RESEARCH ARTICLE

Between Looking and Making: Unravelling Dom Hans van der Laan's Plastic Number

Caroline Voet[*]

Between 1920 and 1991, the Dutch Benedictine monk and architect Dom Hans van der Laan (1904–91) developed his own proportional system based on the ratio 3:4, or the irrational number 1.3247. . ., which he called the plastic number. According to him, this ratio directly grew from discernment, the human ability to differentiate sizes, and as such would be an improvement over the golden ratio. To put his theories to the test, he developed an architectural language, which can best be described as elementary architecture. His oeuvre — four convents and a house — is published on an international scale. His buildings have become pilgrimage sites for practicing architects and institutions that want to study and experience his spaces. His 1977 book *Architectonic Space: Fifteen Lessons on the Disposition of the Human Habitat*, translated into English, French, German and Italian, still inspires architects today, as does his biography, *Modern Primitive*, written by the architect Richard Padovan in 1994. But beyond the inspiration of his writings and realisations, the actual application of the plastic number in Van der Laan's designs is unclear. Moreover, Van der Laan's theories seem to be directed towards one goal only: to present the plastic number as the only possible means by which eminent architecture can be achieved, making them a target for suspicion and critique.

To understand and evaluate Van der Laan's application of the plastic number, this paper approaches it as a practical design tool. It analyses its genealogy and defines its key concepts. From that framework, Van der Laan's architectonic space is interpreted as a design methodology that combines antique tectonic theories reminiscent of writers from Plato to Vitruvius with more recent atectonic approaches towards space through experience and movement.

Introduction

> I believe that the secret of the language of architecture does not lie in the being of space itself, but in the way in which we connect to it.
>
> Dom Hans van der Laan (VDL C1 1940: 3)[1]

Between 1920 and 1991, the Dutch Benedictine monk and architect Dom Hans van der Laan (1904–91) developed his own proportional system. Just as the Benedictine monk Dom Mocquereau (1849–1930), in the beginning of the twentieth century, defined a universal notational system to restore Gregorian chant, called 'le nombre musical', Van der Laan set out to develop a universal ordering system to restore architecture: 'le nombre plastique' (the plastic number) (Mocquereau 1908, 1927; Van der Laan 1960: Introduction). Strangely enough, this 'plastic number' did not entail a number, but a series of numbers based on the ratio 1.3247. . . approximated as 4:3.[2] According to Van der Laan, this ratio grew directly from discernment, the human ability to differentiate sizes, and as such would be an improvement over the golden ratio. To put his theories to the test, Van der Laan developed an architectural

language, which can best be described as elementary architecture.[3]

His oeuvre of only four convents and a house is published on an international scale (**Fig. 1**). They have become pilgrimage sites for practicing architects and members of various institutions who want to study and experience his spaces.[4] His 1977 book *De Architectonische ruimte: Vijftien lessen over de dispositie van het menselijk verblijf* (*Architectonic Space: Fifteen Lessons on the Disposition of the Human Habitat*), translated into English, French, German and Italian, inspires many architects still today, as does his biography *Modern Primitive*, written in 1994 by the architect Richard Padovan, who had earlier translated *De Architectonische ruimte* into English (Van der Laan 1977; Padovan 1994).

To critically evaluate the plastic number and Van der Laan's theory of architectonic space, it is necessary to address the problem of the mythical image that Van der Laan created for himself. Van der Laan believed that architecture produced meaning through its affective qualities, and he saw his proportional system as an essential contribution to producing such meaning. Indeed, beyond presenting his plastic number as a design tool, Van der Laan aimed to elevate it to the status of a philosophical principle, and this aim dominated almost all of his writings. The Belgian philosopher André Van de Putte described

* KU Leuven, Faculteit Architectuur, Campus St. Lucas, BE
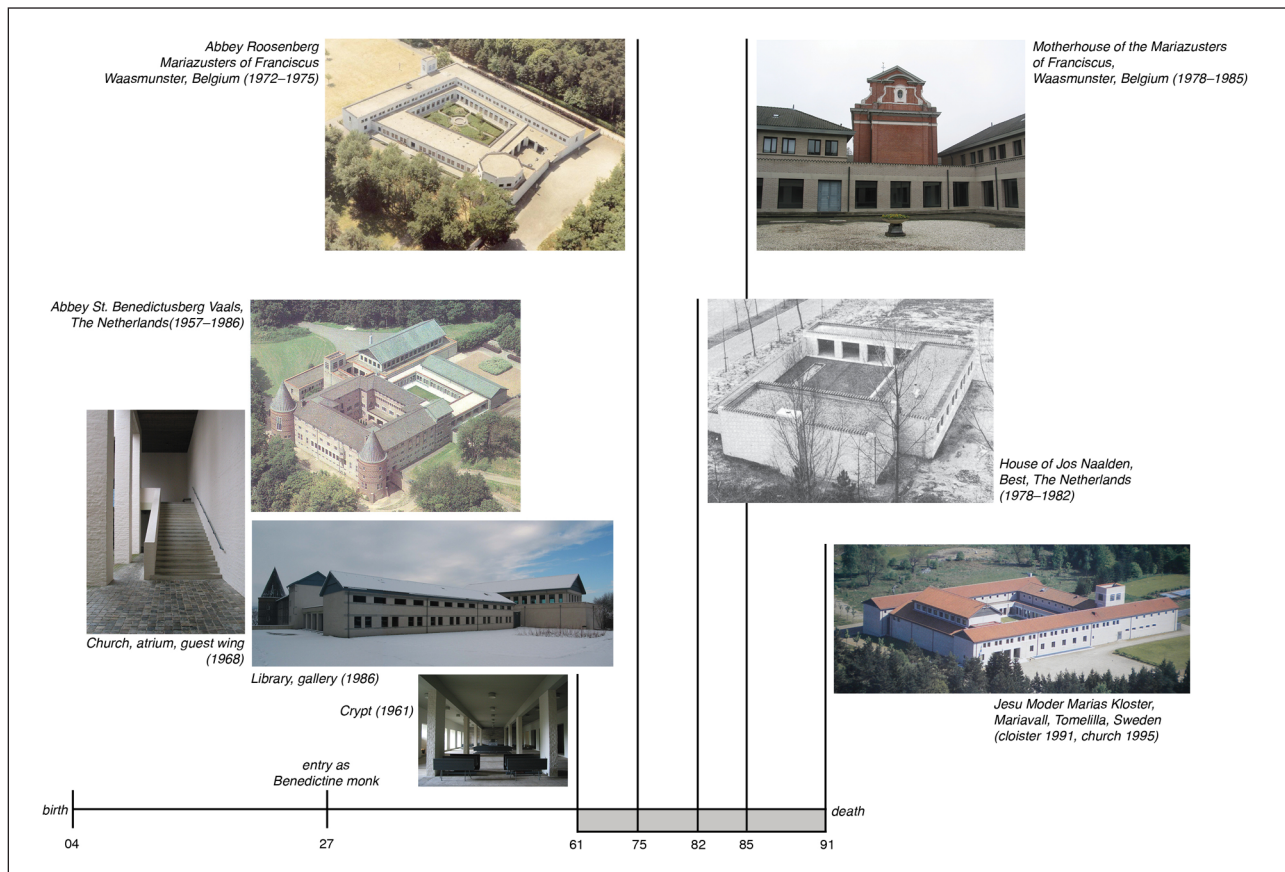 voetcaroline@gmail.com

Figure 1: Overview Dom Hans van der Laan's elementary architecture, 1961 to 1995. Aerial photos are courtesy of the abbeys. Other photos by the author.

Architectonic Space as philosophical as well as phenomenological poetics.[5] Nevertheless, Van der Laan's poetics of architecture seems to be directed towards one goal only: to present the plastic number as the only possible means by which this architecture could be achieved, making it a target for suspicion and critique. When Van der Laan introduced his theories, before he had developed his elementary architecture, critics, including Geert Bekaert, labelled them rigid and dogmatic (Bekaert 1957: 59). Also, there are no references or comparisons in Van der Laan's discourse, which denies useful critical positioning.

In this paper, I will demonstrate that the plastic number is a practical design tool, by expanding upon Van der Laan's attempts to elevate it to a philosophical principle. Van der Laan's design methodology and philosophy, though reinforcing and even legitimizing each other in *Architectonic Space*, are actually two different entities and need to be evaluated as such. I will first analyse the genealogy of the plastic number. I begin with unpublished source material, including Van der Laan's personal correspondence and lecture notes. From them I define key concepts used by Van der Laan to shape the plastic number. I avoid interpreting it as a sort of magical proportion, and instead approach it simply as a sequential series of numbers and ratios. Comparisons with the golden section and Le Corbusier's Modulor will help to define the plastic number. I will then interpret Van der Laan's architectonic space as a design methodology that combines antique tectonic theories reminiscent of writers from Plato to

Vitruvius with more recent atectonic approaches towards space through experience and movement.[6]

Reading Space: Measuring Spatial Dimensions Through Counting

The main question dominating Van der Laan's life from his early youth onwards was, 'How can I know things as they are?' Knowing, as a continuous process of cognition between ratio and perception, for Van der Laan meant ordering, and architecture had the fundamental task of facilitating this process of ordering. In a letter to his biographer Richard Padovan, he defined the difference between 'the natural spatial phenomenon as it is and the space as we humans perceive it' (VDL C2 1983). He explained, 'I separate these two spatial phenomena one from the other and I call the first objective because it concerns everybody, and the other subjective because it concerns myself' (VDL C2 1983). After differentiating these phenomena, Van der Laan devoted himself to finding a relation between them by analysing the intuitive process of cognition that interweaves the concrete sensorial perception and the abstracting intellect. He aimed to bond the surrounding space to the space of our experience. Only this bond, he believed, enabled the experience through our senses of space as it is.

The key to achieving this bond, this transformation of phenomena from the sensorial to the abstracting ratio, was the creation of a perceivable order in space, a spatial system governed by proportional relations. According

to Van der Laan, one intuitively placed oneself in relation with one's surroundings, reading the surroundings by relating the measurements of objects to each other. Relations were made through comparison and differentiation. When understanding a space through perception, one measured it, not with measuring equipment, but with one's eyes. Natural space, however, consisted of endless continuous quantities that could not be measured as such. In order to measure, one had to abstract these continuous quantities into discrete quantities expressed in whole numbers.[7] Measuring the continuous quantity of spatial dimensions was done through counting and this for Van der Laan was the foundation for a spatial order. Intuitively one estimated sizes by choosing a yardstick as a basis for the 'counting' of space. As the mathematician Gottfried Kruijtzer pointed out when describing Van der Laan's theory, 'Measuring becomes counting through pacing out' (Malschaert and Oldenburger 2011: 33).

Van der Laan defined the fundamental function of architecture through its direct connection with the process of cognition: to make space readable. To inhabit a space (*bewonen*) meant to relate oneself to that space through 'counting' it. As such, architecture needed to be the embodiment of the process of counting. He defined this function as the 'expressiveness' of architecture, as its most essential element. 'Expression serves to open the forms to the intellect,' he wrote (VDL C2 1983). For Van der Laan, a space became a house when one could relate oneself to its dimensions, when there was a bond between this space and the experience of space: 'A house is the reconciliation of the objective and the subjective space' (VDL C3 1983).

These theories of space and perception were more intertwined with Van der Laan's Benedictine background than with the architectural scene of his time. After three years of architectural study in Delft, in 1927 Van der Laan entered the Benedictine St. Paul Abbey in Oosterhout, the Netherlands. The monks organised their life according to the rules of St. Benedict, which centred all thoughts and actions around the concept of 'ora et labora', a clearly defined repetitive succession of prayer through contemplation, Gregorian chant and work. Every day was rhythmically ordered around seven periods of prayer, but the other moments and modes of communication and silence or contemplation were also clearly ordered. All of this alternated with manual labour and study. Recreation was also orchestrated: outside walks were done in *wagens* (carriages), two lines of about ten monks facing each other, walking up and down the garden lanes, some walking backwards, the others forwards (Remery 2010: 48). Besides its focus on prayer, Benedictine life was marked by an attention to a wide range of crafts, to provide for its own needs. As a novice, Van der Laan was active in the vestment workshop, making liturgical garments. Alongside the process of developing sewing skills, he conducted research on historical vestments, abstracting and designing sewing patterns. Already at this point, Van der Laan hovered between contemplation and manual labour, developing a relationship between a concrete object and the act of making.

His ideal was to maintain the spirit of the liturgical prayer in his daily activities (VDL C4, 1942). He followed the advice provided by Dom Guéranger (1805–1875), the spiritual leader from Solesmes, to honour God with concrete actions and objects. Guéranger regarded nature as disorderly, as a part of the mystery that could not be understood. But every human action and creation enabled a relationship with God. In that light, for Van der Laan every gesture, every object, its use and its function, became a liturgy and bore a spiritual character. Through his initiation into the Benedictine neo-Thomist tradition, his main question, 'how do we know', was fed by the thoughts of Thomas Aquinas. Thomas' concept of *vis cogitativa* helped Van der Laan define the relationship between the intellect and the senses: *nihil est in intellectu quod non sit prius in sensu* ('nothing is in the intellect which is not first in the senses').[8] Van der Laan regarded art, or architecture, as a concrete thing, a means that could lead to intellectual insight as described by Thomas Aquinas. It was the artist's or architect's task to define an order in nature so that it could be read and understood. Although Van der Laan only started teaching after 1945, in 1939 he began to engage in a discussion group in Leiden initiated by his two architect brothers, Jan and Nico van der Laan. From then on he started writing down his theory of proportion in small notebooks. These, together with his correspondence to his younger brother Nico, give an account of Van der Laan's motivations and sources.

In the beginning of the twentieth century, designing through proportion was very much alive. Architects such as Hendrik Petrus Berlage and Mies van der Rohe were inspired by the geometrical studies of Jan Hessel de Groot (1896, cited in Banham 1960: 141) or Jay Hambidge (1920), while Le Corbusier incorporated the mathematical studies on the golden ratio by Matila Ghyka (1927). Although Van der Laan was a twentieth-century architect, his main references for the development of his architectural theory were Plato and Aristotle, whom he studied in the Benedictine environment of Oosterhout through the works of Thomas Aquinas. Van der Laan tried to distance himself from other design theories of proportion promulgated by his contemporaries, by constructing a personally blended interpretation of these ancient philosophies. Plato began from the belief that the universe was constructed through the objective values of order and proportion. But when it came to searching for a necessary order in architecture, Van der Laan's emphasis was fundamentally different. He even turned Plato's logic around. He did not take the universe or nature as the foundation for proportion. Nature for him was the divine creation, which could not be grasped by man 'too weak to recognize God's sovereign power everywhere' (VDL L1 1940). Clothing and architecture, then, were for him means to restore the disturbance of the natural harmony between man and nature — i.e., the disturbance of the original sin. Already in his first lecture series in Leiden between 1939 and 1941, he made his stance clear, attributing to architecture a new ontological meaning:

> We are overwhelmed by nature and we are look-
> ing for artificial principles to dissolve this contrast,
> to again get a grip on space, to again understand
> and control it. Architecture in this sense becomes
> a necessary instrument for our intellect as well as
> an expression of a regained authority, of an under-
> stood space. (VDL L2 1941: 1–2)

Van der Laan linked proportion to the perceiving human
beings by abstracting it from the way they perceived
space, or more precisely, from their intuitive ability to
distinguish different sizes. To establish that link, he went
back further than Plato, towards the Pythagoreans. In
contrast to Plato, whose proportion was geometrically
based, the Pythagoreans believed that number was at the
source of everything. Van der Laan identified this abstract
number as the discrete quantity.[9] The continuous quanti-
ties, which for Van der Laan were the physical quantities
present in nature, were understood and measured by the
intellect, through certain imitation or approximation, into
an abstract number. This was where architecture came in.
Van der Laan was looking for an order as the embodiment
of that artificial process of counting or the imitation of
abstract number. By this process of imitation, he was not
pointing to self-referential logical systems such as decimal
notation, which followed its own logic based on the num-
ber ten. Rather, Van der Laan sought an artificial number
that could be abstracted from space itself: a yardstick for
that space relative to the scale of that space. His further
research focussed on defining this yardstick as one used to
count space. What could this yardstick be, and how could
it be deduced from a spatial construction in order to read
that construction?

When Van der Laan started teaching in 1939, he referred
to Aristotle to establish a foundation for this reading of
space through number. For the concept of the yardstick,
he took his reference directly from Aquinas' reading of
Aristotle's *Metaphysics*.[10] There, he found a passage in
Book X, Chapter I, that would inspire him throughout all
of his writings, the definition of a yardstick indivisible and
relative to scale:

> For in the case of a furlong (measure of length) or
> a talent (measure of weight) and always in the case
> of something larger, any addition or subtraction
> might more easily escape our notice than in the
> case of something smaller, so that the first thing
> from which, as far as our perception goes, noth-
> ing can be added or subtracted, all men make the
> measure, and they think they know this quantity,
> when they know it by means of this measure. (VDL
> notes, 1940).

From the Aristotelian notion of the indivisible num-
ber 'one', Van der Laan continued to develop his spatial
framework based on sensorial perception. He defined the
'one' as the smallest perceptible yardstick, or the margin
of space. This margin was not a fixed number, but a ratio
relative to the scale of a building. It was the smallest 'one'
that could still be perceived in that building: measures

beyond it were not recognisable and thus discarded in
the process of counting a space. When space is paced out
(*afpassen*), the simple relationships of abstract numbers
are abstracted: rounded up. What was this smallest mar-
gin, or ratio that could still be defined within a whole?
To arrive at a ratio that could be integrated into a design
methodology, he asked himself the question: what are the
limits of our ability to differentiate spatial dimensions?
What is on the one hand the minimum and on the other
hand the maximum perceivable difference between two
dimensions?

The Series of the Plastic Number: Eight Ratios as Van der Laan's 'Order of Size' and the Three 'Measure-Systems'

The genealogy of the plastic number is quite ambiguous.
Van der Laan claimed that already in 1928 he had come
across the 3:4 ratio (VDL 1988). He found it when he was
designing a façade of a chapel in Baarle-Nassau, as he saw
much aesthetic potential in it as a proportion. But in his
lectures and writings, the plastic number was never intro-
duced just like that: a practical design tool. Van der Laan
aimed to present the plastic number through a philosoph-
ical framework as the key to human perception. As such, it
equally provided the answer to his questions stated above:
the minimum perceivable difference was 1:4, the maxi-
mum 1:7. He aimed to prove this through empirical tests,
developed carefully to define 1:4 as the minimum differ-
ence between two measures that could be perceived, and
1:7 as the maximum difference. For example, he engaged
his students in a sorting test, to explain how concrete sizes
can be rounded off into knowable abstract sizes.

He selected 36 pebbles that diverged in diameter by
1/25th from each other in a continuous series (Van der
Laan, AS V.5) (**Fig. 2a**). For Van der Laan, 1/25th constituted
a difference that could be perceived, but not defined with-
out a measuring instrument. He instructed his students
to arrange the pebbles into groups that appeared to be of
the same size, which Van der Laan called the same type.
When a difference in the size of a pebble was distinct, so
that it could be defined through perception, he instructed
his students to categorize the pebble in a different group.
All the students ordered five groups of seven pebbles each
(**Fig. 2b**). The result was that the largest pebble of each
group related to the largest pebble of the next group in a
ratio of 4:3 (**Figs. 2c** and **2d**). This for Van der Laan proved
that 1:4 was the threshold at which a difference between
sizes could be recognised and clearly defined.

When I repeated this process with my own students,
however, other groups of pebbles, both smaller and larger
than seven pebbles, were defined.[11] Van der Laan's test
proved to be a clarifying pedagogical tool to explain the
visual ordering process, but it by no means constituted
conclusive research leading to the plastic number ratio
4:3. This is where the main ambiguity surfaces: Van der
Laan presented the plastic number proportion as the only
possible outcome of his theories on perception, space and
architecture, but in fact it developed two distinct identi-
ties because it arose from two different motivations. On
the one hand, there was the Benedictine monk Van der

2a. A continuous series of 36 carefully selected oval pebbles, differing 1/25th in diameter.

2c. Five types of size: five groups of seven pebbles that appear to be of the same size.

4:3

2d. Six transition-measures that define the groups. They each relate to each other as 4:3. Van der Laan called this series an order of size of six measures.

2b. Sorting into groups of pebbles that appear to be of the same size. Van der Laan claimed that his students all selected groups of seven pebbles.
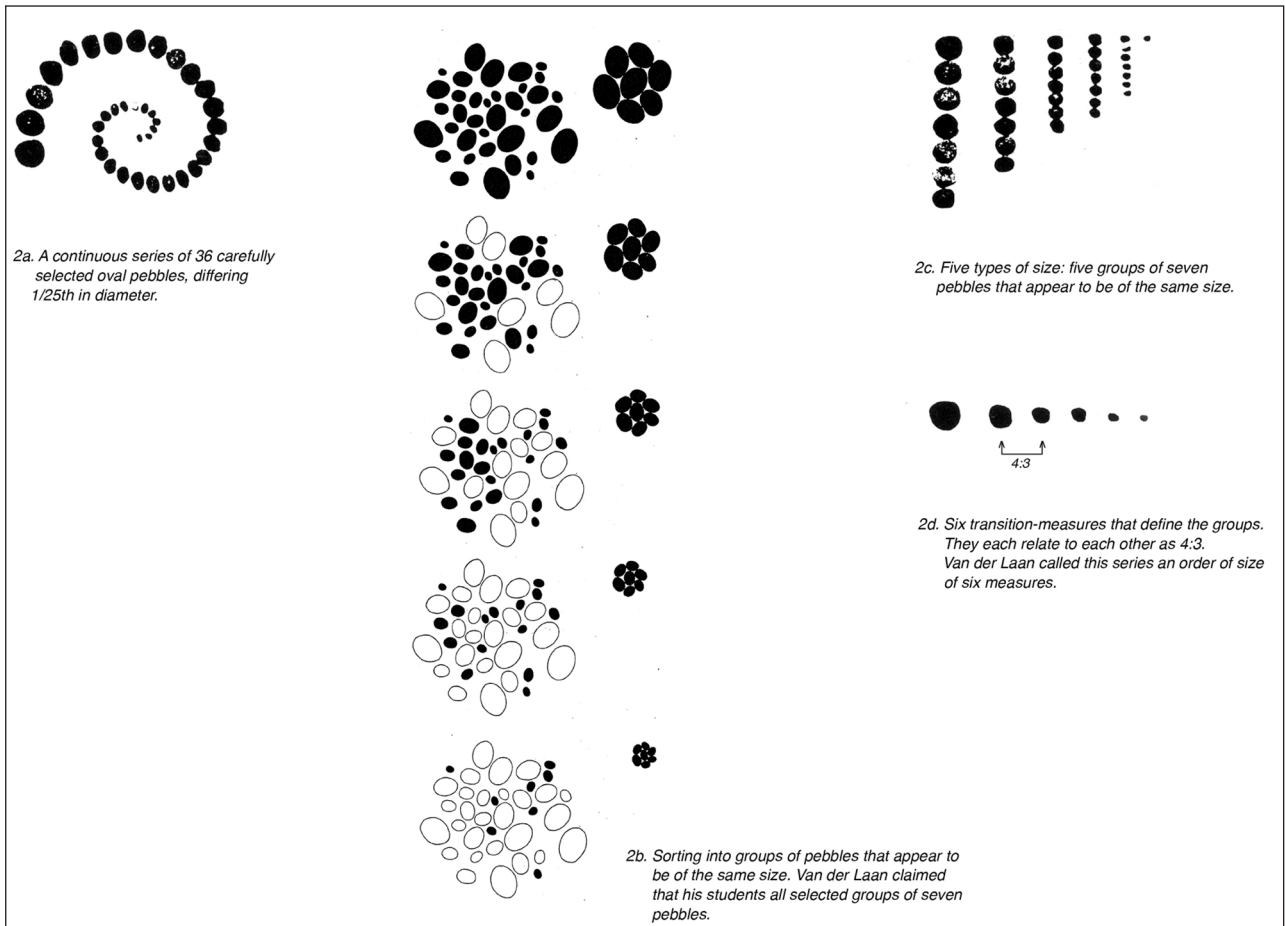
Figure 2: Dom Hans van der Laan's sorting test of a quasi-continuous series of 36 pebbles. Drawings by Dom Hans van der Laan, 1987 (VDLA).

Laan, struggling to establish a deep-level structure, a philosophical framework that would offer stability and order in one's relationship to the world. But on the other hand, there was the young architect Hans van der Laan, who even before his entry into the convent had proposed that the ratio 4:3 had interesting aesthetic potential as a design tool. It is clear that Van der Laan had conceived of the plastic number through designing, before he defined its theoretical framework. First he developed the plastic number, then the theory of space and architecture, not the other way around, as presented in *Architectonic Space.* This is an important distinction. To grasp its application, it is necessary to define this design tool without the mystifying framework that Van der Laan created for it.

When reviewing Van der Laan's first lecture series from 1939 to 1941, we find a definition of the plastic number, which until 1955 he called the 'ground ratio', as a hierarchical series of abstract measures that aimed to approximate as closely as possible the infinite and continuous series of concrete, natural measures.[12] He clarified this definition in a comparison with the golden ratio, which he did not include in *Architectonic Space* (VDL L3 1940: 21, 24). The comparison shows that when a measure is divided in three according to the golden ratio, the result is a pair of equal measures, and one remainder (**Fig. 3a**). For Van der Laan, this meant that the golden ratio was not suited to simulate the range of natural measures. When a measure

is divided according to the plastic number 1.3247. . ., an endless hierarchical series can be constructed (**Fig. 3b**). These measures are defined mathematically as $x + 1 = x^3$, where x equals 1.3247. . ..[13]

Nevertheless, it was of no interest to Van der Laan to express this series as a sequence of irrational ratios. For him, it provided the tool to interrelate abstract measures into a hierarchical series, with 4:3 and 1:7 as its keys. Just as he expressed the concrete measure 1.3247. . . through the abstract measure 4:3, he translated the series into their abstract approximate equivalents. He developed a series of eight measures, which he called the 'order of size' (**Fig. 4a**):

$$1 \quad 4{:}3 \quad 7{:}4 \quad 7{:}3 \quad 3 \quad 4 \quad 16{:}3 \quad 7.$$

The series of the plastic number did not consist of fixed measurements, but of ratios that can be used to proportionally relate all manner of building scales. Within the eight measures that are bound by the multiplication factor 4:3, the outer limits relate as 1:7. Several relations are possible, while remaining within the series. The sum of two sequential measures is not the subsequent measure (as in the Fibonacci series, which approximates the golden ratio) but the one after that; for example, 1 + 4:3 = 7:3 (because 1 + 4:3 = 3:3 + 4:3 = 7:3). Furthermore, any measure in the series is equal to the difference between the fourth and fifth measures after that.
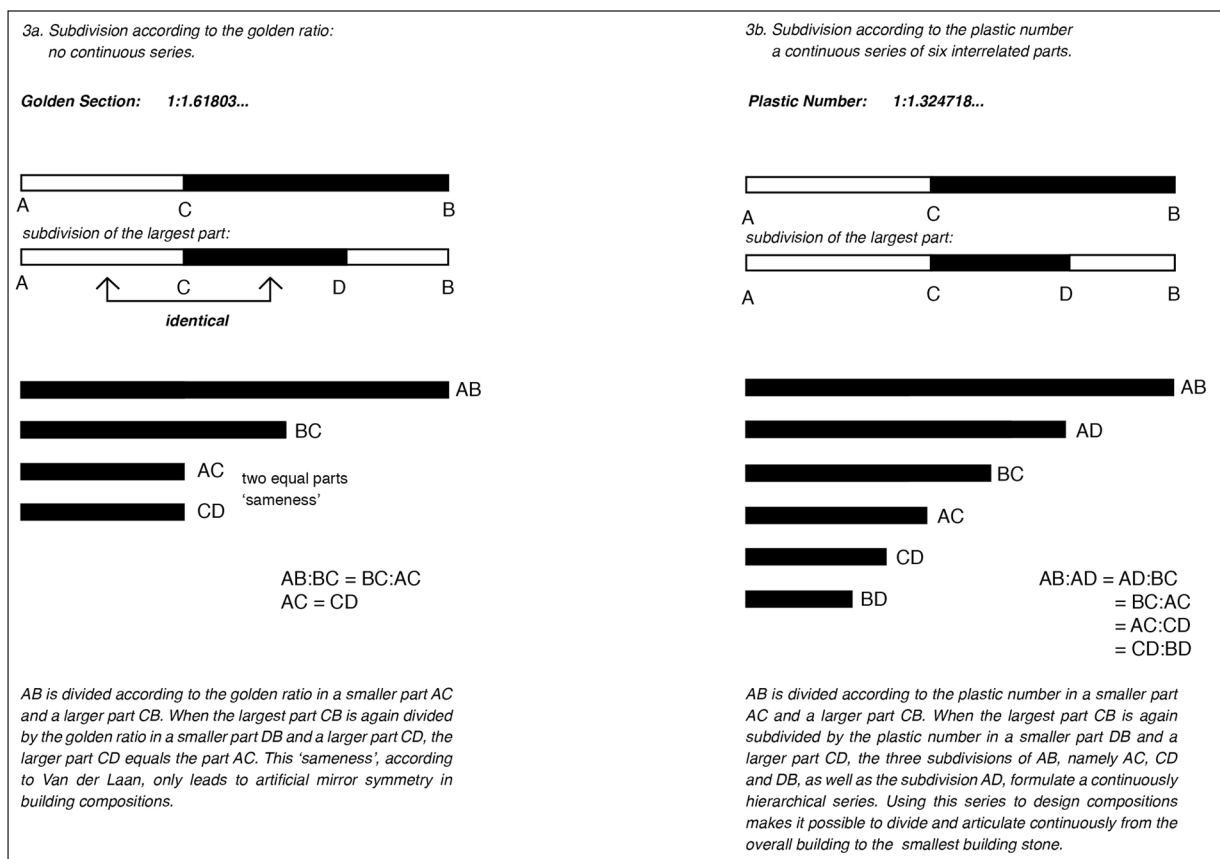
3a. Subdivision according to the golden ratio: no continuous series.

Golden Section: 1:1.61803...

3b. Subdivision according to the plastic number a continuous series of six interrelated parts.

Plastic Number: 1:1.324718...

AB:BC = BC:AC
AC = CD

two equal parts
'sameness'

AB:AD = AD:BC
= BC:AC
= AC:CD
= CD:BD

AB is divided according to the golden ratio in a smaller part AC and a larger part CB. When the largest part CB is again divided by the golden ratio in a smaller part DB and a larger part CD, the larger part CD equals the part AC. This 'sameness', according to Van der Laan, only leads to artificial mirror symmetry in building compositions.

AB is divided according to the plastic number in a smaller part AC and a larger part CB. When the largest part CB is again subdivided by the plastic number in a smaller part DB and a larger part CD, the three subdivisions of AB, namely AC, CD and DB, as well as the subdivision AD, formulate a continuously hierarchical series. Using this series to design compositions makes it possible to divide and articulate continuously from the overall building to the smallest building stone.

Figure 3: Dom Hans van der Laan's comparison between the plastic number and the golden ratio. Charts based on Padovan (1994).
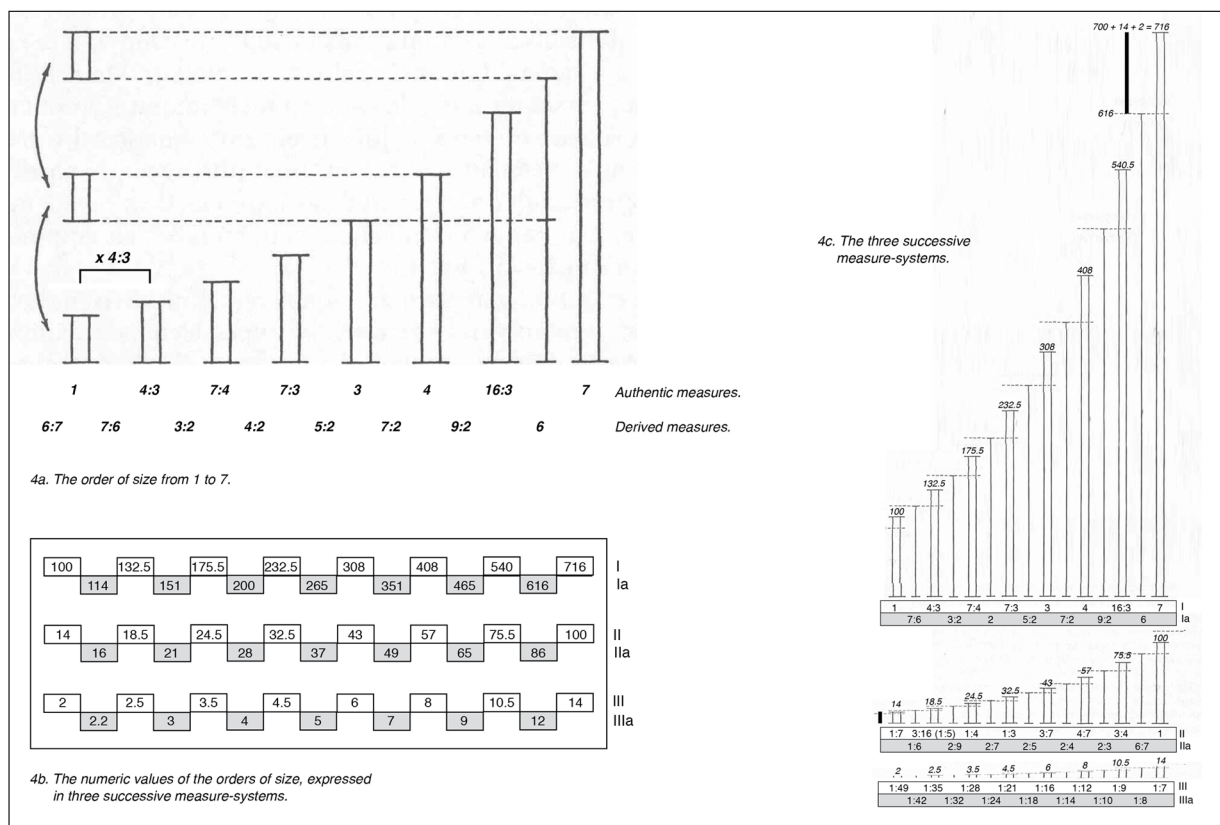

Figure 4: (a): Van der Laan's 'Order of Size' from 1 to 7 with authentic and derived measures. From Dom Hans van der Laan, drawing for *Architectonic Space* (Van der Laan 1977). **(b):** Three successive measure-systems with numerical values based on the plastic number series. **(c):** The three successive measure-systems.

To achieve a finer grain of measures, Van der Laan added a 'derived' series with the same sequence as the first order of size, ranging from 1 to 7, which he called the 'authentic' series. Like the authentic measures, the derived measures are also interrelated through 4:3. Following the logic of Pythagorean means, an authentic measure lies in the arithmetic mean of two derived measures. A derived measure lies in the harmonic mean of two authentic measures.[14] The derived measures thus allow for double sizes to become parts of the composition.[15] The derived order of size is:

6:7   7:6   3:2   4:2   5:2   7:2   9:2   6.

These abstract measures expressed as numerical ratios are only roughly related through 4:3. They do not constitute a geometric series, but a sequence of simple whole numbers, individually and in ratios, that demonstrate arithmetic coherence. The series is not entirely regular, but the deviations are minor.[16] Thus the series that precisely answers $1 + 4:3 = 7:3, \ldots, 3 + 4 = 7, \ldots$ or more generally $x + 1 = x^3$, has a proportional number that is only slightly smaller than 4:3. For Van der Laan, this meant that the plastic number resulted in a system that delivered an infinitely continuous series ruled by a single irrational ratio, 1.3247. . ., while as an arithmetic system it remained close to the simple whole numbers 3, 4, 7 and the fractions they can form, so that it was capable of answering to our limited perception and judgement (Van der Laan (junior) 2009).[17] He defined the simple multiples 3, 4, 7 . . . as approximations that we use when reading a building, and that as such can be incorporated into the design process when drawing by hand.

To adjust the deviations, Van der Laan determined numerical values for the series. He did this for three successive orders of size, which he called the three 'measure-systems' or Series I, II and III (VDL L4 1946) (**Fig. 4a**). The largest measure of a measure-system is the smallest one of the following system. He compared the sequence of series to the succession of octaves with their eight notes in the musical scale (VDL L5 1951). For the definition of the numerical values, Van der Laan used the measures of the smaller measure-systems to eliminate as much as possible the small deviations by which the measures diverge from simple multiples (**Fig. 4b**). For Series III Van der Laan began with an assumed smallest unit of 100. The largest unit then had a numerical value of 700 + 14 + 2 = 716. Note that 14 and 2 are the largest values in the two smaller orders of size or 'measure-systems'. The measure-system of Series III then becomes

100 132.5 175.5 232.5 308 408 540.5 716.

And its derived measure-system is

86 114 151 200 265 351 465 616.

The difference between an authentic and its derived measure is the authentic value in the lower measure-system: 716 − 616 = 100. In the design of buildings, the three measure-systems form an interlocking sequence of consecutive building scales. In the example in **Figures 4b** and **4c**, Series I was used for the overall spatial compositions, Series II for the composition of wall pieces and Series III for the design of details.

According to Van der Laan, designing with the orders of size as frameworks of measures for all building parts enabled a clear reading of the proportions of a structure with whole numbers, since they could be perceived through counting. He aimed to introduce a type of architecture that had as its goal the combination of abstract thinking and sensorial perception, an architecture where 'number and measure meet' (VDL L3 1940). He compared his system with the concept of time:

> I compare it with time, where the 'now' without duration separates the duration of the past from that of the future. And also we as 'reasonable beings' can differentiate that notion from experienced time, to which we give a duration with a beginning and an end = hours, days and weeks. Those times unroll themselves against the background of our objective knowledge of time that we make graspable through our festivities as we make natural space habitable through our architecture. In the endlessness of time we make times with a beginning and an end as our seasons, and in the borderless space we make spaces between walls. (VDL C2)

With the series of the plastic number as an underlying framework, Van der Laan developed a design methodology based on numerical proportions. This manner of working was more in line with Wittkower's view of Alberti's generation of ratios as a theory of music and of Palladio's fugal system of proportion, than with the geometrical constructions of Hendrik Petrus Berlage or the *tracés régulateurs* of Le Corbusier (Alberti 1452: Book IX; Palladio 1570: Book I, Chapter XXI; Wittkower 1962).

Van der Laan studied several monuments, believing that they embodied the plastic number. The Parthenon and Hagia Sophia were his first objects of analysis. By 1936, Van der Laan had marked the Parthenon as essential study material for understanding the plastic number (VDL C5 1936). One of his first analyses purporting to find the plastic number consists of a sketch containing partial elevations of this monument (**Fig. 5**), about which he wrote:

> It is magnificent to see how in the Parthenon, in which the whole pyramid is followed, all values of form and measure softly and naturally flow into each other. It is as if in a mighty manner everything is taken into account whilst placed gently so as not to break the subtle and all comprising balance. (VDL C6 1940: 2–3)

To prove his theory of the plastic number through the proportions of the Parthenon, Van der Laan looked for a potential expression of the 4:3 ratio. He found it in a specific point within the capital, which divided the lower
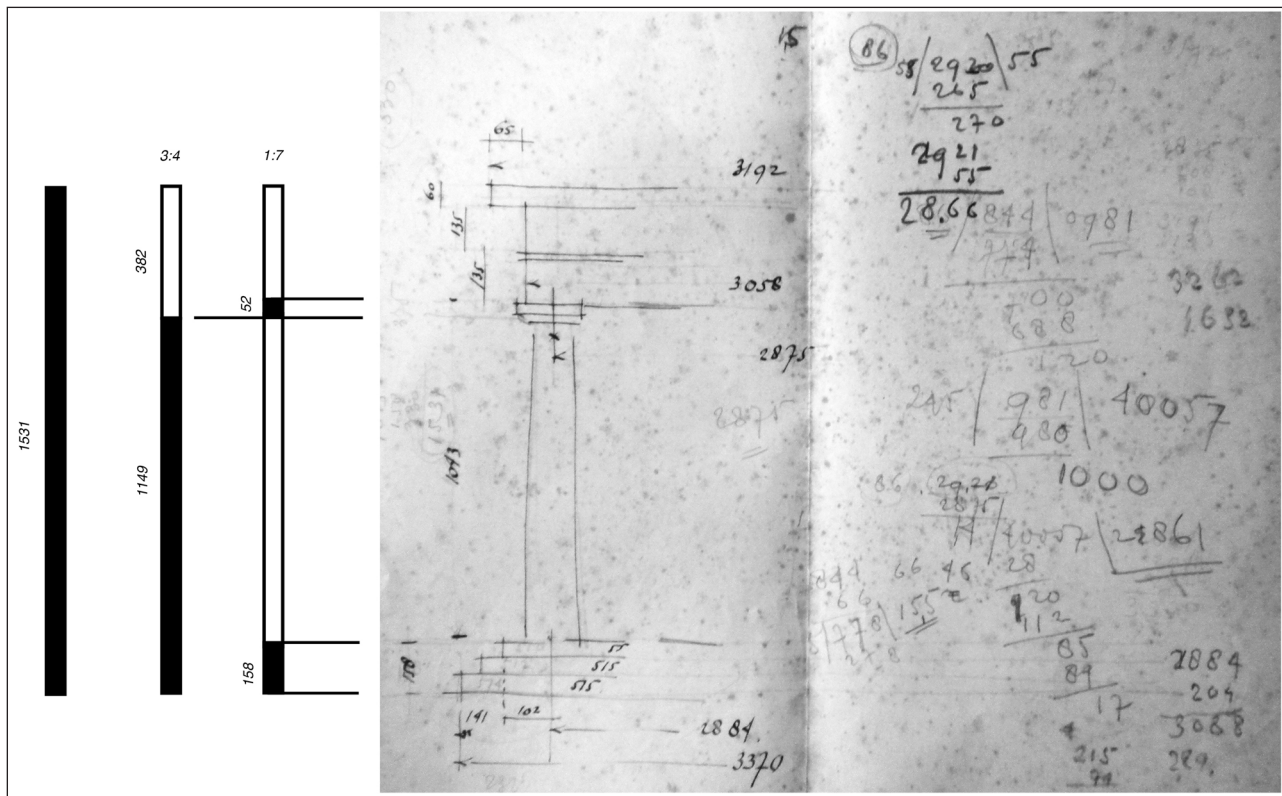
Figure 5: Dom Hans van der Laan, studies of the plastic number proportion in the Parthenon, 1940 (VDLA).

and upper parts into 1149 cm and 382 cm, respectively: 'a symmetrical hinging point in the vertical sense, a point from carrying to being carried, where the capital becomes rounded' (VDL C7 1943: 4). The parts both above and beneath this point were then defined by measures set in a 1:7 relation: the base or steps (158 cm) related to the lower carrying (1149 cm) part as 1:7, while the upper carried part (382 cm) was defined by the abacus and the capital (52 cm). Once found, he was surprised that it could be so simple. For him, this method offered a way to find proportional relations between the whole structure and its parts according to the plastic number. He was convinced that these principles, which he defined as universal, were known in ancient times and were used in architectural design. Tracing this ancient usage, he wrote, was like 'working in the opposite direction, but the effect is that we obtain insights into the rhythmical structure' (VDL C7 1943: 4).

Putting the Plastic Number into Practice: Early Application and Dissemination

In 1945, Van der Laan started teaching a class for practicing architects in Breda and 's-Hertogenbosch, the Cursus Kerkelijke Architectuur (Course on church architecture, CKA). Although the aim was to introduce the architects to church design and restoration, Van der Laan focused on his architectural theory as a means for creating liturgical space. For this purpose he developed study material to explain how the ratios 4:3 and 1:7 could be implemented. From this material, two essential elements can be deduced.

First, Van der Laan emphasised an intrinsic relationship between what he called 'mass and space', meaning that mass and space related as 1:7, the outer limits of one order of size. He believed that measures beyond this ratio, for example 1:8 or 1:9, resolved in walls that were too thin, so the mutual nearness was in danger of dissolving. Walls thicker than this appear heavy in his opinion, and are in danger of relating to the space as a form (Van der Laan, AS XI.4). To realise this perceptible and pleasing range of scales architecturally, Van der Laan defined the 'spatial cell' as an intimate space for one person between 3 and 5 metres wide. During the first CKA lecture series, which lasted from 1945 to 1955, the capital served as a module for the spatial cell. Van der Laan explained this in a sketch, where the relation between the capital and the spatial cell is at least 1:5 (**Fig. 6**). In most of the architectural designs by Van der Laan and his students, the capital and spatial cell related as 1:7 (**Fig. 10**).

Second, Van der Laan composed larger spaces from the spatial cell. He used the Hagia Sophia to illustrate his concept of spatial overlap, which he called superposition (**Fig. 7**). In a diagram he showed his interpretation of hierarchical relationships between the wall thicknesses and the widths of the side chapels, and between the main space and the whole, a layered relationship between outside and inside.

In the CKA Van der Laan also presented the basilica building type as the ideal model for new churches. For him, the narthex, apse and side aisles, which he called 'marginal spaces', were necessary to introduce the spatial cell and relate a large, monumental nave to a smaller,
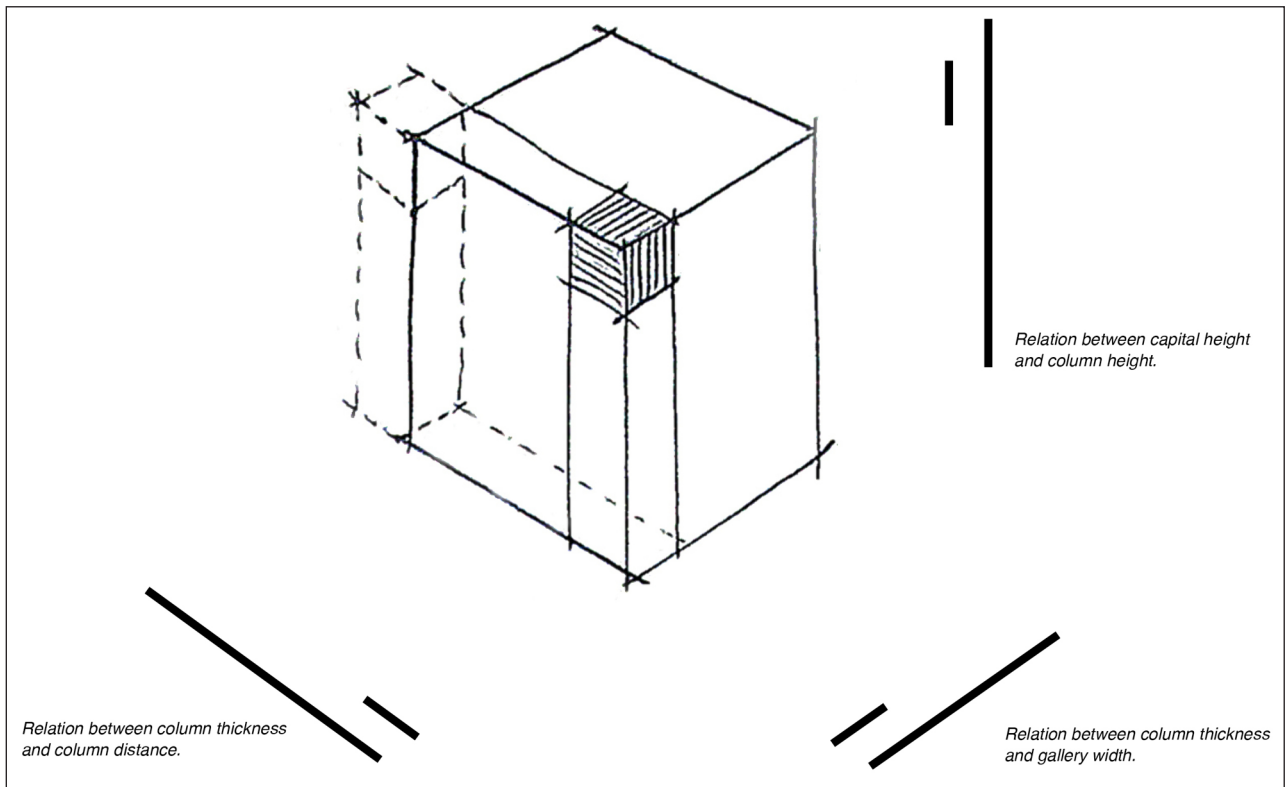
Relation between capital height and column height.

Relation between column thickness and column distance.

Relation between column thickness and gallery width.

Figure 6: Dom Hans van der Laan, relation between the capital and the spatial cell, as part of the gallery or side aisle, through its three dimensions. In his architectural designs, this relation was mostly 1:7. VDL, CKA II, 19 Nov. 1955–14 Jan. 1956–1955, p. 7 (VDLA). Text and scales added by author.
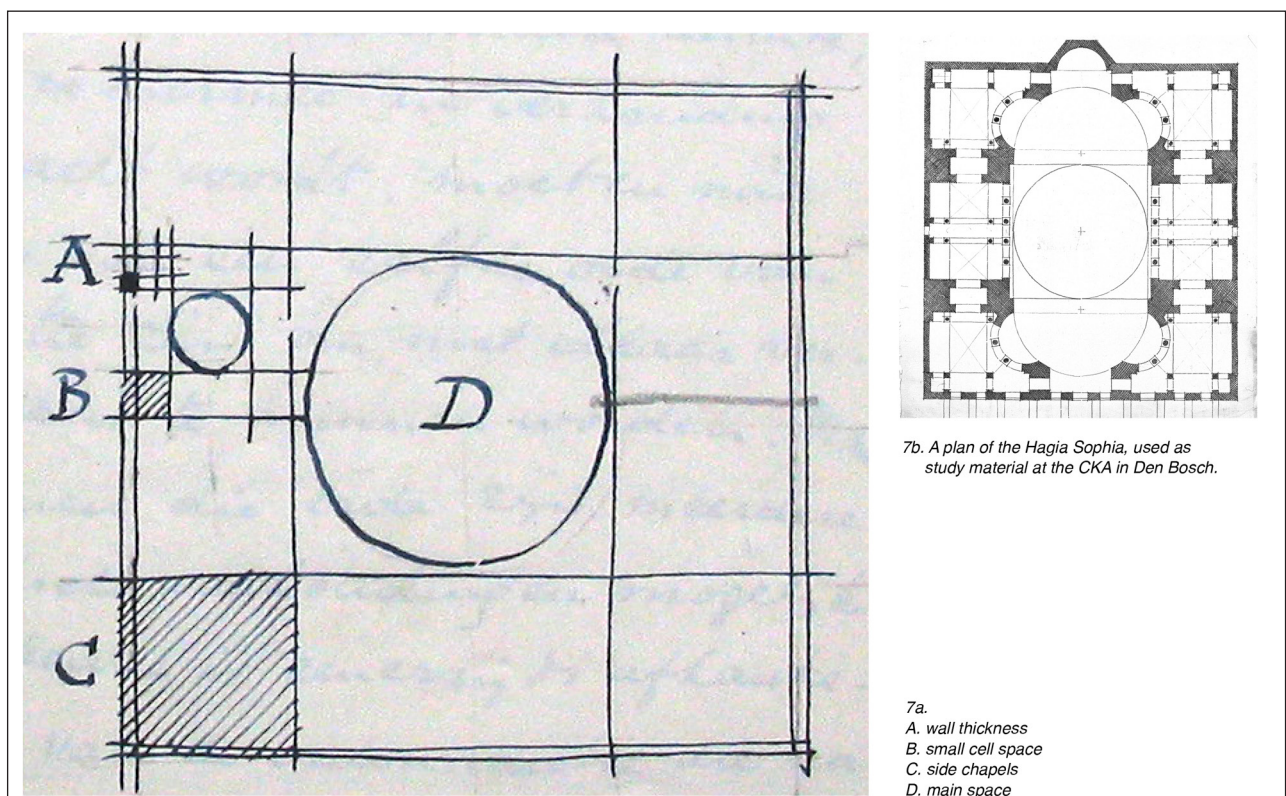
7b. A plan of the Hagia Sophia, used as study material at the CKA in Den Bosch.

7a.
A. wall thickness
B. small cell space
C. side chapels
D. main space

Figure 7: (**a**): Dom Hans van der Laan, diagram analysis of the Hagia Sophia, 1955. VDL, CKA II, 14th lecture, 21 May 1955, p. 17 (VDLA). (**b**): Drawing of the Hagia Sophia plan by one of Van der Laan's students, name unknown (VDLA).

more intimate human. For example, the apse and the nave would relate as 1:7. Taking the example of a spatial cell or narthex of 3.5 m deep, the length of the nave would be 24.5 m.

Van der Laan highlighted the mass-to-space relationship through ornamentation such as mouldings or capitals, emphasising the tectonic expression of the structure. In the example of the spatial cell of 3.5 m, the capital that defined this space was set at 0.5 m. All columns, wall pieces and ornaments ranged between 0.5 m and 3.5 m, all set in proportion to each other through the plastic number series. As such, all measurements, from the overall space to the spatial cell, and from the spatial cell to the capital, could be hierarchically interrelated by three successive orders of size. This sequence of proportions can be seen in a 1953 study of the Byzantine Mshabbak Church in Syria, made by one of Van der Laan's students (**Fig. 8**).

The students analysed other Early Christian basilicas, redrawing them according to the series of the plastic number in order to study its application. As their sources they used drawings by Butler (1929) or Laprade (1940–50), but they also travelled to Italy to measure for themselves.[18]

The classes also dealt with the training of the students' discernment. For that purpose, Van der Laan developed his teaching aid, which he called the 'abacus': a box with 144 bars that included three successive orders of size and several intermediate measures (**Fig. 9**). His students would practice for hours in the comparison and recognition of different sizes.

From 1945 onwards, a vast production by Van der Laan's students came out of this systematised way of working (**Fig. 10**).[19] The CKA students discussed their church designs after the lectures. These first endeavours resulted in a traditional style reminiscent of Early Christian churches, still far removed from Van der Laan's own elementary architecture that would only be developed later. These classical basilicas were heavily criticized in the architectural community of Van der Laan's day (English 1957; Bekaert 1957–58; Peeters 1964). Critics found them to be unacceptably traditional and formally regressive, and they dismissed the plastic number as a dogmatic proportion system responsible for producing these types of basilicas (Urbain 1949–50: 54–55). Although Van der Laan had many students who ardently
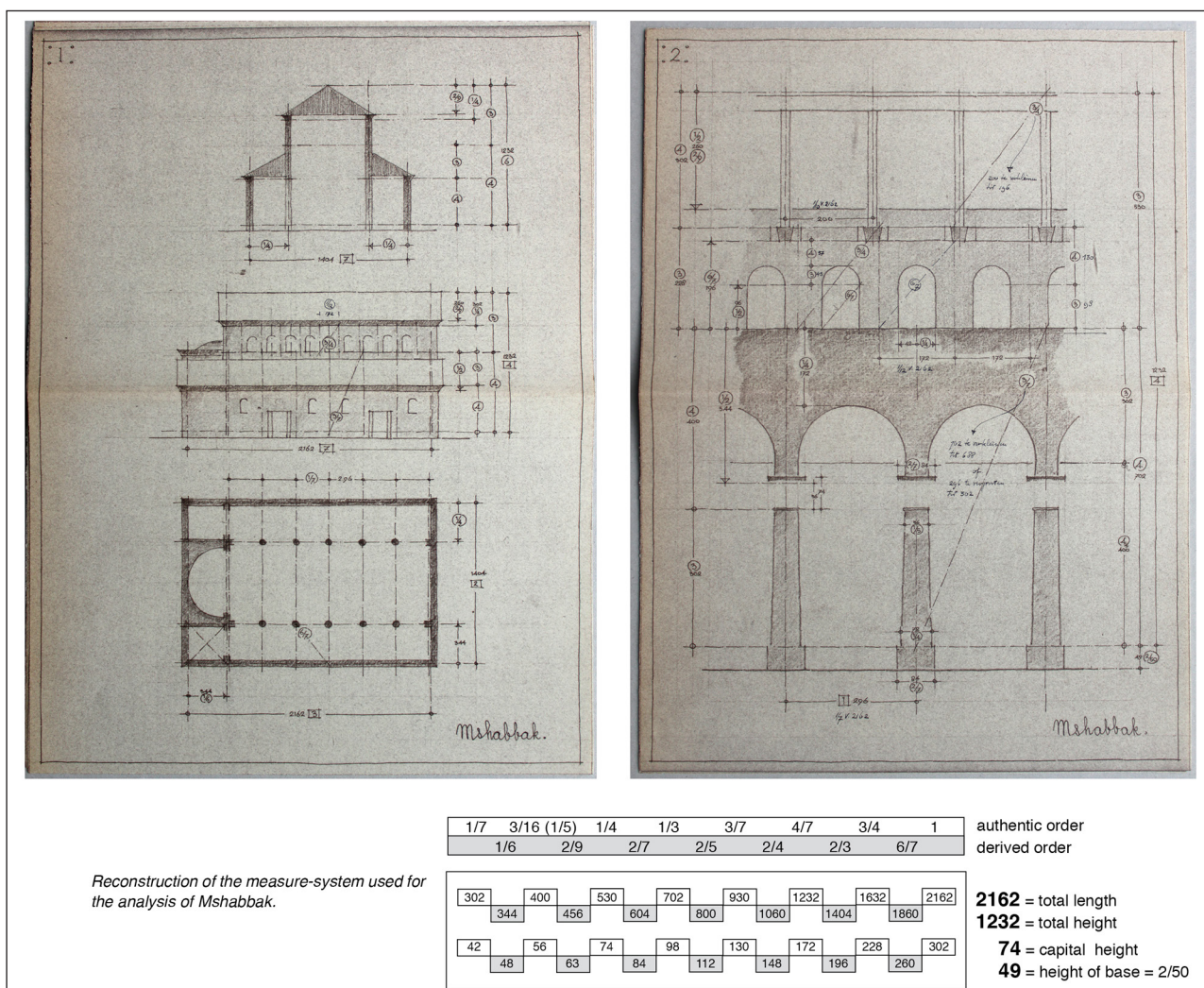

1/7	3/16 (1/5)	1/4	1/3	3/7	4/7	3/4	1	authentic order
	1/6	2/9	2/7	2/5	2/4	2/3	6/7	derived order

Reconstruction of the measure-system used for the analysis of Mshabbak.

302		400		530		702		930		1232		1632		2162	**2162** = total length
	344		456		604		800		1060		1404		1860			**1232** = total height
42		56		74		98		130		172		228		302	**74** = capital height
	48		63		84		112		148		196		260			**49** = height of base = 2/50

Figure 8: Cursus Kerkelijke Architectuur (Course on church architecture), student work: a study of Butler's Mshabbak, presumably 2nd year, student name unknown, 1953. Cees Pouderoyen Private Archives, Nijmegen. Original drawings from Butler (1929). Reconstruction of the measure-system used for the analysis of the Mshabbak by the author.

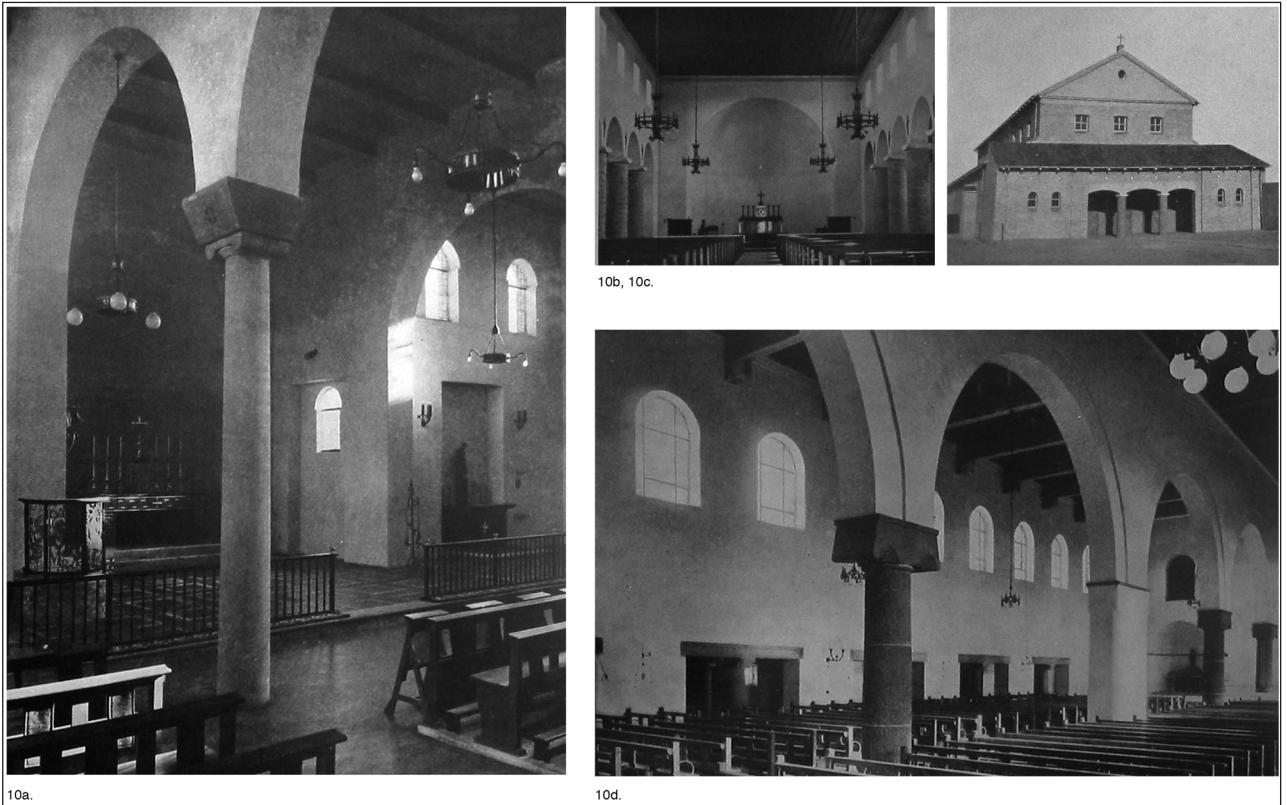**Figure 9:** The abacus. Photograph added to the *Plastic Number* (1960).

10b, 10c.

10a.

10d.

Figure 10: Examples of churches built by the students of the Cursus Kerkelijke Architectuur (Course on church architecture) (VDLA). (**a**): St. Bavo church, Angeren, architect N. van der Laan, 1951 (Sarlemijn 1953). (**b, c**): H. Eligius church, Oostburg, F. Mol and J. Brugman (Ritzen 1949). (**d**): Carmel church, Nijmegen, architects J. G. Deur and C. Pouderoyen, 1951 (Sarlemijn 1953).

believed in his approach — among the approximately 370 architects he taught between 1946 and 1973 — he did not succeed in convincing a broader audience of the value of his method.[20] Criticizing from another angle, Van der Laan's own Benedictine brothers scorned him for being too modern. Instead of teaching liturgy, they complained, he insisted on studying the plastic number with his students, which none of his Catholic peers, who had invited him to teach this course, understood.

This lack of acceptance can be partly ascribed to Van der Laan's own attitude. He himself criticized other approaches to proportion that were ongoing in his day. In 1939, he wrote to his younger architect brother Nico: 'I flipped through your book on Ghyka, [...] I would not recommend you to read these types of books. You lose yourself in mathematical jokes that are quite pleasant, but with no value to reach a harmonious insight. [...] I believe we have to do it ourselves' (VDL C8 1939).[21] Van der Laan also openly scorned all modern design. In the newspaper *De Tijd* he announced that Le Corbusier's Ronchamp was a 'non-architectonic grouping of forms', the expression of an architecture that had form as its highest goal and grew from 'a fantasy that has been intoxicated by the contact with natural shapes'.[22] With such comments Van der Laan did not make himself popular among his contemporaries in architectural circles and he was not taken seriously. Thus when his first book *Le Nombre Plastique* came out in 1960, although positively reviewed by the architect Gerrit Rietveld, it hardly caused a ripple in architectural culture (Rietveld 1960: 403), in sharp contrast to the success of the architectural bestseller published ten years earlier, Le Corbusier's *Le Modulor* (Le Corbusier 1950).

At first glance, the system of the plastic number shows striking resemblances to the Modulor. It too is conceived as a mathematical series, and moreover has two interwoven series, the authentic and the derived order of size, like Le Corbusier's red and blue series. If Van der Laan was influenced by Le Corbusier's writings on how a series could be implemented in architecture, however, he never admitted to it. Nevertheless, it is clear that the plastic number was developed before the Modulor. Although Van der Laan claimed to have discovered the plastic number in 1928, there is no proof of this date (VDL 1988). It is documented that he lectured on it from 1939 onwards, while Le Corbusier patented his Modulor only in 1945.[23] The two systems, however, sprang from different motivations, and are quite different in their essential features. The Modulor, with a geometrical base of squares, straight edges and golden section derivatives, offers *une règle mathématique*, a series of fixed measurements, loosely based on the Fibonacci series as a proportional system (Le Corbusier 1952: 128). Le Corbusier combined it with his earlier *traces régulateurs*, or geometrical schemes for the composition of large building parts or façades. He intended the Modulor as 'a universal gamut of harmonious dimensions' linked to basic ergonomic measures such as the height of a step, chair or table (Le Corbusier 1952: 127). The series of the plastic number has no geometrical basis and does not consist of fixed measurements, but rather of ratios interrelated by the plastic number 4:3

and grouped by the limits of 1:7. As such, it can be hierarchically applied to architectural elements at a variety of scales, from ornament to wall compositions and spatial layouts of rooms to the overall building and the site.

Van der Laan never compared the plastic number with the Modulor in *Le Nombre plastique*, nor did he explain the successive division of a line (**Fig. 3**), which in the case of the plastic number resulted in a hierarchical succession that could not be achieved with the golden ratio or the Modulor. Van der Laan introduced his series primarily as a fundamental architectural principle, not as a useful design tool. He presented the plastic number as more suitable to designing three-dimensional space than was the golden ratio, through a series of complex definitions and arguments.[24] By contrast, Le Corbusier promoted the Modulor through his international network as a simple but useful tool, 'like aviation and like many other improvements that man had created' (Le Corbusier 1952: 127). He used it in his own designs, from the Unités d'Habitations to Chandigarh, in the hope of turning it into a universal proportional system. Van der Laan tried to disseminate *Le Nombre plastique* through his limited network, but he did not succeed in promoting it very much beyond the CKA. In 1961, for example, the French Catholic philosopher Jacques Maritain (1882–1973) sent a copy of the book to Jean Labatut (1899–1986), director of Graduate Studies at Princeton's School of Architecture, as a favour to his friend Dom Pieter van der Meer de Walcheren, a fellow monk who tried to help Van der Laan. In his accompanying letter, however, Maritain made it clear that he did not understand the book at all, expressing his reluctance very clearly. Labatut, who corresponded extensively with other academics, architects and artists, would never mention Van der Laan.[25]

Van der Laan's Elementary Architecture
Van der Laan felt misunderstood by his architectural colleagues as well as by his fellow Benedictine brothers. But for him this was part of the difficult road he had to travel, and he continued to develop his theories as a personal calling (VDL C9 1953: 4). Van der Laan gradually developed a new idea: proportion is not only about the intellectual assessment of sizes of building elements and spaces, but also about physical presence and movement in space. In 1957 he formulated a new architectural language: an architecture stripped of all ornamentation, which he realised in a new crypt in Vaals (**Fig. 11**).

As in his earlier work, Van der Laan designed a composition of numerous in-between spaces such as galleries or porticos, each of them integrating the scale of the spatial cell. But in the crypt, the monumental and elementary architecture is further expressed through a rough formal language, dominated by heavy-looking walls and galleries of stone or concrete. Because of the lack of ornamentation — typical details such as plinths, frames or inclined windowsills — the building parts are defined by sharp lines separating mass and space. Windows are rhythmical openings with the same dimensions inside and outside. Lintels and thresholds are continuous concrete elements that provide horizontal articulation. The only material finishing

Figure 11: The crypt of St. Benedictusberg Abbey, Vaals, 1958–61. Photo by Coen van der Heiden (2008).

that accompanies the bare concrete is roughcast with plaster, and wooden boards painted in complementary grey colours. Guided by the articulated series of openings, daylight illuminates the spaces with varying intensities, and creates patterns through a pronounced play of light and dark shadows. The light plays over the rough topography of the wall surfaces, bringing the architecture to life. Van der Laan likewise designed the furniture in complementary colours and all the liturgical objects as parts of a whole. This architecture does not rely on religious symbolism for the production of meaning. Instead it thrives on a spirituality implied through its affective qualities.

Van der Laan designed this new elementary architecture through a more dynamic implementation of his proportional number series. His drawings changed, becoming abstract patterns of lines denoting distinctions between mass and space (**Fig. 12**). He moved from ornamentation, with the capital at its core, as the expression of mass, towards the seam: the delineation of mass as the expression of experienced space. A building was seen as a matrix of superimposed rhythms. To explain this approach in his lectures, Van der Laan sought abstract examples, like the pattern of a Scottish tartan grid (VDL L6 1968). He thus introduced his concept of superposition (spatial overlap) on an atectonic level; the starting point had not a structural but rather a spatial emphasis. He designed through spatial figures. Similar spatial-dynamic effects, derived from the superposition of spaces, can be found in the architecture of Frank Lloyd Wright and Mies van der Rohe, though Van der Laan never referred to them. These architects introduced space as liquid and flowing, a succession of frames between inside and outside, to be experienced through movement. In his convent architecture Van der Laan put successive spaces in superposition through galleries, porticos and in-between spaces. Each of them introduces a distinct rhythm through different densities of columns and window series. No bilateral symmetry can be found in the positioning of the passages from one space to another. In Roosenberg Abbey, for example, which he completed in 1975, the internal circulation unfolds gradually, from the main entrance, which is conceived as a slit in an otherwise closed wall, proceeding through a forecourt, an entrance area, a staircase and a cloister hall, all connected to each other through asymmetrically placed portals (**Fig. 13**). Various vistas unfold as one moves through the spaces of the abbey.

The capitals, impost blocks and frames (as seen in **Fig. 10**) as tectonic expression, furthermore, have disappeared. Van der Laan instead chose the thickness of the wall as a yardstick for the measuring of space. For his design, he first selected a basic measure for the wall thickness, and with it the spatial cell, in a 1:7 relation. In Roosenberg Abbey the walls have a thickness of 0.5 m, while the space they enclose is 3.5 m wide from axis to axis. This 3.5 m spatial cell served as the module for a pattern according to which the building could grow. This module is apparent in the widths of galleries that enclose the convent garden and corridors, sleeping cells and side aisles. This is a much grander scale than Le Corbusier's basic 2.26 m, based on a standing man with his arm raised.

Van der Laan's Three Abstract Spatial Diagrams

The approach of Van der Laan's book *Architectonic Space* (1977) is different than that of *The Plastic Number* (1960), which focussed on explaining his proportional system. Here he embedded his ideas about the perception of
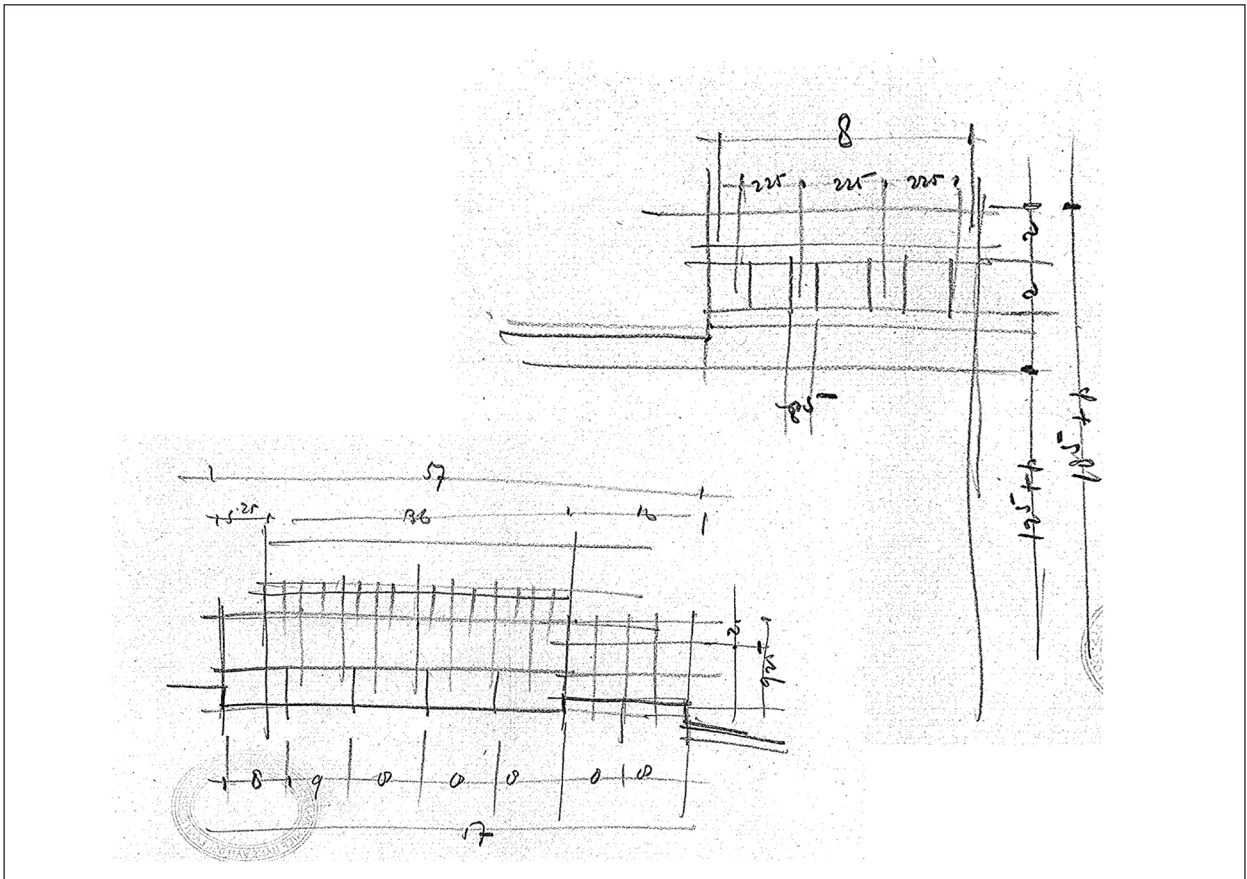
Figure 12: Design sketches by Dom Hans van der Laan for church and atrium of St. Benedictusberg, 1956 (VDLA).

Terrain 175 m.

Typical half-hall.
   5 bay rhythms through the windows.
   3 bay rhythms in the gallery.

1:7

Rooms and wings 25 m.

Entrance.
Gradual passage
from exterior to interior.

Ground floor.

1:7

Cella 3,5 m.

1:7

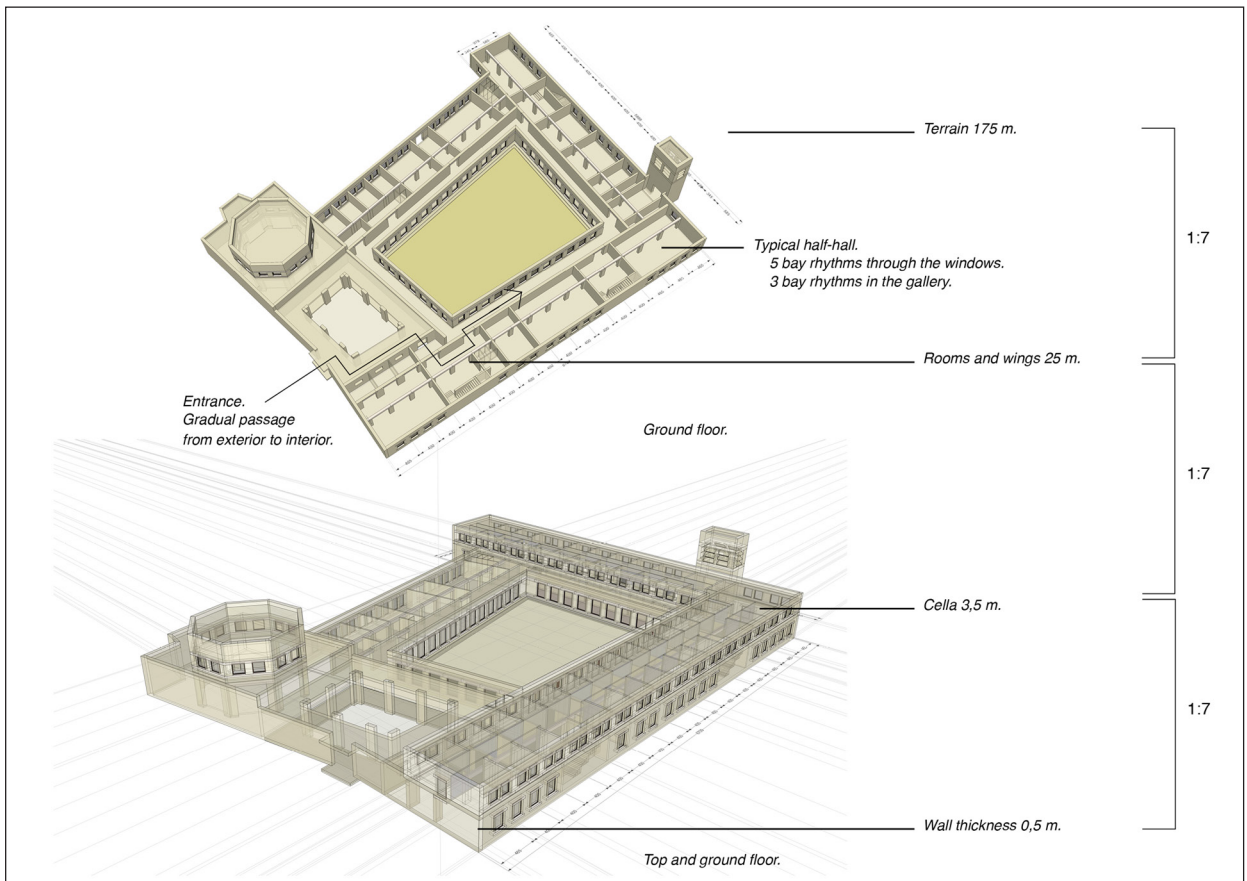Wall thickness 0,5 m.

Top and ground floor.

Figure 13: Roosenberg Abbey, Waasmunster, 1975. 3-D model by author.

architecture through counting in a more general atectonic theory about the relationships between inside/outside and mass/space. The main influence for this shift was the book *Mensch und Raum* by the phenomenologist Otto Friedrich Bollnow (1903–91) (Bollnow 1963).[26] Van der Laan developed a new language with which to express his theories on perception in relation to space. He defined the primordial 1:7 relationship between two walls and the space they enclosed as 'mutual nearness'.[27] To explain this concept of mutual nearness and how it could be incorporated into architecture, Van der Laan developed three series of abstract diagrams that can be seen as typical models that fed into his building schemes. The first series of diagrams was based on Bollnow's concepts. It related the intimate human scale, defined by Bollnow as the space of one's own body, to the scale of a building complex or urban ensemble (**Fig. 14**).

Van der Laan's diagrams showed a field of experience around a person on three scales: work space — walking space — field of vision (**Fig. 14a**). He then translated these physical qualities into architecture, embodied by abstract architectonic elements: cella — court — domain, the cella being his earlier spatial cell (**Fig. 14b**). He developed a series of nine possibilities, where one became part of the other. Van der Laan defined the sixth possibility as the most interesting condition of superposition: the domain being formed by courts that in turn were formed by cellas (**Fig. 14c**). When applied to architectural design, these possibilities interrelated two orders of size. For example in Roosenberg Abbey, in rounded measures, the first order of size is from 3.5 metres for the cella to 25 metres for the overall space or scale of the court, the second order of size

ranges from 25 metres to 180 metres for the whole building complex or domain; each pair of dimensions retains the 1:7 relation. The 3:4 ratio runs from the thickness of the wall to the whole building complex (**Fig. 15**).

Van der Laan based the second series of diagrams on the scales of the larger spaces. Just as the wall thickness served as the module for the cella in a 1:7 proportion, the smallest space served as a module for the whole (**Fig. 16**). As the cell was multiplied in one direction, the other direction remained under the influence of the nearness between the wall and the column series. In this manner Van der Laan formed a bar-like space, presenting itself as a gallery. Like the wall-to-cell space ratio, the gallery was a maximum of seven times longer than the cell. Galleries then formed larger spaces, in the same manner that side aisles framed the nave of a church.

Through this superposition of galleries, he aimed to secure the concept of mutual nearness between the whole space and the wall: the wall related to the gallery, and the gallery to the whole space. Van der Laan applied this cell-to-gallery relation in the designs of his buildings. In the crypt of Vaals, for example, side aisles are formed by a series of cells (**Fig. 17**).

In each cell the mass-to-space (wall thickness-to-cell width) ratio of 1:7 has the dimensions 0.6:4.2 m. This cell is not a closed entity. It seems to blend with the surrounding space. All the elements together evolve through the movements and changing perspectives of the visitor. The same dynamics appear in the typical halls in Roosenberg Abbey (**Fig. 13**). These half-halls each have a gallery superimposed on one side, where the gallery relates to the whole as 2:5. The windows express 5 bays, where the
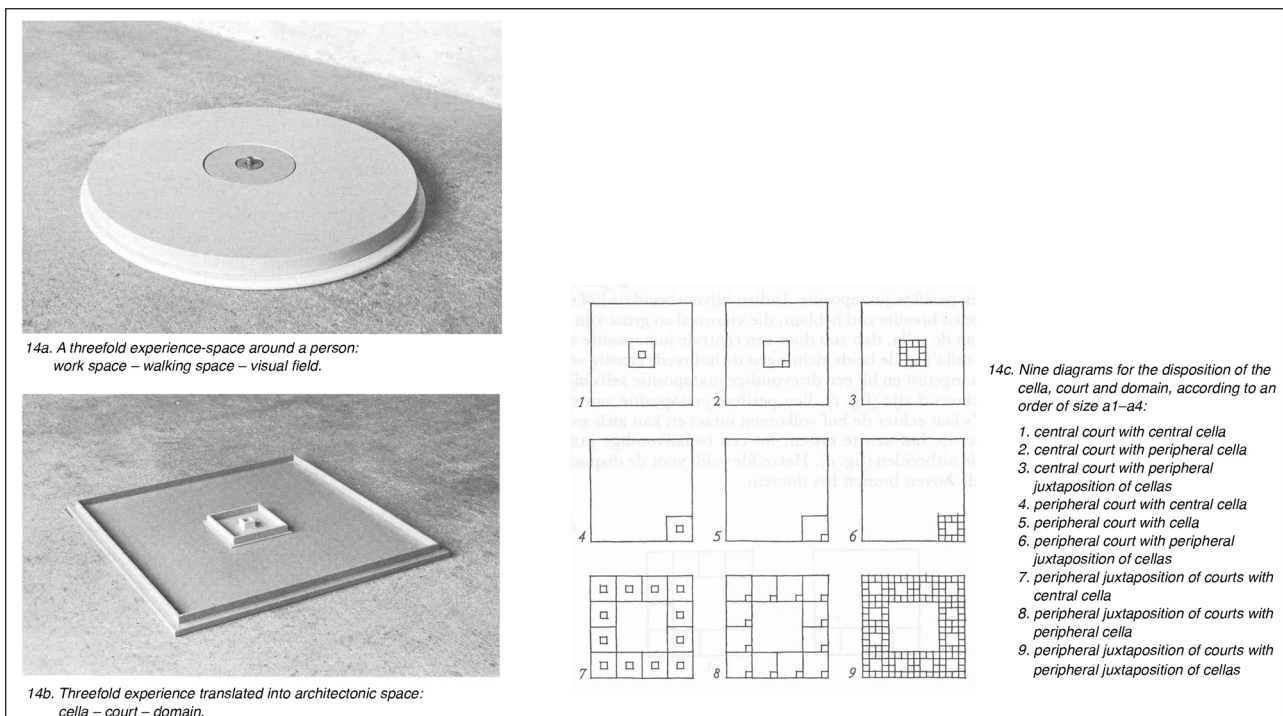

14a. A threefold experience-space around a person: work space – walking space – visual field.

14b. Threefold experience translated into architectonic space: cella – court – domain.

14c. Nine diagrams for the disposition of the cella, court and domain, according to an order of size a1–a4:

1. central court with central cella
2. central court with peripheral cella
3. central court with peripheral juxtaposition of cellas
4. peripheral court with central cella
5. peripheral court with cella
6. peripheral court with peripheral juxtaposition of cellas
7. peripheral juxtaposition of courts with central cella
8. peripheral juxtaposition of courts with peripheral cella
9. peripheral juxtaposition of courts with peripheral juxtaposition of cellas

Figure 14: (**a, b, c**): Dom Hans van der Laan, Phenomenological models: The fitting together of experience space and architectonic space through three fields. Source of (**a, b**): VDL, CKA VII, Het menselijk verblijf in stedelijk verband, 21 October 1972 (VDLA). Source of (**c**): AS III.12.
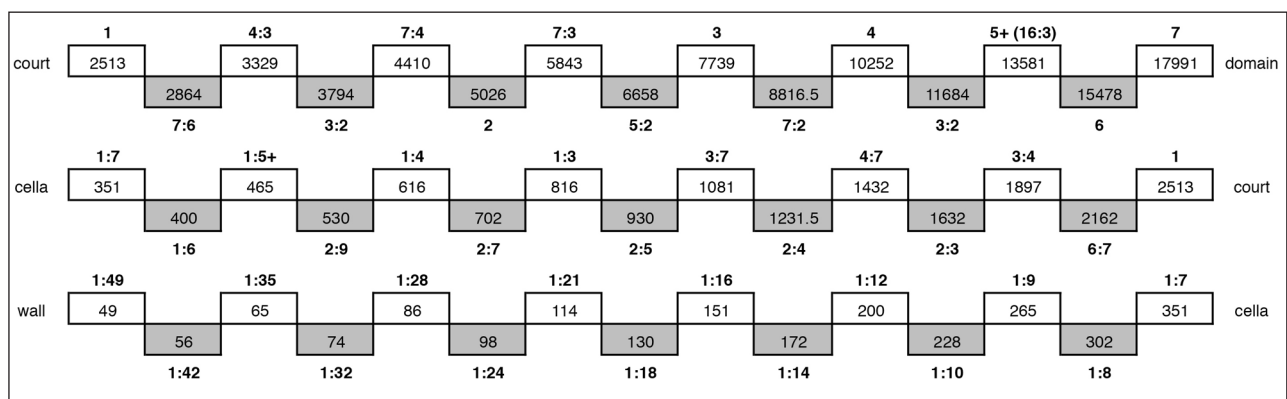
	1		4:3		7:4		7:3		3		4		5+ (16:3)		7	
court	2513		3329		4410		5843		7739		10252		13581		17991	domain
		2864		3794		5026		6658		8816.5		11684		15478		
		7:6		3:2		2		5:2		7:2		3:2		6		

	1:7		1:5+		1:4		1:3		3:7		4:7		3:4		1	
cella	351		465		616		816		1081		1432		1897		2513	court
		400		530		702		930		1231.5		1632		2162		
		1:6		2:9		2:7		2:5		2:4		2:3		6:7		

	1:49		1:35		1:28		1:21		1:16		1:12		1:9		1:7	
wall	49		65		86		114		151		200		265		351	cella
		56		74		98		130		172		228		302		
		1:42		1:32		1:24		1:18		1:14		1:10		1:8		

Figure 15: The three orders of size of Roosenberg Abbey in detailed centimetres. Authentic measures are in white, derived measures in grey. The measures incrementally grow with the 4:3 ratio. Every order of size is 7 times larger than the one below. The order from 49 cm (thickness of the wall) to 351 cm (cella size) is used for dimensioning wall segments, window openings and columns. The order from 351 cm to 2513 cm is used for spaces and the convent wings. The order from 2513 cm to 17,991 cm defines the position of the building in the terrain. Reconstruction by the author.
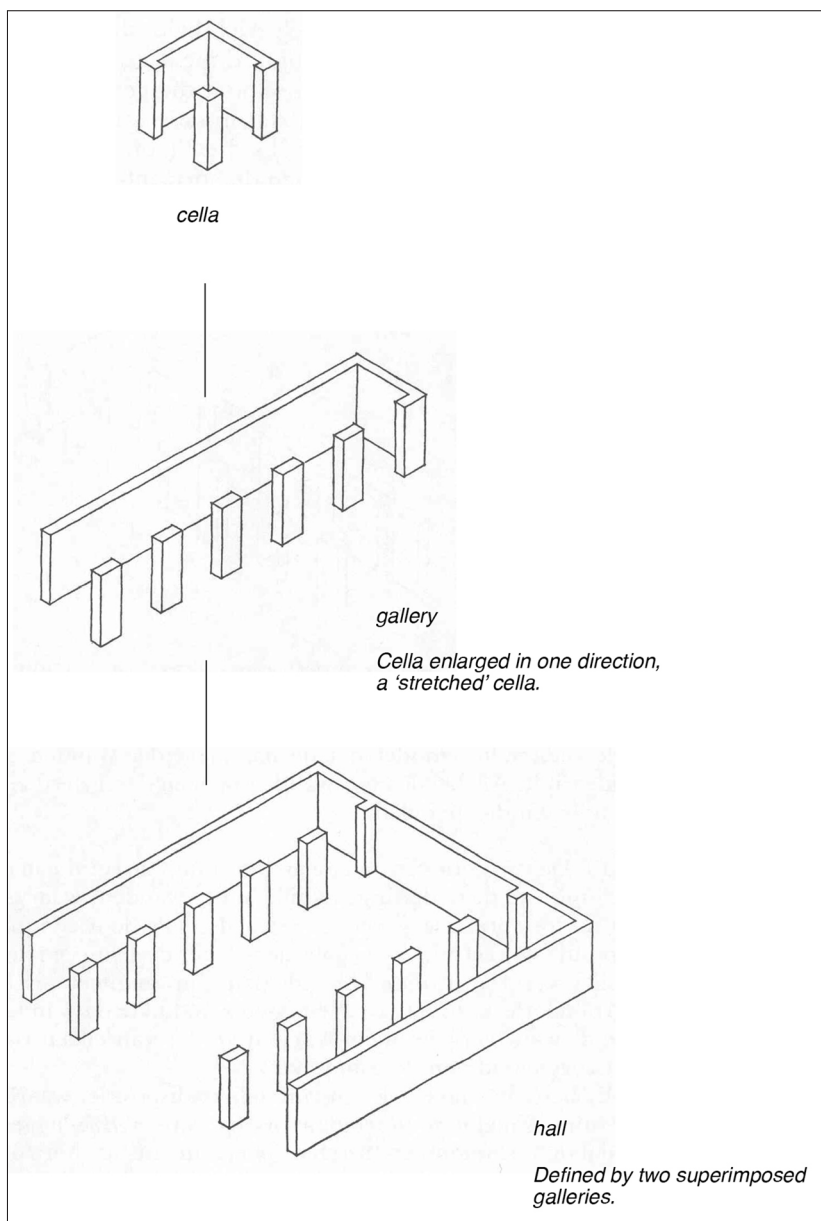

cella

gallery

Cella enlarged in one direction, a 'stretched' cella.

hall

Defined by two superimposed galleries.

Figure 16: Generic models showing continuous superposition of space: cell — gallery — hall. VDL, CKA V, Vijfde les over de architectonische ruimte, 4 March 1967 (VDLA).

17a. spatial cell

- mass / space
- 1 / 7
- series

17b. extended spatial cell

- space as three-dimensional construct
- spatial effect
- movement

17c. superposition of rhythms

- spatial matrix
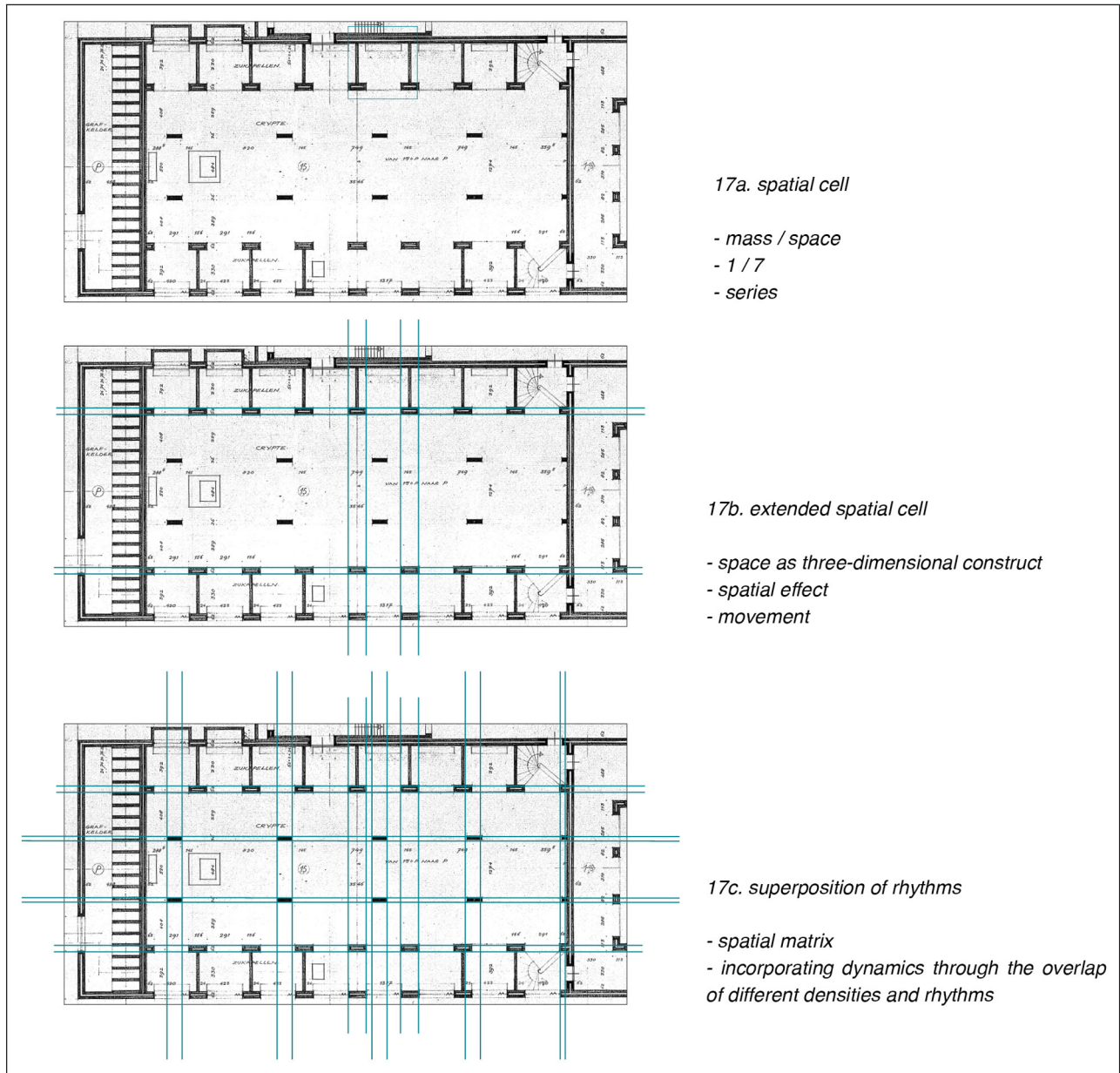*- incorporating dynamics through the overlap of different densities and rhythms*

Figure 17: Dynamic spatial superposition. Source: Design drawing of Dom Hans van der Laan, 1959 (VDLA); defined rhythms added by author.

gallery expresses 3 to 4 bays. As such, Van der Laan strove for spatial eurhythmy and symmetry, not a mirrored self-similarity but symmetry as defined by Vitruvius.[28] Van der Laan sought a sense of spatial unity through asymmetrical compositions.

As a third series of diagrams, Van der Laan introduced Vitruvius's five intercolumniations to define the density of openings in a column row (**Fig. 18**). Vitruvius expressed the column interval as a function of the diameter of the column, fixing five distinct proportions. Van der Laan altered these proportions into ratios of his order of size. He believed the eustylos was the most pleasing (Van der Laan, AS XI.11).[29]

Van der Laan regarded the wall as a composition of wall pieces with orthogonal open and closed parts. He included every wall piece, not only the columns but also the horizontal concrete bands of bordering elements, such as thresholds and lintels, into a composition of measures within the order defined by the wall thickness as the basic unit (Van der Laan, AS XI.7). Through the repetition of openings and columns, each wall defined a distinct column spacing. As Van der Laan explained, 'This repetition in the wall of open and closed parts to the rhythm of the smallest spatial unit is a universal architectural phenomenon; at all times and in all places, walls display rows of doors or windows, of columns or piers' (Van der Laan, AS XI.6). As with the superposition in plan, the pier spacing did not cohere with a logic of construction. Van der Laan composed the different bay dimensions with the intention of expressing certain dynamics of spatial atectonic rhythms.

The result of this articulation of rhythms is prominent in, for example, the library in St. Benedictusberg, Vaals (**Fig. 19**). As in all the larger spaces in this complex, the library, in this case a double height, vertical reading space,
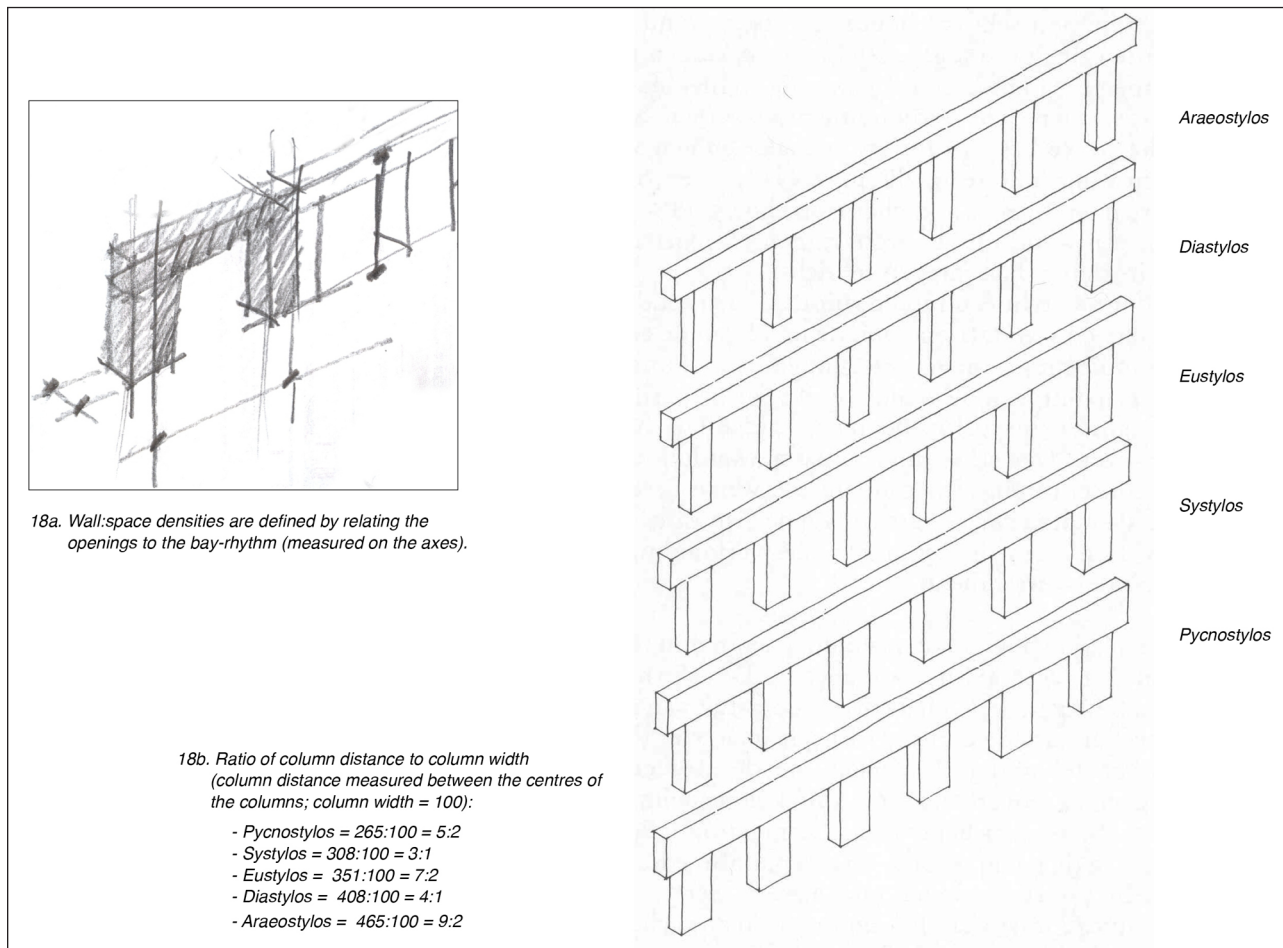
18a. *Wall:space densities are defined by relating the openings to the bay-rhythm (measured on the axes).*

18b. *Ratio of column distance to column width (column distance measured between the centres of the columns; column width = 100):*

  - Pycnostylos = 265:100 = 5:2
  - Systylos = 308:100 = 3:1
  - Eustylos = 351:100 = 7:2
  - Diastylos = 408:100 = 4:1
  - Araeostylos = 465:100 = 9:2

Figure 18: (**a**): Expression of a wall. Sketch by Rik van der Laan. (**b**): Dom Hans van der Laan, The five column spacings of Vitruvius according to the plastic number (VDL, AS, XI.10).

is surmounted by a gallery. Two rows of windows provide an abundance of light. Adjacent to the gallery are two floors for the storage of books. They have low ceilings and are quite dark. As such, a vertical-horizontal overlap is emphasized here. Within the expression of the building elements, this effect is reversed. The continuous concrete thresholds and lintels of the windows give a horizontal effect, in contrast to the verticality of the columns. Furthermore, there are the typical shifts in the rhythms of column spacing, 6 in total where the outer ones of the cellas are more dense, and there are 8 horizontal window openings at the top and 12 paired vertical windows at the bottom. All of these different rhythmical narratives come together in the reading room. Moving along the stair, this experience unfolds through changing diagonal perspectives.[30]

The realisation of the crypt in 1961 and the church in 1968 at Abbey St. Benedictusberg remained unnoticed in the architectural community for a decade. Only from 1971 onwards did Van der Laan's elementary architecture begin to draw attention, thanks to two Belgian journalists, Anthony Mertens and Guido van Hoof. They wrote an article accompanied by an interview in the *Standaard der Letteren* titled 'Wederdoper der architectuur bouwde in Vaals abdijkerk' ('Anabaptist of Architecture Built an Abbey Church in Vaals') (Van Hoof and Mertens 1971: 17).

This article drew attention to Van der Laan in Belgium, and as a result the architect was invited to design his two convents in Waasmunster. In 1977 *Architectonic Space* came out in Dutch and, as mentioned above, in 1994, three years after Van der Laan's death, the English architect Richard Padovan wrote the first comprehensive monograph of Van der Laan's work, *Modern Primitive*. Sporadically more articles, and also exhibitions, studies and conferences followed.[31] Although these publications and activities exposed Van der Laan's work, they did not critically address his theories, his unique way of describing his design methodology, or his quest for a fundamental architecture.

The Plastic Number: A Design Tool or a Philosophical Tool?

Until the end of his days, Van der Laan remained true to his quest: for him the plastic number was not just a means for the creation of architecture (as a working method or a means of creating beauty), but the end goal of architecture itself. The plastic number for him was not a design tool, but a philosophical tool. The framework that Van der Laan formulated in *Architectonic Space* was intended to be a philosophy of space. In his writings, as this paper has shown, Van der Laan drew inspiration from Pythagoras, Plato, Aristotle

Figure 19: Library at St. Benedictusberg Abbey, Vaals. Photo by the author (2008).

and Vitruvius. For him, using the plastic number was the only way in which the reading of space could be guided from a subjective to an objective foundation. He aimed to develop an architectural theory of looking and making, rooted in the manner in which we look at and define spatial relationships. Van der Laan called it 'the objectification of our experience of space' (VDL C10 1983).

Nevertheless, what *precedes* this philosophical framework is the series of the plastic number as a practical design tool, imbedded in a design methodology that evolved between 1939 and 1977. For Van der Laan, space needed to be measurable cognitively, without the use of measuring instruments. His elementary architecture consists of building parts that are all bound together through numbers, as in the design systems set up by Alberti. But Van der Laan's series differed, as it introduced a system that hierarchically ordered these numbers with the ratio 3:4. Van der Laan sought to relate the concrete, natural measures (as 1.3247. . .) and the abstract, knowable measures (as 4:3). The plastic number is a series that aims to unite both of them by bridging the deviations between them. For Van der Laan, the proportional series of the plastic number facilitated design with proportion through visual counting. Of course, his elementary architecture is not a product of the plastic number tool alone. The plastic number is applied through an elaborate design methodology that is explained in *Architectonic Space* through a series of abstract spatial diagrams. In his buildings Van der Laan incorporated these diagrams in an asymmetric manner, aiming to express layered relationships between inside/outside and mass/space. As such, he combined classical aesthetics with a modern atectonic approach to space: massive walls, defined through various intercolumniations put into a dynamic asymmetrical spatial superposition. This paper has shown that, together with the typically rough materiality, this approach defines the main characteristics of his architecture. Beyond its philosophical framework, the plastic number series, as three successive measure-systems, for Van der Laan proved to be a most useful design tool to implement continuous hierarchical proportions in this superposition, from the smallest building stone to the overall building complex.

Competing Interests
The author declares that they have no competing interests.

Abbreviations
AS　　*Architectonic Space*
CKA　　Cursus Kerkelijke Architectuur (Course on church architecture)
VDL　　Dom Hans van der Laan
VDLA　Van der Laan Archief St. Benedictusberg, Vaals (Van der Laan Archives St. Benedictusberg, Vaals)
VDL C　correspondence of dom Hans van der Laan, Van der Laan Archives St. Benedictusberg, Vaals
VDL L　unpublished lectures by dom Hans van der Laan, Van der Laan Archives St. Benedictusberg, Vaals

Notes
[1] Dom Hans Van der Laan, in a letter to his brother Nico, 21 April 1940, (VDL C1 1940: 3): 'Zo heb ik geloofd dat het geheim van de taal der architectuur niet ligt in het wezen van de ruimte zelf maar in de wijze waarop wij er mee contact nemen.' Unless otherwise stated, all translations are the author's.

[2] Van der Laan explicitly used the term number, not ratio, because he intended to refer to Mocquereau's 'nombre musicale'.

[3] This term was used to describe Van der Laan's architecture in the Italian journal *Domus* in 1992 by architect and critic Rik Nys, as he found it more suitable than the term 'minimalist architecture'. Although Van der Laan's architecture is devoid of ornamentation, it is not reductive. On the contrary, it is characterised by rough materials and numerous complementary colours. See also, later in this paper, the descriptions of the crypt and library in Vaals.

[4] Many architects and members of particular institutions visit Van der Laan's abbeys in Vaals and Waasmunster, as can be seen in the archives. For example, in the last three years, Roosenberg Abbey in Waasmunster (1974) has been visited by several national and international universities, including ETH Zurich; University of Venice, Dep. of Architecture; University of Valladolid, Dep. of Architecture; Università della Svizzera Italiana, Accademia di Architettura di Mendrisio; and Leibniz Universität Hannover, Fakultät für Architektur und Landschaft Institut für Entwerfen und Gebäudelehre.

[5] The Belgian philosopher André Van de Putte described *Architectonic Space* as a 'masterly philosophical poetics of architecture. Philosophical because the essence of architecture is unfolded in a phenomenological-genetic manner from the acting, perceiving and reasoning presence of man in the world. A poetics because in this phenomenological explication, the position of the human who builds and orders his habitat, has a central position' (Van de Putte 1987: 541).

[6] Tectonics is the study of how building elements are assembled. Ornamentation is then introduced as an emphasis of the tectonic structure, for example the capital of a column. With the term 'atectonic approaches', I refer to the legacy of Gottfried Semper, whose influence occurs in the works of, for example, Hendrik Petrus Berlage. The emphasis is here on the enclosure of space and spatial effects. Ornamentation is then related to patterns (Semper's 'dressing') and spatial figures. Le Corbusier and Mies van der Rohe used an atectonic, meaning spatial, approach in their architecture. See, for example, Max Risselada, *Raumplan versus Plan Libre, Adolf Loos / Le Corbusier* (Rotterdam: 010 Publishers, 2008). This is discussed in more detail in Voet and Schoonjans (2009).

[7] Van der Laan differentiates continuous quantities from discrete quantities. A continuous quantity is infinite and can take any value, such as 3,6834. . . or 3,576. . . . The golden ratio 1,618. . . is a continuous quantity. A discrete quantity must take certain values, such as 1, 2, 457, for example, for shoe sizes or a number of people. These are also called integers, whole numbers or commensurable numbers. They are applied and abstract. Van der Laan defined the continuous quantities as natural or concrete, and the discrete quantities as abstract.

[8] St. Thomas Aquinas, *De Veritate*, q2 a3. Van der Laan often used this quote in his architectural teachings. During Van der Laan's early Benedictine formation, St Thomas's *Summa theologica* was read in class and commented upon orally by older fathers. Van der Laan himself wrote in retrospect that the instruction was based on Neo-Thomist manuals (VDL C11). Though no names or titles are known, Remery mentioned that these were probably the writings of Joseph Gredt OSB (1863–1940), Adolphe Tanquerey (1854–1932) or D. M. Prümmer OP (1866–1931) (Remery 2011: 414). When Van der Laan started teaching, the Benedictines in Oosterhout used Saint Thomas d' Aquin, *Somme théologique, la pensée humaine*, traduction par Wébert, J. O.P. (Paris: Editions du Cerf, 1930), and Saint Thomas d'Aquin, *La Vertu*, traduction par Bernard, R. O.P. (Paris: Editions du Cerf, 1953). [From an interview with Father Pieter Roose, Abbey St. Benedictusberg, Vaals, 13 September 2008.] On the cogitativa, also see Gardeil, Henri-Dominique, *Initiation à la philosophie de Saint Thomas D' Aquin* (Paris: Les Editions du Cerf, 2007).

[9] Van der Laan often used the term 'abstract number' to refer to ideal, discrete numbers, as opposed to concrete, natural or continuous numbers: 'The abstract number we use to count discrete quantity is perfectly knowable, since the unit on which it is based is absolute: it is the individual oneness of the things that we count, the smallest indivisible whole' (Van der Laan, AS V. 4).

[10] St. Thomas Aquinas, *Commentary on Metaphysics*, Book 9, Lesson 2, Unity as Measure, paragraph 823. Lesson 2 starts with the translation of Aristotle's *Metaphysics* Chapter: 1:1052b 19–1053b 8, followed by St. Thomas' commentaries. The quote by Van der Laan is taken from the direct translations, not the commentaries.

[11] I have conducted this experiment annually since 2008 with my master's students from Sint-Lucas School of Architecture, Brussels-Ghent.

[12] Van der Laan introduced the term *grondverhouding* (ground ratio) for 4:3 already in his first lessons in 1939. He introduced the term *plastisch getal* (plastic number) in 1953. Van der Laan, *Eerste uiteenzetting*, Leiden, September 1939, unp. (VDLA); Van der Laan, *Het plastisch getal dus discretie en continuïteit,* CKA2, 28 November 1953, unp. (VDLA).

[13] Starting from 1 as the smallest measure, this series is: 1 1.3247. . . 1.7548. . . 2.3246. . . 3.079. . . 4.079. . . 5.4039. . . 7.158. . . . . . . By comparison, the Fibonacci series consists of the numbers in the following integer sequence: 1 1 2 3 5 8 13 21 ... The series is an approximation of the mathematical definition $x + 1 = x^2$. The sum of two adjacent terms in the series equals the next term in the series.

[14] The Pythagorean means are as follows: The arithmetic mean is the middle term between two others that exceeds the one term by as much as it is itself exceeded by the other. The harmonic mean is the middle term between two others that exceeds the one term and is exceeded by the other by the same proportion of each term. The geometric mean is the middle term between two others that has the same ratio to the one term as the other has to itself (Van der Laan, AS VII.12). Arithmetic mean h of two lengths l and w: $l - h = h - w$; geometric mean: $l/h = h/w$, harmonic mean: $(l-h)/(h-w) = l/w$.

[15] For example: the authentic measure $7:4 \times 2 = 14:4 =$ the derived measure 7:2.

[16] The abstract measures are:
1 4:3 7:4 7:3 3   4 16:3 7.
1 1.3333. . . 1.75 2.3333. . . 3 4 5.3333. . . 7.
When comparing each part of these series with the 4:3 multiplication factor, the following deviations occur: The third measure (7:4) already deviates slightly ($4:3 \times 4:3 = 16:9$, which is 64:36 instead of 63:36 = 7:4) and would be 1/36 larger than 7:4. The fifth measure (3) deviates more ($7:3 \times 4:3 = 28:9$ instead of 27:9 = 3) and would be 1/9 larger than 3. The eighth measure (7) has the same deviation (1/9) as the fifth and needs to be reduced by 1/9 to end at 7 ($16:3 \times 4:3 = 64:9$ instead of 63:9 = 7). This means that the multiplication factor is not exactly 4:3, but it nevertheless shows limited variations of it.
Deviations when interrelated with the multiplication factor 4:3 are:
– Third measure: $4:3 \times 4:3 = 1.7777. \ldots$ This does not equal 1.75, but deviates 0.0277. . . from it.
– Fifth measure: $7:3 \times 4:3 = 3.11111. \ldots$ Deviation from 3: 0.1111. . . .
– Eighth measure: $16:3 \times 4:3 = 7.111111. \ldots$ Deviation from 7: 0.1111. . . .
Van der Laan considered these deviations to be minor, meaning that 3, 4, 7, etc., could be used to describe the measures of the series. In the translation into the numerical values of the three measure-systems, these become more exact, e.g. 7 then is 716 (700 + 14 + 2).

[17] The architect Hans van der Laan (junior) is the son of Nico van der Laan, Dom van der Laan's younger brother.

[18] Original drawings and references can be found in the VDLA.

[19] For example, Sint Antonius Church, Groesbeek (arch. J. G. Deur and C. Pouderoyen, 1948), Holy Eligius Church, Oostburg (arch. F. Mol and J. Brugman, 1949), and Catharina Church, Heusden (arch. Nico van der Laan, 1951).

[20] This number is deduced from the research conducted at the Van der Laan Archives Sint Benedictusberg, by J. M. M. van der Vaart, 2005 and 2007. Within the list of 371 participants, one has to make a differentiation between students who followed the three-year post-academic course and the participants in the open lecture days, Saturdays, which were open to the public. The official document produced by the CKA treasurer J. J. Van Dillen (VDLA) shows that between 1950 and 1967, 88 new students were admitted, of which 27 left with a charter. There was an average of 20 students

per year. In the open days between 1955 and 1967, there were 316 participants.

21 It is not clear to which of Ghyka's publications Van der Laan was referring. Two possible examples are Esthétique des proportions dans la nature et dans les arts (1927) and Le Nombre d'or; rites et rythmes pythagoriciens dans le développement de la civilisation occidentale, précédé d'une lettre de Paul Valéry (1931).

22 The 1957 international Syracuse competition, which selected Michel Andrault and Pierre Parat's monumental cone-shaped church in glass and concrete and not the more classical horizontal basilica with forecourts by Van der Laan's pupil Jan de Jong, was the final proof for Van der Laan that the general opinion did not favour his approach (Van der Laan 1957).

23 In 1939, Van der Laan started a lecture series in Leiden, the Netherlands, for which he took notes in small notebooks (VDLA). For the date of the patent, see Le Corbusier (1950: 44).

24 For example, Van der Laan claimed that the golden section was two-dimensional, whereas the plastic number was three-dimensional. He based this claim on mathematical definitions. The golden ratio is defined by $x^2 = x + 1$, while the plastic number is defined by $x^3 = x + 1$. This reasoning is first exposed in VDL L3 1940. This justification has no relation, though, with designing in three dimensions or with spatial perception.

25 Maritain was a close friend of Pieter van der Meer de Walcheren (1880–1970), and like Van der Laan, a Benedictine monk at Oosterhout. Van der Meer de Walcheren set out to help Van der Laan in the recognition of his work. Maritain wrote, 'L'auteur s'appelle Van der Laan et le livre Le Nombre Plastique. Je suppose que le génie vaut mieux que tous les nombres d'or, mais au fond il n'y a pas d'opposition' (J. Maritain, letter to Jean Labatut, 26 September 1961 (Labatut Papers, Firestone Library – Princeton, Box 7/Folder 4)). This document was pointed out to me by Rajesh Heynickx.

26 Van der Laan had read the book in 1966. He explains this in a letter to Richard Padovan on 26 October 1983 (VDLA). He wrote to Padovan that he had received the book in 1966 from Granpré Molière.

27 Richard Padovan translates the word 'nabijheid' as 'neighbourhood', with the approval of Dom van der Laan himself. Nevertheless, the author here prefers the term 'nearness'.

28 Van der Laan's definition of eurhythmy and symmetry is as follows: 'When the measures of a system are realized in the squared forms of the mass they can be proportionally related to each other in two ways. The form of the mass is fixed by the ratios between its various dimensions, which were referred to in antiquity by the name eurhythmy. But the size of the forms is fixed by its relation to that of other forms, and ultimately to that of the unit. Two three-dimensional sizes stand in a threefold linear ratio to each other; that is to say the three dimensions of one concrete datum stand in a ratio to the corresponding dimensions of the other. Here, it is not the several dimensions of a single form that are compared with each other, as with eurhythmy, but the corresponding dimensions of two distinct forms. This the ancients called symmetry, not in the sense in which the word is used at present, to mean the identity of two opposite halves, but in the sense of the proportion between the sizes of the parts of a building, from the smallest up to the whole' (Van der Laan, AS IX.6).

29 Vitruvius defined five column-intervals by relating the intercolumniation (the space between the columns) to the diameter of the columns. Van der Laan did not use this intercolumniation, but related the width of the column to the bay-rhythm (intercolumniation + column width).

30 For more in-depth research in Van der Laan's application of the three measuring scales into his architecture, see Voet (2012).

31 Most notably, Haan and Haagsma (1996, 2010), Ferlenga and Verde (2000), Tummers and Tummers (2005), and Remery (2012). For exhibitions, see, for example, those held in Maastricht (Architectuur, Modellen en meubels at the Bonnefantenmuseum, 1979), Esslingen (Villa Markel, 2001) and Vicenza (Rudolf Schwarz and Hans van der Laan: Mostra alla basilica Palladiana di Vicenza, 2000). For conferences, see, for example, the series in consideration of the Work of Dom Hans van der Laan, organised by the Henry Moore Foundation External Programmes, Abbey St. Benedictusberg Vaals and Inverleigh House, at the Royal Botanic Garden, Edinburgh on 4 March 2000 (Art, Natura and Mathematic), on 17 and 18 November 2000 (Living and Correspondences), and on 26 October 2001 (The Line Under the Spell of Its Measure).

References

Published Sources

Alberti, L B 1955 *Re aedificatoria*. Translated by J Leoni (1726). Edited by J Rykwert. *Ten Books on Architecture*. London: Alec Tiranti Ltd. (First published in 1452.)

Banham, R 1960 *Theory and Design in the First Machine Age*. London: Butterworth & Co.

Bekaert, G 1957–58 Tien jaar kerkbouw, een kritisch commentaar, deel 1. *Streven* 11(1–6).

Bollnow, O F 1963 *Mensch und Raum*. Stuttgart: W. Kohlhammer.

Butler, H C 1929 *Early Churches in Syria, Fourth to Seventh Centuries*. Leiden: Brill.

De Groot, J H, and **de Groot, J M** 1896 *Driehoeken bij ontwerpen van ornament voor zelfstudie en scholen*. Amsterdam: Joh. G. Stemler.

De Haan, H, and **Haagsma, I** 1996 *Plastisch Lexicon: Een kleine encyclopedie van de 'Bossche School'*. Haarlem: Architext.

De Haan, H and **Haagsma, I** 2010 *Gebouwen van het Plastische Getal, een lexicon van de 'Bossche School'*. Haarlem: Architext.

English, M 1957 Kerkbouwkunst van nu in West Vlaanderen. *De Autotoerist* 10 (16 April): 547–553.

Ferlenga, A, and **Verde, P** 2000 *Dom Hans van der Laan: Le opere, gli scritti*. Milan: Electa. Republished in English: Ferlenga, A, and Verde, P 2001 *Dom Hans van der Laan: Works and Words*. Amsterdam: Architectura & Natura Press.

Republished as extended version: Ferlenga, A, and Verde, P 2011 *Dom Hans van der Laan: Works and Words.* Amsterdam: Architectura & Natura Press. PMid: 11012037.

Ghyka, M 1927 *Esthetique des Proportions dans la nature et dans les arts.* Paris: Gallimard.

Ghyka, M 1931 *Le Nombre d'or; rites et rythmes pythagoriciens dans le développement de la civilisation occidentale, précédé d'une lettre de Paul Valéry.* Paris: NRF.

Hambidge, J 1920 *Dynamic Symmetry: The Greek Vase.* New Haven, CT: Yale University Press.

Laprade, A 1940–50 *Architectures de France à travers les croquis d'Albert Laprade.* Paris: Vincent Fréal et Cie (des albums différents par région).

Le Corbusier 1950 *Le Modulor: Essai sur une mesure harmonique à l'echelle humaine, applicable universellement à l'architecture et à la mechanique.* Boulogne: Editions de l'Architecture d'aujourd'hui.

Le Corbusier 1952 Le 'Modulor' et la 'Loi des 7 V'. In: *Il prima Convegno Internazionale sulle proporzioni nelle arti, Atti e Rassegna Tecnica della Società degli Ingegneri e degli Architetti in Torino, new series,* 6(4): 118–135.

Malschaert, T, and **Oldenburger, J** 2011 Interview met Godfried Kruijtzer. *Thematismos* 13–14: 30–34.

Mocquereau, R P Dom A 1908 (Tome I) 1927 (Tome II) *Le nombre musical ou rythmique grégorienne, théorie et pratique.* Rome, Tournai: Société de St.-Jean L'Évangéliste and Desclée & Cie.

Padovan, R 1994 *Dom Hans van der Laan, Modern Primitive.* Amsterdam: Architectura & Natura.

Palladio, A 1570 *I Quattro libri dell'architettura.* Translated by I Ware (1738). Reprint 1965. New York: Dover.

Peeters, C J A C 1964 West-Vlaamse kerkbouw in een Nederlands vizier. *West-Vlaanderen* 13 (73 January–February): 17–22.

Remery, M 2010 *Mystery and Matter.* Leiden: Brill. DOI: http://dx.doi.org/10.1163/ej.9789004182967.i-663

Rietveld, G Th 1960 Boekbespreking. *Bouwkundig Weekblad* 78: 403.

Ritzen, J 1949 Holy Eligius church, Oostburg, *Katholiek Bouwblad* 24: 277–79.

Sarlemijn, G J M 1953 De vernieuwing der kerkelijke architectuur na de oorlog, *Katholiek Bouwblad* 22: 338–348.

Tummers, L, and **Tummers, J** 2005 *Abdijkerk te Vaals.* Bloemendaal: Van der Laan Foundation.

Urbain, B 1949–50 Ter inleiding bij Nederlands Nieuwe kerken. *Schets* 3(2).

Van der Laan, H 1957 Vernieuwing in kerkenbouw te Ronchamp en Syracuse, architectonische ordonnantie en plastische verhoudingen. *De Tijd,* 13 July, p. 10.

Van der Laan, H 1960 *Le Nombre plastique: Quinze leçons sur l'ordonnance architectonique.* Translated by Dom Xavier Botte. Leiden: Brill. PMid: 13757949.

Van der Laan, H 1977 1983 (2, revised), 1992 (3, revised), 1997 (4) *De Architectonische ruimte: Vijftien lessen over de dispositie van het menselijk verblijf.* Leiden: Brill. (Van der Laan, AS).

Van der Laan, H (junior) 2009 Symposium on Dom Hans van der Laan. Tomelilla, Sweden, June 2009.

Van de Putte, A 1987 Recensie over De Architectonische Ruimte. *Tijdschrift voor Filosofie* 3.

Van Hoof, G and **Mertens, A** 1971 Wederdoper der architectuur bouwde in Vaals abdijkerk. *Standaard der Letteren,* 9 April 1971, p. 17.

Vitruvius, M 1914 *De Architectura.* Translated by M H Morgan (Written ca. 15 BC.). *The Ten Books on Architecture.* New York: Dover.

Voet, C 2012 The Poetics of Order. Dom Hans van der Laan, *Architectural Research Quarterly,* 16(2): 137–154.

Voet, C, and **Schoonjans, Y** 2009 Dom Hans van der Laan's Architectonic Space as a Contemporary Interpretation of Connaissance Poetique within Sacred Architecture. In: Between the Concept and Identity, Communications II, International Congress of Contemporary Religious Architecture, Ourense, Spain, 12–14 November, 2009. DOI: http://www.arquitecturareligiosa.es/index.php/AR/article/view/97/54.

Wittkower, R 1962 *Architectural Principles in the Age of Humanism.* London: Tiranti. PMid: 14464363.

Unpublished Sources
Van der Laan, H, Interview
VDL 1988 Text for an Interview with Antoine Bodart, 26 March 1988. Unp. VDLA.

Van der Laan, H, correspondence (VDL C):
VDL C1. Letter to his brother Nico, 21 April 1940, copy VDLA.
VDL C2. VDL, Letter to Richard Padovan, 2 August 1983, copy VDLA.
VDL C3. VDL, Letter to Richard Padovan, 26 October 1983, copy VDLA.
VDL C4. VDL, Letter to Sr G. van der Laan, 26 October 1942, copy VDLA. As quoted in Remery (2010: 66).
VDL C5. VDL, Letter to his brother Nico, 28 October 1936, copy VDLA.
VDL C6. VDL, Letter to his brother Nico, 5 July 1940, copy VDLA.
VDL C7. VDL, Letter to his brother Nico, 29 August 1943, copy VDLA.
VDL C8. VDL, Letter to his brother Nico, 3 February 1939, copy VDLA.
VDL C9. VDL, Letter to his brother Nico, 24 October 1953, copy VDLA.
VDL C10. VDL, Letter to Richard Padovan, 17 August 1983, copy VDLA.
VDL C11. VDL, Letter to Richard Padovan, 5 November 1987, copy VDLA.

Van der Laan, H, unpublished lectures for Cursus Kerkelijke Architectuur (CKA) (VDL L):
VDL L1. VDL, *Vierde uiteenzetting,* Oegstgeest, January 1941, unp. VDLA.
VDL L2. VDL, *Resumé,* 1941, unp. VDLA.
VDL L3. VDL, *Tweede uiteenzetting in Leiden,* 2 January 1940, unp. VDLA.
**VDL L4.** VDL, *Over muziek en architectuur,* 15–16 September 1951, unp. VDLA.
VDL L5. VDL, *Matenstelsels,* 6 July 1946, unp. VDLA.
VDL L6. VDL, *Over een schotse tartan,* 23 November 1968, CKA8 series 6, unp. VDLA.