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HEINZ ISLER – 50 YEARS OF “NEW SHAPES FOR SHELLS”

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THE ARCHITECTURE OF HEINZ ISLER

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ABSTRACT

The Swiss engineer Heinz Isler (1926-2009) is regarded around the world as one of the pioneers of shell structures. In his specific interest in shell form two concepts were melded: Lardy's concept of aesthetics and the universality of the natural laws. Out of this a form-oriented scientific organicism has emerged that, on one hand, coincides with the ideas of Violett-le-Duc and, on the other hand, reflects Alberti's thinking of concinnitas. It is argued that the all-encompassing importance of the laws of nature within Isler's thinking has limited his architecture.

Keywords: *Heinz Isler, shell structure, aesthetic concept, architectural concept, structural art*

1. INTRODUCTION

The Swiss engineer Heinz Isler (1926-2009) is regarded around the world as one of the pioneers of shell structures. In particular, he gained renown for his experimental, physical methods of form-finding (Figure 1) and the resulting expressive shell structures produced in thin-walled concrete. In 1959, at the first congress of the International Association for Shell Structures in Madrid, led by Eduardo Torroja, Isler debuted his methods of "the freely shaped hill, the membrane under pressure and the hanging cloth reversed" in the context of his presentation, "New Shapes for Shells." With this presentation he triggered an intensive discussion among his colleagues [1, p.16-20].

Apart from Torroja, other leading engineers, such as Nocolas Esquillan and Ove Arup, were also involved in the discussion, which revolved around three themes: the relationship between model and reality and the problem of scale; the difficulty of describing the resulting form and the associated problem of economic realizability; and the self-sufficiency of the form-finding methods with respect to architectural demands. While Isler addressed the first two themes in great detail in his commentaries, he largely ignored the question brought forth by Ove Arup regarding the integration of the architectural aspects [2, p.16]. For Isler, the forming of shells was a primarily technical problem whose solution would give way to the necessary architectural effect [3]:

> In the design of a building, some rules have to be observed: for instance, good proportion, simplicity, honesty, etc. The same rules are valid when designing a building with shells. The foremost task lies, in the opinion of the author, in leaving off everything that is not necessary. A well-shaped shell is such a dominant structure, that it needs no addition of other dominant elements. On the contrary it forbids them. The shell is the supporting structure and the space enclosure at the same time. So it cannot be but honest.

With this, Isler is implicitly formulating an architectural design attitude which is directly expressed in questions of the appropriateness of built form and the related means of construction necessary for this form. The appropriateness is understood here as an economy of means – as quantifiable entity and regularity that follows the laws of nature, and which sees a low consumption of materials and energy, as well as decades-long reduced need for maintenance combined with the greatest possible degree of covered space [4]. With this concept of appropriateness, Isler was able to realize almost 1400 shell structures in Switzerland alone and thereby shape the built landscape of his native country.

Figure 1: *Study of shell forms at Isler's office*

In general, Swiss architecture to this day is strongly influenced by a tradition of craftsmanship and construction in which precision and the appropriate consumption of materials were also always signs of efficient resource management. This specific form of efficiency also shapes the infrastructure of the country with civil engineering constructions such as bridges and tunnels. Examples of this understanding of efficiency are buildings of engineers such as Robert Maillart or Christian Menn – in their works the static necessity develops a formative power and as such reveals itself in the problem of loading and bearing as a form of architectural expression.

Isler's fundamental architectural attitude of appropriateness, therefore, is rooted deep in the cultural environment of Switzerland, and offers only an inadequate description of the specific quality in his work. This specific quality is much more manifest in Isler's pronounced interest in forms (Figure 1), which clearly sets him apart from the Swiss background. In contrast to the aspect of appropriateness that is at the center of most Isler reception up to this point, this paper will attempt to examine the outcome of this idea of appropriateness more closely, thereby bringing Isler's specific interest in form and the achieved architectural quality into the spotlight.

2. SHELLS AS AESTHETIC FORM

On long and lonely walks throughout his early youth, Isler developed an intimate and direct relationship to nature which would later shape his entire body of work. Natural shell shapes in particular piqued his curiosity and sense of wonder: mussels, egg shells, nuts, flower petals, and onion peels served as sources of inspiration for his creations (Figure 2). In these natural forms, he saw "stiffened shells, double-curved shells, rotation shells, flawlessly formed shells in countless variations, wafer-thin and still resistant." [5, p. 52]. In Isler's perception of natural forms in general, the shell constituted the dominant principle. According to Isler, the shell's shape is always optimal: "It is natural law, and therefore also the most ecological form in the universe." [5, p. 54].

Figure 2: *Isler's collection of shells*

Isler's experimentally generated shell shapes are the result of such natural laws, and, for this reason, can be built with a minimum amount of material while remaining resistant to tears and breaks. In the area of wafer-thin shell construction, Isler's love of nature and his interest in engineering come together. The solving of technical problems based on inspiration from nature, however, did not constitute Isler's primary goal in his dealings with shell construction; the solving of such problems was much more so the consequence of an aesthetic consideration of the supporting structure. Isler wrote: “Shell structures have an inherent capacity to express structural beauty…. The author, in 1954, discovered the virtually unlimited potential of non-geometric shell-shapes, which especially pleased him because of their high aesthetic value” [3, p. 149]. In this statement, the influence of Pierre Lardy, one of Isler’s teachers at the ETH Zurich, is clearly visible. For Lardy, “the full-scale structural design is permeated by aesthetics. Everything Lardy described began with aesthetics.” [2, p. 10].

In this way, Isler’s understanding of form was a sort of melding of two concepts: on the one hand, Lardy’s concept of an aesthetics of the supporting structure, and the universality of the natural laws on the other; they came together to form a concept of the “Wholeness of Being, phenomena and things, which would have important consequences for structural engineering: overall design instead of cutting all in parts” [2, p. 11]. In other words, an idea of unity within the process of building which is based on unity as it is found in nature, a first principle in the design process pulled out of the natural laws. Through Isler’s “Wholeness of Being,” a specific understanding of the design approach becomes explicit – an understanding that coincides strikingly with the ideas of Eugène Violett-le-Duc, who, a century earlier, had formulated this idea in his major work *Entretiens sur l’architecture*, published between 1863 and 1872. In it, he describes the principle of unity in nature as a guiding principle for design [6, p.34]:

> It is then that art intervenes and that the law of unity establishes itself, and establishes itself naturally, because everything in the created order exists only by means of unity of intention and conception…. The law of unity, therefore, is in the first place based on structure, whether in a hut or in the Pantheon in Rome. Nature does not proceed differently, and it is more than foolhardy to search for laws other than those she has established, or rather, it would be to try to withdraw from these laws, when we are a part of it…. In one word, creation is unity; chaos the absence of unity.

As with Isler’s design concept, in the design concept of Violett-le-Duc, the architectural aspects arise as a result of a focus on the technical aspects: architecture is an art of building which renders inseparable static logic on the one hand and the aspect of economics and pragmatic rules of production on the other; the coming together of these two generates a concise form of expression [7, p. 56-62]. As a result of his study of gothic architecture of the 12th century, Violett-le-Duc deduced that architecture must express the interdependence with nature; by way of a dialogue between form and forces, architecture must demonstrate the way in which it resists the effects of gravity. In this context, Isler’s experimental, physical methods of form-finding act as a sort of response to Viollet-le-Duc's demand.

Figure 3: *Isler’s office, Spring 2011*

Such a fusion of architectural thought and conceptions of nature is a recurring theme in the history of architecture (Figure 3) and, as a so-called organicism [8], was of particular importance for European architecture in the 19th century. Viollet-le-Duc's concept of unity thereby exists in a continuum of organic thought beginning in the Renaissance, and representing a version of Alberti’s idea of *concinnitas* [9, p. 51]. For Alberti, this constituted the absolute and highest law of nature – the *absoluta primariaque ratio naturae*. “Everything that Nature produces is regulated by the law of *concinnitas*…. Without *concinnitas* the critical sympathy of the parts would be lost” [10, p. 302]. For Alberti, *concinnitas* is the creation formula per se, from which results the rendering equivalent of the laws of nature with the laws of beauty, and therefore also with the laws of architecture: an equation which permeates Isler's organicism, too, and strongly influenced his understanding of form as well as the architectural thinking associated with it.

3. SHELLS AS ARCHITECTURAL FORM

Isler's view of the question of the form of shell structures as a primarily technical problem, as well as the associated architectural design concept of appropriateness, can be understood as the expression of his organicistic principle of the "Wholeness of Being," in which the creative impetus and the drive for construction are exchangeable – therefore, architecture and engineering ultimately comprise a unity: "Architecture and engineering are just two aspects of one thing" [11, p. 72].

This unity, however, is based on a classical, form-oriented understanding of architecture, and does not take into consideration a development within architecture in the early 20th century; this development saw the creative force moving away from questions of form and toward questions of space. With this, the absoluteness of the shape lost in importance to the relativity of the pattern of relationship [12]. This shift accelerated a process of division between architecture and engineering that had already begun during the age of industrialization with the introduction of new materials, which set in motion the new possibilities for construction and calculation which arose as a result [13]. In this architectural conception that is rooted in space, the constructive also remains a significant element for the formal arrangement and creative process – however, the constructive is no longer exchangeable with it. "Construction is a design medium of architecture; architecture, however, is an art of space [14, p. 10].

Following from this division, the definition of industrial building was established thus: as a building erected for a specific purpose, whose form is defined primarily by constructive, static and economic questions, and where the design of spatial relationships is of lesser importance. For Isler, the questions of construction, statics and economics may be central, but they do not represent the primary motivation for the design. Rather, they are the welcome consequence of the method of form-finding that is rooted in nature (Figure 4). For this reason, the engineering aspect does not constitute the chief concern of the design. His buildings therefore cannot necessarily be regarded as industrial buildings, even if the majority of his realized projects were used in as such. This is due to the fact that the primary field of application for shell structures was for industrial use up to the 1960's. It were Isler's buildings – such as the service station in Deitingen (1968), the Wyss Garden Centre in Solothurn (1962) or the supermarket in Bellinzona (1964) – which brought the shell structure into the public consciousness as a possibility for non-industrial application.

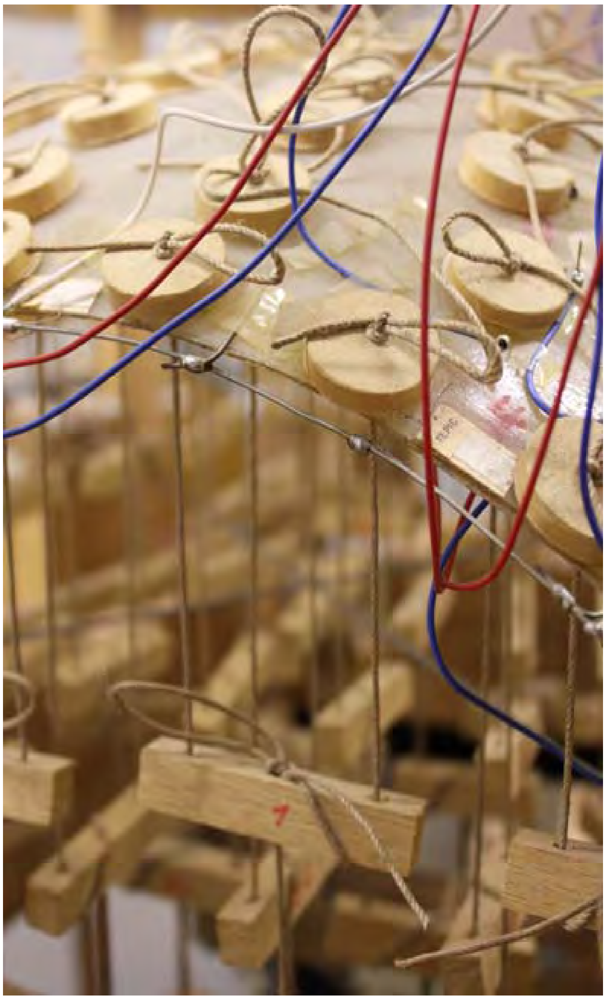

Figure 4: *Detail of model*

In terms of form, therefore, shells are a young phenomenon in the context of architectural history; as space-forming types, however, they can be seen as a variation of dome structures. Isler's shells generally operated without specific spatial differentiation; they are archetypical one-room-structures which span and mark an open space with a thin covering. Zones of varied spatial effect are produced as a result of the varying height of the space: while the space is compromised near the supports, it opens up towards the center. In the area around the supports in particular, an impression of connectedness with the ground is produced, in which the shell no longer seems a floating canopy, but rather a supported roof. Especially Isler's membrane shells, therefore, often appear introverted, closed, enshrouding in terms of perception of space. As a consequence, they contrast the impression of openness and lightness which the shell generates from the outside because of its elegant curved shape and minimal thickness.

The contradictory impression is further reinforced by the deep division between interior and exterior space produced by the pragmatically placed planar windowfront along the shells' edges. This defines a precise border which not only interrupts the spatial flow, but also, as a result of the change in the language of forms, is perceived as a foreign body. The same is true for the entrance situation, which normally does not develop in a self-evident or inherent way from the shape, but rather must be added on as an artificial element. Hence, in Isler's projects the spatial transition between inside and outside often constitutes a place of breakage; spatially, the building seems to be added on, rather than integrated. This is also true because the shell shape generated is understood by Isler as a pure, unchangeable form and expression of natural laws. For this reason, it experiences no later adaptation to the circumstances of the real place of construction.

Figure 5: *Water color drawing of shell by Isler*

Therefore, and particularly in an urban setting, the shell and the surrounding area often do not comprise a unified entity, or "Wholeness of Being." Isler was aware of this problem, as "[a shell] fits very well in natural environments…. If placed in a reasonable distance from cubic buildings it can also fit into urban or other manmade surroundings" [3, p. 149]. The correct environment for his shells is the most unchanged, most natural environment possible (Figure 5), because "its natural and harmonious form, found in the laws of nature, fits better with many natural landscapes than it does with other constructed forms" [4, p. 39]. According to Isler, only in the unadulterated landscape can the laws of nature truly harmonize with the laws of architecture and generate beauty.

This can be witnessed in projects like the nature theatre in Grötzingen. Because of the absence of spatial division, or by "leaving off everything that is not necessary" [3, p. 149], the space can flow freely between inside and outside, and subvert the shell's introversion. By way of the asymmetry in form, this introversion fits into the spatial environment, and the resulting differentiated opening behavior generates a spatial dynamic which further encourages the exchange between inside and outside.

4. CONCLUSION

Figure 6: *Heinz and Maria Isler*

Isler's experimental, physical design process can be regarded as a form-oriented scientific organicism – it is based on an idea of the all-encompassing importance of the laws of nature for building and reflects Alberti's thinking of *concinnitas*. The formal quality of the design concepts resulting from such a process generally fulfils not only constructive, static, and economical aspects from a classical engineering standpoint, but in many cases, fulfils aesthetic demands as well. The architectural quality of the design, however, is limited, and heavily dependent on the definition of the boundary conditions within the setup of the experimental form-finding.

Due to his firm belief in the universality of the natural laws Isler neither questioned nor bent the experimental set-up. This is in stark contrast to others carrying out comparable work, such as Frei Otto, who adapts the boundary conditions to the building context. Due to this conceptual rigidity, the full architectural potential of shell structures remained unrealized for Isler – a limitation that Otto clearly recognized [15, p. 0.5]:

> It is extremely difficult to carry out architectural design with the self-formation processes. The experiment does indeed lead directly to the form, which in itself has already passed through an optimization model, but a design work can only be seen with reference to the complexity of a building project and to the way the building integrates into its surroundings and into society.

From this perspective, Isler's shell structures can only be viewed as pure industrial buildings, albeit industrial buildings with high aesthetic quality. This quality is the result of a well-defined forming process whose richness of form Isler tirelessly studied over the course of a number of decades. Looking back, his well-known sketch "natural hills on different edge lines" from his presentation at the first Congress of the International Association for Shell Structures in Madrid can be read as the description of his life's work: the investigation into the variation of possible shell forms as an aesthetic exploration of the natural laws in action – a continual search for *concinnitas*. It is from this perspective that Heinz Isler (Figure 6) truly must be regarded not only as an engineer, but as a structural artist [2].

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