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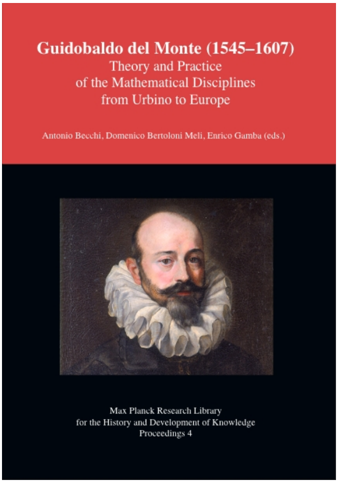

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Chapter 14
Court Mathematicians, Rosicrucians, and Engineering Experts: The German Translation of Guidobaldo del Monte's *Mechanicorum liber* by Daniel Mögling (1629)

Marcus Popplow

14.1 Introduction

In 1629, the renowned editor Matthaeus Merian published, in Frankfurt, the "first part" of the *Mechanische Kunst-Kammer* by Daniel Mögling.[1] The title of this book did not refer to a collection of real objects, but to a collection of intellectual gems: Mögling intended to present the best works on mechanics of his time to the German reader. As he explained in the preface, mechanics was a science oriented toward technical practice, and a means of explaining the functioning of all sorts of devices and instruments. According to Mögling, its study could serve to perfect daily technical practice in every art and craft.[2] With such an intention, Guidobaldo del Monte's (*Mechanicorum liber*), first published in Latin in (1577), and in an Italian translation in 1581, obviously represented a text of particular importance for Mögling and played a key role for his (*Mechanische Kunst-Kammer*).

Daniel Mögling was born 1596 in Böblingen, near Stuttgart, into a family of men of letters of various disciplines like philosophy, law, and medicine.[3] In this tradition, Mögling studied medicine at Tübingen and at Altdorf, near Nuremberg. From 1621 to 1635, he served Landgrave Philipp III of Hessen-Butzbach as court physician, astronomer and mathematician. Despite being situated right in the centre of the Holy Roman Empire, the small residential town of Butzbach remained unharmed by the numerous battlefields of the Thirty Years' War. In 1635 Mögling died in the course of a local outbreak of the pest. Like the location of

[1] See (Mögling 1629); digital version Dresden, Sächsische Landesbibliothek – Staats- und Universitätsbibliothek, http://digital.slub-dresden.de/ppn263770931. The book was edited by Merian, and printed by Röteln.

[2] This argument was often raised in the prefaces of contemporary works on machines and mechanics. For such contemporary interpretations of mechanical technology, see (Stöcklein 1969; Popplow 1998; Wolfe 2004).

[3] The most detailed and recent account of Mögling's life is (Neumann 1995).

his activities, also Daniel Mögling himself is not particularly known, especially among historians of science. However, he figures quite prominently in what appears at first sight as a completely different field, namely the beginnings of the Rosicrucian movement, which propagated the unification of different strains of Protestant belief, not least by proposing a culture of advanced learning with a special focus on the study of nature. Mögling supported these ideas by means of anonymously published texts in the years directly after the first major Rosicrucian treatises had been published in 1614, but later saw his own initiatives rather critically. Also in general, the clamour connected to this movement cooled down after 1620, as the outbreak of the Thirty Years' War did not leave much space for intellectually advanced reform movements.

In trying to do justice to both the "scientific" as well as to the "spiritual" aspect of Mögling's activities, the following essay will delineate the historical context of his early seventeenth-century German translation of Guidobaldo del Monte' treatise on mechanics. Special emphasis will be given to three aspects: Firstly, the role of the translation of Guidobaldo's treatise in Daniel Mögling's career. Secondly, the interest in mechanical technology in the above-mentioned circles of Protestant reform in Southern Germany of which Mögling formed part. And, thirdly, the relation of the mechanical theories as outlined in the *Mechanische Kunst-Kammer* to the practice of German engineers of this time.

Taken together, these aspects of the reception of Guidobaldo del Monte in Germany show how mechanical knowledge, in the early seventeenth century, travelled across Europe among densely connected personal networks. The most important institutional context in which mechanical thinking evolved in these times was early modern court culture, and not yet institutions like academies and universities. In this panorama, printed treatises, such as those by Guidobaldo del Monte and Daniel Mögling, only represent the "tip of the iceberg" of exchanges on early modern theories of mechanics.[4] This case study seeks to throw some light on the contexts out of which such formal results of mechanical thinking emerged.

14.2 The Translation of Guidobaldo's Treatise in the Context of Daniel Mögling's Career

For Daniel Mögling, as for many other mathematicians, natural philosophers and engineers, printing offered new possibilities to present oneself in public as an author of learned treatises. Given the intense competition between smaller and larger European courts, the act of publication raised the status of a scholar

[4]See for the development of early modern mechanics in Italy the contributions by J. Renn, W. R. Laird, W. Shea, D. Bertoloni Meli, and M. van Dyck in this volume.

with regard to future patronage as well as to the esteem among one's colleagues. Mögling, officially employed as physician and astronomer-mathematician at the court of the landgrave of Hessen-Butzbach, with a publication like the *Mechanische Kunst-Kammer*, fulfilled the expectations of a learned court very well. However, his work was more than only a superficial attempt to raise his personal prestige. The frontispice, in this regard, is somewhat misleading as it suggests that Mögling's publication was limited to a translation of Guidobaldo's treatise on mechanics alone, as only the latter's name is mentioned on the central panel of the title page (Figure 14.1). Still, in modern research, if it is mentioned at all, Mögling's book is often superficially commented upon as such a translation. Antonio Becchi, however, has recently drawn attention to the fact that Mögling's translation of Guidobaldo's work is followed by a translation of the (Pseudo-)Aristotelian *Mechanical problems*, based on the respective commentary by Bernardino Baldi published in Mainz a few years earlier in 1621.[5]

In addition, Mögling, on nearly forty pages preceding the translation of Guidobaldo del Monte's text, cited and discussed a series of passages from other authors as an introduction to the topic of the simple machines. They are listed here to give a first impression of the breadth of Mögling's reading. Nearly half of this thematic introduction is covered by considerations on the balance taken from Walter Ryff's *Von rechtem verstandt / Wag und gewicht*, which formed part of Ryff's compilation of texts on the relation of mathematics, mechanics, and architecture.[6] In this work from 1547, Ryff (or Rivius, c. 1500–1548), physician in Nuremberg and translator of various technical treatises into German, had provided, among others, passages from Luca Pacioli, Nikolaus of Kues, Niccolò Tartaglia, Oronce Finé, Sebastiano Serlio, and Gemma Frisius, supplemented with what were most probably his own comments (Jachmann 2006, 59–74). With this structure, Ryff's treatise might be perceived as a formal predecessor of Mögling's compilation, published about eighty years later. Next, Mögling briefly explained the notion of *centrum gravitatis*, explicitly referring, besides Guidobaldo's use of the term, to Pappus, Commandinus, and Valerius, and then went on to comment on a passage concerning the simple machines from Cardano's *De subtilitate*. Furthermore, Mögling translated from Latin a brief discussion of Johannes Kepler on different opinions of Cardano and Guidobaldo del Monte on a problem of the disequilibrium of a balance with equal arms. Finally, between Guidobaldo's preface and the beginning of the translation of the *Mechanicorum liber*, Mögling inserted an introduction to Euclid's *Elements*, in so far as he considered them as relevant for understanding Guidobaldo's text. As he explained, Euclid's theorems were

[5] See (Becchi 2004), in particular p. 62.

[6] See (Ryff 1547); digital version Dresden, Sächsische Landesbibliothek—Staats- und Universitätsbibliothek, http://digital.slub-dresden.de/ppn263566811/1.

not easily accessible in German, but were essential in helping artisans to understand the theory of mechanics.

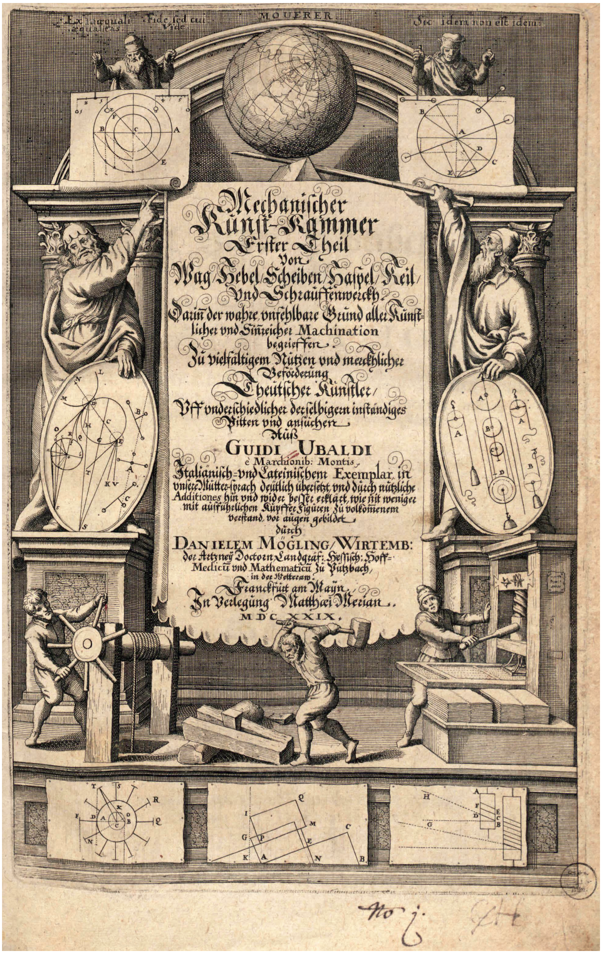


Figure 14.1: Title page of Daniel Mögling's *Mechanische Kunst-Kammer* by Matthaeus Merian (1629). The illustration visualizes theory and practical application of mechanics, the fusion of which Mögling proposed as one of the aims of his publication. With kind permission of the Sächsische Landesbibliothek – Staats- und Universitätsbibliothek Dresden.

As one learns from letters written in 1629 and 1630, Mögling had planned to supplement this "first part" of the *Mechanische Kunst-Kammer* with a "second part," presenting comments on the theory and practice of pneumatic devices as treated by Heron of Alexandria, Giambattista Della Porta, and Salomon de Caus. This second part should furthermore have contained original reflections by Mögling himself on those texts already published in the "first part." Together, these two parts would have represented a comprehensive encyclopaedia of contemporary texts on mechanics for German readers (Schickardt 2002, Vol. 1, 494 and 511). However, as far as we know, the second part was never realized so that Mögling's commentary on Guidobaldo's treatise mentioned in his letter has also not come down to us.

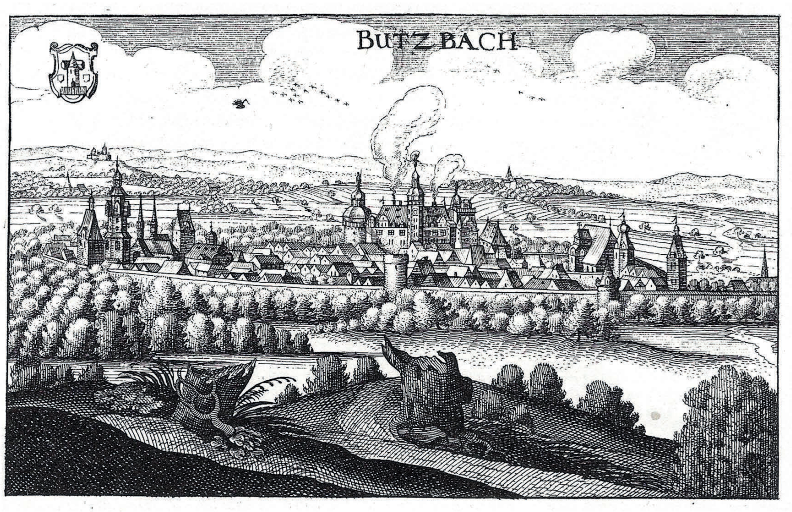


Figure 14.2: Butzbach, the small residential town where Mögling served Landgrave Philipp III as court physician. Engraving from *Topographia Hassiae* (1645), edited by the heirs of Matthaeus Merian. The castle's tower to the right was equipped with an observatory.

For a person serving at a rather small court in a tiny German territory, the list of authors cited and translated by Mögling in the *Mechanische Kunst-Kammer* comes somewhat as a surprise. It raises the question of how Mögling assembled such detailed knowledge of contemporary mechanical writings without, as far as we know, having ever travelled outside Southern and Central Germany. At first sight, Butzbach seems to be last place one would expect to find someone engaged in mechanics (Figure 14.2).[7] Landgrave Philipp III (1581–1643) was surely among the most educated princes north of the Alps, and, like several other members of the house of Hassia, was particularly interested in astronomical issues. He had travelled the Low Countries, France, Spain, and Italy and knew not only French, Spanish and Italian, but also Latin, Greek, and Hebrew. He carefully assembled a large library, which toward the end of his life comprised more than 3.000 volumes, many of them in foreign languages, and among them numerous works on astronomical and mathematical matters.[8] The landgrave had even met Galileo Galilei during two trips to Italy in 1602 and 1607. He had acquired several scientific instruments from him and the two later exchanged letters on related topics. The landgrave often invited scholars to Butzbach for exchanges, especially on matters of astronomy. In addition to an observatory constructed on top of a new part of his residence at Butzbach in 1618, in the times of Mögling, the landgrave possessed a gigantic telescope about fifteen meters in length that was erected in his garden by means of a large lifting device, which collapsed spectacularly during the observation of sunspots in 1629 (Rösch 1975).

In seeking further sources of Mögling's knowledge on mechanics in particular, some possibilities might be mentioned here. Concerning the text of Guidobaldo del Monte, in his preface Mögling explained that he had first translated some passages from an incomplete Italian version—obviously the translation by Filippo Pigafetta—before a relative of his in Nuremberg provided him with a complete copy of the Latin text—the *Mechanicorum liber*—which he then used to expand his translation (Mögling 1629, 6). In general, Mögling mentions having already been introduced to topics of mechanics during his time at the *Academia Norica* in Altdorf, where he studied medicine from 1616 to 1619. According to a letter to a friend from 1617, besides his "official" studies, he also pondered perpetual motion machines and alchemistic issues and had, as he mentioned in the preface to the *Mechanische Kunst-Kammer*, at this time already translated the *Pneumatica* by della Porta and Heron's *Spiritali* (Neumann 1995, 99). Most probably, he had also attended lessons by Daniel Schwenter who, in these years, taught arithmetic, geometry, stereotomy, optics, and gnomonics at Altdorf (Mährle 2000). Details of Schwenter's courses are not known, but he later became famous in Germany for his extensive didactic work on the application of mathematics to all branches of daily life. His *Deliciae physico-mathematicae oder mathematische und philosophische Erquickstunden*, jointly published with Georg Philipp Harsdörffer in 1636, also covered issues

[7] See (Wolf 2003). I am grateful to Dieter Wolf for detailed information concerning the landgrave's residence at Butzbach in the times of Mögling.

[8] See (Schmidt 1917). Unfortunately, it was not yet possible for me to analyze the catalogues of the landgrave's library.

of mechanical technology. In another treatise published in 1625 under the pseudonym Valerius Saledinus and devoted to the possibility of mechanical perpetual motion machines, Mögling discussed a number of contemporary authors who had reflected on related problems, among them Gerolamo Cardano, William Gilbert, Buonaiuto Lorini, Simon Stevin, Johannes Faulhaber, Salomon de Caus, Cornelius Drebbel, and Robert Fludd.[9] All of these examples show that throughout his career, Mögling took into account a broad range of European writings on mechanics.

In addition, information on Mögling's acquaintances discloses further connections to mechanics—whether with regard to its theory or to its practice—and doubtlessly gives occasion to discuss related issues. Of particular importance was Mögling's friendship with Johannes Faulhaber (1580–1635), fortification engineer and mathematician from Ulm and author of an impressive series of treatises on mathematics and engineering (Schneider 1993). After his studies at Altdorf, Mögling had often visited Faulhaber's house, which, due to the private lessons Faulhaber gave and due to his large library, constituted an informal centre of mathematical knowledge. Throughout his life, Faulhaber was interested in Cabbalistic speculations, which brought him into several conflicts with the worldly and ecclesiastic powers of his hometown. He tried early on to get into contact with the clandestine Rosicrucian fraternity and was later reproached for having organized meetings with other adherents in his house (Schneider 1993, 13–14, 29–30). In this context, Faulhaber in 1618 also introduced Mögling to Philipp III, landgrave of Hessen-Butzbach, after the landgrave had showed interest in getting to know the author of the Rosicrucian writings Mögling had published anonymously.

Most interestingly, in 1628, one year before the publication of Mögling's *Mechanische Kunst-Kammer*, Faulhaber had published a brief treatise of about thirty pages with a similar title, namely *Geheime Kunstkammer*. This "secret Kunstkammer" listed one hundred technical problems that Faulhaber offered to solve, against payment, to any person visiting his house in Ulm. Some of the problems he would solve using demonstrations of his large collection of scaled-down models.[10] Most of the problems Faulhaber listed were related to fortification and military technology. However, a number of them also concerned different kinds of mills and water-lifting devices. Because it is unlikely that Mögling was not aware of this publication, the title of his own book might perhaps be read as a response to Faulhaber's "secrets," in defiance of which Mögling, in *Kunst-Kammer*, now freely presented his readers with basic knowledge on mechanics.

[9] See (Saledinus 1625). For the identification of one of Mögling's pseudonyms, see (Neumann 1995, 94–95, note 8).
[10] See (Faulhaber 1628; Schneider 1993, 34–35).

Mögling was also acquainted with the astronomer Johannes Kepler (1571–1630), who was experienced with mechanical contrivances as well. This was particularly the case for what concerned representations of celestial motions on a reduced scale, but also, for example, in connection with the idea of realizing a gear pump equipped with rotating parts only. For a long time, Kepler pursued this project with the intention to finally employ his invention to drain mines (Prager 1973). For years, Mögling also exchanged letters with the astronomer, professor of Asian languages, and inventor of an advanced calculating machine, Wilhelm Schickardt (1592–1635), in Tübingen. Mögling furthermore probably knew Wilhelm Schickardt's uncle Heinrich Schickhardt (1558–1634), who for more than thirty years served the dukes of Württemberg as engineer and architect.

These examples make clear that Mögling moved in circles of persons who, as many others in these times, escape any attempt at clear-cut modern definitions like "scientists" or "technicians." Instead, the individuals dealt with here might best be perceived as an interdisciplinary network interested in technical issues they tackled with quite different traditions of knowledge. In any case, it can easily be imagined that Kepler's studies of gear pumps, Wilhelm Schickardt's successful construction of a calculating machine, Heinrich Schickhardt's knowledge of constructing mills and water-lifting devices, and the engineering experience of Faulhaber, reinforced Mögling's interest in any sort of theoretical approach toward machine technology and mechanics, which led to his translation of Guidobaldo's treatise.

14.3 Technological Innovation and Proponents of Protestant Reform

The second aspect to be discussed in this context is the relation between technological innovation and Protestant reform projects, in particular, the Rosicrucian movement in early seventeenth-century Southern Germany (Yates 1972; 1987; Kühlmann 1996). The Rosicrucians were conceived of as a secret fraternity that disclosed their existence by means of anonymous publications inviting interested persons to contact them. Due to the purely literary character of the fraternity, this turned out to be impossible. Until about 1630, public discussion of the Rosicrucians and their ideas and activities was manifested in roughly 600 printed publications. It had been set forth by three anonymously published treatises between 1614 and 1616. The treatise outlined a movement built around an imaginary character, Christian Rosencreutz, who allegedly had founded a secret society that followed a spiritual path in imitation of Christ. The ideas connected to this fraternity entailed a revitalization of Protestant reform projects, which, a hundred years after Martin Luther, were seen as having come to a standstill. Today, it is clear that the author of at least one of these early treatises was Johann Valentin Andreae

(1586–1654), a Lutheran pastor from Herrenberg near Stuttgart (Montgomery 1973; Dülmen 1978). Obviously, Andreae had not foreseen the effects his anonymously published writings would provoke until the series of public statements in favor of or against the Rosicrucians came to a standstill during the Thirty Years' War around 1630. In addition to the theological and political fusion of different strains of Protestant belief, Rosicrucian texts in particular proposed ways to achieve forms of advanced knowledge by means of connecting theology and science. This was done in part by uniting the republic of letters—which had been fragmented by countless quarrels—to strive for a higher goal, in part by criticizing the established authorities of learned knowledge, and especially by investigating nature as God's creation using human intelligence.

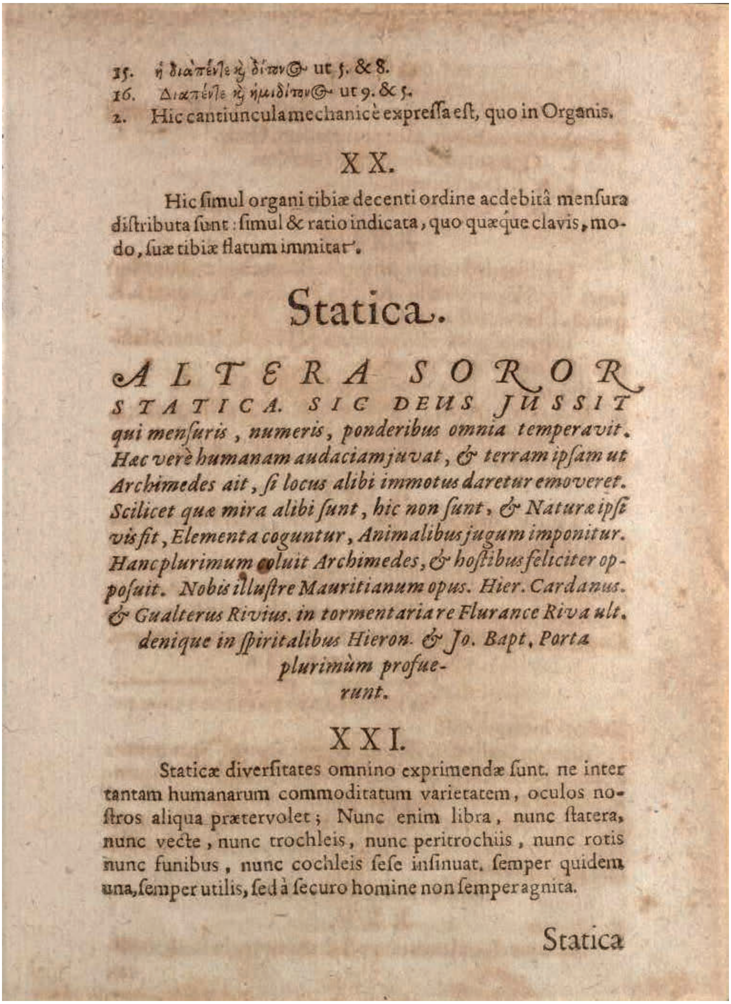
Daniel Mögling, in 1617 and 1618, and thus some ten years before the publication of the *Mechanische Kunst-Kammer*, had himself anonymously published treatises in which he defended Rosicrucian ideas. Like Rosicrucian writing in general, Mögling's texts did not mention topics of mechanics, but rather dealt with alchemy and magic, which in this context should not be understood as being opposed to "rational" technology, but rather as a different field of inquiry for advanced knowledge. Regardless of the prominence of alchemy in the symbolism of Rosicrucian writing, it is important for the issues dealt with here that several persons connected in one way or another to that movement, especially those already acquainted with Daniel Mögling, showed great interest in practical engineering tasks.

For example, in another famous work by Johann Valentin Andreae, his utopian *Christianopolis* (1618), interest in mechanical technology is clearly visible. In a similar direction as indicated in *La città del sole* (1602/1611) by Tommaso Campanella (1568–1639), to which Andreae directly referred, the betterment of society through the study of nature was of particular importance for Andreae's text. Technology in the sense of mills, metallurgical workshops, and advanced hydraulic networks is explicitly mentioned as playing a crucial role for the functioning of Christianopolis (Andreae 1999, 164–169, 274–275). Some passages in Andreae's autobiographic writings explain the attention he paid to such issues. He reported having developed, already in his youth, great interest in architecture and mechanical technology, and having found great joy in assembling scaled-down machines. The art of building, he stated, seemed to him to be "ultimate human happiness." Andreae had been informally instructed in these subjects by Johann Kretzmaier, one of Württemberg's most able carpenters when it came to building machines. Kretzmaier had often worked with the better-known Heinrich , who praised his remarkable ingenuity (Dülmen 1978, 29). As a person broadly interested in all sorts of learned knowledge, the "technical" activities of Andreae's youth later seem to have turned into interest in theoretical mechanics. A telling outcome of this is Andreae's treatise *Collectaneorum Mathematicorum Decades XI* (1614). In the previous year, Andreae had assembled a circle of interested persons to study writings on theoretical issues of architecture and mechanical technology. The published outcome of this was an assembly of corresponding problems. These are formulated only in a very general manner and cover about sixty pages of Latin text, supplemented by about one hundred illustrations, often copied from the original works (Figures 14.3 and 14.4).

The aim of this introductory piece was to stimulate the application of mathematical and mechanical knowledge in technical practice.[11] Without going into detail here, a brief overview shows Andreae's group having discussed the writings of Heron of Alexandria, Ryff, Cardano, Serlio, della Porta, Specklin, Stevin, and others. In this context, Andreae's knowledge of Italian literature might be traced back to a trip over Venice to Rome in 1612. What is more, one of the persons of the circle, Christoph Besold (1577–1638), was famous for his rich personal library comprising works from all disciplines in various European languages.

It is not clear if Mögling, who was distantly related to Andreae, already belonged to this group, as his name does not appear on a list of the participants written down by Andreae in one of the extant copies of this book (Gilly 1995, 53). However, his participation cannot be ruled out as he was studying in Tübingen at that time (Neumann 1995, 99–100). In any case, Mögling later cited Andreae's publication in his treatise, mentioned above, on perpetual motion machines. The publication of Mögling's *Mechanischer Kunst-Kammer* might in any case be interpreted as a refined sequel to the approach taken by Andreae's *Collectaneorum mathematicorum* fifteen years earlier. Instead of brief summaries of certain problems, Mögling now provided translations of complete treatises with extensive introductions and—at least as intended for the "second part"—commentaries. Instead of a small and cheap octavo, illustrated by means of simple copies from the original sources, Mögling now opted for a large folio publication. Not only the frontispice of the *Mechanische Kunst-Kammer*, but also 42 tables visualizing the problems treated in Guidobaldo's and Pseudo-Aristotle's texts had been carefully composed by the famous editor and engraver Matthaeus Merian (1593–1650) for that occasion (Figure 14.5).

[11] See (Andreae 1614); digital version: Wolfenbüttel, Herzog-August-Bibliothek, http://diglib.hab.de/drucke/28-4-geom/start.htm.



15. ἡ διαπέντε καὶ δίτονος ut 5. & 8.
16. Διαπέντε καὶ ἡμιδίτονος ut 9. & 5.
2. Hic cantiuncula mechanicè expreſſa eſt, quo in Organis.

XX.

Hic ſimul organi tibiæ decenti ordine acdebitâ menſura diſtributa ſunt: ſimul & ratio indicata, quo quæque clavis, modo, ſuæ tibiæ flatum immitatr.

Statica.

ALTERA SOROR STATICA. SIC DEUS JUSSIT qui menſuris, numeris, ponderibus omnia temperavit. Hæc verè humanam audaciam juvat, & terram ipſam ut Archimedes ait, ſi locus alibi immotus daretur emoveret. Scilicet quæ mira alibi ſunt, hic non ſunt, & Naturæ ipſi vis fit, Elementa coguntur, Animalibus jugum imponitur. Hanc plurimum coluit Archimedes, & hoſtibus feliciter oppoſuit. Nobis illuſtre Mauritianum opus. Hier. Cardanus. & Gualterus Rivius. in tormentaria re Flurance Riva ult. denique in ſpiritalibus Hieron. & Jo. Bapt. Porta plurimùm profuerunt.

XXI.

Staticæ diverſitates omnino exprimendæ ſunt. ne inter tantam humanarum commoditatum varietatem, oculos noſtros aliqua prætervolet; Nunc enim libra, nunc ſtatera, nunc vecte, nunc trochleis, nunc peritrochiis, nunc rotis nunc funibus, nunc cochleis ſeſe inſinuat. ſemper quidem una, ſemper utilis, ſed à ſecuro homine non ſemper agnita.

Statica

Figure 14.3: Introduction to the topic of statics in Johann Valentin Andreae's *Collectaneorum mathematicorum* (1614) with references to the works of Archimedes, Gerolamo Cardano, Walther Ryff (Rivius), Heron of Alexandria, and Giambattista della Porta. With kind permission of the Herzog-August-Bibliothek Wolfenbüttel.

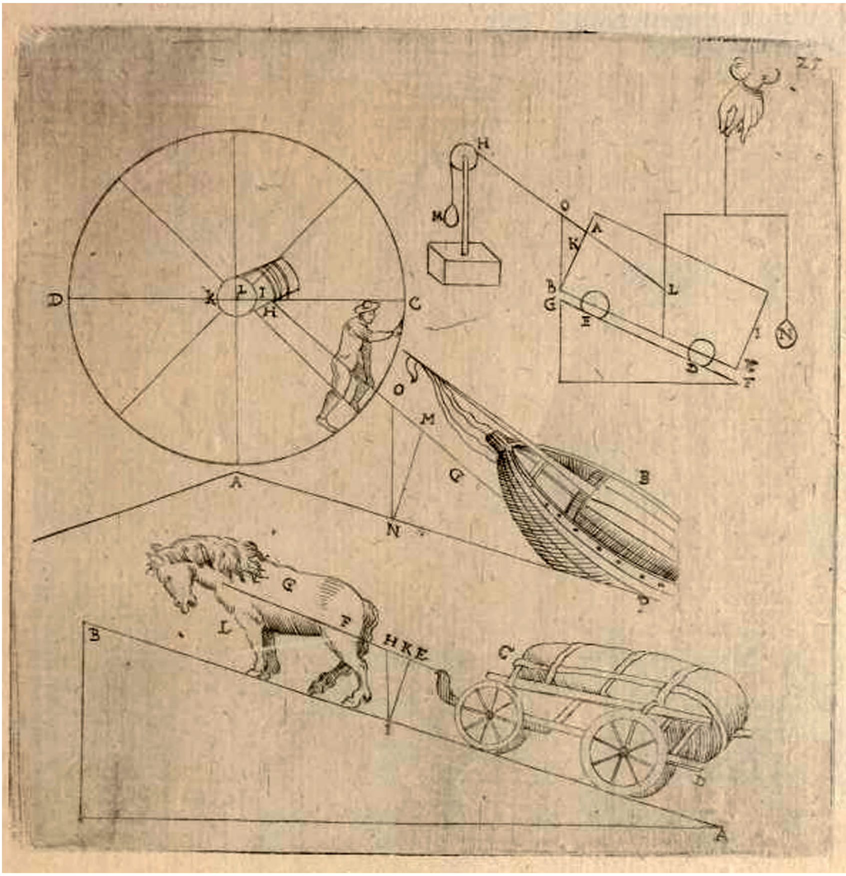


Figure 14.4: Copies of illustrations from Simon Stevin's *De Weeghdaet* (1586) in Andreae's *Collectaneorum mathematicorum* (1614). With kind permission of the Herzog-August-Bibliothek Wolfenbüttel.

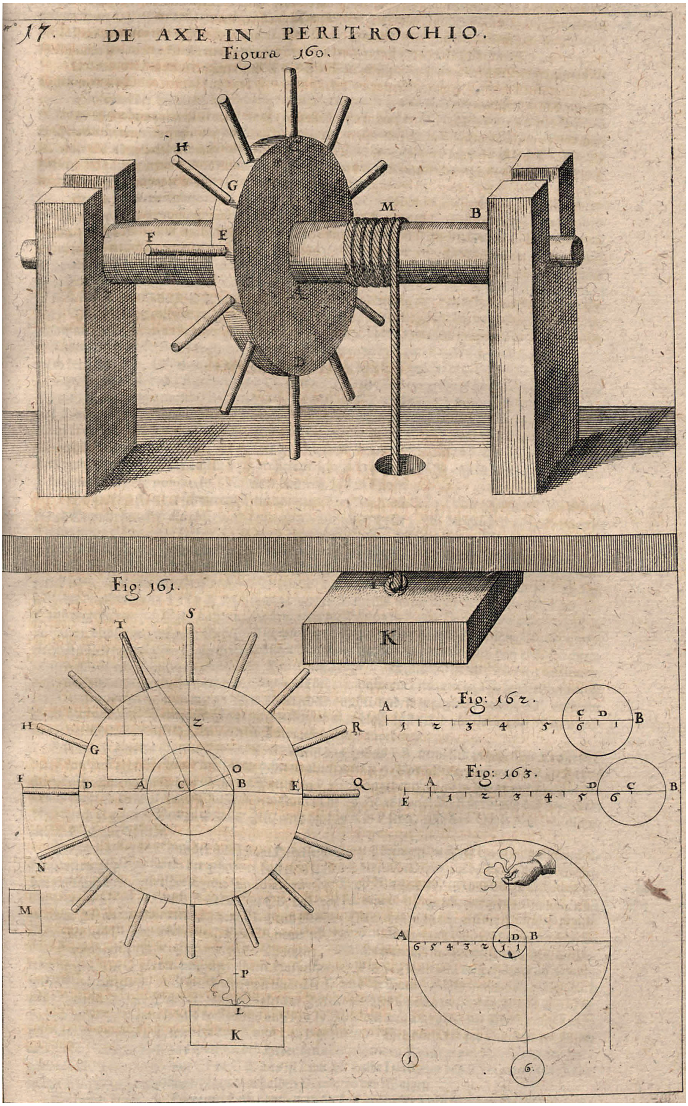


Figure 14.5: One of the tables illustrating Mögling's translation of the *Mechanicorum liber*, reworked by Matthaeus Merian (*Mechanische Kunstkammer*, 1629). With kind permission of the Sächsische Landesbibliothek—Staats- und Universitätsbibliothek Dresden.

Merian himself might be perceived as another interesting link between the "technological" and "spiritual" activities of Mögling. In the early years of his career from 1616 to 1620, Merian had worked in the workshop of Johann Theodor De Bry at Oppenheim, then part of the Palatinate, and later at Frankfurt. The publishing activities of de Bry and the artwork by Merian, who later ran his own workshop, were closely related to a reform-oriented Protestant network which, in the years between 1613 and 1620, was centered in Heidelberg as the capital of the Palatinate. This network had been formed in the context of the marriage of Friedrich V, Prince Elector of the Palatinate, and Elisabeth Stuart, granddaughter of Mary Stuart, in London in 1613. Their marriage had promoted hopes for a strong alliance of Protestant territories against the Habsburg-dominated Catholic territories (Rüde 2007). For a few years, until Friedrich V was defeated near Prague after accepting the Bohemian crown in 1619, printers in Oppenheim and Frankfurt stimulated cultural exchanges between London and Heidelberg in particular, but also with other Protestant territories, not least with regard to issues of Rosicrucian thought, alchemy and technology. Hassia, adjacent to the Palatinate, itself governed by Princes highly interested in astronomy and mathematics, also formed part of this context. Matthaeus Merian, in this setting, among many other works illustrated treatises on alchemy like Michael Maier's (1568–1622) *Atalanta fugiens* (1617), Robert Fludd's (1574–1637) extensive encyclopedia *Utriusque cosmi historia* (1617–1621), and, not least, one of Daniel Mögling's Rosicrucian writings, *Cimelia rhodostaurotica*, with what are still today considered the most refined illustrations of Rosicrucian thought (Figure 14.6 and 14.7). Technological issues were not alien to Merian who in 1617–18 had designed the frontispice of the *Theatre of Machines* by Jacopo Strada. Thus, Merian's activities again, even if indirectly, represent the coexistence of interest in alchemy and technology in one and the same personal network between 1613 and 1620.[12] Mögling's translation of Guidobaldo's treatise on mechanics, even if published years after the defeat of Frederick V, might thus also be perceived as a late outcome of the activities of these networks.

[12]See (Wüthrich 2007). For the frontispice of Mögling's book, see pp. 317–318; for Strada, see pp. 318–320; for illustrations of esoteric writings, see pp. 84–100. See also (Yates 1972, 70–90).

Figure 14.6: Engraving by Matthaeus Merian representing the Rosicrucian fraternity in Theophilus Schweighart's—that is, Daniel Mögling—*Speculum sophicum rhodo-stauroticum universale* (1618).

Figure 14.7: Engraving by Matthaeus Merian illustrating pansophic ideas of a study of nature as a way to obtain higher knowledge in Theophilus Schweighart's—that is, Daniel Mögling's—*Speculum sophicum rhodo-stauroticum universale* (1618).

In a highly debated, but still very valuable and stimulating study, Frances A. Yates, nearly forty years ago discussed possible connections between the Rosicrucian movement and cultural life at Heidelberg Castle during the short reign of Friedrich V. She especially interpreted the design of the new castle gardens by Salomon de Caus (*Hortus palatinus*) with their grottoes and automata as a symbolic representation of Rosicrucian thought.[13] In the preceding passages, it has proven more rewarding not to investigate interest in mechanical technology in Protestant territories in these years as *expressions* of Rosicrucian thought, but rather with regard to the "virtual" character of the Rosicrucian movement, to consider the *coextension* of these two strains of reform-oriented thought in one and the same network of people. Mögling, since the early 1620s, had already detached himself from Rosicrucian thought. This does not appear to have been alien to his interest in mechanics. On the contrary, one is confronted with motivations that intensified themselves reciprocally. Technology—even if not yet defined as such—in the networks sketched above was raised repeatedly as an important topic. And for members of the Republic of Letters—to which most of the characters named above belonged—advances in the theory of mechanics seem to have represented the most promising way toward technical innovation.

Mögling, however, in his treatise on perpetual motion machines of 1625, had been astonishingly sceptical about the connection between technological improvement and the common weal. In a quite unusual way for authors of contemporary technical treatises, Mögling underlined that he did not want to see his perpetual motion project, like other proponents, applied to devices like self-moving mechanical ploughs. He expressed the concern that peasants would become completely useless if all ploughing were done automatically. Instead, he wanted to reserve his perpetual motion machine for noble aims such as driving a perpetual clockwork (Saledinus 1625, 52–53).

To conclude this second aspect, one might argue that from a sociological point of view, the learned circles to which Mögling pertained were not very different from those formed by experts in various disciplines at Italian courts, such as astronomy, mechanics, or engineering. But the context of early seventeenth century Protestant reform roughly outlined above, which entailed the perfection of technology as one element, obviously differed markedly from the situation in Italy. In Italy, considerations on mechanics—in the sense of refined reflections on the simple machines in the ancient and medieval tradition—emerged as an integral part of the new figure of the cultivated and learned engineer in the fifteenth and sixteenth century; they were famous and in demand at all the major Italian courts, independently of any specific religious context. In the German regions in

[13] See (Yates 1972). For a more sceptical interpretation concerning symbolic links between the design of the Hortus Palatinus and Rosicrucian thought see (Morgan 2007).

the times of Mögling, on the contrary, investigations in the science of mechanics seem to have been taken up with special zeal within movements of Protestant reform who were interested, in a somewhat abstract manner, in the perfection of artisanal practice. In the third and last part of this essay, it will be argued that these attempts might indeed be considered a new development, because mechanical theory in the German territories at that time did not yet play an important role among engineering experts.

14.4 Mechanical Theory and Contemporary Engineering Practice

The relation between the theory of mechanics on the one hand, and early modern technical and engineering practice on the other has been discussed extensively in modern research. One of the results of this debate is that modern dichotomies of "scientists" on the one hand, and "practicioners" or "engineers" on the other, do not adequately reflect the historical situation.[14] It has already been mentioned, for example, that the "scientists" among Daniel Mögling's acquaintances often also dealt with mechanical contrivances. Guidobaldo del Monte, as Enrico Gamba and Vico Montebelli have shown, also took great care to prove theorems of his *Mechanicorum liber* by means of refined brass models of the simple machines (Gamba and Montebelli 1988, 85–86). Johannes Kepler, in the course of his work on gear pumps, at one point asked an artisan to construct a copper model of his design.[15] Finally, also Daniel Mögling was experienced in the construction of hydraulic clocks, mathematical and astronomical instruments and, for several years, as mentioned above, had studied the possibility of realizing a perpetual motion machine with the help of magnets. In a letter to Wilhelm Schickardt in 1627, he stated that his "iron machine with lead balls and lever" was so advanced that he needed only a further step as small as "half the diameter of a straw" to achieve his aim (Schickardt 2002, Vol. 1, 285). In other letters to Schickardt, Mögling also reflected intensively on technical devices, especially on one devoted to a discussion of Heronian automata (Schickardt 2002, Vol. 1, 511–514). Thus, one is repeatedly confronted with "scientists" who dealt intensively with "real" mechanisms.

Although it has a rather anecdotal character, one tiny detail reported in another letter Mögling sent to Schickardt on 16 January 1630, shows in a nutshell the interaction of learned knowledge, theoretical speculation, playful ex-

[14] See, for example, (Popplow and Renn 2002).

[15] See (Prager 1973). For the employment of scaled-down models in early modern engineering in general, see M. Popplow: Presenting and Experimenting. Renaissance engineers' employment of models of machines, in *Les machines à la Renaissance*, edited by Pascal Brioist, Luisa Dolza, and Hélène Vérin (in press).

perimentation, and knowledge exchange that testifies to the various knowledge cultures of such early modern "scientists." Schickardt, in a previous letter, had asked Mögling for his opinion on the principle of smoke-jacks mentioned by Cardano. Even if such devices were also described by numerous other engineers from Leonardo da Vinci to Vittorio Zonca and were effectively realized in these times, Mögling did not seem to notice. He remarked that such a device, in any case, would require a considerable amount of smoke to be set in motion. However, in the mixture of German and Latin typical for Mögling's writing when he switched from everyday to learned issues and back, he stated: "Doch wer weists [Who knows]. Tentando discimus in mechanicis multa." Seeming to adhere to the principle of tentative trial and error as a way to future innovation, Mögling continued in German to explain a child's toy: First, a paper circle, by folding it as often as possible toward its centre, was turned into a kind of hat in form of a cone. A piece of iron wire connected to a small wooden disc was then put on top of an oven so that the wire stood perpendicularly. The paper hat, put on the end of the wire, suddenly rose and flew around rotating around its axis once the oven had produced enough heat—which was nice to observe, as Mögling commented. After producing a sketch of the device in the margins of the page (Figure 14.8), Mögling finally assembled such a paper hat, enclosed it in the letter to Schickardt, and added a respective note at the end of the passage (Schickardt 2002, Vol. 1, 521).

Whereas "scientists" interacted in many different ways with practical handicraft, treatises on machine technology published in the sixteenth and early seventeenth century increasingly praised the theory of the simple machines as an explanation of contemporary machine technology such as cranes, mills, water-lifting devices, or automata. Around 1600, such references can be found, for example, in the *Theatre of Machines* by Vittorio Zonca published posthumously in 1607. Salomon de Caus, in his machine book from 1615, additionally reflected on the different sources of energy that could be employed to drive machines. However, not much is known about the practical application of such theories. Some authors, for example Giuseppe Ceredi in his treatise on the applications of the Archimedean screw (1567), suggested that in Italy there were frequent attempts to use the theory of the simple machines to evaluate different types of mills or other mechanisms (Zonca 1985; Caus 1615; Ceredi 1567). Such reasoning is also documented in one of Galileo Galilei's letters in which he, during his times at the Florentine court, explained to an engineer why a device the latter had designed, and which contained a pendulum to drive mills or other machines, would not work effectively on a large scale.[16] In the Netherlands, similar considerations

[16]Galileo Galilei, *A proposito di una macchina con gravissimo pendolo adattato ad una leva*, in (Galilei 1968, vol. VIII, 571–581).

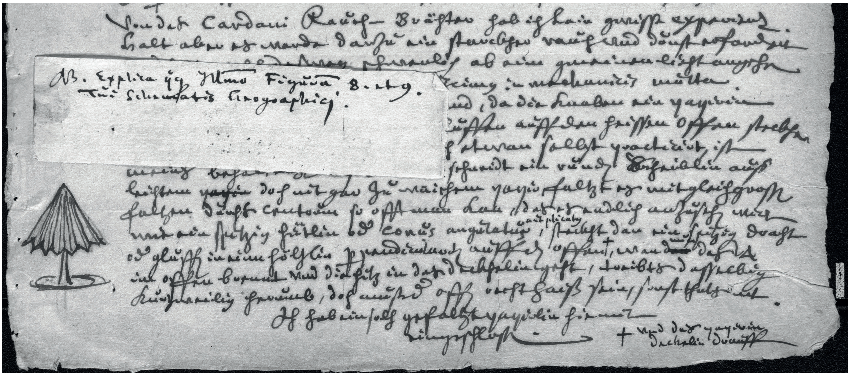


Figure 14.8: Passage in a letter from Daniel Mögling to Wilhelm Schickardt (16 January 1630) devoted to a discussion of the principle of smoke-jacks as described by Cardano. The illustration on the left shows a paper toy to be raised by hot air when set on a stove. The original toy Mögling enclosed in the letter has been lost. With kind permission of the Österreichische Nationalbibliothek, Vienna, Cod. 9737v, fol. 39r.

can be found in the writings of Simon Stevin who calculated the effectiveness of different designs of windmills to drain marshes (Stevin 1966, 311–379). Obviously, Daniel Mögling attempted to foster such a theoretical approach toward contemporary technological practice in the German context as well.

To briefly sketch the relation of such initiatives to the practice of building machines, one might take the activities of Heinrich Schickhardt as an example. In his function as engineer and architect (*Landesbaumeister*) for the Dukes of Württemberg, Schickhardt kept in his home numerous drawings and documents pertaining to the building projects he had supervised during his long career (Popplow 2004).[17] As already explained, he was situated close to the circle of Protestant reform to which Daniel Mögling also pertained. Schickhardt came from the same town—Herrenberg—as Johann Valentin Andreae to whom he was even related, and was also the uncle of Wilhelm Schickardt. One might get the impression that Schickhardt spent most of his life turning ideas of "technological" reform proposed by authors such as Johann Valentin Andreae into practice. For decades, he sought to provide Württemberg with the most advanced sorts of mills and water-

[17]For Schickhardt's machine drawings, see also W. Lefèvre, M. Popplow, *Database Machine Drawings*, Berlin, Max Planck Institute for the History of Science, http://dmd.mpiwg-berlin.mpg.de.

lifting devices—may not be the most spectacular designs, but advanced ones that had already proven their feasibility elsewhere. However, considerations on the theory of the simple machines are nowhere to be found in the hundreds of drawings and documents that have come down to us, even if in the list of books of Schickhardt's rich private library one finds a comprehensive collection of contemporary European treatises on architecture and machines. One can thus be quite sure that his projects were realized with the "traditional"—even if very advanced—knowledge of engineers and carpenters of his time.

As far as we know, the conclusions to be drawn from the extensive documentation of Schickhardt's activities might be generalized: In the early seventeenth century, the theory of the simple machines did not play a significant role in the context of engineering projects in the German-speaking territories. Commissioners did not require acquaintance with such theoretical approaches from engineering experts. In Italy, on the contrary, a certain familiarity with theories of mechanics for decades already formed an integral part of the figure of the learned engineer-scientist. The translation of Guidobaldo del Monte's treatise by Daniel Mögling in the above-mentioned context of Protestant reform was thus an attempt to make these issues known to German readers, following and extending earlier sixteenth-century approaches by Ryff, and those of the circle headed by Johann Valentin Andreae fifteen years earlier. However, as engineering experts in the strict sense only formed a smaller part of the circle of persons in which Mögling moved, it seems that his inclination toward mechanical theory first and foremost neither originated in an attempt to raise the social status of the engineer, nor was it related to concrete and pressing engineering problems. Mögling's interest in mechanics, one might conclude, was rather connected to growing expectations from court intellectuals to produce some kind of "useful" knowledge, a move that was intensified, in his case, by connecting hopes for technological innovation to religious and political reform projects. In any case, Daniel Mögling doubtlessly perceived Guidobaldo del Monte's treatise on mechanics as a key text for any attempt to promote mechanical knowledge in Germany.

References

Andreae, I. V. (1614). *Ioannis Valentini Andreæ collectaneorvm mathematicorum decades XI.: Centum & decem tabulis aeneis exhibitæ*. Tübingen: Cellius. URL: http://diglib.hab.de/drucke/28-4-geom/start.htm.

— (1999). *Christianopolis*. Ed. by E. H. Thompson. Dordrecht: Kluwer.

Becchi, A. (2004). *Q. XVI. Leonardo, Galileo e il caso Baldi: Magonza, 26 marzo 1621*. Venezia: Marsilio.

Caus, S. de (1615). *Les raisons des forces mouvantes*. Frankfurt: Jan Norton.

Ceredi, G. (1567). *Tre discorsi sopra il modo d'alzar acque da' luoghi bassi*. Parma: Seth Viotti.

Dülmen, R. van (1978). *Die Utopie einer christlichen Gesellschaft. Johann Valentin Andreae (1586-1654)*. Stuttgart: Frommann-Holzboog.

Faulhaber, J. (1628). *Geheime Kunstkammer: Darinnen hundert allerhand Kriegs Stratagemata, auch andere Unerhörte Sectreta, und Machinae mirabiles zusehen / dergleichen in Europa (respective) wenig zu finden*. Ulm: Jonas Saur.

Galilei, G. (1968). *G. Galilei, Le opere*. Ed. by A. Favaro. Florence: Barbera.

Gamba, E. and V. Montebelli (1988). *Le scienze a Urbino nel tardo Rinascimento*. Urbino: QuattroVenti.

Gilly, C., ed. (1987). *Johann Valentin Andreae 1586-1986. Die Manifeste der Rosenkreuzerbruderschaft*. Amsterdam: Bibliotheca Philosophica Hermetica.

— ed. (1995). *Cimelia Rhodostaurotica. Die Rosenkreuzer im Spiegel der zwischen 1610 und 1660 entstandenen Handschriften und Drucke*. Amsterdam: In de Pelikaan.

Jachmann, J. (2006). *Die Architekturbücher des Walter Hermann Ryff. Vitruvrezeption im Kontext mathematischer Wissenschaften*. Stuttgart: ibidem.

Kühlmann, W. (1996). Sozietät als Tagtraum: Rosenkreuzerbewegung und zweite Reformation. In: *Europäische Sozietätsbewegung und demokratische Tradition. Die europäischen Akademien der Frühen Neuzeit zwischen Frührenaissance und Spätaufklärung*. Ed. by K. Garber, H. Wismann. Tübingen: Niemeyer, 1124–1151.

Mährle, W. (2000). *Academia Norica. Wissenschaft und Bildung an der Nürnberger Hohen Schule in Altdorf (1575-1623)*. Stuttgart: Franz Steiner.

Mögling, D. (1629). *Mechanischer Kunst=Kammer Erster Theil / Von Waag / Hebel / Scheiben / Haspel / Keyl / und Schrauffen: Begreiffend die wahre Fundamenta aller Machination*. Frankfurt am Main: Caspar Röteln. URL: http://digital.slub-dresden.de/ppn263770931.

Monte, Guidobaldo del (1577). *Mechanicorum liber*. Pesaro: Hieronymum Concordiam.

Montgomery, J. W. (1973). *Cross and Crucible. Johann Valentin Andreae (1586-1654), Phoenix of the Theologians*. Den Haag: Nijhoff.

Morgan, L. (2007). *Nature as Model: Salomon de Caus and Early Seventeenth-Century Landscape Design*. Philadelphia: University of Pennsylvania Press.

Neumann, U. (1995). Olim, da die Rosen Creutzerey noch florirt, Theophilus Schweighart genant: Wilhelm Schickhards Freund und Briefpartner Daniel Mögling (1596-1635). In: *Zum 400. Geburtstag von Wilhelm Schickardt*. Ed. by F. Seck. Stuttgart: Thorbecke, 93–115.

Popplow, M. (1998). *Neu, nützlich und erfindungsreich: Die Idealisierung von Technik in der Frühen Neuzeit*. Münster: Waxmann.

— (2004). Why Draw Pictures of Machines? The Social Contexts of Early Modern Machine Drawings. In: *Picturing machines 1400-1700*. Ed. by W. Lefèvre. Cambridge: MIT Press, 17–48.

Popplow, M. and J. Renn (2002). Ingegneria e Macchine. In: *Storia della scienza. L'età della Rivoluzione Scientifica*. Ed. by D. Garber. V. Roma: Istituto della Enciclopedia Italiana, 258–274.

Prager, F. D. (1973). Kepler als Erfinder. In: *Internationales Kepler-Symposium, Weil der Stadt 1971*. Ed. by F. Krafft, K. Meyer, B. Sticker. Hildesheim: Gerstenberg, 385–408.

Rösch, S. (1975). Landgraf Philipp III. von Hessen-Butzbach und Johannes Kepler. *Wetterauer Geschichtsblätter* 24:99–108.

Rüde, M. (2007). *England und die Kurpfalz im werdenden Mächteeuropa (1608-1632). Konfession, Dynastie und kulturelle Ausdrucksformen*. Stuttgart: Kohlhammer.

Ryff, W. H. (1547). *Der furnembsten / notwendigsten / der gantzen Architectur angehörigen mathematischen und mechanischen Künst / eygentlicher Bericht*. Nürnberg: Johann Petreius. URL: http://digital.slub-dresden.de/ppn263566811/1.

Saledinus, V. (1625). *Valerii Saledini Doctoris Medici et Philosophi, Germani, perpetuum mobile, Das ist: Immerwehrende Bewegung*. Frankfurt am Main: Lukas Jennis.

Schickardt, W. (2002). *Briefwechsel*. Ed. by F. Seck. I, 1616-1632; II, 1633-1635. Stuttgart-Bad Cannstatt: Frommann-Holzboog.

Schmidt, A. (1917). Die Bibliothek des Landgrafen Philipp von Butzbach. *Quartalsblätter des Historischen Vereins für das Großherzogtum Hessen* 6:175–191.

Schneider, I. (1993). *Johannes Faulhaber (1580-1635): Rechenmeister in einer Welt des Umbruchs*. Basel: Birkhäuser.

Stevin, S. (1966). Van de Molens. In: *The Principal Works of Simon Stevin*. Ed. by R. J. Forbes. V: Engineering, Music, Civic Life. Amsterdam: N. V. Swets & Zeitlinger, 1–412.

Stöcklein, A. (1969). *Leitbilder der Technik*. Munich: Moos.

Wolf, D. (2003). Butzbach. Eine kleine fürstliche Residenz im Dreißigjährigen Krieg. In: *Valentin Wagner (um 1610-1655). Ein Zeichner im Dreißigjährigen Krieg*. Ed. by H. Th. Gräf and H. Meise. Neustadt an der Aisch: Verlagsdruckerei Schmidt, 61–69.

Wolfe, J. (2004). *Humanism, Machinery, and Renaissance Literature*. Cambridge: Cambridge University Press.

Wüthrich, L. H. (2007). *Matthaeus Merian d. Ä.: Eine Biographie*. Hamburg: Hoffmann & Campe.
Yates, F. (1972). *The Rosicrucian Enlightenment*. London: Routledge & Kegan Paul.
Zonca, V. (1985). *Novo Teatro di Machine et Edificii 1607*. Ed. by C. Poni. Milan: Il Polifilo.