An Inquiry into the Computational Design Culture in Turkey: A Re-Interpretation of the Generative Works of Sedad Hakkı Eldem and İlhan Koman

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Abstract: Computational design can be discussed as a phenomenon which has developed throughout the history within distinct forms of art and architecture. As well as its familiar connotations with digital technologies, the research concerning the origins of computational approach provides a better understanding of the contemporary challenges in digital architecture, while stimulating unexpected relations with early dated examples. This paper aims to discuss the computational design culture in the context of Turkey through the disconnected but both well-known works of architect Sedad Hakkı Eldem's theoretical research and sculptor İlhan Koman's form studies. Apart from their common interpretations in Turkish art and architecture discourse, Eldem's "Turkish House Plan Types" and Koman's developable sculpture series are claimed to imply an underlying computational approach. Although Eldem and Koman are two leading figures who shared entirely distant interests and had worked in two different disciplines, their highlighted works in this study are re-interpreted and discussed as potential examples of the two faces of one computational approach.

1. Introduction

1.1. AIM OF A HISTORICAL PROSPECT

Digital-based design and its manifold implications in architecture have been frequently discussed with emphasize on their novelty. Particularly in the recent decades of architectural discourse a "digital revolution" is announced which calls for a radical detachment from the conventional modes of architectural paradigm. It is undeniable that technological innovations in digital tools have provided a rising interest in the experimental researches that are opening unforeseen perspectives to architecture, by both practical and conceptual means. However, it is still worth to ask if the underlying paradigm of digital architecture is totally "new" to architecture and what the premises of a computational design approach detached from improvements in digital technology can be.

As Antoine Picon (2010) puts it, "Confronted with massive technological change, a common temptation is to focus on the present only, as if what is happening was without roots in the past." From such a critical point of view, not only the historical thresholds in the development of computer technology but also the distant seeds of the underlying computational approach seem to be important research fields.

In contemporary architecture theory, the historical research into the origins of computational perspective has rare but remarkable examples. One of them is Antoine Picon's studies for they evoke critical thinking on the common conception of digital architecture. In his recent book *Digital Culture in Architecture,* including a historical overview of digital culture and design, Picon (2010) defines his ambition as to "map the main issues linked to the development of digital design." Another significant theoretical point of view can be found in Mario Carpo's very recent book *The Alphabet and the Algorithm*. In this book, Carpo (2011) develops a theoretical basis for the history of digital architecture through the changing concept of identical. He reviews the unfolding of digitally based design and construction by setting a perspective through the rise and fall of the paradigm of identical from the Renaissance. Another noteworthy research belongs to Altino Joao de Magalhaes Rocha (2004) who suggests that, his PhD dissertation titled *Architecture theory 1960-1980: Emergence of a Computational Perspective,* "reveals and reflects upon some of the cultural, historical and technological contexts that influenced the emergence of a computational practice in architecture."

Based on similar purposes, but covering a limited and a more specified field, this paper introduces the distant seeds of computational thinking in the unique context of Turkish art and architecture. Turkey -by its nature, a different context in regard to being not a center of technological development for many historical reasons- seem to have peculiar thresholds in terms of its integration with computer culture. For the field of architecture and design, in the first sense, it seems reasonable to accept that the ideas are translated along with the transfer of digital technology. However, a more thorough insight will show that an important accumulation, increasingly in the recent decades, can be revealed highly in academic field as well as it is possible to discover earlier works that contain computational qualities in different forms.

1.2 A BRIEF HISTORY OF DIGITAL-BASED DESIGN

During 1960s and 1970s, particularly in the both sides of Atlantic, the computational approach was experimented by some leading architects mostly with emphasize on the notions of patterns, systems and networks. (Picon, 2010) For this period, Christopher Alexander's works based on the identification and combination of patterns is frequently marked as the leading theoretical studies. In addition, cybernetics was an important path where Gordon Pask was the most important figure with his innovative works on cybernetic-oriented architectural research. (Picon, 2010)

However, computers' involvement in the field of architecture and design is usually started by the attempts in digital design studios dated back to early 1990s. In its first encounter, computers are used in architecture mainly as a tool for maintaining a better drafting and representation capability. Besides, the very different nature of designing within digital medium is soon realized and discussed with enthusiasm in architectural discourse, giving way to works set in a multi-layered conception of the possibilities offered by digital technologies.

In present, the use of digital technologies in architecture has an impact throughout the entire processes of design and building practices both in the levels of conception and materialization. For instance, beginning from the conceptual phase until its materialization, design process can be "seamlessly" realized within digital medium where the relation of form, structure and material is inherently re-shaped. The whole conception of design process is due to change by gaining a non-linear and a generic quality, and usually discussed through concepts like difference, variability and performance.

In the history of digital based design, one of the most remarkable challenges has been in the field of form where the term "blob" is used to characterize the unusual complex geometries. The complex forms that were hardly considered and constructed before, are made possible by the use of computers in design and manufacturing. As architectural theorist Branko Kolarevic (2003) states, digital design medium proves itself as a generative tool in the derivation and transformation of form. During the design process in digital medium, instead of defining the physical mass or the boundaries of the surface of the object, operational procedures that will generate the form – algorithms – can be set up. Form can be designed as a "family of objects" that can be defined digitally, computable and can change relationally; thus, consists of the countless possibilities of form.

Besides the increasing variation of architectural forms, the underlying computational paradigm has other potentials that are still explored. In its contemporary digital sense, computational design approach is related to parametric design and algorithmic processes. Architects like Kostas Terzidis and Karl Chu are trying to find out how can architecture be closer to programming by a more active use of software. (Picon, 2010) Terzidis (2006), in his book *Algorithmic Architecture*, makes a clear distinction of computation and computerization, which are the two terms usually confused. Computerization defines the effective use of the computer as a tool in the storage and operation of the data. The technical capacity of speed, memory or other developable qualities is related with computerization. On the other hand, computation is the procedure of dealing with the computable amount of data and calculating, so computation is related with the determination of something by mathematical or logical methods. Terzidis (2006) underlines the characteristics of computation by relating it with the concepts of rationalization, reasoning, logic and algorithm. He states that "the dominant mode of utilizing computers in architecture today is that of computerization; entities or processes that are already conceptualised in the designer's mind are entered, manipulated, or stored on a computer system." (Terzidis, 2006) While, most of the architects stay in the limits of computerization, some of them experiment with a computational approach through using algorithms by "scripting".

By the use of scripting, the constraints of the software are not strictly determinist to the design. For example, instead of the limitations emerge by the obligatory use of any three dimensional representations in a software or utilization of paths pre-determined, the scripting language allows a more open-ended process through relational thinking. In a sense, the relations that are set by the architect through parameters are allowed to be "formless". The code contains all information about each of the possible variations. Terzidis (2006) states that algorithms are not end-product, but they are rather a vehicle for exploration. He argues that "what distinguishes these processes from common "problem-solving" is that their behaviour is often non-predictable and that frequently they produce patterns of thought and results that amaze even their own creators."(Terzidis, 2006)

Computation defines computational thinking procedure which necessitates defining mathematical relations, an algorithmic problem solving process. Computational design proceeds as a research process of design problem that is defined upon a digital serial of relations. (Çolakoğlu and Yazar, 2007) Computational design process is not the process of reaching a single and finished solution of a design object. It requires designing the form in the interval that is defined by relations between parameters. Digital technology makes this process easier, faster, and accessible.

Computation can be emphasized as a design research area that became widespread with digital technologies but that can also be operative without using the computer as a tool. Defining the form relationally in an operational logic system means being part of a computation experience. This situation requires thinking the form as an abstract mathematical equivalent, outside of the world of meanings that it implies. Form's property of being digitally definable creates a concept of form that does not contain any representative reference except itself. In this approach, the fundamental task of design is not about deciding what the end product will look like or what it represents, but what is decisive is relational fiction that makes the form into being.

As well as its obligatory non-representative character, computation is dominantly related with the notions of variable, relational, generative and developable. Although the design media and tools may change, the works that consist of a computational approach coincide within the procedures of abstraction, rule finding, generation of a relational system over set parameters and definition of the range of parameters.

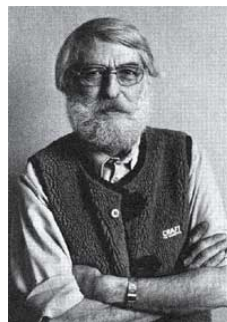## 2. Early Examples of Computational Design: Two Different Contexts
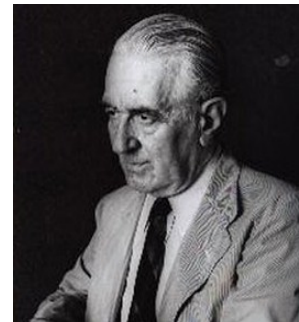

Fig 1. İlhan Koman   Fig 2. Sedad Hakkı Eldem

The examples discussed in this paper should be evaluated as fragments which will be deemed as disconnected for some justifiable reasons, rather associated here by the computational design approach they are claimed to share potentially. Despite of the differences that can be proved in several contexts, there exist a few common points between the life span of these two important figures –Sedad Hakkı Eldem and İlhan Koman. Even their disciplines and working periods do not coincide at all, they had been the leading pioneers of their period, and their works are still discussed from different perspectives.

The more obvious connection between the careers of Eldem and Koman is that both had been graduates of Academy of Fine Arts, with its present name Mimar Sinan University where Eldem graduated in 1928 and Koman in 1951. Also, both had been professors at their departments: Koman between the years of 1951 and 1958 and Eldem between 1928 and 1978.

Another point they share is their visits to Western countries where they had experiences that influenced their future work and interests. For example, Koman's first radical attitude towards the conventional figurative art work had first occurred in his Paris years. Koman went to Paris in 1951 as a student at Académie Julien with a scholarship. (Artun, 2007) However he did not carry on the lessons there, because he was not satisfied with the figurative art education using models. Rather, he was very interested in the avant-garde movements and abstract art. Likewise, Eldem had also been awarded by a scholarship by which, succeeding his graduation from Academy in 1928, he visited England, France and Germany. It was an opportunity for him to develop his ideas about the forms and expectations about the Modern Architecture.

It is not possible to cover the entire motivations behind Eldem's and Koman's innovative and generative works, yet within the limits of this study some related instances are mentioned above. The following parts will focus on the methodology of their selected works, detached from the other possible contextual arguments they consist potentially.

2.1 SEDAD HAKKI ELDEM AND "TURKISH HOUSE"

2.1.1. An Overview of Eldem's Study on Turkish House

Sedad Hakkı Eldem is probably one of the most famous and explored architects in Turkey, where his studies are still remarkable in the Turkish architecture history. One of the reasons of ongoing research may be related to the fact that Eldem had been a great collector of both his own practice and other architectural documents including vernacular examples of housing and other historical buildings. His study consistently had been developed on documentary analysis of architectural examples, including building surveys and photography.

The 'Turkish house' was defined by Eldem as the "house type, which was located within the borders of the Ottoman Empire, in the Anatolian and Rumelian regions, that existed with its own peculiar characteristics for a period of five hundred years." (Eldem, 1983) Eldem's systematic studies include a totally thousand and five hundred houses from different regions, evaluated according to their plan types.

Eldem's purpose on studying the documentary outcome of vernacular housing was his ambition to combine the traditional aspects with a Modern language. His architecture is usually argued as a response to the socio-cultural context of its era shaped by the tension between modernity and tradition under the effect of Westernization. (Uysal, 2004) As Sibel Bozdoğan (1987) points out, "The Turkish house type would be the source of "cultural" and "national" identity for his modern Turkish architecture. It is also possible to clearly observe the same argument in Eldem's words:

"We must first gain an understanding, become familiar with the values of our own culture and architecture and learn to love them and be proud of them. Only after structuring the foundations with the help of knowledge and sensitivity can we design our own new style." (Eldem, 1983)

Eldem's studies on the Turkish House covered a long period of his profession. Besides his motivation on design that had been exemplified by many of his built works, the reason behind his long life building survey studies is argued by İhsan Bilgin (2008) as related with his ambition to find out repetitive elements. As Bilgin (2008) points out, the major quality of Eldem's relievo studies is his pure drawing style, by which he tried to distinguish from the historical aspects and the secondary ones. Esra Akcan (2009) interprets the studies of Eldem on the systematical documentary of the vernacular house defined by texts and photography, presenting the subjective drawings that can be used in archives and studying a typological map out of them, as well as publishing all the outcome to share with colleagues, as a translation of these structures to a modern language. On the other hand, Uğur Tanyeli (2007) offers a critical stance on Eldem's abstraction process in Turkish House Types. Tanyeli discusses that Eldem "invents a universal category of Turkish house which has a national validation, out of a vernacular house architecture that is local in its own definition." (Tanyeli, 2007) Tanyeli states that:

"His aim was not to shed light on the vernacular traditions of Turkey, rather was to invent a central Turkish House tradition. Not only he denies the local aspects of Turkish house, but also he ignores the variability of the housing made up of differences in social status. His Turkish House is a "classless" house that spreads from the village house to the Topkapi Palace. In order to achieve that, the proceeded typological historicism neglects particularly the planimetric details by abstracting." (Tanyeli, 2007)

2.1.2 The Computational Aspects of "Turkish House Plan Types"

The abstraction process in Eldem's studies is held by the utilization of grid, which serves for a basis for the planimetric schemas. As Özbil (2002) suggests, "the grid allows for the abstraction and standardization critical for Eldem's compositional method." Furthermore, Eldem states that "Typical modular features of the Turkish House have the capacity to be regenerated in contemporary design principles...as a system of structure, the Turkish House presents a tradition for contemporary architecture" (Eldem, 1983)

Fig 3. The Matrix of Planimetric Organizations of the 'Turkish house: the plan type with an outer sofa

Fig 4. The Matrix of Planimetric Organizations of the 'Turkish house: plan type with an inner sofa
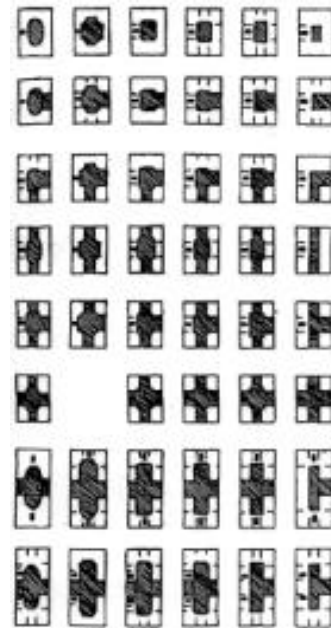
Fig 5. The Matrix of Planimetric Organizations of the 'Turkish house: plan type with a central sofa
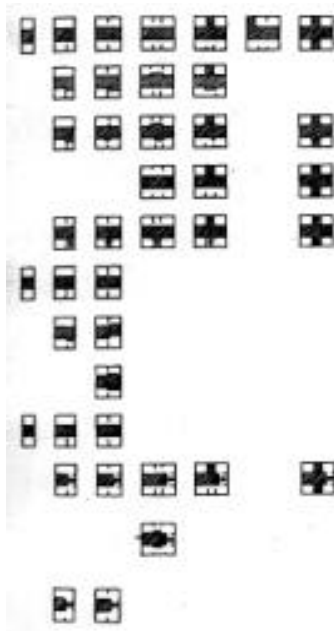
These abstracted plan types are explored due to the planimetric organization of *sofa* which is a special form of hall, constituting the distributive space and the focal point of the traditional house. Eldem had grouped the plan types in four basic categories: the plan type without a *sofa*, the plan type with an outer *sofa*, the plan type with an inner *sofa*, and lastly the plan type with a central or an oval *sofa*. (Bozdoğan, 1987)

Out of these abstracted four plan types, Eldem composed a matrix which consists of the possible forms evolved from the same planimetric type. Sibel Bozdoğan (1987) discusses the utilization of type in Eldem's work through the definition of two different notions of type. Bozdoğan (1987) suggest that the first notion of type is the static outcome of documentary analysis or rather the ideal that Eldem aimed to reach at. Rather, in the second one, the first is operated as a methodological and compositional device to direct future designs. (Bozdoğan, 1987) Bozdoğan's statement is a very crucial interpretation of Eldem's matrix of planimetric typology, for it is highlighted as a developable, generative tool in the production of new variations. Furthermore, as indicated by Bozdoğan (1987), the type as the static outcome of the first implication, which appeared as the result of compositional analysis, was utilized in the second implication as a *'generative tool'* for a methodological design approach.

Eldem's approach in Turkish House Plan Types typological matrix can be related to the use of shape grammars which is a contemporary research field in digital-based design. As introduced by Gülen Çağdaş (1996), the shape grammars are used to generate languages of architectural design. Ranging from implicated on different subjects such as Chinese Lattice Gardens (Stiny, 1977), Palladian villa plans (Stiny and Mitchell, 1978), Japanese Tearoom Plans (Knight, 1981) to Greek vase motifs (Knight, 1986), as Çağdaş (1996) points out, the common point of the works implying a shape grammar method is to regenerate the patterns of the products which belong to various languages of designs in a generative approach.

Furthermore, Gülen Çağdaş, in her study *A Shape Grammar: The Language of Traditional Turkish Houses* (1996) has introduced a parametric shape grammar which generates the plans of traditional Turkish houses. Based on the abstracted two-

dimensional plan types generated by Eldem, Çağdaş introduces a shape grammar concerning the possibilities in the formal world of a vernacular architecture. (Çağdaş) In a similar context, Birgül Çolakoğlu's studies on Hayat house type found in Sarajevo, Bosnia Herzegovina also introduces a re-interpretation of vernacular housing typology by the use of shape grammars. Similarly, Belinda Torus's studies on Mardin vernacular housing, introduces a parametric model in which different potential plan types are generated based on a rule-based design method. (Torus, 2008) As Çolakoğlu (2001) claims, shape grammars define a rule-based design method, expressed as algorithm that describes the computational mechanism for composing shapes, utilizing symbols, geometry and algebraic operations. (Çolakoğlu, 2001)

As to be found in Eldem's approach, computational procedures are open-ended by their nature. The abstracted amount of data set in a mathematical operation is open to a re-development and re-interpretation process succeeding the initial study. It is the potential of any computational study is to be made up of algorithms which are understood as abstract and universal mathematical operations that can be applied to almost any kind of any quantity elements. (Terzidis, 2006)

2.2 İLHAN KOMAN AND DEVELOPABLE SCULPTURE SERIES

İlhan Koman's work of art is usually cited with its modern connotations by art historians. However it should be accepted that Koman's work varies according to the materials used, the scale and the design approach he had developed in various periods of his art work. Although Koman had always been interested in engineering and curious about mathematical concepts, he had intensely worked on mathematical–based forms after 1970s.

Koman studied the forms inspired by mathematics predominantly between the years of 1970-1986 in Stockholm. Sculpture series such as *Hyperforms*, *Polyhedra and Derivatives*, *Infinity -1 Series* and *Pi Series* can be marked as examples of that period. In these years, although computer was not a widespread technology, some early experimental studies on computer are known as well. While he had not used computer technologies in his works, Koman's approach in his formal studies imply the elements that can today be set and developed by digital technologies.

Like π, *3D Moebius*, *Hyperform* and *Infinity* consist of series of different, yet identical forms that are derived from the same single formula. Being definable as digital codes today; these forms can be reproduced at different scales by being derived from each other according to the formula they use.

The equivalent of this approach in contemporary digital design discourse can be found in the definition of 'parametric design'. Parametric design implies an approach in which the possibilities of architectural form that are more than one are defined. Mathematical definitions of almost infinite number of probabilities are possible for the same object using parameters. As Branko Kolarevic (2003) argues "What is expressed in parametric design is not the shape of the specific design, is but the parameters. By appointing different values to parameters, different objects and configurations can be created."

It can be claimed that regarding form as a multiple and derivative concept cannot be valid without the potentials of digital medium. Yet İlhan Koman's approach on form accommodates a remarkable exception: Although they were not produced using digital technologies, Koman's form series are results of a computational and relational thinking system. In Koman's series, which presents an approach that overlaps with the form conception of contemporary digital architecture and

design discourse, as an answer to one simple question on form, there is a series of forms deriving from a single formula.

In the field of form, the traces of transformation—often associated with the use of digital technologies—can be searched in the works of İlhan Koman who studied form through numbers, in other words, explored the formal solutions to mathematical problems. Koman's form studies, in which he interprets mathematical concepts with his unique artistic approach, can be reconsidered in the scope of digital design studies, so that they can contribute to the contemporary discussions on art, architecture and design.

The design object existing independently of any kind of representation, resemblance relations, by the nature of digital and computational design, can be found in Koman's works. On the consideration of Koman's form researches on material as "works not going beyond abstract beauty" by some commentators, Orhan Koçak (2007) expresses: "These works' abstractness is at best related to the fact that they do not resemble anything in nature. But except this fact, they are quite concrete; they have abandoned the rule of resemblance, they are only themselves." The *Pi Series* may exemplify this discourse.

2.2.1 The Computational Aspects of $\pi + \pi + \pi + \pi + ...$

The *Pi Series* that İlhan Koman produced with materials such as paper and sheet metal between 1980-83 in Stockholm can be defined as a serial of form created with the rule of expanding surface of a circle with multiples of the π value, without changing its radius. In his article about this serial, written in 1983, Koman grounds his basic idea on mathematician Euler's (1707–1783) theorem that proves the possibility of 720 degree surfaces such as 2π. Koman states that:

"I asked myself what a surface that is more than 1π would look like; even how it would be with more πs. This serial is the answer to this. If a circle section is added in a two dimensional circle, circle will rise and become three dimensional. The more angle of the section is increased, the more curve becomes larger. When the angle of the section becomes 1π, surface will be formed from 2π and will become another form. 3π, 4π, etc. new forms will exist – in these forms not only an axis but full opposite symmetry does exist. Many numbers of πs will create a sphere like form."(Koman, 1983)

Fig. 6 Nine variations from $\pi + \pi + \pi + \pi + ...$ series (Photograph: Tayfun Tuncelli)

In the same text, Koman claims that creation of a sphere by endless number of Pi's would result in a new definition of the sphere and that new definition could be used in theoretical physics. As an example of the developable surface, the fundamental principle of the Pi Series is also used in Frank Gehry's Bilbao Guggenheim Museum Project in 1990s. Similarly, in respect to its capability of minimum volume when folded, Koman offers that Polyhedra -a mathematical innovation that had also been patented- can be used in space applications. Relying on these examples, it can be claimed that Koman designed his works as fully functioning models –prototypes- which are the results of a design research.(Özsel Akipek and Kozikoğlu, 2007)

Designing his works as prototypes entails the re-production of them at different times and in different places in large scale. In correlation with contemporary design processes, Koman's form series include the potential for being a digital prototype next to being designed as material prototype reproducible in large scale. For instance, in digital medium, Pi can be suggested to gain the capability of production in different scales with various material choices through the integrated seamless design and manufacturing process. The re-production process in Koman's form serials does not operate by imitating, resembling or replicating but needs an analysis of the digital codes of the form. For Koman's works of art, even material or digital, every reproduction process includes a new research process in which the initial step by Koman is extended in different layers.

Koman (2005) stated that: "The content I expect to see in a work of art must be part of a chain, the last link of which is always open to welcome the newcomer. Just like concepts of science. All in all, I would like to be able to make the art of 'the enabling link'." In accordance with his expectation, Koman's works are placed at the heart of contemporary research in the fields of mathematics, art and design. In their paper called "Developable Sculptural Forms of İlhan Koman", Ahmet Koman, Tevfik Akgün and Ergün Akleman (2006) explore the developable surfaces including their use in recent architectural examples and mention successive studies on the *Pi Series*. As highlighted in this paper, the form of *Pi* seems to be an anonymous discovery which can also operate as an instrument to other sub-discoveries. The reproduction potential of *Pi* both in material and digital medium also supports this suggestion. The interpretation of Koman's work as an early example of computational design not only provides to understand his work in a different point of view, but also contributes to expand the content of concept of computation.

3. Conclusion: Two Faces of a Computational Approach

Having distinct contexts, both studies introduced in this paper can be claimed to have issues related to an underlying computational approach, but in two different ways. İlhan Koman, in developable form studies such as Pi Series, used a simple form of algorithmic equation to reach a formal expression. He was consciously aware of that his form research was not only about any artistic concerns, but also his inventions have the potentials to be developed for other future uses in science or engineering. This exceptional attitude of Koman proves itself in his emphasize on mathematical concepts and implications of computational procedures to his work of art.

On the other hand, Sedad Hakkı Eldem's methodological studies are shaped for a more determinist purpose related with his own design practice. He used the abstracted typological matrix to form a basis out of the repetitive elements of vernacular architecture. His aim was to show the possible combination of various evolving types that are possible to be re-

interpreted with the elements of Modern architecture.

In contemporary design practices, it is possible to find similar practices for both of the mentioned works. In the present reproduction process of Koman's works, the computational aspects are being used. For example, Mehmet Göğüş who is producing some of İlhan Koman's work has discovered their availability in digital medium as parametric equations. Besides conventional material reproduction, he tries to experience a digital reproduction process out of the algorithmic expression of Pi Series in digital medium.

Furthermore, Eldem's matrix in Turkish House is already adapted to a shape grammar implication whose parameters and rule-sets can be re-composed several times. Based on a similar approach, it is also possible to mention other contemporary works either concerning housing or collected data of any kind from other fields.

The research into the generative works of Sedad Hakkı Eldem in Turkish House Plan Types and İlhan Koman in developable form series provides to reveal some unexpected traces of a computational approach which is usually confused with the possibilities offered by digital technologies. This pair of works associated with contemporary practices in this study is not the only possible path for the exploration of the origins of computational design culture.

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