

# architecture at the beginning of the fourth industrial revolution

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To approach an interpretation of "architecture at the beginning of the fourth industrial revolution", or rather to attempt an undoubtedly subjective forecast, is the subject of this lecture.

Architecture as the art and technology of construction satisfies both the tangible needs of people such as protection and envelopment, as well as intangible needs such as communication and aesthetic pleasure. In other words, architecture does not only accommodate the various activities of people, but also communicates their experiences, memories and ideas – by its form. This is Vittorio Lampugnani's definition of architecture as a culture.

Architecture has always responded to the phenomena of the respective industrial revolutions. It projects the technical, environmental and socio-cultural developments like a seismograph.

For example, the technological revolution of the Renaissance and its architecture has had a lasting influence on the city culture. The trigger for the new building culture was a previously unseen information flow after the invention of printing in the 15<sup>th</sup> century. Scientific findings, historical experiences and new cultural developments were quickly distributed and exchanged all across Europe via publications. And hasn't Krakow been shaped, from the happy times of the Jagiellonians until today, by the humanistic - Christian ideas which could be found in the libraries of the University and the royal family?

Philosophical books, such as those who were printed by Erasmus of Rotterdam in his publishing house in Venice, have shaped the culture in Europe - a culture which is founded on humanistic ideals and was expressed by its building culture. Publications from the 16<sup>th</sup> century such as works on Vitruvius, Alberti, Vignola and Serlio are still standard works of architectural theory and continue to have a lasting impact.

The fourth industrial revolution, which is now beginning, is characterized by a comprehensive flow of information all around the world. Software is connecting all steps of the development of a product to its manufacturing. Tools and products are exchanging information among themselves. The production is largely independently optimized by the production site, according to predetermined objectives by experts. The user is becoming part of the information system.

The global networking of all relevant information in real time, and a thereby possible maximum flexibility, is certainly going to have a revolutionary impact on our culture and thus particularly on the building culture - just like it did in the Renaissance with the invention of the printing press.

Let me give you a little example of a personal experience on the threshold of this development: When we planned and implemented the faculty library of the Muenster School of Architecture and the Academy of Arts in Münster, we wanted a special architecture: One that corresponds to the *genius loci*, but also one that creates a memorable place on the university campus. The transparent façade and the supporting pillars of the roof, floating over the books, should respond in a differentiated way to the various technical and especially formal requirements. In order to achieve the distinctive effect which should respond to the according meaning of the building, we did not want to plan an architecture which uses the serial elements redundantly.

The differentiated production of the various and personalized details could only be managed in an economic way by computer-aided manufacturing in accordance with a specialized industry. For the assembly work on site, the executing company Gartner used modern logistic. For economic reasons, no special workers of the company were able to do the assembly in Munster. So a group of fitters was hired on the spot. As these workers had no relevant experience, a special process was necessary. There was no storage at the construction site. The components, which were to be mounted on a particular day, were delivered on that day with detailed installation instructions for each step. The installation information was exchanged via the Internet. In order to save transport costs, the components of the construction were added to the transport of other goods. A corresponding computer-controlled logistics ensured a timely delivery of the various transport goods.

The differentiation of the production of the components, made possible by computer control, the segmentation of the task in several steps, and the corresponding logistics, also of additional and very special components from around the world, will form the basis for the use of computer-controlled robots for the final assembly in the future. In Münster, we still required a group of assembly workers. An example of the use of robots in the assembly phase, we can study in the realisation of Google's new headquarters in California. There robot-crane hybrids will play a specific role in the construction of Bjarke Ingels and Thomas Heatherwick designed structure.

The examples does not only show the beginning of the possible development of a highly flexible production in the factory, but also of an economic assembly of differentiated components at the construction site. This creates the possibility of a strong individualization of the single components. This means the end of the serial architecture which has dominated the second half of the last century.

In 1959, Konrad Wachsmann stated in his book "The Turning Point of Building" that the demand for a serial architecture acts as a prerequisite for the industrialization of the construction process. The consequence of the use of repeatable industrialised elements was until now, that the architects used aids such as the grid, to organise and control the construction. The idea of prefabricated serial elements in architecture led to the monotony of redundant modular buildings in the big cities all over the world. As a result of the fourth industrial revolution, we can now observe a turning point in construction – away from the serial and towards the digital architecture. A clear individualization of structures can be expected.

Gramazio and Kohler from the ETH Zürich formulate it: “through digital materiality architecture becomes increasingly rich and diversified. This diversification affects different scales from materials and building components to spatial sequences and loadbearing structures, to houses and urban development zoning. Variation emerges as it becomes possible to design large numbers of elements in differentiated ways using digital means.”

This means a huge paradigm shift in architecture and a change of our cityscapes. Architects who used grids and redundancy as the shape matrix of their planning, such as David Chipperfield in the UK or Max Dudler in Germany, will probably have to change. Also, grid irritation that tries a varied design approach to grid structures, as done by Peter Eisenmann, did not really offer a way out of the constraints of serial architecture.

But not every alternative of the industry 4.0 to the conventional construction methods seems to me like a real step forward. For example, the spectacular production of complete houses by the world's largest 3D printer is currently of great interest for the media. In China, the inventor and entrepreneur Ma Yihe prints house framings within two days right at the building site in the suburbs of Shanghai; these homes are based on designs by architect's offices, which the client can choose from anywhere in the world and which are connected with the construction process via the internet.

However, due to the printing technology, these building structures must comply with the conventional concrete structures. The resulting formal possibilities were thoroughly examined in 1901 by Tony Garnier in his study Cité Industrielle for homes which use cast concrete. Compared to Garnier's proposals, the printed houses don't offer any formal progress. As a result of the printing technology, the material of the wall structure is still homogeneous and can barely be differentiated.

Most importantly for me, however, is that, thanks to the revolutionary possibilities of the industry 4.0, the upcoming architecture can develop intelligent and hence differentiated building structures that can interact with the environment and the inhabitants. On the one hand, floors, walls and roof can meet individual needs and be easily replaced when requirements change. On the other hand, they can react accordingly to summer and winter, day and night, as well as the user cycle. They will not only save energy, but also produce it. The philosophy of so-called "zero energy houses" with their high ecologically senseless insulation and poor ventilation is hence becoming obsolete.

As with various technical installations, whole components might need to be replaced when problems occur – this has certainly an impact on the building structure. It is thus clear that, as with other sophisticated technical devices, there will be an expiration date for constructions. Homes cannot be designed anymore with a claim to eternity. Sustainability will therefore no longer be a design parameter, but the ability to recycle the materials will be of enormous importance.

The question how architecture will look like as a consequence of the revolutionary development by the industry 4.0 is difficult to answer. But I am sure that my colleagues here in the auditorium already have certain images in their minds, which will no longer meet the so-called "high-tech style" of the second half of the last century, since this was only a design and not a real technical achievement. A reorientation back to earlier designs such as Hans Kolhoff in Germany will also not meet the new requirements and is hence only nostalgia.

But we cannot only unilaterally consider the possible changes in the architecture due to changes in production methods." Architecture has a social function, which has always been closely linked to the philosophical, political, economic, technical, and artistic developments of its time", as this was formulated by Victor Hugo at the beginning of the second industrial revolution.

In the fourth industrial revolution, humans become independent of locations by detaching themselves from the centre of their lives, the location of the development and of the production, and by their worldwide connection via the Internet. The new human is a “nomad,” just as the well-known sociologist Saskia Sassen predicted. He can contribute his power at different times in different places via digital networking as a "global player". He will be located both at a physical location as well as in a virtual world.

As a consequence, architecture will have to create places of identity for the various individuals and thus contribute to a new urban culture. Therefore, the uniqueness of the place, as opposed to the anonymous randomness of serial buildings, needs to become an important design factor again. What happens when people lose their identification with the place and hence the home can be observed in the new towns in the Banlieue of Paris, such as Toulouse le Mirail. Urban decline and chaotic street battles reflect the frustration of the young residents who could not develop a bond with the place and feel uprooted in an anonymous architecture.

The design of places for individual identification which appeal to all senses will need a great creative performance by a new urban culture. This socio-cultural development of a human city requires other design parameters which no longer can be defined by a simple profit maximizing by the investors. Even the simple formal recourse to historical or nostalgic clichés, to generate a corresponding environment as in Venturi's "Learning from Las Vegas", proved to be an inappropriate mean at the end of the last century.

But Saskia Sassen does not see the development of a liveable new urban culture as a utopia; in her opinion, the cities will be forced in a competition with each other to achieve their relative attractiveness by a high architectural quality of the habitats. On the other hand, she is of the opinion that the nowadays-easy exchange of unconventional new ideas by urban residents via the Internet creates an enormous political potential for a particularly sensitive urban culture. Ms Sassen sees an equally great creative potential in people in shelters of refugee camps, or the simple temporary quarters which are still the home for people of the bourgeois middle class who have been affected by the property crash in the US and want to build a new world. She refers to the according urban development under the social pressure at the beginning of modernity at the end of the Second Industrial Revolution.

Currently, one can observe the development of another phenomenon whose impact on architecture cannot be assessed yet. As a consequence of the changed lifestyle due to the fourth industrial revolution, some young people have developed a different relationship with their personal possessions and their dependence on them: The phenomenon of the "Sharing Community".

These young people exchange views on global networking on the Internet and the corresponding logistics of the delivery to each other. For them, the use of goods is no longer tied to their personal property. One does not own a bike or a car anymore; one uses the bike or car when needed within an anonymous community. Whereas in a conventional situation consumers would buy products and become owners, in an accessibility-based system consumers pay for temporary access-right to a product. For example, at the moment it is hip for some young people in New York to swap shoes after a couple of days. By doing so, these people can individually change their personal outfit on a day-to-day base. In their book, "What's mine is yours - The Rise of Collaborative consumption", Rachel Botsmann and Roo Rogers vehemently defend the new philosophy of independence from personal possessions. They pay homage to a lifestyle which has evolved out of the metropolitan culture onto various Internet platforms. It is aimed solely at a new way of consumption and has, by the way, nothing to do with socialism.

Applied to architecture, this would mean: the space is evolving into an ever-changing "event offer" in the urban structure. The private house with a small garden as a personal possession in so-called dormitory towns is no longer of any interest to these people, and may even be a hindrance. Their whereabouts in a metropolitan urban architecture are becoming a fashion object. The residence frees itself more and more of practical requirements and projects itself as art. Spontaneous actions are communicated via the Internet and become the urban lifestyle of these people.

As has become obvious, the fourth industrial revolution can release an unprecedented creative potential. A high degree of individuality can shape the future architecture and its use. Unconventional new thought patterns are possible. At the universities, corresponding research is going to trigger interesting discussions and influence the further development of architectural culture accordingly.

What if the few images created in my lecture were too optimistic? When it comes to industry 4.0, should the pessimism regarding the possible developments not be the order of the day? Did not Jacques Derrida, one of the most important philosophers of deconstructivism, already paint the crossing of critical thresholds by new information technologies, due to the proliferation of electronics and IT, as a possible apocalypse at the beginning of the 3rd industrial revolution? Could there be a dehumanization process due to the mechanisms of networking via software and its possible manipulation? Have the NSA scandal and the report by Snowden not given us food for thought? Could there be a loss in the relation to the human itself, due to the total and completely detached virtual availability which is developing parallel to the real world? Will industry 4.0 become the crisis of humanism?

In the end, I would like to admit that I am influenced by the optimism of Taillard de Jardin. With his theory, that the creation of the world may not yet be completed; the theologian reconciled the conflicting concepts of the creation and a technical development as a consequence of a positive evolution. His writings have influenced my worldview at the beginning of my architectural studies. I believe that the fourth industrial revolution will turn into an evolution and that it can have a positive impact on architecture. The global exchange of the enormous creative capacity of humankind, the rapid spread of knowledge, and the new industrial possibilities of its implementation are an unprecedented potential for a cultural evolution. Just like back in the times of the Renaissance, a necessary formal change will develop out of the changed behaviour of people in the cities of the future. We should equip our students in our seminars with the tools for this evolution. The universities have always been the place where besides the technical feasibility, questions of the cultural context have been asked, which makes it the basis of a cultural transfer.