description of the pamphlet war between 1650 and 1661. The most important achievements in this area have been made by Rienk Vermij and Thomas Arthur McGahagan.[88] There is not enough space to fully explain the debate here. Therefore, I will restrict myself to the pamphlets exchanged by Hudde and Du Bois at the peak of the war in 1656. Nevertheless, it is important to remember that the controversy between the student and the minister is one case in a broader cultural development in which (natural) philosophy, philology, archaeology, and also the (re)discovery of new parts of the world questioned the authority of the Bible.[89] Because Hudde did not address the theological aspects of the debate, but solely focussed on astronomical and mathematical arguments, it is possible to discuss his pamphlets in relation to Du Bois' responses in isolation.

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82 Lambertus van Velthuysen, *Bewys dat noch de leere van der sonne stilstant, en des aertryx bewegingh, noch de gronden vande philosophie van Renatus des Cartes strijdig sijn met Godts woort* (Utrecht 1656).

83 Vermij, *The Calvinist* Copernicans, 253. Zuidervaart & Beurze, 'Samuel Carolus Kechel', 25-58.

84 Jacobus du Bois, *Oude-tyds tyd-thresoor ende kerkelikke historie* (Leiden 1650).

85 Ibidem, *Veritas et authoritas sacra in Naturalibus et astronomicis asserta & vindicata* (Utrecht 1655) 106.

86 For more information on Wittichius and his role in the pamphlet war see: Bunge (ed.), *The dictionary*, II, 1083-1084. Vermij, *The Calvinist Copernicans*, 293-317. Verbeek, *Descartes and the Dutch*, 70-89.

87 [Johannes Hudde], *Wiskonstigh-Bewys der Onnoselheyt van Jacobus Du Bois* (Rotterdam 1656).

88 Thomas Arthur McGahagan, *Cartesianism in the Netherlands, 1639-1676. The New Science and the Calvinist Counter-Reformation* (unpublished dissertation, University of Pennsylvania, 1976).

89 Paul Hazard, *La crise de la conscience européenne 1680-1715* (Paris 1935). Van Miert, *The Emancipation of Biblical Philology*.

Hudde's first pamphlet was published anonymously in Latin and the vernacular in Rotterdam by bookseller Johannes Benting.[90] It seemed that at first not even Hudde's acquaintances Van Schooten and Huygens knew who wrote the refutations.[91] Although it is evident that Hudde did not want to reveal his identity, it is also likely that he wanted to prove his point based on (mathematical) arguments rather than authority. This extensive work of forty pages was a direct attack on the minister's proof of the error in Cartesian philosophy in which the philosophy would refute itself. This evidence was based on the motion of the celestial bodies Venus and Mercury in their orbit around the Earth. Du Bois misused the Copernican inspired Lansbergen tables (1632) to prove that Mercury had completed its orbit around the sun in 116 days, while it takes Venus 19 months to complete its circuit.[92] This contradicts the notion in the Copernican system, which was supported by Descartes, that celestial bodies that are closer to the sun complete their orbits faster than bodies further away from the sun. Therfore, Venus must complete its orbit around the sun faster than the earth. Both Copernicus and Descartes argued that Mercury and Venus complete their orbits around the sun in eighty days and nine months, respectively.[93]

Instead of preaching the truth among the 'silly' believers, Du Bois only promulgated falsities, through which a significant number of untruths persist in the world, according to Hudde.[94] Therefore, 'both Du Bois and his work are not taken seriously by mathematicians anymore'.[95] By appealing to the Lansbergen tables, the minister argued that it is false to state that the sun is the centre of the solar system.[96] In the *Dialogus* Du Bois proves this through mathematical arguments and that he even has 'an irrefutable argument'.[97] Moreover, the minister states 'that he could not see a possible way that the Copernicans could refute this', through which he not only invalidated the Copernican system but also the philosophy of Descartes.[98]

Hudde disagreed and presented the fundamental error in Du Bois' argumentation. It is correct that Venus and Mercury complete their orbits in 583 and 115 days respectively; however, this is seen from 'our' viewpoint, i.e. from the Earth.[99] The real circulation time of the celestial bodies as seen from the middle point of the solar system, i.e. the sun, conforms to the Copernican system and

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90 [Johannes Hudde], *Demonstratio mathematica ineptiarum & ignorantiae Jacobi du Bois, ecclasiastae Leydensis, in oppugnanda hypothesi Copernicana, et philosophia Cartesiana* (Rotterdam 1656). [Ibidem], *Wiskonstigh-Bewys*. Benting's shop was at 'de Beurs' with the sign 'Calvinus'.

91 Frans van Schooten to Christiaan Huygens, 25 April 1656, in: Christiaan Huygens, *Oeuvres Complètes,* vol. I (The Hague 1888) nr. 285. Ibidem, 3 May 1656, in: ibidem, nr. 286. Huygens to Van Schooten, 6 May 1656, in: ibidem, nr. 288. Van Schooten to Huygens, 30 May 1656, in: ibidem, nr. 293.

92 Philippus Lansbergius, *Tabulae motuum coelestium perpetuae* (Middelburg 1632). [Hudde], *Wiskonstigh-Bewys*, 3. For more information on Lansbergen see also: Rienk Vermij, 'Waarom werd Philips Lansbergen Copernicaan?', in: *Scientiarum Historia*, vol. 24, no. 1 (1998) 39-64.

93 [Hudde], *Wiskonstigh-Bewys*, 4.

94 Ibidem, 3-4.

95 Ibidem, 4.

96 Ibidem, 8-9

97 Ibidem, 9.

98 Ibidem, 10.

99 Ibidem.

philosophy of Descartes. Hudde even argues that Du Bois had probably seen this 'weakness' but nevertheless argued that the Lansbergen tables represent the real circulation time as seen from the sun.[100] The minister even refers to Copernicus, arguing that the tables concern the real circulation time, seen from the sun, not the Earth: 'Copernicus and Lansbergen speak from the real circulation time of Venus and not the period seen from the Earth.'[101]

Hudde argued for the opposite position; the movement that Lansbergen calls '*anomalia orbis*' is not that of a body at rest, but seen from a body in motion.[102] Therefore, Hudde calls Du Bois 'a child in astronomy … a parrot who does not know the foundations of the tables of Copernicus and Lansbergen'.[103] In the eyes of Hudde, Du Bois was nothing more than a simple man who was not capable of thinking critically.[104] Copernicus, Galileo Galilei (1564-1642), Pierre Gassendi (1592-1655), Lansbergen and Descartes all proved that Du Bois was wrong, according to Hudde, along with his own demonstration 'as a learned man in astronomy'.[105] By relying on the authority of these scholars and Simon Stevin (1548-1620): the 'mathematician of Maurits, Prince of Orange', Hudde made an attempt to undermine the minister's credibility.[106]

After showing that Du Bois' evidence was based on a fundamental error, Hudde tried to make his point again by proving the difference between perceiving the orbits of celestial bodies from the Earth and from the sun with a mathematical demonstration.[107] Nevertheless, Hudde did not include complex calculations, since, as he stated mockingly, 'Du Bois does not have sufficient knowledge of astronomy'.[108] Therefore, Hudde argues that he has to explain it easily and in small steps because otherwise Du Bois would not understand any of it.[109] Hudde's proof of Du Bois' error is twofold. On the one hand, it is made through appeals to 'the most excellent astronomers and mathematicians', and on the other hand through calculations and algebra.[110]

The remaining part of the pamphlet is an attack on Du Bois' morality. Hudde accuses the minister of blaming Descartes too easily based on false information. According to Hudde, Descartes did not copy Lansbergen and Galileo's work blindly, but calculated the duration of the celestial bodies' orbits around the sun himself to discover the 'truth'. Therefore, Descartes' calculation of Venus' circuit was eight instead of nine months, and for Mercury it was not eighty days but three months, according to Hudde.[111]

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100 Ibidem, 11. Du Bois, *Dialogvs*, 36.
101 [Hudde], *Wiskonstigh-Bewys*, 13.
102 Ibidem.
103 Ibidem, 16.
104 Ibidem.
105 Ibidem, 17.
106 Ibidem, 19-21.
107 Ibidem, 22-23.
108 Ibidem, 23-24.
109 Ibidem, 24.
110 Ibidem, 29.
111 Ibidem, 31.

Because of his mistakes that Du Bois made, Hudde argues that not only could he not be trusted in astronomy anymore, but that he could not be trusted at all due to the error he made in this simple matter. [112] Furthermore, his contempt for the astronomers and mathematicians was unprecedented from a man of God.[113] His opponent was Descartes, and therefore, he should not have attacked the other scholars, according to Hudde.[114] Moreover, Du Bois used the same evidence in his *Dialogus* as in his *Veritas* two years later. Therefore, the minster had seen his evidence again before publishing it for the second time, so Hudde suggests that Du Bois deliberately presented false information to the reader for his own gain.[115]

Although Du Bois argued that he was the man who would slay the imitator, he was the imitator himself.[116] He pretended to be 'the minister who wielded the telescope who could explain the matter to the ordinary people'.[117] However, nothing seemed to be further from the truth. Hudde even suggested that he was not surprised that these statements came from the pen of a theologian. He argued, 'I have learned from experience that it is hard to exterminate a prejudice, especially by scholars of age … [such as] Du Bois or other ministers who fight the Cartesian philosophy.'[118] Therefore, Du Bois is not only guilty of ignorance, but also of contempt and poor judgement, due to which everything he wrote on philosophy, physics, and mechanics should not be believed.[119]

From this pamphlet, we know that Hudde not only defended Descartes' philosophy anonymously or by using a pseudonym (his initials) in public, but also that he believed that theologians should not interfere with the practice of (natural) philosophy.[120] This is a notion that we will see again in his later life when he is mayor of Amsterdam. This was especially the case when Hudde acted as a patron in the publication of controversial works by Gregorio Léti (1630-1701), Spinoza, and Balthasar Bekker. Moreover, we can conclude from this work that Hudde read Descartes' *Meditationes* and *Principia philosophiae*, since he explicitly refers to specific works, which confirms that he was not only familiar with Descartes' mathematics, physics, and dioptrics, but also with his metaphysics.[121]

Du Bois' answer did not take long after Hudde's public attack. In *Den Ingetoomden Cartesiaen*, the minister writes that Hudde 'should be ashamed of what he said without using his name'.[122] The pamphlet should have been a short response to Hudde's work. However, Du Bois does

112 Ibidem.
113 Ibidem, 32.
114 Ibidem.
115 Ibidem, 10, 32-33.
116 Ibidem, 33.
117 Ibidem.
118 Ibidem, 34-35.
119 Ibidem, 38, 40.
120 I.G.H. [=Johannes Hudde], *Den hollenden astronomus J.D.B. gecapuchont. Zijnde een antwoord op een blauw boexken genaemt Den ingetoomden Cartesiaen* (Leiden 1656) 29.
121 [Hudde], *Wiskonstigh-Bewys*, 35, 40.
122 J.D.B. [= Jacobus du Bois], *Den ingetoomden cartesiaen, ofte Korte antwoordt op een cartesiaensch libel, genaemt Wiskonstich bewijs van d'onnoselheyt* (Leiden 1656) 3.

not react to Hudde's mathematical arguments and argues that he does not value them. The minister represents the word of God, so criticising Hudde's work in principle has no value.[123] According to Du Bois, Hudde should have delivered mathematical proof of Copernicus' hypotheses and Descartes' philosophy. But instead, Hudde failed to understand what the minister was arguing.[124] This was no surprise, according to Du Bois. It is impossible to deliver such as mathematical proof, since it is contrary to God's word, according to the minister.[125] However, the only part Du Bois did accept were Hudde's references to mathematical authorities such as the Copernicans Gassendi and Stevin. Both authors mentioned the periods in their works that they and Du Bois had deduced from the Lansbergen's tables. Therefore, Du Bois was compelled to admit that these periods were compatible with the Copernican theory and the Cartesian philosophy.[126]

Du Bois avoids answering Hudde's criticism by referring to his earlier works, the *Dialogus* and *Veritas*. He makes an attempt to discredit Hudde's credibility by arguing that Hudde sold and published his pamphlet anonymously.[127] His mathematics was solely a 'trick', according to the minister, which Hudde did not use for the right end, but only in vanity and arrogance.[128] Furthermore, Du Bois argues that Hudde should deliver irrefutable proof that the Earth moves in an orbit around the sun, while the sun is at rest.[129]

Hudde's answer was published under the pseudonym 'I.G.H' with the title *Den Hollenden Astronomus J.D.B. Gecapuchont*. In this work, Ioannes Gerritsz. Hudde cites Du Bois at length, annotated with commentaries. In this way Hudde tries to deconstruct the minister's answer, ending with a parable, about which Hudde states 'that my ending is most pleasant and amusing'.[130] To summarise the story, the parable is about a simple shepherd (Du Bois) who pretends to be an excellent fencer. Although he challenges the master (Descartes), one of the master's pupils (Hudde) steps forward to accept the challenge. At first, the battle is not praiseworthy for the student; nevertheless, with the first blow (the first pamphlet), he disarms the shepherd. However, the shepherd argues that the fight was not fair. The spectators (since the pamphlets were published in public) see that the student was right and convince the shepherd. Thus, the spectators insist that the shepherd should stay within the boundaries of his own profession, and be a good shepherd again.[131] Although Hudde withdrew himself from the debate, the publication of pamphlets and other works on the subject

123 Ibidem.
124 Ibidem.
125 Ibidem.
126 Ibidem, 3, 8.
127 Ibidem, 3, 6, 8, 9.
128 Ibidem, 8.
129 Ibidem, 9.
130 [Hudde], *Den hollenden astronomus*, 26.
131 Ibidem, 26-29. Vermij, *The Calvinist Copernicans*, 292.

continued until Du Bois' death in 1661, by Velthuysen, Regius, Wittichius and the Calvinist minister and Cartesian Abraham Heidanus (1597-1678) under the pseudonym 'Irenæus Philalethius'.[132]

Although the matter continued after Hudde withdrew himself, in September 1656, a decree was published by the Court of Holland and West Friesland stating that philosophers and theologians should not interfere with each other. The Bible would remain the main authority in matters that could be explained theologically or philosophically.[133] Furthermore, several professors from Leiden University, such as Heereboord and De Raeij, had to sign the treatise to enforce the decree.[134] Nevertheless, in practice it was nothing more than a formality to ensure peace.[135]

However, Hudde was on the Grand Tour since 1659, visiting, among other places, Saumur, whose theological faculty was known for its liberal interpretation of the Bible and the embracement of Descartes' philosophy.[136] Upon his return, Hudde established himself in his hometown of Amsterdam, where he received a place in the *vroedschap* and several other governmental positions. As mayor, Hudde again took up arms against 'unjustified accusations' by the church council, who used their power to silence liberal and unorthodox (Cartesian, Arminian and Cocceian) voices.[137]

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132 Vermij, *The Calvinist Copernicans*, 293-294, 387. Van Bunge, *From Stevin to Spinoza*, 81. For more information about Abraham Heidanus see: Van Bunge (ed.), *The dictionary*, I, 397-399.

133 Molhuysen (ed.), *Leidsche universiteit*, III, 117-118, 787-792, 803-807.

134 Ibidem, 117-118.

135 Vermij, *The Calvinist Copernicans*, 310-312.

136 J.P. Dray, 'The Protestant Academy of Saumur and its relations with the oratorians of Les Ardilliers', in: *History of European* Ideas, vol. 9, no. 4 (1988) 465-478. For the Grand Tour see: Hendrick van Heuraet to Frans van Schooten, 13 januari 1659, in: Frans van Schooten (ed.), *Geometria à Renato Descartes* (Amsterdam 1683) 517. The 'Mr. Hudde' who was on Grand Tour from 1649-1651 with Arnout Hellemans Hooft is not Johannes Hudde, but his older brother Jonas. See: E.M. Grabowsky & P. J. Verkruijsse (ed.), *Arnout Hellemans Hooft: Een naekt beeldt op een marmore matras seer schoon: het dagboek van een 'grand tour' (1649-1651)* (Hilversum 2001).

137 [Hudde], *Den hollenden astronomus*, 31.

Chapter 3

The introduction of practical and 'new' mathematics at Leiden University

In the meantime, while Hudde entered the ring against Du Bois, he specialised in (Cartesian) mathematics under the Leiden professor Frans van Schooten. There are already traces of his mathematics in Hudde's pamphlet against the minister on the motion of the earth. However, further explanation is needed due to the appearance of a new form of geometry. Descartes had introduced a union between geometry and algebra that became known as the 'new' geometry, or analytic geometry. This section discusses the practices and Hudde's contributions in the field of mathematics, in which he worked along with Christiaan Huygens, Johan de Witt, and Hendrik van Heuraet (1633- ca. 1660).[138]

Hudde's merits in the discipline of mathematics have hardly been studied in their context. His interest in mathematics must have been stimulated at Leiden University where he was enrolled as a medical student and resided with the Cartesian physicist, De Raeij. As a member of the Amsterdam patriciate and related to Van Schooten's pupil, Huygens, it is no surprise that Hudde became a student of Van Schooten. Van Schooten took over his father's position as professor of the engineering school established in Leiden, also known as the school for *Duytsche Mathematique*, and taught practical mathematics.[139]

To place Hudde's mathematical activities into perspective, we shall first discuss the practice of the discipline *Duytsche Mathematique*. The mathematics taught in this programme were expressed in Hudde's work especially after 1667, when he was an advisor and governor for the States-General, the States of Holland, and the city of Amsterdam.[140] This makes it likely that Hudde was at least trained in the practical mathematics of land surveying and fortification; disciplines which his correspondent and teacher, Van Schooten, taught as a professor. It is therefore plausible that Hudde received lessons *Duytsche Mathematique* in private or at the engineering school itself. Later, we will briefly discuss Hudde's theoretical works that were published in Van Schooten's *Geometria*. Through a discussion of both the practices of the engineering school and Hudde's theoretical works, we can arrive at a new perspective on Hudde's period as a student at Leiden University.

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138 Van Schooten (ed.), *Geometria*. J.A. van Maanen, *Facets of Seventeenth Century Mathematics in the Netherlands* (Utrecht 1987) chapters 1 and 2 in particular.

139 A.J. van der Aa, *Biografisch woordenboek der Nederlanden*, vol. XVII (Haarlem 1874) 420.

140 SA, Handschriften [5059], inv. nr. 47-49. Ibidem, Archief van het Stadsfabriekambt en Stadswerken en Stadsgebouwen [5040], inv. nr. 13 (Johannes Hudde, 'Afteikeningen en eenige vastelling van de houte beertjens, sluitbinten, sluisjes en molens diende tot zuiveren van de stadtswateren, anno 1687 en 1688'). Nationaal Archief Den-Haag/National Archive The Hague (NA), Archief Staten van Holland na 1572 [3.01.04.01], inv. nr. 104, fol. 44-52 and 58-63 for respectively: 'Verbael [...] op de inspectie van de Neder-Rhijn en IJssel' and 'Advis aengaende het beneficieren van den Neder-Rhijn ende IJssel'.

The Leiden engineering school: Duytsche Mathematique

The discipline of *Duytsche Mathematique* was founded in 1600 at the request of stadholder Maurits of Nassau (1567-1625).[141] During the period of Eighty Year's War, the future Prince of Orange attached great value to mathematicians who were trained in, among other things, fortification and land surveying. The discipline was focussed on the practical use of mathematics and of being in service for the Republic, as stated in his request: 'count Maurits of Nassau … for the service of the country and the for the improvement of those in the practice of engineering'.[142] The reputable natural philosopher Simon Stevin (1548-1620) created the curriculum that was taught to the students by the land surveyor Simon Fransz. van Merwen (1548-1610) and the mathematician Ludolf van Ceulen (1540-1610).[143] After the death of both extraordinary professors in 1610, Frans van Schooten, Sr. (1581-1646) took over, after which he was appointed as ordinary professor of *Duytsche Mathematique* in 1615.[144]

Van Schooten Sr. continued the tradition begun by Stevin under Van Ceulen and Van Merwen, in his education based on Stevin's *De sterctenbovwing*.[145] In the winter period, students were educated in the theory of fortification, after which they put the theory into practice in the field with the army during the summer.[146] The relation between theory and practice and the value of them is described in Stevin's instructions for the discipline itself: 'He will learn arithmetic and surveying, but only to the extent that is useful as an engineer'.[147] To clarify the second part of the quotation, this means that the student only learned geometry and algebra for plain surfaces.[148] The use of higher-degree equations from which curvatures derive was limited to the theoretical mathematics taught by professor Rudolph Snellius (1546-1613), who was succeeded by a relative of Van Schooten and Huygens, Jacobus Golius (1596-1667).[149]

Around the time that Hudde went to university, the Eighty Years' War had ended, and the political situation in the Republic reached calmer waters. The direct threat of an invasion ended with the Peace of Münster in 1648. The change in the political climate resulted in the modification of the programme of *Duytsche Mathematique*. The previous focus on the construction of siege works and

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141 Charles van den Heuvel, 'Wisconstighe Ghedachtenissen. Maurits over de kunsten en wetenschappen in het werk van Stevin', in: Kees Zandvliet (ed.), *Maurits Prins van Oranje* (Zwolle 2000) 106-121, especially, 119-120. Frans Westra, *Nederlandse ingenieurs en de fortificatiewerken in het eerste tijdperk van de Tachtigjarige Oorlog, 1573-1604* (Alphen aan den Rijn 1992) 82-89.

142 P.C. Molhuysen, (ed.), *Rijks Geschiedkundige Publicatiën. Bronnen tot de geschiedenis der Leidsche universiteit 1574-1811*, vol. I (The Hague 1913) 122, 389.

143 Ibidem, 122.

144 University Library Leiden, ASF, *Codices actorum academicorum 1595-1604*, vol. VIb, fol. 189. P.C. Molhuysen, (ed.), *Rijks Geschiedkundige Publicatiën. Bronnen tot de geschiedenis der Leidsche universiteit 1574-1811*, vol. II (The Hague 1916) 42, 47.

145 Simon Stevin, *De sterctenbovwing* (Leiden 1597).

146 Eduard R. M. Taverne, *In 't land van belofte: in de nieue stadt: ideaal en werkelijkheid van de stadsuitleg in de Republiek 1580-1680* (Groningen 1978) 64-66.

147 Molhuysen (ed.), *Leidsche universiteit*, I, *389-390.

148 Ibidem, *390.

149 Dijksterhuis, 'Moving Around the Ellipse', 90-108.

fortifications shifted towards the reclamation of land and urban expansion.[150] This shift in orientation took place around the time that Van Schooten, Jr. succeeded his father. Trained in both the theoretical mathematics of Golius and the practical mathematics taught by his father, Van Schooten, Jr. started teaching from 1635, until he replaced his father ten years later after visiting scholars in Paris and London.[151]

During this period of travel, Van Schooten, Jr. studied the mathematics of French scholars such as François Viète and Pierre de Fermat building forth on the 'new' mathematics introduced in Descartes' *La Géométrie* (1637) for which Van Schooten made the drawings.[152] Van Schooten was a friend and admirer of Descartes of who the latter even advised his correspondent and the father of Christiaan, Constantijn Huygens (1596-1687), to hire Van Schooten as mathematic teacher for his children who received and continued their lessons at that time from Jan Stampioen (1610-1653).[153] The mathematical knowledge Van Schooten gained through his travels and Descartes, he would teach his students, such as Hudde and Huygens with whom he published his *Geometria* (1659).

The French influence is manifested in Van Schooten's *Organica Conicarum Sectionum* (1646), which was included a year later in the *Exercitationum mathematicarum*. This book was in Hudde's personal possession, and he also added various contributions to it.[154] Two years after the Latin edition, it was published in the vernacular as *Mathematische oeffeningen*, in which the *Organica* was also included.[155] This piece is a clear example of Euclidean geometry combined with French geometry in relation to what was taught during the programme of *Duytsche Mathematique*.[156] On the one hand, this is evident in presenting situations of complex geometrical figures, such as curvatures, and on the other hand by discussing the algebra that is related to the geometry.[157]

Hudde's improvement of Cartesian mathematics

The beginnings of analytical geometry in three dimensions is generally said to be found in the work *Les lieux géométriques* (1679) by Philippe De Lahire (1640-1718).[158] Although this cannot be disproven, since most of Hudde's mathematical work is lost, Van Schooten, Jr. does refer to Hudde's achievements in the same territory.[159] It is about calculating the intersections between higher degree

150 Ibidem, 'Duytsche Mathematique', 175.

151 Ibidem, 'Moving Around the Ellipse', 110.

152 Ibidem, 94, 120-121. Rienk Vermij, *Christiaan Huygens. De mathematisering van de werkelijkheid* (Diemen 2004) 12.

153 Ibidem. René Descartes to Constantijn Huygens, 21 December 1644, in: Huygens, *Oeuvres*, XXII, nr. xxii.

154 Swetz & Katz, 'Mathematical Treasures'.

155 Frans van Schooten, *Mathematische oeffeningen, begrepen in vijf boecken*, vol. I (Amsterdam 1659) 283-346.

156 Ibidem.

157 Ibidem.

158 J.L. Coolidgde, 'The Beginnings of Analytic Geometry in Three Dimensions', *The American Mathematical Monthly*, vol. 55, no. 2 (1948) 76-86, especially, 80.

159 Frans van Schooten, *Exercitationum mathematicarum liber primus propositionum arithmeticarum et geometricarum centuriam* (Leiden 1657) 475, 493, 498, 515. Van Schooten, *Mathematische oeffeningen,* 444, 462, 467, 483. See for Hudde's private copy of the *Exercitationum mathematicarum*: Frank J. Swetz & Victor J. Katz, 'Mathematical Treasures - Frans van Schooten's Exercitationes mathematicae', in: *Convergence* (January 2011).

equations in three-dimensional space. The method is quite similar to that which Descartes used in his *Geometria*; however, this was only for low-degree functions on a flat surface, whereas Hudde's transformations took place in three-dimensional space.[160] Hudde's merits lie in the combination of algebra and geometry, which allowed him to solve high-degree equations that are shaped on curvilinear surfaces.[161] According to Van Schooten, Hudde was the first, as far as he knew, who had derived higher curves, and beyond that, conics, as sections of a surface.[162]

This was not the only mathematical work of Hudde's that was published. The formally enrolled medical student seemed to be specialised not only in Descartes' metaphysics and natural philosophy, but also in his geometry. Hudde wrote at least two treatises to Van Schooten, which were published in his (Van Schooten's) *Geometria à Renato Descartes* (1659). This work was a translation of Descartes' *La Géométrie* (1637) with commentaries and clarifications by Van Schooten and his students De Witt, Van Heuraet, and Hudde.[163] In his first treatise, 'De Reductione aequationum' from 14 July 1657, Hudde presents his method through which it becomes possible to solve higher-degree equations. In his second treatise dated 27 January 1658, 'De Maximis et minimis', he elaborates on his earlier work. What is remarkable about the dates of the treatises is that it took between one and two years before Hudde's work was published. It suggests that Hudde did not feel the need to publish his work earlier and to go public. Therefore, although Hudde was interested in mathematics, it seems that he himself did not seek for a wider audience to become reputable scholar. This presumption is made presumably through Hudde's letter to Van Schooten wherein he explicitly states that he does not want to presume with his work on curvatures.[164] Hudde used his method to calculate the extremes of high-degree curvatures. Currently, mathematicians calculate these coordinates through the method of differentiation. Through this method, the mathematician calculates the derivative of a function. When the derivative is equal to zero, the slope is zero, meaning that the function has an extreme at the given x coordinate.

After the publication of these two treatises, Hudde's reputation as a mathematician was established internationally. Even with his withdrawal from academic society, when he became mayor of Amsterdam, he was still visited by erudite mathematicians. To give an example, Leibniz visited Hudde in 1676 to acquire detailed knowledge of his mathematical writings. In 1681 a correspondent of both Leibniz and Hudde, the Swiss scholar Jacob Bernoulli (1654-1705) honoured Hudde with a visit,

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160 Van Schooten, *Exercitationum mathematicarum*, 475, 493, 498, 515.

161 Ibidem, 475-480.

162 Ibidem.

163 Van Schooten, *Geometria*.

164 Johannes Hudde to Frans van Schooten, December 1657 in: Christiaan Huygens, *Oeuvres Complètes*, vol. II (The Hague 1889) nr. 437: 'de reden waerom ick voordesen versocht dat verswegen mocht warden dat ik d'auteur van die voorgestelde 3 krommen was, alleen synde om in toekomende niet weer gehouden te wesen om diergelijcke of andere, daer ick geen nudt in sach te ontbinden, te meer ik mij tot een ander studium heb begeven'. Like Hudde, De Witt also kept his work private on the conic section. See: Fokko Jan Dijksterhuis, 'Duytsche Mathematique and the Building of a New Society: Pursuits of Mathematics in the Seventeenth-Century Dutch Republic' in: B. Lesley (ed.), *Mathematical Practitioners and the Transformation of Natural Knowledge in Early Modern Europe* (2017) 167-181, especially, 179

followed in 1693 by the Scottish mathematician David Gregory (1661-1708), who also learned from Hudde's mathematical writings. Moreover, in 1682 the Saxon naturalist Ehrenfried Walther von Tschirnhaus (1651-1708) counted Hudde as one of most excellent mathematicians of his time. In 1697 Leibniz lamented that Hudde was one the few scholars in Europe who could have solved the complex problem of the brachistochrone, if Hudde had not turned his back on mathematics long ago.[165]

Hudde's method of solving high-degree equations and finding the extremes

The 'new' geometry is especially expressed in Hudde's mathematical works written between 1655 and 1657.[166] These are his contributions to Van Schooten's *Exercitationum mathematicarum*, his correspondence with his mathematics teacher, and the treatises 'De reductione aequationum' and 'De maximis et minimis' in Van Schooten's *Geometria*.[167] Due to the remarkable work of Karlheinz Haas in analysing Hudde's mathematical achievements in his dissertation *Die Mathematische Arbeiten von Johannes Hudde* (1956), I discuss here only the two works that are included in the *Geometria*. In these two articles Hudde presents a method that can be seen as a predecessor to differential calculus. The importance of calculus for modern mathematics and Hudde's relation with Leibniz, who discovered the differential calculus independently of Newton, is the reason I will briefly discuss the two articles.

Hudde's hundred-page-long 'De reductione aequationum' is a commentary on Descartes' *Geometria*. This piece introduced a new method of practicing mathematics whereby geometry and algebra were no longer separated. Therefore, geometrical objects could be represented algebraically or arithmetically.[168] In his *Geometry*, Descartes presents a method to find the tangent of a given curve, or more specifically, it is a method to find where the intersection of two curves have a double root which corresponds to a point of tangency. Currently, mathematicians would calculate this through the method of differential calculus, through which one is able to find the slope in every arbitrary coordinate of the function. Although this method was not known during Descartes' lifetime, he described a method for finding tangents to algebraic curves, which was accompanied by several limitations.[169]

Descartes' method worked for low-degree equations. However, finding the tangents of high-degree equations derived from more complex algebraic curves was possible in theory, but in practice it was unrealizable due to the long calculations it required.[170] In his articles, Hudde introduced a feasible

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165 Leibniz to Bernoulli, 23 February 1697, in: Gerhard (ed.), *Leibnizens Mathematische Schriften*, III, 369-371, especially, 370.

166 Hudde to Van Schooten, 1 December 1657 in: Huygens, *Oeuvres*, II, nr. 436. Hudde to Van Schooten, December 1657. in: ibidem, II, nr. 437.

167 Johannes Hudde, 'De Reductione aequationum', in: Frans van Schooten (ed), *Geometria à Renato Descartes* (Amsterdam 1659) 406-506. Johannes Hudde, 'De Maximis et minimis', in: Frans van Schooten (ed), *Geometria à Renato Descartes* (Amsterdam 1659) 507-516.

168 Bos, *Redefining Geometrical Exactness*, 293-312.

169 Suzuki, 'The Lost Calculus', 339.

170 Henk J.M. Bos, 'Descartes en de wiskunde', in: Willem Koops (ed.), *Née Cartésienne/Cartesiaansch Gebooren. Descartes en de Utrechtse Academie 1636-2005* (Assen 2005) 51-69.

method to solve high-degree equations by using a consecutive numerical sequence. A concrete example demonstrating this method is provided in the article 'De maximis et minimis' to find the extremes of elliptical equations. Without digressing into endless mathematical examples to show that the method works, as Hudde did in 'De reductione aequationum', I will limit myself to Hudde's own demonstration that he provides in 'De maximis et minimis'. In this commentary, Hudde recapitulates the method he used in the earlier article with the following theorem:

> When in an equation two roots are equal and multiplied with an arbitrary numeric sequence, so: the first term with the first term of the sequence, the second term of the equation with the second term of the sequence et cetera: I argue that the result will be an equation in which one of the named roots will occur.[171]

To prove his theorem, Hudde uses two equations that he multiplies together: $x^3 + px^2 + qx + r = 0$ and $x^2 - 2yx + y^2 = 0$. We could rewrite the latter as $(x - y)^2$, from which it follows that $x = y$ with a double root, because the function was squared. When the functions are multiplied, it results in the function I will call $p(x)$. Namely, $p(x) = (x^2 - 2yx + y^2)x^3 + (x^2 - 2yx + y^2)px + (x^2 - 2yx + y^2)qx + (x^2 - 2yx + y^2)r = 0$. Although this is only a quadratic equation, solving it is already difficult. With this equation, Hudde refers to Descartes' method, for which he provides further calculations in his 'De maximis et minimis'.[172] Since this is not relevant here, I shall limit myself to Hudde's method. Instead of multiplying the functions together, Hudde argues that one could also multiply the function by a consecutive numeric sequence, as he demonstrated in both works. Since Hudde starts by providing the reader with a kind of proof, he does not work with numbers, but with letters that could represent any number in a sequence. He uses the following sequence to represent a consecutive numeric sequence: $a, a + b \; and \; a + 2b$. If we muliply this sequence by the function $x^2 - 2yx + y^2$, it results in the equation $ax^2 - (a + b)2xy + (a + 2b)y^2$. This can be rewritten as $ay^2 - (a + b)2y^2 + (a + 2b)y^2$, since $x = y$ as is stated above.

Hudde does not elaborate any further on his proof, but provides the reader with various examples to demonstrate that what he argues for is possible. Take for example the function $\frac{x^3 - 10x^2 - 7x + 346}{\begin{matrix}3 & 2 & 1 & 0\end{matrix}\quad 3x^3 - 20x^2 - 7x}$. Hudde multiplies every term of the function by the consecutive numeric sequence below, which could be arbitrary. Solely to illustrate my point, I used the sequence 3, 2, 1, 0, through which number 346 disappears and only terms with the variable x remain. Because of this, the function can be rewritten as $f(x) = (x(3x^2 - 20x - 7)$ since I divided the function by x. When this function is equal to zero, one can find the coordinates of the extremes. The function $x^3 - 10x^2 - 7x + 346$ that I use demonstrates that Hudde's method works in this case because $f(x) = 3x^3 - 20x^2 - 7x = (x(3x^2 - 20x - 7) = x \cdot f'(x))$. The derivative of $f(x)$ is $f'(x)$. Therefore, when one tries to find the x coordinates of the extremes, it results in the following calculation: $x = 0 \; \wedge (3x^2 - 20x -$

171 Hudde, 'De Maximis et minimis', 507-508.
172 Ibidem, 508.

$7) = 0 \rightarrow x = 0 \wedge x = -\frac{1}{3} \wedge x = 7$, for which it is true that the function $f(x) = x^3 - 10x^2 - 7x + 346$ has two extremes on x coordinates $-\frac{1}{3}$ and 7. Now that we have seen that Hudde's method works, it is remarkable that Hudde does not provide the reader with a definite proof. Hudde, Jeff Suzuki and Jan van Maanen argue that it is evident that this seventeenth-century theorem works in all cases.[173] Although this is likely, after taking the works of Haas, Suzuki and Van Maanen on this topic into account, the theorem is not proved as long as one sticks to examples without delivering an encompassing proof.

Having said this, I am convinced that it was not Hudde's aim to provide the reader with a definite proof. In his 'Maximis et minimis' and 'Reductione aequationum', he provides the reader with various examples of high-degree functions that demonstrate that his method is superior to and much easier than that of Descartes. Hudde likely saw his method solely pragmatically as an instrument that works without providing a conclusive proof. This conviction does not make Hudde unique in the context of other mathematicians such as Fermat. He never proved what is known as Fermat's Last Theorem: $a^n + b^2 = c^2$. The conclusive proof was presented by mathematician Andrew John Wiles 357 years after its formulation.[174] To support the idea that it was not Hudde's intention to provide a conclusive proof, we can consult his letter to Van Schooten:

> My lord, the reason why I asked not to reveal my name as the author of the three curvatures was that in the future I do not want to work on these or similar topics that I do not find useful, since I devoted myself to a different study.[175]

Several days later he wrote to his teacher that he did not want to work on 'futile questions anymore', so it seemed that Hudde would abandon the more theoretical mathematics for some time.[176]

After his Grand Tour he devoted himself to experimental medicine, microscopy, and the production of lenses, which will be discussed in part in the next section. Instead of working on theoretical knowledge, Hudde devoted himself to the practical use of knowledge for 'the greater good'.[177] Nevertheless, in his leisure time, Hudde remained interested in theoretical questions and mathematics, as we have seen from the mathematicians who visited him, but also based on his inventory after his death and the following sections of this thesis.[178]

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173 Suzuki, 'The Lost Calculus', 345. J.A. van Maanen, *Een complexe grootheid. Leven en werk van Johann Bernoulli 1667-1748* (Utrecht 1995) 3-10.

174 Andrew John Wiles, 'Modular elliptic curves and Fermat's Last Theorem', in: *Annals of Mathematics*, vol. 141, no. 3 (1995) 443-551.

175 Hudde to Van Schooten, December 1657, in: Huygens, *Oeuvres*, II, nr. 437.

176 Ibidem, 1 December 1657, in: ibidem, nr. 436.

177 Ibidem, December 1657, in: ibidem, nr. 437.

178 SA, Notarieel Archief Amsterdam [5075], protocol notary Casper IJpelaer, inv. nr. 5336b (1705) fol. 1547-1650.

Chapter 4

The operation of microscopic lenses in theory and practice

Hudde's theoretical treatise on spherical aberration, Specilla Circularia

Hudde's mathematics teacher, Frans van Schooten, wrote to Christiaan Huygens on May 30th, 1656:

> Recently at a local print shop, a paper was for sale with the title *Specilla Circularia*, however without the name of the author and printer. I thought that you were the author, however I want to know if this is true, because you wrote ingenious material on dioptrics that is similar to this piece.[179]

Only eight pages written by an unknown author on dioptrics alarmed the most advanced mathematicians of the Republic. Huygens responded to Van Schooten three days later that it was not his work, but that he wished to receive a copy.[180] The next day, Van Schooten sent a copy to Huygens and the English mathematician John Wallis (1616-1703), accompanied by a letter. He was surprised that Huygens did not know the work because it was for sale at various bookshops in Leiden, though, it seems, not in The Hague (where Huygens lived).[181] It is through a copy of the work at the Royal Society, a letter from Spinoza to Hudde, and a recently discovered printed edition of the *Specilla* that it has been confirmed that Hudde is the author.[182] More importantly, it proves that Hudde's work was still read and used decades after its publication on 25 April 1656. The letter from Spinoza dates from June 1666, while the London copy addresses the author as 'Huddenius consul Amstelodamenis', the position of mayor Hudde required in 1672.[183]

While the *Specilla* was read by some of the most eminent scholars of the early modern period, the question remains: what were its contents and why did Hudde not reveal his authorship? The *Specilla* can be read as a practical solution for the problem that is known today as spherical aberration: the problem that not all light rays that are refracted by a lens come together in one focal point. The rays at the rim of the lens are refracted more strongly than those at the core of lens, resulting in a vague image of the object. Since it was impossible in the seventeenth century to grind the elliptic and hyperbolic lenses presented in Descartes' eight discourses in *la Dioptrique* (1637), Hudde's *Specilla* provided a practical solution.

By using a diaphragm on convex-concave lenses, Hudde presented through a series of calculations that the same result can be achieved as by using aspherical lenses. Through blocking the rim of the lens, Hudde showed that by using only a relatively small part of the convex-concave lens,

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179 Frans van Schooten to Christiaan Huygens, 30 May 1656, in: Huygens, *Oeuvres,* I, nr. 293.

180 Christiaan Huygens to Frans van Schooten, 2 June 1656, in: ibidem, nr. 298.

181 Frans van Schooten to Christiaan Huygens, 30 May, 1656, in: ibidem, nr. 293.

182 Vermij & Atzema, 'Specilla circularia', 104-121. [Johannes Hudde], *Specilla circularia* (1656). Baruch Spinoza to Johannes Hudde, 7 January 1666 in: Baruch Spinoza, *Spinoza. The Letters*, translated by: Samuel Shirley (Indianapolis 1995) 206-210.

183 Vermij & Atzema, 'Specilla circularia', 106. For further information on Spinoza's relation with Hudde see also: Wiep van Bunge (ed.), *The Continuum Companion to Spinoza* (London 2011) 14, 20, 22, 24, 27. Rienk Vermij, 'Huddes *Specilla circularia*', in: Huib Zuidervaart (ed.) *Studium – Tijdschrift voor Wetenschaps- en Universiteitsgeschiedenis*, vol. 11, no. 1 (2018).

the variation in refraction of the light rays through the center is almost negligible. Therefore, instead of having a geometrical focal point, Hudde created a mechanical point that resulted in a sharp image.[184] The lesson that can be drawn from his treatise is that by using only a small part of the lens, one can obtain a sharp image. Although this was already known in practice, Hudde provided a theoretical justification for the common practice.[185]

The reason that Hudde did not reveal his authorship can be found on the first page of the *Specilla*. His praise for the 'incomparable' and 'brilliant' René Descartes shows his commitment to the 'new philosophy' that could bring harm to anybody who was associated with it.[186] As we have seen in the chapter on the pamphlet war between Hudde and Du Bois, it was to a certain extent controversial to be a Cartesian.[187] For Hudde, it was especially important because he printed his treatise in the same year as his *Wiskonstigh-Bewys* and *Den Hollenden Astronomus*. Furthermore, in his later life as a mayor of Amsterdam he could have been associated with the controversial philosopher Spinoza. His *Opera Posthuma* was published in 1677, in which letter 36 contains an image from Hudde's *Specilla* accompanied by questions about lens grinding.[188]

Hudde's alternative to lens grinding

A year after Hudde's *Specilla* and the pamphlets directed at Du Bois were published, Hudde wrote to Van Velthuysen that after he would have learned the foundations of medicine, for which he used also magnifying glasses for his experiments, he would devote himself to making the most advanced microscope lenses.[189] Hudde fulfilled his promise the moment he came back from his Grand Tour. He had already proved in his *Specilla* that he had theoretical knowledge of dioptrics. But it became known in the early 1660s that he was also capable to craft purer lenses with a higher magnification than his predecessors.

Instead of grinding lenses, Hudde had a unique method of lens craftsmanship that he demonstrated to Balthazar do Monconys in August 1663:

> M. Hudde is very skilled in Algebra, and has found a way to make small single lens microscopes, of which he gave one to me and my son. He told us the manner in which he forms these small lenses. He simply makes the lamp to melt very pure crystal, from which he removed the salt that is in it, by making it blush, because then this salt comes at the surface of the glass, which then is easily removed. So the glass being very pure, he then takes a bit at the tip of a small rod of red iron, where he attaches the

184 [Hudde], *Specilla*.

185 See for Hudde's relation concerning lenses with Spinoza: Vermij, 'Instruments and the Making of a Philosopher', 75-81.

186 Ibidem, 1.

187 See also the case of Samuel Kechel and his preference for the Tychonic system instead of Copernican' heliocentricsm due to also the debate on Cartesianism: Zuidervaart & Beurze, 'Samuel Carolus Kechel ab Hollenstein', 40-42.

188 Spinoza to Hudde, 7 January 1666 in: Spinoza, *Spinoza*, 208-210. Also in Spinoza's letter to Huygens Hudde's image from the *Specilla* is included, see: Baruch Spinoza to Christaan Huygens, May 1666, in: *Oeuvres Complètes*, vol. VI (The Hague 1895) nr. 1541.

189 Johannes Hudde to Lambertus van Velthuysen, 13 October 1657, in: University Library of the University of Amsterdam, OTM: hs. D 29.

> amount that one wishes &c. During the melting of the lamp, the rod of iron is turned on which [the glass] is attached, and it is perfectly smoothed around it. Sometimes, instead of crystal, he takes a small bladder glass, full of water, which has the same effect.[190]

Therefore, instead following the time-consuming method of grinding lenses that could take days, Hudde's method allowed him to make several dozen lenses in an hour. Swammerdam even argued in 1678 that he himself could make 40 lenses in one hour.[191] Although this is probably slightly exaggerated, it is clear that Hudde's method was more efficient than grinding lenses. In short, he made these lenses by heating a piece of glass on the point of a copper needle. Through surface tension on the molten glass while holding it in fire, a smooth and round surface was created, because a round shape has the smallest possible surface for an object. The same principle is true for a small amount of water, which will shape itself into a drop. The small spherical drop formed at the end of the needle constituted the lens of the single lens microscope.[192]

The origin of these lenses can be traced back to the curious phenomenon of 'glass drops', also known as 'larmes de verre', or 'Prince Rupert's Drops'.[193] These curious glass drops in the form of a teardrop with a fine tail were made by dripping molten glass into water. They had the unique characteristic that the head of the drop was unbreakable by force. However, when you broke the fragile tail, the drop immediately exploded. Therefore, because of the paradoxical feature of the drop being nearly unbreakable and extremely fragile at the same time, many natural philosophers were interested in the glass tears. Future friends and colleagues of Hudde, namely Huygens and Coenraad van Beuningen, already discussed the objects in 1660-1661.[194] In the same years, they were presented

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190 20 August 1663: 'M. Hudde estimé très habile dans l'Algebre, & qui a trouvé la façon des petits microscopes a une seule lentille,dont il en donna un à M. un a moy, & à mon fils. Il nous dit la manière de laquelle il tailloit ces petites lentilles. Il faisoit simplement fondre à la lampe du cristal bien pur de soy, d'où il oste le sel qui est dedans, en le faisant rougir, car alors ce sel vient tout à la superficie du verre, dont on l'oste apres avec facilité: le verre donc estant bien pur, il en prend un peu au bout d'une petite verge de fer rouge, où il s'en attache la quantité qu'on veut. & Lors le faisant fondre à la lampe, & tournant la verge de fer, au bout de laquelle il est, il s'arrondit de luy mesme parfaitement. Quelquefois, au lieu de crystal, il prend une petite vessie de verre pleine de l'eau, qui fait le mesme effet', in: Balthazar de Monconys, *Journal des voyages*, vol. 2 (Lyon 1666) 161–162. A week earlier De Monconys visited Isaac Vossius in The Hague, who also had one of these microscopes. Ibidem, 153. See also: Zuidervaart & Anderson, 'Antony van Leeuwenhoek's microscopes', 5.

191 Jan Swammerdam to Melchisédec Thévenot 1678, in: G.A. Lindeboom, *The Letters of Jan Swammerdam to Melchisedec Thévenot* (Amsterdam 1975) 138-139.

192 Tiemen Cocquyt, 'Johannes Hudde en zijn gesmolten microscooplensjes', in: Huib Zuidervaart (ed.) *Studium – Tijdschrift voor Wetenschaps- en Universiteitsgeschiedenis*, vol. 11, no. 1 (2018).

193 Mihnea Dobre, 'On glass-drops: a case study of the interplay between experimentation and explanation in seventeenth-century natural philosophy', in: *Journal of Early Modern* Studies, no. 1 (2013) 105-124, especially, 107. See also: Pieter de Clercq, 'Brittle Glass: A Fragile Chapter in the History of Experimental Physics', in: R.G.W. Anderson, J.A. Bennett & W.F. Ryan, *Making instruments count. Essays on Historical Scientific Instruments presented to Gerard L'Estrange Turner* (Aldershot 1993) 255-267.

194 Zacharias Conrad von Uffenbach, *Merkwürdige Reisen durch Niedersachsen, Holland und England*, vol. III (Ulm 1753) 359. Christiaan Huygens, 'Journal de Chr. Huygens Le voyage à Paris et à Londres de 1660-1661', in: Christiaan Huygens, *Oeuvres Complètes*, vol. XXII (The Hague 1950) 562.

at the Royal Society and De Raeij's teacher Henricus Regius wrote about them in his *Philosophia Naturalis* (1661).[195]

In the same period, the experimental philosopher and secretary and curator of experiments of the Royal Society, Robert Hooke (1635-1703) used a similar method to Hudde, presented in his *Micrographia* (1665), to make fire-shaped lenses.[196] Hooke's method, however, was slightly different and more advanced: over a flame, a rod of glass was pulled into a fine wire until it broke. One end of this wire was put into the flame and twirled until a small spherical bead was formed, which then was ground and polished into a plano-convex lens.[197] The important difference between the methods is that Hudde's lenses were shaped like globules, while Hooke's lenses were flat on one side. Furthermore, Hooke did not shape the lens at the tip of a needle to avoid contaminating the glass.[198] Huygens wrote to Hudde in April 1665 about Hooke's *Micrographia*, to which Hudde responded a day later with the request that Huygens translate some pages, since he was unable to read English.[199] Within a week Hudde received a summary of the most important aspect of the book.[200]

Now that we know how lenses were made, we should learn how they operate. We have seen that melting lenses is less time-consuming than grinding them, but the most important feature of Hudde's lenses were their magnifying qualities and the distinctness of resolution.[201] The amount of refraction and the magnifying qualities depend first and foremost on the shape of the lens. The stronger the curvature of the lens, the stronger the refraction. Therefore, microscopists used a diaphragm at the rim of their lenses, for which Hudde provided a theoretical explanation in his *Specilla*. However, with the (ground) lenses used as an example in the *Specilla*, a lens maker could adapt not only the curvature, but also the shape and thickness of the lens. With the round fire-shaped lenses, only size mattered, since half the radius of curvature is the diameter of the lens. This leads us back to Hudde's earlier work on the mathematics of curvatures. In a practical sense, it means that the shorter the radius of curvature, the stronger the curvature, which results in a stronger refraction and therefore higher magnification.[202] Therefore, we can conclude that it is not only simpler to craft Hudde's lenses, but also the amount of refraction could be adjusted more easily by changing the diameter of the lens. Since the number of variables is limited compared to ground lenses, almost anyone could make proper lenses without being an advanced lens grinder.[203]

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195 Henricus Regius, *Philosophia naturalis* (Amsterdam 1661). Laurel Brodsley, Charles Frank & John Steeds, 'Prince Rupert's Drops', in: *Notes and Records of the Royal Society of London*, vol. 41, no. 1 (1986) 1-26, especially, 1.

196 Hooke, *Micrographia*.

197 Zuidervaart & Anderson, 'Antony van Leeuwenhoek's microscopes', 6.

198 Ibidem, 7.

199 Christiaan Huygens to Johannes Hudde, 4 April 1665, in: Christiaan Huygens, *Oeuvres Complètes*, vol. V (The Hague 1893) nr. 1374. Johannes Hudde to Christiaan Huygens, 5 April 1665, in: ibidem, nr. 1375.

200 Huygens to Hudde, 10 April 1665, in: ibidem, nr. 1384. Hudde to Huygens, 17 April 1665, in: ibidem, nr. 1392.

201 Hudde to Huygens, 5 April 1665, in: ibidem, nr. 1375.

202 Steven Blankaart, *Collectanea medico-physica, oft Hollands jaar-register der genees- en natuur-kundige aanmerkingen* (Amsterdam 1680) 200-201.

203 Robert Hooke, *Lectiones Cutlerianae, or a collection of lectures* (London 1679) 90.

It seems that Hudde, like Hooke, found the method to create 'perfect' lenses. However, it seems that with his death, his method (at least for experienced microscopists) died with him. At first, microscopists like Swammerdam, Van Leeuwenhoek, Spinoza, and Nicolaas Hartsoeker (1656-1725) used Hudde's method, although over the course of the century they all returned to using ground lenses.[204] One of the reasons for this is perhaps the short back focal length of melted lenses. Because of the strong refraction, the distance between the object and the lens has to be shorter than with grinded lenses. Furthermore, a smaller lens bead resulted not only in a higher magnification, but also reduced the amount of light coming through the lens, resulting in an inversely proportional relation between the amount of magnification and the amount of light needed to see the magnified object. According to Hartsoeker, this was the greatest drawback of the glass beads.[205]

Although Hudde's lenses were relatively easy to make and provided the microscope with a clear and high magnification, it seems that their practical use became more difficult with smaller lenses. Nevertheless, Hudde's method provides an insight into the discontinuity of microscopic evolution. Instead of improving lens grinding, Hudde showed that through melting glass he could make glass beads with a smoother surface and higher magnification than ground lenses. Furthermore, his method allowed him to make dozens of beads per hour, rather than grinding lenses, which could take days. Moreover, Hudde found a method of lens craftsmanship that virtually everyone could use without much effort. Therefore, he made the practice of microscopy available not only to scholars and wealthy individuals, but also to interested laymen. It would therefore be interesting to investigate to what extent Hudde's method was used among amateur microscopists.

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204 Zuidervaart and Anderson argue that Leeuwenhoek also used a melted lens after Hudde's design. See: Zuidervaart & Anderson, 'Antony van Leeuwenhoek's microscopes', 260-261. Anthoni van Leeuwenhoek to Regnerus [Reinier] de Graaf, 28 April 1673, in: Anthoni van Leeuwenhoek, *Alle brieven van Antoni van Leeuwenhoek. Deel 1: 1673-1676* (Amsterdam 1939) nr. 1.

205 Edward G. Ruestow, *The microscope in the Dutch Republic: the shaping of discovery* (Cambridge 1996) 30. Vermij, 'Instruments and the Making of a Philosopher', 202.

Chapter 5
Hudde's question about the existence of only one God

Hudde's correspondence with Spinoza

One of the lens grinders who were inspired by Hudde's work in microscopy and his *Specilla* was the philosopher Spinoza. His letter addressed to Hudde in June 1666 discusses the *Specilla*, but also a topic that would hold Hudde's attention until his death: a proof of the existence of only one God. Hudde tried to obtain irrefutable evidence for the matter through consulting Spinoza, Burchard de Volder (1643-1709), and John Locke, which he did in utmost secrecy. The topic was extremely sensitive, as we already have seen in the section about Du Bois. Questioning God could mean that one could be branded as an atheist; therefore, some matters could only be discussed in private, since it was too controversial for the public domain and the consequences too risky for Hudde's career. Through exploring this 'secret' matter, we can gain an insight into Hudde's private interest and beliefs in a changing cultural landscape leading up to the Enlightenment.

Spinoza's *Opera Posthuma* was, as the title suggests, published posthumously in 1677. The volume contained, among other things, 88 letters. Fifty letters were by his hand, and 38 by his correspondents. Letters 34, 35, and 36 are written to a *Viro amplissimo ac prudentissimo*, 'To the highly esteemed and sagacious', who we know through the notes of Leibniz and John Locke's correspondence was Johannes Hudde.[206] It is not remarkable that Hudde did not want to see his name in Spinoza's work, since the philosopher was branded an 'atheist'. This was not only dangerous for himself, but also for his correspondents. Nevertheless, the real danger was not the name of Hudde's correspondent but his own question. This is confirmed by the fact that Hudde's correspondence, like almost all original letters published in the *Opera Posthuma*, have not survived to the present. He asked for *a priori* proof of the existence of only one (and not multiple) God(s). This matter will be discussed here in detail. First, we shall discuss Hudde's correspondence with Spinoza, which has an even more interesting sequel thirty years later, when Hudde asked Locke the same question.

In January 1666 Spinoza wrote that he received Hudde's request for a 'demonstration of the unity of God, on the ground that His nature involves necessary existence, which you asked for, and I took note of'.[207] Although at first this does not seem to be an odd question, Hudde does question the

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206 Ludwig Stein, *Leibniz und Spinoza: ein Beitrag zur Entwicklungsgeschichte der leibnizischen Philosophie* (Berlin 1890) 320. See also: Wiep van Bunge, 'Hudde en Spinoza: waarom er maar één God is', in: Huib Zuidervaart (ed.) *Studium – Tijdschrift voor Wetenschaps- en Universiteitsgeschiedenis*, vol. 11, no. 1 (2018).

207 Baruch Spinoza to Johannes Hudde, 7 January 1666 in: spinoza, *Spinoza*, 201. In this letter there is already a demonstration of Spinoza's ontological proof for God's existence that was published posthumously in his *Ethica* in

unity of God. This is questioning a noncontroversial assumption that was not seen as problematic. However, as we have seen in his dispute with Du Bois, Hudde does not want to be dogmatic, and since even his source of inspiration, Descartes, did not question the assumption that there is only one God, he asks Spinoza to deliver proof.[208] Asking Spinoza to answer the question is not that remarkable, given the fact that the philosopher published *The Principles of Descartes' Philosophy* in Amsterdam three years before Hudde wrote him. Furthermore, Spinoza explicitly refers to this work on the unity of God in his letter from April 1666.[209]

To deliver his evidence, Spinoza began with four premises:

1. The true definition of each single thing includes nothing other than the simple nature of the thing defined. Hence it follows that: 2. No definition involves or expresses a plurality, or a fixed number of individuals, since it involves and expresses only the nature of the thing as it is in itself. For example, the definition of a triangle includes nothing but the simple nature of a triangle, and not a fixed number of triangles, just as the definition of mind as a thinking thing or the definition of God as a perfect Being includes nothing other than the nature of mind and of God, and not a fixed number of minds or Gods. 3. There must necessarily be a positive cause of each thing, through which it exists. 4. This cause must either be placed in the nature and definition of the thing itself (because in effect existence belongs to its nature or is necessarily included in it) or outside the thing.[210]

Based on these assumptions, it follows that if in nature there exists a fixed number of individuals, there must be one or more causes that produced exactly that number of individuals, no more and no less.[211] Thereafter Spinoza concludes:

> Now since (according to our hypothesis) necessary existence pertains to God's nature, it must be that his true definition should also include necessary existence, and therefore his necessary existence must be concluded from his true definition. But from his true definition (as I have already proved from the second and third hypothesis) the necessary existence of many Gods cannot be concluded. Therefore there follows the existence of one God only. Q.E.D.[212]

Spinoza based this on the 'principle of sufficient reason', which means that of everything that exists, there must be a sufficient or positive cause due to which it exists. In this case, 'cause' can also be read as 'reason'.[213] A definition of people or God does not say anything about the number of people or

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1677. Already eleven years before the publication Hudde knew Spinoza's proof but argued that it was inconsistent. See Spinoza's letters to Hudde from 10 April and June 1666 and Spinoza's *Ethica*, part I.

208 F. Akkerman, *Spinoza. Korte Geschriften* (Amsterdam 1982) 65-66.

209 Baruch Spinoza, *Renati Des Cartes principiorum philosophiæ pars I, & II, more geometrico demonstratae* (Amsterdam 1663) 29. Baruch Spinoza to Johannes Hudde, 10 April 1666 in: Spinoza, *Spinoza*, 203.

210 Spinoza, *Spinoza*, 201.

211 Ibidem, 202.

212 Ibidem.

213 Baruch Spinoza, *The Principles of Descartes' Philosophy,* translated by: Halbert Hains Britan (Illinois 1974) axiom XI, part I, 29-30. 'Nothing exists of which we may not ask, what is the cause (or reason) [*causa (sive ratio)*], of its existsence. If anything postive exist we cannot say that it exists without a cause (per Ax. 7). Therefore we must assign some positive cause for its existence. This may be external, i.e., some cause outside of the object itself, or internal, i.e.,

Gods that exist. The reason or cause of this number lie outside the nature of people and God. However, since God exists due to his nature, there is no such reason outside his nature. Therefore, there can only be one God and not several, as is the case with people.[214]

Spinoza concludes the letter with a sentence that provides us with new insight into Hudde's Cartesian convictions: 'I have proved this same proposition in a different way, making use of the distinction between essence and existence; but having regard to the consideration which you pointed out to me, I have preferred to send you this proof.'[215] Therefore, it appears that Hudde not only knew Cartesian metaphysics, as he demonstrated in his pamphlets, he was also critical of it by asking for an anti-Cartesian proof. From the quotation above we can conclude that Hudde explicitly asked ('pointed out'), that the evidence does not have to involve the distinction between *essence* and *existence* that is essential for Descartes' philosophy.[216]

In Hudde's letter from that March, he clarifies his response to Spinoza in February.[217] Spinoza answered both letters in April, in which Hudde formulates his question more concretely. His question is 'An scilicet non nisi unum sit Ens, quod sua sufficientia vel vi subsistit'[218] ('whether there is only one Being which subsists through its own sufficiency or force').[219] The word 'Ens' or 'Being' is interesting. Hudde does not specify the word 'God', but uses a more general term that is closer to contemporary philosophy.

Since Hudde was not satisfied with the philosopher's proof from letter 34, and he rephrased his question, and in letter 35 Spinoza began his ontological proof of the existence of God with a reference to his commentary on Descartes' *Principia Philosophia* on the proposition 'There are not many Gods'.[220] Before treating the subject, he briefly showed, as preliminaries, what properties must be possessed by a Being that includes necessary existence: 1. It must be eternal; 2. it must be simple, not made up of parts; 3. it cannot be conceived as determinate, but only as infinite; 4. it is indivisible, for if it were divisible, it could be divided into parts either of the same or of different nature.[221] From these four properties, it follows that if a necessary existence includes an imperfection, it contradicts these four points. Therefore, 5. 'Everything that includes necessary existence can have in itself no imperfection, but must express pure perfection.'[222] 6. There can only be a single Being, of which existence belongs to its nature: 'that Being which possesses in itself all perfections, and which I shall

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something comprehended in the nature and defintion of the object.' (Although Spinoza does not call the principle of sufficient reason by name, as Leibniz does in his *La Monadologie* (1714), he does use the principle).

214 Spinoza to Hudde, 7 January 1666 in: Spinoza, *Spinoza*, 202.

215 Ibidem.

216 Adam & Tannery, *Oeuvres de Descartes*, VII, 63-71 (fifth meditation).

217 Spinoza to Hudde, 10 April 1666 in: ibidem, 203.

218 B.d.S. [= Spinoza, Baruch], *Opera Posthuma. Quorum Series Post Præfationem Exhibetur* (Amsterdam 1677) 603.

219 Spinoza to Hudde, 10 April 1666 in: Spinoza, *Spinoza*, 203.

220 Ibidem. Spinoza, *The Principles of Descartes' Philosophy*, 43.

221 Spinoza to Hudde, 10 April 1666 in: Spinoza, *Spinoza*, 203-204.

222 Ibidem, 205.

call God.'[223] 'Therefore, if we suppose that a Being which does not express all the perfections exists by its own nature, we must also suppose that a Being which comprehends in itself all the perfections exists as well.'[224]

Again, Hudde was not satisfied with Spinoza's argumentation, since he based his argument on several unjustified assumptions. Therefore, Spinoza writes in his third letter to Hudde: 'As I understand that for the most part you suspend judgment about the proof which I sent you … I shall here endeavour to explain its meaning more clearly.'[225] Hudde did not have any difficulty with the first two properties, since they were nothing more than axioms. Point three, that God must be conceived as infinitive, was problematic, according to Hudde. Hudde's question was: if *cogito* (thinking substance) and *res extensa* (extended matter) are autonomous or indefinite, this does not mean that they are infinite.[226] However, Hudde said that he did not understand Spinoza's logical conclusion. According to Spinoza:

> It is a contradiction to conceive under the negation of existence something whose definition includes existence, or (which is the same thing) affirms existence. And since 'determinate' denotes nothing positive, but only the privation of existence of that same nature which is conceived as determinate, it follows that that whose definition affirms existence cannot be conceived as determinate.[227]

Spinoza clarifies this with an example:

> If the term 'extension' includes necessary existence, it is just as impossible to conceive extension without existence as extension without extension. If this is granted, it will also be impossible to conceive determinate extension. For if it were conceived as determinate, it would have to be determined by its own nature, that is, by extension, and this extension by which it would be determined would have to be conceived under the negation of existence. This, according to the hypothesis, is a manifest contradiction.[228]

Spinoza clarifies points four and five from letter 35 in letter 36. However, Hudde's problem was with the sixth property. He admits that he wants to accept Spinoza's logical conclusion, but it does not provide an answer to Hudde's initial question: 'why there could not be several beings existing through themselves but of different natures, just as Thought and Extension are different and perhaps can subsist through their own sufficiency'.[229]

Spinoza responds that the two scholars have different perspectives on the matter: Hudde, a Cartesian who wants to uphold Descartes' dualism, against Spinoza who in his *Ethica* develops his transition from dualism to monism. This is the position that would condemn Spinoza as an atheist, because how could we distinguish God from the (material) world in which we live? Spinoza's metaphysical adjustment compared to Descartes' dualism is the idea of only one substance, instead of

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223 Ibidem, 204-205.
224 Ibidem, 204.
225 Ibidem, June 1666 in: ibidem, 206.
226 Ibidem, 207.
227 Ibidem.
228 Ibidem.
229 Ibidem, 208.

two, with an infinite number of 'attributes', of which we know *thought* and *extension*. This is due to the fact that people consist of a body and a soul, two modifications of Gods 'attributes'.[230]

Through his devotion to monism, Spinoza had placed himself on dangerous ground. Therefore he refers in letter 36 to points five and six, on imperfection.[231] He repeats his earlier point that 'if we suppose that something which is indeterminate and perfect only in its own kind exists by its own sufficiency, then we must also grant the existence of a being which is absolutely indeterminate and perfect. This Being I shall call God.'[232] Spinoza argues explicitly thereafter that this applies to both *thought* and *extension*, but that the existence of God, who is absolutely perfect and indeterminate, must be admitted.[233] From this follows Spinoza's monistic notion through his idea of 'imperfection':

> Namely, that it signifies that a thing lacks something which nevertheless pertains to its nature. For example, extension can be said to be imperfect only in respect to duration, position, or magnitude; that is to say, because it does not last longer, because it does not retain its position, or because it is not greater. But it will never be said to be imperfect because it does not think, for nothing like this is demanded of its nature which consists solely in extension, that is, in a definite kind of being, in which respect alone it can be said to be determinate or indeterminate, imperfect or perfect.[234]

To summarise, God consists of an infinite number of attributes that are each perfect. However, a Cartesian cannot accept this, since only a follower of Spinoza's philosophy would be prepared to accept that *thought* and *extension* are attributes of God.[235] Spinoza concludes his letter by paying respect to Hudde, who he says could deliver a better judgement of the proof than the philosopher himself.[236] With hindsight, based on his correspondence with Locke, we can conclude that Hudde was not convinced of Spinoza's monism.[237] He continued his search by discussing the matter with De Volder and Locke within a Cartesian framework that make the distinction between *essence* and *existence*.

Although these three letters are the only correspondence between Hudde and Spinoza that we have on the matter, it seems that Hudde could not let the matter rest. More than thirty years after his last letter to Spinoza, Hudde asked the same question of the English philosopher John Locke. Because of the delicate subject, Hudde and Locke made use of an intermediary, the 'open-minded' theologian and Arminian Philipp van Limborch (1633-1712).[238] Using precautionary measures such as secret meetings and pseudonyms, an extensive correspondence of more than twenty letters took place. Since

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230 'Baruch Spinoza', (2016) *Stanford Encyclopedia of Philosophy*, consulted on: 10 April 2018, https://plato.stanford.edu/entries/spinoza/.

231 Spinoza to Hudde, June 1666 in: Spinoza, *Spinoza*, 206, 207-208.

232 Ibidem, 208.

233 Ibidem.

234 Ibidem.

235 Baruch Spinoza, *Spinoza Ethica,* translated by: Henri Krop (2004) part I, proposition X, scholium.

236 Spinoza to Hudde, June 1666 in: Spinoza, *Spinoza*, 209.

237 For the *Deus sive Natura* debate see: Yirmiyahu Yovel (ed.), *God and nature. Spinoza's metaphysics. Papers presented at the First Jerusalem Conference (Ethica I)* (Leiden 1991). Philip Goff (ed.), *Spinoza on Monism* (New York 2012). Yitzhak Melamed, *Spinoza's Metaphysics. Substance and Thought* (Oxford 2013).

238 For more information on Van Limborch see: Pieter Jacobus Barnouw, *Philippus van Limborch* (The Hague 1963).

we have the letters of both scholars, studying this correspondence provides us with the opportunity to investigate Hudde's behaviour and convictions in the matter. Because there is not enough space here to analyse each letter extensively, I will only highlight the most important aspects concerning Hudde's thoughts.

Hudde's correspondence with Locke

In September 1697 Van Limborch wrote to Locke that with some prominent gentleman, he had read the philosopher's work *The Reasonableness of Christianity*.[239] Hudde, whose name was not explicitly mentioned in this letter, praised Locke and his book for the clear explanation of the essence of Christianity. He even said that he read the book twice. Nevertheless, according to Hudde, Locke should not have refuted the common opinion regarding the Original Sin that originated from the Fall of man at the beginning of his book. Because of this, the reader would be inclined to have a negative judgement of the author before he arrives at the main argument,

> and accordingly conceive a prejudice against the author, so that they do not read what follows with the requisite serenity of mind and are thys rendered the more averse, when rather their goodwill should have been courted, so that they might ponder with impartial judgement and opinion that indeed agrees little with the common craving of theologians, who almost all want something of their own to be admised with the Christian faith, as if that faith were peculiar to their own religious body [*coetus*] and others were excluded from that faith'.[240]

After this has been said by Hudde according to Van Limborch, the debate developed in a different direction, in which Hudde stated that he was searching for 'some irrefragable arguments by which it may be proved that an eternal being, whether existing of itself or in every respect perfect, is only one.'[241] He argued that Hugo Grotius' (1583-1645) *De veritate religionis Christianae* (1627) addresses the matter, but that he was not satisfied. Later, Hudde heard that Locke's piece *An Essay Concerning Human Understanding* (1690) had been translated into French, and he wanted to have a copy.[242] He wondered if Locke would provide proof concerning the unity of God, or that of a Being that exists necessarily from its own nature.[243] Van Limborch said that he did not know, so Hudde insisted that if Locke had not done it already, he should ask if Locke would add the proof in the next edition. Although Hudde argued that it is evident that only one indeterminate perfect Being could exist, he wanted to see irrefutable proof of it.[244] Here again we can see Hudde's anti-dogmatic attitude, his methodological scepticism, questioning each assumption or his rationalistic approach in questioning if

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239 John Locke, *The Reasonableness of Christianity, as Delivered in the Scriptures* (London 1695).

240 Philippus van Limborch to Locke, 28 September 1697, letter 2318 in: E.S. Beer (ed.), *The Correspondence of John* Locke, vol. VI (Oxford 1981) 207.

241 Ibidem, 208.

242 Ibidem.

243 Ibidem.

244 Ibidem.

such evidence can be delivered. He clearly wanted to have Locke's proof sooner rather than later, considering the fact that three days after the conversation he asked Van Limborch if he had already written to Locke.[245]

Hudde was fond of secrecy, and Locke was no different. His answer consisted of two letters, one uncontroversial letter for Van Limborch's eyes only to improve his Latin and the other in French to provide an answer for a wider audience (e.g. Hudde), written by Pierre Coste (1668-1747).[246] In the French section Locke writes, through Coste's hand, that he would like for his *Essay* to be translated so that it would be accessible to a wider audience. Genuine criticism was more than welcome, according to Locke. However, the third edition did not sell well, and therefore the fourth edition had to wait.[247] Locke did let Hudde know that he was prepared to insert an irrefutable proof of the existence of only one God in his fourth edition, if it is not too controversial.[248] His fear of controversy becomes clear in the Latin part, in which he writes that the bishop of Worcester, Edward Stillingfleet (1635-1699) had attacked his *Essay*. This resulted in a polemic and other unwanted attention to his work.[249] Moreover, Locke was aware of the consequences of the answer to Hudde's question. He asked Van Limborch if it was possible for someone who believes in God to doubt that this God is unique. Locke himself never doubted it.[250]

After Van Limborch read the French section to Hudde, Van Limborch wrote in November that the term *Magnifico* is the pseudonym for 'the highly honoured burgomaster of our city, Mr. Hudde', at whose request Van Limborch was writing.[251] The mayor's answer to Locke's previous question was that indeed no healthy person would question the uniqueness of God. However, since heathens believe in multiple gods and do not know or recognise the authority of the Bible, he needs proof based on arguments derived from nature. This is why Hudde insists on irrefutable arguments that only one indeterminate and perfect Being can exist.[252] Again Hudde states that not even Descartes proved this matter, but made an assumption. Because of this, Hudde says that he wrote a piece of evidence for himself, but it was too subtle, and therefore would like to have Locke's opinion on the matter.[253] Van Limborch emphasises that Locke's answer will only be used for personal interest to discover the truth, and that Hudde does not plan to disseminate it. Moreover, Van Limborch assures Locke that he will not allow any copies of the letters to be made, and that he will keeps them in his possession.[254]

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245 Ibidem.
246 Locke to Van Limborch, 29 October 1697, letter 2340 in: ibidem, 244-245.
247 Ibidem, 243.
248 Ibidem.
249 Ibidem, 245.
250 Ibidem.
251 Van Limborch to Locke, 18/28 November 1697, letter 2352 in: ibidem, 257.
252 Ibidem, 258.
253 Ibidem.
254 Ibidem, 259.

Locke writes that a great honour had been bestowed on him that a genius with such capacities and scientific qualities had asked him to deliver the proof.[255] Subsequently, Locke runs through the conditions under which he would deliver proof of the existence of only one God. First, Hudde must not hold back his thoughts on the matter. Second, no copies of the letters can be made, and when Locke asks, they must be thrown into the fire. Last, Hudde must reveal his motivation for his search for such proof.[256] Afterwards, discussing the conditions, Locke provides evidence that is, in general, similar to Spinoza's answer in letters 34 and 35. It is a rather traditional and uncontroversial proof to answer Hudde's question.[257] Locke does not address the points of what this Being is, what the nature of the divine substance is. This was exactly what Hudde was seeking, without making this explicit to Van Limborch and Locke. Spinoza's answer in letter 36, was that *thought* and *extension* were merely attributes of God, but Locke remains silent.[258] In the Latin letter for Van Limborch's eyes only, Locke approves Van Limborch's earlier request to discuss the matter with other scholars, such as the theologian Jean LeClerc.[259]

In his answer to Locke's letter in March 1698, Van Limborch writes that he was directly convinced of the philosopher's proof of the existence of only one God. However, he questions whether Cartesians would accept the argumentation. After discussing Locke's letter with LeClerc again, he sends another letter to Locke with the request to provide a more elaborate proof. Van Limborch writes that the mayor is a Cartesian, so evidence based on the perfection of God would not win his approval. That is why Van Limborch did not show Hudde Locke's answer, because Hudde would like to see proof based on the Cartesian framework in which *thought* and *extension* have a role in the evidence for the existence of a unique God.[260] Furthermore, Van Limborch explains Cartesian terminology and the role it plays in Descartes' metaphysics. Terms such as *incorporeal* must be replaced by *thought*, for example, because the word *incorporeal* is negative and cannot confirm something positive.[261]

After his request for minor modifications, Van Limborch apologises for being unclear about the answer Hudde is searching for. It has to be an *a priori* proof of the existence of only one God, and not several. 'The argument should be taken from the necessity of the existence and should infer *a priori* … and not *a posteriori,* that is, that it may be proved from the nature of necessary existence that that existence cannot be common to several.'[262] Van Limborch concludes the letter by stating that he gave Hudde the excuse that due to illness, Locke could not have answered sooner.[263]

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255 Locke to Van Limborch, 21 February 1698, letter 2395 in: ibidem, 321.
256 Ibidem, 321-322.
257 Ibidem, 322-324.
258 Ibidem.
259 Ibidem, 325.
260 Van Limborch to Locke, 22 March 1698, letter 2410 in: ibidem, 353.
261 Ibidem, 354.
262 Ibidem, 354-355.
263 Ibidem, 355

Hudde had to wait several months for an answer, but in April Locke wrote his letter. He showed his gratitude to Van Limborch for warning him of the fact that Hudde is a Cartesian. However, Locke is not planning to make significant changes to his evidence, since Hudde cannot expect that Locke knows that he is a Cartesian. Moreover, Locke looks down upon the philosophy of Descartes, as we can read in his *Essay*.[264] Furthermore, he is convinced that *thought* is not an autonomous substance, but an action of a substance.[265] Therefore, we can conclude that Locke does not believe in Descartes' dualism. However, he does use the term *substantia cogitans*, which means 'thinking substance'.[266] This opens the door to a notion of God that conforms with Spinoza's. Out of respect for Hudde, Locke is willing to make a few adjustments, but he doubts whether Hudde would appreciate it from a Cartesian perspective.[267]

After Van Limborch received Locke's letter, Hudde summoned him several days later to discuss the content.[268] Although Hudde accepted Locke's *a priori* evidence proving that only one God exists, he longed for proof in which the argumentation is not based on the definition of God, but from the *ratione naturali*, or 'the natural reason' itself.[269] Hudde himself also wrote a brief statement consisting of three premises, which he asks Locke to comment upon:

> I. There is given an eternal being, independent, existing by the necessity of its own nature, and sufficient to itself. II. Such a being is only one, and there cannot be more than one being of the same sort. III. That being, because it is unique, embraces all perfections in itself; and this being is God.[270]

Hudde claims that his first proposition is similar to that of Locke in his *Essay*.[271] Therefore, he wants to know how the philosopher would prove the second proposition, since the third can easily be deduced from the first two.[272] Hudde argues that everybody assumes the second proposition, although it has never been proved. Although he claims that he has an idea of what such proof would look like, he does not want to share it with Locke before he has seen his argumentation. Propositions two and three need not be turned around, according to Hudde, since one cannot claim that *thought* and *extension* are two autonomous substances and then posit an eternal and indeterminate Being that would comprehend all perfection.[273] First, Locke has to prove that only one eternal and indeterminate Being exists, from which he could derive that this Being embodies all perfection.[274] If he cannot prove

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264 John Locke, *An Essay concerning Human Understanding* (London 1700) Book II, chapter I, §XII, §XV, §XIX.
265 Locke to Van Limborch, 4 April 1698, letter 2413 in: Beer, *John Locke*, vol. VI, 365.
266 Ibidem.
267 Ibidem.
268 Van Limborch to Locke, 6 May 1698, letter 2432 in: ibidem, 386.
269 Ibidem.
270 Ibidem.
271 Locke, *An* Essay, Book IV, chapter X, §III-VI.
272 Van Limborch to Locke, 6 May 1698, letter 2432 in: Beer, *John* Locke, vol. VI, 387.
273 Ibidem, 388.
274 Ibidem.

the second proposition, it means that humans are not dependent on that one God, and that this God cannot exercise power on people.[275]

The core of the problem can be brought back to Descartes' dualism, that God as a thinking substance does not embody all perfection when *extension* is an autonomous substance as well. If this is true, Descartes' notion of God cannot be upheld. This leads to the question: why should *extension* be seen as incorporeal? This is the question that Hudde challenges Locke to answer. The philosopher says that he respects the mayor's astute mind, and that had he received Hudde's clarification earlier, he would have altered his answer.[276] Locke argues that Hudde is still convinced that an eternal and intelligent substance called *thought* exists and that there is an infinite substance called *extension*.[277] Locke states thereafter that there can only be one infinite Being which is also an eternal Being.[278] This infinite and eternal being is indivisible and exists independently and necessarily from its own nature. This is Locke's answer to Hudde's second proposition, from which the third proposition can be derived when the notion of perfection is bound to the second proposition. Therefore, it can be concluded that proposition three confirms the idea of an eternal God that is infinite, omniscient, and omnipotent.[279] If Hudde does not agree with this, Locke writes, then he should do him the great honour of sharing his proof, which he [Locke] would keep secret.[280]

Although Hudde sends his gratitude for all the work Locke did, his answer was not much more satisfactory than in his previous letter. Hudde argues that Locke assumes that there exists a being that in infinite and indivisible. However, for Hudde this is similar to proposition three, which concludes that this Being is perfect, and therefore infinite and indivisible. Locke tried to prove proposition two by the means of proposition three, a step that logically could not be made, according to Hudde.[281] He refuses to share his thoughts for the same reason that Locke is holding back. Hudde fears the unjust judgements of theologians, 'who are wont to put a black mark to everything that is not drawn from their own school and to traduce it with the infamous names of the most detestable heresies'.[282]

The impasse was breached after the summer of 1698. Van Limborch wrote to Locke that he had not spoken to Hudde, since the mayor was suffering from a fever. Nevertheless, Burchard de Volder, Hudde's protégé and professor of philosophy at Leiden University, visited Van Limborch for a few days to discuss the matter.[283] De Volder said that he had talked about the matter with Hudde several years ago, but that they also could not resolve it. De Volder also mentioned that Hudde had discussed the matter with Spinoza. However, De Volder said that he did not agree with Hudde's

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275 Ibidem, 388-389.
276 Locke to Van Limborch, 21 May 1698, letter 2443 in: ibidem, 405.
277 Ibidem, 406.
278 Ibidem.
279 Ibidem.
280 Ibidem.
281 Van Limborch to Locke, 21 June 1698, letter 2460 in: ibidem, 434-435.
282 Ibidem, 435.
283 Ibidem, 2 September 1698, letter 2485 in: ibidem, 464.

reasoning, since he assumes that the two substances, *thought* and *matter*, exist independently from each other, due to which neither can have any knowledge of the other. Although it is possible that *extension* will indeed have no knowledge of thought, *thought* will have knowledge of *extension*. Thought exists of itself and is sufficient to itself and therefore is also infinite. This necessarily means that *thought* knows that *extension* exists.[284] The answer that Hudde is looking for, that proposition three would follow from the second proposition, does not exist, according to De Volder. Proposition three must be proposition two. *Thought* cannot be *thought* about nothing, existing autonomously. Each *thought* needs a being, and this being is *extension*. From this we could derive that *extension* itself is *thought*, so that the two substances are nothing more than attributes of one Being.[285]

This tends towards Spinoza's notion that 'substance thinking and substance extended are one and the same substance, comprehended now through one attribute, now through the other.'[286] In other words, Spinoza's definition of God is as follows: 'By God, I mean a being absolutely infinite—that is, a substance consisting in infinite attributes, of which each expresses eternal and infinite essentiality.'[287] Locke had already expected this outcome, although he had not dared to write it down. Upon reading this, Locke asked Van Limborch if he would ask Hudde to share his proof with him, since the mayor was not satisfied with his evidence.[288] Locke emphasises that he would like to receive the answer as soon as possible, since he does not want his proof to be based on an unjustified assumption. Moreover, he writes that if Hudde is interested, he would publish his proof in the fourth edition of his *Essay*, with or without his name. Locke concludes his letter with the remark that he does not understand what Cartesians mean when they speak about an infinite *thought*, since according to Locke there only exists a thinking thing, or substance, which could be both infinite as finite.[289]

Van Limborch writes to Locke that he agrees, but that he has not spoken Hudde in some time. Only when Hudde invites him, they could meet. It seems that Hudde was keeping his distance and that he would never share his evidence.[290] What Van Limborch suspected seems to have been right. Half a year later, in June 1699, Van Limborch wrote to Locke that De Volder had set up a meeting to discuss Locke's letter. However, unexpectedly, 'people' were in the house, which meant that they could not speak about the matter.[291] Hudde promised that the letter would be discussed at a different time. Nonetheless, a day later De Volder met Hudde, but he did not address the matter.[292] Van Limborch already suspected that De Volder was right in his suggestion that Hudde did not have any proof, but

284 Ibidem, 464-465.
285 Ibidem, 464-467.
286 Baruch Spinoza, *Spinoza Ethica,* translated by: Henri Krop (2004) part II, proposition VII, scholium.
287 Ibidem, 62/ part I, proposition VI.
288 Van Limborch to Locke, 2 September 1698, letter 2485 in: Beer, *John* Locke, vol. VI, 464-465.
289 Ibidem, 494-495.
290 Ibidem, 29 November 1698, letter 2516 in: ibidem, 516.
291 Ibidem, 13 June 1699, letter 2596 in: ibidem, 639.
292 Ibidem.

was merely pretending in order to hear what Locke had to say.[293] Locke shared the same suspicion, that Hudde was trying to gain evidence for something that he could not come up with himself.[294] Van Limborch writes to Locke in September 1699, confirming that he has not seen Hudde, and that he has the feeling that the mayor is avoiding him, from which he and Locke conclude that they should put the matter to rest.[295]

With both Spinoza and Locke, Hudde was searching for an answer that he could not find. Through asking both correspondents for an answer which had to conform to the Cartesian framework, Hudde asked a question which did not have an answer due to his demands. Nevertheless, we can conclude from these letters that Hudde was a committed Cartesian and was not convinced by Spinoza's monism. Furthermore, the letters provide insight into Hudde's critical view of religion and his emphasis on an answer derived from natural reasoning. It seems that as a religious person, Hudde sought the truth primarily within the boundaries of natural philosophy rather than in theology.

We can conclude from Hudde's question about the existence of only one God that he stood (to a certain extent) in the tradition of philologists and the more tolerant and broad-minded Arminians like Grotius, Van Limborch and LeClerc, of which the latter two were part of the discussion with Locke.[296] Each of them was critical of the Bible and contributed to questioning the authority of the Church. However, as the mayor of Amsterdam, Hudde had to operate in utmost secrecy, since he feared the unjust judgements of (less liberal) theologians.[297] Furthermore, although Hudde was critical of religion and Descartes' philosophy, he could not free himself from the philosopher's dualism. Compared to Nicolaas Hartsoeker (1656-1725), who also was a convinced Cartesian in his early life, he did not abandon Cartesianism for a form of physico-theology.[298] This current gained more popularity at the expense of Cartesianism in Hudde's later life, as represented by scholars such as Newton, LeClerc, Bernard Nieuwentijt (1654-1718), and to a certain extent Huygens.[299] Since these currents gained momentum at the end of Hudde's life, it is impossible to know whether Hudde would have made a transition similar to Hartsoeker's in the direction of English empirical philosophy. However, at the end of his life, it seems that Hudde would have remained closer in his convictions to Huygens and Leibniz, rather than moving in the direction of Newton. Nevertheless, Hudde remained mayor of Amsterdam in this period, which continued to be his main priority over scholars and theologians who discussed

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293 Ibidem.

294 Locke to Van Limborch, 5 September 1699, letter 2615 in: ibidem, 680.

295 Van Limborch to Locke, 22 september 1699, letter 2618 in: ibidem, 690. Locke to Van Limborch, 7 October 1699, letter 2621 in: ibidem, 701.

296 Van Bunge (ed.), *The dictionary*, I, 213. Barnouw, *Philippus van Limborch*, 142. Luisa Simonutti, 'Between History and Politics. Philipp van Limborch's *History of the Inquisition* [1692]', in: John Christian Laursen (ed.), *Histories of Heresy in Early Modern Europe. For Against, and Beyond persecution and Toleration* (New York 2002) 101-117, especially, 108-109.

297 Van Limborch to Locke, 21 June 1698, letter 2460 in: Beer, *John* Locke, vol. VI, 435.

298 M.R. Wielema, 'Nicolaas Hartsoeker (1656-1725): van mechanisme naar vitalisme', in: *Gewina*, vol. 15 (1992) 243-261, especially, 243-254. See also: Samar Catherine Abou-Nemeh, *Nicolas Hartsoeker's systeme of nature: Physics by conjecture and optics by design in early modern Europe* (Unpublished dissertation at Princeton University 2012).

299 Vermij, *The Calvinist Copernicans*, 350-358.

philosophical matters. To gain insight into Hudde's public life as a regent, we shall discuss his accomplishments in service of the Republic and the city of Amsterdam.

Chapter 6
From scholar to regent

Origin and background

Johannes Hudde was a member of the one of the oldest regent families of Amsterdam, who consolidated their position within the Amsterdam municipality with the Alteration of May 26, 1578, together with families such as Huydecoper, Pauw, Witsen, and Bicker.[300] On that day, the Amsterdam government made the transition from a Spanish Catholic city, to supporting William of Orange (1533-1584) with a new city board that had a majority of regents with Calvinist sympathies.[301] Due to this shift, Hendrick Hudde Arentsz. (†1596), a merchant in Amsterdam and Hudde's grandfather, received a place within the *vroedschap* of Amsterdam.[302] This college of the town council consisted of 36 members who were the richest, most honourable, and noblest people of Amsterdam. These 'wise' men had to be at least 25 years old and a citizen of the city for at least seven years, which explains why Hudde could enter the city council no earlier than 1667. Before that time, he was a student of Leiden and was abroad on a Grand Tour until 1659.[303] Almost all regents in the council were active as merchants or entrepreneurs. Hendrick Hudde, for example, was one of the founders of the Compangie van Verre (1594), which made the first Dutch expedition to Indies from 1595-1597. Unfortunately, he died in 1596, and was replaced by Gerrit Bicker (1554-1604) as director and investor of the company, who together with the mayor of Amsterdam, Reynier Pauw (1564-1636), became one of the founders of the VOC.[304]

Hendrick's son (Johannes' father) Gerrit Hudde (1595-1647) was a distinguished merchant in Italy and the Levant, and in 1625 he became one of the first directors, concerned with policy making,

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300 Maarten Hell, 'De Oude Geuzen en de Opstand. Politiek en lokaal bestuur in tijd van oorlog en expansie 1578-1650', in: Willem Frijhoff & Maarten Prak (ed.), *Geschiedenis van Amsterdam. Centrum van de wereld 1578-1650*, vol. II-I (Amsterdam 2004) 241-298, especially 251, 257. Johan E. Elias, *De Vroedschap van Amsterdam 1578-1795*, vol. I (Amsterdam 1963) 10-11, 92, 161, 173, 239.

301 Hell, 'De Oude Geuzen en de Opstand', 251.

302 Elias, *Vroedschap van Amsterdam*, 161.

303 Hell, 'De Oude Geuzen en de Opstand', 247, 256.

304 Elias, *Vroedschap van Amsterdam*, 161, 173-174.

of the 'trade in the Levant and navigation of the Mediterranean Sea.'[305] In 1618, he married Maria Witsen (1597-1683), daughter of Jonas Cornelisz. Witsen (1566-1626), who became mayor of Amsterdam a year later and was one of the first directors of the Dutch West India Company.[306] They had three sons: Hendrick, Jonas and Johannes Hudde, all three of whom studied at Leiden University.

The road to mayor

After Hudde's return from the Grand Tour, he settled in his hometown, Amsterdam. Instead of pursuing an academic career, the death of his brother Jonas and the appointment of his brother Hendrick as counsellor in the High Council at The Hague, ensured that Hudde fulfilled his family duty as regent of Amsterdam by pursuing a political career from the 1660s onwards.[307] In the following year, as a new member of the city council, he was appointed to the position of *schepen*. Together with eight other members, he regulated the practice of law in the city.[308] Later, in 1669, 1671, and 1672, Hudde occupied the position of treasurer-extraordinary. This position managed the extraordinary revenue of the city and were advisors for the mayors and treasurer-ordinary.[309]

To understand why Hudde was able to become mayor of Amsterdam, we have to consider the political situation between 1667 and 1672. The mayors of Amsterdam were appointed by the *Oud-Raad*: a college of former mayors, who selected three mayors. These newly installed mayors chose a fourth colleague to represent the sovereign power of Amsterdam.[310] Often they chose a regent who was related to them, which resulted in three factions in the Amsterdam board between 1660 and 1678. These were represented by Henrick Hooft (1617-1678); Hudde's nephew, Gillis Valckenier (1623-1680); and Andries de Graeff (1611-1678), whose niece was married to Hudde's fellow student and Grand Pensionary Johan de Witt. In this period, De Graeff and Valckenier's factions were the most dominant since in 1666 Hooft was deputed to the Admirality of Amsterdam, and in 1669 for three years to the *Gecommitteerde Raden* as well.[311]

In 1670, it became clear that Valckenier favoured Orangism and the return of William (of Orange) III (1650-1702), since 'the cooperation would be difficult with the Grand Pensionary De

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305 Jan François Leopold de Balbian Verster, *Burgemeesters van Amsterdam in de Zeventiende en Achttiende Eeuw* (Zutphen 1932) 91.

306 Elias, *Vroedschap van Amsterdam*, 239.

307 Ibidem, 489. Du Rieu, *Album Studiosorum*, 349.

308 Hell, 'De Oude Geuzen en de Opstand', 242.

309 Jan Wagenaar, *Amsterdam, in zyne opkomst, aanwas, geschiedenissen, voorregten, koophandel, gebouwen, kerkenstaat, schoolen, schutterye, gilden en regeeringe*, vol. III (Amsterdam 1767) 389-392.

310 P.J. Blok (ed.), *Robert Fruin's verspreide geschriften. Met aanteekeningen, toevoegsels en verbeteringen uit des schrijvers nalatenschap*, vol. IV (The Hague 1901) 317.

311 Arthur F. Salomons, 'De rol van de Amsterdamse burgerbeweging in de wetsverzetting van 1672', *BMGN - Bijdragen en Mededelingen betreffende de Geschiedenis der Nederlanden*, vol. 106, no. 2 (1991) 198–219, especially, 205.

Witt'.[312] However, he was overthrown himself during the mayoral election in 1671. In February 1672, Cornelis de Vlaming van Oudtshoorn (1613-1688), Hendrick Hooft, Lambert Reynst (1613-1679), and Jan van de Poll (1597-1678) were appointed as mayors. Valckenier became Hooft's replacement in the executive council in The Hague.[313] Not long thereafter, in March and April, Charles II of England (1630-1685) and Louis XIV of France (1638-1715) declared war on the Republic. In these years, Amsterdam, as a city-state, generally drew its own plans, an attitude that raised resistance from the other cities and Johan de Witt.[314] In 1670, for example, the mayors refused to supply money to arm both the army and navy, as long as the fleet tax was not revoked and no anti-France import measures were taken.[315] Only after the diplomatic intervention of former pensionary Coenraad van Beuningen (1622-1693) did Amsterdam agree to reinforcement plans.[316] However, this seems to have been too late. In June 1672, Louis XIV invaded the Republic.[317]

This resulted in a stream of refugees to the city of Amsterdam, which caused trouble.[318] From June 26 until July 9, daily uprisings represented the civilians' distrust of the municipality, who had to decide between fighting and surrendering. Although the States of Holland thought of peace negotiations with France as a serious alternative, the city board of Amsterdam wanted to fight.[319] However, the States of Holland went ahead without a representative of Amsterdam, deciding to the resume the negotiations. City Pensioner Cornelis Hop (1620-1704) labelled them as the 'sellers of sovereignty and freedom'.[320]

In the meantime, Amsterdam citizens' distrust of some of their governors increased, through gossip and the spread of pamphlets, in which it was argued that the majority of the city board approved the negotiations with France.[321] This suspicion was strengthened on July 1, when the city council agreed to the withdrawal of the Perpetual Edict (1667) and the appointment of William III as stadholder of Holland. De Graeff and Willem Backer wanted to announce this decree to The Hague, but they were stopped at the Haarlemmerdijk, since De Graeff was seen as a follower of De Witt.[322] Although De Graeff and Backer were quickly allowed to resume their way, the citizens of Amsterdam became even more suspicious after July 29. A pamphlet was published wherein Bontemantel, Reynst,

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312 Hans Bontemantel, *De regeeringe van Amsterdam, soo in 't civiel als crimineel en militaire (1653-1672)* (The Hague 1897) 157.

313 Salomons, 'De rol van de Amsterdamse burgerbeweging', 205.

314 Maarten Hell, '"Schatkist van den Staet"'. Amsterdamse regenten en de hogere overheid' in: Willem Frijhoff & Maarten Prak (ed.), *Geschiedenis van Amsterdam. Zelfbewuste stadstaat 1650-1813*, vol. II-II (Amsterdam 2005) 151-217, especially, 177.

315 Ibidem.

316 M.A.M. Franken, *Coenraad van Beuningen's politieke en diplomatieke activiteiten in de jaren 1667–1684* (Groningen 1966) 71-77, 93-95.

317 Hell, '"Schatkist van den Staet"', 177.

318 Salomons, 'De rol van de Amsterdamse burgerbeweging', 205.

319 Hell, '"Schatkist van den Staet"', 180.

320 Pieter Geyl, *Oranje en Stuart. 1641-1672* (Utrecht 1939) 460.

321 SA, [15009], inv. nr. 3363, 'Daghregister van 't gene t'sedert den 26 junij 1672 in Amsterdam en daaromtrent is voorgevallen', d.d. 26 Junij, Sondag (1672).

322 Salomons, 'De rol van de Amsterdamse burgerbeweging', 207.

Cornelis van Vlooswijck (1601-1687), Van de Poll, Oudtshoorn, Hooft, and De Graeff were made to look suspicious.[323] All these regents had in common that they were opposed to Valckenier, who 'wanted to defended Amsterdam with everything in his power'.[324] With the uprising of August 3, it was confirmed that the situation was untenable, since the city guard refused to quash the revolt of their fellow citizens, declining to obey their superiors.[325]

The situation became more severe at August 21, when Grand Pensionary De Witt, and his brother Cornelis (1623-1672) were publicly lynched in The Hague. After this event, the Amsterdam mayors feared sharing the same fate as the brothers.[326] Five days later, the *Gecommiteerde Raden* of the States of Holland, of which Valckenier was a member, advised empowering William III to quell the uprising. To do this, he received the judicial power to replace the entire board of Amsterdam. The prince could therefore remove unwelcome regents and appoint those he favoured.[327] On September 11, the prince sacked 16 members, and four days later almost exclusively friends and family of Valckenier entered the city board. It is no surprise that Hudde was one of them, as he would go on to fulfil this position 21 times between 1672 and 1703. [328]

Hudde's knowledge as a trained scholar in *Duytsche Mathematique* was immediately used to breach the polder dikes at the east and west sides of the city, to flood the land with water and protect them from the French invasion.[329] In the following years, 1674, 1677, and 1678, Hudde was also appointed treasurer-ordinary, a position filled by former mayors. The ruling mayors, with whom Hudde worked on the first floor of City Hall, were concerned with the public works.[330] In all the functions mentioned above, Hudde would leave his marks as a scholar who used his 'scientific' knowledge to find practical solutions for urban problems.

Hudde as an advisor to the States-General

Shortly before Hudde's appointment as mayor of Amsterdam, and between his other government functions, in December 1670 the States-General asked for his advice in the matter of water management. Together with Huygens, who were 'both experienced in mathematics', the States-General requested that the scholars inspect the Nederrijn and IJssel rivers and write a report with their

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323 *Waerschouwinghe aen alle edelmoedige en getrouwe inwoonderen van Nederlandt* (July 1672). *Antwoort van den leeuw aen d'echo* (1672). *De sprekende toonbanck, aen de verkofte Hollander* (1672).

324 Petrus Valckenier, *'t Verwerd Europa, ofte polityke en historische beschryvinge der waere fundamenten en oorsaken van de oorlogen en revolutien in Europa, voornamentlijk in en omtrent de Nederlanden zedert den jaare 1664 … met bygevoegde authentijke stukken* (Amsterdam 1675) 647. Hell, '"Schatkist van den Staet"', 180.

325 Salomons, 'De rol van de Amsterdamse burgerbeweging', 211.

326 Hell, '"Schatkist van den Staet"', 180, 182.

327 Ibidem, 182.

328 De Balbian Verster, *Burgemeesters van Amsterdam*, 92. The nephews of Valckenier: Van Beuningen and Hudde became mayor in 1672. Nanning Cloeck, Louis Trip and David de Wilhem were appointed as *schepenen*. Who were respectively a nephew of Vaclkenier, the father in law of Valcknier's son and the brother in law of Van Beuningen.

329 Ibidem. SA, Handschriften [5059], inv. nr. 47.

330 Willem Ferdinand Hendrik Oldewelt, 'De boekhouding van Amsterdam', *Jaarboek van het genootschap Amstelodamum*, vol. 63 (1971) 11-28, especially, 18-21, 25.

advice for the maintenance of the rivers.[331] The States-General needed urgent advice on the matter, since the previous modifications had hardly resulted in progress. Some 'improvements' even caused the conditions to worsen each year. Therefore, the government needed short-term advice and solutions to make the Nederrijn more navigable, given the increasing threat of war.[332]

The fact that the States-General took the matter seriously can be deduced from the salary Hudde and Huygens received. Each day, they received ten guilders, with payment for their expenses. Moreover, they were licensed to hire engineers and other specialists at the expense of the state to deliver a high-quality report. Their observations were recorded and printed in a *Report … on the inspection of the Nederrijn and Ijssel* accompanied by the *Advice on the improvements of the Nederrijn and Ijssel*.[333] Both works are included in the resolution of the States-General of 15 July together, along with two other pieces in which Hudde comments on the decay of both rivers.[334]

Hudde and Huygens arrived in Arnhem on March 29, where they investigated the situation at the Schenkenschans, the area where the river Rhine splits off into the Waal and the Nederrijn.[335] After various measurements of the rivers, it appeared that the Waal had had the same depth since 1642, while the Nederrijn had become shallower.[336] On April 7, Hudde and Huygens continued their journey from the Schenkenschans, after which they shifted their attention to all the rivers in the Republic. They wrote an extensive report on the matter, in which the vitality and the decay of both rivers is discussed in great detail. The focus lies on the sandbanks, decaying shores, and the lengths of the river groynes, which they thought to be too long.[337]

In the *Advice*, Hudde and Huygens presented several possibilities to improve the upper part of the mouth of the Nederrijn. This would result in some of the water that flows into the Waal being led to the Nederrijn. Through directing more water into the Nederrijn, which splits off into the Ijssel a few kilometres north, both rivers would have a stronger current. Therefore, the rivers would dredge themselves through the drainage of grit and sand into the Zuiderzee. A similar idea to dredge the river by using its current emerged in the same period, when Hudde installed the *Amstelsluizen* to dredge the canals by using the tide.[338]

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331 NA, Archief Staten-Generaal [1.01.02], inv. nr. 201 (Resolution 19 December 1670).

332 Ibidem.

333 NA, Archief Staten van Holland na 1572 [3.01.04.01], inv. nr. 104, fol. 44-52 and 58-63 for respectively: 'Verbael [...] op de inspectie van de Neder-Rhijn en IJssel' and 'Advis aengaende het beneficieren van den Neder-Rhijn ende IJssel'. See also: Johannes Hudde to Christiaan Huygens, 21 April, 22 May and 18 August 1671, in: Christiaan Huygens, *Oeuvres Complètes*, vol. VII (The Hague 1897) letters 1827-1828 & 1839 (wherein also announcements on the visit of the French astronomer Jean Picard and Hudde calculations on life annuity).

334 NA, Archief Staten van Holland na 1572 [3.01.04.01], inv. nr. 104, fol. 44-63.

335 Ibidem, fol. 44-45.

336 Ibidem, fol. 46-48.

337 Ibidem, fol. 7-52.

338 Ibidem, fol. 58-63. SA, Archief van het Stadsfabriekambt en Stadswerken en Stadsgebouwen [5040], inv. nr. 13 (Johannes Hudde, 'Afteikeningen en eenige vastelling van de houte beertjens, sluitbinten, sluisjes en molens diende tot zuiveren van de stadtswateren, anno 1687 en 1688').

The completed report was handed over to the States-General in May 1671. To investigate the possibilities of their advice, a new commission was formed, consisting of Johan de Witt and Willem Adriaan van Nassau Odijk (1632-1705), the Grand Pensionary of the States-General and the representative of William III.[339] That two of the most influential people were chosen for the committee proves the importance of the matter. A suitable water management system was of vital importance for the Republic in this period, and therefore only the most capable people were asked to provide advice and execute solutions.

In August the committee presented their extensive plans based on the advice of Hudde and Huygens to the States-General, along with a request to the Council of State to work out the expected budget. The Council responded with an agitated letter stating that they had previously provided the States-General with various calculations for estimated budgets concerning water management, but not a single plan had been executed.[340] Thereafter, the States-General abandoned the matter, and none of the improvements to the mouth of the Rhine were made.

However, the States-General did execute the recommendation on the minimum width of the rivers, since that would not entail any costs. The States-General asked the provinces of Guelders, Holland, Utrecht, and Overijssel to shorten the river groynes. As Hudde and Huygens predicted in their report, nothing came of that. Therefore, the States-General sent a letter to them in October, accompanied by the 'Decree of Authorisation', in which the Council of State granted permission to shorten the river groynes.[341]

The letter resulted in an uprising in Guelders in which the representatives of the province declared that they would never permit the Council of State to perform an act of sovereignty on their soil. They refused to sign the decree, which caused ill will in the other provinces during the Disaster Year. The fast movement of French troops across the Nederrijn in 1672 was attributed to the stubbornness of the people in Guelders. Since Guelders, Utrecht, and Overijssel did not sign the decree, they provided the States-General with a reason to limit their sovereignty regarding the rivers. Both in 1674 and in 1681, the provinces had no legally valid vote in the modification of their rivers.[342]

The finances of the State of Holland

In February 1678, a new problem emerged. Grand Pensionary Gaspar Fagel (1634-1688) argued that he needed someone to restructure and establish order in the finances of the Republic.[343] Thirteen days

339 For more information about the importance of Willem Adriaan, see: *NNBW*, lemma 'Willem Adriaan van Nassau', I, 1368-1369.

340 NA, Archief Staten van Holland na 1572 [3.01.04.01], inv. nr. 102, (Resolution 6 December 1669).

341 Ibidem, Archief Staten-Generaal [1.01.02], inv. nr. 205 (Resolution 15 October 1671). See for the 'Acte van Authorisatie': Ibidem, Archief Staten van Holland na 1572 [3.01.04.01], inv. nr. 104, (Resolution 25 November 1671).

342 Ibidem, inv. nr. 1244 (Secret resolution 24 March 1674). Ibidem, Archief Staten-Generaal [1.01.02], inv. nr. 244 (Resolution 14 July 1681). Casparus Commelin, *Vervolg van de Beschryving der stadt Amsterdam* (Amsterdam 1693) 1198.

343 NA, Archief Staten van Holland na 1572 [3.01.04.01], inv. nr. 111, (Resolution 11 Februari 1678).

later, Hudde was appointed a member of the committee to investigate 'the finances of the state'.[344] The members had to conduct a thorough investigation to address the deterioration and the mistakes in the financial department. Moreover, they had to investigate how the financial system could be managed more efficiently and where cuts could be made.[345]

The report with their advice was presented to the States of Holland in November, with the main suggestion being to restructure the finances.[346] Furthermore, they argued that the largest cuts could be made in three aspects. First, the wages of soldiers brought extensive costs, and therefore soldiers and officers in 'the state of war' had to be discarded.[347] Second, the model of the financial system had to be reversed as much as possible to its state in the period before 1672.[348] Last, a tax increase would lead to greater revenue to cover the costs.[349] Moreover, an extra advisor to oversee the implementation of the measures from the report would be needed to reduce Holland's costs.[350]

In May 1678, the States of Holland again required Hudde's expertise. They requested that Hudde provide them with his judgement concerning a project of the German alchemist Johann Joachim Becher (1635-1683), who proposed distilling gold from dune sand.[351] Becher was an entrepreneur who established himself in the Republic in 1677, where he already had a vast network of people from the time that he had visited it as an emissary of German princes.[352] His proposition suggested 'a method through which the revenue of the Republic … could be improved each year by a million rijksdaalders'.[353] This was music to the ears of the States, who proposed setting up a contract paying Becher 50,000 guilders and 2% of the expected income if his method worked. Moreover, his invention would be protected by a patent.[354] However, if one looks carefully, the patent was only for the water wheel that was used during the process. Although the States were sceptical of Becher's plans, they made 3,000 guilders available for a trial, under the supervision of two commissionaires. One of them was Hudde, and the other was the pensionary of Haarlem and a nephew of Gaspar Fagel, Michiel ten Hove (1640-1689).[355]

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344 Ibidem, 24 februari 1678.

345 Ibidem, fol. 50.

346 Ibidem, inv. nr. 302, (Secret resolution 25 November 1678) fol. 223-224.

347 Ibidem, fol. 212, 222.

348 Ibidem, fol. 213.

349 Ibidem, fol. 221.

350 Ibidem.

351 F.M. Jaeger, 'Over Johann Joachim Becher en zijne relaties met de Nederlanden', in: *Economisch-historisch Jaarboek – Bijdragen tot de Economische Geschiedenis van Nederland*, vol. V (The Hague 1919) 60-135.

352 J. Hovy, 'Een biographie over Johan Joachim Becher', in: *Tijdschrift voor Geschiedenis*, vol. 65 (Groningen 1952) 357-372.

353 Harry A.M. Snelders, *De geschiedenis van de scheikunde in Nederland*, vol. I (1993) 21-25. One *Rijksdaalder* was worth a silver ducat or 50 *stuivers*/pennies.

354 G. Doorman, *Octrooien voor uitvindingen inde Nederlanden uit de 16^{e}-18^{e} eeuw* (The Hague 1940) 301: Patent H-144 (December 1678).

355 Johann Joachim Becher, *Trifolium Becherianum Hollandicum* (Amsterdam 1679).

In March 1679, the trial was conducted in the presence of the commissionaires at the house of goldsmith Laurens Keerwolf (c. 1613-1702) in the Kalverstraat.[356] It seemed that Becher's method worked, and therefore, without Becher's knowledge, Hudde and Ten Hove secretly repeated the process again in The Hague, obtaining a similar result.[357] The commissionaires had to admit that Becher's procedure worked, and he earned a small profit, but it was not efficient enough. The negotiations were broken off, and, disappointed, Becher moved to England, where he died two years later.

The two nephews: Hudde and Witsen

Hudde's influence on the municipality increased from 1681 onwards. More and more family members of him were elected as mayors, like Gerard Bors van Waveren (1630-1693), Nicolaes Opmeer (1631-1696), and Nicolaas Witsen (1641-1717).[358] This increase of power was caused by the death of Hudde's cousin Gillis Valckenier (1623-1680) in 1680. Because of this, of the four ruling mayors, Hudde received the 'magnificat' that made him president-mayor. Through this appointment, he became the highest-ranking member of the government, which made him until his death, the most powerful man in Amsterdam.[359] Moreover, 13 years later, after the death of his cousin Gerard Bors van Waveren, Hudde ensured that Nicolaas Witsen was hired before the Chamber (*Kamer*) of Amsterdam as one of the directors of the VOC.[360] These developments demonstrate that Hudde's power was based on his (family) network.[361]

Like Hudde, Witsen had a great interest in natural philosophy and Cartesianism.[362] The friendship between the two cousins began in Witsen's childhood. This appears amongst other things in Witsen's disputation titled *Prognostikon*, which he held in April 1662 at the Atheneaum Illustre.[363] Witsen dedicated this disputation to Hudde, whom he characterised as '*philosopho et mathematico incomparabili*', the incomparable philosopher and mathematician.[364] In this disputation, Witsen's interest in Cartesian natural philosophy is also apparent. He explains the trajectory of comets through Cartesian vortices and refers to Cartesian mathematics. Moreover, Witsen followed Descartes' explanation of the characterisations of light.[365]

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356 Ibidem, 42-43.

357 Snelders, *Geschiedenis van de scheikunde*, I, 21-25. See also: Becher, *Trifolium*, 16, 37, 39.

358 Elias, *Vroedschap van Amsterdam*, I, 544. Ibidem, II, 568, 571.

359 Marion Peters, *De wijze koopman. Het wereldwijde onderzoek van Nicolaes Witsen (1641-1717), burgemeester en VOC-bewindhebber van Amsterdam* (Amsterdam 2010) 55.

360 Ibidem, 83.

361 See again: Kooijmans, *Vriendschap en de kunst van het overleven*.

362 *Bibliotheca nitidissima sive catalogus librorum, [...] Nicolaus Witsen* (Amsterdam 1747) 29, 36.

363 Seven months later he was enlisted as a student philosophy at Leiden University. See: Du Rieu, *Album Studiosorum*, 503.

364 Nicolaas Witsen, *Prognostikon* (Amsterdam 1662).

365 Ibidem, vi. Van Miert suspects that Hudde was involved in a significant number of the 'colloraries'. With Witsen the colloraries had a wider variety and were larger in number than with other disputations under the supervision of professor Alexander de Bie. See: Van Miert, *Humanism in an Age of Science*, 262. For a summary of Witsen's

Besides Hudde, who influenced Witsen with Cartesian ideas, they must also have been stimulated, or at least tolerated, by his teacher at the Athenaeum Illustre, Alexander de Bie (ca. 1623-1690).[366] This Cartesian-inspired scholar was the professor of Hudde's friend De Volder, who held his disputation at the Atheneum Illustre about solving mathematical problems, which was also dedicated to Hudde.[367] Hudde and Witsen worked close together their entire lives. Traces of this cooperation can be found in their shared work on the municipality of Amsterdam, in their role as directors of the VOC, and in domestic and family circles. For example, Hudde's method of calculating the maximum capacity of ships (which he developed after a dispute between Amsterdam and the king of Denmark) is also present in Witsen's *Aeloude Scheepsbouw* from 1671.[368] Comparable calculations by Hudde also reside in the National Archives (*Nationaal Archief*) in The Hague, in which he calculated the amount and weight of a specific product by the volume of one square foot for the cargo transported by the VOC.[369] These calculations were made after Hudde noticed the inefficiency with which the 'high government of India' loaded their VOC ships.[370]

It was also together with Witsen that Hudde supported the plans of Johan Huydecoper (1625-1704) and councillor Jan Commelin (1626-1692) to build the new Hortus Botanicus (botanical garden). After the fourth urban expansion, two irregularly shaped pieces of land remained on both sides of the Middenlaan along the Nieuwe Herengracht. In this location, Huydecoper and Commelin founded the new Hortus Medicus, of which they were appointed directors in 1683.[371] The construction was expedient, and in the spring of the same year they were able to start planting exotic botanical specimens.[372] However, they had to ask for Hudde's advice about the construction of the entrance gate, according to Huydecoper. He wrote to Commelin that 'it would be necessary that the lord mayor Hudde (patron of us both) should be consulted'.[373]

Together with Hudde and his nephew Gerard Bors van Waveren, Huydecoper regularly visited the construction of the new Hortus to oversee the planting of the exotic plants.[374] Natural philosophers

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disputation see: C.P. Burger, 'Eene Disputatio van Nicolaas Witsen in het Amsterdamsche Athenaeum', in: ibidem (ed.), *Het Boek. Tweede reeks van het Tijdschrift voor Boek- en Bibliotheekwezen*, vol. XI (The Hague 1992) 114-116.

366 Peters, *De wijze koopman*, 33. Wim Klever, *Mannen rond Spinoza (1650-1700). Presentatie van een emanciperende generatie* (Hilversum 1997) 205. See for more information about the relation between De Bie and Cartesianism: Van Bunge (ed.), *The dictionary*, I, 102-103.

367 Burchard de Volder, *Disputatio mathematica de profunditate maris* (Amsterdam 12 Dec. 1658). Peters, *De wijze koopman*, 35. It was also to De Volder that Hudde left a hertitage of 1.500 guilders. See: Jean LeClerq, *Bibliothèque choisie, pour servir de suite à la Bibliothèque Universelle*, vol. XVIII (Amsterdam 1709) 393. Frederich Eberhard Rambach, *Johan Peter Nicerons Nachrichten von den Begebenheiten und Schriften*, vol. I (1758) 270.

368 Nicolaas Witsen, *Aeloude en hedendaegsche scheeps-bouw en bestier* (Amsterdam 1671) 163, 242.

369 NA, Archief Johannes Hudde (1602-1703) [1.10.48], inv. nr. 22, fol. 43-60.

370 Ibidem, inv. nr. 23, fol. 66. See also: Frederik Wilhelm Stapel, 'Johannes Hudde over de balansen van de Oost Indische compagnie', *Economisch historisch jaarboek*, vol. 13 (1927) 215-239.

371 SA, Archief Thesaurieren Ordinaris [5039], inv. nr. 7, (29 January 1683) fol. 94-95. See also: D.O. Wijnands (ed.), *Een Sieraad voor de Stad. De Amsterdamse Hortus Botanicus 1638-1993* (Amsterdam 1994).

372 Casparus Commelin, *Vervolg van de Beschryving der stadt Amsterdam* (Amsterdam 1693) 656.

373 Het Utrechts Archief/Utrecht Archives, Familiearchief Huydecoper, [67], inv. nr. 60, Johan Huydecoper aan Jan Commelin, 17 February 1684.

374 Ibidem, diary notes 1683.

from all over Europe delivered contributions to the Amsterdam garden. So did Hudde—in 1698 he delivered daffodils from the Cape of Good Hope, which bloomed the next year.[375] He also contributed a plant from the Americas in 1700, the *Agave vivipara*, which flourished two years later.[376] Through the generous contributions of Hudde and Witsen various works of Commelin were as tributes to them as patrons for researchers in botany and medicine.[377]

In 1688 Hudde and Witsen again acted as patrons. This time it was to support the mathematician and engineer Cézar Caze d'Harmonville (1641-1720). He was a French *réfugié* who was held hostage in Leeuwarden that year due to alleged debts that he had left behind in Lyon.[378] Caze fled Lyon due to the abrogation of the Edict of Nantes in 1685. All French Huguenots had to convert to Catholicism, resulting that many sought refuge in more tolerant countries that made them *de facto* outlaws. Therefore, Caze became a citizen (*poorter*) of Amsterdam in 1685, where he became friends with Dutch scholars such as Pierre Bayle (1647-1706), Christaan Huygens, and Johannes Hudde.[379] Nevertheless, he was held captive in Leeuwarden for more than twelve years, despite repeated requests from the Amsterdam municipality (read: Hudde and Witsen) to release him.

During the whole period of his imprisonment, Caze was financially supported by Hudde, who arranged that Caze would receive 1,000 guilders annually from the city of Amsterdam. As compensation during his captivity, Caze could be consulted by the city government 'in every matter in which [they] judge it necessary'.[380] Moreover Caze also received 500 guilders due to 'already proven services' in 1688. What services those were is unfortunately not specified, although this probably had something to do with Caze's recent invention of the 'knipgewicht', a new standardised closing weight that was extremely helpful for merchants.[381]

However, Caze's expertise went further. He spoke with Huygens about the fabrication of binoculars, and with Hudde he discussed Huygens' sea clock. Leibniz, who heard about Caze in 1696 on his trip to the Republic, wrote in his diary that Caze was working on various problems during his

375 D.O. Wijnands, *The Botany of the Commelins* (Rotterdam 1683) 39.

376 Wijnands, *The Botany*, 35.

377 Johannes Commelin, *Horti medici Amstelodamensis rariorum* (1697). Casperus Commelin, *Flora Malabarica sive Horti Malabarici* (1696). Ibidem, *Horti medici Amstelaedamensis plantae rariores et exoticae ad vivum aeri incisae* (1716).

378 I.H. van Eeghen, *De Amsterdamse Boekhandel 1680-1725*, vol. IV (Amsterdam 1967) 146. The legal and political struggle concerning Caze's hostage is discussed extensively in: H. D. Guyot, *Un épisode de la révocation de l'édict de Nantes* (Groningen 1907).

379 Pierre Bayle and Caze knew each other already in the early 1680s. Caze discovered in 1682 that Bayle was the author of his anonymous published book: Pierre Bayle, *Pensées diverses sur la comète* (Rotterdam 1682). See for Caze's correspondence with Huygens and Hudde: Christiaan Huygens to Constantijn Huygens Jr., 23 August 1685 & Cézar Caze to Christiaan Huygens, 26 August 1687, in: Christiaan Huygens, *Oeuvres Complètes*, vol. IX (The Hague 1901) nrs. 2394 & 2476.

380 Van Eeghen, *De Amsterdamse Boekhandel*, IV, 146.

381 Doorman, *Octrooien*, 303: patent H-165. See also: G.A. van Borssum Buisman, 'Pijl - of Sluitgewichten II', *Jaarboek voor Munt- en Penningkunde* (1952) 64-82, especially, 69.

imprisonment. He was also working on ship pumps, although Van der Heijden's pump remained superior, and invented a 'machine' that that could temper the speed of ships during a storm.[382]

In a later correspondence between Witsen and Leibnitz, it appears that Caze was also hired to decode encrypted messages. When Leibniz consulted Witsen to decode Chinese characters, he referred Leibniz to Caze, who 'was familiar with this matter'.[383] During their meeting, Caze told Leibniz that he had been under contract to Hudde for years and that he was consulted in service to the city. Leibniz was overjoyed with this contact because he learned that in addition to himself, Caze had independently invented and worked out binary calculation during his captivity in Leeuwarden.[384] After his release, Caze filed for a patent for the mechanical calculator based on this method of calculating.[385]

Also, there was a strong connection between Witsen and Hudde in their domestic circle. In 1673 Hudde married Debora Blaeu (1629-1702), then already a widow twice over.[386] She, along with Catharina Hochepied (1654-1728), Catherina van Heyningen (1651-1695), and Maria van der Merct (1639-1719), were the wives of Witsen and Valckenier, the sister-in-law of Gerard Bors van Waveren, and lady governor of the civil orphanage (*Burgerweeshuis*) at the Kalverstraat, respectively.[387] Moreover, from the inventory of Hudde's household effects, it appears he possessed portraits of several members of the Witsen family, so it is not unlikely that one of them shows Nicolaas Witsen.[388]

This inventory of more than hundred pages offers new insight into Hudde's life.[389] His personal belongings are described globally, among which are a significant number of unspecified mathematical writings and instruments.[390] Since, in general, the practical matters were specified,

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382 Georg Heinrich Pertz, *Gesammelte Werke aus den Handschriften der Königlichen Bibliothek zu Hannover. Erste Folge, Vierter Band* (Hannover 1847) 185. See also: Kurt Müller, 'Gottfried Wilhelm Leibniz und Nicolaas Witsen', *Sitzungsberichte der Deutschen Akademie der Wissenschaften zu Berlin, Klasse fur Philosophie, Geschichte, Staats-, Rechts-, und Wirtschaftswissenschaften*, vol. V (1955) 3-45, especially, 43. See also: Tresoar Leeuwarden, Family archive: De Carpentier-Van Hylckama, inv. nr. 175.

383 Nicolaas Witsen to Gottfried Wilhelm Leibniz, 6 June 1704: 'J'ay cru que je ne pourois mieux faire que de remettre vos remarques entre les mains de Mr. Caze qui a été reténu par feu Monsr Hudde et moi au service de cette ville depuis plusieurs années, et qui entend ces matières', in: Malte-Ludolf Babin (ed.), *Gottfried Wilhelm Leibniz. Sämtliche Schriften und Briefe*, vol. XXIII (Göttingen 2013) no. 292, pp. 405-406. See also: W.J.L. van Noord, & M.A. Weststeijn, 'The Global Trajectory of Nicolaas Witsen's Chinese Mirror', *The Rijksmuseum Bulletin*, vol. 63, no. 4 (2015) 325-361.

384 See for more information: H.J. Zacher, *Die Hauptschriften zur Dyadik von G. W. Leibniz. Ein Beitrag zur Geschichte des binären Zahlensystems* (Frankfurt am Main 1973).

385 Doorman, *Octrooien*, 307: patent H-221 (August 1711). See also: Jacques Bernard, *Nouvelles de la republique des lettres* (Amsterdam 1707) 574. Gerard Kuyper, *Suite de l'Histoire de l'Académie Royale des Sciences pour l'année 1703* (Amsterdam 1707).

386 Debora Blaeu (1629-1702) was married first with Bartholdus Wormskerck (1627-c.1657) and Joan van Waveren (1613-1670).

387 Peters, *De wijze koopman*, 57-59.

388 SA, Notarieel Archief Amsterdam [5075], inv. nr. 5336b, fol. 1613. See also: Jonathan Bikker, 'An Amsterdam Couple Reunited: Michiel van Musscher's Portraits of Johannes Hudde and Debora Blaeuw', *The Rijksmuseum Bulletin*, vol. 60, no. 1 (2012) 42-51.

389 SA, Notarieel Archief Amsterdam [5075], inv. nr. 5336b, fol. 1547-1650.

390 In the inventory the following mathematical documents and instruments are listed: fol. 1575: 'Eenige papieren van mathematische uytreekeninge; [...] Een doosje met eenige laadjes daarin eenige zaken van de mathesis, [...] zijnde op eene van de laadjes genoteert "ondeugend goedt"'; fol. 1576: 'verscheide caarten, instrumentjes en andere kleynigheden, specterende tot de mathesis'; Een bundel mathematische boeken en papieren met een touw omwonden,

including the fire engine (with hose), the circulation and distilling of water, and the calculation concerning the measuring of ships, the unspecified manuscripts and books are probably concerned with pure mathematics.[391] Pieces about the deepening of the rivers Nederrijn and Ijssel are also mentioned (about which Hudde compiled a report together with Christaan Huygens for the States-General in 1671), as well as other papers on the Middelveld polder, sea dikes, cosmography, cartography, seafaring, the river IJ, and information about real estate. Also, Hudde's correspondence with various people is mentioned.[392] Furthermore, several portraits are included, including a portrait of himself and his wife Debora Blaeu.[393] He also owned a remarkable portrait of his cousin Valckenier, the man who in 1672 was appointed mayor by the stadholder William III along with Hudde, and who received the 'magnificat' (president-mayor) that year until his death, after which it was taken over by Hudde in 1680.[394]

A significant part of Hudde's work for the city of Amsterdam was passed down after his death to the son of Anna Maria (Hudde) Dedel (1649-1718) and Johan Dedel (1636-1715), the secretary of Amsterdam: Willem Gerrit Dedel (1675-1733).[395] Most of these manuscripts are preserved in the Amsterdam City Archives and could provide new insights in practices of governance for the city of Amsterdam under Hudde's rule.[396] Hudde's mathematical manuscripts however were not handed down to Dedel and are still lost since he did not specify to whom he would pass them down.[397] His books have also vanished, after they were auctioned on April 15th, 1716, in the bookshop of Jan Boom at the Singel in Amsterdam; an auction catalog is not preserved.[398]

[...] nogh een bondel met mathematische geschriften als voren; [...] Nogh een bondel mengelmoes van mathematische geschriften met een touw bijeen gebonden. fol. 1581: 'Een vierkant doosje met houten instrumentjes; een papiertje met twee dito'; [...] Een koocker met mathematische instrumenten; [...] Een ledige blicke koocker en eenige mathematische instrumentjes met andere cleynigheeden; [...] Een koockertje met mathematische instrumenten; Nogh een koockertje als boven, daar in oock een schaartje. fol. 1609: Twee weerglazen. fol. 1625: 'Een mathematisch instrument in een Swart leere doos; [...] Verscheyde mathematische instrumenten en een kleijn skeleton van een kindtje; Vijff blicke Lantaarntjes en voorts eenighe cleenigheden van weijnigh belangh'. It is remarkable that optical instrumetns are not listed, however they could have been categorized as mathematical instruments.

391 SA, Notarieel Archief Amsterdam [5075], inv. nr. 5336b, fol. 1575-1576, 1579-1581, 1625-1626.

392 Ibidem fol. 1576.

393 Ibidem, fol. 1577-1579, 1585-1592, 1606, 1608, 1634.

394 Ibidem, fol. 1604, 1606, 1613, 1615. See also: J.C. Breen, 'knipsel over Hudde' (16 april 1904), fol. 3, in: ibidem, Personalia [30579], inv. nr. 881.

395 Ibidem, Archief van de Familie Dedel [728], inv. nr. 37: 'Voor eerst, aan mijn neef Willem Gerrit Dedel, secritaris dezer stad, alle mijne natelatene, zoo gedrukte boeken, als ongedrukte, mitsgaders alle de manuscripten en papieren raakende 't land of de stad van Amst&'.

396 Ibidem, Handschriften [5059], inv. nr. 47-49.

397 Ibidem, Archief van de Familie Dedel [728], inv. nr. 37: 'Ende aangaande mijne Mathematische manuscripten en papieren, dies heb ik goetgevonden noch nader mijne gedachten te laten gaan.'

398 *Oprechte Haerlemsche Dingsdaegse Courant*, no. 13, 31-3-1716: 'Tot Amsterdam sal men op Woensdag, den 15 April, in de Boeckwinkel van Jan boom verkopen verscheyde wel geconditioneerde Boecken, bestaende in Theologie, Rechtsgeleerde, Mathematise en Historise Boecken …'. To confirm that Willem Gerrit Dedel auctioned Hudde's books see: Jan Albertsz. van Dam, *Comptoir almanach, op 't schrickel jaer onses Heeren Jesu Christi, M.D.C.C. XVI. Voorsien met alle de jaer, paerden, beesten, en leer-marckten. Als mede de vacantien, het varen der treck-schuyten en beurt-schepen, het reysen der posten en boodens, &c. Nevens de maens op en ondergangh* (Amsterdam 1716), in: National Library of the Netherlands, Amsterdam KVB Archief. Boekverkopersgilde. VHB 93, (microfiche).

Chapter 7

The protector of free thinkers and controversial publications

Hudde was not only a patron or protector of natural philosophers and engineers, but also of scholars who had 'radical' ideas in the eyes of the church. Like Hudde himself before he took public office, Spinoza, Gregorio Léti (1630-1701), and Balthasar Bekker (1634-1698) were critical of the ecclesiastical authority and wrote controversial books. To explore Hudde's thoughts on freedom of the press and his role as a patron of controversial publications, it is necessary to study censorship in Amsterdam from 1668 onwards. That year, Hudde was one of the six *schepenen*, judges, who were concerned with censorship. Moreover, Hudde's fellow medical student at Leiden University, Adriaan Koerbagh (1633-1669), wrote an offensive work in the same year that led to his death one year later.[399] In this chapter, three cases concerning controversial publications will be discussed preceded by a brief introduction on the practice of censorship in Holland, and especially Amsterdam. In all three cases, Hudde played a role, which became more significant after he became (presiding) mayor of Amsterdam.

The Dutch Republic is often seen as 'The Mecca of Authors', especially the region of Holland and the city of Amsterdam.[400] The Frenchman who wrote this in 1687 must have noticed that there was no censorship before publication, and perhaps more importantly, that only secular authorities and not ecclesiastical ones could press charges against printers and/or booksellers who printed and distributed controversial works.[401] Unlike in surrounding countries in Europe, the union between church and state was shattered with the outbreak of the Dutch Revolt (1560s) against the Habsburg Empire. Therefore, the ecclesiastical authorities could not prohibit books directly, but had to sign a petition to the secular authorities to repress printed works. However, secular authorities passed judgement in accordance with their own criteria, which gave frequently rise to conflicts between the church and the civil powers.[402]

The effectiveness of censorship was therefore dependent on various factors such as the internal and international political situation, the relation between the church council and municipality,

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399 Adriaan Koerbagh, *Een Ligt schijnende in duystere Plaatsen, om te verligten de voornaamste saaken der Godsgeleerdheyd en Godsdienst* (Utrecht 1668).

400 Simon Groenveld, 'The Mecca of Authors? States Assemblies and Censorship in the Seventeenth-Century Dutch Republic', in: A.C. Duke & C.A. Tamse, *Too Mighty to be Free. Censorship and the press in Britain and the Netherlands* (Zutphen 1987) 63-86, especially, 63.

401 Ibidem.

402 Ibidem, 65.

and the personal convictions of powerful individuals like the mayors or the *schout* (sheriff). Therefore, censorship was practiced more on the local level in the second half of the seventeenth century, which made it more difficult to publish controversial work anonymously. This could also provide a certain amount of freedom when powerful individuals in the city government had a liberal attitude.[403] Therefore, there was censorship in the Republic, but due to its political structure and plurality of legal jurisdictions, in practice printers could publish controversial works with relative ease if they knew how to exploit the loopholes in the law.

The most controversial book ever published?

In 1670, Baruch Spinoza's *Tractatus Theologico-Politicus* was published anonymously in Amsterdam and was immediately denounced by the religious authorities as the most dangerous book ever published.[404] The controversy surrounding the *Tractatus* was one of the most significant events in European intellectual history at the dawn of the Enlightenment. According to historians such as Steven Nadler and Jonathan Israel, the book laid the groundwork for subsequent liberal, secular, and democratic thinking and was the most decisive work in the Radical Enlightenment.[405] Despite its reputation as a fundamental danger for religion and society according to the ecclesiastical authorities, the *Tractatus* was not officially repressed by the secular authorities before 1674, while the synods of North and South Holland wanted to censor the book almost immediately after it was published.[406]

In this section, we will investigate how the *Tractatus* circulated for four years in Amsterdam, while the church council denounced the book as 'the most blasphemous book … the world had ever seen'.[407] Through exploring the publishing culture of Amsterdam, it will be possible to provide a critique of Israel's idea of a Radical Enlightenment in which Spinoza played the pivotal role. I will argue that scholars should re-evaluate Israel's concept of the Radical Enlightenment by taking more philologists and bible critics into account, as scholars such as Dirk van Miert, Nicholas Hardy, Henk van Nellen, Piet Steenbakkers, and Jetze Touber have done.[408]

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403 Piet Visser, *Godtslasterlijck ende Pernicieus. De rol van boekdrukkers en boekverkopers in de verspreiding van dissidente religieuze en filosofische denkbeelden in Nederland in de tweede helft van de zeventiende eeuw* (Amsterdam 1996) 12.

404 Willem P.C. Knuttel, *Rijks Geschiedkundige Publicatiën. Acta der Particulieren Synoden van Zuid-Holland 1657-1672*, vol. IV (The Hague 1912) 531.

405 Steven Nadler, *Book Forged in Hell. Spinoza's scandalous treatise and the birth of the secular age* (Princeton 2011) xi. Israel, *Radical Enlightenment*, 6, 715.

406 Knuttel, *Verboden boeken*, 115.

407 Willem P.C. Knuttel, *Acta der Particulieren Synoden van Zuid-Holland 1657-1672*, vol. IV (The Hague 1912) 531. See for the orchestrated attack on Spinoza's *Tractatus* in Utrecht: Albert Gootjes, 'The First Orchestrated Attack on Spinoza: Johannes Melchioris and the Cartesian Network in Utrecht', in: *Journal of the History of Ideas*, vol. 79, no. 1 (January 2018) 23-43.

408 Nicholas Hardy, *Criticism and Confession: the Bible in the Seventeenth-Century Republic of Letters,* Oxford-Warburg Studies (Oxford 2017). Van Miert, *The Emancipation of Biblical Philology*. Jetze Touber, *Spinoza and Biblical Philology in the Dutch Republic, 1660-1710* (Oxford 2017). Henk Nellen (ed.), *Biblical Criticism and Scriptural Authority in the Dutch Golden Age* (Oxford 2017). Timothy Nicholas-Twining, *Criticism and confession: Catholic biblical scholarship from Andreas Masius to Richard Simon,* c. *1570-1680* (Cambridge 2017).

To distribute a controversial work such as the *Tractatu*s without being censored, two factors were necessary. First, Spinoza must have had some help distributing his work. Second, he must have had powerful friends among the city magistrates who protected him in a certain way. In this section, these two factors are discussed in the search for an answer as to how one of the most dangerous books in the early modern period could be distributed while the Amsterdam magistrate did not take any significant action.[409]

Although the *Tractatus* was a critical reflection on society in which Spinoza called for a free exchange of philosophical ideas, the municipality did not intervene. One of the reasons for this is that the intended audience was limited to the scholarly elite. Instead of writing the work in the vernacular from an emancipatory ideal so that more people could read it, as Koerbagh did with his *Bloemhof* and *Ligt*, Spinoza wrote in Latin, which limited the number of readers.[410] This suggestion is confirmed through Spinoza's own preface, as well as a letter that he wrote to his friend Jarig Jelles (ca. 1620-1683) in 1671. When Spinoza heard in February that an anonymous person had translated the *Tractatus* into the vernacular, he immediately took measures. He urged Jelles to do everything in his power to prevent the translation into Dutch, because otherwise Spinoza was certain that he book would be prohibited.[411]

Besides Spinoza himself, it was the liberal printer and publisher Jan Rieuwertsz. who knew the loopholes in the law and used different strategies to publish Spinoza's work. Although the *Tractatus* was already printed and distributed in early January 1670, nobody seemed to know who had written it. This was not remarkable, since besides publishing the *Tractatus* anonymously, it also appeared with the fictitious imprint 'Henricus Kühnrath from Hamburg'.[412] Therefore, there was at first a strong belief that the book was printed by Christoffel Cunradus (1615-1684). However, it was Rieuwertsz. who received Spinoza's manuscript of the *Tractatus*. Instead of printing the work himself, he contracted Israël de Paull (1632-1680) to do the job so that no traces could lead back to him.[413]

The diffusion of the *Tractatus* went fast, and by using a fictitious imprint and a different printer and publisher, Rieuwertsz. and De Paull were safe. Therefore, they increased the number of print runs, so that in 1672 the book appeared in octavo instead of quarto with the same imprint,

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409 Since the subject of this thesis is Johannes Hudde and not Spinoza, the debate on the role of the *Tractatus* in the Radical Enlightenment is only disussed minorly. For more information: Israel, *Radical Enlightenment*. Nadler, *Book Forged in Hell*. See also the books in the previous footnote.

410 Adriaan Koerbagh, *Een Bloemhof van allerley Lieflijkheyd sonder verdriet* (Amsterdam 1668). See the 'preface' in: Baruch Spinoza, *Theologisch-politiek traktaat*, translated by: F. Akkerman (Amsterdam 1997) 93.

411 Baruch Spinoza to Jarig Jelles, 17 February 1671, in: Baruch Spinoza, *Nagelate schriften* (Amsterdam 1677) 591-592.

412 [Spinoza], *Tractatus*. The book was published anonymously with the fictive printer's name: 'Henricus Kühnrath van Hamburg'. It was printed by Israël de Paull (1632-1680) in the Tuinstraat and published by Jan Rieuwertsz. (1617-1689) *in 't Martelaersboeck* in the Dirk van Assensteeg. See: Van Eeghen, *De Amsterdamse boekhandel*, IV, 63. Idem, *De Amsterdamse* boekhandel, V-II (Amsterdam 1978) 381. See also: Fritz Bamberger, 'The early editions of Spinoza's "Tractatus Theologico-Politicus": A bibliohistorical reexamination', in: *Studies in Bibliography and Booklore*, vol. 5 (New York 1961) 9-33, especially, 10. Rindert Jagersma & Trude Dijkstra, 'Uncovering Spinoza's Printers by Means of Bibliographical Research', *Quærendo*, vol. 43 (2013) 278-310, especially, 295.

413 Jagersma en Dijkstra, 'Uncovering Spinoza's Printers', 295.

followed by a 1674 edition in octavo, but without an imprint. Furthermore, Rieuwertsz. published three different editions of the *Tractatus* in 1673 in combination with Meijer's *Philosophia S. Scripturae Interpres* (1660) with a fictitious imprint and title page.[414] However, in July 1674 the *Tractatus* was finally forbidden by the States of Holland and West Friesland.[415] Nevertheless, Rieuwertsz. continued publishing, but in 1678 he had to change his strategy. In February 1678, the Court of Holland issued a more effective edict against the *Tractatus* and Spinoza's *Opera Posthuma* (1677) that the synod of South Holland insisted upon.[416] It became too dangerous to print and distribute new editions of the *Tractatus* in Latin. Nevertheless, Rieuwertsz. did not desist, and published the treatise in 1678 in a French translation in duodecimo format under a fictitious title.[417]

The *Tractatus* entered the realm of clandestine publications, and although the treatise was forbidden, it was not banned in Amsterdam. Meaning that the remaining copies were not confiscated, and remained in circulation illegally. A Dutch translation appeared in 1693 by Rieuwertsz.'s son, Jan Rieuwertsz. the Younger (1651/52-1723), and an English version in 1689.[418] Throughout the ecclesiastical and secular trials of the *Tractatus,* it appeared that Rieuwertsz. was able to continue his radical publishing activities, and did not suffer serious harassment or any legal troubles, although the authorities remained suspicious and kept a close watch.[419] To determine how it was possible for Rieuwertsz. to continue publishing, we shall now examine the people who had the legal authority to repress the book: the governments of Holland and Amsterdam.

In March 1670, the Amsterdam consistory discovered the *Tractatus*, and wanted the treatise to be subsumed under the legislation of 1654 by the States of Holland and West Friesland, which was supposed to prevent the production and distribution of blasphemous books.[420] The city government referred the matter to the States of Holland and West Friesland, who in turn referred the matter in March to the Court of Holland, the highest judicial court of the province.[421] A year later, in April 1671, the commission of the Court advised the States of Holland to prohibit the *Tractatus*.[422]

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414 Spinoza, *Tractatus* in 8°, with fictive title page (1673): Francisci Henriquez de Villacorta, *Opera Chirurgica Omnia* (Amsterdam 1673) (part II contains: L. Meijer*, Philosophia S. Scripturae interpres*). Danielis Heinsius, *Operum historicorum collectio* (Leiden 1673) (part II contains: L. Meijer, *Philosphia S. Scripturae interpres*). Francisci de le Boe Sylvius, *Totius medicinae ... Opera Omnia* (Amsterdam 1673) (part II contains: L. Meijer, *Philosphia S. Scripturae interpres*).

415 Knuttel, *Verboden boeken*, 18, 57, 115. (The *Tractatus* was prohibited with: Lodewijk Meijers, *Philosophia S. Scripturae Interpres* (1660) and Thomas Hobbes, *Leviathan* (1651)).

416 Ibidem, 110.

417 Spinoza, *Tractatus* in 12°, with fictive title page (1678): Pierre Warnaer, *La clef du santuaire, par un scavant, homme de nôtre siècle* (Leiden [= Amsterdam] 1678). Claude Emanuel, *Reflexions curieuses d'un esprit des-interresse sur les matieres* (Keulen [= Amsterdam] 1678). Jacob Smith, *Traitté des ceremonies superstitieuses des Juifs tant anciens que modernes* (Amsterdam 1678).

418 Wayne I. Boucher, *Spinoza in English. A Bibliography from the Seventeenth Century to the Present* (Leiden 1991) 5.

419 SA, Archief van de Hervormde Gemeente; kerkenraad [376], inv. nr. 12, (Resolution 11 April 1669) fol. 26.

420 Visser, *Godtslasterlijck ende Pernicieus*, 7. Nadler, *Book Forged in Hell*, 222.

421 Ibidem.

422 Ingrid Weekhout, *Boekencensuur in de Noordelijke Nederlanden. De vrijheid van drukpers in de zeventiende eeuw* (Meppel 1998) 105. Bamberger, 'The early editions of Spinoza's "Tractatus Theologico-Politicus', 14. Nadler, *Book Forged in Hell*, 224.

However, the States of Holland concluded that 'the advice of the court would be further examined by an appointed committee which would include 'the gentleman from Leiden, Amsterdam Gouda, Rotterdam, Alkmaar, and Hoorn, among whom was Johan de Witt himself'.[423] Therefore, rather than issuing a new law, as the synods and the Court of Holland had requested, the States of Holland referred the question to another committee to delay the process as much as possible.[424]

This 'bureaucracy' brought the provincial synods, local consistories, and district synods (*classis*) to wit's end. The synods of North and South Holland even asked De Witt directly to spur the slow-moving states to act.[425] By July 1672, the States still would not take action; therefore, the synods tried to gain support from the secular authority on a local level. In August 1672, the pensionary of Leiden, Pieter Burgersdijck (1623-1691), was approached by deputies of the synod of North Holland with excerpts from the *Tractatus*. Burgersdijck promised to aid the synod, but one year later he reported that due to the workload and more urgent matters, the case was not a priority for the secular authority.[426] Meanwhile, progress was made in Utrecht. In September 1671, the district synod reported that the town council had complied with its demand, and the *Tractatus* was confiscated.[427]

In Amsterdam, where Hudde was mayor in 1672 and 1673, no action was taken against the *Tractatus* or even the trouble to discover who the publisher and printer behind the manuscript were. This is remarkable because in December 1673, the States of Holland assigned the Court of Holland to confiscate all copies of the 1673 edition of the *Tractatus* that appeared under a fictitious title page bound together with Lodewijk Meijer's *Scripturae Interpres*. In the meantime, Hudde, who was responsible as the mayor of Amsterdam, did nothing to confiscate any copies.[428]

Perhaps this can be explained through Hudde's personal relationship with Spinoza, with whom he corresponded in secret. Furthermore, I am convinced that Hudde did not find it was necessary to act, taking into account Hudde's notions on discussing controversial matters in his correspondence with Locke, his dispute with Du Bois, and the fact that the *Tractatus* was only read by the intellectual elite and did not cause a stir like *Bloemhof* and *Ligt* did. However, it is remarkable that a year later, in 1674, the *Tractatus* was repressed because the president of the Court of Holland, Hadrianus Pauw van Bennebroek (1622-1697), gave in to the demands of the ecclesiastical authorities.[429] That year, Hudde could not be mayor, since he had already been elected two years in a row. Although the edict of July 1674 urged confiscating all the different editions of the *Tractatus*, it seems that the secular authority

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423 Ibidem, 226.
424 Ibidem.
425 Nadler, *Book Forged in Hell*, 227
426 Ibidem, 227-228.
427 Ibidem,
428 Weekhout, *Boekencensuur in de Noordelijke Nederlanden*, 105.
429 P.C., Molhuysen & Fr. K.H. Kossmann (ed.), *NNBW*, IX (Leiden 1933) 760-761. J.H. van den Hoek Ostende, 'De 'uitgever' Henricus Cunrath of Kunraht van de polygamist Lyserus en van de philosoof Spinoza', in: *Amstelodamum. Maandblad voor de kennis van Amsterdam*, vol. 50, no. 4 (1963) 73-85, especially, 77.

did not put much effort into enforcing it; the church councils and synods complained that the godless book was still for sale and urged their deputies to take care of the matter.[430]

Several months later, in 1675, Hudde who was mayor again, appointed Rieuwertsz. as city printer of Amsterdam, which was highly unusual because he was a Baptist and controversial publisher whose shop was known to be a place where people could meet and discuss radical ideas.[431] Therefore, it seems that Hudde must have had a role in tolerating Spinoza's work, since he was familiar with his ideas, knew the publisher of the *Tractatus*, and neglected the orders of the States of Holland and West Friesland. Nevertheless, the evidence in this case is circumstantial. However, although we do not know much *in concreto* about Hudde's role in the relatively long period of the distribution of Spinoza's *Tractatus*, there is direct evidence about how Hudde dealt with another controversial book that appeared in 1697. By investigating this matter, we can gain a glimpse of Hudde's perspective on censorship, a perspective that also appeared to have played a role in the publication of Spinoza's *Tractatus*.

The protection of Léti's and Bekker's work

The Italian 'literary adventurer', Gregorio Léti was appointed by the city of Amsterdam in 1685 as a private teacher for educating the children of the magistrates of Amsterdam and their family members in history and Italian. He was also the father-in-law of Hudde and Van Limborch's acquaintance Jean LeClerc, who became known for his Bible criticism and took part in discussing Hudde's question about God with Locke and Van Limborch.[432] Besides being a private tutor, Léti had the obligation to organise a kind of open salon every month, which was similar to the French and Italian academies. In exchange for his services, he was allowed to call himself 'historian of Amsterdam' until his death in 1701.[433]

In 1697 Léti published his *Critique historique, politique, morale, economique, et comique, sur les lotteries*, a satirical work which also criticised the Amsterdam lottery organised by the Walloon church.[434] Almost immediately after publication, it caused great turmoil in the city of Amsterdam due to its critical reflection on the Walloon church.[435] Both the Walloon church and particular unions connected to the lotteries urged the mayors of Amsterdam to suppress this satirical work. Ruling mayor Hudde responded 'that he was not going to prohibit the work. The particular unions should go to Justice, and the church should look at points Léti addressed, without interfering in other matters.

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430 Bamberger, 'The early editions of Spinoza's "Tractatus Theologico-Politicus', 26.

431 Weekhout, *Boekencensuur*, 93. Van den Hoek Ostende, 'De 'uitgever' Henricus Cunrath', 77.

432 LeClerc, *Ars critica*.

433 Van Miert, *Humanism in an Age of Science*, 107-110.

434 See for more information on Léti: Erich Haas, 'Gregorio Leti und Seine Critica Della Lotterie', *Romanische Forchungen*, vol. 68 (1956) 346-376. Jonathan I. Israel, 'Gregorio Leti (1631-1701) and the Dutch Sephardi Elite at the close of the Seventeenth Century' in: Ada Rapaport-Albert & Steven J. Zipperstein, *Jewish History: Essays in Honour of Chimen Abramsky* (1988) 267-288. Enrico Morpurgo, 'Leti en Nederland', in: J.H. Scholte (ed.), *Neophilologus*, vol. XXXV (Groningen 1951) 193-201.

435 Isabella H. van Eeghen, *De Amsterdamse boekhandel 1680-1725*, vol. II (Amsterdam 1963) 79-80.

Only insofar as he disturbed the peace and order in the city, Hudde took measures'.[436] Moreover, this was not the first time that Hudde defended Léti: to earlier complaints against the historian, he responded, 'We live in a free country; he wrote against you, now you write against him'.[437] In the case of the allegations against Léti, it seems that Hudde pursued an open and rational debate, in which people could write against each other, without disturbing the order, peace, and security of the city.[438]

Hudde's tolerant perspective towards free thinkers and controversial books also played a role in the case of the Amsterdam preacher Balthasar Bekker. His *De Betoverde Weereld* (1691) was a fierce critique of all kinds of superstition, in which even the existence, or at least the operation, of the Devil was questioned. As with the *Tractatus*, the ecclesiastical authorities urged the mayors to suppress this book. Hudde did not find it necessary to take any immediate action and referred the matter to a separate commission to pass judgement.[439] The next year, Bekker was removed from office as a preacher by the synod of North Holland.[440] Nevertheless, Hudde and Witsen kept supporting Bekker by paying his salary.[441]

Although Hudde did not necessarily agree with the ideas of the free thinkers, he continued endorsing a liberal stance so that their ideas could be published. In the case of Bekker, for example Hudde urged Nicolaas Muys van Holy (ca. 1653-1717) to publish an extended version of his refutations of Bekker's denial of the operation of the Devil on humans in *Consideration of the Main Point in Bekker's Book* (1692).[442]

In all the previous cases, it seems that while Hudde was mayor, the Amsterdam government did not feel the need to put significant effort into dealing with the complaints of the church council. Often, a separate committee was installed to arrive at a verdict.[443] As with Bekker's *De Betoverde Weereld*, it took another four years before the committee reached a decision, at which point they concluded that repression would be pointless, since 'so many books have already been sold'.[444] In the

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436 Gregorio Leti, *Kort begrip der helden-deugden, ofte historische, en staat-kundige verhandeling van de daden en maximen, die tot voortplanting, en conservatie van alle staten, en landen noodsakelijk zijn …*, vol. II (The Hague 1700) 375-376: 'Laat ons de saken niet verwerren; dat een yder bij zijn regt blijve, gij segt, dat Leti, en particulieren, en het publijk, en de kerk heeft benadeelt: wat de particulieren aangaat, dat die haarre cours tot de justitie nemen, en hun sal regt geschieden: zo hij het publijk te na is geweest, dat raakt ons, en wij weten wat ons daar omtrent te doen staat: maar zo hij tegens de kerk heeft misdaan, dan is 't u beurt de mislagen na-te-sien: en nergens anders hebt gij u mee te bemoeijen'.

437 Gregorio Leti, *Teatro Belgico overo ritratti historici, chronologici, politici e geografici delle sette provincie unite*, vol. II (Amsterdam 1690) 31: 'che volete che io faccia, noi fiamo in un paese di Libertà egli ba Scritto contro di voi Scrivete contro di Lui'.

438 Weekhout, *Boekencensuur*, 61.

439 Ibidem, 109.

440 Ibidem, 107.

441 Rudolf B. Evenhuis, *Ook dat was Amsterdam. De kerk der hervoming in de tweede helft van de zeventiende eeuw: nabloei en inzinking*, vol. III (Amsterdam 1971) 262-264 and Knuttel, *Acta*, VI, xix-xx.

442 Nicolaas Muys van Holy, *Overweging van het hooftpoint in Ds. Bekkers Boek, genaamt De Betoverde Weereld. Te weten of de duyvel op de mensch werken kan. Vermeerdert met oplossinge van eenige nadere tegenwerpingen.* (Amsterdam 1692).

443 Bamberger, 'The early editions', 13-14. Weekhout, *Boekencensuur*, 105.

444 Knuttel, *Acta*, vol. VI, xx.

matters of Spinoza, Léti, and Bekker, it seems that the municipality of Amsterdam had a high degree of tolerance during Hudde's term as mayoralty.

As we have seen in the section about Locke, Hudde, like Spinoza, Koerbagh, Bekker, and other philologists and bible critics, were critical of Christian dogmas. It is therefore on the one hand not surprising that Hudde protected these scholars, while he himself had to operate in secret during his public function as mayor. On the other hand it was uncommon to protect unorthodox philosophy and theology after William (of Orange) III came to power in 1672, since he could not afford to antagonize the Reformed Church and its ministers.[445] We know for certain that Hudde protected the Koerbagh brothers, Léti, and Bekker, and I have the strong impression that he also used his influence to protect Spinoza.[446] Therefore, further investigation on the matter is required, taking into account the roles of various governmental levels, print culture, the ecclesiastical authority, and contemporary scholarly debates.

[445] Bamberger, 'The early editions of Spinoza's "Tractatus Theologico-Politicus', 14. Nadler, *Book Forged in Hell*, 226-230.

[446] Bontemantel, *De regeeringe van Amsterdam,* 279. Ibidem, lxx-lxxvii.

Chapter 8

Sustainable solutions and technological innovations in Amsterdam

An innovative form of street lighting

As opposed to Hudde's personal convictions and his tolerant perspective on controversial publications, as a mayor of Amsterdam, the safety of its citizens and the improvement of the city were the pillars of Hudde's work. In the summer of 1669, the 'Da Vinci of Amsterdam', Jan van der Heijden (1637-1712) presented a plan to the municipality in manuscript, namely *Het Licht der Lamp-Lantaren*, to implement an innovative form of street lighting.[447] His extensive proposal is unique in the sense that every aspect of his proposition is fully worked out and calculated. For example, Van der Heijden calculates the consumption fuel in one hour; the most optimal locations for the lanterns; and the wages, fines, and instructions for the overseers and maintenance workers.[448] The most important pillars of his proposal were efficiency and the reduction of costs, which evoked great interest among the mayors of Amsterdam. Restructuring and improving the street lightning was a priority for the Amsterdam government. However, as we have seen with Becher, the mayors first wanted to investigate the matter themselves to verify that the proposal was not too good to be true.

In July 1669 Van der Heijden's proposal was referred to a separate committee, led by Johannes Hudde. That year Hudde was treasurer-extraordinary, which means that he provided the mayors and all the treasurer-ordinaries with advice concerning financial matters. Together with secretary Wigbold Slicher (1627-1718) and Cornelis de Vries, Hudde investigated Van der Heijden's proposal. In August, they presented their research to the mayors, and Hudde's recommendations concerning the proposal were positive. Nevertheless, he did advise the mayors that is was necessary to hire an overseer due to the complexity of implementing the proposal. According to Hudde, no one was more capable to fulfil the function than Van der Heijden himself, since it was his plan.[449]

Hudde's positive recommendation for the passage of the project was embraced by the mayors and treasurers. Van der Heijden's proposal was approved at the end of August, a week after Hudde delivered his report. However, the settlement of Hudde's advice to appoint Van der Heijden as overseer was delayed, together with the salary of 2,200 guilders he was asking for.[450] It took another

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447 Jan van der Heijden, 'Het licht der lamp-lantaren ontstoken' (1669) in: *Het gas. orgaan van de Vereeniging van Gasfabrikanten in Nederland*, vol. 33, no. 8-10 (1913). See: Johan C. Breen, 'Jan van der Heyden', *Jaarboek van het genootschap Amstelodamum*, vol. 11 (1913) 29-92, especially, 44, 63-68.

448 Van der Heijden, 'Het licht der lamp-lantaren', 313.

449 Breen, 'Jan van der Heyden', 45.

450 SA, Archief Thesaurieren Ordinaris [5039], inv. nr. 798.

four months for Van der Heijden to receive any compensation.[451] From January 1670, he received a salary of 1,800 guilders, which was increased in June to 2,000.[452]

It is striking that the municipality was prepared to pay Van der Heijden a salary of 2,000 guilders and covered the expenses of the staff.[453] In general, a craftsman received 250-300 guilders a year and a professor 500-1,000 guilders. It is likely that he received it due to his significant reduction of costs for the board. Despite the relatively generous salary, his proposal would lead to an improvement in the amount of light in the city and lower costs. This was mainly accomplished through three innovations: the design of the lanterns, the distance between the lanterns, and the type of fuel.[454]

The innovations in the matter of street lighting became known throughout all the boards of the Republic. However, the success was not only attributed to Van der Heijden. Hudde was also praised for making Amsterdam a safer city through the implementation of a more sufficient and fireproof version of street lighting. An example of this is given by Daniel Lipstorp (1613-1684), a scholar from Lübeck. He wrote to his municipality in Lübeck in 1670 that street lighting in The Hague had been renovated after the example of Amsterdam, which was made possible by Hudde's calculations.[455] Therefore, although the design and execution of Amsterdam's innovative way to light the city is attributed to Van der Heijden, it is not unlikely that Hudde also had a significant share in it as one of the most respected mathematicians of his time.

The invention of the fire hose

This was not the only project on which Hudde worked with Van der Heijden. During the installation of the innovative fireproof lanterns, Jan worked on two other projects with his brother Nicolaas van der Heijden. One was a new fire engine with a fire hose, and the other was a *scheprad* or paddle wheel, for both of which they filed patents with the States-General.[456] Both inventions could transport efficiently significant amounts of water without being labour-intensive. Hudde was involved in both projects. In regards to the the fire engine with a hose, Hudde was recently appointed mayor and supported the brother's innovative plan, contrary to his fellow board members. The project of the paddle wheel, in which Hudde used their design in combination with the construction of his own horse mill, will be discussed in the next section.

As an innovator, Van der Heijden was convinced that he could improve the fire engine. On 24 October of the Disaster Year of 1672, the mayors of Amsterdam encouraged Van der Heijden to improve the fire engine because of the increase in arson in the period of turmoil.[457] In March of the

451 Ibidem, inv. nr. 4, fol. 71.
452 Breen, 'Jan van der Heyden', 45.
453 Van der Heijden, 'Het licht der lamp-lantaren', 320.
454 Ibidem, 312-322, 356-365, 404-406.
455 Archiv der Hansestadt Lübeck, ASA nr. 0344, 22 November 1670. My sincere gratitude to Rik Wassenaar from 's-Hertogenbosch for the information from Lübeck.
456 Doorman, *Octrooien*, 296-297: patent H-120 (29 July 1671).
457 Breen, 'Jan van der Heyden', 87-88.

same year, he had already demonstrated that his engine with a firehose worked by successfully controlling a fire at the Regulierstoren. On 4 April, Van der Heijden presented his machine to the municipality. On 22 September, he received a contract with the magistrate, and on 12 December his expenses were reimbursed.[458] However, a reward had to wait due to a short absence of mayor Hudde.[459]

Meanwhile, on 11 November the *vroedschap*, the town council, decided that half of the existing fire engines should be equipped with two fire hoses; one for the supply of water and one to extinguish the fire.[460] This was accepted on 31 January 1673 after the great fire at the roperies (*lijnbaan*) of the Admiralty of Amsterdam, on the east side of the city, on 12 January. The roperies at Kattenburg and Oostenburg island were used since the 1660s by the VOC to make ropes and as a storage unit where, amongst other things, sulphur, rushes, and a great amount of wood shavings were piled up. Although the Admiralty was relatively new, with enough space on the streets and between the buildings, the fire engines without hoses could not control the fire. Eventually, it was Van der Heijden's engine that stood on the other side of the city at the Wester Church that proved its efficiency. For their invention of the firehose and for preventing the complete destruction of the roperies, the brothers received the appointment as 'overseers of the city's fire engines and fire tools'.[461]

Four years later, in 1677 the brothers presented their invention in public through the publication of *Bericht wegens de Nieuw-Geïnventeerde en Geoctroyeerde Slang-Brandspuiten* by the city printer Jan Rieuwertsz.[462] Their pamphlet was praised by the city carpenter Jan van Petersom (1627-1697).[463] The meeting between the former and ruling mayors in the *Oud-Raad* of 26 July 1677 ensured that in addition to the fifteen engines and hoses from Van der Heyden, another fifteen were ordered. Moreover, the brothers received a reward for their services of 3,000 guilders and a salary of 315 guilders.[464] This was all due to Hudde, since the four treasuries were against the installation of the new fire engines. Hudde's cousin Gillis Valckenier even argued that the engines without hoses by the Nuremburg engineer Hans Heutsch (1596-1670) were more effective. Hendrik Hooft (1617-1678), who was president mayor that year, sided with Hudde and confirmed their salary and prize.[465] Two

458 Ibidem, 120.
459 Ibidem.
460 SA, Archief van de Vroedschap: resoluties met munimenten of bijlagen [5025], inv. nr. 46 (Resolution 11 November 1672).
461 Breen, 'Jan van der Heyden', 50.
462 Jan van der Heijden & Nicolaas van der Heijden, *Bericht wegens de nieuw-geïnventeerde en geoctroyeerde slang-brandspuiten: uitgevonden door Jan en Nicolaes vander Heiden* (Amsterdam 1677).
463 SA, Bibliotheek [15030], inv. nr. 102941, *Berigt Rakende de Stads Lantarens*, fol. 2.
464 Ibidem, Archief van de Burgemeesters: dagelijkse notulen, resoluties en missivenboeken [5024], inv. nr. 16, (Resolution 27 July 1677) fol. 38-39.
465 Breen, 'Jan van der Heyden', 85.

years later, it was again Hudde who ordered 30 more fire engines, so that in 1682 each district of Amsterdam possessed a fire engine after the design of the two brothers.[466]

To pay tribute to Hudde's work in helping the brothers to convince the city government of the installation of their fire engine with a hose, Jan dedicated his *A description of fire engines with water hoses and the method of fighting fires now used in Amsterdam* (Amsterdam, 1690) to 'the Most Honourable Gentlemen Mr. Joannes Hudde [and] Mr. Nicholaas Witsen, Mayors of Amsterdam'.[467] The book was made to honour Hudde and to impress the mayors of Amsterdam by presenting the success of the fire engine with a hose. This work, together with the pamphlet from 1677, provides a clear overview of firefighting before and after the Van der Heijden brothers worked with Hudde to install innovative fire engines. The three most significant improvements were the fire hose, the vacuum regulator, and the mobility of the fire engine. [468]

Sustainable solutions for water management

After the fourth urban expansion (1656-1662), Amsterdam reached the size that would remain similar until 1860.[469] Less than a hundred years earlier, in 1578, the city only contained between 25,000 and 30,000 citizens, which increased in 1650 to 175,000 and almost 30 years later to 220,000 people.[470] This brought three main challenges for the city, which Hudde tried to solve: (1) water quantity, (2) water quality, and (3) water supply. The water quality in the city decreased inversely proportionally with the increase of citizens. This is due to discharge of waste, as well as the increase in polluting industry. Especially after the fourth urban expansion, water quantity became a problem because the edges of the city stood at a lower level than the city centre.

Moreover, the increase in population required an extensive water supply. Clean drinking water could not come from the canals, the IJ or Amstel rivers due to pollution. This also created an odour nuisance in the city, which became more of a problem during temperature increases in the spring and summer. Hudde worked on solution for all the three problems, for example constructing horse mills (*rosmolens*) to tackle the problem of water quantity. He introduced a new system of control locks or tide locks, which improve water quality by artificially increasing the transit of water so that the canals flush themselves clean. Moreover, it also served to prevent the city from flooding through locking

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466 SA, Archief Thesaurier en Ordinaris [5039], inv. nr. 797.

467 Jan van der Heijden, *Beschryving der nieuwlijks uitgevonden en geoctrojeerde slang-brand-spuiten, en haare wijze van brand-blussen* (Amsterdam 1690).

468 Ibidem.

469 Boudewijn Bakker, 'De zichtbare stad 1578-1813', in: Willem Frijhoff & Maarten Prak (ed.), *Geschiedenis van Amsterdam. Centrum van de wereld 1578-1650*, vol. II-I (Amsterdam 2004) 17-102, especially, 89. See also: Abrahamse, *De grote uitleg van Amsterdam*. Siger Zeischka, *Minerva in de polder. Waterstaat en techniek in het Hoogheemraadschap van Rijnland 1500-1865* (Hilversum 2007).

470 Clé Lesger, 'De wereld als horizon. De economie tussen 1578 en 1650', in: Willem Frijhoff & Maarten Prak (ed.), *Geschiedenis van Amsterdam. Centrum van de wereld 1578-1650*, vol. II-I (Amsterdam 2004) 103-188 especially, 104. Ibidem, 'Vertraagde groei. De economie tussen 1650 en 1730', in: Willem Frijhoff & Maarten Prak (ed.), *Geschiedenis van Amsterdam. Zelfbewuste stadstaat 1650-1813*, II-II (Amsterdam 2005) 21-88, especially, 21.

sluices. Finally, Elias Sandra came up with a plan to supply the city with clean drinking water. In this section, all three problems, Hudde's solutions, and the extent to which they were successful are discussed.

To stress the urgency of Amsterdam's water management, we must take into account the economic situation around the Disaster Year (1672) as the subsequent Third Anglo-Dutch War (1672-1674). These events caused a long-term recession and therefore had a significant impact on the city works in Amsterdam. On May 30th, 1673, the treasurers and the mayors decided to stop all the public works. Only the construction of the *Amstelsluizen* (the lock system in the Amstel) continued.[471] The locks (now in front of the Carré Royal Theatre) were installed to stimulate the circulation of water from the river IJ and created the demarcation between the canals within and outside the city. In 1670 the first design for the *Amstelsluizen* was presented to the city council, stating that two sufficient locks had to be constructed. The council committee was made up of Hudde, Cornelis de Vlaming van Oudshoorn (1613-1688), and Gerard Hasselaar (1621-1673), who had to provide the city council with advice on the matter. Nevertheless, Hudde was primarily responsible for urging the construction of the locks.[472]

The commission expected that through the lock system, designed by city architect Daniël Stalpaert (1615-1676), they could artificially control the water level in the city.[473] Stalpaert, who in 1653 wrote a treatise on improving water quality and water supply, is known for the fourth urban expansion, 's Lands Zeemagezijn (now the Dutch Maritime Museum), the warehouse of the VOC at Oostenburg, the Portuguese Synagogue, the Oosterkerk, various city gates, and the completion of the town hall on Dam Square.[474] Therefore, it was not a coincidence that Hudde worked with this respected architect and expert on the city's infrastructure to complete this project.

Furthermore, the forth urban expansion meant that more people could reside in the city, and therefore pollution increased and strength of the current in the river Amstel decreased. This was due to the fact that the waters of the Amstel were diffused in a significantly widely branching system of canals spread throughout the city, with the result that the current was too weak to drain the canals.[475] Instead of using mill dewatering to stimulate the current, Hudde argued for tidal flow to flush the city waters, which was less labour-intensive and not dependent on wind and/or cattle.[476]

Their idea was that by opening the Nieuwmarktsluis, Beurssluis, Rapenburgsluis and the sluice in the Hoogte Kadijk, during high tide they could flush water from the IJ into the city, which

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471 SA, Archief Thesaurier en Ordinaris [5039], inv. nr. 149 (30 May 1673).

472 Ibidem, Archief van de Vroedschap: resoluties met munimenten of bijlagen [5025], inv. nr. 27, fol. 73 (31 October 1670). Ibidem, Archief Thesaurier en Ordinaris [5039], inv. nr. 5, fol. 95 (10 October 1672).

473 Ibidem, inv. nr. 532: Map with the second design of the Amstelsluizen by Daniel Stalpaert (29 April 1672).

474 A.W. Weissman,'Daniel Stalpaert', in: *Oud Holland*, vol. 29, no. 1 (1991) 65-85.

475 Tobias van Dommelaer to Daniël Stalpaert, *Afbeelding der stat Amsterdam: met haar laetste Vergrooting. In den Jare 1665. Getekent- en uytgegeven door Daniel Stalpaert Architect dezer steede Amsterdam*, 1665, Marcus Willemsz. Doornik, Stadsarchief Amsterdam.

476 SA, Archief van de Vroedschap: resoluties met munimenten of bijlagen [5025], inv. nr. 27, fol. 73 (31 October 1670). Ibidem, Archief Thesaurier en Ordinaris [5039], inv. nr. 4, (Resolution 26 April 1670) fol. 108.

could be drained during low tide through the Eenhoornsluis, Kolksluis, Anthonissluis, and both Haarlemmer locks.[477] However, there was a hard condition that drainage of brackish water on the Amstel should be prevented.[478] The Amstelland was used as grassland where cattle could graze. Salinization of this area could result in significant damage to the land and farmers because the land would become less valuable and the price of dairy would increase.[479] To prevent salinization in the Amstel, Hudde ordered the greatest waterworks that was ever built in the Republic: the *Amstelsluizen*.

Through the construction of the *Amstelsluizen*, the Rapenburgersluis, and the lock in the Hoogte Kadijk, Hudde expected that he could keep the water in the city at one artificial level.[480] Therefore, the eight indoor locks would not be necessary to transport ships from water level to another. Therefore, not only would one artificial water level stimulate the circulation of water through a rise in the canal water that could be drained into the IJ, it would also stimulate the transportation of ships. All these results of the construction of the *Amstelsluizen* would stimulate the economy. Fish would return to the Single canal because there would be no more brackish water in the Amstel. The real estate on the canals would increase in value without the odour nuisance, and more people would come to Amsterdam, which would lead to more 'consumption and prosperity'.[481]

Hudde's report on the locks was received and approved by the city council on November 26, 1670 with the estimated cost of 151,000 guilders.[482] No time was wasted, and the next day the treasurers ordered the preparations for the construction to begin.[483] In the spring, the Amstel was partially dammed, and on June 15, 1671 the treasurers ordered the masons to start with ramming the poles for the foundation.[484] In September 1671, more men were hired to finish the job. However, plans for the construction of the locks kept changing. On April 29, 1672 Stalpaert's last design was implemented.[485] Two months later, the Republic was plagued by the invasion of the French. All the work on city constructions stopped in June, except on fortification.[486]

By flooding the polders around the city, Amsterdam succeeded in averting the danger. However, the water level rose significantly, but the dam that was used for the construction of the locks protected the city from excess water.[487] The work was quickly resumed, and October 10, 1672, city architect Stalpaert, city carpenter Van Petersom, and city mason Crabbendam were summoned to

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477 Ibidem, Archief van de Vroedschap: resoluties met munimenten of bijlagen [5025], inv. nr. 27, fol. 73-81 (26 November 1670); SA, Handschriften [5059], inv. nr. 27 (Collection Bontemantel).

478 Ibidem, Archief Thesaurieren Ordinaris [5039], inv. nr. 4, (Resolution 3 March 1670) fol. 100.

479 Ibidem, Archief van de Burgemeesters: dagelijkse notulen, resoluties en missivenboeken [5024], inv. nr. 20, (Resolution 11 December 1675) fol. 49-52.

480 Ibidem, Archief van Burgemeesters: stukken betreffende verscheidene onderwerpen [5028], inv.nr. 604 (17 June 1676).

481 Pierre de la Jolle, *Description de la ville d'Amsterdam en vers burlesques* (Amsterdam 1666).

482 SA, Archief van de Vroedschap: resoluties met munimenten of bijlagen [5025], inv. nr. 27, (26 November 1670). fol. 73-81.

483 Ibidem, Archief Thesaurieren Ordinaris [5039], inv. nr. 4, (Resolution 27 November 1670) fol. 134.

484 Ibidem, (Resolution 15 June 1671) fol. 172.

485 Ibidem, inv. nr. 5, (Resolution 29 April 1672) fol. 28.

486 Ibidem, (Resolution 10 June 1672) fol. 40.

487 Ibidem, Archief van de Vroedschap: resoluties met munimenten of bijlagen [5025], inv. nr. 28, (6 August 1672). fol. 212. Ibidem, Archief Thesaurieren Ordinaris [5039], inv. nr. 5, (Resolution 6 September 1672) fol. 88.

Hudde's home to discuss the completion of the project.[488] The bricklaying had to be completed up to at least the waterline, so that the project could be finished in 1674.[489]

When the *Amstelsluizen* were complete, Hudde assigned Cornelis van der Heijden as 'Overseer of fortifications and locks'.[490] His task was to measure and make notes about the results of the *Amstelsluizen* in order to improve the system. Although complete and operational, the construction did not provide the results Hudde was hoping for. Furthermore, he did not even accomplish one of the goals.[491] To control the water level, Hudde placed measuring stones at different locations in the city, the positions of which were carefully measured out. Nevertheless, he could not bring the city to one water level without flooding the cellars of houses on the lower sides of the city. Therefore, the eight indoor locks could not be abolished and the circulation of water hardly improved.[492]

An alternative solution presented itself for controlling water quality and quantity after the dyke breach on 1 November 1675. The water level in the Amstelland increased, and the drainage of excess water could take months. The *Amstelsluizen* were closed, like the indoor locks, to keep surplus water out of the city. Although this was catastrophic for trade, just after the Rampjaar and the Angelo-Dutch War, water was leaking into the city. According to the city architect and carpenter, only the installation of horse mills, based on Hudde's design, could drain the water to the recently enlarged 'black basin' (*zwarte boezem*).[493]

The three horse mills after Hudde's design with the patented paddle wheel by Van der Heijden, would, according to Hudde's calculations, have enough capacity for the drainage of surplus city water to the Amstelland when the water in the IJ rose too much.[494] Moreover, these mills would succeed in achieving one water level in Amsterdam, with a significant reduction in costs as a result.[495] The mills had to be ready in the winter of 1675, so that the flooded farmlands in Amstelland could be drained in the summer of 1676.[496] In January 1676, horses were bought and the mills were operated.[497] Although the danger of surplus water was averted, again the water quality hardly improved. In 1682, a commission 'to oversee the waters and canals' was appointed to improve the lock system and the quality of the water. Eight months later, on 19 November 1682, an extensive report was presented and discussed by the treasurers.[498]

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488 Ibidem, (Resolution 10 October 1672) fol. 95. See also: Ibidem, (Resolution 12 October 1672) fol. 95-96.

489 Ibidem.

490 Ibidem, Archief Thesaurieren Ordinaris [5039], inv. nr. 6, (Resolution 24 November 1674) fol. 64.

491 Ibidem, Archief van Burgemeesters: stukken betreffende verscheidene onderwerpen [5028], inv. nr. 605 (*Berigt* 19 August 1681). For more information: Ibidem, inv. nr. 604.

492 Ibidem, Archief Thesaurieren Ordinaris [5039], inv. nr. 7, (Resolution 19 November 1682) fol. 70-78.

493 Ibidem, Archief familie Bicker en aanverwante families [195], inv. nr. 827, fol. 80-95. See also: J.H. van den Hoek Ostende, 'Rosmolens in Amsterdam, 1519-1919', *Jaarboek van het genootschap Amstelodamum* (1981) 10-24.

494 SA, Archief Thesaurieren Ordinaris [5039], inv. nr. 144 (15 January 1671). See also Huygens, *Oeuvres*, XXII, appendix 5.

495 SA, Archief familie Bicker en aanverwante families [195], inv. nr. 827.

496 Ibidem, Archief Thesaurieren Ordinaris [5039], inv. nr. 6, fol. 63 (19 November 1675).

497 Ibidem inv. nr. 6, (10 January 1676) fol. 68. Ibidem, (23 January 1676) fol. 70.

498 Ibidem inv. nr. 7, (19 November 1682) fol. 70-78.

However, no new ideas were presented. Most of it had already been done or was unachievable. Only a slight adjustment in the locks that flushed or drained water was made, together with an order for two more horse mills. Only the most logical solutions provided some solace: dredging the canals and reducing the amount of dumped waste.[499] Besides these measures, Hudde kept trying to optimise his lock complex together with Cornelis van der Heijden, and later with his successor Michiel Muiden, which resulted in the report *Afteikening* (1687-1688).[500] Nevertheless, Hudde never achieved his goal of creating his ideal single water line in the city, which is represented by the 'Hudde stones' (*Hudde stenen*) in the city's quays. The lockkeepers remained undisciplined and the rules were not maintained.[501] Ironically, barely two decades after his death, it seems that the indoor locks were abolished.[502]

Since the water quality could not be significantly improved, new ideas were developed to supply the city with drinking water that would be more efficient than the use of water barges to bring fresh water into the city. One of these ideas was presented in 1682 by Elias Sandra, who regularly visited Hudde's residence. Sandra presented Hudde with his Vechtwaterplan, which consisted of three proposals to provide the city with drinking water from the river Vecht.[503] The first and best proposal was the construction of a canal with freshwater basins south of the Rapenburgergracht.[504] The other two proposals concerned an aqueduct or water pipe, which were both unrealizable, according to Hudde.[505]

Hudde's objections to Sandra's plan are included in his edition of the plan from 1684. His six objections for the canal were as follows. 1. Patents from the States of Holland and West Friesland would be required. 2. It would not be easy convince the board of Weesp that they should allow a new canal on behalf of Amsterdam. 3. The people in and surrounding Weesp would protest. 4. The ground is not suitable. 5. The cost will be more than 800,000 guilders. Finally, the municipality did not have enough credit the support such a grand-scale project.[506] Although Sandra provided Hudde with solutions for all his objections, it seems that Hudde still did not support the plan. The water barges remained active in their role to supply the city with drinking water. It was only in 1861 that a feasible

499 Ibidem, inv. nr. 7, (Resolution 19 July 1684) fol. 121. Ibidem, inv. nr. 7, (Resolution 22 May 1685) fol. 149-154.

500 Ibidem, inv. nr. 8, (Resolution 30 June 1688) fol. 30.

501 Ibidem, (Resolution 23 April 1689).

502 Danielle de Loches Rambonnet, 'De watercirculatie in het 18de-eeuwse Amsterdam', in: *Caert-Thresoor*, vol. 12, no. 1 (1993) 17-20, especially, 18.

503 Elias Sandra, *Ontwerp en beschrijvinge om het soet water uyt de riviere de Vegt op driederley wijse te brengen binnen de stad Amsterdam, en vervolgens door de gehele Stad, om yder Huys met SOET en vars water te voorsien, mitsgaders fonteynen te maken, daar men 't begeerd. Als mede om het zoet vars Water te vinden op de vaste grond van een gedeelte van het Muyder-zand, daer de stad op legt, en te halen tusschen de Stadts Kruyt-Tuyn en Rapenburger-Graft aen de Nieuwe heeregraft* (Amsterdam 1684).

504 A similar design was developed in 1688 by Jan de Bray (1627-1697) see: SA, Archief Thesaurieren Ordinaris [5039], inv. nr. 799, fol. 1, 5.

505 Sandra, *Ontwerp en beschrijvinge*, 4-43.

506 Ibidem, *Ontwerpen om de stad van zoet water te voorzien in de XVII eeuw* (Amsterdam/The Hague 1841) 67.

plan was presented by Christaan Dirk Vaillant: the construction of a water pipe for the transport of water from the Kennemer dunes.[507]

Although Hudde worked hard on improving water quality, he was hardly successful. He calculated every aspect of his complex lock system with the help of the city masters, but the odour nuisance remained.[508] Nevertheless, to a certain extent, he succeeded in providing a solution to control water quantity with the construction of several locks, and most important the *Amstelsluizen*. Together with his design for the horse mills and the *scheprad* of Van der Heijden, Hudde succeeded in draining redundant water from the city and protecting it from floods.

With hindsight, it is understandable that Hudde did not succeeded in his plan, first of all due to the recession after the Disaster Year and the lack of technical inventions such as the steam engine. According to the calculation of Cornelis van der Heijden for example, it appears that only 20% of the water was refreshed through Hudde's lock system. Therefore, the brackish water remained just outside the sea locks due to the lack of a strong current. Moreover, parts of the city that were further removed from the sea locks were hardly refreshed at all.[509] Moreover, Hudde's system of improving the quality of water was based on the idea of flushing the canals with water from the river IJ and the Zuiderzee that entered the city during high tide and was flushed away during low tide. However, salt water has a higher density than the water from the Amstel river, of which the river IJ was the estuary. Therefore, during the flushing of the canals with salt water, the polluted fresh water was pushed to the surface because the salt water sank underneath it. With the lack of strong currents in the canals, the Amstel, and the IJ, the rivers could not efficiently be flushed through a system of locks. Only with the invention of the steam engine and the pumping station at Zeeburg (1879) was the problem finally solved. Now there was enough power to create a stronger current, which was technically unrealizable in Hudde's time, as he only had horse and wind mills at his disposal.

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507 J.A. Groen, *Een cent per emmer. Het Amsterdamse drinkwater door de eeuwen heen* (Amsterdam 1978) 52-55.

508 SA, Archief van het Stadsfabriekambt en Stadswerken en Stadsgebouwen [5040], inv. nr. 13 (Johannes Hudde, 'Afteikeningen en eenige vastelling van de houte beertjens, sluitbinten, sluisjes en molens diende tot zuiveren van de stadtswateren, anno 1687 en 1688').

509 Ibidem, Archief van Burgemeesters: stukken betreffende verscheidene onderwerpen [5028], inv. nr. 605.

Chapter 9
Hudde as a director of the VOC

The distillation of seawater into drinking water

Not only as a mayor, but also as a director of the VOC, Hudde worked as an engineer and advisor on water projects. The matter of distillation is one of the projects that are described in Pieter van Dam's *Beschryvinge*, which is concerned with the project of distilling salt water into drinking water onboard VOC vessels.[510] Hudde was both interested and involved in this project because distilling water onboard would reduce sickness and death and the danger of searching for drinking water in hostile territories.[511] The project was the result of a patent application in 1689 by a certain Christiaen Neutwich, 'creditor and merchant in the city of Amsterdam', who discovered a method to extract 'fresh water and white salt' from seawater. His patent for this distilling machine was approved on August 1692 by the States of Holland, after they received a consenting statement from the directors of the Chamber of Amsterdam, namely Hudde.[512]

Neutwich's proposal concerned a *water-werker* which was equipped with a copper still and a pump designed by Christiaen Hartman to pump up salt water.[513] The salty water was boiled and evaporated as steam, whereby the salt would remain in the still. The steam was captured and condensed into drinking water. Moreover, the stills were placed in the galley between the cooking pots, so that his invention would only use a minimum amount of fuel.[514]

Neutwich was not the first inventor who presented a proposal with the promise of converting salt water into drinking water onboard a ship. Several earlier projects had failed, for example that of the medical officer of the Chamber of Amsterdam, Dr. Aegidius Snoeck, the father-in-law of Hans Bontemantel.[515] The Chamber became sceptical of the proposals, through which not only was the distillation system put on trial, but also the quality of Neutwich's distilled water through a full-scale investigation from 1690-1691 onboard a ship. Such a trial was needed because the distilled water had

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510 Pieter van Dam, *Beschryvinge van de Oostindische Compagnie*, published by F.W. Stapel, vols. I-IV (1927-1954).

511 NA, Archief Johannes Hudde [1.10.48], inv. nr. 24 (Resolutio 13 July 1695), fol. 12.

512 Doorman, *Octrooien*, 253, 324, 307: patent G-543 (18 August 1692), U-10 (7 February 1693), H-212 (Extension April 1707).

513 Ibidem, 240, 298: patent G-503 (15 January 1672), H-123 (June 1672).

514 Van Dam, *Beschryvinge*, I-I (1627) 409-410. Ibidem, I-II (1929) 673-674. Doorman, *Octrooien*, 240, 298: patent G-503 (15 January 1672), H-123 (June 1672).

515 Elias, *Vroedschap van Amsterdam* I, 96-97.

to improve the welfare of the sailors and reduce the costs of omission, without entailing significant costs for the equipment itself.[516]

After a year, the trial was considered a success, since the quality of the water was significantly better than the water that was brought onboard in barrels. Hudde, therefore, saw potential in Neutwich's invention and continued his research on the matter. The VOC was familiar with the fact that sickness and mortality rates were high on voyages to the East. The directors stated that this was the result of setbacks at sea, together with a lack of fresh water and food.[517] Moreover, food supplies were often of poor quality, and alcoholic beverages such as beer and brandy were preferred over water. This was not conducive for the sailors' health, although they were easier to preserve.[518]

As a consequence of the positive result of the first trial, Hudde extended the trial period for Neutwich's invention for another three years to study the efficiency of the stills in comparison with disease and mortality rates. From 1691 to 1694, Hudde analysed the 88 voyages between the Dutch Republic and Cape of Good Hope. Of the 88 voyages, 31 were undertaken with onboard distillation systems, the results of which were positive. Of the ships without a distillation system 13.25% of the sailors died and $17\frac{2}{3}$ % arrived ill, while on the ships with distillation 9.5% died and 15% arrived ill, a reduction of more than 28% and 15% respectively.[519]

Nevertheless, there was some criticism of the *water-werkers* (distilling machines). Although this was mainly concerning the efficiency of the system, some claimed that water distilled in copper stills could be unhealthy. This was refuted with the fact that brandy; a malt wine was, also distilled in copper stills. Furthermore, physicians claimed that the medicinal power of the spring water in Aachen was due to the presence of copper.[520] The benefits seemed to outweigh the disadvantages, and moreover, the copper would preserve its value, which reduced the expenses.[521] This resulted in the implementation of copper stills onboard VOC vessels, at the cost of 140 guilders per ship. This was at total of 4,340 guilders for 31 vessels, which was a good investment compared to the expenses of death and disease.[522]

With mathematical precision, Hudde calculated the expenses of the sailors who died, the required wood as fuel for the stills, the amount of space the equipment and the fuel would occupy, and the other expenses.[523] Hudde's calculation lead to a more efficient use of space onboard the ships, since significantly less water had to be taken onboard at departure, as it could be freshly distilled at any time. Moreover, the still reduced the risks during the voyage, since the crews did not have to search for drinking water in hostile territories when they had a setback, for example. Due to its

516 NA, Archief Johannes Hudde [1.10.48], inv. nr. 24 (Resolution 13 July 1695), fol. 12.
517 Ibidem. fol. 1.
518 Ibidem, fol. 3.
519 Ibidem (Resolution 13 July 1695).
520 Ibidem, fol. 11-12. Mac Lean, 'De nagelaten papieren', 147-148.
521 NA, Archief Johannes Hudde [1.10.48], inv. nr. 24, fol. 12, 14-15.
522 Ibidem, fol. 15.
523 Ibidem, fol. 14-16.

reduction in travel time, risks, and expenses, Neutwhich's proposal was approved. The *water-werkers* were ordered, sailors were trained to use them, and from 1691 onwards, the first ships with copper stills on board sailed to the East. However, the measure was revoked in 1707, shortly after Hudde's death, since the firewood for the still took up too much space for the return journey from Java to the Republic, at the expense of the marketable cargo.[524]

The construction of a marine clock with Christiaan Huygens

A second project Hudde worked on as a director of the VOC was the development of a marine clock with Christiaan Huygens. Huygens had been working on the project of making a pendulum clock since 1656, and constructed the first timekeeper specifically intended for the purpose of finding longitude at sea in the year 1662.[525] However, Huygens did not succeed in constructing an accurate marine clock and receiving the price of 25,000 guilders, rewarded by the States-General, for solving the problem of finding longitude at sea.[526] Nevertheless, when Hudde opened the meeting with the directors of the company in February 1684, they showed great interest in the project, because of the possibility to calculate longitudes at sea. Huygens states that his mobile clock should work for a full day 'without an error'.[527] Johannes van Ceulen, who worked out the design, was contacted, and the directors asked Hudde to contact Huygens for the further development of the marine clock.[528]

A year later, in 1685, Hudde asked Huygens to test the marine clock at sea.[529] Three months later, in December, a marine clock was send to the Cape of Good Hope onboard the Huis te Zilverstein and returned on the ship Het wapen van Alckmaer. Two supervisors executed the trial with strict instructions.[530] After the test phase, Huygens reported that the marine clock had not functioned according to his expectations.[531] The report was quite comprehensive because of 'the new consideration that the rotation of the Earth has influence on the pendulums'.[532] Huygens referred here to 'what has recently been written by professor Newton, in his book named *Philosophiae Natueralis*

524 See also: *Instructie en Informatie voor Water-werkers* (Amsterdam 1695). *Informatie ofte Onderrechtinge voor de Water-Werkers* (Amsterdam 1695).

525 Michael S. Mahoney, 'Christiaan Huygens: The measurement of time and longitude at sea', in: H.J.M. Bos (ed.), *Studies on Christiaan Huygens. Invited Papers from the Symposium on the Life and Work of Christiaan Huygens, Amsterdam 22-25 August 1979* (Lisse 1980) 234-270, especially 252. Vermij, *Christiaan Huygens*, 53.

526 Vermij, *Christiaan Huygens*, 57.

527 NA, Archief Johannes Hudde [1.10.48], inv. nr. 44 (Resolution 31 December 1682). See also: Alfons van der Kraan, 'The Dutch East India Company, Christiaan Huygens and the Marine Clock, 1682-95', *Prometheus*, vol. 19, no. 4 (2001) 279-298.

528 Ibidem (Resolution 28 February 1684).

529 Johannes Hudde to Christiaan Huygens, 3 September 1685, in: Huygens, *Oeuvres*, IX, nr. 2396. See also: Christiaan Huygens to Constantijn Huygens Sr, 9 September 1685, in: idem, nr. 2398. See also: NA, Archief Johannes Hudde [1.10.48], inv. nr. 44 (Resolution 30 August 1685).

530 Christiaan Huygens to Johannes Hudde, 26 October 1685, in: Huygens, *Oeuvres*, IX, nr. 2407. Christiaan Huygens to Thomas Helder, 1686, in: ibidem, nr. 2520. Christiaan Huygens to Abraham de Graaff, 24 April 1688, in: idem, nr. 2516. NA, Archief VOC [1.04.02], inv. nr. 5342, fol. 5, 75.

531 See for the extended report, Christiaan Huygens to the directors of the VOC, 24 April 1688, in: Huygens, *Oeuvres*, IX, nr. 2519.

532 Christiaan Huygens to Johannes Hudde, 24 April 1688, in: ibidem, nr. 2517.

Principia Mathematica'. In his accompanying letter, Hudde wrote to Huygens that 'when the marine clock was sent back to sea, some improvements have to be made'.[533] In his answer on 30 April 1688 Hudde wrote that he himself had no time to 'examine everything' concerning the clock.[534] After a conversation with Hudde in May 1689, Huygens agreed with him that concerning his clock, he would report everything to VOC Director Salomon van de Blocquery (1641-1701). Also, the professor from Leiden De Volder, was hired to examine the development and all the findings.[535]

On the second sea trial on a journey to the Cape of Good Hope and Batavia in the years 1690-1691, Hudde no longer formally worked on the project. However, this did not stop Huygens from sending Hudde a copy of his work on the cause of gravity: the *Discourse de la cause de la pesanteur*, included as an appendix to his *Traité de la lumière*. He did this out of the conviction that Hudde worked on 'important matters, with which the peace and well-being of the homeland is concerned'.[536] Huygens also met Hudde occasionally for his project concerning the marine clock, about which Hudde expressed his preference not to test the clock only on the way to the Cape, but also on a further journey to Batavia.[537] Huygens' last direct message to Hudde dates from the end of 1690. The VOC vessel the Brandenburgh was ready to sail to Batavia with an improved clock, accompanied by three supervisors, among which was the young mathematician Johannes de Graaff, who was also on board during the first trial.[538]

In 1692, after the return of the clocks, is seemed again that the trial did not go according to their expectations.[539] At first, Huygens shared De Graaff's opinion that the method of finding longitudes was unsuccessful. However, a further analysis of the returning journals made him more optimistic.[540] According to Huygens, on their voyage home, the clocks were hung up incorrectly, and therefore, the swing of the pendulums was irregular. Huygens provided the evidence for this to De Volder, who Huygens believed would confirm his conclusions. However, although the design could be perfected to create a better clock, in the meantime Huygens had discovered something that eliminated all the previous difficulties. Huygens stated to the directors that he would reveal his new invention to Hudde, but only under the precondition of secrecy. If Hudde concluded that Huygens' new design was a significant improvement on the previous design, then the secret was revealed. However, if Hudde did not see the potential in Huygens' new design, the invention would remain secret.[541]

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533 Ibidem.

534 Johannes Hudde to Christiaan Huygens, 30 April 1688, in: ibidem, nr. 2521.

535 Christiaan Huygens to Johannes Hudde, 25 May 1689, in: ibidem, nr. 2539. See also: NA, Archive Johannes Hudde [1.10.48], inv. nr. 44 (Burchard de Volder to Johannes Hudde, 22 July 1689).

536 Christiaan Huygens to Johannes Hudde, 11 February 1690, in: ibidem, nr. 2562.

537 Christiaan Huygens to Johannes de Graaff, 28 September 1690, in: ibidem, nr. 2621.

538 Christiaan Huygens to Johannes Hudde, 14 December 1690, in: ibidem, nr. 2642. See also: NA, Archief VOC [1.04.02], inv. nr. 5375, fol. 3, 41 en 42.

539 Salomon van de Blocquery to Christiaan Huygens, 16 November 1692, in: ibidem, nr. 2773.

540 Christiaan Huygens to the directors of the VOC, 6 March 1693, in: ibidem, nr. 2796. See also: Christiaan Huygens to Salomon van de Blocquery, 6 March 1693, in: ibidem, nr. 2795.

541 Ibidem. See also: Christiaan Huygens to Burchard de Volder, 24 March 1693, in: ibidem, nr. 2798

Hudde's reaction has not been handed down to historians today. However, it is clear that there were no more VOC-subsidised trials for a marine clock. The fact that De Volder's findings were not as positive as Huygens hoped for likely contributed to the matter.[542] Hudde's silence towards Huygens seems significant in this regard. For Huygens, there were no other options than to accept that he would not receive the VOC premium. His idea for a 'balancier marin parfait' would in the end be published in Paris in 1735.[543]

A company history at last

At the end of Hudde's career as a president and member of the VOC, he left behind the initiative for a piece of work designed to prevent the directors from making mistakes. In July 1693, at the age of 65, he was once more present at the meeting of the Chambers of Amsterdam and gave a powerful speech in which he urged the necessity of writing a comprehensive history of the VOC.[544] After the directors deliberated after the meeting, they agreed unanimously with Hudde's plan.[545] Using similar words to Hudde's speech, the directors assigned secretary Pieter van Dam (1621-1706) the task of writing a complete history of the VOC.

The members of the *Heeren XVII* (the directors), asked Van Dam to write a 'pertinent and accurate description of the company's constitution, government, and trade from its birth to the present … such a work would be of great value for studying the company. After all, on a daily basis, mistakes are made through ignorance of the company's history'.[546] Writing such an overview of the company would offer solutions and insight into past matters. The board could learn from earlier mistakes and operate more efficiently by consulting this manual in difficult matters. This last point was the most important, according to Van Dam. Multiple times, he had seen that the board's change in method was more disadvantageous than profitable.[547]

The decree of the *Heeren XVII* to write a history of the company was the fulfilment Hudde's dream. As a member of the commission, 'cost reduction of company matters, here and in the Indies' was one of Hudde's primary tasks to reorganise the company structure.[548] The commission, which was founded in 1683, consisted of Hudde, Munter, Van Maerseveen, Van Beuningen, Van de Capelle, Van Posbroeck, Becker, Van de Blockquery, De Vries, Decker, and Timminick, with the assistance of Van Dam and the former governor-general Rijckloff van Goens. Their task was to search for mistakes and problems in the company, together with a reduction of VOC employers.[549]

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542 Burchard de Volder to Christiaan Huygens, 6 April 1693, in: ibidem, nr. 2800; Christiaan Huygens to Burchard de Volder, 19 April 1693, in: ibidem, nr. 2802.

543 See also: Christiaan Huygens, *Oeuvres Complètes*, vol. XVIII (The Hague 1934).

544 Van Dam, *Beschryvinge*, I-I, ix-xii.

545 Ibidem.

546 Ibidem, ix. For more information: NA, Archief Johannes Hudde [1.10.48], inv. nr. 3-5.

547 Van Dam, *Beschryvinge*, I-I, ix.

548 Ibidem, x.

549 Ibidem, x-xi.

Hudde, who took his task seriously, pointed his attention first to what is now Indonesia. He noted the 'extraordinary governance and almost total disorder and corruption in the board's business in the East Indies'.[550] As a result, the committee investigated the matter to find more 'errors, abuses, and disorder'.[551] In particular they focussed on redundant positions that could be eliminated so that the VOC could be governed more directly and therefore more efficiently.[552] Hudde already had some experience with the restructuring of government and finance management through his work as mayor of Amsterdam and his plan for the significant cutting of city expenses in 1679.[553]

Together with (mostly) Van Beuningen, Van de Blocquery, Van Dam, and the former governor-general Rijckloff van Goens, Hudde worked towards an efficient and healthy organisation. However, he noticed that a proper evaluation of the company and its methods was impossible without knowledge of its history. Therefore, he wrote a piece titled 'A Brief Memory', in which he explained his ideas for a company history.[554] This piece is divided into fifteen chapters, each of which discusses an aspect of the company in both the Dutch Republic and the Indies, which was likely a stepping stone for Van Dam's work.

After ten years in the committee of redress, Hudde resigned as director of the company, but did not leave before his speech in 1693. For nearly eight years, Van Dam worked on this project, due to which he was released of most of his obligations as secretary of the company. In March 1701, the comprehensive work *Beschryvinge van de Oostindische Compagnie* was handed over to the directors of the *Heeren XVII*, which they could use to administer the company more efficiently.[555]

This confirms that Hudde was a pragmatist who always looked for sustainable solutions for the 'greater good'. However, his insistence on a company history occurred at the end of his career. During his work as a company director, he was consulted in various matters that remain mostly unexplored. In the National Archives in The Hague, there is enough material to write a book on Hudde's work as a company director. Although we have seen only the tip of the iceberg, future investigation could provide new insights in the operation and efficiency of the VOC.

550 Ibidem, x.
551 Ibidem.
552 Ibidem.
553 Knegtmans, *Amsterdam*, 168.
554 Van Dam, *Beschryvinge*, I-I, xxxiv-xxxviii.
555 Ibidem, ix-xii.

Conclusion

Johannes Hudde caught my attention in the spring of 2017 when I investigated print culture in seventeenth-century Amsterdam, with a strong focus on the printer Jan Rieuwertsz. To my surprise, last year I got the impression that, behind the scenes, Hudde, as a public administrator, made it possible for of the most controversial books of the seventeenth century to circulate freely for four years. Even after the *Tractatus* was forbidden, when Hudde was president-mayor, the ecclesiastical authorities complained that the book was still available. This made me wonder: who was Hudde? After concluding that the historiography on him was scarce, I attended a symposium on Hudde organised by the National Library of the Netherlands in June of the same year. What I expected was confirmed: Hudde was a renowned scholar in his own time, but is currently almost forgotten. With the help of scholars who presented at the symposium, and especially Huib Zuidervaart, I tried to find an answer to my pressing question: who was Hudde as a natural philosopher, and how can we characterize him as a versatile scientist, regent and director of the VOC?

Although various aspects of his life have been discussed in the nine chapters, this work has surely raised more questions than answers. This conclusion will be a re-evaluation of Hudde as what we would today call an interdisciplinary scholar, mayor, and company director in one of the most dynamic periods in Dutch history. Although further research is required, I shall attempt to connect Hudde with the wider currents that shaped the second half of the seventeenth century. This results in an overview of the extent to which Hudde was on the one hand unique and progressive, and on the other hand, part of a general tendency. Furthermore, I shall give some suggestions for further research and the aspects I have not addressed.

Hudde was raised and educated in the flourishing Golden Age of the Dutch Republic imbedded in a strong network connected to other towns in Holland. His grandfather and father belonged to Amsterdam's elite and worked in overseas trade. This provided Hudde with a luxurious position as the youngest of three sons. His brother Henrick succeeded their father as regent of Amsterdam, which left the door open for Jonas and Hudde to follow their own path. Unfortunately Jonas died early, and Hendrick moved to The Hague after resigning as member of the Amsterdam City Council to become councillor in the High Council. All this took place before Hudde sent Van Velthuysen a letter stating that he would devote himself to microscopy after he learned the foundations of medicine.[556] However, a year later, Hudde went on the Grand Tour, which was an integral part of one's education at the time. Hudde then moved to Amsterdam so that he could become regent seven years later. It is therefore not unlikely that Hudde had to abandon the natural sciences to succeed his father and brother as the only Hudde in the city magistrates. In that sense, he had to follow the social constraints of his time, and could not devote his life to research, as Huygens had done, for example.

[556] Hudde to Van Velthuysen, 13 October 1657, in: University Library of the University of Amsterdam, OTM: hs. D 29.

However, this made Hudde a highly educated scholar who occupied public office. Hudde had expertise in mathematics and the natural sciences, which made him desirable for the States-General, the States of Holland, and the city of Amsterdam, while the other governors and mayors of Amsterdam usually studied law.[557] This made Hudde (followed by his nephew Witsen) unique, and explains to a certain extent the professionalization of the Amsterdam municipality and the VOC.[558] Therefore, Hudde and Witsen did not only have the power through their office, but also the expertise to find sustainable solutions to improve the infrastructure, well-being, and safety of Amsterdam and the efficiency of technological innovations for the VOC. This led first to an improved form of street lighting, the first fire engine with a hose, and significant changes in the water management and infrastructure in Amsterdam. Second, it led to a distillation machine to make drinking water, a company history, and his work on the marine clock to calculate longitudes at sea.

Although Hudde had a significant role in all these developments, it is not easy to move from theory to practice. Hudde was aware of this, as I demonstrated in the sections on mathematics, lenses, and, to a certain extent, controversial publications. Like Huygens, both scholars, struggled with the relation between theory and practice in their work on lenses, light, and the marine clock.[559] In this respect, Hudde can best be characterised as a pragmatist who used theoretical knowledge in service of or to justify practical purposes. This is best demonstrated in Hudde's *Specilla*, in which Descartes' work on dioptrics is combined with the daily practices and technological shortcomings of the period that made lens grinders unable to grind aspherical lenses. Besides providing a theoretical solution, he also invented a practical solution. Instead of grinding microscope lenses, he melted them into small globules, resulting in a practical method to make high-quality lenses that was accessible for every interested person without the knowledge of an experienced lens grinder. Furthermore, he invented a practical method to solve high-degree equations without providing a conclusive proof. Later, he stated in a letter to Van Schooten that he did not want to keep arguing about theoretical questions, but instead wanted to serve the general interest of society.[560]

Although Hudde wanted to use his knowledge for the benefit of the greater good, there was some friction between what he had learned at Leiden University and what other people, such as non-Cartesians, believed that knowledge was. The struggle between Cartesian philosophy and the scholastic or Aristotelian worldview is an integral part of the society in which Hudde lived, as is discussed in the chapters on De Raeij, the pamphlet war, the question about the uniqueness of God, and the controversial works. Hudde was educated in Cartesian (natural) philosophy, and from his correspondence with Locke, we can conclude that he remained a Cartesian until his death.

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557 Wagenaar, *Amsterdam,* III, 303-304. See also: du Rieu, *Album Studiosorum*.
558 Ibidem, 503.
559 Dijksterhuis, *Lenses and waves*, 159-212. Vermij, *Christiaan Huygens*, 60-61, 134-136.
560 Hudde to Van Schooten, 1 December 1657 in: Huygens, *Oeuvres*, II, nr. 436.

Furthermore, this correspondence provides us with another insight into Hudde's life, the fact that Hudde had two faces: one in public and another in private. He was fully aware of what had been set into motion on the one hand in natural philosophy through Copernicus, Galileo, and Descartes and on the other hand in philology through Scaliger, Grotius, and Spinoza, which led to the authority of Scripture being eroded.[561] This resulted in a hardening of the Voetian orthodox theologians, who followed the scholastic tradition, as opposed to the Cocceians represented by Wittichius, Heidanus or Arminians like Van Limborch and LeClerc who to a certain extent embraced and defended the 'new' philosophy of Descartes. After witnessing the struggle of his professor against Voetius and his colleagues in Leiden, Hudde himself argued for the Cartesian cause by anonymously supporting Velthuysen in the pamphlet war against theologians such as Du Bois. Hudde's pamphlets represent his convictions and beliefs, but also demonstrate that he could not express his Cartesian worldview freely in public. This is due to the fact that it could bring his future carreer and his family in jeopardy, as happened with Velthuysen, who lost his position in the Utrecht municipality when William III came to power and Hudde was appointed mayor in 1672.[562] Further philosophical questions at the intersection of theology where discussed solely in utmost secrecy, to which his correspondence with Spinoza and Locke testify.

With our knowledge of his private convictions, Hudde's opinion of the ecclesiastical authority, belonging to the Voetian camp, expressed explicitly in his pamphlets and letters to Locke, as well with his policy concerning controversial works, it seems that behind the scenes, Hudde protected authors whose work was marked as 'controversial' by the church council. Since we have direct evidence of Hudde's standpoint in the cases of Léti and Bekker and after evaluating the procedures surrounding the publication of Spinoza's work, we can conclude that it is likely that he was also involved in the fact that under his rule, the *Tractatus* was able to circulate freely to a certain extent. Therefore, although Hudde could not publicly defend innovative and critical ideas, he did it surreptitiously. The fact that Hudde not only acted as a patron in the matter of controversial ideas is proven by case of the French *réfugie* Caze, who during his captivity worked on questions of natural philosohy and technology for Hudde and Witsen.

An unequivocal answer to the question of who Hudde was is impossible after witnessing the complexity of his character and his achievements. However, we could make a minor distinction between Hudde before 1667 and after he became member of the city council and held public office. During his 'academic' period, we could characterise Hudde as an eager scholar interested in the 'new' Cartesian philosophy who stood in a tradition of scholars such as Jan Swammerdam (1637-1680), Hartsoeker, De Raeij, Huygens, and De Witt.[563] However, besides studying disciplines such as

561 Van Miert, *The Emancipation of Biblical Philology*.

562 *NNBW*, lemma 'Lambertus van Veldhuyzen', IV, 1368-1370.

563 Swammerdam's disputation to receive the title of *doctor medicinae* was also inspired on the Cartesian natural philosophy. See: Jan Swammerdam, *Tractatus physico-anatomico-medicus de respiratione ususque pulmonum* (Leiden 1667).

philosophy, medicine, mathematics, and astronomy and practicing microscopy, he followed his teacher by defending the 'new' philosophy in public. Although he was trained in both applied sciences and theoretical sciences, he was restricted by the social constrictions of his time after his brother Jonas passed away and Hendrick moved to The Hague.

After succeeding other members of his family as regent of Amsterdam in 1667, and especially when he was appointed as mayor from 1672 onwards, we could characterise Hudde in his private life and behind the scenes as a critical free thinker, while in his public life he was a brilliant scholar, engineer, governor, and advisor. He made Amsterdam a role model in the areas of scientific and technological innovations that was followed within and outside Europe. Furthermore, he stimulated critical thinking in a tolerant intellectual climate, as long as the peace and safety of the society was guaranteed. Moreover, he served as director of the VOC, where he used his expertise in the natural sciences and public administration for the benefit of the company. To summarise the main aspects of his life, from 1672 onwards, and especially after 1680, Hudde was one of the most respected Dutch scholars, held the highest office in the city of Amsterdam, and was director of the largest company in the Republic. His influence was significant in the intellectual, political, and economic domains, which had a compelling impact on every level in the city of Amsterdam, and to a certain extent the Republic and the world in these three domains. This not only justifies further research on Hudde, but also stresses his unmistakable role in the final phase of the Dutch Golden Age. Therefore, Hudde can be considered characteristic of his time in all three domains, and compared with scholars such as Huygens or politicians like De Witt. However, what makes Hudde unique is that he operated in all three domains simultaneously, which is exactly the point that makes him so interesting.

Suggestions for further research are especially relevant in the domain of governance. Currently, some attention in the history of science is directed towards Hudde's scientific and technological merits. However, his policies as an Amsterdam magistrate have hardly been studied. Some examples are the following: first, how he operated as a mayor who was sympathetic to the Cartesian, Cocceian and Arminian camp, in contrast to the less liberal Voetian ecclesiastics.[564] Second, his relation with William III as respectively president-mayor of Amsterdam and *stadhouder* of Holland and king of England and Ireland.[565] Third, Hudde's relation with Michiel de Ruyter (1607-1676).[566] Forth, Hudde's role in several committees in Amsterdam, the States of Holland, and the VOC. Fifth, his role as director of the VOC and last, mapping his entire network of family, patronage, services, and friends. Through placing Hudde back on the research agenda, we could save him from oblivion and honour Thomas Arent's statement that 'Lord Hudde's name shall live until the end of times.'[567]

564 Van der Wall (ed.), *Een richtingstrijd*.
565 SA, Handschriften [5059], inv. nr. 47. Hell, '"Schatkist van den Staet"', 202.
566 Evenhuis, *Ook dat was Amsterdam*, III, 59.
567 Arents, *Mengel* poesy, 80. Jorink, 'In the Twilight Zone', 153.

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