14 ANALYSIS OF BUILDINGS

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PROPORTION AND MEASUREMENT IN EARLY TWENTIETH CENTURY DUTCH BUILDING PRACTICE

14.1 ANALYSIS OF BUILDINGS AS AN EDUCATIONAL TOOL

I cannot exclude history from my investigations, since I am dealing with existing buildings, but I am certainly not a historian. I treat buildings as actualities, not as historical data. I also cannot, should not and do not want, extract the chosen buildings from their cultural environment, yet 'the building of the building' as such is my subject. It is important to relate historical facts to the technical possibilities at the time of building and today by finding and researching the tools used for the design and the way it was realised with the building methods at the time. My hope is that the architectural student will, by analysing, learn from the building for his own future practice. Buildings and their elements of yesteryear are viewed as possible tools for the design-process of tomorrow.

Analysis of Buildings does not wish to select the subject-to-be-investigated *a priori* on the basis of Style or Movement. In fact, we studied works of a great variety of architects from different places and times: from Hendrik P. Berlage and Antonio Gaudí y Cornet to Johannes Duiker and Bruce L. Goff. Gaudí has become a topic without comparison, as may be concluded from the success of our books and our exhibition, shown again and again. But, on the other hand there are the productions that treat the Dutch Modern Movement. These products have come from a profusion of material collected by students in their research projects and elaborated by a small group of faculty members.

As the school was mostly unable to provide the money needed for the publication of the results, so the *Stichting Analyse van Gebouwen* (Foundation Analysis of Buildings) was formed, through which necessary funds are obtained from ministries and private funds. Books appeared about Gaudí, Duiker, Wiebenga, the Dutch New Movement 1924-1936 and exhibitions about the same, but also about Johannes Bernardus van Loghem.[a] A result of the investigation of Van Loghem's work in Siberia is the Uralski constructivist restoration and conservation project, in which faculty members take part as well as external professionals, Russians and Dutch alike.[b]

It will be clear, that there has also been a great variety in the choice of building types as we studied faculty buildings, sport complexes, schools and housing projects, Piet Blom's cubicles in Helmond and mobile homes. In Siberia (Kemerovo Oblast) the research programme even included environmental and urban problems to be solved.

Some time ago the chair for Building Integration and Co-ordination (BIC decided to extend certain studies of *Analysis of Buildings* done in the past and execute an overall research of Dutch building practice in the twentieth Century. The idea of describing this period is not original, but as our research method and viewpoint are different from the historical it can have different outcomes. The central topic is specific: the building as the result of a process of design and building. The reader must acknowledge here, that we do not speak of architecture, but of building.

a The exhibitions produced by Analysis of Buildings:
Antonio Gaudí, rationalist met perfecte materiaalbeheersing, 1978;
Jan Duiker, constructeur in stuc en staal, 1982;
Jan Gerko Wiebenga, apostel van het Nieuwe Bouwen, 1987;
Gaudí in de Beurs van Berlage, 1988;
Het Nieuwe Bouwen en Wonen in Nederland 1924-1936, 1990;
The New Movement in the Netherlands 1924-1936, 1992;
Johannes Bernardus van Loghem, architect van een optimistische generatie, 1996.

b Rudolphine Eggink did the Van Loghem study. Her dissertation formed the basis for the exhibition and the starting point for the Uralski project of the Foundation Analyse van Gebouwen.

14.2 THE METHOD

The method of analysis of buildings is simple. It is advisable to investigate the general structure of the building first, be it spatial or material, and draw a general layout. One needs furthermore good tools for measuring the chosen building, a bit of intelligence to understand its structure and good tools to draw and describe it correctly. It is important to know that archives contain a lot of documents, like construction drawings and contracts. This material can help to understand the building better and eventually the intentions of designer and builder. One needs a lot of training to make a good analysis and a satisfactory description, be it in

drawing or in text. Above all, the researching designer must have the capability of imagining a building spatially and make it spatially imaginable.

When starting to work with the students we first of all visit and investigate with them the chosen building in situ. Then we gather as many specific publications as possible about the object, a building or an ensemble of buildings. It is important to read the existing interpretations, before developing a new vision or drawing conclusions. We especially want to find information about the structural reality of the building and whether it has been build as it was designed. If this was not the case, we want to find out what the reasons have been to deviate. We also want to know which tools were used in the designing process and in the building process.

The second step is inspection of the sources at the NAi, the nation's most important architectural archive, at municipalities, architects offices and in private collections. We look chronologically at the original sketches, drawings, correspondence, commands of consultants, about rules for building permits, articles in newspapers, photographs, etc. We also do interviews, when possible, with the architect or with people who were connected with the architect('s office), the owner of the building, the contractor, consultants, and technical people. It is important in that stage to relate research results to the actual condition of the building.

The third step is to organise the material according to themes. We use essentially the same themes for every building, to be able to make comparisons. Examples of these themes are: assignment, architect, client, situation at location, history of the location, mass and volume, proportion and measure systems (design / build), structure of functions (design / build), structure of space (design / build), structure of materials (designed / build).

The last step is a complete description of the building, if possible into detail, including the conclusions of our investigation.

Specialised articles and lectures about a building or about a theme belong to the results. But, also complete investigations of one building in a monographic study. It is furthermore of interest to combine the results of investigations of several buildings under one of the investigated themes, for instance the proportion and measure studies of The Beurs, Hotel American and The Nederlandsche Handel-Maatschappij, all three in Amsterdam. It shows new ways of interpreting the proportional system, related to the dimensions of bricks.

14.3 IN SEARCH FOR PROPORTION AND MEASURE

The architect must study many aspects. One of these is, although applied by important architects from early times on, many times forgotten or at least underestimated: proportionality. *Proportion and measure* belong to the means to define a building in relation to its site and its functions. Already Vitruvius wrote about it; but also Fibonacci, Alberti, Palladio, Viollet-le-Duc. Le Corbusier wrote about it in his famous Modulor (see page 212).[a] Throughout history it seems to be forgotten every now and then, or devaluated, especially in daily design practice. It was recognised once more by the end of the 19th Century by architectural historians, like the German August Thiersch, but also by practicing architects, as in the Netherlands, specifically in Amsterdam.

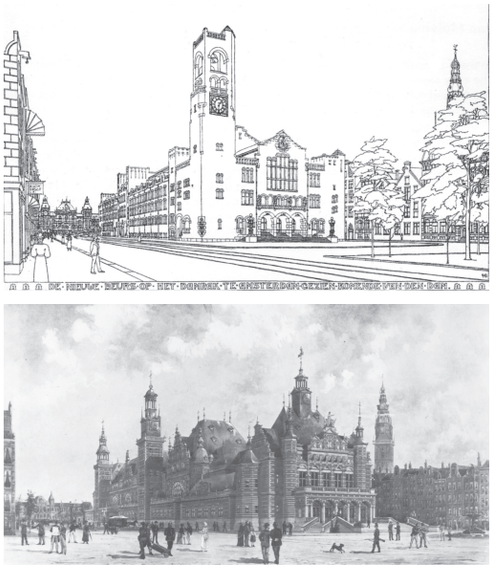
While in the 18th Century Dutch architecture still flourished, it had gone into deep decline in the early 19th Century. In the second half of that century, Pierre Cuypers (1827-1921), architect of the Amsterdam Central Station, the National (Rijks) museum and dozens of Roman Catholic churches, gave Dutch architecture a new impulse. Influenced by Eugène Viollet-le-Duc, Cuypers predicated French Gothic as the right manner for the new architecture.[b] This was not so much out of stylistic considerations as out of rational thinking about the process of designing and building. The availability of new techniques, of newly discovered materials like tropical timber and of newly developed materials, like artificial stone and steel, inspired Cuypers to find a new way in architecture as it did other architects, who found theír ways through Eclecticism and Art Nouveau (*Nieuwe Kunst*).[c]

a Le Corbusier (1948) *Modulor 1;* (1955) *Modulor 2*. English edition: (2000) *The modulor : a harmonious measure to the human scale, universally applicable to architecture and mechanics*. Vitruvius (1960) *Book 3*; Alberti, L.B. (1986) *Book 6* a.o; Palladio, A. (1997) *Book 1*.

b The analysis by Viollet-le-Duc was only partly right. The 'gothic' did not exist as one style, one system or one structure. The common nominator, the essence of "the" gothic is the search and find of a different way of building, one that demands rather less material for larger envelopes of spaces. As such the gothic still exists in our days. It furthermore must have been of influence that the greater demand for permanent structures made it necessary to import materials along longer transport lines or to develop new materials. At the same time there is the wish for exclusiveness in a society of abundance. These are factors that played a rôle in the project for the Beurs.

c Auke van der Woud's extensive study The Art of Building sheds a new light on the rôle of the different movements in the modernisation of Dutch architecture. Woud, A. van der (2001) *The art of building: from classicism to modernity*.

But, it was in fact with the generation of Hendrik Petrus Berlage (1856-1934) and his somewhat younger colleagues, like Willem Ceeszoon Kromhout (1864-1940) and Karel Petrus Cornelis de Bazel (1869-1923) that truly new architecture began. With their buildings architecture in The Netherlands reached international repute within two decades, equalling the worldwide known Dutch 17th Century standards in city planning and architecture alike. The Amsterdam Stock Exchange building, now named *'De Beurs van Berlage'*, became the Dutch hallmark for progressive architecture in the 20th Century. The development of its design shows in plans, sections and perspectives how, step by step, the definition of a new architecture developed. The sequence of proposals for the Beurs, starting with the competition project in 1885, presents the purification of form that became fundamental in Dutch architecture. It is this striving towards purification, the wish to go back to essentials as expressed in the Beurs that impressed later generations particularly.[a]



93 Different designs for *'De Beurs'*.[e]

14.4 THE BEURS, BUILT BETWEEN 1898 AND 1903

The examination of this building with the eyes of a builder provides insight into constructional and measurable physical aspects and reveals intriguing characteristics of it. One of these is the question of the basic measures related to the dimensions of the brick and the proportional system in plan, section and elevation. In his famous lecture in Zürich (1907) Berlage defines precisely how one should look at a building before criticising it.[b] He starts with a quote:

"Time alters fashions (…) but that which is founded on geometry and real science will remain unalterable". He continues: "I have come to (…) the conviction that geometry, the mathematical science, for the making of artistic forms is not only the most profitable, but even absolutely necessary."

Evidently Berlage's lecture was also influenced by theories concerning the coherence of the universe, which had been developed at the same time. He writes, "these shaping / creative / formative laws (*Gestaltung*) are of the same mathematical nature in the whole universe, that is where it concerns the bodily stereometric and where planes are concerned geometric". Berlage identifies the process of slow genesis in nature with quick production in building, the growing of the crystal with artificial imitation or interpretation of the same.

Essential to an understanding of Berlage's work is what he said next in the same lecture:

"...you should at once investigate how it was made, that is: with what consequence the forms have been applied. You have to make yourself clear with what talent the volumes concerned are brought in concordance with it. But, not only that, you even have to admit that the proportions have been applied with excellence and the decoration with great understanding and taste. All in all, you have to admit that the whole work shows an absolute entity in all its parts".

Here Berlage shows himself a classicist, following the old principles of harmony.

Choice of the proportional system

There has been quite some discussion about the basic figure that Berlage introduced in the façades of the Beurs, the so-called Egyptian Triangle with oblique side $\sqrt{41}$, base 8 and height 5 (proportion 1:1,6).[c] Half of this triangle is the square-angled one with base 4 and vertical 5. In this triangle the inclination of the oblique side is important. We know that in the traditional *'grachtenhuis'* (canal house) the windowpanes have a diagonal under ~50° with the horizontal, which corresponds more or less with the angle of the Golden Section (see page 212). In Berlage's Beurs this angle is 52°, very near to the ideal one of 51,82..° of the Golden Section, with a proportion of 1:1,618... The advantage of Berlage's system of proportion is, of course, that it works with full numbers, 8 and 5, in the horizontal and the vertical directions.[d]

On the other hand, Berlage worked with bricks and calculated heights and widths of the building in courses and headers. The measures of the applied 'Waal' brick format are 11.2 cm. and 6.25 cm (9:5=1,8) including joints, which means that only a certain multiple of the element corresponds with the Egyptian Triangle. Thus the question remains how did Berlage solve it?

a Curiously enough it also became in a way the cradle of such opposing movements as De Stijl and the expressionistic brick architecture of the Amsterdam School.

b The text was published as: Berlage, H.P. (1908) *Grundlagen & Entwicklung der Architektur: vier Vorträge gehalten im Kunstgewerbe Museum zu Zürich*.

c Here Egyptian Triangle must be understood as it was defined by Viollet-le-Duc, E. (1977) *Entretiens sur l'architecture* (English translation: (1987) *Lectures on architecture*) and not as the Pythagorian triangle with sides 3:4:5.

d There is no doubt about the introduction of the 'Egyptian triangle' as such in the Beurs design. For instance do we find the figure with its proportions on one of the drawings for the bidding and has Berlage's mentioned its use in several occasions.

e Sources respectively: *Architectura* (1998) nr. 12 and *Topografische Atlas gemeente Amsterdam*.

Berlage was indeed quite clear in his Zürich lectures about his choice of the Egyptian Triangle.[a] Far less clear was his reasoning for the basic module measure concerning which he only declared that it resulted after a long search as the right module.[b] Neither did Berlage attempt to explain the application of the Double Square in his Beurs ground plan, although the use of it there is easy to deduct.

As Berlage would have it, there exists in a well-detailed building coherence between the dimensions and proportions applied and the choice of materials. In main points Berlage applied three materials in the Beurs that co-determined the dimensions of the building: iron, stone and brick, the latter being the only one with standard production measures. Although the immense amount of brick in the Beurs would have made possible a specific standard, Berlage applied an existing one, the so-called Waal format, the most robust format that the Dutch brick industry was able to produce. It is not by chance, that the Waal brick has a basic proportion of 1:2, being 5,25 cm x 10,5 cm x 21,5 cm. Therefore, it did not co-ordinate with the Egyptian proportion Berlage wanted to apply.[c]

The simplest bond would be the running bond, but Berlage used a less dull cross bond in which at terminations (corners etc.) he could use the so-called *'drieklezoor'* (three-quarters of a stretcher) to improve cohesion of the wall. But also the bond that Berlage choose to apply has its restrictions. Parts of walls, as between windows, of odd numbers of brick heads result in a different (symmetrical) termination pattern from those of even numbers: a-symmetrical and therefore not quiet. As Berlage aimed at quietness we may suppose that he prefered the first solution and, therefore, made wall parts between windows with odd numbers of brick heads. The general module of 17 brick heads is thus correct, but the above mentioned wall part is 34 heads with 20 heads for the window openings and 14 between windows at the main floor, both even numbers.

14.5 HOTEL AMERICAN, BUILT IN 1900-1902

From the start, the Hotel American on Amsterdam's Leidseplein - close to the Stadsschouwburg, the new Rijksmuseum, Vondelpark and Concertgebouw - owed its fame to its café, the meeting place of choice for well-known public figures. The building itself, designed by W. Kromhout and H. G. Jansen, was an architectural masterpiece even today greatly admired for its exceptional design.[d] The first Hotel American (1880) was built at the same time as the Rijksmuseum. When, in the nineties, the decision was taken to renovate and expand the hotel, the site was already fixed: adjacent to and under the existing building. What was not yet settled, however, was the ultimate size of that site. The possibilities for expansion increased over time. Although little of the original building has survived, one is struck by the degree to which the new structure has been determined by the preceding structure. The extent of the formerly existing buildings and of the renovation is clearly visible in the archival drawing of the foundations, in which the architects have indicated both the old and the new structure. The structure of the new Hotel American was indeed determined to a considerable degree by the old, both in material and spatial sense.[e]

The desire of the architects to base their design on a simple basic floor plan becomes evident when one looks at the ground floor, especially the café. It is also immediately clear that they did not confine themselves to the basic plan, but were striving for a sound structure with a high degree of complexity, with meticulous detailing, and judiciously chosen proportions. The fact that Kromhout and Jansen made use of a measuring method to recreate the Hotel American on the basis of the existing construction becomes clear from the drawings and from the building itself.[f]

The dynamics of the new hotel are rooted in the buildings, already existing on the site. The old, both in material and spatial sense, determined to a considerable degree the structure of the new Hotel American. Kromhout and his fellow architect Jansen encountered a complicated situation. To conquer this they laid a simple basic figure on it and elaborated upon this until they reached the highest degree of complexity possible.

a For example p. 60 of Grundlagen
b P. 14 of Grundlagen
c The 1:2 proportion would make it suitable for one of the other triangles that Viollet-le-Duc indicated as proportionally correct: the equilateral, right-angled, were it not that there must be space between the bricks for the mortar and tolerance of size deviation. Also would it be difficult to set a brick with the 'Egyptian' proportion in a bond, this in contrast with the applied Waal brick.
d Jansen had already been working for the owner of the hotel; Kromhout was invited to help only when the second or third plan was prepared. His position was probably comparable to the position of 'aesthetic advisor' that Van der Mey took in the *Scheepvaarthuis* case and De Bazel in the *Nederlandsche Handel-Maatschappij*, as will be mentioned later.
e Source material found in archives can be rich in information about the building as such and the building process. Here, by a happy co-incidence, the highly informative diary of the overseer of the project has survived. The diary entries are terse, sometimes even cryptic. For example, why is no mention made of the drawings of the window frames on the second and the third floors, even though the overseer never failed to mention that he had received such drawings? The answer is very simple: they were never made! The frames from the old buildings were saved and re-used. No architectural historian ever discovered this, which led to quite intriguing misinterpretations about the formal intentions of the architects.
f Had the architects been at liberty to build on an empty site, the result would undoubtedly have been quite different from the building that we know as the Hotel American. The unity, which they were clearly aiming for in the façade, would have been greater, and the building would probably have been less dynamic. Looking at the floor plan, one suspects that they would have preferred to execute it in reverse. This would have given the café a more favourable exposure: towards the sun and away from the less attractive Marnixstraat, which even then was a busy thoroughfare. That would have been an appropriate spot for the entrance to the hotel; indeed, this is where it was planned in the preliminary drawings.

Footnotes next page:

a About Le Modulor and other proportional systems inspired by the 'golden section', see: http://www.tu-harburg.de/b/kuehn/lec4.html (also in Dutch)
b Here we find in fact the 'proof of the pudding': if I had been able to precisely follow the rules of Analysis of Buildings I would first have measured the building, with the help of students, and as a result would have had measured drawings to work with. My conclusions would have been more precise.
c It even is evident, that De Bazel has had a big influence on Berlage's evolution as an architect with the published, but not executed, design for the library.
d After a design by Hendrick Jzn. Staets and Lucas Jszn. Sinck and on the initiative of the Mayor Frans Hzn. Oetgens.
e Compare with the Scheepvaarthuis.

Choice of the proportional system

Although we do not find any sign of a proportional system in the Hotel American documents as such, we find evidence in some drawings for a non-executed hotel by Kromhout in 1911. The system there applies exactly to the final solution for the Hotel American. The fact that the architects Kromhout and Jansen made use of a measuring-method to recreate the Hotel American on top of the existing construction furthermore becomes clear from studying the drawings and the building itself.

Kromhout must have quickly become aware of the fact that the L-formed lot for the new hotel comprised about three squares; one of these covered the lot of the existing hotel, being exactly 18.80 x 18.80 m. The architects' need to base their design on a simple basic figure we read at a glance from the ground floor plan. We also see that they did not just stick to that, but as good composers pursued complexity. This is, for instance, reflected in the variety of spans over the main room. We find here the proportions 1:1, 1:2, 2:3 and 3:4, incorporating the numbers 1,2,3,4. These proportions gave the floor plans sufficient variety to fit in any of the desired spaces in the whole building. We can easily trace the applied method of measure and proportion from the drawings for the design, in which 3 existing buildings had to be incorporated. The rectangularity in the plans is pointedly present, as we see in the way the façades divert from the existing alignments at both sides of the building. The square and its diagonals determine the whole building in all three directions.

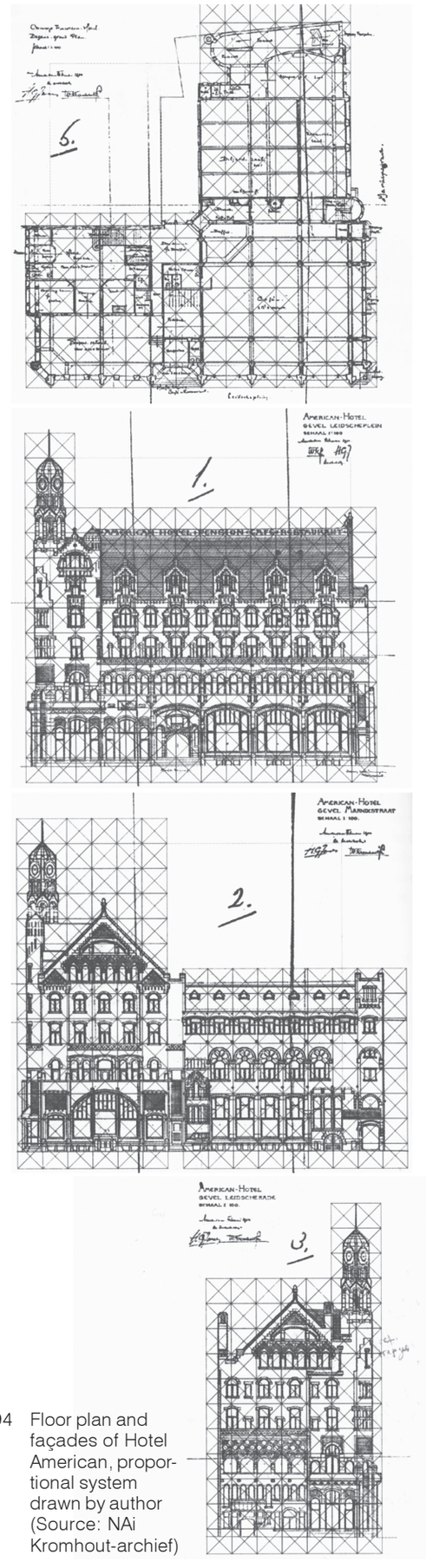
The height of the tower is remarkable. We find that it maintains the basic proportion of the building, 1:1, in the sense that the height equals the total width of the front façade of the hotel. In the preliminary design, made before the client acquired the lot of the neighbouring police station, we find the same principle, be it that the height of the building at that stage was more than the available width. Consequently, this led Kromhout at that moment to the choice of the equilateral triangle as basic regulating figure. All in all, he used the same principle as found in the Berlage Beurs, though with a different triangle in height.

I must add, that the remaining drawings do not show measures of height, length nor width. After carefully measuring I have come to the conclusion that the basic dimensions are those found in the café: height 592 cm and horizontally 592 x 888 cm (rectangle between the four central columns of the café). 592 Co-incides with what Le Corbusier defined much later in his Le Modulor, as well half of it, 296.[a] The latter should be seen as the module on which the building was designed. Also 148 is used for the smaller additions that Kromhout adapted the building to the building lot, which had several oblique sides.[b]

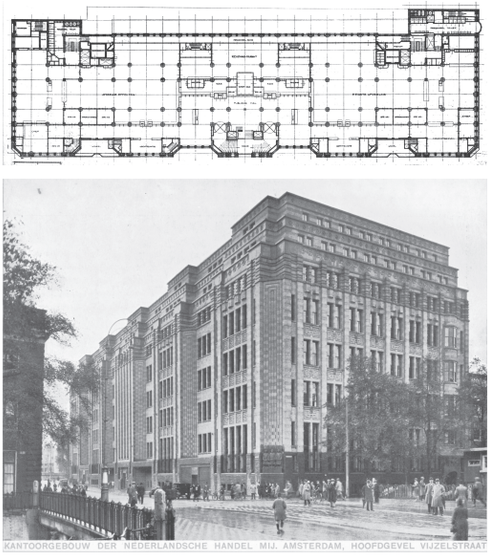
14.6 THE NEDERLANDSCHE HANDEL-MAATSCHAPPIJ, BUILT IN 1919-1926

In spite of the expressionistic exuberance of the Amsterdam School, restricted form was still, around 1920, an expression of modernity. Karel P.C. de Bazel, as aesthetic advisor responsible for the exterior of the building concerned, had already in 1895 acted in accordance with it, with his solution for a library, preceeding Berlage's final design for the Amsterdam Stock Exchange (1898-1903).[c] We may want to ask ourselves, whether De Bazel still belonged in the early twenties to the architectural vanguard with his most important building, finished only after his death in 1923.

The history of the site for the *Nederlandsche Handel-Maatschappij* (NHM, Netherlands Trading-Society) goes back to the year 1612, when the decision was taken for the construction of the famous city-extension, known as the *Grachtengordel*.[d] The southernmost part of this historical plan was built from 1658 on and received as main tangent the Nieuwe Vijzelstraat, at which the NHM building stands today. The parcels along this tangent, which runs from what is now the Muntplein southward, were sold in 1665 and immediately filled. The sixteen parcels of the later NHM grounds, between Heeregracht and Keizersgracht were each slightly more than 20 feet wide and 70 feet deep. The parcels along the two canals were wider (24 feet) and much deeper (180 feet each).[e]



94 Floor plan and façades of Hotel American, proportional system drawn by author (Source: NAi Kromhout-archief)



95 Floor plan and façade of the *'Nederlandse Handel Maatschappij'* [f]

CHOICE OF THE PROPORTIONAL SYSTEM

In his book 'K.P.C. de Bazel-Architect', Wessel Reinink examined extensively De Bazel's use of measure and proportion. Briefly, his explanation is as follows: Already in his competition-design for a library the use of a regulating system of measure and proportion is evident. In the design process for the NHM De Bazel was working from the beginning till the very end on the basis of a square-angled grid for the ground plans and a system of horizontal lines for the façades.[a] The grid was applied as a system of squares, subsequently rectangles, with only one basic figure. In the first case this is a square of 360 x 360 cm; in the other, mostly researched and also finally applied, system the basic figure is a rectangle of 320 x 360 cm. In the vertical sense De Bazel used a line pattern of 30 cm. The most common measures are 90 and its multiples 270, 360 and 450 cm (while 320 cm is not found).

De Bazel's architecture looks very austere, to my mind a direct consequence of the rather rigid use of grids. The singularity of the ground plan grid gave him little compositional material for a high complexity, which becomes obvious in his sketches for the street façade, in which several parts clearly deviate from the grid. On the other hand we can read De Bazel's struggling in the many drafts he made on the basis of a pre-drawn grid. This grid was obviously too rigid indeed to give all different functions the right place, form and dimensions. The preconceived grid is too simple, a common mistake in architectural practice, which in the case of De Bazel is rather amazing. Why did he stick, in spite of his struggling, till the end to the same grid of 320 x 360 cm?[b]

The following explains the choice and his insistence. One of the letters to the architects, in which the municipality comments their plan, says that they must take into account the maximally permitted depth of the buildings on the adjacent lots at the canals at both ends of the NHM building, being 28.3 metres.[c] The measure of 28.3 m. may seem deliberate, but becomes understandable once we know that we find ourselves in the part of town built in the 17th Century. The original parcel division plan shows the dimensions of the parcels in Amsterdam feet. The depth of the parcels along the canals is, as already mentioned, 180 feet, which brings the total depth to 360 feet. The Amsterdam foot equals 28.3 cm.! The maximum building depth is therefore 100 feet. But, the most interesting is, that 360 are the measure of De Bazel's grid module in centimetre, from which follows, that he q. q. could place 28.3 modules on 360 feet!

On the other hand, the fact that De Bazel and Van Gendt applied a different module in the other direction may be explained from the total amount of modules on the depth of the parcel, which varied from 29.89 to 31.82 m. This depth would be sufficient for 8 modules of 3.60 m + 1.09 m to 3.02 m. Dividing the measure of 8 modules of 3.60 m in 9 modules of 3.20 m (both 28.80 m) and leaving the last module free admitted a greater height at the back of the building. Building as many cubic metres as possible was, before and after all, more important than anything else. Even more than representativeness.[d]

14.7 PUTTING THE THREE TOGETHER

As I tried to show, proportion played a major rôle in Dutch architecture at the beginning of the Twentieth Century. It must still be researched, though, how it influenced the move towards modernity. It is known from documents that around 1900 proportional systems were subject to many discussions between architects; especially in architectural circles of Amsterdam, where Berlage, Kromhout, De Bazel and others held talks and gave courses.[e]

The Golden Section was probably the most discussed proportion. Yet, it was certainly propagated more by theorists than practitioners. The definition of it in words sounds simple enough: the proportion between the smaller and the bigger of two elements equals the proportion between the bigger and the sum of both. But, it gives dimensions which are difficult to handle, be it in metre or in feet. The practical architect, like Berlage in his Beurs design, prefers 8:5 (1,6), very néar to the Golden Section (1:1,618..). For human eyes the difference is not perceptible, in building practice, therefore, the simpler method is prefered.

a Here I must remark, that the 'aesthetic adviser' De Bazel was invited to collaborate with the house architect of the NHM, the well-known Amsterdam based Van Gendt firm. The reasons to involve De Bazel were purely political as he was to be the supervisor for the re-construction of the Vijzelstraat, the street at which the building would arise.

b In the descriptions of the building I could not find a reason for it, neither did I find it in the correspondence between De Bazel and his companion A. van Gendt and the representative of the client.

c This in relationship with sufficient daylight at the backside of the building; even in case the neighbours would fully use their right of building.

d Though the building height in Amsterdam was restricted to 22m, the NHM building became in the end more than 30m high, thanks to political intrigue. NB All information about the NHM comes from the related archives at NAi, Rotterdam and the GAA, Amsterdam.

e Molema, J. (1999) *Berlage's Beurs-concept and method*. Furthermore: Molema, J. (2000) *Hotel American aan het Leidseplein te Amsterdam*. and Molema, J. (2000) *Het Scheepvaarthuis, een droomschip met hekgolf*.

f Sources respectively: *Bouwkundig weekblad en Architectura* (1927) no.2 p.11; Publication of *N.V. Nederlandse Aanneming Maatschappij v/h Fa. H.F. Boersma Hoofdkantoor 's Gravenhage* (1934).

Here and now we can conclude that Berlage, De Bazel and Kromhout made use of a regulating triangular figure in their designs.[a] They also had a few other, common, denominators:

- the regulating proportional system always starts at ground floor level; anything in the façade below this level is not taken in account,
- the basic proportion defines the whole building, including height of the tower if there is one.
- the vertical side of the 'grand figure' (half of the regulating triangle) co-incides with the axis of the tower, the basis of it with the ground floor,
- the grid lines co-incide with the boundaries, although not necessarily with the axis of the wall present and most important:
- the grid does not have in the first place an aesthetic function, but is meant to organise design and building process. It helps to clarify the presumably vague ideas at the conceptual stage of the design process and it helps the architect to make decisions.

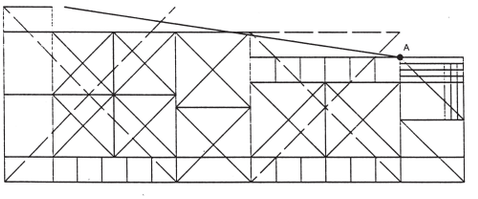
14.8 BACK TO BERLAGE

From his presentation drawings for the final project we can deduce how precisely Berlage was working in the end. The inserted module lines indicate exactly how the different parts of the building are related to each other and to the whole, and also where the material is going to be placed, for instance with the centre line co-inciding with the modular grid. In Berlage's own words: 'The art of building is the art of composing precisely, such that from there on a building which is not composed precisely, can not be described as a piece of art'. (*Seven lectures on the Art of Building*) As mentioned before, Berlage discussed the importance of proportions in a building most extensively in his Zürich lectures, in which he rhetorically asked: "Would designing on a certain geometrical system not be a great step forward? A method, with which several of the modern Dutch architects already are working?" Evidently, he had learned a lot during the design process.

The rectangle 1:2 – the double or super square

In relevant literature the rectangle 1:2 with a diagonal v5 has been identified frequently as ideal for ground plans.[b] Although the Beurs ground plan, because of the given site, has a proportion of nearly 1:3, and thus is not a double square, it becomes obvious that Berlage used this basic figure of 1:2 repeatedly for the division of his ground plan. The three main halls all have the proportion 1:2, not including the side-aisles; also the two groups of small rooms at each end of the main hall are set in a double square. Remarkable is that Berlage secured the wholeness of the main hall and its aisles by moving his ground plan over the given situation along the Damrak building line. He had this possibility as the lot was longer than Berlage needed for building.

Finally, the northern group of small rooms is an exception, although it forms a square together with the two small exchange halls and their side aisles. Berlage made his choice for the double square between 1896 and 1898, as a comparative analysis of the first design phase, and the plans for the building specification, confirm.[c]



96 Proportional system of the ground plan of *'De Beurs'*.

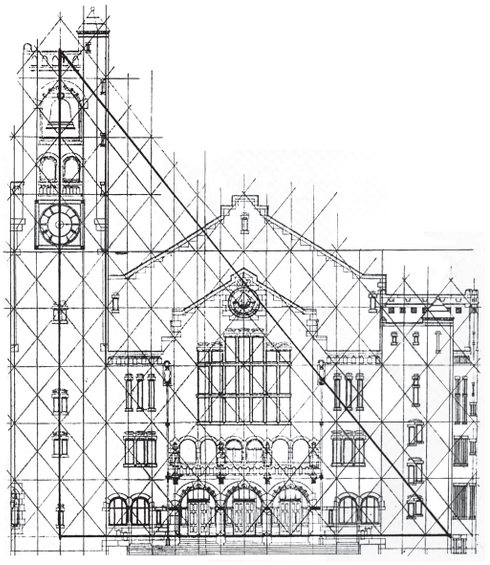
The brick

As observed, the brick applied in Waal format does not fit an Egyptian triangle. The smallest quantity of bricks necessary is 17 headers and 19 courses - each prime numbers. The conclusion is simple: Berlage took the smallest unit possible of whole headers and courses, starting from a header measurement of 11,2 cm and course dimension of 6,25 cm. both including the joint, using normal brick-laying methods, the standard of the Waal format and the practical proportion of 5:8. The course includes a 1 cm joint, the vertical joint being 0,7 cm. 17 headers and 19 courses give 190 and 118,75 cm. The last measure appears rather awkward,

a And the Amsterdam School architects Van der Mey and De Klerk at some moment

b August Thiersch, for example, proved that many Greek temples have a ground plan with this ideal proportion. Thiersch, A. (1893) *Die Proportionen in der Architektur*. Antonio Gaudí y Cornet also repeatedly used this figure as a basis for his design, in plan as well as in elevation.

c It is, therefore, quite certain that Berlage learned about it during the meetings at A. et A. in 1896, where several lectures were held about proportional systems. From my research on Gaudí's work I concluded that the Catalan investigated it in his much earlier work around 1880. Read Molema, J. (1987) *Antoni Gaudí, een weg tot oorspronkelijkheid.*



97 Façade and proportional system of *'De Beurs'*. Fat triangle drawn by author.

but results in exactly 16 courses per 1.00 metre rise, normal bricklaying practice in the Netherlands. The 190 cm is, furthermore, not too difficult to use. In the Golden Section 118,75 cm would mean 192 cm length, while on the other hand 190 cm would give a height of 117,5 cm. Berlage's choice was a rational one.

Façade at Beursplein

From measuring drawings and reasoning it appears that Berlage used the centre of the (main) tower as the measuring line for its height, a precedent established in other architect's work, such as the Hotel American. The tower occupies 4 modules in width; the axis of the tower splits the Beursplein façade into 2 and 17 modules, from these 17 modules resulted the height of the tower: 17 x (190 x 5/4) = 17 x 237.5 = 4037.5 cm (17 vertical modules), which is indeed what the drawings show.[a] It is notable that Berlage choose to use the prime numbers 17 and 19 on a grand scale. At the Damrak, the height of the tower does not have an obvious, clear proportion with the façade, which may indicate the importance and the character Berlage gave to each of the façades. Furthermore, we find the Egyptian triangle starting from the axes of the two towers of the middle section at floor level and their apex: 10 modules of 190 cm correspond with 10 x 237.5 cm = 23.75 metres in height. The gutter level at Damrak, 6 x 237.5 cm, corresponds with 6 modules, which is a 1.5 'canal house' of which 6 fit in the major hall and 5 in the small ones. It follows that the large hall plays the most important rôle in defining the height of the Damrak façade, although the building regulations may also have had a significant influence.

14.9 THE LESSON

Taking everything together we are witnessing a growing interest in, and domination of, the proportional system as a form giving principle in the development of the Beurs and other early-modern buildings in the Netherlands. Under the influence of discussions in those years between architects about proportional systems in the past and which ones could be used in actual practice, Berlage followed the recommendations closely in an analysis of his own, existing, designs for the Beurs. The introduction of the 'Egyptian triangle' led to the building being realised. Without exaggerating: the full proportioning of the design was instrumental in the development of the new architecture. Berlage probably could have gone further if he had been freer in the concept of the ground plan in the given situation.

It has been mentioned that Berlage was not a *Prinzipienreiter*, but it would not have brought him any further if he had been one. Where given conditions and principles do not cope with each other, a way-out must be found, which in most cases means one must leave principles aside. These confrontations of conditions and design principles give the buildings their specific character. There, as always, the architect has to decide what is the best solution in the given circumstances. A proportional system facilitates the decision process during design and is highly adequate in the building process. Such a system is not an aim, but a tool, one of a whole set. As I have shown, designers who use such tools are not the worst.

Analyses of Buildings is there to help students to discover these tools, investigate them, and learn to work with them and add them to their toolbox. Its impact can be much greater as the students also learn to write and publish their findings through articles, books, expositions and in conferences. A much larger public will be reached than just the single student at the faculty. Above all we want the architect(ural student) to do what the architects introduced have done: analyse existing buildings and literature, find out essentials and apply the findings where possible in their own practice. Only simple minds will deny the necessity of it. Originality is to be found in the origins. As Antonio Gaudí said, again and again, to be original one has to return to the origin: *Para ser original hay que volver al origen.* It is our task as a technological scientific institute to go and show that way through analyses of buildings.

a The following heights may be found in the specification drawings:

4037,50	top of main tower	8,5	x	4,75 m.
2850	top of façade of main hall	6	x	4,75 m.
2375	top of towers at Damrak	5	x	4,75 m.
2018,75	top of gutter of main hall (= ½ height of main tower)	4,25	x	4,75 m.
1425,00	top of gutter Damrak (= ½ height of façade main hall)	3	x	4,75 m.