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The Hidden Geometry of the Architecture of Herzog & de Meuron
Digital Tools and Design Practice

Alexandra Castro

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FACULDADE DE ARQUITECTURA

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The Hidden Geometry of the Architecture of Herzog & de Meuron

Digital Tools and Design Practice

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Kai Strehlke

A.02
Kai Strehlke.
Head of the Digital Technologies Group at HdM from 2005 to 2015.

"The important thing is to understand why they do not do it by hand and why I should script it."

Conversation with Kai Strehlke

Zurich HB train station, Zurich, November 6, 2019.

Alexandra Castro (AC): Which were the biggest geometric challenges you had in the Tate Modern extension?

Kai Strehlke (KS): One challenge was the massive amount of data coming from the brickwork. For this, we had to define a kind of data structure that we hadn't used before. In the case of the Tate, we didn't draw geometrically, but we set a point cloud and, after, we informed each point with information about the brick, such as the colour, the geometry, the type.

In this project, we worked with the structural engineers, Ramboll, who wanted to do all the work in Catia. However, as we worked a lot with Rhino in the office we said no, because, from a geometrical point of view, we could have the same precision in Rhino as in Catia. But when we tried to generate the geometry, it was too complex for the computers we had, and it was taking too much data. We decided to define a point for each brick, which would have the information about the geometry. In the end, this allowed us to generate parts of 3D models that we needed for rendering and also 2D drawings. When we had a section or a plan, we could generate a specific drawing from the scripting with only the facade's external layer. I think this was an important step for the team in handling the design of the brick facade.

AC: So, each double brick was defined by a point.

KS: Yes, by a single point. And, for certain kinds of information, we just took some of these points and generated a 3D drawing out of them. So, I think, the biggest challenge was really to define this kind of structure.

AC: In a small description about the Tate Modern 2 project, Ramboll mentioned that, "in total 336,000 bricks in 212 different types were installed (...) The architectural intention was for the

wall to be "movement joint" free and this was a key consideration in developing the most suitable brickwork system. (...) 3D setting-out tools were invented for the project, to ensure that tolerances of +/- 2mm were maintained over the 65m high facade".

KS: It's a long time ago. I had in mind around 400,000 bricks. So, this is more or less okay. But I remember many fewer types of bricks.

AC: I remember you spoke about fifty.

KS: Yes, I think it was about fifty-four. Then we had the concrete structure below, and the corbels were placed on it. So, we didn't have to maintain 2mm over 65m. What we had to achieve was, within the bricks, to reach the next corbel.

AC: The tolerance is between the corbels.

KS: It is between these corbels, from one corbel you have to reach the next one. We would not have achieved a tolerance of 2mm in 65m in the brickwork. This doesn't work. These corbels, I think they were every two metres, and this is something you can reach. I'm not sure how they did it in the end, but I suppose they had the double bricks, and in-between a kind of elastomeric joint.

AC: What kinds of other complex geometric issues did you have?

KS: We worked a lot on the colouring of the bricks. When you look at the buildings in London, you see many bricks, and they all have different colours. When HdM looked at the colour they wanted from the bricks, they decided to have a smooth gradient. For me, that was a very interesting step because it started as very design-wise, not looking at the material but looking at the design. Then afterwards, when they started thinking about the construction, they realised that they could not define each brick's exact colour. So, they tried to understand how bricks are produced, and, coming out of the way they are constructed, HdM came back into the design and said they would like to use this effect with different kinds of colours. Usually, when you burn bricks, you never get exactly the same colour. You burn them in one bunch, and another one, and a third one, and then you mix the bricks for the construction. HdM decided to use that production strategy for the design. They would control the kind of burning, and therefore the type of colour, and decided to do this gradient on levels. The bricks had different colours on different levels. It was not a smooth gradient any more from bottom to top.

AC: But in the end they opted for a continuous mix of different colours.

KS: Yes. However, there was a moment when they had a gradation, from dark to light, and afterwards they decided to have it on different levels. These things were design issues, and they asked me to script them and make small variations of the script. In an early version, the double brick had the same colour.

AC: I think this gradation is now achieved by the pattern variation, when the bricks, above the anticlimbing, start to gradually step back.

KS: Do you also have a photo of the corner in the anticlimbing? This is something I find quite interesting. There, you always see one, one, one, and when you get closer to the corner, at this point, it looks like a mistake. This is something I'm quite proud of because it is scripted.

If you placed a standard brick here, the corner's brick would become too thin. So, you have this kind of "mistake" two bricks before. A little before the last one is where you usually do it because it seems regular when you look at the corner. This is a typical way of dealing with this kind of problem in traditional brickwork. I find this interesting. You see a geometrical problem, you see how it was done in history, and then you use exactly the same kind of logic. And everything is inside of the script.

AC: It's a geometric and construction problem. This happens a lot in the architecture of Siza. He works with stone, and he draws every stone. So he has to solve a lot of these kinds of problems. Could you have solved the corners and creases in the upper part of the building as in the anticlimbing? I know that it is much more complicated because it is not only an intersection of planes. You have a vertical and an inclined facade, and you also have the bricks going in and out.

KS: There was a huge discussion about how to make these corners. I'm still not convinced about the final solution, but that was a design decision.

AC: Who wanted it, Jacques Herzog?

KS: Herzog and de Meuron, because they said they had a pattern.

They are sometimes quite radical in architecture, like in Caixa Forum, in Madrid. There, they worked with bricks, and they just cut the facade and made a big window inside. They sometimes have a very brutal and direct way of making architecture.

The corner of Tate Modern 2 was, for them, something where they went very brutal on it. I was not happy, but they wanted it like this. I scripted it, and I drew it, because, with these points, I could make a three-dimensional visualisation of it, with everything, perfectly. I showed them the corner, but they said, "Yes, it's okay, that's how we want this."

Do you like it? It looks like a mistake.

AC: I didn't know the criteria or what was behind this, but I always thought the corner could be well defined. Maybe they could have started from the corner piece, as in the lower part of the building. The corner piece would be regular and the adjustments made before the corner.

KS: I totally agree.

AC: In a conference in 2017, Jacques said that the corner is crucial in this project. It reveals the concept that is behind the construction. You see these two planes that don't match, and they really wanted to be like this.

KS: I know! You work there, and you have your own opinion. Sometimes you are amazed at what they think, and sometimes you have a slightly different idea.

AC: When you look at the corner, it seems like everything will fall.

KS: Yes, a little bit. It feels like you go to a corner, and you break it a little bit. It feels like it is not perfect. In my opinion, all the building looks perfect but then when you look at these corners...

AC: The corners and also the creases.

KS: But the creases are less visible.

AC: They are less visible, but still, you don't have a perfect line.

KS: Yes, but I find the creases all right.

Another important issue is that I always worked with input geometry working on the script itself. So, in this facade, I only had eight plane faces and the windows as polylines, which was everything I got from the team, and I think this was wise.

The architect gave me a drawing with no other information and, afterwards, I generated the point cloud on the surfaces of the building. Then I calculated the colour, the type of brick, or whatever. So, I had one drawing with, I think it was 440,000 points. Later on, we could select just some of these points and decide to make a 3D model to analyse how it looked. This 3D model was quite heavy, but it was not so heavy as it would have been had I taken all the facade. So, the communication I had with the architect was very simple because he had a very easy drawing. If they changed anything in the building, they would just give me these eight surfaces, and I could generate the entire point cloud on it again.

At the same time, when they had done any plans, I could generate the 2D drawing for them with exactly what they needed, with only the information regarding the bricks. I think this was a good working procedure for this project. If you had to design the bricks, I think it would have been impossible.

I'm not the only one who worked on the scripting. Volker Helm and Dominik Nussen worked on the scripting first. But then Dominik went back to study, Volker left for ETHZ, and I took it over. When I took it over, I went to London, and the architects had changed the facade slightly. I had to recalculate the bricks. They were drawing all the sills by hand, so it was not perfectly scripted. The parts not scripted were drawn by hand, which made it nearly impossible for me to work. So I took everything away, started from scratch and created something in which the changes on the bricks were completely scripted inside.

AC: Did the DT group give support only on the brickwork?

KS: Yes. Very little on the inner staircase, but not a lot.

AC: On the 3D models?

KS: We did 3D models, we used our model-making machines, and we also worked a little bit on the scripts for how these steps should go up. When you have a staircase that is turning around, and it's not perfectly round, but it's opening or doing something like this, you always need to have one line, which you consider to be the main line, along which people are walking. On this line, you have to be careful that the steps have the same proportion. You cannot just define the steps geometrically because it would not be comfortable walking on them. Here, we did a little bit of thinking and helped the team to make a staircase that works, but I don't know if they used it in the end.

As the DT group, we always entered into teams until they said, "Okay, we can go along without you." Then we went out. Only in the brick facade were we involved until the end; not the construction, but the end-of-submission drawings.

AC: I know that the decision to use brick as a cladding material is related to establishing a relationship with Tate Modern 1.

KS: I think that's it! They decided to use the brick.

AC: But they also took into consideration the brick bond. Tate 1 has a Flemish bond, and I suppose that the brickwork pattern on Tate 2 has something to do with this.

KS: Yes, and they just took out the headers.

AC: The Bankside power station was an industrial building, and it still had some decorative details on the brickwork. I wonder if HdM had decided to use the brick in an ornamental way because of this particular aspect.

KS: This is very typical in the work of HdM, to look at what they have on site and reuse it in the project. In Tate 2, they looked at the industrial fabric, but they didn't try to copy or make any mimicry of it. I think they were interested in using this kind of brick more from a design point of view, in a very digital and straightforward manner. Of course, the big relation is that you have one building, Tate 1, in brick, and you make another one where you want to play with this material. This is very typical of HdM. They take something, but then they transform it.

You see this kind of brickwork that belongs to London. You look at it, you analyse it, you play with it, you make a new reinterpretation of it, and, in the end, you have something which fits into the site. It fits into London, and you don't make this in Basel, for example. But it's not from London. It's something you have done with the same material.

So Tate1 and Tate 2, of course, talk to each other, but it is not mimicry.

For example, in Elbphilarmonie, HdM worked with waves and water, and you also have this in the auditorium. Simultaneously, the roof itself is also doing a sort of wave, and you still find the same kind of geometric language in small details. HdM scale them up, they play with them, and I think this is what they are doing in the Tate with the bricks.

AC: How was the brickwork information transmitted to the construction site?

KS: It was simple for the construction. The bricks that were not next to the windows were just standard bricks, and we didn't even control their colour. We didn't tell the bricklayers to put this brick or this one. We had the rules in the special conditions, so we controlled just the kind of variations we wanted.

AC: How did it work for the corners?

KS: We had the logic for finishing the corners. I have to remember, but in the end, I suppose that, depending on the geometry, the workers placed a specific piece or just left it out. That is why we have this porosity.

AC: Do you know anything about the windows? At first sight, it seems that they are all different in height and length and that their position in the facade has something random about it. But you can perceive that there are some rules in it. Most of the time, windows are placed at the corners and creases. I think that only one or two are cut on a single face, contributing to the continuity of the volume. You can also see that at level 5 there's a window that wraps the building, in correspondence with the Switch House roofline. The same happens at level 9 and at the terrace, which helps to conclude the volume.

KS: The architects designed this. They just gave me a drawing in which they put a line for the window. I got one layer with the eight surfaces and another one with these windows.

Once I was involved in many different projects, I always tried to work with one person in the team—only one—and I never chose an important person. Andreas Reeg is a brilliant architect who worked on this building. However, I also worked very often with trainees and didn't care who my partner was in the project. I would rather work with somebody who was totally in the subject than with an associate or partner who was in many different projects and maybe not so much concentrated on the subject. So, I searched for someone who was dedicated entirely to the facade and was controlling the design. Then I decided about what kind of geometry was interfacing between him and me.

When this person gave me the windows, I had no clue where the floor slabs behind them were, and I didn't even care about it. I was concentrated on my work.

AC: Do you know how the design process for Tate Modern 2 started and evolved?

KS: There was this significant moment in which they worked on a glass building, and, afterwards, they went to the brick. This was later in the project, but when you look now, it seems evident that they should have started with the brick, which did not happen.

You have a few buildings in the office which are quite straightforward. For example, the Vitra Museum is a building where HdM worked on the stacking, but they worked quietly, in a small team. They went forward really fast, and they built it. Then you have other buildings which are not like this. When I was in the office, I felt they were having a hard time developing Tate 2. You have some projects which are very easy going and other projects which are difficult in their way.

AC: I think they insisted on the idea of the stacking because, at the time, they were developing other projects which were also about this topic, like Quingdao, Actelion or VitraHaus. These are all stacking projects. Jacques Herzog mentioned that this was a compositional strategy on which they were very keen. So I suppose they tried to test it here on the Tate also. But at the same time, they wanted free movement for the vertical circulation inside the building. The two things were not compatible. So they gave up on it and simplified the external volume.

KS: Yes.

AC: At a certain point, they also realised that it didn't make sense to build a glass building. If they had done it, they would have created a stronger relationship with the surrounding context, with all these commercial buildings, rather than Tate Modern 1.

KS: Yes, this looks very obvious, but I was not involved in the way they were working.

AC: Can you categorise the design tools used in the office?

KS: I would make one very big item. The mock-ups are, for me, a new topic. I have shown you in the presentation about Ciudad del Flamenco that we did a big styrofoam mock-up. To scale-up models to the scale of 1:1, I have never seen this in other big offices, which instead work pretty much in a digital way.

I asked the students in Bern to design small chairs and stools and told them to make a 1:1 scale model in styrofoam. Students who did not construct a 1:1 scale model designed stools entirely out of proportion. Interestingly, when you work with these models, you feel precisely the thickness of the material. At this scale, one or two centimetres make a real difference, which you don't see in a plan or a section. It is something you feel very much at the real scale.

AC: It's like a prototype.

KS: Yes, it's like a prototype. This, we did a lot, in the office, and I think scaling up things to 1:1 is something very particular to HdM.

From the design tools point of view, I always had a big fight with people who wanted to work with a kind of framework to script. They wanted to generate the HdM framework, and I was very much against it. I copy some code from other projects when I have to do intersections because it's a copy-paste thing, but, for me, the important thing was to understand the design, understand what they really want and why they do not do it by hand, and why I should script it. I always created a geometrical interface so that I could work on the script, the team on the project, and then I produced for them whatever they needed for the design.

For me, it's difficult to say that we have one kind of script. What I would say is that I'm always working on the interface between the architect and the group, with very simple geometrical elements, so I could to customise it for exactly the kind of design they wanted.

For example, when you look at the Roche Tower, I think the interface was only these two lines that were generating everything. The minimal surfaces and all these things were done afterwards

on the script. But the architect's input, in the end, was only this spiral in one direction and the other one in the other direction.

So I always worked with minimal geometric information, a kind of DNA for the design.

AC: Steffen Riegas suggested that I speak with Andreas Reeg, the architect who was directly involved in the brick facade design.

KS: My world was eight surfaces, some points, some lines and the script behind. Whatever happened in the whole design, I just heard a little bit of it, but I was quite distant because I was involved in many different projects at the same time. Andreas Reeg was controlling the design.

AC: So you think it would be interesting to have a conversation with him.

KS: It would be super interesting!

Maybe it is not a design tool, but it is undoubtedly a design strategy to work with only one person on the team. I'm doing the same now at Blumer Lehmann.

My biggest problem in HdM was when BIM came, and we lost the "guerrilla" approach. This "guerrilla" terminology came to me from HdM. They say that when they have a problem, they want to have a solution and always try to find an interesting way of getting it. This is how I work. Each project is about a particular design aspect, and, therefore, I must develop a specific script. For me, this was amazing, and when BIM came, it turned.

AC: Do you think that in some way this has changed their way of working? I know that you believe that HdM put architecture first and go forward with their research interest independently from the tools. But it is also true that when you know that a tool can solve a problem in a specific way, maybe you tend to go that way.

KS: Yes, but I think a design tool is like a musical instrument. I may have a guitar, a violin, or a drum; however, having a musical instrument is not the same as making music. I don't know how to play the violin, and if you give me a violin, it's only noise. I'm not making music. I think it is the same for these kinds of tools, like scripting. By scripting, you may destroy a project or make it too complex.

AC: When you joined the office, they had a problem, and they wanted to go in one direction. You came, and you gave HdM the tool to solve that problem. If you hadn't given them the tool, they would have gone in a slightly different direction. So, if people in the office work in a certain way, in the end, this will influence the process.

KS: I think so, but they would never agree on saying this. If you have a hammer, you always see a problem that you can solve with a hammer. BIM has some kinds of complexity that you can perfectly solve with BIM, and I think this is a little bit directing. But this is only one aspect. The other is the hidden complexity you have on this kind of project.

When you start Revit, for example, it tells you the internal conflicts. There was a time in which we had a project with 500 conflicts. When you have 500 conflicts, you don't solve them any more.

You don't see which conflict is becoming harmful and difficult. Once, in one BIM project, suddenly the file didn't open, in a team of twenty-three people. It was so corrupt that you could not open the plans any more, and they had to send twenty-three people home because the model was not working. This was because of this complexity. The file was too big, and, nowadays, this happens a lot in our digital world. We have big buildings which are so complex that they never finish, like the airport in Germany. Look at what is happening to Boeing. They have software problems, they are not in control of the complexity any more, and they have enough money, enough engineers, enough knowledge. Still, they got ruled over by the complexity of this digital world.

I think that this, in BIM, is a danger we have in architecture.

When working on Roche, I got a book with 200 questions that I had to answer, but I said I was not doing that. If we start answering 200 questions when we should make the sketch, you don't do any sketches. Of course we have to solve these things, but we have to neglect them at a certain moment. First, we have to find a big idea, and, later on, we will think about all these things, not first.

I know that in BIM, you have these L1, L2, L3, L4, etc. However, the idea is that you have your brick with all the information. I always criticise BIM, saying that if you have BIM, you work as a legal model. You have the floor, and you have a wall, a door, a window, things like that. But in HdM, sometimes you don't know if it is a wall. You have something flattened that maybe turns, becoming a wall, then a roof. When HdM have an idea, they just come with a folded piece of paper, they give it to you and say, "Now, do something!". And then you start scripting. I'm much more in favour of this "guerrilla" technology where I can say, "Okay, what do they want?"

AC: And in which you have to customise the tools to solve a specific problem.

KS: Yes, exactly.

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