

## Data Reshaped: Literalism in the Age of Digital Design and Architectural Fabrication

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The architectural discourse on 3D production has often asserted that processes of digital fabrication eliminate the need for conventional builders in architectural production.<sup>1</sup> Today, architects can design their ideas as a 3D virtual model and then fabricate the design without requiring conventional builders. Instead, they might only use fabrication tools such as 3D printers, CNC machines, laser cutters, robotic arms, and so forth to realise their ideas in material form, thus eliminating the involvement of builders in the process. This recalls the claim made by one of the principals of the Dutch architectural firm ONL, Kas Oosterhuis, who said that 'parametric detail is the core of a building process that takes the architect's data and produces it *directly*, a process we call "File to Factory"'.<sup>2</sup> Emphasising the direct nature of this process (the italics are in the original quote), Oosterhuis addressed his firm's fabrication of the Acoustic Barrier in Utrecht, the Netherlands. In this project, ONL attempted to directly fabricate building parts from the 3D virtual model without subjecting them to any abstraction or modification of the digital drawing. [fig. 1]

When Oosterhuis made the abovementioned statement shortly after the turn of the millennium, fabrication tools were not as advanced as they are today. In this forward-looking statement, Oosterhuis delineated tendencies within digital architectural research and development, even though the existing technologies were not yet able to provide solutions for the fabrication of emerging design ideas. Today, more than a decade later, technologies that allow

a designer to send a file directly to a factory and have it fabricated without conventional builders or building techniques are increasing in number and availability. Enrico Dini's invention of the D-Shape, which allows the printing of 'full-size sandstone buildings to be made without human intervention, using a stereolithography 3-D printing process that requires only sand and special inorganic binder to operate', is a milestone in the effort to bypass conventional building techniques and develop a file-to-factory (FTF) fabrication process.<sup>3</sup> [fig. 2]

Like many of their contemporaries, Oosterhuis and Dini did not have an explicit ideology that called for the elimination of the middlemen, namely, the builders and fabricators who stood between the architect-designer and the end result. They only wanted to capitalise on digital design technologies and their ability to merge the design and fabrication processes. As Oosterhuis declared at an ACADIA conference in 2004, 'File to Factory refers to the seamless merging of the design process into fabrication. It involves direct transfer of data from 3D modelling software to a CNC (Computer Numerically Controlled) machine. It employs digital design and fabrication strategies based on computational concepts.'<sup>4</sup>

While not yet common as a building procedure, and mostly examined in unique projects and academic contexts, the merging of design and fabrication processes looks likely to become increasing widespread as technology continues to advance.

This is because the conflation of design and fabrication does not end with eliminating builders from the fabrication process. It also leads to a diminished need for other professionals, including engineers, during the design process, mainly because FTF implies a direct connection between architects and fabrication processes. The interim stages that traditionally were carried out by engineers are all integrated into one phase. Thus data and knowledge previously provided by engineers and other professionals must now be considered by architects in the initial design phase. Using advanced software, architects today are able to dynamically calculate a design's structural properties, plan a building's climatic attributes, or assess a structure's sustainable performance. A case in point: whereas before the advent of digital design, architects did not necessarily or directly address a design's structural aspects, but only understood its general structural principles, now they can calculate various aspects of its structural performance. As FTF design processes have become more comprehensive, architects are able to integrate more data during the design process – even before the design is completed and sent to a factory.

Advanced software tools that can perform various tasks were developed to assist architects in integrating knowledge and data that had previously been provided by builders or engineers. For instance, Dr. Clemens Preisinger of the University of Applied Arts in Vienna, together with the Vienna-based structural engineering office Bollinger-Grohmann-Scheider ZT GmbH, developed the software Karamba, a plug-in for Rhino and Grasshopper software. Karamba 'provides accurate analysis of spatial trusses and frames, and is easy to use for non-experts'.<sup>5</sup> Karamba has helped architects to calculate the structural properties of complex surfaces and morphologies. Previously, when using advanced software that enabled them to design multi-curved surfaces and 'oddly shaped' structures, architects did not always know whether

their designs would contain all the structural properties necessary to enable the design to stand. Karamba has resolved this problem and allowed designers to dynamically calculate the structural properties of a work-in-progress during the design process itself. In this fashion, architects are able to develop complex morphology and eliminate doubts about whether it will hold together or not.

The mobilisation of data integration in the design process and the emergence of new digital fabrication technologies have led to a shift in the perception of architectural data. Before the advent of digital design processes, architects generated their designs in 2-D drawings and sketches, as well as 3D physical models. The drawings, sketches and models were representations of ideas, buildings or other elements that were meant to be realised at a later stage. Generally, these representations already integrated knowledge that was provided by other professionals, including engineers; nevertheless, all of them represented designs that would only be realised sometime in the future. Once completed, these representations were then used by builders to bring the designs into material being. Yet architectural representation could never integrate the full range of data necessary for the realisation of a design. Even if the representations were highly detailed, builders and fabricators always had to introduce more data in order to construct a design represented only in drawings and models.

With the advent of digital design processes and the elimination of builders from the realisation process, almost no new data is introduced between the design process and its realisation in the fabrication process. The allographic distance between notation and execution is annulled. As Oosterhuis claimed, the same data that is used for 3D virtual modelling is also used for fabrication so that design and fabrication both stem from the same data and are directly connected. In that respect, 3D virtual modelling does not represent a future realisation;

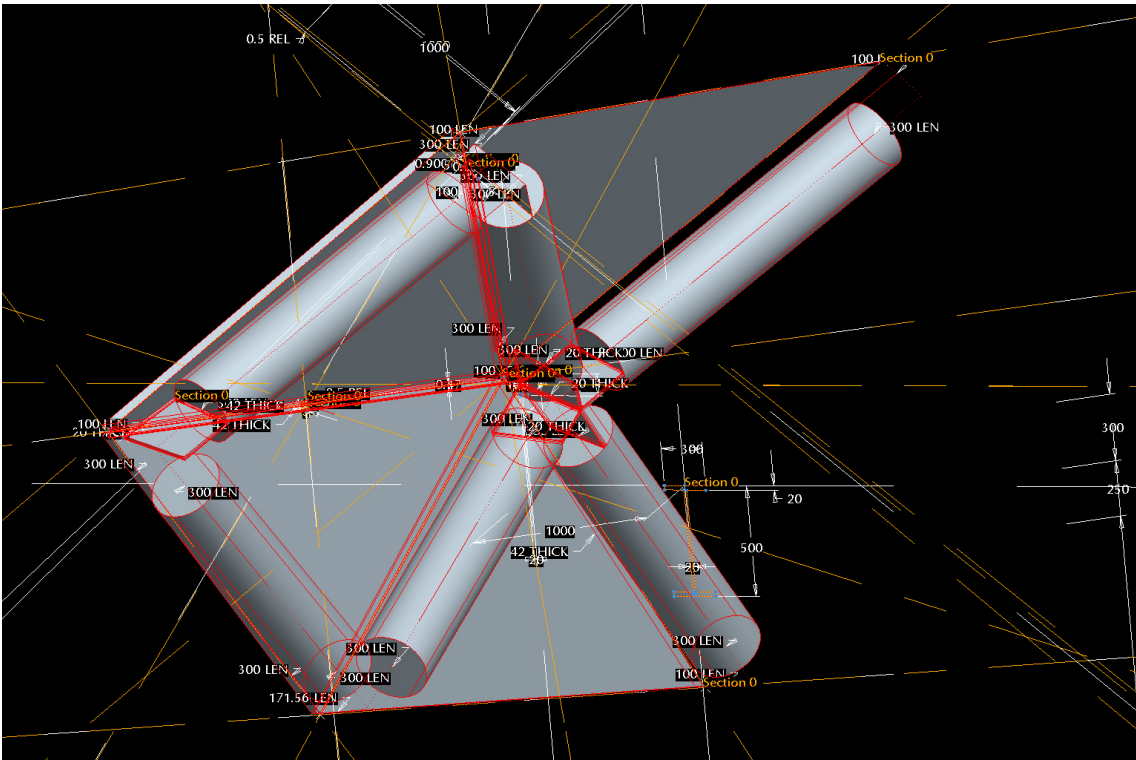


Fig. 1: ONL [Oosterhuis\_Lénárd], Detail Sound Barrier, 2005. Image: © ONL

rather, it becomes one way of uttering data. The physical fabrication of the data is yet another utterance of the same data, this time in matter. Yet both refer to the same data, and, in that respect, they share a direct connection. In what follows, I propose to discuss the relationship between the various utterances of the same data as a process of literalisation of the architectural design process. Whereas prior to the emergence of digital media, and especially the FTF process, design processes drew upon representations, metaphors and analogies, with the advent of digital media and FTF, parts of the design process have become literal in relation to one another. The difference between utterances might be in the media (virtual vs. physical, visual vs. material), but their underlying data remains the same.

The conceptualisation of architectural production in terms of literalism could shed light on emerging procedures in digital design and fabrication. It could also assist both in creating defined processes for architectural design, based on understanding the literalisation of the digital design process, and in the perception of the architectural product, regardless of whether it is an object, space or environment. This essay attempts to establish the connections between digital design and literalism as a first step towards illuminating this emerging phenomenon.

### **Theories of Literalism**

Theoretical discussions on literalism have been conducted in many disciplines, most prominently in linguistics, literature, the arts and philosophy, in relation to issues of representation, contextualism, directness and interpretation. In linguistics, whether in spoken or written language, literal expressions are considered to be non-symbolic utterances, existing outside of representation; they are perceived as standing only for themselves and not alluding to any external signification. A literal expression has its own singular signification, which is direct and particular.<sup>6</sup> Thus, literal expressions are not metaphorical,

analogical or indexical; in other words, what you see is what you get.

The paradox that literal expressions posit is that language is a representational apparatus of communication that usually establishes some references to external significations. How, then, can literal expressions exist and function within language as linguistic structures, and yet at the same time be considered non-representational and non-symbolic? Over the years, linguists have tried to resolve this paradox while examining the ways in which literal expressions function in written and spoken language. They have proposed various approaches to reconcile this paradox, discussing the relations between literal expressions and interpretation, directness and contextualism.<sup>7</sup>

The reference to contextualism was the primary way to demonstrate that literal expressions do not establish relations with external significations. The French linguist and philosopher François Récanati was at the forefront in showing the non-contextual structure of literal expressions when he both defined them as utterances that do not need a context to be understood, and claimed that shifting a literal expression between contexts would not change its meaning.<sup>8</sup> This being so, literal expressions create a condition of parallelism. An uttered literal expression is parallel to its signification, and only to its signification. The phrase 'this is this', which is often associated with literalism, reflects the parallelism that literalism asserts. A literal expression incorporates two sides: one is the utterance and the other is the signification. The two sides are connected and equal to each other, but they function in separate realms: utterance exists in the realm of the signs that make up written or spoken language, while signification is located in the realm of understanding. They are connected in such a way that nothing can intervene between them.



Fig. 2: Enrico Dini, 3D Printer D-Shape. Image: © Shiro Studio

Literal expressions cannot be interpreted because they cannot absorb any additional data and create new signification. The French philosopher Paul Ricoeur claimed that interpretation indicates a surplus of meaning.<sup>9</sup> In order to interpret, one must take an expression and examine possible significations that, on the one hand, stem from the expression and, on the other hand, refer to notions external to the expression. The external signification is added to the expression, yet it must allude and adhere to the initial expression, otherwise the interpretation would be false. This is not so with literal expressions, because if a literal expression is one that stands for itself, it cannot include additional forms of data that would enlarge its meaning and signification. It can have only one signification.

Literature and the arts proposed a discussion on literalism parallel to the discourse in linguistics, in the course of which the media specificity of literature, painting, sculpture and other artistic forms generated new understandings of the topic. In literature, literalism concerned the literal understanding of a narrative that attempted to be direct and not metaphorical or analogical.<sup>10</sup> Thus realism was sometimes associated with literalism. Yet the main thrust of literalism in literature was to create an exact depiction of characters, events or situations without idealising them. This is because idealisation is a mechanism that operates consciously or unconsciously and leads to the misperception of conditions of reality. Consequently, reality is not seen in a literal fashion but as something else altogether.

In the arts, literalism has been associated with minimalism, more specifically with the geometric abstractionism of post-war American painting created by Frank Stella, Ellsworth Kelly and Kenneth Noland, as well as sculpture by Sol LeWitt, Dan Flavin and Donald Judd. In fact, minimalist art was often referred to as literal art, not only because of the minimalism of the artistic objects but also due

to the directness of the expression.<sup>11</sup> In literal art, the material use is direct and does not create an illusion or an image that is not associated with the material itself. Similarly, the use of geometry does not attempt to reflect another meaning. The shape of the artwork is what constitutes the object and it does not try to become something else.

In architecture, literalism involved the discussion of objects and spaces that attempted to be literal. It included mainly architectural expressions that tried to avoid symbolism and representation. Therefore, the architectural discussion also associated literalism with minimalist architecture that tried to 'to strip everything down to its essential quality and achieve simplicity'.<sup>12</sup> The architecture of Tadao Ando, Luis Barragán, Alvaro Siza and, more recently, of Peter Zumthor, has often been referred to as a minimalist expression of architecture that can be associated with literalism. The minimalist characteristics of every work by these architects were seen as attempts to stay within the boundaries of each work in terms of itself alone, and not to expand it into other realms of signification.

In the theoretical discourse on architecture, literalism was discussed and defined in several ways. Colin Rowe was one of the pioneers in addressing the impact of literal expression on architecture when he wrote his critique on architectural production in the 1940s. For him, literalism was about ensuring the transparency of the object and the architectural space so that they would not conceal hidden agendas or ideas.<sup>13</sup> Since Rowe's seminal work, several architectural thinkers and scholars have addressed the topic; nevertheless, the writing on literalism has been sporadic and has not provided a wide-ranging overview of the topic. In recent years, Mark Linder has provided the most comprehensive discussion of architectural literalism. In several essays, and more extensively in his 2004 book, *Nothing Less than Literal: Architecture after Minimalism*, Linder proposes an historiographical

account of literalism as he returns to the discussions on art and architecture of the 1950s and '60s, especially the ideas put forth by Colin Rowe, Clement Greenberg, Michael Fried and Robert Smithson.<sup>14</sup> Although Linder does not explicitly attempt to provide a general theory of literalism, or one specifically related to architecture, throughout his discussion he clarifies several discrepancies within the ongoing discourse. These clarifications can be regarded as a basis for a theory on literalism in architecture.

For Linder, literalism was a reaction against modernism's occupation with production, representation and the formalist tendencies that emerged in post-war architecture; it called for non-referential and autonomous architecture. Thus Linder also posits literalist expressions as objects or spatial conditions that stand for themselves, independent of representation. Nevertheless, this does not mean that literalist expressions are autonomous. Following the discussion of the American philosopher Stanley Cavell on literalism, and the long-running debates among linguists about the signification of literalism, contextualism and relativism in linguistic utterances, Linder clarifies one of the errors associated with literalism.<sup>15</sup> Literal expressions are not about autonomy. Unlike Peter Eisenman's post-functional and self-referential architecture of the 1960s, literalist architecture does not attempt to maintain a position of autonomy in relation to other modes of expression.<sup>16</sup> It is not about disconnectedness and singularity. In his book, Linder expands on this matter and claims that '[l]iteralism is against interpretation and for application'.<sup>17</sup> Cavell best described this idea when he claimed that 'literal usages can be *rephrased* but not *paraphrased*'.<sup>18</sup> In other words, it is not that literal expressions try to be autonomous and cannot be mobilised or receive various utterances. Rather, in the movement of an expression from one format to another, it cannot be interpreted or receive additional data. On the contrary, it is supposed to maintain its integrity.

The non-interpretative trait of literal utterances does not imply that they are reductionist in nature. Indeed, Linder uses minimalist art objects and architectural designs to demonstrate the literalist tendencies of post-war artistic production. Nevertheless, his reference to minimalist art and architecture is related to the historical period that he examines, and to the artistic production of that time. His reference to minimalism does not imply that literal expressions are reduced solely to a consideration of the constituents that compose an expression. Rather, literal expressions allow a broader understanding of a phenomenon, but only within the scope that its constituents construct.

Linder views literalism as a mechanism that functions in a direct fashion, writing that '[l]iteralism locates the turning point when language or representation seems entirely adequate and direct, but also utterly inflexible and maddeningly indeterminate'.<sup>19</sup> For Linder, the directness of literalism is about rigidity, the maintenance of adequacy. Nevertheless, the directness of literalism can be seen in a more flexible way. This is because literalism implies that data can be transferred from one format to another, even without the addition of new data, which, in turn, implies that any utterances of the same data are interchangeably connected. Thus, the maintenance of adequacy does not require sameness or even similarity. It only requires the ability to interchange data among various media and formats without the addition of new data that would create new signification.

The process of expressing data in various formats raises a question in relation to literalism and contextualism. François Récanati argues that a literal expression cannot be contextual because the literal expression might be framed in a new light that could lead to its reinterpretation.<sup>20</sup> The question that might be raised here is whether a reformatting of an expression constitutes a new context that may or may not introduce new data to the expression.

Or to reiterate Cavell's idea, does the reformatting of data result in reshaping or paraphrasing it? In his writing, Linder does not address this question directly. Cavell, on the other hand, provides what can be seen as a resolution to the problem in his seminal book *Must We Mean What We Say?*, published in 1965. For Cavell, the paraphrasing of a poem does not maintain its 'core, essence and essential structure'.<sup>21</sup> The reformatting of data, which would be considered as reshaping the data, must maintain these conditions. The different usage of the terms 'literal' and 'literalism' in the various disciplines opens possibilities for understanding the phenomenon of literalisation in digital design processes. Whether addressed as an artistic historical phenomenon (Linder), or considered in relation to philosophy and interpretation, utterances or referentiality, literalism relates to data mobility and signification. In the following section, I will address the concept of literalism in relation to digital design procedures.

### **Digital Literalism**

Rowe, Fried, Greenberg and Linder provided accounts of literalism in art and architecture, but these studies mostly considered artistic and architectural expressions, whether object-based or spatial, and not the processes that made them come about. Thus, they discussed the ways in which a literal expression stands for itself and functions self-referentially in its attempt to create signification and eliminate the shifting of data between expressions. A major reason for the concentration of post-war artistic and architectural literalist discourse on the object and space and their respective significations might be found in the difficulties that exist in shifting between media while maintaining the data as-is with regard to physical objects. How is one supposed to maintain data integrity while shifting between two media in a manual production? Can it be done by maintaining the form conveyed by the data and creating the same shape, only in different materials? Or is it done by maintaining the material use

or performance and changing the form? After all, if on the one hand the reshaping of data is supposed to create a parallel expression, not a new one; on the other, the making of two objects that would be literal to one another does not mean a duplication of the same object. Indeed, maintaining all the aspects provided by that data in physical production would simply result in the creation of the same object twice.

With digital media, the maintenance of data integrity is somewhat easier. Digital media permits processes of data conversion and the transliteration of data that result in the encoding of the same data in different formats and the creation of variation. Defined as 'the process of producing meaningful information by collecting all items together and performing operations on them', data processing allows different software to refer to data and to present it according to its relevant format.<sup>22</sup> Indeed, in some cases the transformation of data from one format to another would bring about a loss of data in the encoding process. For example, in processes of transcoding – a conversion of one encoding format into a new format – some data is lost. Nevertheless, the data loss in transcoding is deliberate. It usually happens when seeking to reduce the size of a file and make it lighter in order to transfer the file more rapidly. In this case, parts of the data are omitted and not transferred. The representation of the new data with the new software would not be as detailed or as high a resolution as it could be.

Yet in other cases, mainly in processes of data conversion, the full data may be used. Data conversion is usually needed when specific software cannot encode data either for visual representation or for physical production. In pre-digital production, data that conveyed the ways in which an object – artistic or architectural – should be made could be stored in drawings, models, text or other formats. When a builder or a fabricator wanted to create the object or spatial design, they could refer



to the stored data and execute it. In this process, builders or fabricators might add or subtract data according to their understanding of the initial data and the ways in which it was meant to be realised. The initial data was usually incomplete and did not represent the entire range of information necessary for the execution of a project.

Digital data, however, can be stored in many ways and then be converted into new formats that enable the data to be encoded. Once the data is converted into a new format that suits the software's encoding systems, this same data can be used and expressed in a new way. This process is called 'character encoding', meaning that characters of the data are replaced with new characters that can be deciphered by the software. The replacement of the characters does not have any semantic signification; it is only a syntactical procedure that transliterates one set of characters into another. In this process no data is lost. The data in its initial format and the data in its new format are identical. The encoding of the data and its representation might be different, but the inputs that made them come about are similar. As a result, both versions of the data can be used to create two different expressions that can be considered literal.

Another way to maintain data and create various utterances from the same data can be found in processes of design optimisation. Based on evolutionary algorithms, such as genetic algorithms, design optimisation seeks to create the best solution for any given problem. This involves searching within specific data for the elements that would help construct the best solution. However, this does not mean that data is lost in the iterative process; rather, it simply operates in a different manner. The full data is contained in each of the iterations, although only parts of the data are activated. In mathematics, this process is based on maximising or minimising a function. In these cases, a system usually chooses an input value that would best compute the desired

function, either maximising or minimising the data's functionality. Nevertheless, the full data is at hand to create the next iteration. Evolutionary algorithms function similarly, and they create possibilities for data maximising and minimising, which produces an outcome in which the various iterations are interconnected and stem from the same data.

In architecture, ideas about data conversion, design optimisation, and the creation of variations that stem from the same data have been explored in the work of several architects, including Kas Oosterhuis, Marcos Novak, Greg Lynn and Matthias Kohler, and Fabio Gramazio. More specifically, when discussing the possibilities of topological design in architecture, the architectural discourse on digital design also addressed the issue of data mobility in relation to the creation of variations. As Mario Carpo noted in his 2011 book, *The Alphabet and the Algorithm*, Greg Lynn introduced the term 'differentiability' to architecture when he developed ideas about creating serial variations of a design.<sup>23</sup> Lynn posits that since topological design allows the creation of variations derived from the same data, the variations will be interconnected in their conception and production but different in their appearance. Lynn introduced this idea to differentiate in architecture between mass standardised fabrication and digital mass customised fabrication.<sup>24</sup> In mass standardised fabrication, variations cannot be made from the same data. The process ends with a unique fabrication process. In digital mass customisation, on the other hand, each of the produced items may be different yet stem from the same data. Lynn examined this possibility in several of his projects. For example, in the Flatware he designed in 2007, now part of the permanent collection of the Art Institute of Chicago, Lynn created a series of subtly varied metal sintered and silver-plated tableware prototypes that stem from the same data. [fig. 3]

Lynn's idea introduces the possibility of literalism in digital architecture. For Lynn, literalism exists



Fig. 3: Greg Lynn, GLForm, Flatware, 2007. Image courtesy of GLForm



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Fig. 4: Open Source Architecture, the Hylomorphic Project, 2006, Mak Center, West Hollywood, CA, 2006. Image: © Joshua White, JW Pictures Inc.

between the objects since they stem from the same data. However, he does not limit his consideration simply to the objects and their interrelations. His work also addresses the process that brought the objects into being, since he relates to their conceptual and physical aspects in the way made possible by topological thinking and production. In that respect, Lynn's designs provide an opportunity for taking Linder's discourse a step further, since the literalism proposed by Lynn's production relates not only to the end result, in other words the designed object, or artistic or architectural expression, but also to the design process.

Thus literalism has been examined in relation to both the object and the design process, while taking into consideration the conversion between different media. We at Open Source Architecture examined this possibility in the Hylomorphic Project installation that was assembled at the Schindler House in West Hollywood as part of the 2006 Gen[H]ome Project exhibition.<sup>25</sup> [fig. 4] The installation was a structurally efficient 3D truss of linear members joined at nodes by pin connections. Its aim was to optimise material use while sustaining the installation's structural properties. The explorative part in relation to data maintenance occurred when the Los Angeles-based composer and sound artist Clay Chaplin used a converted form of the same data to compose a piece that was installed in the structure. In other words, the same data was used in two formats: built form and audio form.

The conversion of data in order to create similar objects in various media is another way to relate to literalism in digital design. As discussed earlier in this essay, Oosterhuis and other architectural researchers examined the possibility of FTF processes and the directness they established. In many ways, the researchers' ideas rely on the connectedness between the computer-aided design (CAD) and computer-aided manufacturing (CAM) processes developed by the inventor of stereolithography,

Charles W. Hull, as early as 1984.<sup>26</sup> Hull sought a way to enable the printing of 3D objects. Throughout the development of stereolithography procedures, Hull attempted 'to harness the principles of computed generated graphics, combined with UV curable plastic and the like, to simultaneously execute CAD and CAM, and to produce 3-dimensional objects directly from computer instruction'.<sup>27</sup> The outcome was a connectedness between CAD and CAM data that allowed for the creation of a 3D printed object. Processes that started in graphic virtual presentations in CAD ended up in 3D objects that were generated directly from the CAD files. In stereolithography, the CAD and CAM procedures became literal to one another.

### **Towards a New Literalism**

Over the years, the manifestations of literalism in art and architecture have varied according to contemporary cultural contexts and technological capabilities. With the advent of digital media, literalism once again acquired a new mode of manifestation that alludes to the cultural and technological circumstances of our time.<sup>28</sup> Thus, contemporary literal expressions and their signification differ considerably from pre-digital modes of literal expression, especially those of the 1960s and '70s. During those years, literal expressions concentrated mostly on the artistic and architectural object, its materiality and primary geometrical appearance. Therefore, literal expressions tried to avoid representation, and the concentration on the medium (matter, shape and form) of the artistic and architectural expressions became a means of articulating literalism.

This focus of post-war literal art and architectural objects and spaces on the respective media as the main mode of expression had several effects. In *Nothing Less than Literal*, Linder, following Michael Fried, discusses one of these effects, and posits that the intense preoccupation of post-war literal expressions with materiality and primary geometry is a reference to presence.<sup>29</sup> Literal objects of

the post-war period both dealt conceptually with presence and conveyed an experience of presence. Several factors engender the strong feeling of presence that these objects convey. One is the minimalist aspect of the literal expressions. As objects that refer only to themselves, that do not have an external signification and cannot be interpreted, literal expressions limit the ability to let one's thoughts wander to other places after having engaged with these objects. Whereas other artistic and architectural expressions may allow the mind to wander, literal expression leads the subjects who experience it to focus on the direct expressions it conveys. They stay in the locus created by the literal expressions because these expressions do not permit mental displacement. This concentration enhances the feeling of presence.

In this respect, the non-representational aspects of the literal expressions make them into objects of the Real, in Lacanian terms. As Hal Foster suggested in his 1996 book, *The Return of the Real*, with minimalist art – or literal art, as he occasionally refers to it – ‘it is precisely such metaphysical dualism of subject and object that minimalism seeks to overcome in phenomenological experience’.<sup>30</sup> The minimalist object and the subject that experiences it are both present and both literal. Literal expressions that are based in objects attempt to go beyond the representational and the symbolic, and, in so doing, create an effect of the Real.

Literalism today is not based on the artistic and architectural object or space but rather on design, production and fabrication processes. The ability to transliterate data, and to have data expressed in several ways that result in outcomes that would be literal to each other, shifts the notion of literalism from the object to the process. Unlike the literal objects of the 1960s and '70s, which were the site and locus of literalism and created its signification, objects of digital literalism are not the mechanisms that create its signification. Instead, the nature of

the data and the process of its implementation become the mechanism that creates signification in literalism.

Digital literalism proposes a shift away from the singularity of the literal object and towards multiplicity. Whereas literalism in the 1960s and '70s concentrated on the object as a singular presentation of a literal signification that stemmed from and referred to the object itself, in the case of digital literalism, the ability to transliterate data and have it presented in several modes and media creates the conditions for multiplicity. If both the data that generates a digital process and the resulting architectural expression can be transliterated, then we can obtain multiple iterations of the same idea actualised in different media. The data and the process connect the various expressions and make them literal to each other. Such is the case with the digital presentation of the data for an architectural model in the virtual dimension, and its material realisation, for example, in print form. They are two iterations of the same data, yielding presentations of the data in multiple formats.

This recent shift of literalism from the object to data and processes is related to digital architecture's reference to emergence and evolution. The concentration of literalism in the artistic and architectural object and space in the 1960s and '70s refers to the philosophy of being: a phenomenological interest in presence. The object is there; it is finite and present. Today's interest in data and process, however, strongly alludes to digital architecture's discourse on becoming. In the last two decades, architects who deal with digital procedures have set algorithmic procedures, let the computer run its course, and allowed architecture to emerge out of the algorithmic process. Following Gilles Deleuze's philosophy of becoming, the architectural discourse opened a discussion about ideas such as flows, swarms and vectors as a means of creating dynamic, responsive and changeable architecture:

architecture that constantly emerges.<sup>31</sup> Similarly, the procedures of digital literalism in architecture are based on the rationale of emergence.

Thus, the concentration of digital literalism on processes may affect design methodology as a whole. The decline of the metaphor and analogies in design, along with the advent of the literalism proposed by digital procedures, require the architect to know how things are actually going to work. Metaphors and analogies do not necessarily convey the ways in which architecture might eventually operate. They are only suggestions for several modes of operation. Architectural metaphors and analogies refer to the signification of the design. Literalism, on the other hand, concentrates on the thing itself, and therefore it enfolds and delineates the ways in which architecture performs and operates – not only as a technical apparatus but also as a mechanism for experiencing architecture. As such, the shift from a metaphorical way of thought towards literalism in digital design requires architects to focus on the ways in which things work – in other words, to focus their attention on the process and performance of architecture.

### Notes

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## Biography

Eran Neuman is an architect and the head of the Azrieli School of Architecture, Tel Aviv University. His research focuses on digital design methodologies and culture, fabrication, and algorithmic design. Eran has lectured worldwide, including at Harvard University and Tongji University in Shanghai. Eran's book, *Performatism: Form and Performance in Digital Architecture* (co-edited with Yasha Grobman), was published by Routledge in 2012.

