

## ALLURE OF THE "CRYSTAL: MYTHS AND METAPHORS IN ARCHITECTURAL MORPHOGENESIS

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### Abstract

*'Form' has always been one of the most important issues in architectural design. In the process of form-giving to the end-product, architects make use of different sources from typologies to intuitions or metaphorical ones. When the generic ideas of the prominent examples in architectural history have been traced, it can clearly be stated that one of the most effective metaphors used in architecture is the 'Crystal.' Appearing at the intersections between nature and human history and having a long history going back to myths, the 'Crystal' has been used extensively in architecture both as reflecting the meaning originating from its mythical background, and also, as a metaphor representing the perfection in nature. This article will try to trace the use of 'crystal' metaphor in history and analyzing the two examples, namely, the Royal Ontario Museum: 'Crystal' in Toronto (2007) by Daniel Libeskind and Musée des Confluences: 'Crystal Cloud of Culture' in Lyon (2014) by Coop Himmelb(l)au, will try to evaluate the change in the use of crystal metaphor in contemporary architectural morphogenesis.*

**Keywords:** *Crystal; Myth; Metaphor; Nature; Morphogenesis*

### INTRODUCTION

Crystal is one of the most sophisticated inorganic structures of nature which is repeatedly used in the past and still continues to be a significant source in the architectural form-giving process. An overview of the history reveals that crystal and crystalline formations have been used both literally and metaphorically in all arts and architecture from Antiquity up until today. The meanings attributed to crystals and the way they were incorporated into design process have varied in different periods of architectural history. They have come forward either as a reflection of a myth or as a symbolic metaphorical relationship representing transformations in social life and technology taking its cues from 'nature'. This timeless allure of the 'crystal' has been accepted as coming from its symbolism. It is the symbol of 'perfection', 'purity' and 'clarity' in the form derived from inorganic nature; the symbol of transformation from 'life to death', and also, the symbol of the 'organic' or 'living' with its potential to generate new forms of life. In contemporary architectural practice, crystal metaphor still continues to be an important symbol of natural processes in the morphogenesis of architectural end product. In other words, 'nature', once a source of inspiration for imitation by analogy, has become a source with its inherent principles discovered by scientific developments for the genesis of architectural form through computer based parametric design generations.

### The Genealogy of Crystal Metaphor

Peter Behrens (1868-1940) explained the meaning of crystal as:"the symbolism of the crystal relies on a metaphorical relationship between transformations which take place at the micro- and macro- cosmic levels; for example, just as mere carbon under intense conditions assumes a particular crystal structure and becomes the prized diamond, so the power of art may transform everyday life into a resplendent life filled with meaning" (Anderson, 2002, p. 50). In this respect, he used crystal symbol for the opening ceremony of Exhibition for Darmstadt Artists' Colony in

1901. Although it was not an architectural example, the crystal symbol was used in the meaning of "metamorphosis of everyday life into a heightened artistic experience" (Bletter, 1981, p. 31). The most celebrated architectural example of 'crystal' in history is Crystal Palace (1851) which is accepted as "...a revolution in architecture from which a new style will date" (Giedion, 1967, p. 251), and in Lothar Bucher's words "all materiality blend into atmosphere" as cited in Giedion's famous book *Space, Time and Architecture* (Giedion, 1967, p. 255). Although named as crystal, the idea in the generation of form in Crystal Palace was not derived from the crystal form and idiosyncrasies of crystalline formations; instead, the technological advancements of the age used in garden structures of the period - iron skeleton and glass cladding were more effective in design. Paxton used the features of glass as 'transparency', 'lightness' and 'the ease of rationality in production' in his design. Crystal Palace was a real technological breakthrough in linear tectonics and the rationalized production techniques of the period, but, Ruskin criticized Paxton's design as "the New Crystal Palace as the poetical public insists upon calling it, though it is neither a palace nor of crystal..." (Ruskin, 2009, p. 96). In fact, these qualities, 'transparency and lightness' which were the prime motivation behind the use of glass in Crystal Palace were also the reason behind many glasshouses built at the end of the Seventeenth Century without any reference to mythical or metaphorical background. Glass became a favourite building material with its clarity and quantity of light in the age of enlightenment and rationalism instead of 'the aura of mysticism obtained by stained glass' in Gothic interiors (Hisham, 2006, p. 8). In the Nineteenth Century, glass developed to be an indispensable complementary building material in iron skeleton systems in glasshouses due to the developments in the glass industry such as *Jardin de Plantes* (1833), *Munich Glass Palace* (1834), *Palm House in Kew Garden* (1844).

The second recurrence of the crystal and crystalline forms as a metaphor appeared at the beginning of the Twentieth Century among German architects who sought to create an architecture free from traditional norms and constraints of the Nineteenth Century Schinkel tradition within utopian expectations in search for a new society against the political turmoil and social upheaval after the First World War. The idea of new architecture had expanded among architects belonging to a circle named as *Crystal Chain* (*Die Gläserne Kette*), generally referred as 'Utopian Correspondence' initiated by Bruno Taut, who signed his letters to friends with the pseudonym *Glas*. Taut designed *Glass Pavilion for Werkbund Exhibition in Cologne* just before the outbreak of First World War. Affected by his ideas about glass architecture, Taut dedicated this building to his friend, poet Paul Scheerbart, who is known for his book *Glasarchitektur* (1914) written with the inspiration under the effect of the glasshouse of the *Dahlem Botanical Gardens* in Berlin. The *Glass Pavilion* reflecting the ideals of the new architecture became the symbol of German Expressionism after the War. Taut, had linked the domed shape of his glass Pavilion with crystalline forms in his explanatory report as: "The large dome that resembles rhombohedron of crystal in its form, is composed of glass planes between ferroconcrete ribs and rests on iron-reinforced support, which comes out from a concrete scale" (Yamini-Hamedani, 2009, p.101). Rhombohedron crystal form was also used by *Violet-le-Duc*, in one of his drawings in which he juxtapose rhombohedrons of granite crystals with hexagonal crystals of volcanic basalt (Donahue, 1995, s. 50).

Taut's statement 'the Gothic Cathedral is the prelude to glass architecture' and one of the Scheerbart's couplets written on the plinth as "Light permeated the Universe/ It comes to life in crystal" (Scheerbart, 1972, p. 14) reflected Taut's interest both in mythical and spiritual meaning embodied in 'glass' architecture and also in debates of the Nineteenth-Century about the nature as a source of inspiration in architecture. What Scheerbart and Taut hoped for from 'Crystal Culture' was a new morality for the society (Pehnt, 1973, p. 74). Adolf Behne, who had hailed 'the alluring beauty of the ideal' - 'the ideal of glass architecture,' saw a delightful fragment of his ideal in the pavilion built for the glass industry (Pehnt, 1973, p. 75). He wrote in a 1915 review of Bruno Taut's architectural projects: "The longing for purity and clarity, for glowing lightness, crystalline

exactness, for immaterial lightness, and infinite liveliness found in glass a means of its fulfilment—in this most bodiless, most elementary, most flexible, material" (Bletter, 1981, p. 34). Crystal, representing the ultimate and the supreme, became the symbol for this new architecture, named as Expressionist Architecture by Behne in 1915. This architecture, contrary to the Paxton's Crystal Place, "...has no other purpose than to be beautiful" according to the pamphlet prepared by Taut for the visitors of the Glasshaus (Ersoy, 2007, p. 240).

In search of the background of German Expressionist Architecture appearing at the beginning of the Twentieth Century, Rosemary Bletter traces the mythical origin of glass back to King Solomon referring to Old Testament, Biblical descriptions, and Koran. King Solomon is said to have built a palace of glass (with glass floors). When Queen of Sheba, not knowing with the illusory effects of glass architecture, upon entering Solomon's palace: (Bletter, 1981, p. 23) "...when she saw it, she thought it was a body of water and uncovered her shins [to wade through]. He said, "Indeed, it is a palace [whose floor is] made smooth with glass." She said, "My Lord, indeed I have wronged myself, and I submit with Solomon to Allah, Lord of the worlds" (Koran 27:44).

According to Bletter, the meaning of glass architecture and its suggestion of shimmering water is quite direct and literal in Solomon's Legend (Bletter, 1981, p. 25). On the contrary, both glass and crystal, which has been used interchangeably, represented a spiritual meaning and superiority as a result of their symbolic metaphorical consideration in later examples.

The Crystal metaphor reappeared in German Expressionist architecture, coincided with a paradigm shift 'from the history-based approaches of the Nineteenth Century into the Twentieth Century visions of abstract' (Inceköse, 2006, p. 10). Especially, following the publishing of Wilhelm Worringer's book 'Abstraction and Empathy' (1907) and later 'Problems Of Form in Gothic Art' in 1911, architectural discourse centered around the idea of abstract in art and architecture and the 'crystal' form was accepted as true reflection of the natural order as Gothic architecture did. It is stated in his book *Words and Buildings* by Adrian Forty that "for most of the last five hundred years 'nature' has been the main, if not the principle category for organizing thought about what architecture is or might be" (Forty, 2012, p. 220).

Although addressed from different perspectives, or in some periods, the superiority of human being over nature has been accepted as a result of worldview, nature has been a creative repertoire in the formation of built environment from Antiquity up today. In the Eighteenth Century, architects interested in the processes and the rules of the nature for imitating as the origins of built form, like Leon Battista Alberti, in search for the organizing rules in the harmony of parts, as expressed in his book *De Re Aedificatoria* (mid 15th C), Vitruvius's myth of first building in *De architectura*, or Abbe Laugier's *Primitive Hut* (1753).

Nature was one of the prime concerns in art and philosophy also in the Nineteenth Century. Together with an increasing interest in Goethe's natural history studies, Goethe's interests in both crystal formation and plant 'morphology' influenced not only the German architectural theory but also philosophy. In his book, *The World As Will And Idea* (1851), Schopenhauer, referring many times to Goethe, asserted the role of crystal in the formation of life and also its unity: ".....the crystal has only one manifestation of life, namely its formation, which afterwards has its fully adequate and exhaustive expression in the coagulated form, in the corpse of that momentary life" (Schopenhauer, 1969, p. 155) and also: "in the inorganic kingdom of nature all individuality completely disappears. Only the crystal can still to some extent be regarded as individual; it is a unity of the tendency in definite directions, arrested by coagulation, which makes the trace of this tendency permanent. At the same time, it is an aggregate from its central form, bound into unity by an Idea" (Schopenhauer, 1969, p. 155).

In the Nineteenth Century, as a result of scientific studies of mineralogy and history of the natural world's own formation- Geohistory, an accumulation of a new knowledge on both forms of the earth's surface and also of the underlying unities of the diverse forms of nature like crystals and plants affected all arts and also the architectural discourse. The architectural discourse's

increasing interest in natural sciences with the tendency toward implanting theories, concepts and methods derived from natural sciences in architectural form-giving process reflected itself in the unconventional arguments in seminal works of three figures' at the beginning of Nineteenth Century: John Ruskin's (1819-1900) *The Seven Lamps of Beauty* (1849) and *Stones of Venice* (1851), Eugenie Viollet-le-Duc's (1814-1879) *Dictionnaire Raisonné de l'architecture française* (1856), and Gottfried Semper's (1803-1879) *Der Stil* (1860). Although they considered nature from different points of view, all three architects referred to crystal and crystalline forms. Semper, referring to geological formations using crystal metaphor for clarity and homogeneity stated that: "...just as the splendid marble that gives shape to the coasts and cliffs of Greece - notwithstanding its homogeneous formation- betrays its sedimentary origin through veins, scattered fossils, and other signs embedded in it, Hellenic art cannot deny its secondary origin. It too reveals to the observer all the deposits that form its material base but that, in a great metamorphosis of a whole people, rushed together from their sedimentary conditions into a crystal-clear homogeneity" (Bergdoll, 2007). In a similar way, fascinated with the Alps, both Ruskin and Viollet-le-Duc undertook extensive studies of the mineralogy and geology of the Alpine earth formations. Ruskin's exquisite watercolours of 'Fragment of the Alps' and by Viollet-le-Duc's studies of the glaciers of the High Alps outside Lausanne (Bergdoll, 2007) influenced art and architecture extensively that can be traced in Caspar David Friedrich's *Sea of Ice* (or *Arctic Shipwreck*) (1823-4) and in Walter Gropius's *Memorial to March victims in Weimar* (1921). (Figure1)



Figure 1.(Left) C.D.Friedrich's *Sea of Ice*, (1823-24) (<http://www.wga.hu/art/f/friedric/3/309fried.jpg>); (Right) Walter Gropius; *Memorial to March Victims in Weimar* (1921). (<https://www.pinterest.com/pin/452048881324350949/>)

Both Viollet-le-Duc and Ruskin sought analogies between natural formations and architecture especially with Gothic. Ruskin objecting the straight line's being at odds with nature, he discusses: "to find right lines in nature at all we may be compelled to do violence to her finished work, break through the sculptured and colored surfaces of crags, and examine the processes of their crystallization" (Donahue, 1995, s. 50).

In *Stones of Venice*, Ruskin stated that "(but) against crystalline form, which is the completely systematized natural structure of the earth... The four-sided pyramid, perhaps the most frequent of all natural crystals, is called in architecture a dogtooth; its use is quite limitless, and always beautiful ... and all mouldings of the middle Gothic are little more than representations of the canaliculated crystals of the beryl, and such other minerals" (Ruskin, 2009, p. 226).

Bruno Taut's famous book, named as *Alpine Architecture*, illustrating his ideals for a utopian future also explains the continuity of thoughts on nature behind German Expressionist Architecture. Although their utopian designs for glass buildings in 1920's couldn't find the

opportunity to be realized, the crystal has become the symbol of Bauhaus, most significant architectural movement in history, influenced by the ideas of Taut and Glass Chain. In the program pamphlet for opening speech in 1919, Walter Gropius explained the aim of the regeneration of German visual culture through the synthesis of arts and crafts as: "Let us create a new guild for craftsmen, without the class distinctions which raise an arrogant barrier between craftsman and artist. Together let us conceive and create the new building of the future, which will embrace architecture and sculpture and painting in one unity and which will rise one day toward heaven from the hands of a million workers like the crystal symbol of the new faith" (Curtis, 1996, p. 184). The cover of the program illustrated by Lyonel Feininger included a woodcut expressing a crystal cathedral, an allegory of the total work of art which represented the three arts of painting, sculpture and architecture as a symbol of social unity (Droste, 1993, s. 19). To summarize, a direct and literal use of glass in Solomonic myths has been transformed into a crystal metaphor for a new social order and salvation for architects. However, Bauhaus drew away from the complex and subtle ideas of Expressionist architecture fulfilling the demands of industrial productions and the functionalist approaches in design within the socio-political context of the age

The Crystalline forms faded from view during the political shifts of the early 1920's. Siegfried Gideon evaluated German Expressionism as: "The Expressionist influence could not perform any service for architecture" in his famous book *Space, Time and Architecture* (Giedion, 1967, p.485). On the contrary, parallel to the form priority approaches of 80's, as a reflection of the search for perfect form and geometry, crystal metaphor reappeared in the form-giving process. The *Crystal Cathedral* (1980) which has been designed as a religious monument with an appearance of a transparent four-pointed crystal by Philip Johnson and John Burgee, explained as hinted by the Bauhaus Manifesto illustrated by Feininger's woodcut: "the crystal symbol of a new faith."

When the latest examples of the architectural practice are analyzed, it is clearly seen that the Twenty-first Century has inherited the growing fascination for the crystal metaphor both in naming and in the visual appearance of the end-products. UFA Cinema Center in Dresden (1998) by Coop Himmelb(l)au; Denver Art Museum (2006), massive crystalline addition to existing Royal Ontario Museum (Michael Lee-Chin Crystal) in Toronto (2007) and Crystals at City Center, in Las Vegas (2009) by Daniel Libeskind; The Basque Health Department Headquarters by Coll-Barreu Arquitects in Bilbao (2008), and Musée des Confluences in Lyon by Coop Himmelblau (2014) ; and Soyak Crystal Tower in İstanbul are only some of the prominent examples that make use of the 'crystal metaphor'. All these examples bring to mind the following question: are the expressionist design approaches accepted as 'crystal utopias' at the beginning of the Twentieth Century coming to real with the help of technological advancements as in farsighted words of Otto Kohtz as early as 1909: "It is highly possible that later generations will achieve such mastery of materials and technique that they will construct a building or a landscape for no other purpose than that of contemplation, simply out of a desire to create in a particular mood, rather in the way that many pieces of music are written today" (Pehnt, 1973, p. 9).

### Contemporary Use of Crystal Metaphor in Architectural Morphogenesis

Following the exhibition of *Expressionist Utopias: Paradise, Metropolis, Architectural Fantasy* in Los Angeles in 1993, the Crystal metaphor has emerged back from the memory, and the stunning design of the exhibition by Wolf D. Prix provoked architects' attention into Expressionist ideals of the 1920's.

In 1998, Coop Himmelb(l)au architectural office of Wolf D. Prix designed The UFA Cinema Center in Dresden. The UFA has displayed similarities with the visionary design ideas of the German Expressionism. The building, characterized by two intricately interconnected units: The Cinema Block– with eight cinemas and the Crystal- a glass shell which serves simultaneously as the foyer and public square, has been expected to be "a crystalline lamp displaying a series of

complex and fragmented images to the city" (Heathcote, 2001). The contrast of lightness and sparkling brilliance of huge walls of glass and the heavy concrete structures containing the auditoria which anchor the building to the earth reinforce this notion of the revival of Expressionist imagery, of the building as a crystal cathedral rising mystically from the solid rock of the earth (Heathcote, 2001, p. 91) (Figure 2).



Figure 2. (Left) The UFA Cinema Center, Dresden The Crystal from outside; (Right) The Crystal from inside (Devrim Işıkkaya, 2012).

Coinciding with the Deconstructivism in architectural discourse, the attractive and unusual geometries proliferated at the beginning of the Twentieth Century. Libeskind designed a massive expansion to the Royal Ontario Museum: ROM, in Toronto. Named as 'The Crystal', the museum is simply an assemblage of five giant cubes in between two historic stone buildings. Thinking about the museums' role in rebuilding and revitalizing cities, Libeskind designed ROM with an unusual geometry to create public attraction and activity point. The 3-Dimensional intersection of predefined regular forms creates an enclosure for 'a multilevel space created at the intersection between the crystals' (Stanwick, 2007) in which the reclaimed natural light through the refracted spears piercing the cubes create a spacious effect. In ROM, The Crystal, on the contrary to the precedents of crystal metaphor, don't carry the characteristics of illuminating its environment with its gleaming crystal's "purity and clarity" and "infinite liveliness found in glass" as Behne stated in defining German Expressionism (Figure 3).



Figure 3. The Royal Ontario Museum:ROM, in Toronto (2007) by Daniel Libeskind

(Azan Kozbe, 2015).

On the other hand, both The UFA and The Crystal- ROM are the prominent examples of a changing form paradigm that started to challenge the everlasting use of Cartesian space understanding in the form-giving process.

Today, a new paradigm of form as well as the idea of space developed in architecture as a result of the advances in digital technologies and modelling techniques. Paralleled with the changing environmentalist attitudes to the relations between human beings and nature, stimulated the alternative approaches, 'employing techniques and processes outside the mainstream of industrial production' (Forty, 2012, p. 238), 'nature' has become a new source of architectural quality. As a result of incorporating the volumetric matrices, growth, adaptation, pattern derivations as in nature, a shift in form paradigm transformed the architectural design from a form-giving act into a designing of a form-finding process. The new architecture, freed from Cartesian space understanding with the help of digital design processes, therefore, has also changed the idea of form. The current technological advances allow architects to use computers and digital tools for generating forms, in other words, morphogenesis. The concept of morphogenesis, originating from biology in the Nineteenth Century and transferred to the Twentieth Century by geology, is understood as a group of methods that employ digital media not as representational tools for visualization but as generative tools for the derivation of form and its transformation. Digital morphogenesis in architecture bears a largely analogous or metaphoric relationship to the processes of morphogenesis in nature, sharing with it the reliance on gradual development but not necessarily adopting or referring to the actual mechanisms of growth or adaptation (Roudavski, 2009, p. 348). In morphogenetic processes of design, instead of fitting into a predetermined form as in form-priority design paradigm, designers develop a generative model which proposes many alternatives for the designer to choose. Therefore, design process becomes a form-finding process among the numberless variability: "The plan no longer 'generates' the design; sections attain a purely analytical role. Grids, repetitions, and symmetries lose their past *raison d'être*, as infinite variability becomes as feasible as modularity, and as mass-customization presents alternatives to mass-production" (Kolarevic, 2005, p. 13). The computational derivations out of nature have made possible even large scale complex structural productions like the Bird's Nest (2008), Water Cube (2007), and CCTV Headquarters Building (2008) in Beijing. All these projects taking inspiration from nature have created a new understanding of form. They also became the examples of mass-customized production operating through the logic of optimization with the use of digital morphogenesis.

Digital morphogenesis, or in other words, the new form paradigm as form-finding has also been applied to the designs with Crystal metaphor. In this new approach, crystalline aesthetic has developed to be meaning fractures, reflections, imperfections as in natural processes instead of accepting the beauty of a predefined perfect crystal form, parallel to the change in the evaluation of nature as a process. Nature and natural processes and crystals are still the main sources of inspiration in design. Deleuze and Guattari affected the architectural discourse as: "We took as our point of departure cases of this kind on the geological stratum, the crystalline stratum, and physicochemical strata, wherever the molar can be said to express microscopic molecular interactions ("the crystal is the macroscopic expression of a microscopic structure"; the "crystalline form expresses certain atomic or molecular characteristics of the constituent chemical categories") (Deleuze, 1987, p. 57).

Always in search for dynamic space, fluid context, vibrant representation of life, and vitality, Austrian Firm Coop Himmelb(l)au designed Musée des Confluences (2014) in Lyon. The Museum is one of the contemporary examples of the Crystal metaphor in architecture that also makes use of the morphogenetic process in design. The Museum, taking its name from its site known as the "Pointe du Confluent," has been built on an old industrial area at the intersection of the Rhone and Saone rivers with the purpose of revitalizing the devastated industrial area. Taking its cue

from its special site, the Confluence, Museum becomes a point for encounters between natural and man-made nature, science and art, education and recreation to fulfill its founding 'mission of increasing and disseminating knowledge among mankind.' (Couturier, 2014, p. 25) The building embodies three heterogeneous components as the Crystal, the Cloud, and the Plinth, bringing the earth and sky together within "progressive differentiation" in Manuel DeLanda's terms without homogenizing the parts (DeLanda, 2002, p. 14). Displaying the organic unity in the form of assemblages, Museum is expected to be a "Crystal Cloud of Culture" for the City of Lyon. (Figure 4)

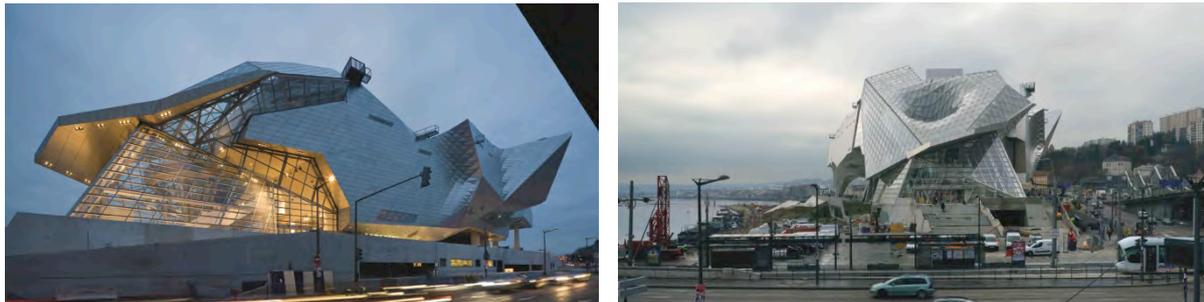


Figure 4.(left) "The Crystal Cloud of Culture": Lyon; (Right) Entrance Hall, (© Duccio Malagamba, 2014) Musée des Confluences (2014) by Coop Himmelb(l)au.

The Crystal, housing the entrance hall, brings together the museum and the city and its immediate environs as an urban forum and connect entrance hall to exhibition spaces through the vertical circulation space. Entrance hall's crystalline form is completely structured by glass and steel. Wolf D. Prix explains the essence of the design as the 'concept of fluidity' that is derived from turbulence created by the flow of the two rivers confluence at the tip of the land. The flow starts from the river, continues into the entrance hall hosting the multi-faceted crystal structure that is constructed out of rectangular steel tubular frames carrying the transparent glass panels. Crystal's multifaceted planar surfaces supported by steel and glass structure transforms at one point into a curvilinear vortex touching the ground, as a supporting element called 'gravity well' (Figure 5).

By virtue of digital computational techniques, transformation of the 2-dimensional planar surface's rational grid structure into a 3-dimensional grid to create a support displays the morphogenetic character of the design process. The Cloud, hovering above the ground contains the exhibition spaces as Black Boxes. A grid system also continues within the Cloud creating multifaceted geometries, covered with metal sheets in contrast to the transparency of the Crystal's glass-panelled surfaces. As a result, the emergence of a form generating multiple reflections and visions both from the inside and outside, day and night, adds to the vitality of the city, similar to the Expressionist ideals. In fact, Wolf D. Prix has criticized the Expressionist architecture as "representing an insufficient level of formal achievement", although he has accepted influence on their design approach (Benson, Dimendberg, Frisby, Heller, & Kæs, 2001, p. 180). Departing from the regular forms with the help of digital technologies creating asymmetric, dynamic, multifaceted three-dimensional forms, crystal metaphor in contemporary architecture has become the symbol of three-dimensional dynamization of space. Adding 'movement' with the inclusion of human being into space, the crystal has been transformed from inorganic to organic living organism (Figure 6).



Figure 5. The Gravity Well: Entrance Hall, Musée des Confluences (2014) by Coop Himmelb(l)au, Lyon (© Duccio Malagamba, 2014).

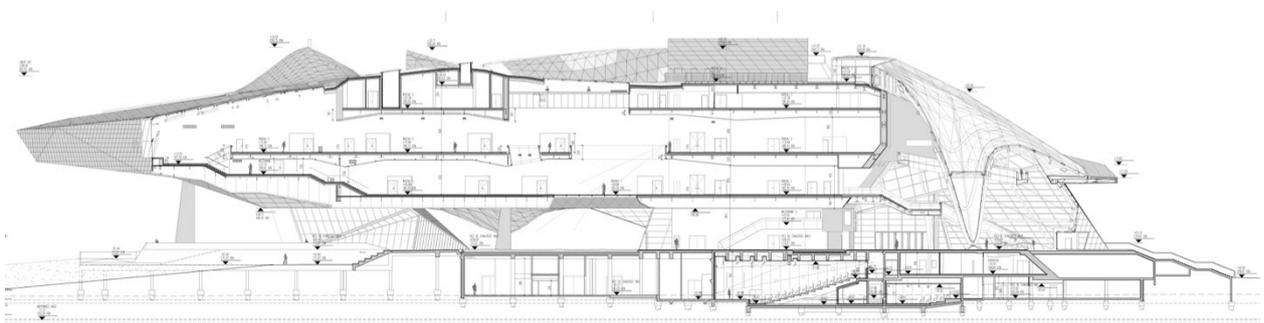


Figure 6. Musée des Confluences, Section (2014), (© Coop Himmelb(l)au).

## Conclusion

This paper aimed at evaluating the transformation of the crystal metaphor from glass- a transparent and lightweight building material used as a cladding, to an architectural form representing the esoteric roots and the idea of perfectness, and finally the state-of-the-art approaches as crystalline formations in form-finding processes. Crystal metaphor has always been an important generic idea in design, either as a representation of a myth or as a metaphor reflecting the idea of perfectness, purity, and transformation derived from the 'nature' that is a source of inspiration either for imitation or driving the laws of order. The use of crystal metaphor traces a discontinuous emergence at the intersections between humanity- natural history and architectural thought, where the 'nature' has been accepted to develop human experience in creating arts. Since "mere imitation of natural forms and objects would achieve..... inferior and derivative beauty" as Ruskin stated, rejecting imitation advocated the "acceptance of sources of delight from nature" in the power of mental expression in architecture.

The confluence of humanity, nature and architecture also coincide with the intersections of art and natural sciences in history like geohistory, mineralogy where the ordering laws of nature discovered. In the contemporary world, harnessing the digital technologies in the generative process, a whole new world of formally and spatially different, fluid, dynamic digital designs, other than Cartesian space, has developed.(Figure 7)

Unfortunately, many architects incorporated natural forms from biology or zoology just for the sake of visual similarities to nature. On the other hand, the experimentation with natural forms and processes are the topic of many articles in recent years. Roudavski gives a detailed information on the studies related to natural morphogenesis in architecture. He discusses about the difference of the biomimetics and the bioinspiration which emphasizes "indirect and multiplicitous characteristic of knowledge transfer between biology to architecture" (Roudavski, 2009, pp. 365-368). Most of the digital morphogenesis studies have concentrated on material performance over appearance, and on processes over representation (Leach, 2009, p. 34).

The reuse of patterns and tessellations inspired from the patterns of nature applied to many architectural designs like pinwheel aperiodic tiling of Federation Square (2002), Serpentine Pavilion by Toyo Ito or Voronoi tessellations are not only mere skins but also spatial designs.

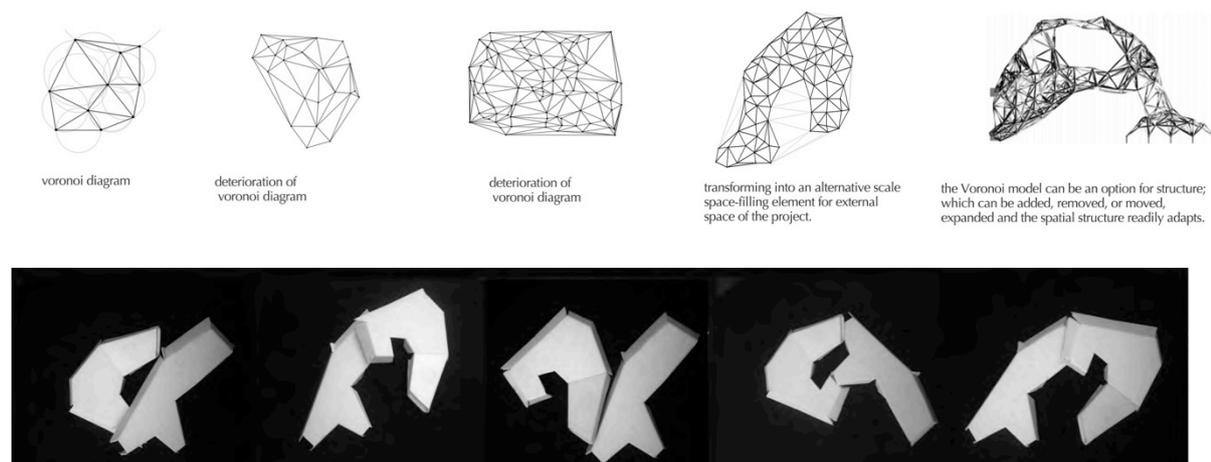


Figure 7. Voronoi Tessellations and alternatives for masses for an Aviation Museum Project by Öykü Arda, Graduation Project at Bahcesehir University (Source: Author).

Furthermore, modelling three dimensional forms using polygonal meshes, usually made up of triangles and quadrilaterals or deformed meshes with straight lines has ended in multifaceted continuous surfaces and spatial continuities as well. The new modeling technique making use of

curves –NURBS, instead of straight lines together with the developments in evolutionary biology used in digital design and fabrication paved the way for more natural, adaptive and transformative architectural morphogenesis.

The Crystal's structural system in Musée des Confluences shows how the rectangular mesh transforms into a curvilinear surface creating a flow of outer space into interior creating a structural element. Therefore, differentiating from other architectural examples still accepting the formal analogy of crystal, Musée des Confluences shows the development one step further approaching to natural morphogenesis in the 'becoming' process.

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