# Codifying, Envisioning, and Ideating through Data on Information Based Designs

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**Abstract.** One of the fundamental issues raised by Mario Carpo in *The Second Digital Turn* in relation to the digital revolution in architecture has to do with the paradigm shift that incorporates computational logics and replaces conventional "ways of doing" with new "ways of thinking". The role that information plays in this context allows for new ideation strategies that often invite architects and designers to incorporate data not as something to be analysed and from which to act and make decisions, but directly as project material, thus enhancing *information based designs*. Some examples are examined in which, in various ways, data is manipulated, abstracted and digitally processed to help formalise the design proposal. Sometimes following *form-finding* strategies, sometimes deploying geometries encoded in *scripts* in order to define the form to recall relevant data from an event or to display the information and explore ways of visualising that data to produce the final configuration. Many of these proposals challenge the limits of temporality traditionally associated with architecture and contribute to define a new phenomenology between users and architecture.

**Keywords:** Second Digital Turn, Computational Design, Envisioning Data.

## 1 Introduction

The emergence of an informational paradigm in architectural design dates to the Renaissance era. Alberti introduced this novel idea through the graphic representation thus anticipating built architecture, projected in plan form. From that moment on, the architect's work began to be considered as an activity of an intellectual nature to which to attribute a recognition of authorship [1]. Built architecture is conceived from then on as a faithful replica of the architect's design, establishing a division between conception and making, totally alien to the medieval tradition of master builders. Plans were drawn for others to construct the architecture or "translate it into buildings" [2]. This relationship has remained largely unchanged beyond graphic techniques and technologies until, with the advent of computing and computational logic, form can be encoded in *scripts*. Unlike conventional blueprints, the *script* defines a geometry in which the form is digitally encoded and the visual or analogue similarity of the architectural drawing is replaced or abstracted into a code [3].

Thus, the representation resulting from this coding is not based on geometric projectivity but on a *script*, which establishes a more direct bridge between the geometry of the project and any other type of information that may contribute to shape it. Information could be considered, in a sense, as a new design "material". This new informational paradigm introduces as a primary material the bits of information that, without possessing a corporeal existence, operate as "digital bricks". In this type of architecture, information is the new material that shapes and facilitates the design, whose formalisation depends on the assembly of the data itself, turning it into genuine "design material" [4].

The adoption of this paradigm is related to the determining role played by the informational in the advances of cybernetics and its influence on certain approaches of recent architecture. The static vision of architecture has been replaced by a systemic and processual conception that considers the complex relationships produced by its interaction with the context [5], something that goes beyond the purely geographical, topographical or local.

This research proposes to study the idea of information as an enabler of design, that allows architects, designers and artists, to use the potential of digital information processing in order to integrate it into the design through abstraction strategies. In addition, it critically reflects on architecture in the context of digital design through the complex relationships established between creation and technology [6].

The methodological approach of the research is based on the selection of a series of representative examples of the different ways in which the role of information as a key factor in the ideation process can be considered as a real "material" in the design process. Based on the analysis of this set of significant examples, a classification of qualitatively different approaches is established, whose common denominator entails using information as a pretext and as "material" for the project.

## 2 *Scripting information:* codification of form

The conscious use of coded information in architectural design was addressed early on in deconstructivist architecture following in the wake of philosophers such as Jacques Derrida or Gilles Deleuze, coinciding precisely with the dawn of CAD development. The introduction of code as a tool for ideation, is related to the dimension of complexity provided by the linkage with metaphors from the scientific field. Peter Eisenman, for example, has used this type of design approach in much of his work since the last decade of the 20th century. Projects such as the *Bibliotèque de L'Ihuel* (Geneva, Switzerland 1996-97) in which a diagram of neurological activity –real data– is superimposed on the conditions of the landscape and the program [7] turning the form into the very fingerprint of the ideation process (Fig. 1). The code becomes an allegorical reference to memory in the context of a library and a graphic representation of brain activity.

Faced with the primacy of visualisation, the codification of form carried out by parametric or algorithmic design strategies involves going a step beyond the limits of conventional representation. Designing with codes (*scripts*) implies a different degree of abstraction. Traditional representation systems based on geometric projection as a data

understanding technology, and on the predominance of visualisation, give way to the conception and configuration of geometry by means of lines of code generated by programming languages [1]. These computational strategies are extended with the introduction of tools based on the concept of "emergent systems" developing in the field of information theory and complexity sciences [8]. Recursive processes, cellular automata, genetic algorithms, neural networks, etc., are incorporated into architectural design using information and data as design enablers, with the capacity to integrate different layers of reality in multidimensional environments.

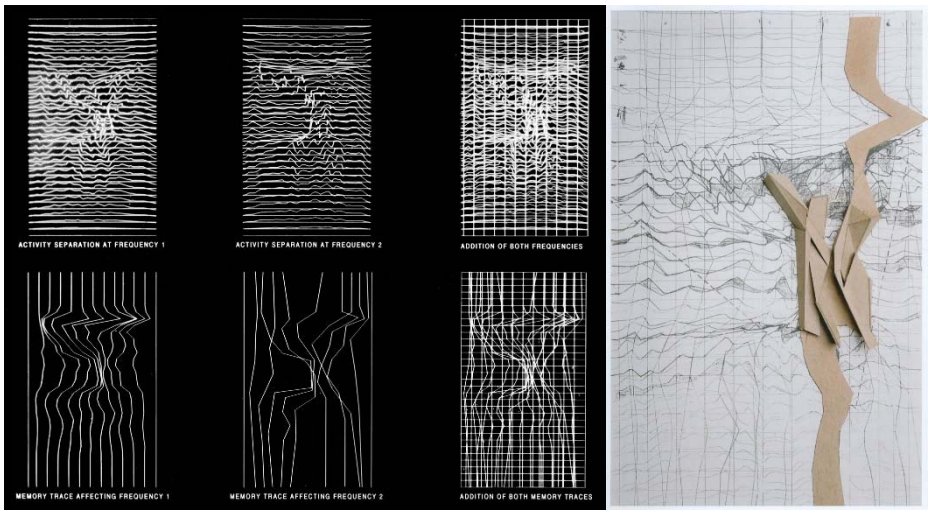


**Fig. 1.** Peter Eisenman, *Bibliotèque de L'Ihuel*, Geneva, 1996-1997 (Source: https://eisenman-architects.com/Bibliotheque-de-L-iheul-1997)

This new approach to design, conditioned by the informational paradigm, defines a conceptual change in architectural ideation processes traditionally based on formative processes, in which the designer acted directly on the material by means of drawings, sketches or models [9]. The emerging concepts of *open form* and *bottom-up* learning processes mean that the geometry of the project is not imposed hierarchically by the designer, but that the data itself is the agent that allows the form to be "found" in a process of *form finding* [10].

## 3 *Art connection*: data as an external reference

Approaches to informational complexity from the art world open new creative possibilities and generate a meaningful connection that actively influences architecture. The artist Rafael Canogar has used algorithms and information to produce some of his most recent works. This is the case of his generative *video-mapping* installations *Amalgama el Prado* (2019) and *Amalgama Phillips* (2021). These are two installations created from the collection of the Museo del Prado in Madrid and *The Phillips Collection* in

Washington, D.C., respectively. By means of an algorithm, the works are liquefied into images, producing a dynamic and abstract pictorial amalgam of fluctuating figures in constant reconfiguration. The works are dematerialised to become a series of digital files projected on the facade of the Madrid museum and on the walls of the Phillips Collection museum (Fig. 2). Thus, the facade and walls of both buildings became phenomenological canvases as well as a metaphor for the constant flow of information on the network, also evidencing the emergence of new forms of art and culture consumption through digital media [11].

**Fig. 2.** Daniel Canogar, *Amalgama Phillips*, The Phillips Collection, Washington D.C., 2021 (Source: https://www.spainculture.us/city/washington-dc/amalgama-phillips-by-daniel-canogar/)

The series of dynamic sculptures titled "*Earthtime 1.78*" (Fig. 3) created by artist Janet Echelman are literally inspired by data sets of wave heights generated by the 2011 tsunami (1.78 is the number of microseconds the day was shortened after the Tōhoku earthquake) that caused the Fukushima catastrophe. Echelman uses data from the US National Oceanic and Atmospheric Administration (NOAA) to generate a 3D model that materializes in a layered textile shape that adapts to different locations [12].

The interpretation of the data recalls the event and the actual data recorded from the physical event can be considered as the *material* that makes up the work, reflecting the complex interdependence and interconnection that exists in the cycles of time and matter. Unlike Canogar's installations, in which a graphic imaginary was scanned and encoded to produce a new visual image, Echelman's proposal is based on real data of raw information [4]. This information is not simply recorded but digitally processed, transformed and abstracted into a geometry that is then constructed as an ethereal networked sculpture.

**Fig. 3.** Janet Echelman, *Earthtime 1.78 Helsinki*, Senate Square, Helsinki, 2021 (Source: https://www.echelman.com/#/178-helsinki/)

## 4 *Abstract information*: data as *performance*

The fusion of science, art and technology allows the possibility of devising architectures through abstract information processes. In her *myThread Pavilion* project, Jenny E. Sabin collects real data from the movement of a group of runners by transforming biological patterns into the geometry and material of a structure produced with digital weaving techniques to produce an artefact on an architectural scale [13].

Its *ADA* project, named after computer programming pioneer Ada Lovelace and realised in collaboration with Microsoft Research, incorporates performance, materials innovation, human-centred adaptive architecture and emerging technologies. It is the first architectural pavilion project to incorporate Artificial Intelligence (AI) to produce a cyber-physical, adaptive, data-driven architecture informed by individual and collective participation. The pavilion structure consists of a series of tubular components that configure a shell of 895 3D printed nodes and fiberglass rods that is complemented by a lightweight layer of luminescent textiles and fibres. The resulting structure collects data from a network of sensors and cameras located throughout the building that record visitor interactions. The data includes facial patterns, voice and sound tones that are processed by AI algorithms and correlated with feelings and emotions that are reflected through colours, fibre-optic spatial zones and responsive materials. It is a social,

environmentally responsive, interactive and transformative structure that feeds on the information it receives, transforming it dynamically [14].

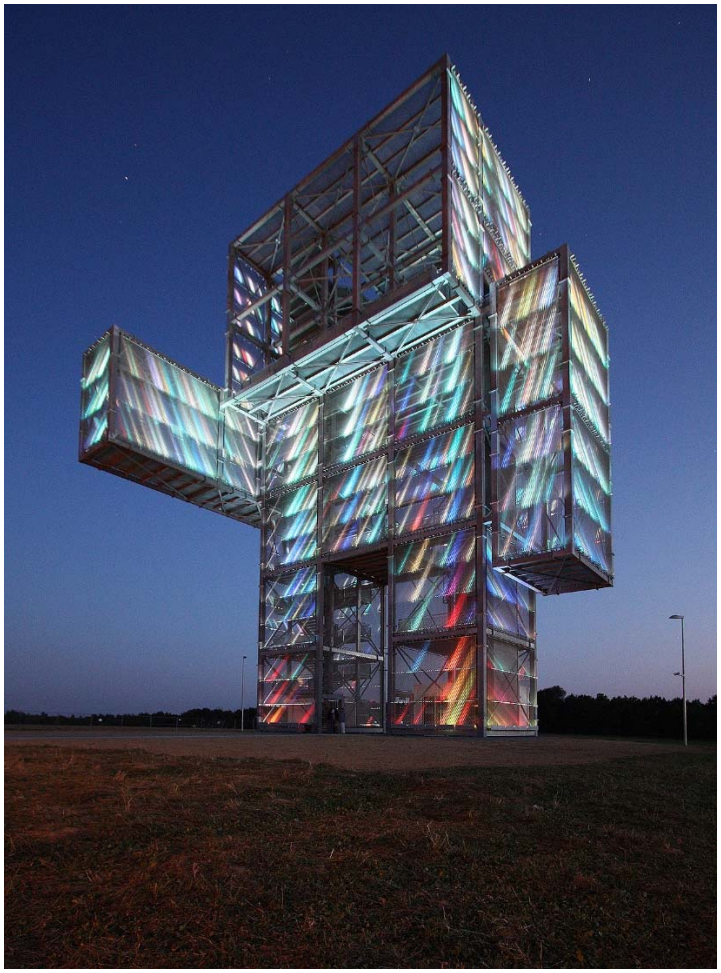

**Fig. 4.** Maurer United Architects, Indemann (viewing platform), Inden (Germany) 2009 (Source: https://mua myportfolio.com/indemann)

The performative approach in architecture allows for the merging of time and space while challenging the traditional *status quo* of the discipline. The building envelope in digitally aware designs can introduce kinetic facades, responsive membranes or large architectural displays, which engage time in a variety of ways: reacting to external conditions, interacting with users or changing to qualify space. Such is the case of the viewing platform designed by Maurer United Architects, *Indemann*, a watchtower with transparent grid floors and metallic fabric façades highlighted at night with 40.000 LED lights to create a magic vision (Fig.4).

**Fig. 5.** Vitamin Studio, *Voltereta*, three-dimnsional time wrap inmersive luminic instalation (Source:https://www metalocus.es/en/news/immersive-experience-three-dimensional-time-wrap-vitamin-studio; photo by Oscar Rivero)

There are many examples of the use of information as direct project material on facades or other architectural surfaces to propose a phenomenology that, by animating temporality, breaks the static or permanence conception of architecture. The pioneering '*Electronic' Bauhaus* by OMA in 1992 for the ZKM in Karlsruhe; the *Blinkenlights Project* proposals by the Chaos Computer Club in Berlin (2001), Paris (2002) or Toronto (2008); or the installations by the studio *realities:united* such as *BIX* (2003), a "communicative membrane" designed for the Kunsthaus Graz, an example of "*blobitecture*" by Peter Cook and Colin Fournier; Lars Spuybroek's (NOX) projects such as the *D-Tower* (1998-2004), the *Maison Follie* (2001-2004) or the installation *Voltereta* by Vitamin Studio, a truly luminic inmersive installation (Fig. 5).

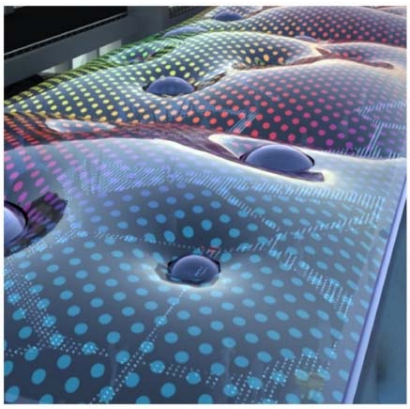

**Fig. 6.** Simone Giostra & Partners. "La Porta di Milano", pneumatic roof detail integrating digital technology and photovoltaic cells, The Malpensa International Airport, Milan, 2010 (Source: http://sgp-a.com/#/single/la-porta-di-milano-at-the-malpensa-international-airport/)

More recently we find phenomenological *displays* such as the façade of the *Green-Pix-Zero Energy Media Wall* project by Simone Giostra & Partners in Beijing (2008) in which a "dedicated" software allows the building skin to interact with the interior and with the exterior public space transforming the facade into a responsive environment [15] or the flexible roof incorporating photovoltaic panels in a novel inflatable structure for the Porta di Milano at the Italian city's international airport in the context of the World Expo 2015 (Fig. 6).

## 5 *Flowing curvatures*: data as a design restriction

Along with interactive architectural displays, *performance based design* is an emerging approach to architectural design. Computers make it possible to simulate the structural behaviour, energy efficiency or acoustic qualities of a given design. The performance of the building related to these types of evaluable and quantifiable aspects become the guiding principle of the design for the configuration of the geometry using digital quantitative and qualitative simulation technologies developed in interdisciplinary fields [16]. In a context based on spatial, social, cultural and technological information and simulation, digital tools enable geometry modelling and design decisions. This digitally aware computational design can incorporate data abstraction to improve the performance of the final product, which combined with *form finding* strategies significantly alters the architect's role in defining form while digitally exploring existing relationships between material, structure and surface to create new types of spatial experience.

We find an example in the projects of Marc Fornes/THEVERYMANY that straddle the line between art installation and architecture. The structure *Under Magnitude* (Fig. 7) continues the "*Structural Stripes*" series that aims to unite surface, structure and space to create a new architectural experience of a markedly three-dimensional nature and complex topology [17]. It is based on the concept of extensive curvature and Frei Otto's bubble patterns. Resistance is achieved in this case through "intense curvature" that maximizes double curvature by limiting the maximum radii to configure characteristic coral structures of tubular curved branches [18]. Here the data is a constraint imposed on the geometry in order to maximize the structural performance of the assembly. The result is a shape that evokes the trabecular structure of bones or a coral formation obtained by very precise cutting of an ultra-thin 1 mm thick aluminium sheet. This formal strategy makes it possible to achieve structures of a surprising scale despite the extraordinary lightness of the whole, following a line already pointed out by Robert Le Ricolais when he considered that the problem of the resistance of the constructed form lies in where to place the voids rather than in where to distribute the material [19].

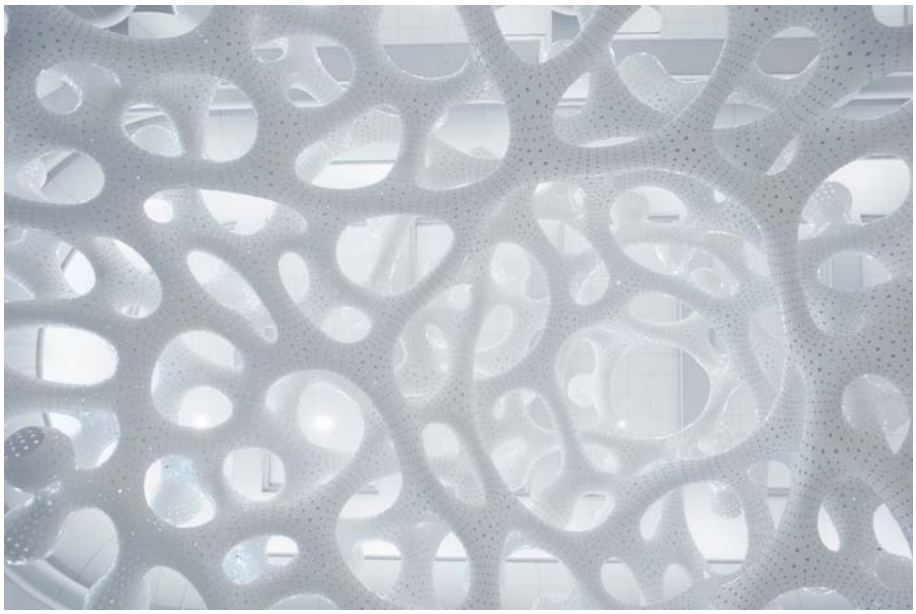

**Fig. 7.** Marc Fornes/THEVERYMANY, *Under Magnitude*, Orange County Convention Center, Orlando (Florida), 2016 (Source: https://theverymany.com/15-orlando)

Most of this selection of art works, installations and architectures are based on collaborative design and a transdisciplinary approach, as the complexity involved requires the adequate expertise in different fields of knowledge and technologies so that artists or architects alone might not have the skills to work on their own [20].

## 6 Conclusions

The projects illustrating this research can be linked to what Mario Carpo [5] has coined as *The Second Digital Turn*, which is characterised by a prevalence of ways of thinking over ways of doing with respect to the implications of technological change. Computational design can address the encoding of form and the use of information with an extraordinary variety of approaches. The importance of this informational paradigm shift lies in the way information is processed or used. The hierarchical imposition of form in traditional architecture as a product of the designer's authorship is altered by means of *bottom-up* strategies that configure the geometry of the proposals by means of abstraction processes, in which information constitutes the *raw material*, either as a direct source, as a reference outside the design, or as an informational condition or restriction for obtaining the result. Accordingly, this kind of design strategies could be referred to as *information based design*. Never in the millennial history of the discipline, media and tools had such a determining influence on the achievement of architectural form and constitute such an exuberant wealth of geometries, as those that characterise this digital architectural culture.

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