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Architectural Form and Ornamental Rules

Characteristics of Neo-Structural Ornamentality

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"Ornamental rules are the basic artistic rules of Architecture" (Michael Dürfeld)

From the use of parametric data models via the implementation of genetic operations and self-organising processes to evolutionary design strategies a large number of different approaches to design in architecture and urban planning are now covered by the label *Neo-Structuralism.* They all have in common a rule-based design process translated into mathematical algorithms.

In this context a reinforced appearance of probably one of the oldest architectural-artistic phenomena – *Ornamentality* – is to be observed. Now, however, this ornamentality differs radically from a traditional interpretation of ornament as an applied decoration element and shows more of a structural quality, more exactly: a quality of structuring the architectural form on the whole. An interesting link between architectural form and ornamenality is to be observed for example in the projects of Barkow Leibinger, in the so-called proto-architecture of Achim Menges, in the Watercube of PTW Architects, the Serpentine Gallery of Toyo Ito and Cecil Balmond and the Railwaystation project for Florence by Arata Isozaki. These ornamental phenomena can no longer be described by a classical definition of ornament as an applied decorative element. What can be observed here is that the whole architectural form is developing into a large three-dimensional ornament. The ornamental movement rules the structural elements of the architecture (walls, covers, pillars). The structural and the ornamental merge into one.

Is this a new phenomenon or maybe only an old one? And is this Ornamentality only a byproduct, as many architects say, or is it something basic?

At first sight, this *neo-structural ornamentality* seems close to the *structural ornamentality* of the 1960s and 1970s and because of this the article takes this apparent resemblance as an occasio to take a closer look at the ornamental rules. What exactly are the ornamental rules of the structural ornamentality of the 1960s and 1970s and of neo-structural ornamentality today? What are the differences and what are the common characteristics? And how do they influence the genesis of the architectural form?

I want to show that differences and similarities can be observed in both ornament concepts along the differentiation by programme and function. They are similar in the basic function of ornamentality in structuring space and time. But the programmes used for structuring are different. In the 1960s they were symmetry and repetition, today they are asymmetry and recursion. So we can see in this new ornamentality something new – in the structuring rules – and something very old - in the structuring function. Such an investigation into the relationship between architectural form and ornamental rules enables us to think the relation of architecture and ornament radically anew.

History: Structural Ornamentality in the 1960s and 70s

In the architecture and art discourse of the 1960s and 70s the catchwords and slogans "ornament without ornament?," "new ornamental art" and "structural ornament" played an important role. This discussion starts with the exhibition "ornament ohne ornament?" (Ornament without Ornament?) in 1965 at the Zurich Kunst- und Gewerbeinstitut (Arts and Crafts Museum). Here an attempt was undertaken for the first time to take the huge number of ornamental phenomena back to the symmetrical mathematical structure. To gain a deeper insight, I will take in the following a closer look at the 1965 Zurich exhibition.
In the sixties, a quiet uneasiness interfered with the satisfaction at having stopped the style costumes of ornament: "The battles have been fought, victory over the ornament is history. Where do we go from here?"[1] Antonio Hernandez asked 1965 in view of the "ornament ohne ornament?" exhibition. This question seemed even more urgent in that half a century after Adolf Loos's verdict on the ornament in the built environment that an unexpected presence of ornamental forms was to be observed.
The three modern design maxims *material justice, construction purity* and *functionality* were for a long time no longer guarantors of architectural beauty without ornament; these categories got into more of an ornamental form excess. In the *material cult* the ornamental charm of patterned surfaces celebrated its triumphs, *construction carried expressively too far,* showing its structure exhibitionistically, was transferring to an ornamental character and where the ornament had disappeared in the old sense, *pure form behaved ornamentally*. Thus Mark Buchmann asked in the introductory text to the exhibition: "Must we now admit the internal deficit in view of a modern reactivation of the ornamental? Or can we still escape behind the word structure?"[2]
Even before the critique of functionalism was to question massively and radically the principles and maxims of modern architecture in the late 60s, the Zurich exhibition undertook the attempt at a rehabilitation of the ornamental with a specifically modern view. The exhibition tried to take this complicated enterprise forward in five parts. I will concentrate on the largely independent exhibition part entitled *Symmetry* that was located in front of the exhibition walk in the entrance hall. This part served primarily the concept of purification:

"It should be shown here that different manifestations from the world of the nature and the technology are often inherent in the same or related legitimacies of the formal construction. Besides, the 'ornamental' seems – from the formal – to be part of a more complicated whole, the symmetry."[3]

In addition one undertook a systematisation of symmetrical-ornamental phenomena in six groups. The two classical groups are the *band symmetries* and the regular plane figures, i.e.

[1] Antonio Hernandez: Reflexionen über das Ornament, in: Mark Buchmann (ed.): ornament ohne ornament? Zurich 1965, Volume V, p. 14
[2] Mark Buchmann: Einleitung, in: Mark Buchmann (ed.): ornament ohne ornament? Zurich 1965, Volume I, p. 2
[3] Mark Buchmann: Einleitung, in: Mark Buchmann (ed.): ornament ohne ornament? Zurich 1965, Volume I, p. 3

the *plane symmetries*. These groups are complemented by the groups of *space symmetries*, *circular symmetries*, *spherical symmetry* and the *spiral axis*. Each of these groups was divided into three categories: a category of symmetrical ornamental *objects* formed by man, a category of symmetrical ornamental animals and plants produced by nature and a category of mathematical geometries that underly the phenomena of the other two categories.
The achievement of the symmetry-exhibition part consisted of reducing the varied ornamental forms to just one rule: the symmetrical operation. Linking the concept of ornament and the mathematical concept of symmetry reveals an attempt to mathematise art by the construction of artistic forms from mathematical forms. So the exhibition goes back on a millennium-old tradition of the mutual conception of mathematics and ornamental art – a discussion I will skip here. Nevertheless, a short look at the mathematical foundations of symmetry is necessary for the further argumentation.
Mathematically spoken, symmetrical operations are transformations of an object that leave its appearance unchanged. In mathematics a form is called symmetrical if it remains invariant under the symmetric transform. So there are three different symmetrical operations: *reflection, rotation* and *translation*. Reflection can be divided into *miror reflection* and *point reflection*. These three basic operations can be combined with the effect that the combined operation is also a symmetrical operation, that is an isometric transformation. For example, *glide reflection* is a combination of a reflection and a translation.
If one now looks at ornaments as a system of elements (e.g., lines, waves, triangles) that are reflected, rotated and translated – and theses elements remain always unchanged –, symmetry can be called the main attribute forming the basis of all ornaments. What are the consequences of identifying "symmetries as [...] the mathematical structures of all 'ornaments without ornament'"[4]?
First, it widens the spectrum of ornamental forms in architecture beyond the classical band ornaments and surface ornaments. Because if you have a mathematical point of view on symmetry, you know that all symmetrical operations also work not only in the two-dimensional plane but also in the third dimension. And of course they found these three-dimensional symmetrical operations in nature – the most obvious examples are the crystal-symmetrical structures that were found in the wider field of crystallography in the 19th century. Thus the idea of a *spatial ornamentality* was born:

> "The medium of sculpture and architecture is space. Here, therefore, space symmetries play, above all in architecture, an important role; if we think of the classical vaults or of their modern counterparts, the spatial structures. [...] The interest of the architects in space-grid constructions has of late strongly increased. […] We stand here probably at the beginning of a new development."[5]

As examples of this spatial ornamentality the gridlike structures of Konrad Wachsmann and Buckminster Fuller are named. This is a notable enlargement of the ornament concept, because, finally, the ornament was characterised predominantly – and traditionally – as flat,

[4] Roland Gross: Symmetrie, in: Mark Buchmann (ed.): ornament ohne ornament? Zurich 1965, Volume II, p. 28
[5] Roland Gross: Symmetrie, in Mark Buchmann (ed.): ornament ohne ornament? Zurich 1965, Volume II, p. 9

as a plane. Now ornamentality was also conquering space and from being an *applied architecture ornament* it developed into a *structural ornament architecture*.
Second, the concept of a spatial ornamentality is extended by the fact that it is not only limited to Euclidean and elliptical geometry; the laws of symmetry are also transferred to hyperbolic geometry. In particular, the constructions with hyperbolic paraboloids as in the Philips Pavilion by Le Corbusier and Janis Xenakis at Brussels in 1958 came into the focus of the exhibition organisers and enabled them to refer, in addition to a Euclidean and elliptical, to a *hyperbolic ornamentality*:

> "Speiser and other mathematicians regret over and over again that so many creation possibilities – uncovered by mathematics – were not made fertile by the artists. [...] Nevertheless the supposition may be probably still ventured that the hyperbolic paraboloid assumes a special importance in the 'new space concept'."[6]

So much for a short insight and overview of the structural ornament of the 60s and 70s which shows, nevertheless, a highly phenotypical proximity to a huge number of current ornamental structures in architecture and design.

Distinction: Ornamental Rules

But a more exact observation shows significant differences between the structural ornamentality of the 1960s and 70s and today's neo-structural ornamentality. I would like to emphasise here the two following differences, which at first may appear to be very simple, and to show them in some confrontations:

First, the single elements of the ornamental structures are different in many current projects. While the structural ornamentality of the 1960s and 70s consists of *identical* elements, the elements of the current ornamentality are merely *self-similar*. It is this self-similarity which leads to an increased appearance of *fractal structures*. Now, in addition to a Euclidean, elliptic and hyperbolic ornamentality a fractal ornamentality appears.

Second, and this is in a certain sense the result of a radicalisation of the first characteristic, in many current projects single elements cannot be isolated at all. While the structural ornamentality of the modern age was marked by *repetition*, the current was marked by *transformations*. We have to deal here with a continuous form process that calls to mind organic growth and that seems less planned than self-organised. If we summarise these two items, we can say that the ornamentality of the 1960s could be described as a somewhat *static structure* while the current ornamentality can be described as more of a *dynamic structure*.
It lies in the nature of the thing that *theory* with its *concepts* can make a distinction more sharply than the practice with its phenomena, but I think that we can also perceive these differences in the following confrontations.

[6] Roland Gross: Symmetrie, in Mark Buchmann (ed.): ornament ohne ornament? Zurich 1965, Volume II, p. 15-17

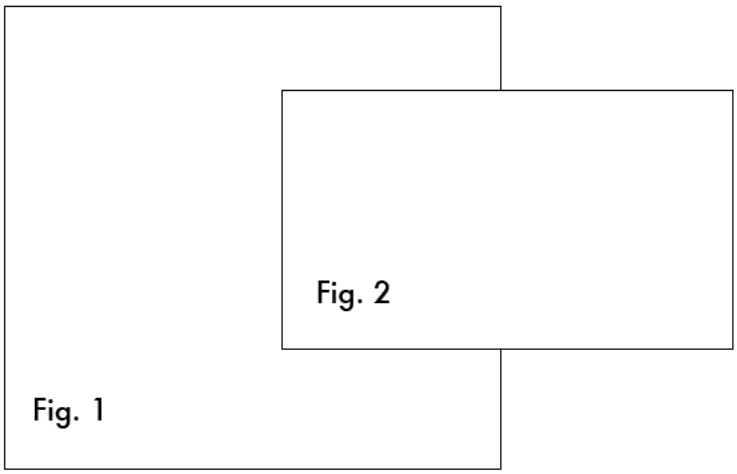

Fig. 1: Space-frame structure for an airplane hangar, 1951-53, Konrad Wachsmann.
(From: Mark Buchmann (ed.): ornament ohne ornament? Zurich 1965, Volume 2, p. 13)

Fig. 2: Beijing National Aquatics Centre (Watercube), China, 2008, PTW + Arup, © Arup

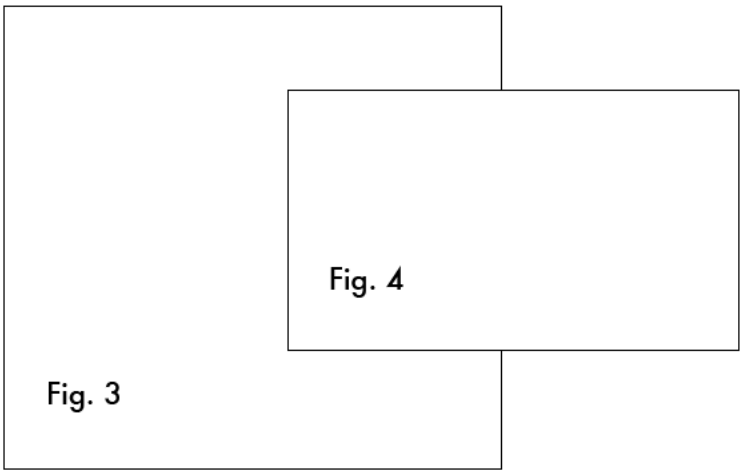

Fig. 3: Facade, untitled.
(From: Mark Buchmann (ed.): ornament ohne ornament? Zurich 1965, Volume 4, p. 3)

Fig. 4: Serpentine Gallery Pavilion, London, 2002, Toyo Ito + Cecil Balmond + Arup

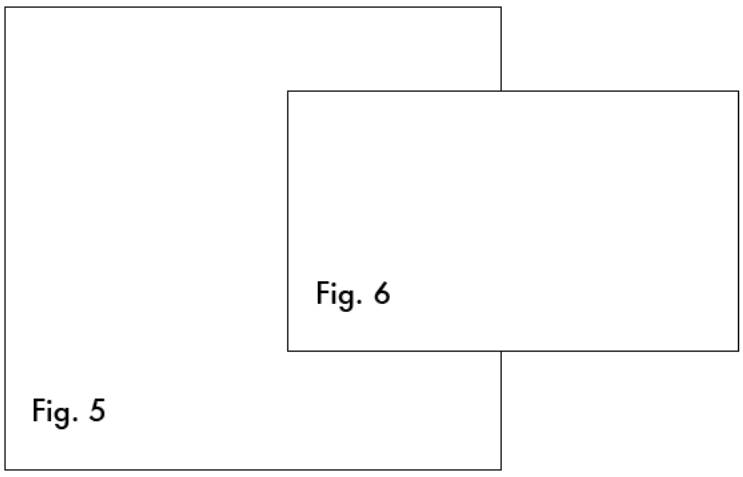

Fig. 5: Partition wall, 1950, Josef Albers.
(From: Mark Buchmann (ed.): ornament ohne ornament? Zurich 1965, Volume 1, p. 29)

Fig. 6: Honeycomb Morphologies, AA London, 2003, Andrew Kudless.

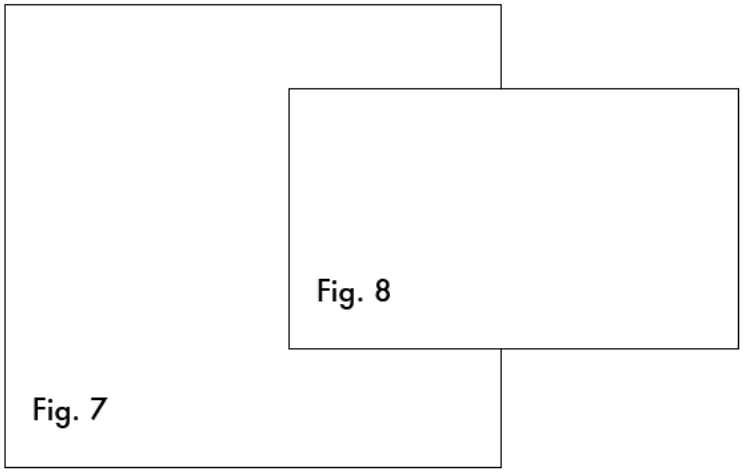

Fig. 7: "Landi"-Chair, 1938, Hans Coray.
(From: Mark Buchmann (ed.): ornament ohne ornament? Zurich 1965, Volume 1, p. 25)

Fig. 8: csh chair, 2008, Akihisa Hirata Architecture Office.

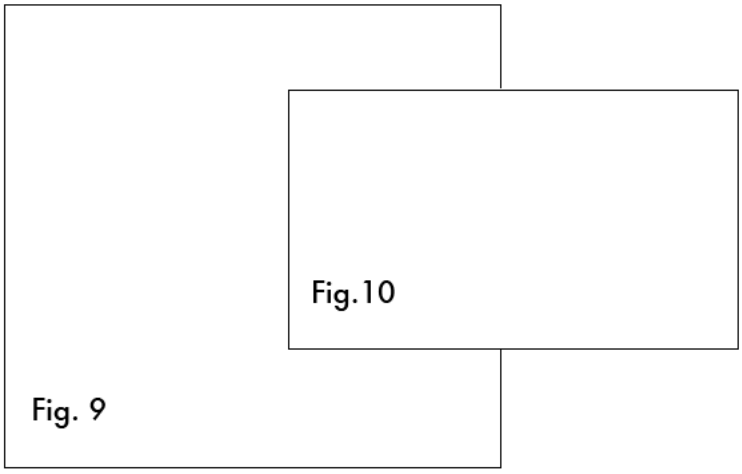

Fig. 9: Gratings.
(From: Mark Buchmann (ed.): ornament ohne ornament? Zurich 1965, Volume 1, p. 21)

Fig. 10: Balcony Nikolaistrasse, Munich, 2000, Hild und K Architekten + ces civil engineering solutions

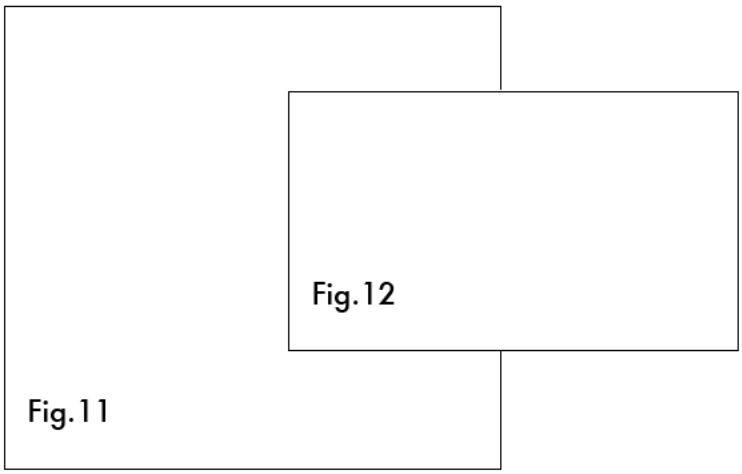

Fig. 11: Marina-City, Chicago, 1959, Bertrand Goldberg.
(From: Mark Buchmann (ed.): ornament ohne ornament? Zurich 1965, Volume 4, p. 27)

Fig. 12: Railwaystation, Florence (Project), 2002, Arata Isozaki

A large part of the ornamental forms shown in the exhibition would also match a formulation by the art historian Hans Sedlmayr as “ornamental patterns”. The price, so we might say, for the rehabilitation of the ornamental in architecture of the 1960s was a reduction to ornamental patterns radicalised in some cases down to minimalistic grids. However, the current designs show a lot of greater structural complexity and individuality. We could be more precise:

While 1960s ornamentality tended to a grid-like, raster-like *minimum ornamentality*, today’s ornamentality tends toward a chaos-like *maximum ornamentality*.

The question now arises: What is the reason for this phenomenological change? Is it only a result of the higher arithmetical efficiency of the computer age – of the *digital* – or is it the result of quite another basic rule – of something more *structural*? Here in my opinion both apply. On the one hand the rules of the form-generating programme are different; on the other, we need the arithmetical efficiency of the computer age to use this new generational programme. In short, both must be combined so that qualitatively new results can be achieved. That is precisely the point at which the combination of the structural and the digital generates newness! I want to sharpen the difference of the rules in both programmes of generation with the following formulation:

While the structural ornament of the 1960s and 70s is based on the classical principles of symmetry and repetition, ornamentality today is marked by asymmetry and recursion. With this shift the basic principles and rules are identified that lead from a static structure to a dynamic one.

Now the static in the structural ornamentality of the modern age is based exactly on the symmetrical structure. It is the emphasis of the symmetric structure that leads to a determining restriction. Because symmetrical operations always leave the original, outgoing form unchanged, the construction of complicated ornamental forms can be carried out only in an additive coupling of identical elements to a bigger form complex. The form generation by means of symmetry and repetition must basically be considered very limited. The result is a static ornament model – which should not surprise us if we recall that it is descended, in the final analysis, from crystallography and solid state physics.
To make it now clear that we have to imagine a shift from symmetry and repetition to asymmetry and recursion, I want to come back again briefly to the Zurich exhibition of 1965 because the important intermediate stage from a static to a dynamic structure is already found there. We find asymmetrical, free, irregular, apparently non-geometrical ornamental forms, i.e. ornamental forms which are marked by a running transformation and variation of form, in the exhibition where so-called “strecksymmetrische” (bend-symmetrical) forms are discussed, for example, in the category of *spiral axes*.
Bend-symmetrical-ornamental forms occure if the symmetrical operations of reflection, rotation and translation are coupled with bendings. The best known special case of a bending is the golden section. The bending of a rotation on the level leads, for example, to the logarithmic spiral. We find a spatial three-dimensional logarithmic spiral in the Nautilus bowl. As we see, an approach to organic ornamental art could be gained around these bend-symmetrical operations in the 1960s. As a rare use of the snail line in architecture the exhibition organisers mention Frank Lloyd Wright’s Guggenheim Museum.

Bend-symmetries differ from the symmetrical operations of reflection, rotation and translation discussed above by the fact that the outgoing element changes by the symmetric operation constantly, it is transformed. The American artist Jay Hambidge, 1867-1924, introduced in the 1920s for such bend-symmetries the concept of *dynamic symmetry*. In contrast he called the symmetries of reflection, rotation and translation *static symmetry*. Dynamic symmetrical operations leave – in quite a specific sense – the mathematical order of symmetry. Strictly speaking, they operate by breaking symmetry, i.e. they produce broken symmetries, they produce asymmetrical structures that still exhibit traces of the symmetries from which they emerged. Only symmetry breaking permits the structural complexity of these ornamental forms. This corresponds with the results of research in the modern natural sciences which see symmetry breaking as the key procedure for the generation of highly complicated structures and systems.

Also in the current ornamentality we deal with a kind of dynamic symmetrical operations. The characteristic feature of bend-symmetrical operations – the self-similarity of its elements – gives the determining instruction to what we could today call its successor: fractal symmetries. Like bend-symmetrical operations, the recursive mechanism of fractal geometry changes the original form with every operation – only a resemblance to the original form must remain protected. Form complexity originates therefore from a running transformation of form. Whereas identical forms are attached to forms by means of symmetrical operations, forms are generated from other forms by means of recursive operations. The procedures of recursivity and asymmetry allow in the area of geometry in quite another mass than repetition and symmetry a complex form variety, and with this variety fractal symmetries appear as dynamic symmetries par exellence.

It is this efficiency of the fractal geometry that makes them a “language of complex structures”[7] in science and nature. Such an operational procedure of form generation based on asymmetry and recursion is used not only in geometry for the calculation and construction of fractal figures but also in natural sciences for describing complex dynamic systems and in mathematics for an algorithmic calculation of complex arithmetical problems. Fractal symmetries can in this sense be called the basis of the *structuralising programme* of the current ornamentality. This identifies the qualitative difference between the structural ornamentality of the 1960s and 70s and neo-structural ornamentality today. It is that the basic form generating rules. On the one hand symmetry and repetition and on the other hand asymmetry and recursion.

To cope with these “arithmetic problems” we need the computing capacity of computers. But that does not mean that this neo-structural ornamentality is an invention of today, of the digital age. No, we are today merely able to *build* this complex ornamental architecture, but it was thought and designed a long time ago: in the age of the Baroque.

[7] Hartmut Jürgens / Heinz-Otto Peitgen / Dietmar Saupe: »Fraktale – eine neue Sprache für komplexe Strukturen«. In: Spektrum der Wissenschaft: Chaos und Fraktale, 1989, p. 106.

Excursion: Baroque Ornamentality

For Baroque ornamental art one figure is decisive: The Rocaille. The ornamental form of a rocaille features “shells, pebbles, and scrolls as well as flower, fern, and coral forms, all emphasizing brief, asymmetric single or double curves.”[8]

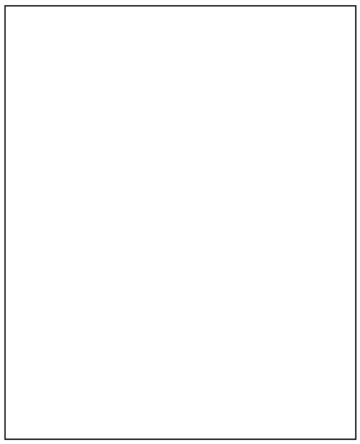

Fig. 13: Rocaille,
© Bibliographisches Insitut, Berlin

One can recognise very well the ornamental rule of asymmetry and the fact that it is not an easy repetition of identical elements but rather a transforming form development as in organic forms. The German art historian Carl von Lorck, 1892-1975, tied together the art of the Baroque by characterising it as a “neighbourhood of the parts” and an “adaptation”:

“In the Baroque age one can observe a general trend of adjustment, of nestling up of the neighbouring parts of a fine structure. In graphic arts, in painting, in sculpture every small part bends over to an other like a good neighbour. Where an elementary part approaches the other, it tries to become similar to it. Where it is disconnected from the other, it adopts the form of the next. It is like the rule of the domino game, which is obeyed in many chains by small elements and which rests above the surface of artwork like a net of countless relations.”[9]

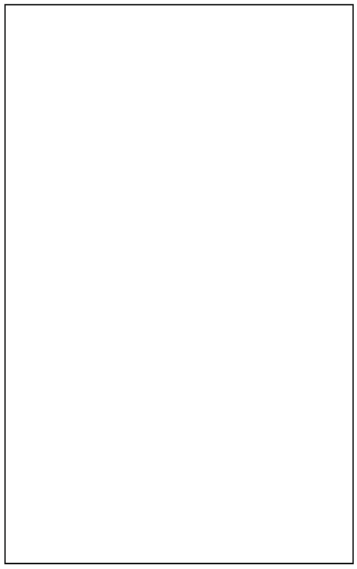

Fig. 14: Jacques de la Joue, Cascade, 1736

Is this not already the description of what we today understand as a parametric design? According to Lorck, the same system appear not only in ornaments but also in the buildings of the Baroque. Carl von Lorck cites as an example Balthasar Neumann’s Vierzehnheiligen church. But even more clearly we can see how this ornamentality rules architecture in the 1736 engravings in the fantastic architecture of Jacques de la Joue.

The German philosopher and writer Max Bense gave Lorck’s law of the Baroque a mathematical version as it was developed in Baroque mathesis universalis: the *non-linear infinitesimal calculus.* This is interesting because one could call non-linear infinitesimal calculus a precursor of recursive calculation in mathematics.

[8] "rocaille." *Encyclopaedia Britannica. Encyclopaedia Britannica Online*. Encyclopædia Britannica Inc., 2014. Web. 27 Aug. 2014. <http://www.britannica.com/EBchecked/topic/505859/rocaille>.
[9] Carl von Lorck: Grundstrukturen. Strukturanalyse des Kunstwerks, Berlin 1965, p. 23.

Similarity: Ornamental Function

To summarise, first, the ornamental rules of structural ornamentality are different from the rules of neo-structural ornamentality in the distinction between symmetry and repetition on the one hand and asymmetry and recursion on the other. Second, and as a consequence, these rules mark a different level in generation forms. Third, the rules of neo-structural ornamentality originated in Baroque ornamentality.
As a result we can formulate that today's neo-structural ornamentality is closer to Baroque ornamentality than to the structural ornamentality of the 1960s and 70s.
But we must not forget that there is a very strong similarity. In both – or all three – concepts we can recognise how the ornamental assumes a structuralising function in the architectural design. We can observe this only if we shift our focus of observation from the ornament as a shape to the ornamental as a process. No longer is the decorating function of the ornament the main focus; the basic structuralising function was the starting point of all following observations. With this a basic shift takes place from the ornament as a quality of shape to the ornamental as a quality of process. The ornament discussion in the architectural discourse of the 1960s initiated this shift while it focused on the symmetrical *operation* of the genesis of ornamental forms.[10] If the ornamental assumes a structural function, two questions arise. First, what is to be structured? Which material, which medium? And second, how is it to be structured? Which are the special characteristics of the structuralisation process?
For the French art philosopher Paul Valéry it was in 1895 very much as if *the empty space and the empty time* must be filled first by the ornament before a work of art can be produced. For the German art historian Wilhelm Worringer it was in 1908 – starting from a style psychology approach – man's *fear of space* of man that leads him to structure it in an ornamental way in order to control it. And for the German sociologist Niklas Luhmann in 1995 – starting from a constructivist theory of perception – the *media space and time* are organised by the ornamental. They are filled with *redundancy and variety*.
At a basic level the answer to the two questions – what is to be structured and how it is to be structured – is quite easy. The perception media space and time are structured in an artistic way. Or, differently formulated, the ornamental is the basic form of an artistic structuring of space and time – an artistic space-time-ruling-process.
If on the one hand the ornamental structures space and time and on the other hand form in architecture stand for its spatial quality and structural potential then it becomes apparent that ornamental form and architectural form belong together much more fundamentally than a definition of adornment and decoration states. We could even state that ornamental rules are the basic artistic rules of architecture. Before architecture can be designed and ruled by functional parameters like tension or pressure it has to appear, to become visible and perceivable, and this is only possible by ruling the perception media of space and time. Therefore a structural organisation of architecture is also always an ornamental one.

[10] In the art discourse we can find much earlier in the 1920s a discussion about shifting from the concept of ornament to the concept of the ornamental. Here the German art historian Theodor Hetzer must be mentioned. Cf: Michael Dürfeld: L'ornemental comme ornement intrinsèque. In: Perspective. La revue de l'Institut national d'histoire de l'art, 2010/2011-1 "Ornement/Ornemental", pp. 21-22.