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RESEARCH ARTICLE

Proportional Design Systems in Seventeenth-Century Holland

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This article focuses on architectural drawings, some only recently discovered, that contain indications of authentic proportional systems from the 'inner circle' of Dutch seventeenth-century classical architecture. These drawings demonstrate how these architects used arithmetical grid systems as well as geometrical constructions in the hope of achieving their classical ideal of beauty and harmony. In light of these proportional systems we may propose a method for analysing other drawings from this period that do not have any proportional systems inscribed.

The study of proportional design in architecture offers a minefield of misunderstandings and over-interpretations. As historiography of this kind of research illustrates, the quest for a golden key that may unveil universal harmony in architecture of all ages resulted mostly in geometrical shapes in which especially the air around or the soil below the buildings seem to be well proportioned. Both Gothic and classical buildings always show a manifold of horizontal and vertical lines. By attempting to reconstruct an architect's intended geometrical frame on a modern drawing of an existing building, one always runs a risk of coincidence: there may always be something that, at first glance, seems to fit in any system imposed on it. The main question, nevertheless, should be the other end of the design process: *could a certain proportional system indeed have been used from the start of the design*? In other words, *is the proportional system indeed a necessary help to define the outline and the crucial parts of the final design as we know it*?

In order to prevent anachronisms in the reconstruction of proportional systems it is essential to go back to evidence of contemporary design practises. Unfortunately, in early modern times written sources on contemporary design systems are rare and drawings showing a proportional system applied are even rarer. The well-known treatises of Andrea Palladio, Vincenzo Scamozzi and others offer some basic theoretical principles as well as the final results, the ground plans and façades of villas and palaces. On the other hand, the actual practise of how to construct a design step by step is never explained — not because this was something 'secret', one may presume, but since it was a common practise well known to the reader.

Fortunately, some seventeenth-century witnesses are available who illustrate what had happened at the architect's drawing table in Holland (see Ottenheym 1991; Ottenheym 2007; Ottenheym 2009).[1] All these accounts date from the heyday of Dutch classicist architecture, between 1630 and 1680. In this period Dutch architecture was strongly embedded in the legacy of sixteenth-century Italian architects and their theoretical works, such as those of Palladio and, above all, Scamozzi (Ottenheym 1999a; De Jonge and Ottenheym 2007). The most important protagonists in this development had been the architects Salomon de Bray (Lammertse 2008) and Jacob van Campen (Huisken, Ottenheym and Schwartz 1995), followed by their younger colleagues Pieter Post (Terwen and Ottenheym 1993), Arent van 's-Gravesande (Steenmeijer 2005), and Philips Vingboons (Ottenheym 1989). Not only architectural details and the use of the orders were based on these printed works but occasionally even ground plans and façade schemes published in Palladio's and Scamozzi's treatises were used as sources of inspiration for contemporary Dutch buildings. Also the theoretical frameworks of these Italian treatises were well received by this small group of architects and their erudite patrons like Constantijn Huygens, secretary to the Prince of Orange and a successful poet and composer as well as architectural dilettante. His serious aim was to achieve architectural beauty by practising humanist principles in which the mathematical system of Euclid and Pythagoras was regarded as the key for divine and universal order (Blom, Bruin and Ottenheym 1999; Ottenheym 2008).

This paper will focus on those architectural drawings that contain indications of authentic proportional systems. Some of these are already well known, while others have been discovered only recently. In contrast to the many hypothetical reconstructions of proportional systems presented by later historians, these drawings provide various examples of how these architects actually used arithmetical grid systems as well as geometrical constructions to achieve unity and coherence within their designs.

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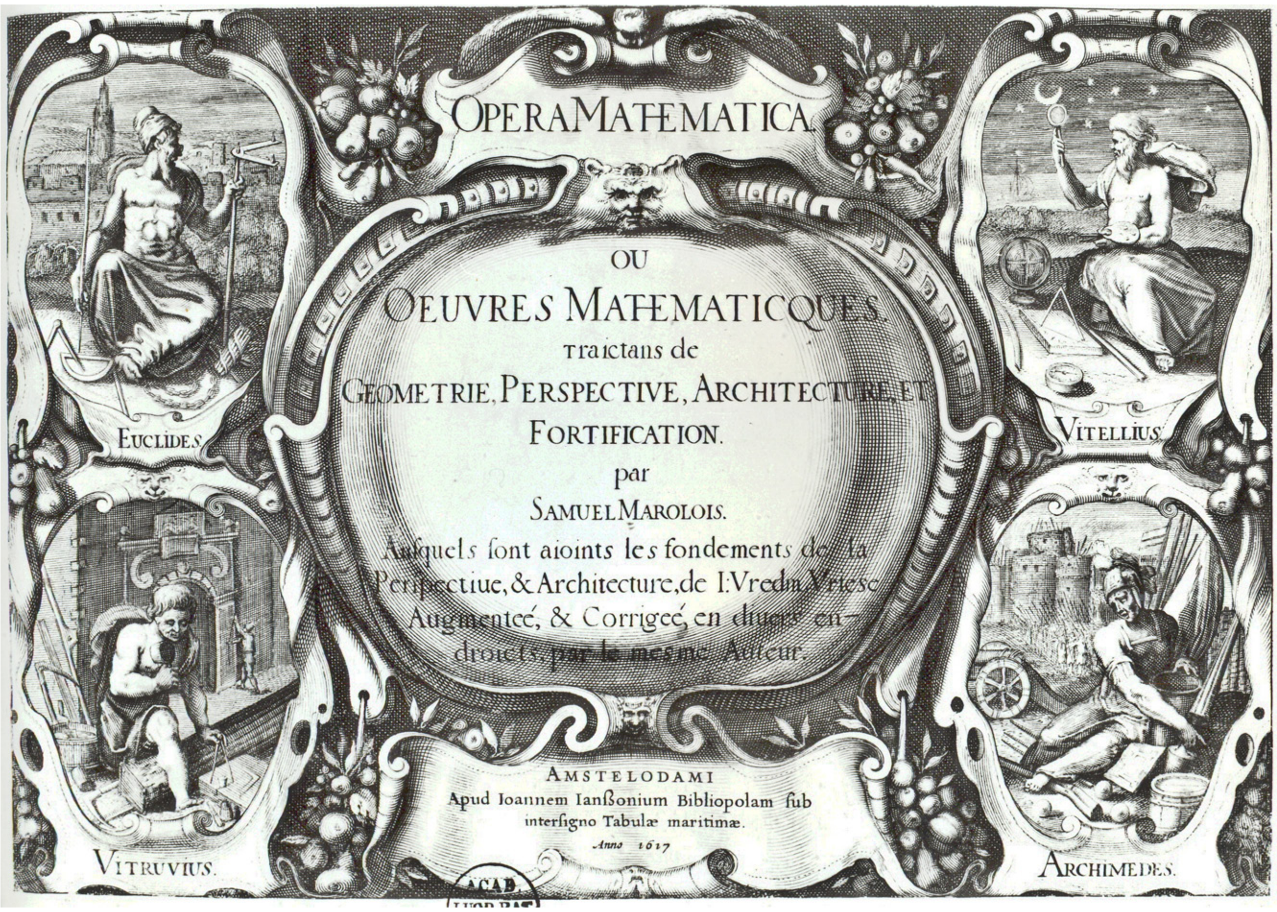


Fig. 1: Marolois, *Opera mathematica* (1628), frontispiece (University Library, Leiden).

In addition this paper will look at some other buildings of the period that are well documented by contemporary prints of the designs, without the proportional systems but with all essential measurements inscribed by the architect (what interests us now are the design principles as practised on the architect's desk, not the measurements of the final constructions, which are always less perfect than what was envisioned on the drawing table). The knowledge of the design systems of the period, as demonstrated by the aforementioned contemporary drawings, and these exact measurements indicated on the prints enable us to reconstruct design systems applied by the architects.[2]

Evidence of Dutch seventeenth-century design practice

Mathematical principles were always prominent in Dutch seventeenth-century architectural treatises and handbooks. Even before the rise of classicist architecture in Holland in the 1630s, and certainly after, architectural design had been regarded there as a kind of applied mathematics. Model books, such as posthumous editions of Hans Vredeman de Vries's *Architectura* of 1606, were incorporated into treatises on geometry, land surveying and fortification. On the frontispiece of the 1617 Amsterdam edition of Marolois's *Opera mathematica* we find the names of Vitruvius together with his antique colleagues Euclides (geometry), Vitellius (surveying) and Archimedes (fortification) (**Fig. 1**).

In his introduction to the *Architectura moderna* of 1631, the posthumous publication of the works of Hendrick de Keyser (1565–1621), Salomon de Bray states that only by the use of mathematical principles can the craft of building be elevated to the art of architecture. According to the De Bray, De Keyser's buildings were actually works of art, and one should check the true principles of De Keyser's designs by investigating the proportions of his buildings as shown in the engravings. Therefore the reader was encouraged 'to test the true principles of mathematical architecture and to take its measures' ('de selve met de ware redenen der wiskonstige Bouwinge [te] proeven ende near [te] meten'; De Bray 1631, 5).

Such a focus on mathematics is not surprising since seventeenth-century Dutch society was permeated with mathematics. Mathematics was essential to the Dutch mercantile and maritime society, and as such, was necessary for everybody who was educated for the pursuit of trade and navigation as well as building and fortification, even before the rise of classical architecture at the beginning of the century. The first six books of Euclid may be regarded as a starting point for any applied science during this period, architecture included. The mathematical principles explained, for example, in Serlio's Book I and Scamozzi's Book I, are based on these same first six books of Euclid, such as geometry and proportions as well as square-root proportions and *quadratura* principles with squares and circles (Euclid, Book 4). Everywhere in Holland these basics from Euclid were taught in schools, generally using the Dutch edition by Jan Pietersz. Dou from Leiden, published for the first time in 1606 and reprinted many times.

The focus on proportions in architecture as explained in the works of Palladio and Scamozzi fitted easily into Dutch society, not only among the scholarly elite but also among the intellectual middle class. As elsewhere, mathematical principles were used in architectural design at all times but, with the introduction of the Vitruvian theory, in its contemporary transformation by Palladio and Scamozzi, into seventeenth-century Dutch society, proportions became a major issue in architectural theory (Ottenheym 2010). This is reflected in contemporary Dutch architectural drawings and designs.

The proportional lessons of Nicolaus Goldmann

We have a few authentic witnesses for the use of mathematical systems in architectural design practice. The first is a series of hundreds of drawings made by Nicolaus Goldmann, a teacher of architecture in Leiden from 1640 until his death in 1665 (Goudeau 2005; Goudeau 2006–2007).[3] His course may be regarded as a private enterprise alongside the official school for surveyors and military engineers, the so-called *Duytsche mathematique*, founded by Prince Maurits according to a teaching programme by Simon Stevin (Muller and Zandvliet 1987: 23–27; Van den Heuvel 2004). Goldmann made the drawings in the mid-seventeenth century whilst teaching his pupils, like sketches on a blackboard. They show how to design all kinds of building types according to fixed mathematical principles. Goldmann followed the classical ideal of a mathematically perfect universe created by divine will and order as expressed in the Temple of Solomon (Goudeau 2005: 327–342). Mankind could only produce something of any value by following these eternal and universal principles. Goldmann's architectural designs are not created for real execution but as a teaching model to explain his principles. He works with whole numbers, in basic arithmetical proportions such as 1:2, 2:3, 3:4, etc. The square root proportion of 2 is used as well, but not often. One of his most basic instruction examples shows a villa on a square ground plan of 30 x 30 modules (Goldmann always uses an abstract measure, never the actual Rijnland foot that was in common use in Leiden and most parts of Holland). The main body of the building is a cube since its walls are also 30 modules high, the height of the roof excluded (**Figs. 2**, **3**).

The ground plan is divided into nine squares of 10 x 10 modules, with outer walls 2 modules and inner walls 1 module wide, thus creating nine inner spaces of 8 x 8 modules. The exterior height is divided into 5 modules for the cellars and 25 for the main and upper floors together. Engaged columns are 2 modules wide and 20 high (1:10), with a water table profile of 1 module and a crowning entablature 4 modules in height, which is thus 1/5 of the height of the engaged columns below. The central bay is 10 modules wide on centre (with an intercolumniation of 8), the two outer bays 8 each (with an intercolumniation of 6 modules), and 1 module is added at each end to

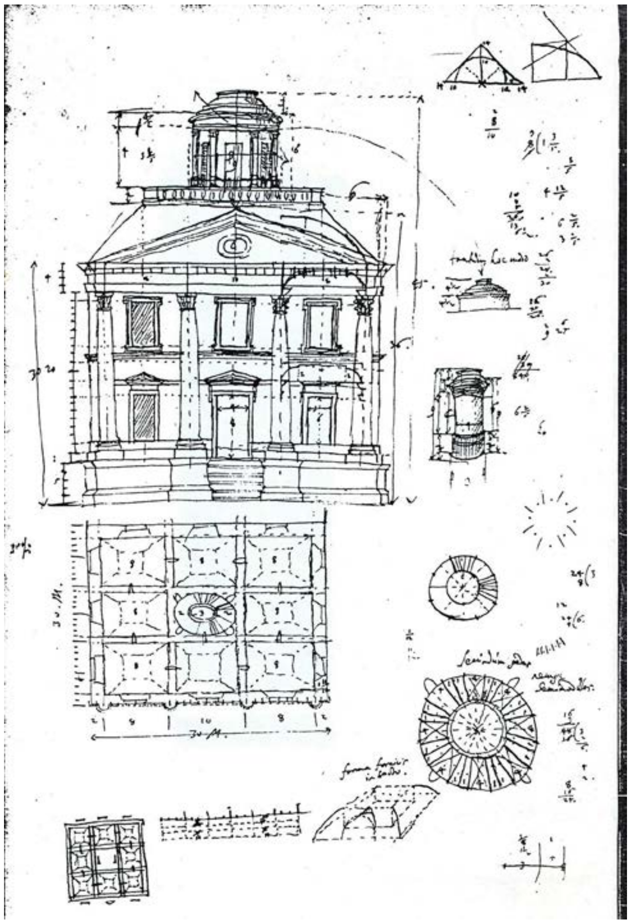


Fig. 2: Nicolaus Goldmann, sketch for a cubic villa (Berlin, Staatsbibliothek).

support the projecting parts of the bases and capitals of the outer pilasters.

The Schielandshuis design

Another important contemporary source for our understanding of seventeenth-century Dutch design practises is a drawing made by Jacob Lois of his design for the Schielandshuis in Rotterdam, built in 1662 (Meyerman 1987) (**Fig. 4**).

Ten years later, in 1672, the architect prepared a manuscript for a book on the history of this institution, which controlled the dikes and polders in the area. In this manuscript he included a drawing of the geometrical system of his facade design (**Fig. 5**).

At first glance this seems to be utter fantasy, but in fact Lois is just showing various steps of a very lucid design system presented all together in one drawing, as convincingly demonstrated by Terwen (1983: 172–173; Terwen and Ottenheym 1993: 218) (**Fig. 6 a–d**).

The starting point is two squares, creating a rectangle of 80 x 40 feet (a).[4] The circles used here are only an aid for drawing a perfect square. In a second step the root proportion of the left square is drawn, which creates the height of the attic zone (b) (meanwhile, the height of the basement below is found with the same square root, which is not drawn). In the third step the central projection is drawn, positioned precisely between the two squares, thus

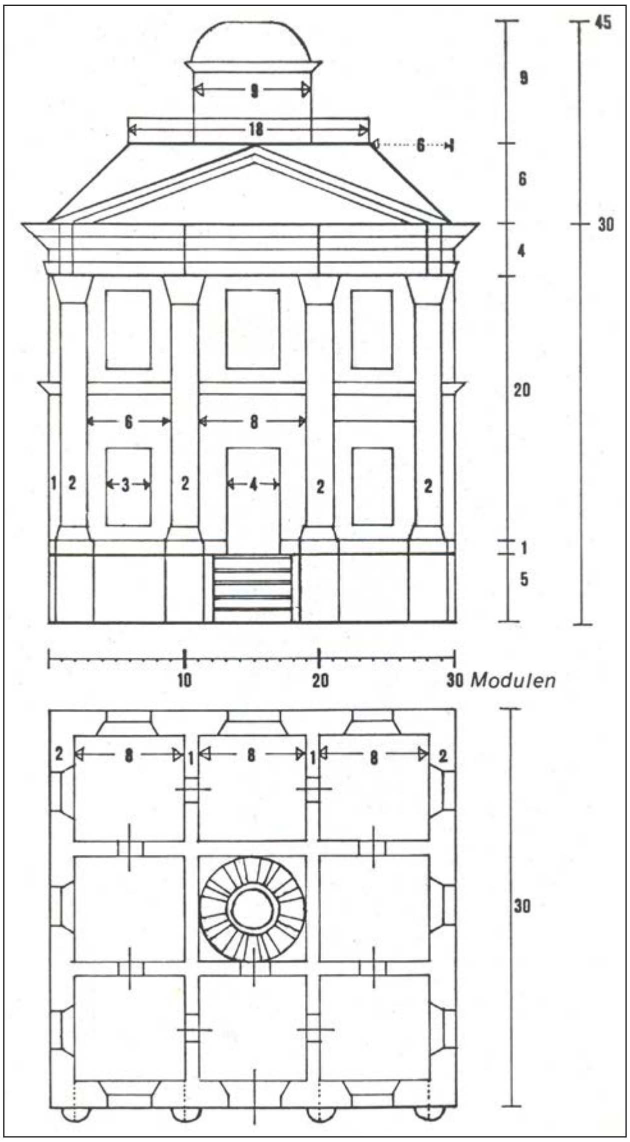


Fig. 3: Reconstruction to scale based on Nicolaus Goldmann's sketch for a cubic villa. Drawing by the author.

creating a façade rhythm of 20 – 40 – 20 feet. The circle drawn around the central square is in fact only used to find the height of the pediment on top of the central projection (c). Finally, the height of the roof is determined by an equilateral triangle while the central entrance is constructed according to a proportional system already published by Serlio in 1545 (Serlio 1545: chapter 1, fol. 13r) (d).

The floor plan of the Schielandshuis is a square of 80 x 80 feet. The division of the interior spaces behind the façade do not correspond to the bay system of the exterior. While the façade is divided into a sequence of 20 – 40 – 20 feet, as shown above, the ground plan behind it is divided into three bays with widths of 25 – 30 – 25 feet. Lois's drawing also shows various proportional systems for individual rooms, including two overlapping circles in the main assembly hall in the centre, indicating that this space has a proportion of 2:3, and the small room at the left side on the front with an indication of the proportion of 4:5. As far as we know these are the only examples of such geometrical systems based on intersecting circles drawn in interior spaces. Since interior measurements of individual rooms were mostly the result of the main grid minus the thicknesses of the walls and not the starting points of a proportional division, there is scarcely a whole number to be found with an evident proportional relation to the grid of the plan. But in this building design it seems that Lois wants to show his acquaintance with comparable ideas in Palladio's and Scamozzi's treatises and therefore presents things even more perfectly than they were. For instance, the great room at the left side is marked with two interwoven circles, suggesting this space has a proportion of 2:3; however, as the drawing shows, this system does not fit well in the room since it aligns not with the back wall but with a point just in front the chimney.

The preceding examples reveal some general principles. First, in the seventeenth-century Dutch method of mathematical design, the general outline of the volume or façade has to be found, preferably based on a rectangle that has been constructed by adding together squares. That base rectangle may be enlarged by volumes derived from rational or square-root proportions. Once these principal measures are defined, the classical orders are added, these being design elements of a second rank; and after these the other ornaments, if any. A grid system is used to organise the ground plan. Sometimes this is related to the geometry of the façade, sometimes it is not. The walls are drawn alongside the theoretical lines of the grid and as a result — because of the wall thicknesses — the actual interior spaces are never as perfect as those indicated in theory by the grid. These principles may be used as a starting point to investigate other design projects of the same period. Apparently, here we have a set of design tools that we may use to investigate seventeenth-century Dutch architecture without the risk of over-interpretation.

Some examples from the architect's drawing table

The proportional systems practised by Goldmann and Lois must have been rather common among those Dutch seventeenth-century architects who had a thoroughly artistic and scholarly education, like Jacob van Campen and his former assistants, Pieter Post and Philips Vingboons. There are no drawings of proportional systems from their hands, but there are carefully engraved prints made after their drawings that carry a lot of information. These prints always show many inscribed measurements which are the final results of a design system that is not illustrated. Considering the numbers inserted in these designs, which sometimes seem to be quite awkward or illogical, it may be possible to find the systems behind them.

The design drawings of the Amsterdam town hall by Jacob van Campen from around 1648, but only published posthumously in 1661 by his former drawing assistant Jacob Vennekool, constitute a well-known example of such engravings (*Afbeelding van't Stadt Huys van Amsterdam* 1661; Vlaardingerbroek 2011: 45–53). On the ground plans are many measurements indicating the lengths of the various parts of the interior in Amsterdam feet (one Amsterdam foot is 28.3 cm, which was divided

Fig. 4: Jacob Lois, Schielandshuis, Rotterdam, 1662. Photograph by the author.

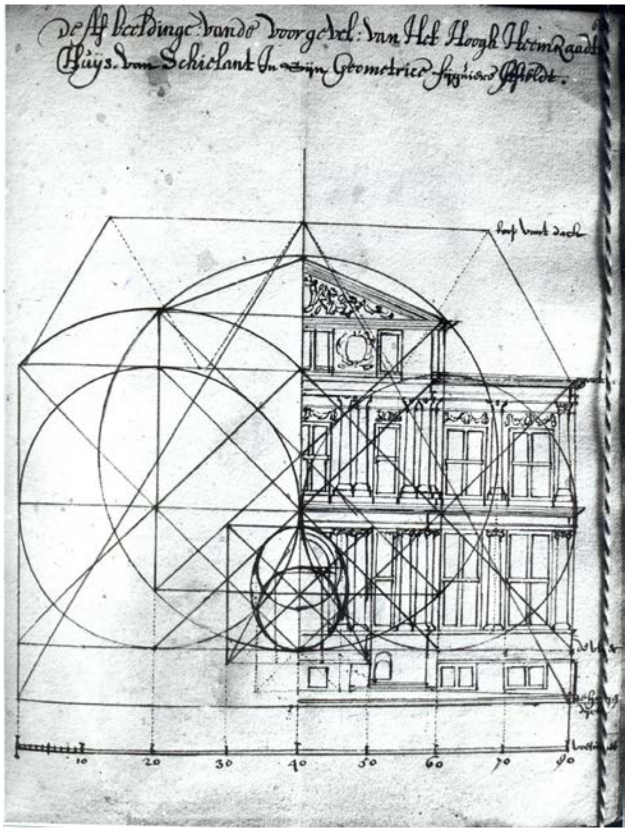


Fig. 5: Jacob Lois, proportion system of his Schielandshuis, from his manuscript *Oude en ware beschrijving van Schieland*, 1672, coll. Gemeentearchief Rotterdam.

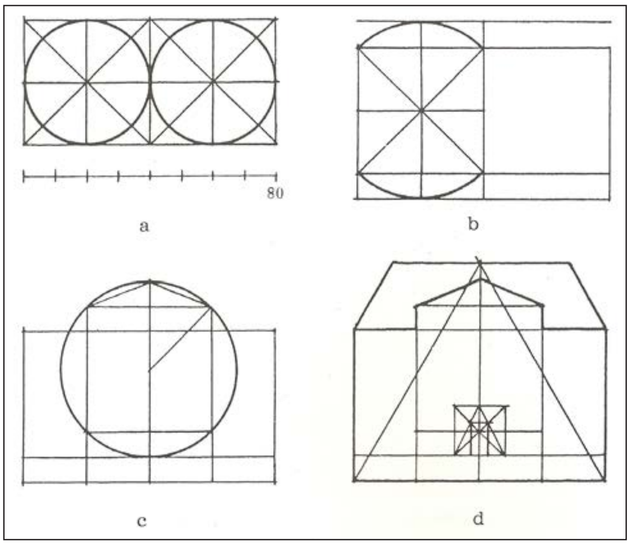


Fig. 6: Explanation of the four steps in Lois's drawing. Reproduced from Terwen (1983).

into 11 inches). The indications of the dimensions are very detailed, even more subtle than could be useful in practise, such as 33 feet and 9 1/17 inches, or 21 feet and 9 12/17 inches, and even 23 feet and 95/102 inches. These refined fractions have no practical justification and, as Wegener Sleeswijk demonstrated in 1940, are the result of a very elaborate but conscious arithmetical division of some basic measurements that lay at the origins of the design (Wegener Sleeswijk 1940) (**Fig. 7**).[5] The building measures 280 x 200 feet, overall. The corner pavilions are erected on square ground plans of 40 x 40 feet, and the central projecting pavilions at the front and back façades are each 80 feet wide, creating a rhythm along the Dam square of 40 – 60 – 80 – 60 – 40 feet. The main spaces of the interior are also organised along this pattern of units of 10 feet: the galleries are 20 feet wide, and the central hall, called the *Burgerzaal*, is 60 x 120 feet, etc. These decimal numbers, however, are not indicated in the engravings. Nevertheless, they are the starting point of a process of meticulous division of the various building parts into regular bays. All pilasters (of the main floor) are 3 feet wide and the bays are always close to 12 feet on centre, but in reality they are always a little bit smaller since they are not the stepping stones of the proportional system but just the result of the division of the decimal grid of the building as a whole.[6] For example, each outer wall of the corner pavilions is 40 feet wide and divided into three bays. The pilasters on the corners are positioned 6 inches from the edges of the pavilion. The remaining space of 38 feet 10 inches is divided into three bays (defined by four pilasters) resulting in a bay width of 11 feet and 10 2/3 inch. Another example: at the front façade the 200 feet between the corner pavilions is divided into 17 bays. At the far left and right in **Figure 7**, where the walls meet the corner pavilions, the pilasters are missing. As a result, the width of one bay in this part of the building is 11 feet and 10 6/17 inch.[7]

At the sides of the building the walls between the corner pavilions are each 120 feet long. The central part of

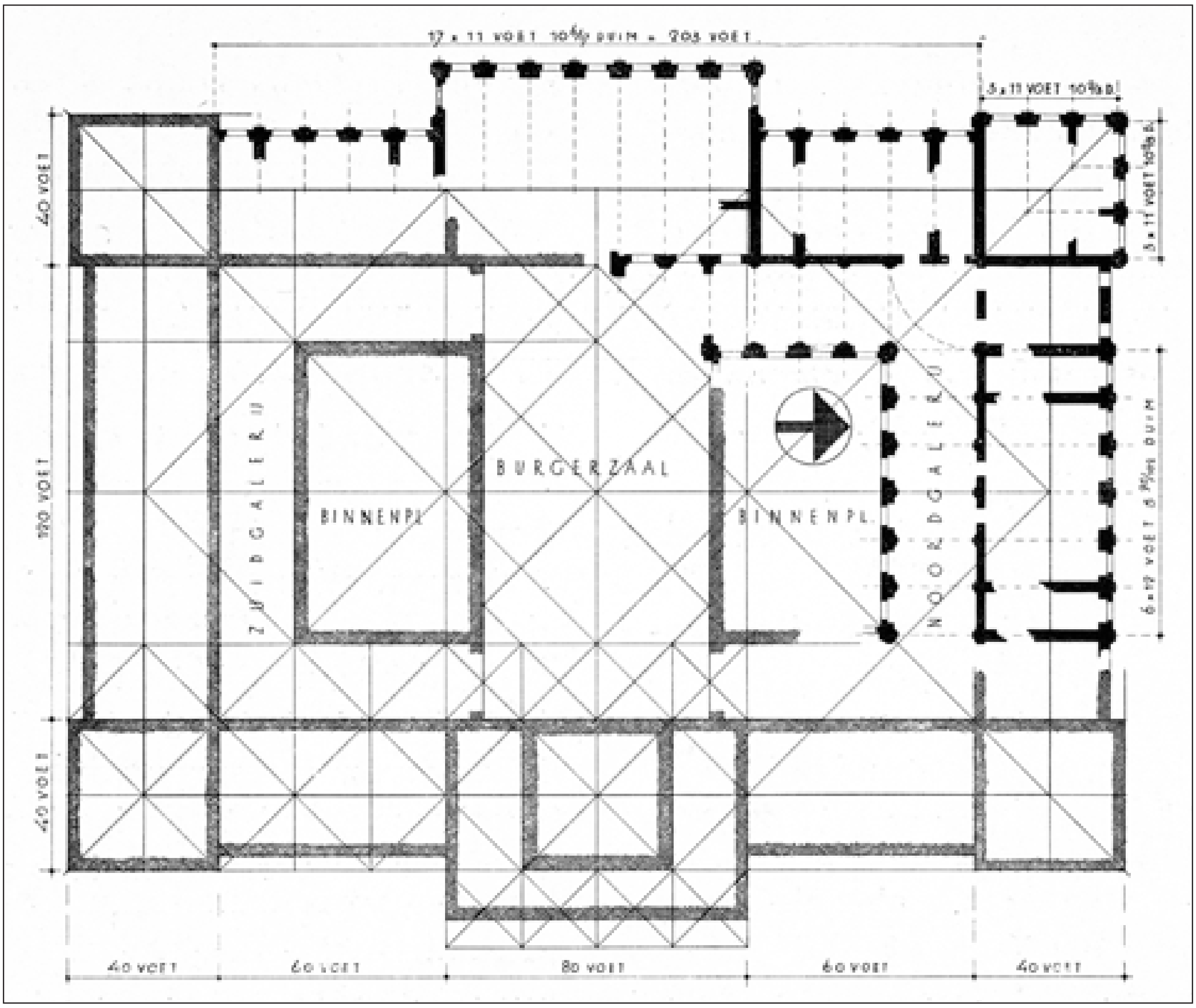


Fig. 7: Reconstruction of the grid system of the ground plan of the Amsterdam Town Hall and its division into bays (Wegener Sleeswijk 1940).

this wall in between is divided into 6 bays of 12 feet 5 95/102 inches each.[8] These kinds of measurements with their fractions were at the base of further divisions of interior spaces, creating the numbers indicated in Vennekool's prints. Comparable principles can be found in the prints published by Vingboons and Post, though without the meticulous fractional detailing ad absurdum.

Vingboons's villa of 1648

Philips Vingboons concludes his 1648 publication, *Afbeelsels der voornaemste gebouwen uyt alle die Philips Vingboons geordineert heeft* ('Illustrations of the most important buildings designed by Philips Vingboons'), with two unrealised and even unrealistic villa projects (Vingboons 1648: pls. 53–59) (**Fig. 8**).

He is well aware that these projects are beyond the usual scale of construction demanded by his Dutch mercantile patrons. Apparently, these projects represent true *capriccio* merely to show his capacity to master the ideal of a grand country house with perfect proportions. In one of these projects, he explains: 'perhaps this design is too grand and expensive but we may build it in the same system on a lesser scale' ('al is 't begrijp wat groot, en de Huysingh kostelijck toegestelt, kan echter wel op een geringere en kleynder manier herstelt worden en evenwel dese verdeelingen houden'), which means, on a smaller scale but using the same proportional system (*verdeelingen*) (Vingboons 1648: caption to pls. 56–59). The villa depicted on his plates 53 to 55 is based on a square of 96 x 96 feet, enlarged with central projections at all four sides, 48 feet wide and 12 feet deep, creating façades with lengths of 120 feet on all sides, divided into 12 – 24 – 48 – 24 – 12 feet, or a proportion of 1:2:4:2:1 (**Fig. 9a**).

The height of the façade, from the pavement of the ground floor up to the cornice, is also 48 feet, plus another 5 feet from the raised basement to the pavement. The result is that the front of the central projection, measured from the pavement of the ground floor, fits inside a square of 48 x 48 feet. This square is flanked on each side by walls of 24 x 48 feet, and beyond them, further back in the distance, additional side walls of 12 x 48 feet (**Fig. 9b**).

In the ground plan of 120 x 120 feet we find two interwoven ratios: a system in which these 120 feet have been divided into 10 units of 12 feet (like the exterior), and a

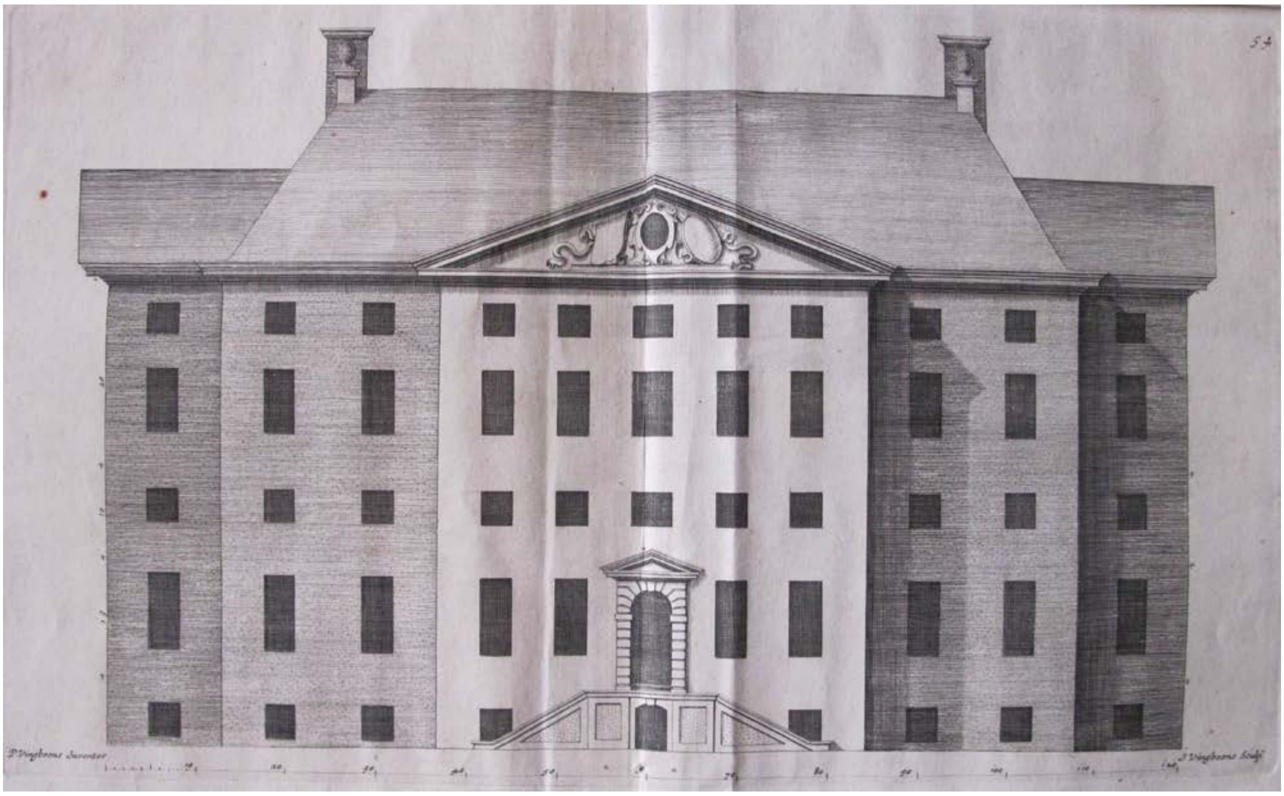


Fig. 8: Philips Vingboons' 'ideal' villa, published in his *Afbeelsels der voornaemste gebouwen uyt alle die Philips Vingboons geordineert heeft* of 1648.

second system that divides them into 8 units of 15 feet. These two divisions create the possibility for manifold proportions of the internal spaces, such as 12 x 12, 15 x 15 and 15 x 30, but also combinations of both systems, such as 12 x 15 (4:5), 15 x 24 (5:8) and 24 x 30 (4:5). For instance, the entrance hall is drawn on this grid as 48 x 30 (8:5), both spacious side rooms as 30 x 50 (3:5), and the main salon at the rear, 48 x 45 feet (16:15). These interior measurements are all theoretical proportions, created by *lines* rather than actual *walls*. In reality these proportions are far less 'mathematically perfect' because of the thicknesses of the walls that are constructed alongside the theoretical lines.

The Town Hall of Maastricht

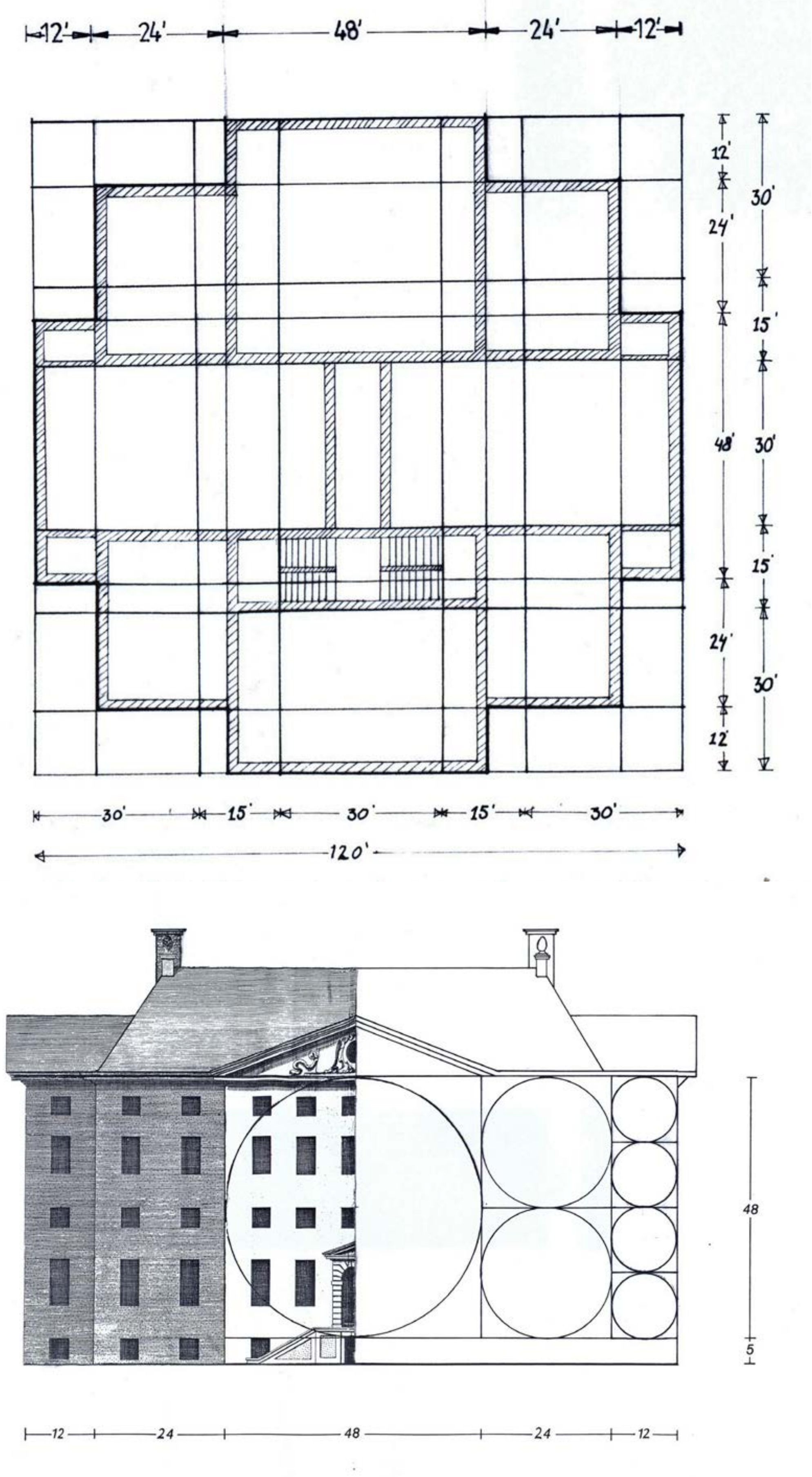
This grid-based system of design, as shown in the preceding theoretical design by Vingboons, may be productively compared with the design of an actual building, the Town Hall of Maastricht, designed in 1656 by Pieter Post and built from 1659 to 1664 (**Fig. 10**).

This investigation is based on the original design as published by Post himself in 1666 (De Heer and Minis 1985; Terwen and Ottenheym 1993: 176–182, 226–227).[9] It is a freestanding square building, centrally located on a market square. Its ground plan measures 100 x 100 Rijnland feet (see note 4), divided into two intersecting grids of 25 x 25 feet and 33 1/3 x 33 1/3 feet (**Fig. 11**).

The front façade of 100 feet is divided by two interwoven central projections of 50 and 33 1/3 feet into ratios of 25:50:25 feet and 33 1/3:33 1/3:33 1/3 feet. The first and second storeys together are also 33 1/3 feet high, situated on a ground floor of 13 1/3 feet, which can be derived, in approximation, from the ratio 1:√2 (as shown in **Fig. 11**). In the interior plan, the central hall is based on the 25-foot grid system and measures approximately 50 feet wide and 75 feet long, surrounded by various rooms, each with at least one side measuring almost 25 feet. This main space is surrounded by a gallery that connects the rooms of the upper floor. Within the main hall is situated the substructure of the central tower, measuring 33 1/3 x 33 1/3 feet in its outside dimensions (this central space, covered by a dome with an open oculus, also served as the high court of justice). Again, the real measurements of the internal spaces are less perfect than the published ones due to the thicknesses of the walls that are situated alongside the mathematical system's lines. The proportional system has been used to facilitate the division of the overall floor plan in a logical way, not for creating perfectly proportioned individual rooms.

Adriaan Dortsman's drawings for Finspång Castle in Sweden

With examples of Goldmann, Lois, Vingboons and Post at hand, it seems the design toolbox of the qualified Dutch seventeenth-century architect was primarily focussed on the exterior measurements of the building volume. To take the external silhouette as the starting point of the design makes sense if we presume it was important above all to create a convincing impression of balance and order for spectators and visitors of the building. But in the meantime there were other possibilities as well, as illustrated by a set of drawings by Adriaan Dortsman, overlaid



Figs. 9: a, b) Reconstruction of Vingboons' design system for the villa of 1648. Drawing by the author.

Fig. 10: Pieter Post, Town Hall, Maastricht, 1656. Photograph by the author.

with proportional grids that show another attitude. These are the designs for the floor plan of Finspång Castle in Sweden, the country house and centre of an industrial development built by Louis de Geer the Younger in 1670 and subsequent years (**Fig. 12**).[10]

Dortsman created the drawings in Amsterdam between 1669 and 1670, who did not visit the building site but sent his drawings to Sweden by mail (Noldus 1999; Noldus 2004: 163–169). The castle was constructed almost exactly according to his designs by local craftsmen and perhaps some Dutch building masters at the site.

The starting point of the design is a square grid of 75 x 75 *ell*, which is approximately 40 x 40 meters, divided into units of 5 x 5 *ell* (**Fig. 13**).

In small notes on the drawing Dortsman explains that 1 *ell* is equivalent to 20 Amsterdam *duim* (inches), which makes 1 *ell* equivalent to 1 9/11 Amsterdam feet, or 1 2/3 Rijnland feet. Therefore, one unit of 5 *ell* contains 100 *duim*, a convenient start for further detailing. The architect also informs us that the module (*moduul*) is 2 1/2 *ell*, or 50 *duim*. It was used for the widths of the window openings and the wall piers between the windows. The floor plan of the castle is designed on this grid system. The primary building volumes are based on units of 15 x 15 *ell*: the corner pavilions both at the front and rear are 15 *ell* wide, and the space in between, 45 *ell* wide, is divided into three bays of 15 *ell* widths each. The central spaces — the hall and the circular salon — and the rooms along the side walls are all 15 *ell* wide, and the bays framing the central hall are divided into chambers 10 *ell* wide, plus a 5-*ell* corridor. This rhythm is also reflected in the façade with its two corner pavilions of 15 *ell* wide and a central projection of 15 *ell* flanked by slightly inset walls of 15 *ell* wide.

The internal walls are 1 *ell* thick, and the outer walls, 1 1/2 ell. An essential difference with the previous examples of proportional systems lies in the position of the walls on the grid. Unlike the examples discussed above, here the grid line is in the wall, not alongside it. It is right in the middle of the interior walls with 10 *duim* of wall thickness at both sides. At the outer walls there is 10 *duim* of wall thickness at the interior side and 20 *duim* at the outer side (**Fig. 14**).

Therefore neither the actual measurements of the internal spaces nor the exterior dimensions of the building correspond with the proportional system of the grid. For example, the facade is not 75 *ell* wide equally divided into five parts of 15 *ell* but instead 77 *ell* divided into five parts: 17 *ell* – 13 *ell* 11 *duim* – 15 *ell* 18 *duim* – 13 *ell* 11 *duim* – 17 *ell* (17 *ell* for the corner pavilions, 15 *ell* 18 *duim* for the central projections and 13 *ell* 11 *duim* for the walls in between). This is not based upon any proportional system but is simply the result of the fine tuning of the design once its outlines were established by the grid: the outer walls of both corner pavilions gained additional thickness and the central projection was embellished by pilasters detailed according to Scamozzi's rules, Doric on the ground floor and Ionic on the upper level.

This grid of squares of 5 x 5 *ell* is apparently a useful design system to bind the whole composition of the ground plan together within a strict logic. It is not used for the elevation. This proportional system appears to have been intended neither to create perfect spatial proportions inside nor at the exterior, unlike the previous examples. This proportional system appears to be merely a design tool for achieving coherence and balance in general.

Conclusion

To most builders in seventeenth-century Holland the introduction of the classical architectural style according to Palladio and Scamozzi simply amounted to a change of ornament. Only among a small group of architects, including Jacob van Campen, Pieter Post and Philips Vingboons, and some of their patrons, were the theoretical principles of this new kind of architecture seriously studied. The examples discussed here were selected from this limited group. To these architects, the true principles according to 'the proportions and rules of the Antique' ('de liefde tot de Bouwkunst, op maet en regelen der Ouden'), to quote Vingboons from his 1648 publication (Vingboons 1648: Dedication to the burgomasters of Amsterdam), was not just a hollow phrase but the clue to a rather strict and clear design system for all kinds of buildings. Encouraged by texts by Vitruvius, Palladio, Scamozzi and others pointing to the importance of mathematical order in architecture, the small group of classicist architects in Holland developed their own proportional systems that are not merely copied from those treatises. However, their systems, as far as we may reconstruct them today, seemed to facilitate creativity within specific limits containing possibilities for manifold variations.

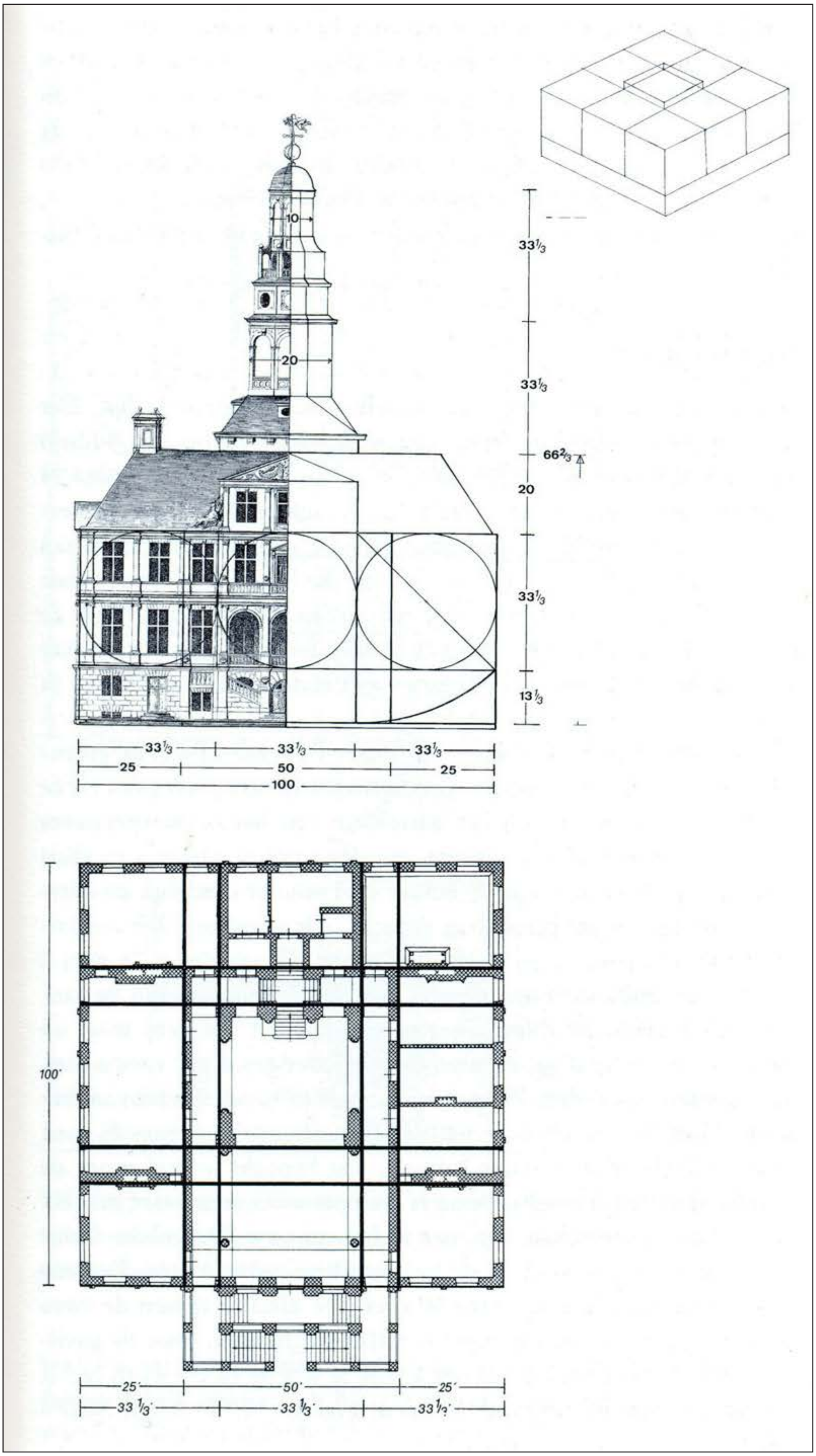


Fig. 11: Reconstruction of Pieter Post's design system for the Maastricht town hall. Drawing by the author based on Post's publication of his town hall design of 1664.

Fig. 12: Adriaan Dortsman, Finspång Castle, Sweden, 1669–1670. Photograph by the author.

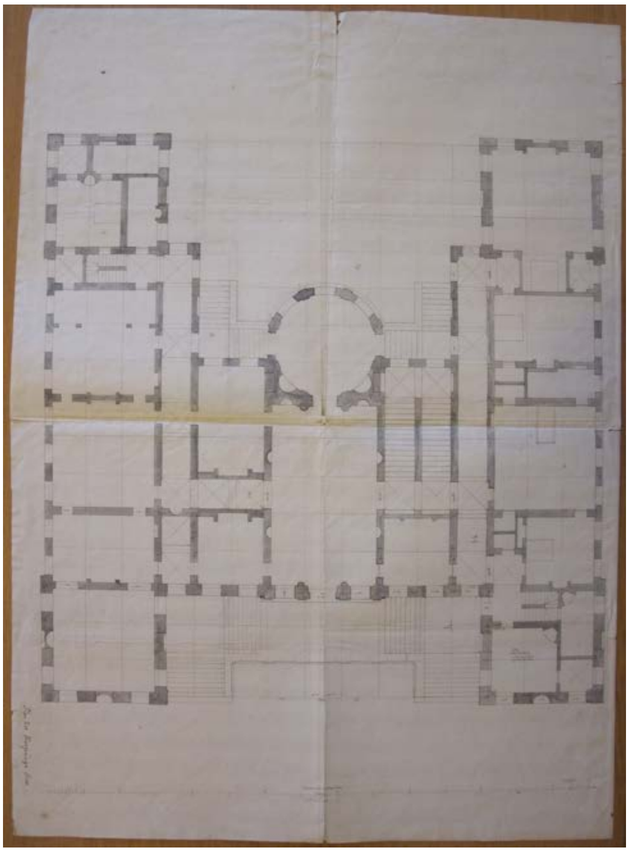


Fig. 13: Adriaan Dortsman, Finspång Castle, ground plan on a grid of 5 x 5 *ellen*. Stockholom, National Museum, TH coll. inv. nr. 2989.

The general outline of the building volume or the façade was the first concern of the design systems, preferably based on whole, perhaps even decimal, numbers, as demonstrated by the various examples. The classical orders were added afterwards. A grid system, not only of squares but sometimes of rectangles, was used to organise the floor plan. In general the outer lines of the grid are coincident with the exterior of the outer walls, while the interior walls are situated alongside the grid. The example of Finspång, however, shows that the grid could also be used to mark the centre lines of the walls. Proportional systems may differ in time and place and we are well aware there is no universal system that can be imposed on the history of architectural design in general. Even within one period and within one peer group of architects, we must be careful not to look for general solutions as these case studies demonstrate.

Finally, the question remains whether or not these kinds of design systems had anything to do with aesthetic thoughts of Dutch seventeenth-century patrons or architects. Sources to answer this question are scarce. Once again it is in the writings of Constantijn Huygens that we find hints to the tradition begun by Alberti two centuries before, where the essentials of classical architecture are not the five orders or other ornament, but the harmony of proportion of the design. In the minds of Huygens, Van Campen and their circle, the antique idea of macrocosmic harmony as the divine principle of universal beauty was still rather vivid (Goossens 2010). In his texts and poems Huygens discusses the beauty of regularity and right angles in urban designs of his home town, The Hague, as well the qualities of symmetry and musical proportions in architecture (Ottenheym 1999b). For instance, in his elaborate poem on Hofwijk, his small country house near The Hague, he praises symmetry and axial order as one of the prime principles in architecture and gardens, comparable to the divine design of human beings.

> There is a central axis, dividing Hofwijk into two parts, the left side is exactly the same as the right side.
> [...]
> He who negates this division, despises himself above all as well as the most beautiful creature of God. Before I started digging
> I took a wise lesson as guideline for my work:
> I just regarded my own body, that was enough.
> (Huygens 1653: vs. 969–970, 977–980; translation by the author)

From his point of view, symmetry, balance and order were basic necessities for decent architecture. On the other hand, he abhorred oblique angles and irregularities:

> Wherever I looked, I couldn't find any rule better than this one. Away, I shouted, away with oblique angles and irregularity, and cross-eyed disorder.
> (Huygens 1653: vs. 784–787)

Several years before he described the discussions about the creation of a new urban quarter in The Hague, where Huygens and the Prince of Orange opposed an earlier plan by the local authorities with an irregular layout of streets instead of an open square, as a battle of compass and ruler against outrageous errors and injustice forces (Huygens 1637: fol. 739v: 'angulos in obliquos deformari, monere me cum animi quondam impetus memini [...] turpiter et iniquo vim inferri normae simul et amussi; [...] atque hoc, ut par erat, suffragio tandem funis ac dioptre pervicere'; Blom, Bruin and Ottenheym 1999: 16). Such remarks, of course, seem to echo Scamozzi's advice

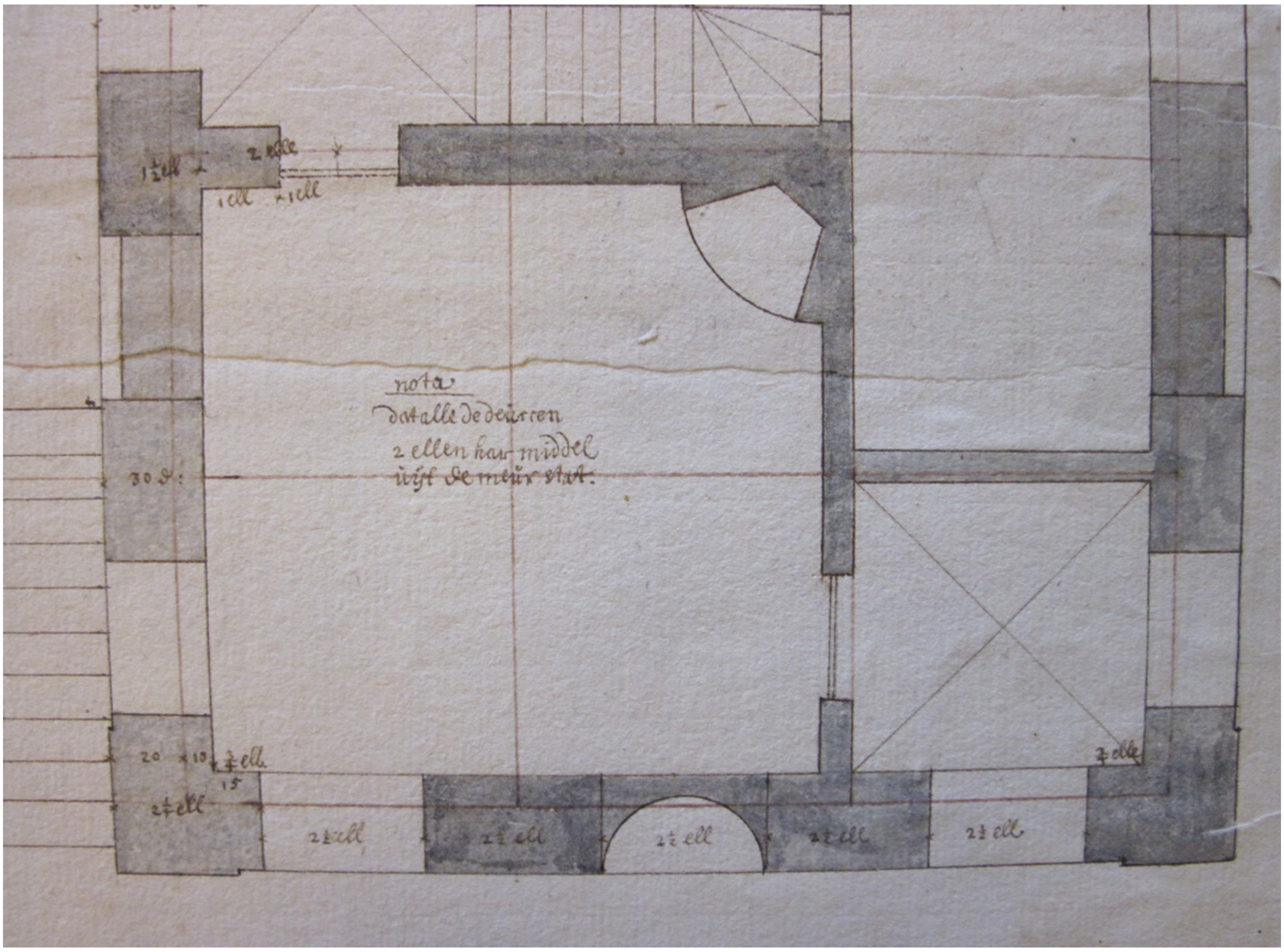


Fig. 14: Adriaan Dortsman, Finspång Castle, detail, ground plan on a grid of 5 x 5 *ellen*. Stockholom, National Museum, TH coll. inv. nr. 2989.

that an architectural design should be composed as regularly as possible, with straight lines and right-angled corners ('e per lo piu di le line rette') while oblique angles and slashes would cause 'brutezza alla vista' (Scamozzi 1615: Libro 1, 46).

Being a gifted musician, Huygens also studied theoretical connections between principles of musical harmony and architecture, like those presented by Daniele Barbaro in 1556 in his commentary on Vitruvius (Barbaro 1556).[11] Huygens and other Dutch scholars also had a lively interest in Henry Wotton's synoptic publication on architecture of 1624. Huygens had been acquainted with Wotton from the time the latter had been the English ambassador in The Hague. Wotton formulated a logical system of proportions, in which the rules of mathematics, musical harmony and architecture converged, 'reducing symmetrie to Symphonie, and the harmonie of Sounde, to a kinde of harmonie in Sighte' (Wotton 1624: 53). In the late 1630s the architect Jacob van Campen joined Huygens in his study of Vitruvius and all related later treatises, including Villalpando's publication on the Temple of Jerusalem (Villalpando and Prado 1596–1604, vol. 2), regarded as the divine origin of classical architecture.[12] In the early 1640s they even intended to publish a Dutch edition of Vitruvius, with a translation of Wotton's treatise as an introduction and Barbaro's explanation of the principles of musical harmony as an addendum (Ottenheym 1999b: 95–96).[13] We may expect to find a comparable scholarly mentality in Van Campen's thinking about architectural beauty. In his Amsterdam Town Hall he gave prominent place to a marble relief relating the classical legend of the foundation of Thebe, where the stones were moved by the force of the harmony of Amphion's lyre.

Presumably Huygens' and Van Campens' engagement with classicist theory was exceptional. Elsewhere in the Dutch Republic as well, order and regularity were regarded as desirable qualities. To the civic elite of the Republic and their architects, classicist architecture may well have been regarded as an expression of social order, class and style, but to what degree they shared Huygens's scholarly ideas on universal beauty is uncertain. The use of proportional grid systems in their architectural drawings may have been merely a design tool.

Notes

1. This article is partly based on an earlier conference paper focussed on the designs by Philips Vingboons (Ottenheym 2009).
2. For other detailed examples of the use of proportional systems by Post and Vingboons, see Ottenheym (1989: 162–172), and Terwen and Ottenheym (1993: 220–237).

[3] See also the contribution by Jeroen Goudeau to this volume.

[4] The Rijnland foot was the most common scale in the Dutch Republic during the seventeenth and eighteenth centuries. It measures 31.4 cm and is divided into 12 *duim* (inches). But this scale was not used in Amsterdam, which had its own foot of 28.3 cm divided into 11 *duim*.

[5] Wegener Sleeswijk was one of the assisting architects of the 1935–1939 restoration of the former Town Hall; see Vlaardingerbroek (2011: 216).

[6] Unlike the columns from which they originate, the shafts of these pilasters do not have an entasis; they have the same width on top and below. According to Scamozzi, in the Composite order the width on top is 6/7 of the width at the bottom of the shaft. At the Amsterdam town hall, as in most other cases in Dutch seventeenth-century classicism, the size on top became the standard for the whole shaft. Nevertheless, for finding the right proportion between the width of the pilaster and its height, the modulus of the original column was used (7/6 of the width of the pilaster).

[7] To find the width of one bay one should theoretically add one pilaster of 3 feet to the length of 200. Thus 203 feet divided into 17 gives a width of 11 feet 10 6/17 inches for each bay. This is what Wegener Sleeswijk did in his drawing (our **Figure 7**) — in fact including a part of the corner pavilions.

[8] This part of the wall measures 75 feet 2 10/17 inches; divided into 6 this makes 12 feet and 5 95/102 inches per bay. See Wegener Sleeswijk (1940).

[9] The architect did not supervise the construction, since the city of Maastricht was 200 km away from his home town of The Hague, and the final result thus differs in many details and in essential proportions from the design. In 1664, when the building was finished, Post published his own original designs in a series of engravings.

[10] Stockholm, National Museum, Tessin-Hårleman collection, inv. nrs. 2951, 2959, 2988, 2989.

[11] Barbaro's notes on the relations between architecture and music were also incorporated into the Vitruvius edition compiled by Johannes De Laet in 1649 (*M. Vitruvii Pollionis de architectura libri decem*, Amsterdam 1649). See Ottenheym (1998).

[12] In 1628 Samuel Marolois presented in the introduction of his treatise *Architectura, dat is Bouwkunst* (Amsterdam 1628), a reconstruction of the history of architecture, using Villalpando's ideas on the divine origin of classical architecture in biblical antiquity. Also, Salomon de Bray referred to the biblical origin of architecture in his foreword to the *Architectura moderna* (1631); see also Ottenheym, Rosenberg and Smit (2008: 30–31).

[13] This book project came never to an end and Huygens' concept for this publication was finally taken over by De Laet in his Vitruvius edition in Latin, 1649. See above, note 11.

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