

# Four Chairs and All the Others - Eigenchair

## Data driven design

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**Abstract.** *By contemplating on the Eigenchair project, we ponder upon strategies and concepts of designing by using information technologies. What are the potentials of data driven design? What happens with objects when they are abstracted and reduced to a set of data? The emphasis is no longer on the creation of physical objects, but on conceiving meta-objects in the possibility space. Furthermore, this enables us to manipulate with a whole population of objects, instead of a single object. How do we get this abstract system to relate to the real world? Information technologies have opened up a number of new ways of thinking about the world and the object and they, by far, surpassed the formally simplified expression in design and architecture. Based on intellectual heritage of history and culture, information technologies can, by utilizing and recycling various elements and information, explore the 21st century object.*

**Keywords.** *Eigenchair; eigenvector; Principal Component Analysis; data; indexing.*

## EIGENCHAIR

The project *Four Chairs and all the others* opens the possibility of an alternative definition of design. Rather than offering yet another thesis in support of linear design development, it emphasises its polysemantic nature by understanding design process as an open field of possibilities, which not only explore physical limitations of space, but also react to contemporary social and cultural phenomena. In order to explain the idea, specific techniques were used to replace simple design concepts with a series of parallel narratives, thus provoking new and unexpected situations. The primary field of interest of this project becomes the intersection of different domains of human knowledge, especially architecture, culture and information sciences.

*Eigenchair* is a concept that results from the effort to design a chair that refers to the genealogy of chairs, yet carries the potential of all chairs that might ever be created in future (Figure 1). This is the central subject of the project *Four Chairs and all the others - Eigenchair* which is observed and explored as a sum of ideas. Prefix *Eigen* is commonly used in linear algebra in compounds such as *eigenfunction*, *eigenstate*, *eigenvector*. It comes from the German word *eigen* which means "own". The basic tool for the design of the population of chairs - i.e. "all the others" - is the *Principal Component Analysis* algorithm (Abdi and Williams, 2010). It is a standard tool for contemporary data analysis that has been adapted to various needs, from the neuroscience to comput-

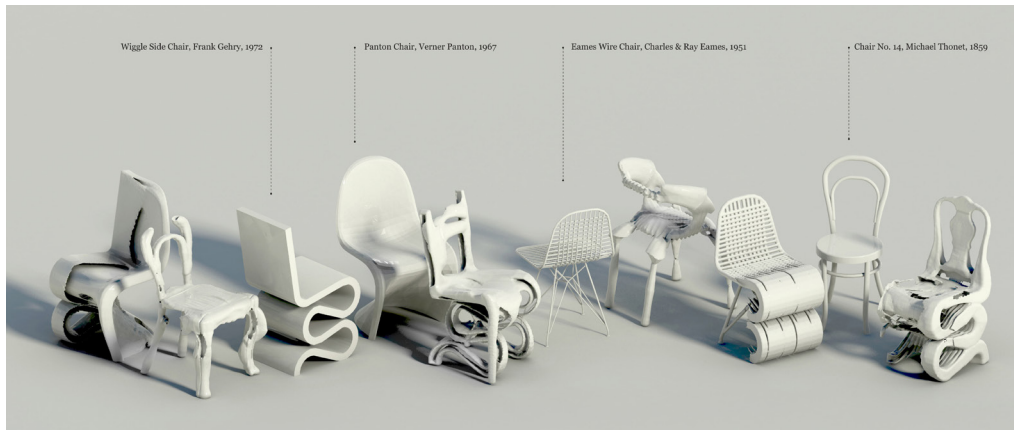


Figure 1  
Different renderings of an  
EigenChair.

er graphics, and which is now being applied in the field of design (Sirovich and Kirby, 1987; Turk and Pentland, 1991). *Principal Component Analysis* reduces a given data set to a set of *principal components*, i.e. *eigenvectors*. The key feature of this algorithm is the intersection and interconnection of all data, whose result adapts and changes according to the required point of view, i.e. subjective interpretation.

The objective of this project is to show strategies and concepts of designing by using information technologies. What happens with objects when they are abstracted and reduced to a set of data? What are the potentials of data driven design?

## ALTERNATIVE DEFINITION OF DESIGN - DESIGN APPROACH

Radical view of the world and society is today mediated through advanced technological systems. Thanks to – or perhaps due to – such circumstances, the design seeks new ways of thinking and conceptualizing, as well as producing objects and ideas. The informatization of the society and the computer-aided design are opening a whole range of new ideas about the perception of time and space we live in. The algorithmic design is now based on new parameters: design of ideas, narratives, procedures, populations, digital production, and new understanding of the materiality. Generative design methods mean

creation and modification of rules and systems, which then generate an abstract machine - or a population of objects. The designer therefore does not manipulate the “artifact” itself, but rather the rules and systems which generate it. The emphasis is no longer on the creation of physical objects, but on conceiving meta-objects in the possibility space.

## Recycling Information

The postmodern condition defines a set of critical, strategic and discursive practices which, as their main tools, use concepts such as *difference*, *repetition*, *simulacrum*, *hyperreality*, in order to destabilize modernist concepts such as *identity*, *linear progress of history*, or *unambiguity* (Aylesworth, 2013). The supermodern condition, on the other hand, is not focused on the creation or identification of the existing “truths”, but on the filtration of useful information among the plenitude of new media cultural practices. In order to avoid postmodernist tautological nihilism, the supermodernist paradigm approaches the deafening cacophony of sings in an active manner. This paradigm also operates within the field of design, in which it is no longer the object that is in the focus of research, but its characteristics, features, relations, ratios, structures, indexes. The information age enables a redefinition of postmodern techniques such as *collage*, *assemblage* or *bricolage*,

Figure 2  
Initial data set of 12 chairs.



all of which define an object by collecting and reassembling various information and elements. The newly created object is now a fusion of different objects' data but it is also completely unique and independent in form. This project is an example of digital recycling which, recycles information and data of chairs (Figure 2).

### **Elitism And Exceptionalism Of Singular Object Vs. Individual Populism Of Generic Objects**

So far, the field of design understood practices which dealt with singular objects, that is, the creation of unique and specific "ideal" objects. Such an approach was closely related to the modernist paradigm. Today, however, the emphasis is moving from the design of an object to the design of an idea. The new paradigm changes designer's relation to a static object by putting an emphasis on conceptualization, interaction of the components, systems, and processes. What was once the design of a perfect, unique object featuring *specific* materiality is today the design of a population of objects featuring *any* materiality. Instead of a specific object, the designer creates an algorithm. Elitism and exceptionalism contained in the idea of a *singular* object is replaced by "individual populism" of *generic* objects. The key role is taken over by generative systems that offer methodology and theoretical world view in the framework that go beyond dynamic processes. The

design process becomes an abstract definition of algorithms. Instead of focusing on a "perfect" chair a whole population of chairs was designed (Figure 3).

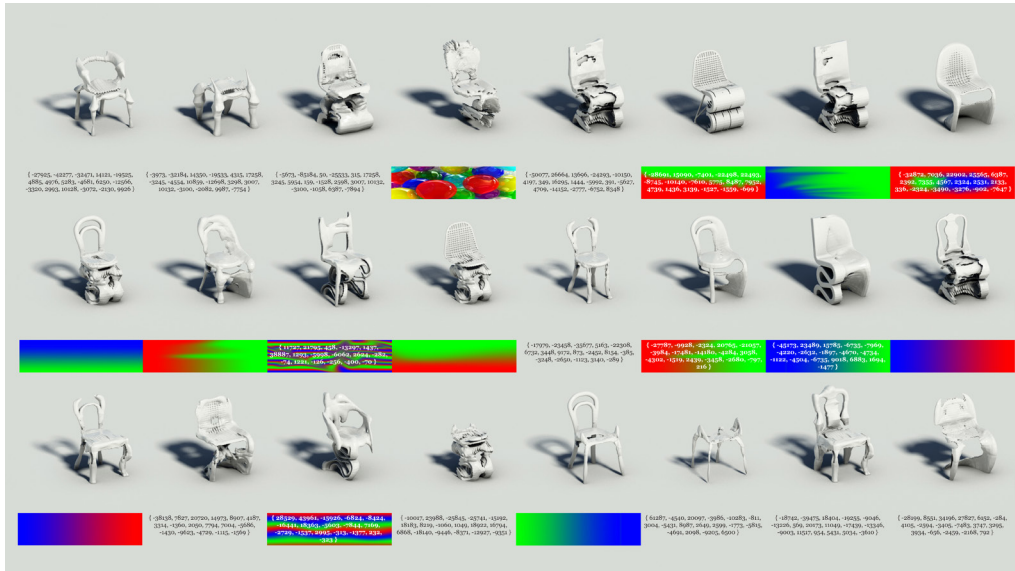
### **Imposed Materiality**

In generative object design, materiality of an object is not a precondition for its final manifestation. The choice of material has so far served as the basis for determining the design process, defining the expected execution of details, connections and textures. Today, the generative system design enables the imposition of materiality to the object. The form, uncomplimentary to certain material, can now be attached to it by mere use of intellectual control. Therefore, the objects, previously described by *fixed* geometry, can now gain *relative* geometry that can be rendered into reality via 3D printing. Its materiality is the last, almost arbitrary decision done by a designer (Figure 4).

### **Designing Narratives**

By rethinking the notion of "good design", one comes to the conclusion that design is just a tangible fragment of reality, which narrates one of the many stories that surround us. Design never appears in silence. What we call "good design" nowadays is imbued with a series of narratives constructed by different discourses: formal, ideological, psychological, and theoretical. Only one part of the design process is constituted by its material and formal as-

Figure 3  
Population of chairs defined by maps and Eigenweights.



pects, while most of it is built upon stories which describe it and the individuals who transfer the stories or identify with them. Therefore, besides designing an object, it is also necessary to design a narrative which defines its meaning.

The research focus of the project *Four Chairs and all the others* is the design of a chair which does not carry on the heritage of iconic or functional pieces of furniture, but a one which contains information about "all chairs ever created", for which the term *Eigenchair* is used - to describe a sum of ideas. The algorithm database contains a number of "other chairs". Their fusions enable an infinite variety of possible results. In order to achieve a certain control over the results, out of "all other chairs" we have chosen four chairs as a precondition for creating identity and narrative. Fusions of characteristic parts of those four chairs with all the others are defined by user made maps that define the transformations, upgrade the performance of the *Principal Component Analysis* tool, and enable the control of the result (Figure 5). The project *Four Chairs and all the others* refers to four iconic chairs: Thonet's *Chair No.14*,

*Wire Chair* by Charles and Ray Eames, *Panton Chair*, and Ghery's *Wiggle Side Chair* (Vege sack et al., 1996). Their main mutual link is specificity and uniqueness of the material and their respective technological innovation, depending on the context in which they were designed. It is the richness of meaning and historical references of these examples that are responsible for enabling us further creation of analogies, stories and narratives, which, in turn, fertilizes viewer's active participation in the process of visual representation.

### MULTIDIMENSIONAL VECTOR - TECHNICAL APPROACH

The project *Four Chairs and all the others* deals with manipulating data, thereby generating new objects. A whole library of chairs, that is, their geometric and spatial characteristics, along with their historical importance and their narratives, is taken as the starting point of the project. By using open source 3D models of chairs from Google warehouse, their geometry is appropriated through a set of algorithms, after which the *Principal Component Analysis* algo-

Figure 4  
3D printed models of chairs  
generated by EigenChair  
application.



rithm is used to fuse, merge and manipulate input information and create new objects. The result is a population of objects that are over coding cultural and historical space-time relations through logistic networks. Final design is entirely a product of mathematical and logical thinking. The object now becomes a product of pure intellect, grounded in history and culture. The main algorithm, which defines the whole project, is *Principal Component Analysis* algorithm.

### Logical steps

The initial step was to normalize and prepare the data of all the chairs. In this case study, 12 chairs

were used as testing data set due to the computational limitations. All data had to fit in the same bounding box, and mesh vertices were equally distributed throughout the mesh.

The whole application consists of three main parts. The first part is the *Algorithm for Voxelizing Polygon Meshes*. This algorithm transforms each mesh into a voxel based object defined by a one-dimensional numerical array list, i.e. multidimensional vector. In case of the highest resolution, each chair is represented with 2,788,875 values. Each value marks the distance between the given voxel and the closest mesh vertex. Values for each chair are exported as separate txt files, in order to reduce computing time of the main application (Figure 6).

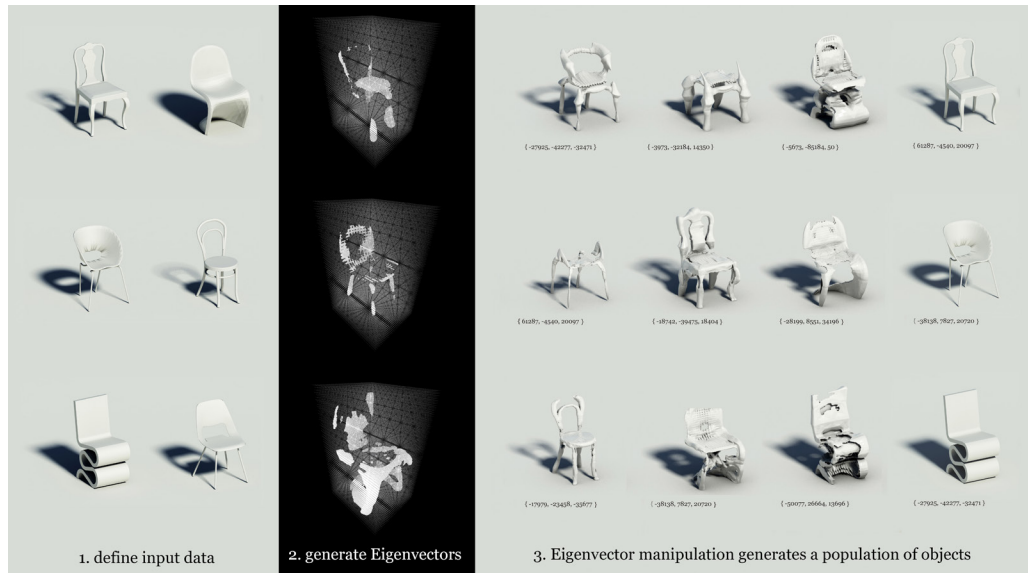
The second part is the *Algorithm for Morphing Chairs*. The base of this algorithm is the *Principal Component Analysis*. The goals of *Principal Component Analysis* are to extract the most important information from the data set; compress the size of the data set by keeping only the important information; simplify the description of the data set; and analyse the structure of the observations and the variables.

Figure 5  
New chair as a fusion of  
Panton Chair and Wiggle Side  
Chair.





Figure 7  
Workflow of the Algorithm for  
Morphing Chairs.



### Reflection On The Real

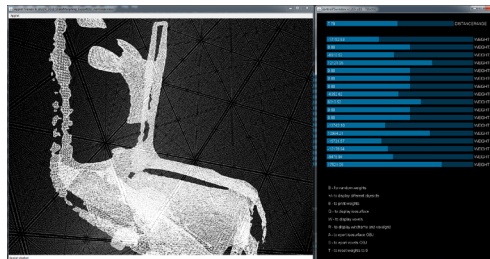
It is impossible to comprehend or examine what is “real”, because it depends on quantisation and formalisation of ideas. The hierarchy and the relation between the original and its copies, which was the key concern of the materially oriented society, have become completely irrelevant in an age in which virtual reality dominates human lives. Depending on the ways of our understanding and accepting of the “unfamiliar”, we legitimatise and comprehend the real. Brian Massumi perceives this in a multifaceted way, by comparing Baudrillard’s interpretation of the reality-simulation, in which there is no division

between the real and the virtual, with Deleuze’s and Guattari’s negation of the linear approach to the real. Such understanding of reality is supported by the vanishing of boundaries and the influence of the virtual on the real. *Simulation is a process that produces the real, and vice versa* (Massumi, 1987).

### Abstraction

The Internet age is exactly such condition, in which immaterial information is part of what we call reality. In this context, the only way of manipulating with information is abstraction, and it can be adequately used only by those who are, in a mass of information, able to define their context as a flexible, adjustable field of possibilities with multiple meanings. The project *Four Chairs and all the others* considers the abstraction of objects to the degree that enables their manipulation and the creation of new meanings (Figure 10). If objects - chairs, or whole populations of objects, are abstracted to the level of multidimensional vectors, i.e. to a series of numbers in a line - indexes, they become very potent and manipulative (Figure 11). Such abstract objects, i.e.

Figure 8  
Main EigenChair application  
interface – left Voxel based  
space – right – control board.



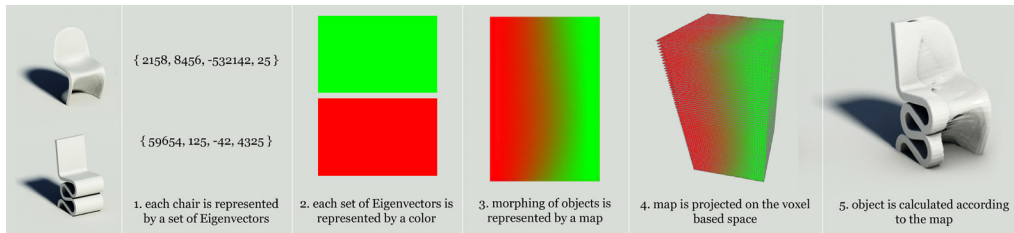


Figure 9  
Diagram of an Algorithm for  
Mapped Morphing.

indexes, are placed in a meta-space, which contains potentials of all objects present there (Figure 12). Governed by the *Principal Component Analysis* algorithm, meta-space is able to correlate indexes of all objects, creating thus an open logistic network, a possibility space. This marks the level of articulation of different elements and the creation of whole populations of objects of the same “kind”. By looking at objects through the level of their abstraction, we realise the potency of information (in meaning and shapes, with which we can manipulate), but at the same time its complete emptiness when perceived on the index level alone.

### Meaning, Context And Narrative

Post-traditional society offers new perspectives on old concepts, to which we give new meanings or judge them by creating our own context. The mass of information shapes our world: text, visual representation, music, money. However, the idea that “information does not carry meaning” offered by the information theory pioneer Claude Shannon, has become rather liberating in the academic discourse; information carries unlimited freedom of manipulation. It is important to emphasise that contextualisation and the successive creation of narratives “fill” the systems of information. They gain power by careful selection of data implanted in them, taking care at the same time that the contextualisation and the creation of stories which surround them rely on culture and history (Figure 13). It is also important to note that in the process of contextualising the generic before the generation itself, there is a whole scale of possibilities which had been predetermined, but which are also opening the potential for the un-

expected. This project shows that design is able to manipulate predetermined potentials, while filling them, at time same time, with narratives. Design is not a part of the endless evolutionary process aimed at creating the next new ideal object, but a part of a defined context and chosen references with their respective genealogies.

### EIGENCHAIR - DATA DRIVEN DESIGN

By using information manipulation and various spatial conceptions, algorithmic design approaches an object in a completely abstract manner, separating it thus from the “reality”. While making it extremely flexible for different interpretations and contextualisation, it also contributes to the instability of the process as a whole. The object can easily be reduced to a geometry exercise. Therefore, the key feature of design is not only the definition of algorithms, but also the construction of parallel narratives around the object. It is therefore necessary to re/turn to the postulates of the pre-Socratic philosopher Empedocles who claimed that “nothing comes out of nothing and nothing disappears into nothing”. Such philosophical re/turn marks an effort to observe context and processes as more important factors for defining the object, than those implicit in the Objectiv-

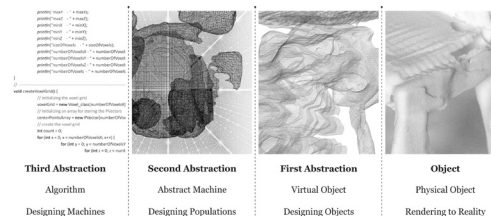
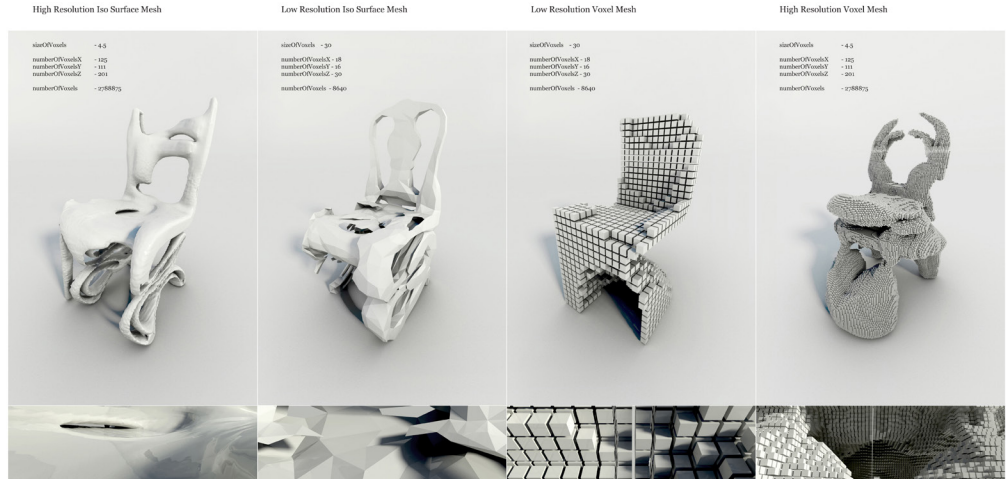


Figure 10  
Levels of abstraction.



Figure 11  
 Different resolutions and visualization of an EigenChair



ism (Terzidis, 2012). The advantage of the processual design in contemporary world is its ability to refer to the sum of global knowledge and to use it effectively. The result of such turn/over is the creation of new perspectives in defining objects, as well as a gradual

shift of design's limits. Finally, the algorithmic design should adopt strategies and dynamics which deal with the creation of narrative and contextualisation. This project tries to show – by conceiving and shaping the idea of a chair for the 21st century – the ne-

Figure 12  
 Meta space - possibility of interconnection and interrelation of all active data.

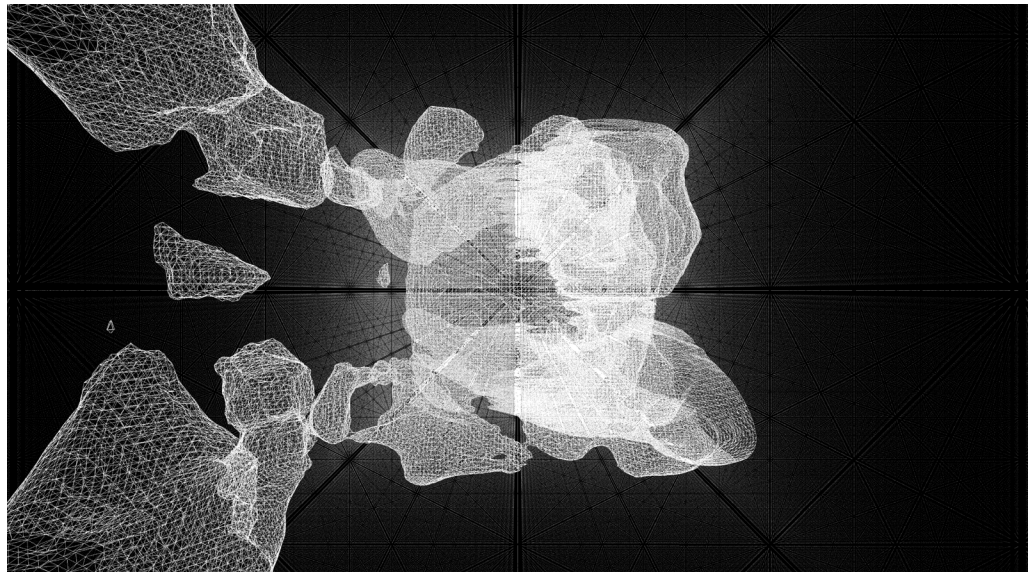




Figure 13  
Contextualisation and the  
creation of stories around  
objects.

cessity of perceiving design through three equally important, interdependent positions: design, theory and technology. Design is now data driven.

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