

Solar driven Form Finding as a Source for Aesthetics – A Case Study

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Abstract

This paper presents the public building *church and municipal centre Rif* [1] in Salzburg being a case study for solar integrated self-sufficient design, where urban issues, space allocation plan and energetically functions have been solved simultaneously. The solar issue was the main relevant boundary condition for the form-finding of the architecture, whereas the appearance of the building does not attract the attention to solar energy but to a useable sculpture. This paper describes the methodical experiences of the self-forming design process, where the main interdisciplinary participants and representatives of the users worked in a philosophy based on the ideas of David Bohm [2] and Chiara Lubich [3].

The presented case study consists of a simple form of a folded stripe and an upper enclosure of a hyperbolic paraboloid. The inclined facades increase the effectivity of the integrated solarthermics and they create an adequate interior for the ritual space. The continuous glass layering façade concept provides a homogenous appearance during day and the wanted visibility of the significantly formed cut out at night.

Keywords: Self-forming process, Design method, Integrated solarthermics, Aesthetics, Active energy building, Case study

1. Background of the case study *church and municipal centre Rif*

Responsible representatives of the Catholic church in Salzburg as well as political representatives are aware of the importance to be and to act authentically particularly in the field of integrity of creation. Both parties decided to share building ground and to profit from win-win aspects of the collaboration in terms of saving money and concerning the social life in the suburban district with more than 4000 inhabitants.

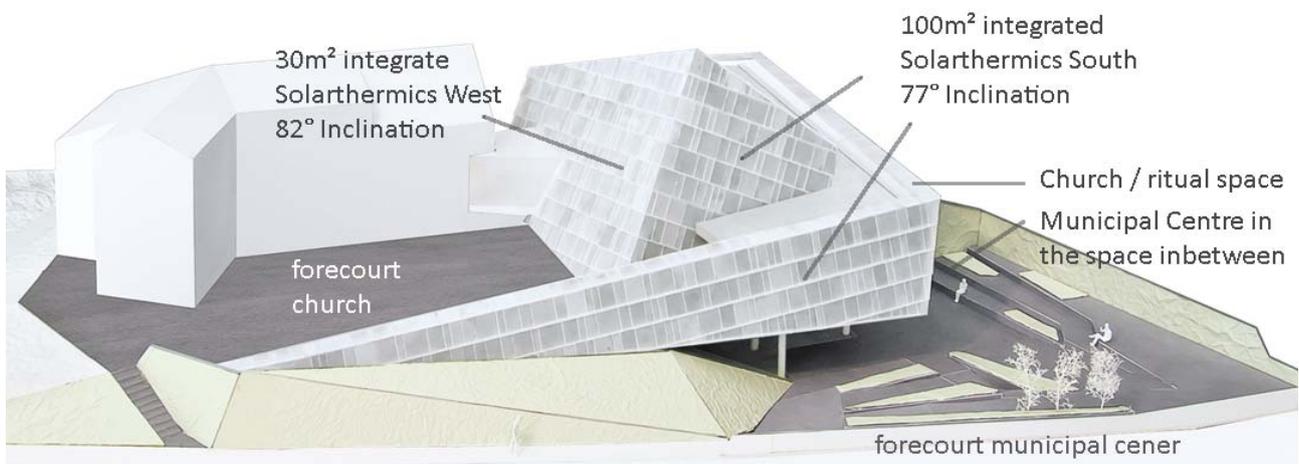


Figure 1: Design Model 1:50, South-west Façade; The upper part for ritual use and the public centre below

The holistic form-finding process was accompanied from the very beginning by the architect together with the energy consultant. The design-solution was found in a usable urban sculpture. The main form of the folded stripe with the upper enclosure of a hyperbolic paraboloid provides the ritual space. The public municipal centre is located in the gap between this form and the topography.

1.1 Socio-cultural integration

The design solution provides two clearly separated spaces with outdoor puffer zones. At the same time the building is appreciated as one (not two) relevant public building of the living district. The long-time success of the collaboration of both partners consists in the closeness and clear separation at the same time, which supports spontaneous interactions and evolving relations.

1.2 Energetically challenge

The approach was that the new building should be energetically self-sufficient and it should provide energy to reduce the costs of the attached 25 year old existing building used as parish centre (see Figure 1 left side). Defining the aims it was decided at the beginning that the average temperature in the coldest months in the church should be by 15 degree and the municipal centre 21 degree.

2. The self-forming design process in solar architecture

The term “self-formation process” is used in light weight structures – respectively in the research field of active bending [4]. In this engineering context the designer defines and controls the boundary conditions to provide elastic materials to find their bent form. This approach can be translated to the complex design process of architecture in that way that the architect focuses not on the form itself but on the boundary conditions, which evoke a form-finding process. The role of the architect consists in the art to define the relevant players in this process and to understand the relevant interactions and relationships between all participated disciplines and determined parameters at the site.

2.1 The Method of the Bohmian Dialog for solar integrated design

Whereas participative design is state of the art in contemporary architecture, the approach of David Bohm’s dialog offers an efficient way to achieve a high level of integration of solar issues and architectural quality. All relevant players / planners and users try to find the appropriate solution not in defending their ideas nor in convincing the others but by intensive listening to each other. Every participants tries to contribute to an emerging not known solution. This method was applied in the described case study during the whole process of five years in different intensity.



Figure 2: Guided Dialog groups and impressions during the process; Photos: W. Klasz

Concerning the solar integration there have been two main phases where following two main decisions have been done as a result of the dialog:

2.2 The ideal inclination to the sun is together with the spatial quality the main player in the form-finding process



Figure 3: Interior of the church with inclined facades

The emerged form provides two large inclined surfaces orientated to south and west (Figure 1,3,4). The west façade is slightly (6°) turned to south breaking the 90 degree order of the other edges. On the one hand the energetically effectivity is higher and on the other hand the architectural quality is increased. The building faces with an inviting gesture to the public place and street (Figure 1) and the atmospherically tension of the interior space is improved. The furniture react to this changing angels and keep an emotional equilibrium.

2.3 One homogenous covering glass layer for the whole skin



Figure 4: South-west façade and entrance to the church

The concept of the glass façade was determined by various parameters. In terms of function a glass-material of a high g-value was selected to reduce the degradation of the solar efficiency. Concerning the appearance white glass was wanted to achieve an attractive surface reflecting the changing colours of nature. Technically the façade has to be dismountable for long time maintenance. The technical details and the efficiency have been tested in a full scale prototype of 5m². The measurements have shown a reduction of efficiency caused by the upper layer by 20%. As a result the area of solarthermics have been increased from 100 to 130m². The decision to realize one homogenous covering glass layer was based on following other benefits: the continuous skin supports the clearness and readability of the primary form reflecting the importance of the building being of special use (church and municipal centre). The Bohmian dialog and the design model (Figure 1) helped all partners in the project to back the decision of the covering glass. Public buildings require a high degree of social acceptance to guarantee an added value for the society and aesthetics plays an important role in this social acceptance.

Summarizing the Bohmian dialog supported the emergence of the solar driven form of the architecture and it helped to get a holistic view on the made decisions in terms of efficiency. Simultaneously the project stresses the importance of further research in a technically higher degree of integration of solarthermics (see perspectives).

3. Solar driven Form Finding

The terminology “solar driven” describes the main relevance of being orientated to the sun. Due to the building site with a noisy street in the south and visually less attractive residential buildings in the surrounding the form or the ritual space had to be generally introverted without direct sun to the space except the gap at the end of the folded snail and the cross, which is cut out in the west façade.

The starting point of the form-finding process was to place large inclined surfaces to the south and to the west. Secondly the part in the west was turned six degree to the south (Figure 3). Then it was decided that the intersection line of the west and the south façade should mark the highest point of the building. In the north and east the folded stripe inclines negatively to the inner space collecting daylight along the longitudinal gaps between the roof and the stripe (facades). In the south the outer stripe reduces height until 1m – exactly to the scale of a handrail – picking up the visitor with an inviting gesture to follow the entrance ramp (Figure 4 and 7).



Figure 5: The digital 3d model in comparison to the realized structure

The described stripe was realized in prefabricated laminated wooden-panels. The form provides the efficient assembly of the doubled curved roof being a hyperbolic paraboloid. Straight wooden members with the diagonal roof boarding are statically self-interlocking the whole configuration.

The horizontal floor of the church - being at the same time the ceiling of the municipal centre below - is realized in concrete of 40cm thickness resisting the load bearing forces as well as providing enough mass for the concrete core heating.

Figure 6 shows the installation of the customized solar panels on the solar driven form. In the south 100m² of solar panels were fixed and in the west 30m².



Figure 6: Customized solar panels and the continuous glass layer above the hole building during installation

4. Source for Aesthetics

The form of the case study is – due to the jury of the Landesarchitekturpreis Salzburg [5] – the main quality of the project. Figure 7 shows the final result comparing the west façade during day and during night. The form is determined by the appropriate angle of the solar panels to the sun. The form is solar driven – as explained in chapter 3. There is a close relation of form and function. The solar panels are not added in the end, but they are the reason for the form of the architecture.

Lois H. Sullivan [6] wrote in the year 1896: “It is the pervading law of all things (...) of all true manifestations of the head, of the heart, of the soul, that the life is recognizable in its expressions, that form ever follows function.” In the contemporarily still ongoing period of deconstructivism and the increasing technical ability that every form can be produced in and as architecture, the desire and attention for a new kind of order is increasing nowadays. People discover and appreciate again the philosophy of autochthon architecture, where we can find an inner order based on a deep understanding of nature inherent laws.

Solar driven form-finding is a source to enrich contemporary architectural culture beyond the compact box and the widely spread compact court yard projects. Solar driven form-finding offers a clear order which provides a new kind of freedom and a close relation to our environment. This nature related forms may be appreciated aesthetically when they answer the architectural challenges in an integrated way.



Figure 7: Photos of the finished project, façade west during day (left) and at night (right)

5. Conclusion

Solar driven form finding is an inspiring source to let emerge aesthetic qualities.

The built case study proves that the Bohmian dialogue is a useful tool in a complex architectural design process to achieve a high level of holistic sustainability. The dialog at the very beginning – having the common aim in mind - allows a high level of fully integration of solarthermics.

6. Perspectives

The case study was built under a certain time and cost schedule, which didn't allow further research on a higher degree of integration of the solar technology and the homogenous façade. The perspective is to use the outer multifunctional design - glass layer in a closer configuration for solarthermics to avoid the double layering and the reduction of efficiency.

The challenges of holistic sustainable architecture can be solved only in a respectful collaboration of all disciplines. My perspective - being a lecturer for integrated design at the university Innsbruck since 2015 – is to contribute to a culture of holistic interactive research at universities [7].

7. References

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Project Team / Acknowledgments

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