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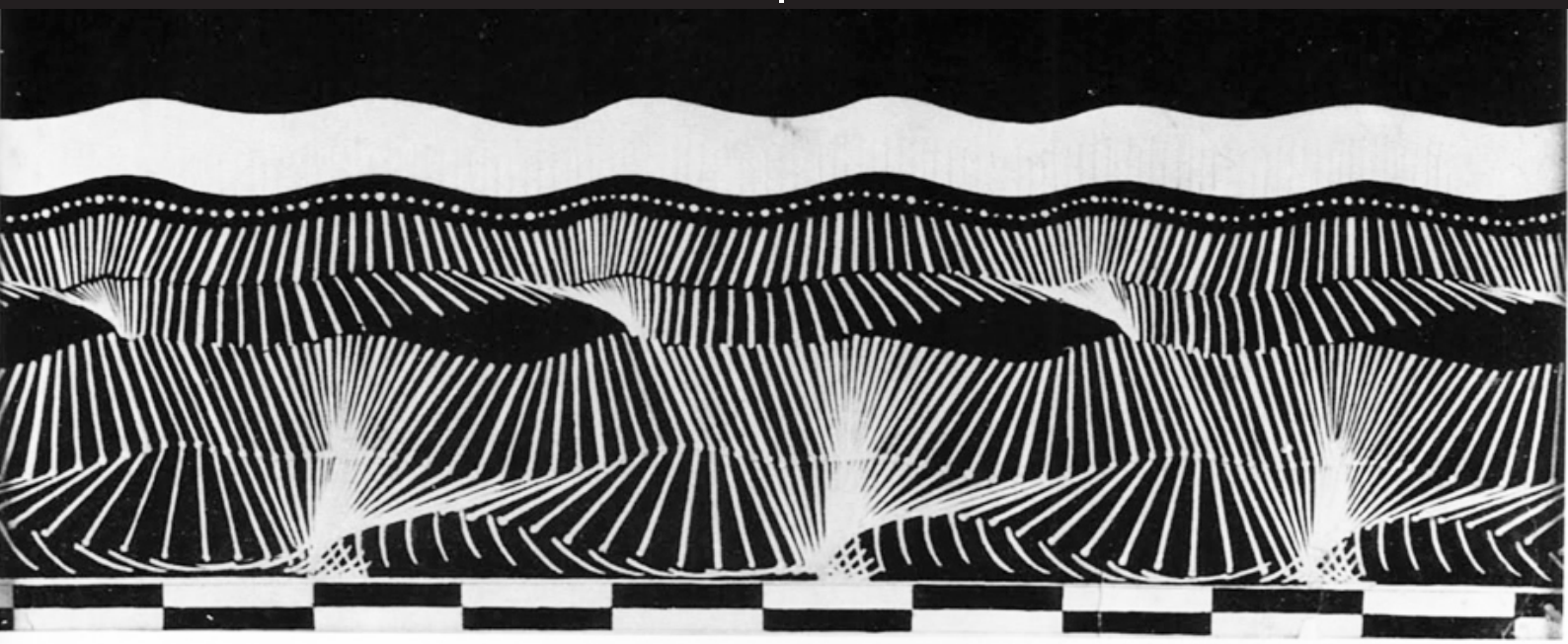

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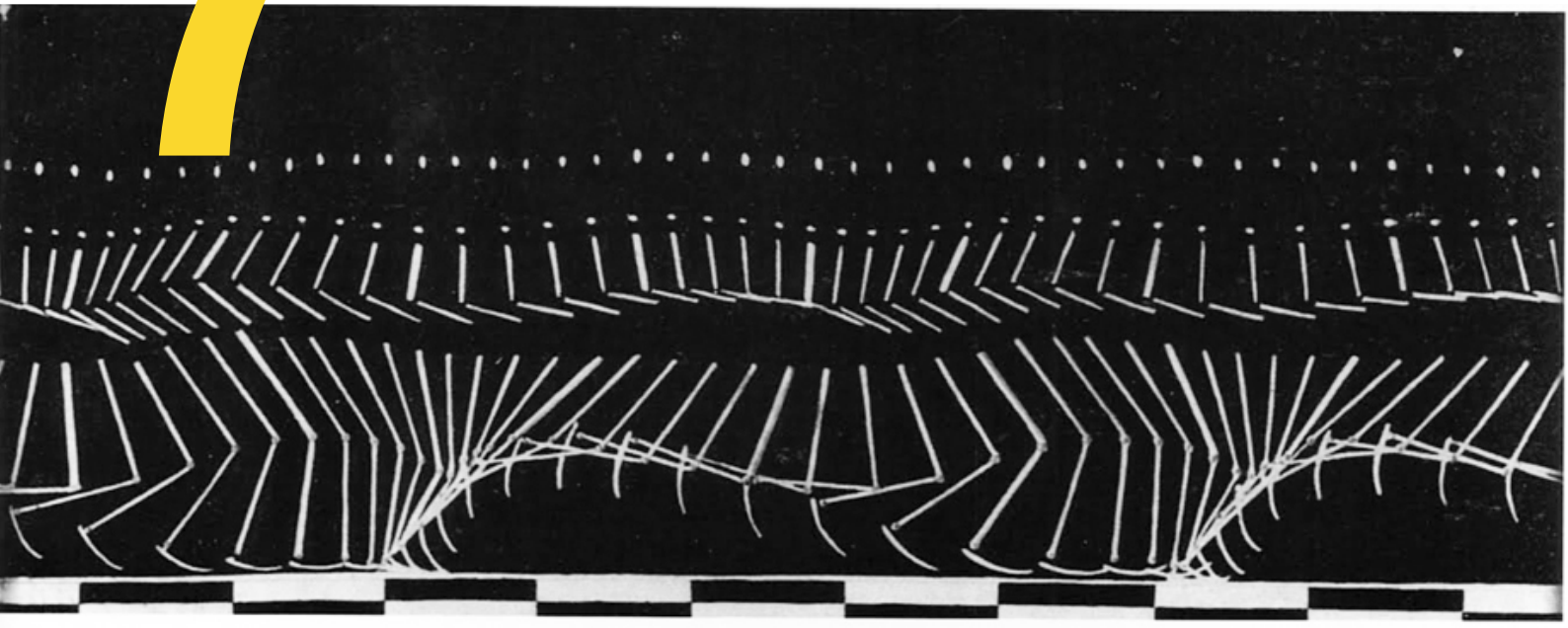
TRANSFORMABLE ARCHITECTURE



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Transformation principles in the architectural design of a contemporary house

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Abstract

The process of constant changes in social, spatio-physical, technical, technological, and economic frames reflects on the functionally physical structure of contemporary residential buildings. It actually initiates a faster development of new approaches as well as redefining traditional residential concepts. The development and application of the transformability concept is essentially connected to the fact that the traditional concept of residential architecture is not adapted to the circumstances of a contemporary resident and his needs, which, besides those that are predictable, can often include those unspecified and unknown. The applicability of design principles is changing and questioning the design patterns of contemporary residential buildings at the same time. This work emphasizes the importance of the application of transformation principles in the development of an architectural design methodology for contemporary residential buildings. It also raises new analytical questions which lead to an upgrading of knowledge in the field of design process. The concept refers to the physical transformation of an inner spatial plan and the transformation of the object membrane. It is about the spatially physical modifications which are accomplished by changes in the position, shape and structure of the characteristic elements of transformation. The research and analysis of the transformation principle, based on architectural design, emphasizes the importance of the identification of the basic characteristics which define the structure of the concept of transformable residential buildings and which are able to adapt to the constant changes caused by the needs of today's users and environment. The term "transformable residential buildings" refers to objects which can be transformed, changed and adapted, even after they were built. The aim of the application of the transformability concept is the improvement of the functionality of a building, and that is why this research is dedicated to the establishing and explaining of transformation principles which are applied in the architectural design of contemporary residential buildings in the conceptual phase of their project. The application of transformation principles, on the conceptual level of designing decisions, represents a part of notional designing strategy, where the assigned goals of a transformability of a residential structure are being accomplished. Actually, it is dedicated to the difficulties in designing buildings which can be transformed even after they were built. The analysis of the transformation concept of contemporary residential buildings is being done through the analysis of referential examples, according to the previously noticed transformation models and key influences on concept development. The examples are analyzed on the basis of applied transformation of an inner space plan and transformation of an object membrane, whereas the functional analysis of the structure of residential spaces is not emphasized. However, this research attempts to establish principles which, if applied, will help for diverse functions and forms to be accomplished. In other words, it is aimed at noticing the basic transformation elements which are used in the process of accomplishment of the concept of transformation. The visual and physical transformations are dependent on eachother and inseparable. However, the physical transformation of an object, which relates to a spatially mechanical movement of basic constructive elements, is dominant and the main topic of this work.

Keywords

Transformability; Transformation principles.

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The History of the Transformable House

Contemporary architectural practice actualizes the topic of transformability concept development in residential architecture and raises questions concerning the adaptability of contemporary residential structures in the continuous process of changing needs and different situations, as well as the set of development models of possible transformations, which represents the central topic of scientific research. The awareness of changeable spatio-physical, economic and technological conditions, capacities and the contemporary social needs of life processes has reflected on and largely built itself into the tendencies of contemporary architectural design.

If we look at the development and implementation of transformation principles in architectural design from the beginning of the 20th century till the present day, we notice that residential structures have a dominant position compared to other types of objects with a changeable spatio-physical structure (Lee, 2012).

In the past the very existence of humans was based solely on their ability to adapt to a new environment in a neverending process of habitat change. From the 18th century on, with the appearance and development of the idea of a skeletal construction system, the aim was to finish with a massive construction system and introduce steel spatial structures, the goal of which was to make the design and use of inner space simpler and more transparent. Till the end of the 19th century, most structures built in this way were designed without inner partitions in order to set them afterwards in a way that suited users best. Between the two World Wars, with the development of modernism, the architecture of residential buildings became a field where experimental and innovative concepts of design processes were applied. This was a time when a house became an experimental polygon and the implementation of new materials and technologies was promoted [Figure 1]. At the beginning of the 20th century, Le Corbusier (1986) defined "five points of architecture," one of which was known as "the free plan" (p.9). His Dom-ino house was designed according to these principles in 1914. It had clear horizontal flats supported by a skeletal holding system without any fixed inner partitions, in order to eventually define the space according to the specific needs of the user. It resulted in an absolute liberalization of the form and function of flexible architecture. In his postulate of these principles, Le Corbusier relied on architect Adolf Loos's Raumplan concept, which brought a new approach to the perception of flexible space in the design process of residential houses. In the period of the development of modern architecture, Theo Van Doesburg (1924) explained his theory in an article, Towards a Plastic Architecture, wherein he expressed his view that modern architecture was the one which was open (p.79).

World War II largely slowed down the development of experimental residential architecture and the design process was directed to fast and efficient construction rather than to innovation and a new approach to accomplishing a contemporary residential concept. During this period, the architecture of contemporary residential bulidings was, above all, based on the elaboration of a prototype architecture concept, and was in accordance with priorities directed to a fast and efficient restoration of cities and settlements. It significantly influenced the appearance of industrialized concepts and ideas, like Buckminster Fuller's prototype house, called Dymaxion [Figure 1-right], which emphasized construction adaptability and flexibility as innovative components. This was when the period of an advanced development of prefabricated construction started, whose basic priority was rationality, speed, flexibility, and the implementation of modular systems.

Encouraged by the rapid development of prefabricated architecture, the experimental design in the architecture of the 1960s became a predominant idea [Figure 2], through the work of young avant-garde groups like *UFO*, *Archizoom* and *Superstudio* in Italy; *Coop Himmelblau* and *Missing Links* in Austria; *Ant Farm* and *Experiments in Art and Architecture* in the USA; and all the way to visionary utopian architectural elevations like the *Archigram* in Great Britain. At the same time these groups

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Figure 1.
(from left to right) Gerrit Rietveld, Schroder house, Netherlands, (1924); Le Corbusier, House 14 and 15, Germany, (1927); Buckminster Fuller, Dymaxion House, USA, (1945).

Figure 2.
(from left to right) Arhigram, Peter Cook, Plug in city, (1964); Kisho Kurokawa, Nakagin tower, Japan, (1972); Arhigram, Michael Webb - Suitaloon, Studio Vista, London, (1972).

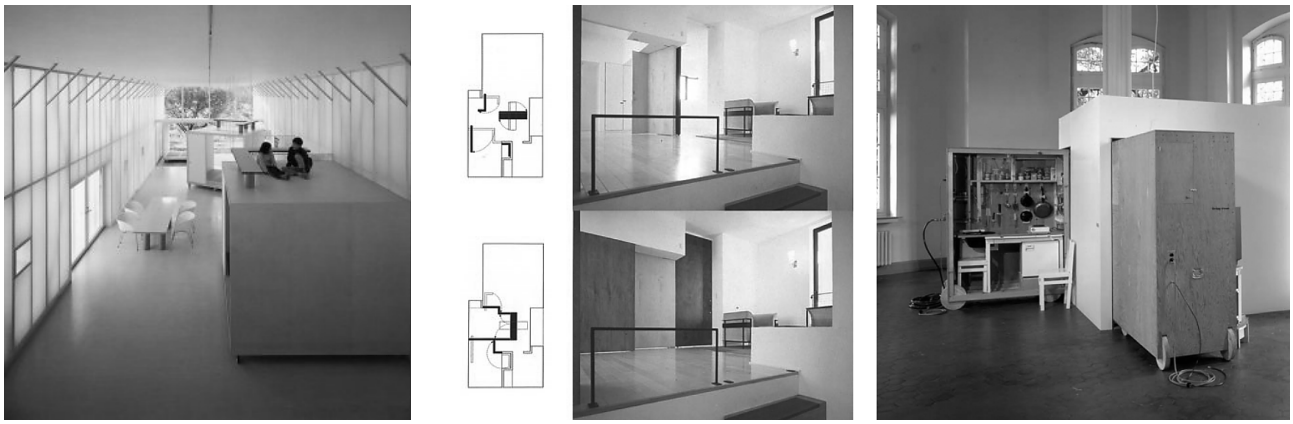

Figure 3.
(from left to right) Shigeru Ban, Naked house, Japan, (2000); Steven Holl, Fukuoka housing, Japan, (1991); Allan Wexler, Crate house, (1991).

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appeared, the manifesto of Japanese architects called "The Metabolism of 1960: The Projects of New Urbanism" started. It tried to answer the question of where contemporary residential architecture in Japan was heading at the very moment when the nation was losing its own identity. At the same time this concept was developing, another term appeared - "the capsule." It represented a very adaptable, fast and rational element of contemporary residential architecture.

In the 1970s, compact residential units were the focus of the designing ideas of Marco Zanuso, Alberto Rosselli, and others, who developed the concept of one-room residential units through their innovative projects, and those units served as places where more than one person could stay at the same time. These mostly utopian concepts continued to exist throughout the developing process of transformable residential structures. At the end of the 20th and the beginning of the 21st century, the implementation of the transformation principles in residential buildings became more and more noticeable as technology was developing and users' demands were becoming more complex, whereas experimental, liberal and innovative ideas became the predominant stream once again. The implementation of transformation principles in residential houses' architecture became more prominent and bolder, starting with Alan Wexler's experimental Crate house and the Fukuoka multi-family residential house in Japan by architect Steven Holl, both of which were built at the beginning of the 1990s, over the innovative technically technological solutions of the Massachusetts Institute of Technology (MIT), to a contemporary Japanese house, such as the Naked house by Shigeru Ban [Figure 3].

The end of the 20th century was greatly connected to the beginnings of technologically inspired concepts in transformable residential architecture. Non-contextual architecture with restricted spatial capacities was developing rapidly; i.e. the architecture which was adaptable to context changes in the phase of the exploitation of the object [Figure 4]. Contrary to the technologically inspired concepts, which were typical of the end of the 20th and the beginning of the 21st century, Japanese contemporary residential architecture could be seen, above all, in the implementation of transformation principles in accordance with traditional postulates, where variability of a spatial plan or the object structure was achieved by implementation of the simple principles of adjustment.

Over the last decade, the need for multi-purpose structures is growing consequently to the actualization of the sustainable development topic, where the accomplishment of the concept of transformable and changeable structures becomes an unrestrained process of rapid development (Asefi, 2010). Today, besides the basic implementation of transformation principles in architectural design of residential structures, a distinct dynamism and variety of influences direct this concept to finding solutions to design problems, which are related to distinct socially-demographic destabilization, caused primarily by war destruction (migration, finding solutions to the problem of a growing number of displaced persons, economic crisis, etc.) and by natural changes (natural disasters, which are partly caused by a negative influence of human technological development).

The Key Influences on the Development of the Transformability Concept

The implementation of transformation principles in the architectural design of contemporary residential houses represents an infallible part of architectural discourse, taking into account the fact that the concept which does not have transformation principles becomes insufficiently useful with changes in users' needs. The dynamics and change in general and specific needs, as well as the design for a familiar and unfamiliar user, demand a high level of flexibility in solutions, where the predominant problem is an unfamiliar user, who is statistically generalized, and who is faced with his residential space only when it has already been built and when a lot of energy and resources are needed to adapt it to his own needs (Lazovic, 1988). Thus, in general shortage, the residential space resolves primarily biological

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Figure 4.
(from left to right) Eduard Böhtlingk, The Markies, (1985); Richard Horden, Micro compact home, (2002); Joe Colombo, Total furnishing unit, (1972).

Figure 5.
(from left to right) Andrea Zittel, A-Z wagon station, study, (2012); Michael Jantzen, M house, study, (2011); Michael Jantzen, Transformer house, study, (2002).

Figure 6.
(from left to right) Seifert and Stoeckmann, Living room house, Germany, (2005); Bevk-Perovic architects, House R, Slovenia, (2008); dRMM Architects, Sliding house, UK (2009).

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needs, and its social and psychological aspects, while an upgrading of primary needs is disregarded (small and inadequate spaces, overcrowding, impossible additional work, inadequate layout of rooms, inadequate location, impossible transformation, etc.) The individuality of users' needs, which is expressed by the uniqueness and singularity of their demands, is a basis for the idea of the variety of needs in the construction of residential structures. The transformability concept in the architectural design of contemporary residential houses is essentially linked to the idea of change in contemporary architectural discourse, in the context of social, spatio-physical, technological, and economic conditions. These circumstances (spatial limitations, the change of spatio-physical surroundings, frequent change of users, etc.) have the crucial influence on the establishment of transformation principles in a practical architectural discourse. Architecture becomes more flexible and adaptable in order to fulfill a contemporary context. Architecture has evolved as technology and contemporary human needs develop, but the identification of context with a physical frame has become a problem in the process of architectural design. The acceptance of the concept determined only by the physical characteristics of a place has evolved into finding the answer to the question of aesthetics and form, while at the same time marginalizing or denying the need for more complex insight into the comprehensive idea of contextualization.

The development of construction and information technologies stimulates a multiple implementation of the transformability concept in architectural design, enabling the generating, checking and evaluating of the changeable structure concept and its accomplishment. It presumes the usage of systems enabling new models of architectural design to be created. Such models become part of the technological approach to contemporary architectural design, by means of implementation of transformation principles.

Key Influences

Social aspect
- Users' conceivable needs
- Users' indefinite needs
- Familiar user
- Unfamiliar user

Spatio-physical context
- Inner spatio-physical context
Spatio-physical limitations of inner layout; the reconfiguration of inner space layout in order to join it with the outer spatio-physical context; the reconfiguration of inner space layout according to newly developed guidelines from the immediate outer spatio-physical context
- Outer spatio-physical context
Influences of constant changes in the immediate physical surroundings; natural influences; non-contextual architecture

Technically technological aspect
- The influence of thenically technological aspect during the conceptual design phase - software
- The influence of thenically technological aspect during the phase of transformability concept accomplishment - hardware

Economic aspect
- Design of structures – minimal dimension spaces with a high level of space qualities;
- rationalization of the construction process

Transformation Models

By observing the structures with changeable layout and form as multi-layered structures which have no distinct spatial limits as a group of "Shearing Layers of Change," (Brand, 1944) we notice two basic transformation models [Figure 7] in the architectural design of contemporary residential houses:

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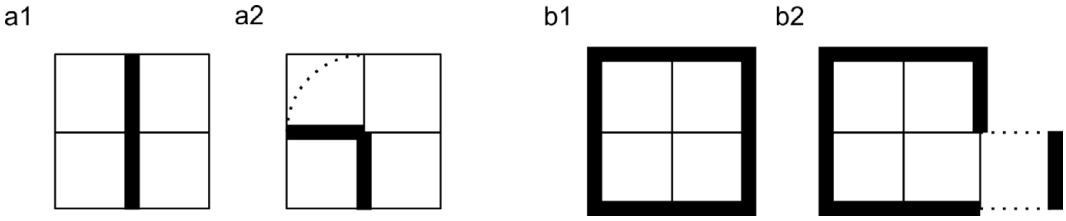

Figure 7.
Ideogram of transformation models.

A/ The transformation of the inner space layout

This represents a spatio-physical transformation of the inner structure of an object, wherein we differentiate two basic levels of changeability according to transformation elements where transformation elements represent the basic building elements of a structure (Partition elements, façade membrane elements and furniture) by which change in disposition or structure the transformation is achieved.

1/ *The primary transformation of the inner space layout*

The transformation which is achieved by implementations on the level of primary elements of residential space, meaning change in disposition, shape or structure, partition elements, and inner space structures (partition walls and inner openings, different spatial volumes, communication elements, etc.)

2/ *The secondary transformation of the inner space layout*

The transformation which is achieved by changes on the level of secondary elements of residential space, meaning change in disposition, shape or structure, movable and fixed furniture (multipurpose furniture which allows change and usage complement by its transformation.

B/ The transformation of the membrane

This represents a spatio-physical transformation of the outer structure of the building, where we differentiate two basic levels of changeability according to transformation elements:

1/*The transformation of the outer membrane with a change in the dimensions of structures*

The transformation which is achieved by changes on the level of the primary elements of a façade, meaning changes in disposition, façade panels and openings.

2/*The transformation of the outer membrane without a change in the dimensions of structures*

The transformation which is achieved by changes on the level of secondary elements of a façade, meaning changes in structure, façade panels and openings. This transformation represents the change in the membrane structure of the building (external influence protection, change in the exposure to the sun, change in the extent of an open space, visual connection between inner and outer space, the formalistic change of the structure aesthetic, etc.)

Determining Principles

Step 1: Analysis of referential examples [Table 1.]
Step 2: Comparative analysis of typical transformation [Table 2.]
Step 3: Determining transformation principles [Table 3.]
Step 4: Definition of transformation principles

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Table 1.
Analysis of referential examples

Key influences:
SP – Spatio-physical
TE – Tehnological
SO – Social
EC – Economic

Transformation model type:
IT – Transformation of inner space
ST – Skin transformation

The degree of influence on the transformation concept:
1 – Low
2 – Medium
3 – High

P1 – Principle 1
P2 – Principle 2
P3 – Principle 3
P4 – Principle 4

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hno	Building description	P1	P2	P3	P4	SP	TE	SO	EC	IT	ST
1	1923-24 **Villa Le Lac (Une Petite Maison)** *Le Corbusier* Corseaux, Switzerland.					1	/	3	1	1	/
2	1924 **Rietveld-Schröder House** *Gerrit Rietveld* Utrecht, Netherlands.					1	/	3	/	2	1
3	1927 **House 14, 15** *Le Corbusier* Stuttgart, Germany.					/	/	2	2	2	/
4	1932 **Maison de Verre (House of glass)** *Pierre Chareau & Bernard Bijvoet* Paris, France.					2	1	3	/	2	1
5	1932 **Kleinwohnung** *Carl Fieger* Germany.					/	/	3	/	2	/
6	1942 **Movable space dividers** *Fred J. Mac Kie, Jr. and Karl F. Kamrath* USA.					/	/	3	/	3	/
7	1954 **Planetveien12 (Korsmos villa)** *Ärne Korsmö + Christian Norberg-Schulz* Oslo, Norway.					2	/	1	/	1	1
8	1973 **Frey house** *Ernst Plischke* Graz, Austria.					1	/	2	/	1	/
9	1985 **the Markies** *Eduard Böhtlingk* Netherlands.					3	1	/	2	1	3
10	1991 **Crate house** *Alan Wexler* Germany.					3	/	/	/	3	3
11	1991 **Fukuoka Housing** *Steven Holl* Fukuoka, Japan.					/	/	3	1	2	1
12	1993 **"gucklhupf" mobile lookout** *Hans Peter Worndl* Austria.					3	/	3	/	/	3
13	1994 **Vinyl milford house** *Allan Wexler* New York, USA.					/	/	1	3	2	/
14	1995 **Bordeaux House** *Rem Koolhaas* Bordeaux, France.					1	/	3	/	1	/
15	1995 **Curtain Wall House** *Shigeru Ban* Tokyo, Japan.					2	/	/	/	/	2

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no	Building description	P1	P2	P3	P4	SP	TE	SO	EC	IT	ST
16	1996 **Fahrt ins Grüne** *Kalhöfer - Korschildgen* Lüttringhausen, Germany.					2	/	2	1	/	2
17	1996 **House in a Suitcase** *Eva Prats and Ricardo Flores* Barcelona, Spain.					3	/	1	/	2	/
18	1997 **Nine-Square Grid House** *Shigeru Ban* Kanagawa, Japan.					3	1	1	/	3	2
19	1998 **Kubus** *Sturm and Wartzeck* /					2	1	/	2	1	/
20	1999 **T.O. Penthouse** *pool Architektur* Vienna, Austria.					3	/	/	2	2	1
21	1999 **Expander** *Kalhöfer - Korschildgen* /					2	/	3	/	3	2
22	1999 **Villa les roses** *Couvert & Terver* Provence, France.					3	/	1	/	2	/
23	2000 **Naked House** *Shigeru Ban* Kawagoe, Japan.					2	/	2	/	3	1
24	2001 **Suitcase house** *EDGE design institut* Beijing, China.					2	/	3	/	3	1
25	2002 **w.o.m.b. project** *Johnson Chou* exibition, Design Show, Canada.					3	2	/	/	3	/
26	2002 **I-box** *Iwaoka Tatsuo laboratory* /					2	/	1	/	/	3
27	2003 **Drawer house** *Nendo* Tokyo, Japan.					3	/	2	/	3	1
28	2004 **CircuitBox** *StudioX* Tokyo Designer's Week, Japan.					3	1	2	/	3	/
29	2004 **Black Treefrog** *Splitterwerk* Bad Waltersdorf, Austria.					3	/	1	/	3	/
30	2004 **Garden hut** *Eightyseven architects* Sant Miguel de Crilles, Spain.					2	/	2	/	1	2

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no	Building description	P1	P2	P3	P4	SP	TE	SO	EC	IT	ST
31	2005 **Living Room house,** *Seifert and Stoeckmann* Gelnhausen, Germany.					2	1	2	/	1	2
32	2005 **Safe house,** *Robert Konieczny* Warsaw, Poland.					2	/	2	/	2	2
33	2008 **House R** *bevk+perovic arhitekti* Slovenia.					2	/	2	/	2	2
34	2008 **House K** *bevk+perovic arhitekti* Slovenia.					1	/	3	/	2	1
35	2009 **1K House** *MIT, Ying Chee Chui* /					2	/	3	3	3	1
36	2009 **bloomframe** *Hofman Dujardin* Amsterdam, Netherlands.					2	1	1	2	1	2
37	2009 **Sliding house** *dRMM Architects* Suffolk, UK.					2	2	2	/	/	2
38	2009 **Linear house** *Patkau Architects* British Columbia, Canada.					3	/	1	/	/	2
39	2010 **24 Rooms, Domestic Transformer** *Gary Chang* Hong Kong, China.					3	/	3	/	3	/
40	2010 **Sunken house,** *Kazuhiro Kojima* Odawara city, Japan.					3	/	2	2	2	1
41	2011 **M House** *Michael Jantzen* /					2	2	/	1	2	3
42	2011 **Whangapoua (small hut)** *Crosson Clarke Carnachan* New Zealand.					2	/	1	/	1	2
43	2012 **A-Z wagon station** *Andrea Zittel* /					3	1	1	2	1	2
44	2012 **Caja Oscura** *Javier Corvalan* Asumcion, Paraguay.					3	1	/	2	1	3
45	2013 **Sharifi-ha house** *Nextoffice-Alireza Taghaboni* Darrous, Iran.					2	1	2	/	2	2

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Table 2.
Comparative analysis of typical transformation

CT - Characteristic transformation
STCH – Structural change
IT – Transformation of inner space
ST – Skin transformation
I – Primary transformation
II – Secondary transformation
hno – House number
LOR – Level of representation

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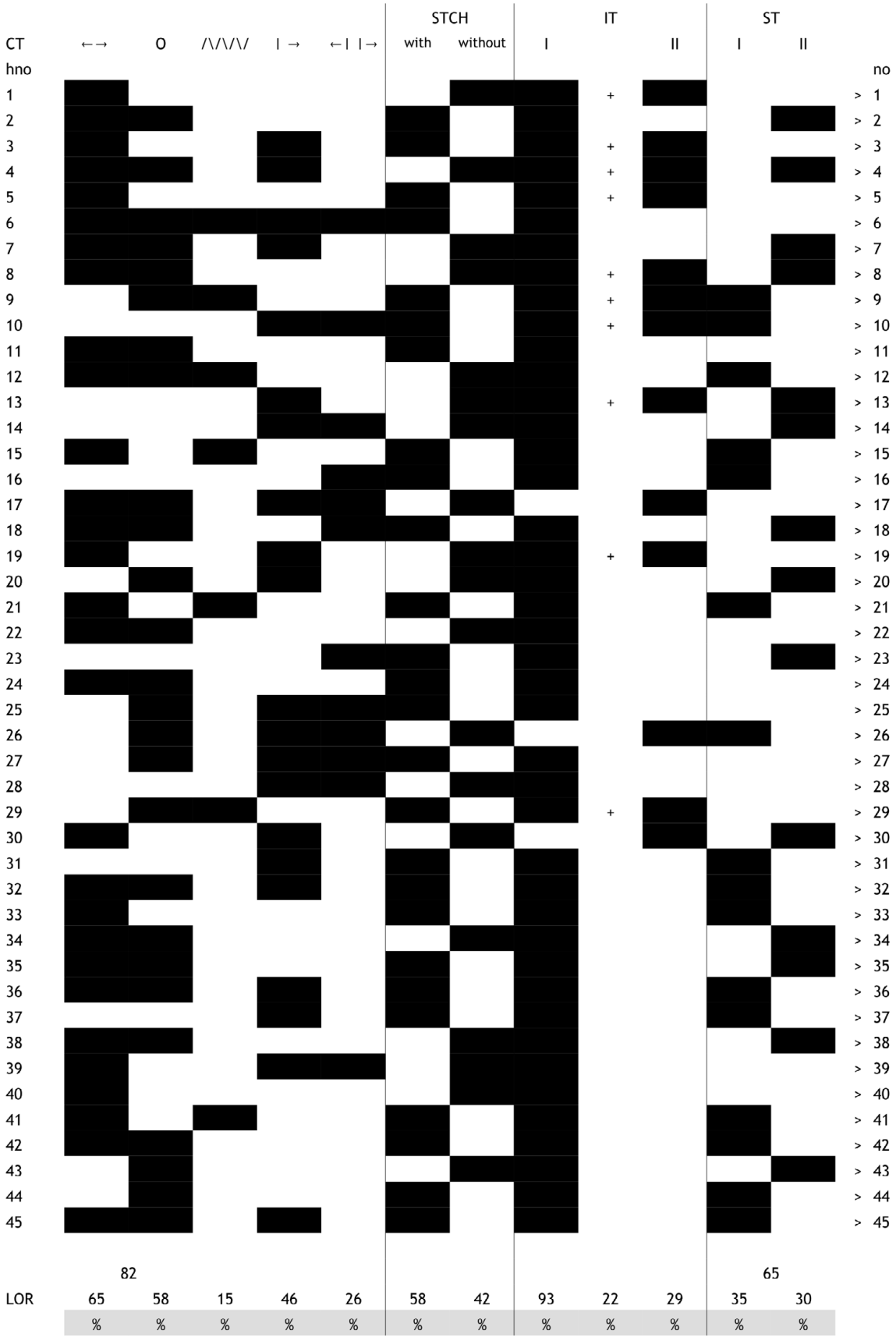

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Table 3.
Determining transformation principles

CT - Characteristic transformation
STCH – Structural change
IT – Transformation of inner space
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II – Secondary transformation
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	Description of the applied principles of transformation		
> 1	Opening and closing of inner partitions	1.1	1
> 2	Opening and closing of inner partitions	1.1	1
> 3	Opening and closing of inner partitions, pulling in and drawing out of furniture	1.1, 2.1	1 2
> 4	Opening and closing of inner partitions and furniture, pulling in and drawing out of f.	1.2, 2.1	1 2
> 5	Opening and closing of inner partitions, furniture dismantling	1.2	1
> 6	Opening and closing of inner partitions, furniture dismantling	1.2	1
> 7	Opening and closing of inner partitions, furniture dismantling	1.2	1
> 8	Opening and closing of inner partitions	1.1	1
> 9	Expanding and contracting of membrane, furniture dismantling	3.1, 1.3	3 1
> 10	Expanding and contracting of furniture, joining and division of furniture	2.1, 4.1	2 4
> 11	Opening and closing of inner partitions	1.1	1
> 12	Opening and closing of membrane	1.3	1
> 13	Pulling in and drawing out of furniture	2.1	2
> 14	Joining and division of furniture	4.2	4
> 15	Expanding and contracting of membrane, Opening and closing of membrane	3.1, 1.3	3 1
> 16	Joining and division of building structure	4.3	4
> 17	Opening and closing - pulling in and drawing out of furniture	1.2, 2.1	1 2
> 18	Opening and closing of inner partitions, pulling in and drawing out of furniture	1.1, 2.1	1 2
> 19	Pulling in and drawing out of furniture	2.1	2
> 20	Pulling in and drawing out of furniture	2.1	2
> 21	Expanding and contracting of inner partitions and outer membrane	3.2	3
> 22	Opening and closing of inner partitions and furniture	1.2	1
> 23	Joining and division of inner volumens	4.4	4
> 24	Opening and closing of inner partitions, furniture dismantling	1.2	1
> 25	Opening and closing - pulling in and drawing out of furniture	1.2, 2.1	1 2
> 26	Opening and closing of membrane	1.3	1
> 27	Expanding and contracting of inner partitions, drawing out and dismantling of furniture	3.2, 2.1	3 2
> 28	Pulling in and drawing out, joining and division of furniture	2.1, 4.4	2 4
> 29	Expanding and contracting, opening and closing of inner partitions	3.2, 1.1	3 1
> 30	Opening and closing of membrane	1.3	1
> 31	Pulling in and drawing out of membrane	2.2	2
> 32	Opening and closing of membrane, pulling in and drawing out of membrane	1.3, 2.2	1 2
> 33	Opening and closing of membrane	1.3	1
> 34	Opening and closing of inner partitions	1.1	1
> 35	Opening and closing of inner partitions	1.1	1
> 36	Opening and closing, pulling in and drawing out of membrane	1.3, 2.2	1 2
> 37	Pulling in and drawing out of membrane	2.2	2
> 38	Opening and closing of membrane	1.3	1
> 39	Pulling in and drawing out, joining and division of furniture	2.1, 4.1	2 4
> 40	Opening and closing of inner partitions	1.1	1
> 41	Expanding and contracting, dismantling of membrane	3.1, 1.3	3 1
> 42	Opening and closing of membrane panels	1.3	1
> 43	Opening and closing of membrane panels	1.3	1
> 44	Opening and closing of membrane	1.4	1
> 45	Pulling in and drawing out of membrane, opening and closing of membrane	2.2, 1.3	2 1

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Transformation Principles

The implementation of transformation principles in the architectural design of contemporary residential houses enables the establishment of new design strategies, and in that way initiates their further development. These principles, as principle application, are not much different from the general transformation principles which are applied in design, and are set by Per Mollerup (2001) through twelve collapsibility principles (p.30). However, the field and results of their implementation are rather differentiated. These principles treat different art forms, but they all have the same conclusion, which is that the transformation principles represent the basis of the transformable architecture (Soozhee, 2008).

According to previously performed analysis about the presence of characteristic transformations according to set parameters of referential examples of transformable residential architecture, four main transformation principles are established:

1. The principle of opening and closing;,
2. The principle of expanding and contracting;
3. The principle of joining and division; and
4. The principle of pulling in and drawing out.

The observed transformation principles are all about the change in disposition, shape and structure of the transformation elements, which results in spatially physical structure transformations, while at the same time their implementation is mutually dependent and closely connected, and in many cases equivalent.

The transformation principles represent the physical and perceptive transformation of the inner space layout and membrane transformation, which is achieved by opening and closing, expanding and contracting, joining and division, and pulling in and drawing out of transformation elements whose change of disposition, shape or structure achieves the transformation. It is achieved by the basic and complex (spatial) geometric element of transformation by means of rotation, translation, and rotation with translation. The implementation of this principle is usually achieved by:

a/ Partition and other elements,
b/ The elements of the façade membrane which are the part of the structure membrane, and
c/ The elements of the inner fittings.

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Transformation principles in the architectural design of a contemporary house

1/ The principle of opening and closing

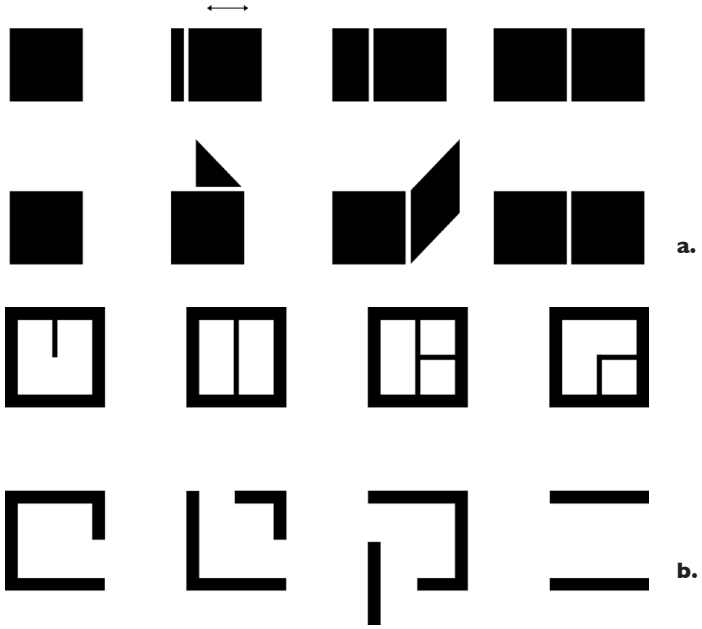

Figure 8.
Ideogram of possible transformations, according to the opening and closing principle, where we can see: a.) The transformation of elements; and b.) Transformation of the inner space layout and membrane transformation.

Figure 9.
The basic elements of the opening and closing transformation principle, where we can see: a.) An element of inner fittings; b.) A partition element; and c) A façade element.

Figure 10.
Examples of applying the Principle of opening and closing.

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2/ The principle of expanding and contracting

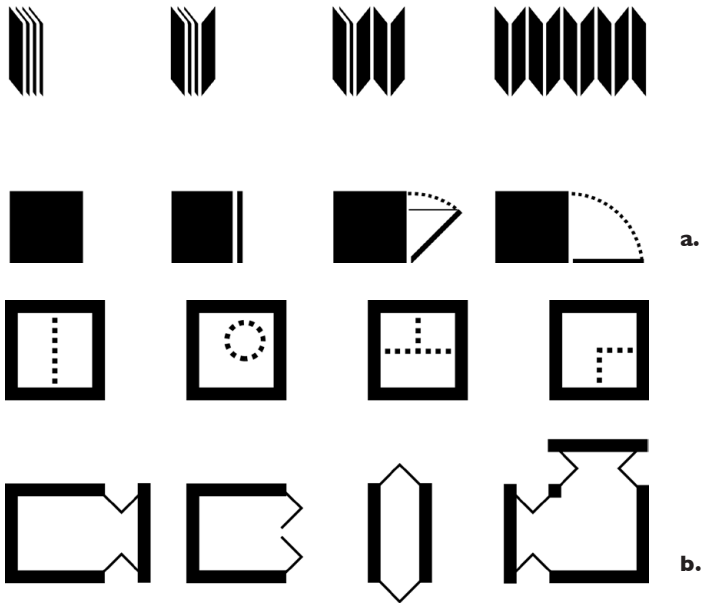

Figure 11.
Ideogram of possible transformations, according to the expanding and contracting principle, where we can see: a.) Transformation of elements; and b.) Transformation of the inner space layout and membrane transformation.

Figure 12.
The basic elements of the expanding and contracting transformation principle where we can see: a.) An element of inner fittings; b.) A partition element; and c.) A façade element.

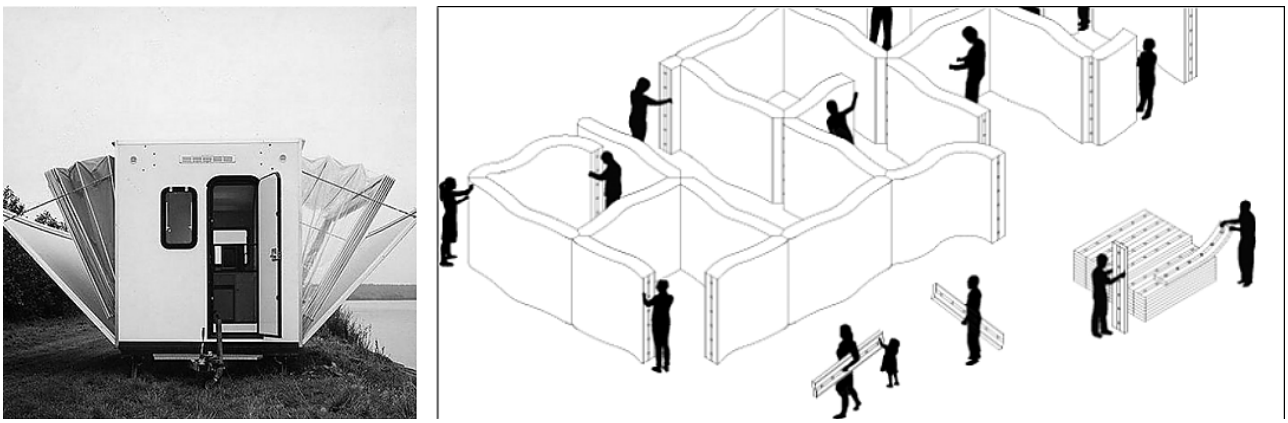

Figure 13.
Examples of applying the Principle of expanding and contracting.

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3/ The principle of joining and division

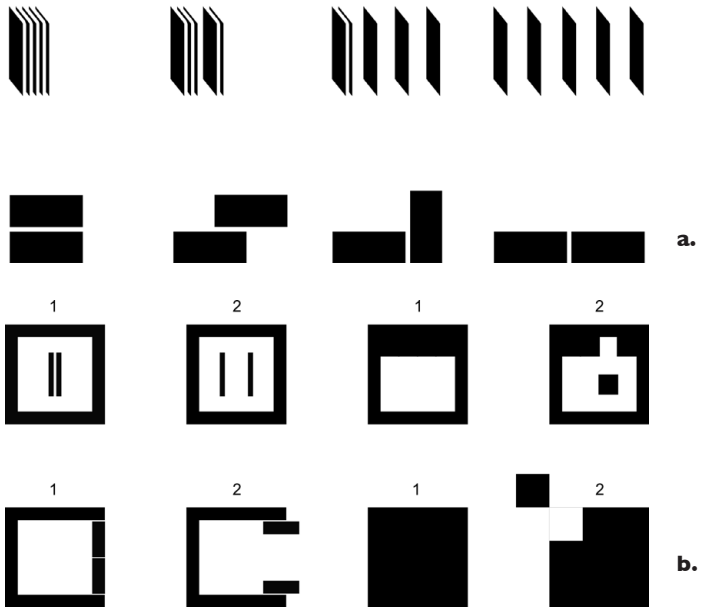

Figure 14.
Ideogram of possible transformations, according to the joining and division principle, where we can see: a.) The transformation of elements; and b.) Transformation of the inner space layout and membrane transformation.

Figure 15.
The basic elements of the joining and division transformation principle, where we can see: a.) An element of inner fittings; b.) A partition element; and c.) A façade element.

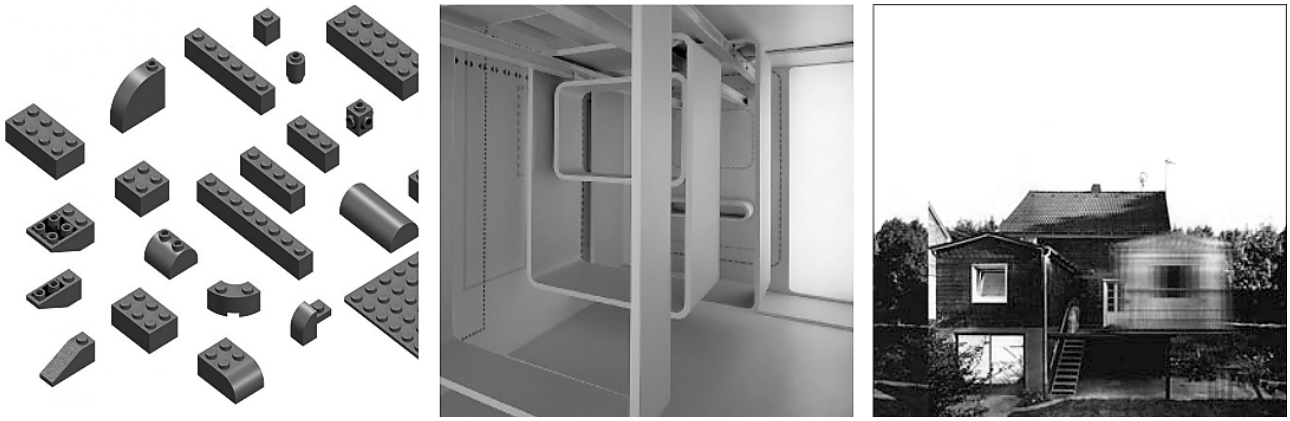

Figure 16.
Examples of applying the Principle of joining and division.

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Transformation principles in the architectural design of a contemporary house

4/ The principle of puling in and drawing out

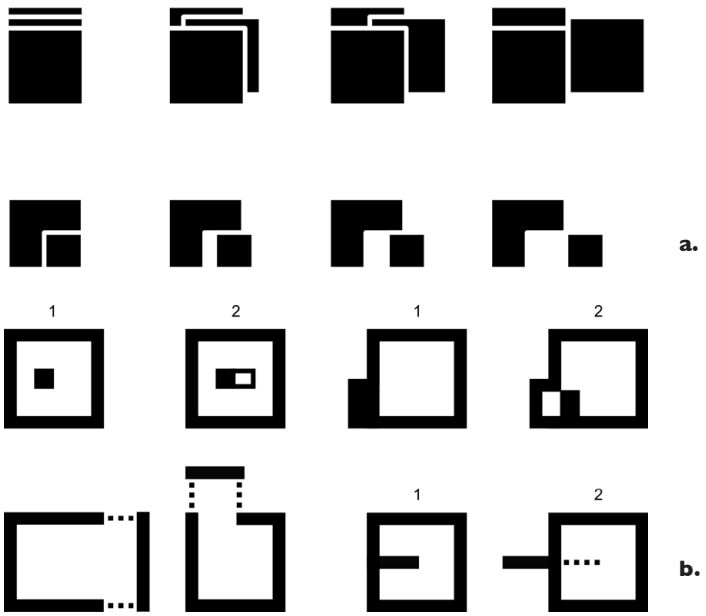

Figure 17.
Ideogram of possible transformations, according to the pulling in and drawing out principle, where we can see: a.) The transformation of elements; and b.) Transformation of the inner space layout and membrane transformation.

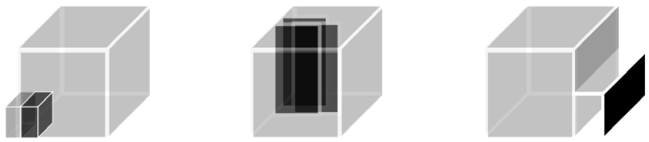

Figure 18.
The basic elements of the pulling in and drawing out transformation principle, where we can see: a.) An element of inner fittings, b.) A partition element; and c.) A façade element.

Figure 19.
ples of applying the Principle of pulling in and drawing out.

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