PROGRAMA DE DOUTORAMENTO EM ARQUITECTURA

The Hidden Geometry of the Architecture of Herzog & de Meuron

Digital Tools and Design Practice

Alexandra Castro

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Alexandra Castro. The Hidden Geometry of the Architecture of Herzog & de Meuron, Digital Tools and Design Practice

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FACULDADE DE ARQUITECTURA

The Hidden Geometry of the Architecture of Herzog & de Meuron

Digital Tools and Design Practice

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Steffen Riegas

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Steffen Riegas.
Head of the Design Technologies department (2014) and Associate Partner of HdM (2020).

“Digital tools are not the driver of anything. They are just tools."

A conversation with Steffen Riegas
Herzog & de Meuron, Basel, August 6 and 7, 2019

Alexandra Castro (AC): Can you give me a quick introduction to where we currently are?

Steffen Riegas (SR): Yes, of course. Over the years, we have grown into these premises and moved into more and more buildings. It’s what we call the Campus, and it’s where the majority of our project teams work. There are a few additional facilities elsewhere across town, like the Atelier, which is our large-scale prototyping workshop equipped with a five-axes milling machine, or The Kabinett, which houses a collection of our architectural models.

But of course, we have our main model-making workshop here, in the heart of the Campus. It’s a combination of both a traditional architectural model-making workshop plus a CNC workshop. The DT team sits close by, so we can support the teams with technology like 3D scanning or modelling to allow for ideas to quickly move between digital and physical, and vice versa. The idea is to give the design teams direct access to tools like laser and cutting and milling machines or small desktop 3D printers.

AC: I read, and I also spoke to Kai Strehlke about this. From what I've understood, in your opinion, 3D printers don't add much to the understanding of an object's construction process. It's too easy to model a complex shape and then print it.

SR: If you want to develop a specific detail, the assembly of components or just investigate some complex shapes it can be an excellent tool. But yes, it’s true, sometimes technology makes it a bit too easy, and you may easily overlook some important issues. It’s an interesting part of model making, that you encounter many of the difficulties of building already, only at smaller scales.

I think that’s why we never invested into a professional-grade stereolithography printer. If we need those kinds of models, we work with external companies.

AC: Do you also outsource other services, which are typically part of the Design Technologies domain?

SR: Sure we do. It wouldn't be feasible to do and develop everything in-house. But many times, it adds fundamentally to our design processes. It makes a huge difference if you apply technology as part of the design team or bring it in through external providers.

Take architectural visualisation as another example, another field where the DT group supports the project teams. The entire process of rendering images becomes a tool itself, which we can use to question and develop our designs. The process is much different than working with an external studio.

AC: What is your background? When did you join the office, and when did you become responsible for the DT group?

SR: My background is architecture, as it is for almost all of us working in the group. I was lucky that when I joined architecture school, I already had a bit of computer and code experience from my childhood and high school years. So when I discovered the APIs of Rhino or other CAD applications, I realised that I could automate things by writing down the rules, and the program would work for me. That was something quite fascinating as it had a highly creative side and enormous productive potential. Already, before I finished my Master's degree in Architecture, I was lucky enough to work with a firm like UNStudio in Amsterdam, where I could still focus on my personal interests in technology while working on different projects.

Parametric modelling was in high demand with tools such as Bentley's Generative Components and various scripting and programming languages. Information-enriched 3D models and BIM began to become a bigger subject that would soon change the entire architectural profession.

To handle the complexity of some of the designs, we developed what we called the "poor man's BIM" toolkit, which allowed us to attach more data to 3D objects instead of just having pure geometry. When I joined Herzog & de Meuron, we applied similar methods to stadium design or the facade of the Messe project.

I then moved to Copenhagen to work with 3XN in their innovation unit.

Back in 2014, I took over the leadership of the Design Technologies Group from Kai.

AC: How do you compare the practice of UNStudio to Herzog & de Meuron? Do you find any differences?

SR: Of course! Every organisation has its own culture where people with very unique skills and interests work together in such studios. Even today, I am amazed at the openness and the level of technical skills I have met in Amsterdam.

AC: What about architecture and the way of thinking in architecture?

SR: One of the special things about HdM is that there is a lack of a strong aesthetic framework. The studio has the feel of that great openness which you experience at a design studio at university in many parts. In Amsterdam, we worked with "design models". Essentially, these were high-level geometric approaches used to articulate and organise programme into architecture and buildings.

AC: But then you have these shapes that are autonomous and seem not to establish any kind of relationship with the context, for instance.

SR: Well, that depends on the rationale or justification for the expression of such architectures. I agree that it is sometimes hard to follow the narratives and logic of why something has come to a given shape.

AC: When I look at this kind of architecture, in my opinion, this is mainly about being at the forefront of technology. This architecture is always linked to keywords such as movement, flexibility, innovation or sustainability, and you always have these eye-catching buildings whose shapes result from a very free creative act.

When you look at the practice of HdM, you talk about other concepts. I suppose they appreciate the vernacular, the local and its potential for technological research. The prerequisite for every project is the context analysis, and they always try to take something from the context, even if sometimes it is only at a concept-based level. They often refer to important figures or buildings of the architectonic culture. I remember, for example, Elbphilharmonie and the relationship with Scharoun and the Berlin Philharmonie; how HdM have read that building and tried to use some elements of it, reinterpreting them in the new building.

In HdM, I find these kinds of topics, whereas, in other big important offices, the architects are very much for experimentation, technology, movement and new things.

SR: In concept design everything should be possible. Why is it only three stories and not five stories, why is it long and square and not round, why is it curvy and not a box. You always must find a reason for why and how those decisions were made. I guess it many times helps to develop ideas along a narrative.

What we can bring to the table, as the ones in this organisation who implement technology, is that here, technology is never the driver. You can surely use a tool to explore new possibilities and come up with new ideas. Rhino, for example, is at the same time an intuitive and precise modelling tool that we use a lot to explore geometries. Here we also apply scripting, parametric design or even generative approaches. However, when you give away control to a system, then you better make sure you understand and manage the system.

I mean, we use 3D modelling as a tool to solve a problem, not to create new ones.

AC: "Digital Technologies" group, is this the correct name?

SR: It was at some point. Recently we tried to sharpen the term and be more specific because it's 2019 and everything is digital. Our group is now called "Design Technologies", so still shortens to "DT". We are supporting the architecture projects with all their technological needs. Everything that we as architects produce to deliver our works. It stretches the entire project delivery pipeline, with the classical CAD and BIM management at its core. And then extends to visualisation and the workshop teams.

AC: So, digital workshop and digital fabrication.

SR: Exactly. In-house, we maintain the digital workshops with CNC machines, 3D printers and laser scanners, but we can also get involved when coordinating with contractors and manufacturers for projects under construction.

AC: What is the relationship between the "Design Technologies" department and the design teams? For example, when a project starts, are you suddenly called in, or do you wait until the design team has some issue to solve?

SR: Unfortunately, the latter is often the case. We do a lot of support, when teams call us too late, when they've already run into problems. It has something to do with the ability of architects to suffer. They try to solve everything by their own means until they come to a point where they realise this needs to be done differently.

AC: What kinds of problems are you usually asked to solve?

SR: Tasks like studying complex geometry facades, facades with thousands of different members which are hard to model, and it takes a lot of time if you'd do this with a manual approach.

Stadium design is the same. You don't want to put tens of thousands of seats into the stadium by hand, because you know you are going to change those again the next day, so our own tools help us a lot to control our models. Sometimes it makes it obvious that we should be joining a team from the very first day on.

When talking about visualisation, where a team typically needs some high-quality images for press releases or public presentations—in competitions this is a standard—we join them very early on and try to develop a visual narrative.

BIM and CAD, of course, especially if we have big teams working together. I would say Revit is still a big beast. If you have a project with 20 people having to work together, collaborating on the same model, you need people who really understand how these models are put together, how to drive them, and to set the boundaries for these people. That's why CAD managers and BIM managers join these projects from the first day on. You can't expect a normal architect to manage this. It's a complex task, and you need a lot of experience in software, but also in leadership.

AC: In these almost 15 years, since 2005, what has changed in the DT group?

SR: Mostly, we have grown. BIM and Revit, which have become a huge part. As we speak, we have eight BIM managers full-time, and every project has a BIM lead. The BIM competencies in the office are still growing. Last time we met with all BIM Managers and BIM Leads, we realised that we can call 5% of the staff in projects Revit experts.

AC: Has BIM in the office become more relevant in developing the projects?

SR: Yes, of course! This is always the question: what is the driver behind this change process? Now we are doing things that we were not doing five years ago, so why are we doing this, did we

choose to do this or not, was it our decision to document everything in 3D or is this coming from somewhere else?

It comes from different sides. In the UK, for example, since 2016, for every public building of a certain size, you have to deliver the project at a certain BIM level. We don't have this in Switzerland, we don't have this in Germany yet; it's not a government mandate, but still, we do it. So, the question, why are we doing it? One reason is that it is a great tool, and it makes sense to work like this. Maybe for the architects, at first glance, it is more work, it takes longer, it's more effort you are investing, but you get a better result. The quality of the model is better. The quality of your delivery is better.

AC: But this is not about architecture.

SR: No, it's about collaboration.

AC: It's not a tool you use to develop your initial sketches.

SR: No, but it makes sense in the later stages of design. We constantly change tools for different tasks or phases. In an early concept phase, a pencil and a napkin, that's fine, we should still do it, why not? But of course, if you are on a construction site, you should maybe replace the pencil with something a bit more precise that can handle more information. That's when BIM as a method and Revit as software become interesting. It is very precise, and it's easy to coordinate with a lot of different people and then we have to quickly talk about collaboration, and how do we share all this information centrally.

AC: Otherwise, if you change something, you must inform others and send them another drawing. Then they have to change it and re-send it to you again.

SR: Yes. I always have this feeling that when you talk about this to non-architects who don't know the history of these tools and have no idea how architects work, they are sometimes surprised for how we work with drawings and how we exchange information. Working collaboratively in 3D models seems so obvious. The way architects work can seem pretty old school, and not the best use of technology that is around.

AC: It is very laborious.

SR: Yes.

AC: I have this diagram which Kai made, and, for me, this was very useful because it helped me to understand that when we talk about the design tools of the office, we have to consider these three phases: Hand-drawing, 2D CAD, 3D Data and BIM.

SR: I should show you the latest version of this diagram. We tried to simplify this a bit but still you can see these different phases. The first transition is somewhere here in the nineties. Then we have another transition phase around which peaked 2015 that is still going on. But also, the “pen and paper” projects that you see here at the beginning of the timeline still exist nowadays.

AC: Kai told me about a recent project for a wooden building in which someone had drawn a 1:1 scale detail by hand.

SR: Yes, “pen and paper” drawings still exist, and might as well also continue to do so. It still has its right to exist. Same with CAD, for sure; we’ll use it less, but we’ll still use drawings in the future.

AC: When you refer to BIM, is this the “3D data” from the first diagram?

SR: Yes.

AC: And where do you put the scripting?

SR: If you take 2005, and this could be, for example, the Olympic Stadium in Beijing, of course, we did have 3D models for that. Otherwise, we could not build this. But it was not a BIM model, like a full-on BIM model that had every building element with attributes and so on. There was a three-dimensional model from which we could derive a lot of information and also the 2D drawings from it. But, usually, a model exists at the centre of the project.

AC: Do you see any difference between a 3D model, manually done, and one based on the scripting?

SR: Yes, but that just means how this model was made, how the pieces came together. You can do this by hand and click a lot of buttons, or you can automate the process, and the result is generated from your scripts. It does make a huge difference. It's a different way of making these models. For stadiums, it requires programming and scripting because otherwise you wouldn't be able to control these models.

AC: If you look at this first transition from hand-drawing to 2D CAD, this is an easy shift because you think about the project in the same terms. You changed the tool from analogue to digital but still work mainly with projections. Scripting and 3D modelling imply another mindset. It is a different way of thinking about the project and defining it. BIM, in my opinion, is yet another thing. Do you agree with this?

SR: Yes, it depends on how you work. I don't see scripting as a concept. Scripting is a tool. In a way, it is like model making. Here in this diagram, CAD, BIM and hand-drawing are seen as a process. This is about how you produce your final product. It also means that your final product is also different. Here you are producing a piece of paper, here a file that has 2D information in it and here you are producing a file that has 3D information and data.

Within this BIM data, we still do a lot of 2D work. I would say that maybe thirty per cent of the work is put into the 3D model. Then you take the model, you generate projections from that, and you work on those, putting dimensions or tags. This is 2D work, it is like drawing on plans, and that is sometimes more work than actually producing the geometry. So, modelling is one-third of the work, the creation of the 2D documentation is another third, and then the last third is enriching all this with attributes and data.

I think this is one of the misconceptions of BIM. People always think that Building Information Modelling is all about 3D documentation and that we will be working without drawings. People will still be working with plans. Just not on paper, hopefully.

AC: So this is a process of working. And what about Rhino? Is it in BIM?

SR: Rhino should be part of the BIM process. Somehow, we must put this Revit model together. Some things are much easier to do with Rhino. For example, a spiral staircase, we would today not do in Revit.

The problem was always that these two programs describe geometry in quite a different way. We have some tools that bridge the gap. With Rhino7 comes a new feature called Rhino-Inside which lets you run Rhino with all its parts from within other applications. So you can move sliders in Grasshopper, and create native Revit objects. So, modelling in BIM, Rhino is already part of it.

AC: When Kai was in the office, you did not use BIM so much. Is it a recent thing?

SR: Yes, BIM hadn't hit the industry as hard back then. The first project we did as a pilot with an early version of Revit was Roche Building 97.

AC: I think the computer started to have a more relevant impact in the design process some years before Kai came into the office, roughly around 2000. From this period, we have, for example, the free form of the window frames for the Schaulager, which HdM describes as "Digital Landscape: calculated forms produced with digitally controlled tools".

Then, there is also the project for Prada Levanella, with its very particular roof, the two stadiums—Allianz Arena and the National Stadium in Beijing—and Jinhua, which I suppose is a particularly relevant project for the office. About the latter, Jacques mentioned that this was the first time HdM conceived a building directly in the computer's virtual environment.

SR: It's not computer generated, like in a generative process that runs on its own.

Actelion and VitraHaus are similar projects, in which you take simple extrusions and shapes and merge them, ending up with very complex intersections. They are beautiful, but sometimes they would be hard to conceive if you didn't have the computer and the 3D model to control them.

In Jinhua, it is the same. You are using even more simple extrusions, you arrange them in 3D and what you get as a result are very complex artifacts and spaces. In a way, you can say the computer generates them because you generate them on the computer.

AC: I have the idea that when Kai was in the office between 2005 and 2015, scripting was a very relevant tool.

SR: I still think it is relevant; I just don't like to overexpress this term. For me, it is a tool, and it solves a problem. Parametricism. Of course, you can use it to create a certain aesthetic, or it might even be a prerequisite. But scripting does not generate an architectural style. Scripting, for me, is when we sit down and write our own libraries of code to make our life easier.

You would be surprised which projects have had a significant contribution of programming and scripting exercises, while others didn't. It doesn't always manifest in the appearance of the projects.

For example, Beirut Terraces was done with a lot of scripting to generate the arrangement of slabs. Messe was a long term job too. In Südpark, we used scripting at a point where it was about data transferred to manufacturers, but not so much for the design studies. All these different types of windows, we could do them by hand and most of them were also done by hand. However, later on, once you have these thousands of different windows and you are dealing with this complexity, how do you make sure that the manufacturer doesn't show up with the wrong pieces? So scripting was used late in the process to support digital fabrication. The same happened with Messe.

AC: Kai told me that the ETHZ assisted early on in the development of the project for the Südpark Basel. They created a script for the facade. However, I suppose there were some issues in the relationship between the random composition of the windows and the internal program planning. So, later on, when he took over the scripting, he made some adjustments to rationalise all the logic behind it. In this case, I think the scripting was also used to support the facade composition.

SR: Randomness is an interesting function because you cannot mimic this by hand. The same happened with Beirut Terraces. However, the scripting was not generating the architecture, it was just assisting you in finding the best working configurations.

You need to understand first what works and what not. Then, based on your observations, you can write the rules. So, for Beirut Terraces, we simply excluded many sequences so that, in the end, the script could generate only working configurations. There were only a few configurations you could choose from.

AC: It helped to give some design possibilities.

SR: It actually helped to narrow the possibilities down.

Unterlinden, for example, there are two free-form spiral stairs. We had to model them very precisely in Rhino and then give that information to the manufacturers who would cast them in concrete. Everything had to be precise, but to shorten the drafting process I wrote a lot of short functions for automatically rounding all of the corners off.

This is what I mean scripting is to me. It's a tool you may use or not. It can be part of your repertoire, but ideally it doesn't drive the entire design or even leave a visual trace.

AC: At the beginning of our conversation, you told me that the projects' geometric complexity had decreased in these last years. Why do you think this happened?

The geometric complexity we may particularly recognise in the projects between 2000 and 2010 came above all from HdM's interest in exploring ornament. Do you think that this interest has changed towards another thing?

SR: I wouldn't say the texture or ornament lost its relevance. And scripting is, in fact, a great way to approach ornamentation problems since the nature of this problem is partially geometrical. The more

recent National Library of Israel is quite ornamental, where we play with a certain degree of randomness in the facade.

AC: Which projects by HdM do you highlight as being paradigmatic of a strong relationship with digital tools?

SR: From all the projects happening in parallel at the office, there are some we heavily support and some we hardly communicate with at all as the DT group. For the Chelsea Stadium, for example, we had almost the entire team working on it at some point.

I think there was a phase in which it was a little bit like "anything is possible", and from a design or formal standpoint, the office was exploring the limits of geometric complexity. The Beijing Stadium, Actelion, VitraHaus, and Leonhard Street, the initial design for a Tower for Roche, fell into this era. You look at this curvilinear geometry, which is very challenging to design and build.

AC: But once a specific technology has solved a problem, you know that you can count on it, that you can use it again to solve other similar design issues and even go further in exploring them. However, I agree with you. In this office, architecture comes first, and technology serves to solve a specific problem you already have in the design.

SR: Exactly. In Elbphilharmonie we used digital tools extensively. It simply is a huge and ambitious project with a high degree of complexity. Why did we bring in technology? I think we did because it promised to solve a couple of problems. It's not the other way around where we bring in technology, and now we can go all crazy. If you look at other design studios, I get the impression it is sometimes the other way around. So, digital tools and scripting make some things possible, but they are not the driver of anything. They are just tools.

But back again to your question about which projects I would highlight. I would say Messe and Tate Modern 2, in the sense that we never went this far in terms of producing manufacturing data. Then about BIM, data and 3D documentation, "M+ Museum" as an experiment where we had to learn many things about a BIM process the hard way. This was the first big project under construction for us using data from the model.

AC: Do you think that any of these projects could have been built if you didn't have digital technologies?

SR: Sure. We can build all of these without them. It would have just taken a long time, or the process would have been different.

We discussed if whether we should buy an industrial robot for manufacturing. We looked at what universities were doing with these robots. I liked the ornamental exercises with bricklaying patterns where you work with a material, which is very analogue, archaic. For us, this was interesting. So, we prepared a presentation for Jacques and Pierre to show them what we could do with these robots, and I remember Jacques looked at it and said: "Yes, it's interesting, but what do we need the robot for?" And he is right. You could make this wall without the robot. It's an interesting fact that it was done with

the robot, but it's not what enabled us to do an ornamented curved brick wall. We could already make curved walls thousands of years ago.

So, what is the goal here? Using a robot or making the curved wall? So we have to see what tools do we need to do a curved wall, and if we need a robot, we'll get a robot. It's never the other way around.

AC: But if you think, for instance, in the Elbphilharmonie, there are a lot of things that would have been hard to accomplish without the support of digital technologies, or maybe that if you knew that you wouldn't have had the help of those tools, perhaps you wouldn't have gone for them.

SR: I think that you would just find a different tool. Look at these two projects, Signal Box and Messe Basel that are, in a way, very similar; both have metal stripes that open and close. They look different, but they follow a very similar idea. You have horizontal bands, and you bend the metal strips to create openings. The differences are in terms of scale and material, but it doesn't matter. I think that Messe in terms of pattern is a bit richer, indeed.

AC: Yes, a little bit more complex. And it is also integrated with the manufacturing process, right?

SR: Yes, they are both fully integrated with their manufacturing processes. But again, and this is quite interesting, when we designed this we didn't limit ourselves by how this could be made. At the beginning you design and then you have to find ways of doing it. So, in the case of Messe, we went to talk to different manufacturers to say, "this is what we want to get, can you make this?" And there was only one company that could do it.

When you make these waves, they consist of three parts, one is the wave itself, the sheet metal; another one is the profile that is curved in the back, and they are joined together; then there's the substructure. To connect these pieces you have to drill holes and put a screw through it, but we didn't want that. We wanted to have threaded pins welded on the back so you wouldn't see them from the outside

The machines that existed on the market could punch or cut out shapes, but they couldn't weld pins at the same time. This machine did not exist. So this company said that they could alter their machine and add this extra functionality. In a way, it was not that we designed this so it could be producible with the machines that existed. We had to design and built a machine that can do this. That company was the only one that could do it, so they got the commission to do it.

This is a good example. You don't limit yourself by what is possible, or what the technology allows you to do, but instead you define what you want to achieve and you find a solution for it. Sometimes it means that you have to write some software, sometimes it means that you have to build a different machine, sometimes it means you have to invent a new building material.

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