

Architectural Cognition Sociology

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Abstract The aim of this paper is to promote Architectural Sociology keeping cognition in focus. Firstly architecture, cognition and society are considered in their relationships. Secondly associations promoting cognition, its study and extensions of architectural cognition are discussed. This all is made in order to form a clear conceptual basis to understand architectural action in socio-psychological reality. This is tested by using architectural goal setting as example. Application of the frame in solving recent challenges is commented.

Keywords Architecture, Certainty, Information Society, Cognition, Cognitronics, Sociology, Teleology

1. Introductory Remarks

Architecture manifests human creative potentials in culture [Alvar Aalto, 1963 in discussion]. These potentials are evidently cognitive and achieved by talent and education [1-2]. In this sense Architectural Sociology [3-6] is the most natural forum to discuss architectural cognition and its role in society. We have the following key questions:

Architecture, cognition, society and cognition
Cognition society, study, cognition sociology extended

Architecture and thinking have the same roots in ordination, which according to Aristotle is central content of thinking [7, p 25]. Later Vitruv [1, p 37] adopted the concept of ordination into the constituents of architecture. Cognition is a broader concept than thinking. The common point mentioned gives, however, a good start to discuss the problem. In practical life designers do not think thinking but just think [8]. In theory the notification of this has been emphasized [9]. It is also a commonplace to say that architecture is one of the so many targets of thinking and cognition, but how this happens is a new question. [10] The relation of architecture and thinking changes when we speak about the architecture of knowledge first as allegory

(Kant) but today as key idea in knowledge engineering (KE).

2. Introduction to Architectural Cognition Sociology

2.1. Architectural Cognition

Architecture consists in its relation to cognition of ideas represented in its basic theory [1], like:

Ordination, disposition, harmony (and cognition)
Symmetry, décor, distribution (and cognition)

Architecture is subordinated to the idea of order analogical with cosmic order [11]. We are directed toward world (Brentano) and its architecture. In ideal form this relation is harmonic, but fight for harmony and peace is one possible and important extreme in our attitudes.

Our relation toward world is dually “symmetric”, and a lot of similarities exist in supposed reality and mental representations due to the cosmic order [12-13]. We are interpreting our environments and décor tells us the social content of the targets. Finally architecture is distributed and this correspond the most accurate descriptions of it in mind.

Architecture has its cognitive modes discussed in literature [14-15]. Environmental Psychology is a study area of cognitive problems also in architecture [16]. More surprising is that cognition has its architecture [17-19]. Spatial architecture refers both to performances and products and the same holds true for cognitive architectures, which have also their mental performances and products. It is, however, hard to define architecture with the aid of concrete activities and in many cases goal setting is then decisive.

2.2. Cognition and Architecture

Cognition is studied not only in philosophy but in cognitive psychology as well. In architecture the applications to perception and vision are well-known [20].

How to define cognition is a problem, but we define it in a relatively unproblematic way to consists of ideas related here to architecture, like:

Perception, memory, thinking (and architecture)
Abstraction, knowledge, information (and architecture)

Architectural perception does not differ from general one in principle, but in orientations [16]. The role of memory in architecture has been noted, but also problematized [21]. The word “reminiscences” has been used in design speech [Aalto, 1968 in discussion] and art history to mean the use of loans from other buildings. Thinking is the key element of cognition in rationalistic architecture [8].

Abstraction [22] has its typical forms both in science but also in art [23, p 71-]. Knowledge-based approach in architecture [24-25] has brought architecture closer to KE (Knowledge-Engineering) and AI (Artificial Intelligence). Ideas like Information Society [26-27] have catalyzed discussion in architecture and its communication [28, 15, 29, 3].

Architects have discussed a lot of how to guarantee multi-modal convenience in architecture and prohibit strong reflections or noise [23, p 37-]. Information on the other hand is the same as the elimination of uncertainty, which has central task in all cognitive faculties above. – Rational skills are the first tools to discuss cognition, but rationality is only one sector in cognition. Covering discussion has to consider belief, knowledge, volition, desire, emotion and skills. Information is key term in order to discuss the reception of architecture. In addition to that we have to note trans-informational tasks concerning how architecture transmits information. Many environmental solutions eliminate our uncertainty of how to behave and orientate.

2.3. Societal Cognition

The form and content of human societies separates us from other animals. The secret behind this depends on cognitive potentials (Aristotle > rationem particeps). [2, p 16-] Societal cognition has its forms like:

Ecological, communal, technological (cognition)
Economic, cultural, civilization/ civilized (cognition)

Ecological cognition renders it possible to survive in a world in a sustainable manner. Human world has evolved to be an Anthropokosmos [30, p 251]. It consists of community societies [31] challenging the human mind to react to social needs and desires in renewing ways. This catalyzes technological evolution based on typical ways of cognition in the same way than architecture does as “arche-technology” [23].

Humans have developed fiscal ecology called economy, which has its characteristic ways of thinking in good and bad. In normal societal discussion the concept of thinking

is most connected to cultural phenomena (above). In culture we may differentiate civilized forms or not of cognition. Crucial question in this evaluation is the dilemma between human or not human [23]. Today it is important to note recent transition toward Information Society [25, p 20-], Electromediative [32] or “Smart Society” [33].

3. Some Significant Aspects of Architectural Cognition Sociology, Objectives, Methods, Results

3.1. Cognition Societies as Objectives of the Study

The dispersion of our opinion concerning what is cognition forces us to found cognition-associations or mini-societies to promote right ways of thinking [34, p 3, p 5]. Key ideas to note include:

(Cognition) ecology, community-networks, technology
(Cognition) economy, culture, civilization

Cognition is under constant process of change. [7] Some ideas are born whereas other die or decade. The only way to fight for cognition promotion is to network locally and globally for professional assertion [23, p 96-] (CIAM [35]). Cognition technology in the form of mnemonics has its long roots and can be connected today to ICT (Information and Communication Technology) [36].

Cognition has its own economy, which can be traced to the ideas of Occam and Mach [37, p 18-]. In practical level we also know that cognitive tools are targets of exploding business (> Nokia, Microsoft, Apple). The ways how we manage cognition can be called cognition culture, which may reach its civilized forms or not. Today there are a lot of mal-uses of cognitive devices, like in cyber-war, cyber-crime, reckless confusions in digital education etc. Smart societies are from our point of view commune-technological ecosystems utilizing ICT [33].

3.2. Study and Methods

Cognition sociological problems can be studied first of all in Cognitonics [38]. From methodological point of view we may separate forms [5-6], like:

Statistical, empirical, logical cognition-study
Comparative, qualitative, quantitative cognition study

Statistics is a natural tool to run brain-study in the same way than behavioral approach in sociology. Brain and mind are, however, not identical research targets. Empirical study of mind is a problem and should be reconnected with the idea of internal experience or experiment (Hutcheson). In this sense we need reflective conception-logics and notification of modal and deontic logic. [39]

Cognition is naturally compared as related to variation of content (> Carnap, Hintikka > [40]). These ideas can be studied in qualitative [41] or quantitative information theory [29] discussing the elimination of uncertainty in environmentally related action.

Logical study of cognition starts e.g. from the logic of perception. If some of the cognitive operations above (2.2) hold for target x, and hold for target y, then they hold for target x and y. If cognitive operations hold in the case of target x then they hold for more general targets like x or y. They either hold or not for x. Then if I perceive a house and I perceive a sauna, (then) I perceive a house and sauna. If I remember a red door, then I remember (a red or green door), it is I remember a door. Cognitive operations are thus connected to Propositional (Boolean) Algebras to be presented in Set Theoretical tools in the so-called Stone Space (created). [40] In the case of perception we have the situation of standard scientific experiment. It is however well known that in addition to perception experiments we may have remembering, thought, abstraction/determination, knowledge acquisition and information gathering experiments as well. In fact for example perception experiment is also information gathering experiment per se in eliminating our uncertainty about the target. [29]

The level of logicity of our thinking can be questioned outside “knowledge”. Then if I want a red car it is problematic to say that I want a car, because redness may be an obligatory demand. This means that the notification of (often contradictory) desires of the client is demanding.

3.3. Cognition Sociology Extended

Architectural Cognition Sociology has its key targets in society. The complex problem means that it is natural to enlarge the study to dimensions like:

- Sociality, society, state (and cognition)
- Function, work, politics (and cognition)

The study of cognition starts from personality [18]. Personality is built, however, on collective achievements. [23, p 92-93] Society is the primary growth environment for us. State however gives still mainly the rules for societies. In this sense it is customary to speak about Finnish or Scandinavian design and so on. The situation is however changing and we have lost Regional idea [23, p 96] on the altar of not only International Style but also of Global forces, which are often speculative.

Architecture refers only seldom to global problems of Mankind in war and peace. The normal level of thinking in architecture is functional. [11, 35, 25] In this sense we have to recognize sacral, public, work, free-time, private and profane tasks and challenges to be solved with our creative potentials (above). Work has its special status. Design is work and design for work is decisive because success in it catalyzes success in general [42]. In this sense politics and

work politics have key role in directing human potentials to right targets. According to Aristotle the best politics in Politeia picks people to realize their own talents and skills achieved by education.

4. Results of Our Study

4.1. Definition of Architecture

The type of this study concerning the foundations of Architectural (Gognition) Sociology is Literature study in searching relevant definitions starting from the definition of architecture.

The first definitions of architecture return to the works of Cicero and Vitruv. Cicero characterized [43, p 110] architecture as art “prudens, honestas et utile” it is using values. The first value is in modern terms nearly the same as knowledge-based [24]. Honestas [34, p 3] is used as the most directly connected value with architecture. It includes ideas like durable (noble), beautiful and good. Utile means useful. Here we become close to Vitruvian values firmness, beauty and usefulness [1]. Vitruv himself defined architecture by using as contents the six categories (mentioned above) containing terms that were known already by Socratic tradition (> Xenophon). The form of the Vitruvian definition is close to the self-definition of rhetoric (> Ad Herennium).

The way to define architecture survived through Medieval Time in the usages of certain monasteries. [44, p 59] Renaissance was critical in relation to the formal definition but admired the characterization of architecture with the three values mentioned above. Since renaissance Vitruvian terminology was used in miscellaneous way when several masters tried to make definitions of their own [45].

Modernism started a completely new phase in defining architecture. Again many agents presented their personal ideas [35]. Eliel Saarinen can be mentioned among the few who has utilized the Vitruvian definition in his literal works [28]. Especially interesting and important novel definitions then included those of Continental and American Schools (below).

August Perret defines architecture as: “The art of ordering space, which expresses itself in structures” [29, p 1]. Frank Lloyd Wright [34, p 141] uses expression “Architecture is the scientific art of making structures express(ing) ideas. Both formulations are relatively close to each other. They lead us to consider architecture as symbolic expression [30, 3]. Alvar Aalto [23, p 50] mainly close to Wright in ideology takes his position and surprisingly criticizes the idea to subordinate architecture to science. He says that architecture is “still the same great synthetic process ... task to combine thousands of decisive human functions, and it remains architecture”. Here we come close to the idea of Cicero that architecture is skill/art. In fact Wright comes in his most personal definition

also close to the process view. According to him [34, p 257] “Architecture is that great living creative spirit which...creates according to the nature of man, and his circumstances as they change.” The idea of process view links architecture nicely to cognition, which is characterized in dictionaries as mental process or process of knowing.

The idea of change is here essential in the extent that the definition of architecture itself changes. Architecture is multi-definitional. [46, p 16] When we use architecture in highly abstract sense and in combinations like the architecture of knowledge or cognition in general, it is best to return to the Vitruvian categorical definition. [47, p 33] In addition to that it is possible to utilize more personal ideas depending on the case.

According to Aristotle Politics is architectural skill in the sense that it like architecture “defines or orders” other arts. [48 line 1094a26, (p 137)] In this sense definition of architecture has deep cognitive content and can help us even in defining or “ordering” cognition.

4.2. Definition of Cognition as a Problem

The definition of cognition is hard task like the definition of thinking as well. It is possible to say that thinking is ordering of mind, like architecture is ordering of space [7, p 25]. One obstacle for more specific definition is that the definitions have to be made with the aid of thinking itself. One model for the definitions in general is offered by the very old definitions of architecture and rhetoric. They are made by using the most important constituents. In this study we have noted cognition to include perception, memory, thinking, abstraction, knowledge acquisition and information gathering. This definition can be improved for some special reasons. Thus it is time to ask “is cognition also multi-definitional?”. The motivation of our definition here has mainly been to make architecture and cognition comparable in discussion.

In cognitive (con + gnosis) study the notion of cognition (con + agere) is often central because it opens our view to rationality.

Architectural thinking is a specific term [49, p 1-, 47, p 20-] but is not very well articulated as a concept. One way to consider the various definitions and sub-definitions needed in architecture is to utilize ontology. This has especially been practiced in Urban Ontology or “Towntology” [50, 51] discussing definitions needed in urban planning [52, p 13], building and artifact design.

4.3. Definition of the Society

Definition of the society is important in architecture because architects form, order and “define” urban, built and artificial “structures”. Discussion of societies and the need to see its constituents has long roots from Aristotle [53, line 1252a20] to our days.

In many cases the key constituent of society seems to be order of action or law whereas in architecture it is order of environment and in cognition order of concepts. [54 passim] [55, p 3-] [56, p 67, p 98, p127]

In philosophy the concrete definition of society or state is considered mainly too hard and definitions are teleological discussing the goals involved, like auto-teleology, security or happy life. [54]

Modern systems philosophy has taken seriously the challenge of exact definition [57, p 407-]. In this paper we have considered society to consist of ideas, like ecology, community, [58] technology, economy, culture and civilization. This definition makes architecture, cognition and society as concepts all comparable together.

In sociology we have also the environment-independent idea of sociality as key tendency of inhabitants. This idea has levels of consideration [59, p 7, p118], like:

Personality, role/ status, group
Collective, organization, institution

When noticing this we have to separate general social study and environmentally related study. [55, p 35] Architecture creates facilities for social human action [Aalto, in discussion 1963] but in the case of architecture this action is bound to environment via real architecture. In this work some values, discussed below, become crucial.

5. Discussion Concerning Values

5.1. The Recognition of Security

The recognition of security as key idea of architecture was mentioned already in the law of Hammurabi. Vitruv mentions the more concrete idea of durability but discusses also sustenance. Today it is possible to generalize the ideas of health and safe environment under key world Sustainable Development (> change above). [60]

Health has been taken as key concept in Architectural theory especially as regards the so called Organic Architecture [55]. This wisdom has been acute during Industrialism and especially today due to ecological problems, like pollution and climate change. - Architecture has to transmit information about safe behavior in traffic and habitation. The building base should be safe and also special healing institutions are concerns of architecture. In normal planning goals like security, health, convenience and moderate beauty are often mentioned.

5.2. The Recognition of Beauty

The recognition of beauty has been mixed to that of goodness in antiquity. [61, p 184] The separation process culminated during Enlightenment when aesthetics got its name and the study of art was divided to consist of the new aesthetics and earlier poetics. [62]

Beauty may be studied in architecture at three levels including perception modalities [20], aesthetic modifications and order aesthetics. Order aesthetics has been studied in scientific sense in early cognitive psychology (> Wundt/ [63], p 60)). According to it the experience or recognition of beauty in nature or as intentional goal is a function of order and complexity (O/C) [29]. This idea can be mixed to other levels of aesthetics. In basic level it means that we have problems, like:

Visual, acoustic, olfactory (O/C)
Gustatory, haptic, kinesthetic (O/C)

The notification of synesthesia makes things more complicated. In total synesthesia all six factors count, but in certain sense we have two to the power six cases. For example music in Gothic cathedral is a question of audio-visual experience. Suitable amount of tar in a balcony of a Finnish sauna is part of multi-modal sauna experience (e.g. odor + color). In modern urban context the odor of tar is surprising, but it belongs to the old tradition.

5.3. The Recognition of Utility

Safety and aesthetic pleasure are preconditions for using environment in a useable way. The teleological spectrum of utility or quality of environment (> city, building, artifact setting) is complex target. In the study of architectural quality we may find factors [64], like:

Technical, experienced, usability (quality)
Ideal, formal, optimal (quality)

Then technical quality means satisfaction of certain determined criteria like in many forms of sport. Experienced quality is a complex problem because it depends on internal factors. It correlates to aesthetic problems. Then we have to note that beauty is only one modification existing as opposite to ugliness. Personal history and expectations influence to experience. Usability goals are not only technical but also functional [59, p 14-] and concern the use of environment as regards social formations from persons to institutions.

Architecture is related to normative action and its preparation. To be able to make future solutions one has to notice ideals of culture. These ideals like goals of the practical situation can be formalized by making clarifications and accounts. Then in multi-optimal action like architecture a feasible solution notices both types of demands. (> Perret/ [29, p 1]) One-sided emphasis of quality criteria leads easily to constructivism, aestheticism [23], functionalism [25, p 7-] or idealism, formalism and rationalism.

5.4. Summa Summarum

It is possible to give operative definitions to things or processes like architecture, cognition or society. In order to

combine constituent view and process view it is possible to redefine those things at higher conceptual level. Then the constituents involved are [28, 55, 65, 36]:

(Past, present, future state)
Essence, aesthetics/ experience, significance and value
Structure, function, behavior
(Architecture, cognition, society)

In this system the dynamics of processes and the real or more fictive history [66, 67] is discussed under the notions of the first row. Essence presents the natural conception of human mind as regards the target on last row. Intensions are born in experience and refer also to future in expectations.

Rational concept formation starts from structural [68] notions, functional analysis and consideration of detailed behavior (> exact statistics) [29].

In our approach our operative concepts have been made by giving structure to essential dimensions. The transition to process ontology renders it possible to notice the results of Transformation Sociology. [69, p 2, p 198] [29, p 2] [70, p 109-,] [71, p 29] [72]

6. Applications of our Frame to Recent Study-Problems and Future Work

6.1. The Simulation of Architectural or Social Space

In architecture we have to orientate to past, present and future, but future is the most critical concern [28, 55].

In the study of future space the main tool is simulation in laboratory conditions [73, 74, 75]. In such settings image of the space is for example projected inside a (geodetic) cupola in analogical or digital means. When using audiovisual tools, the effect is relatively good, because the visual sense already transmits environmental information so well [76, 77]. Architecture is however a multi-modal phenomenon. Simulation of kinesthesia is partly possible with the aid of movies (CINERAMA). In any case there are problems in simulating odor and temperature or wind pressure and rain.

When we have realistic simulation tool of space as concrete or virtual model the experience should be studied with other settings. Today brain study offers tools to register the activation of brain in experimental situations. The study of brain activation works well in music or in film when the study person or group sits under fixed settings. In the future portable brain registration systems are most probably available with practical price. Then the activation of brain can be studied also in realistic experience of architecture in statistically significant mode. One important study dimension is of course the experience of pleasure (> aesthetics).

ICT of today renders it possible to simulate by digital means high-resolution environments. Human perception

and understanding is based, however, on Gestalt phenomena [20]. Today 3D technology can be combined to brain study. Then one of the key problems is to see emergent phenomena on the basic sensations [78] as connected to art study [79]. The idea of emergence can be evidently applied into architecture and its social dimensions. [80]

In architecture the emergent levels of the artifact production mean that simulation has levels, like [28, 30]:

Energy, form, tool (simulation)
Goal setting, expression, idea (simulation)

6.2. The Gap between the Brain Study and the Mind Study as Related to Recognition

In addition to the simulation of past, present and future artifacts in architecture we have to react to the various emergent levels of the whole world and note corresponding ontology [29]. Cognitive theory of architecture [81, p 19-25] studies architecture-man relation, on the levels of artifact generation. Then we need in addition some contact surface on the hierarchy of sciences [29, p 26], like:

(Architectural cognition) physics, biology, psychology
(Architectural cognition) sociology, semiology, anthropology

We discuss here the fourth form. Cognition Sociology is today a large body of knowledge [82] and it may be interesting to invent what is said about architecture under this umbrella [69, 83, 84]. Here we discuss architectural cognition from the viewpoint of architectural sociology [3, 4, 5, 6], which restricts the scope more rapidly. So we have to understand what architectural or spatial cognition study is in general or under social focus. [85, 86]

The main frame in cognitive study is psychology. Then the relevant dimensions of cognition study between mental and neural dimensions include [69, p 2] [78, p 36-37] [compare 87]:

Collective consciousness, personal consciousness, mental processing

Neural processing, physical phenomena, quantum - phenomena

Architecture is a dynamic process and basic study of cognition offers only starting points for understanding what is going on in the minds of the participants. The first problem field is the cognition of an architect, which is embedded into a continuous flow of recognition between automated [41, p 139-142] [29, p 24, p 46-47] and creative recognition consisting, according to our theory of:

Reception, remembering, rethinking
Re-abstraction, re-knowing, re-information

Architectural recognition starts from standard reception in the sense of physiology and art theory (both). Remembering in architecture is also repetitive and iterative

process. [78, p 34-35] We have to go back to our thought also in a chained and cyclic way in our dialogue with architectural environment.

Abstractions at the level of art are creative and based on abductive insights [88, p 29]. Earlier “knowledge” has to be corrected and new information flows are mixed both in the experience and active making of architecture.

6.3. Digital Design and AI

Digital Design develops rapidly from the level of pixel studies to comprehensive paradigm [89]. Then the study of artifacts [46, p 28-30] [89, p 40-60] [90, p 10-20] and design cognition [91] form the basis for AI applications [92, 93].

The complexity of Design knowledge [80] means that design is performed in practice on the level of tacit knowledge [94, 95] especially in its explorative function. Then the co-operation of eye-brain/ mind-hand is the key of human expression behind drafting or digital processing. Digital design and AI have set new demands for design study to be solved in Designology [96]. Under this frame it is possible to combine the ideas of physical space and mental sense of place [97, 98, 99].

Design is based on alternation of signs and their concretization. In this process symbol-level signs are important manifestations of emergent and Gestalt phenomena (above) [30, 3, 88, 100, 101]. The recognition of symbols and architectural works in interaction is central cognitive skill to be studied in art related Architectural Cognition Sociology. Then the definition of architecture is relatively unproblematic. Problems arise especially when we think what cognition or for example thinking really is. [102, 103] Conceptions vary as regards how much knowledge-related thinking should dominate other mental faculties [81, p 19] [87, 104, 105, 106]. In this sense we have to separate but also combine the technical and human dimension as possible first of all in systems sciences [107, 108, 109, 110, 111, 63].

6.4. Synopsis

A synthesis between architectural cognitive and societal dimension can be found from the posthumous writings of architect and Bauhaus-teacher Hannes Meyer (1889-1954) [112, p 204-]. According to Meyer as written between 1936 -1939:

“Architecture is a Gestalt-related process of the social life of a society.”

The relation of architecture and cognition is represented with the aid of the idea of an architect:

“Architect is an “order-” and Gestalt-maker of the life-process of his community.”

In fact these ideas are in harmony with the society

concept of Meyer coherent with our own (OTO) proposal via interpretation:

Meyer-model (1936-39)	OTO-model (2016-2017)
Definite temporal place	Ecology
Social system	Community
Technology	Technology
Economy	Economy
Life content	Culture
Collective class	Civilization

These ideas are found independently and thus the tableaux above gives strong support to our (originally hypothetical) approach to understand society as environment dependent community, related to certain definite and essential factors. Meyer discussed his ideas of architecture, cognition and society under the title of Architectural Education, which term via learning relates clearly to intelligence and talent. Here we come to the 2000 years old start text of Vitruv [1], opened with the chapter "The Education of an Architect". When the fundamental ideas presented above can be understood in their full depth, then Architectural Cognition Sociology can develop in both in factual and value related levels [113 > ([86] [94] [114]), 115 > ([60] [84])] and merge to Cognition Sociology in advance [116, p 6, p 10, p 25, p 163-].

7. Conclusions

We have shown what Architectural Cognition Sociology is in its big picture. Society is the basic unit to consider interaction of architecture and social activities. This concern can be deepened to personal aspects of cognition and toward global problem formulations. The main field of application of the theory lies on the side of Information, Electromediative and Smart Societies. These forms of societies challenge us to understand new forms of AI and ICT related design. Ideas of architecture, cognition and society are however relatively permanent in spite of surface and up-to-date phenomena.

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REFERENCES

- [1] Vitruv. Zehn Bueher ueber Architektur, uebers. C. Fensterbuch, Wissenschaftliche Buchgesellschaft, Darmstadt. 1991.
- [2] T. K. Oksala. Homeroksesta Alvar Aaltoon (From Homer to Alvar Aalto), W+G, Espoo, 1986.
- [3] R. W. Smith, V. Bugni. Symbolic interaction theory and architecture, *Symbolic interaction*, 29 (2), 123-155, 2006.
- [4] H. Delitz. *Architektursoziologie*, Transcript Verlag, Bielefeld, 2009.
- [5] T. Oksala, S. Toivanen. *Architectural Sociology, Art or Science*, Proceedings of InterSymp 2016, Art and Science, IIAS, Baden-Baden, 73-78, 2016.
- [6] T. Oksala, S. Toivanen, *Sociology Meets Architecture*, Proceedings of InterSymp 2016, Sustainable Development and Global Community, IIAS, 23-28, 2016.
- [7] J. A. Wojciechowski. *Ecology of Knowledge*, RVP, Washington 2001.
- [8] P. G Rowe. *Design Thinking*, MIT, Cambridge, Mass, 1987.
- [9] N.-E. Wickberg. *Ajatuksia arkkitehtuurista*, (Thoughts on Architecture), Otava, Helsinki, 1946.
- [10] T. Oksala, G. E. Lasker, *Design: Evolution Cognition*, DEcon '94 symposium, APS, Ci 105, Espoo, 1996.
- [11] K. Ålander. *Rakennustaide renessansista funktionalismiin*, (Architecture from Renaissance to Functionalism), WSOY, Porvoo, 1954.
- [12] H. Weyl. *Symmetry*, Princeton University Press, Princeton, 1952.
- [13] L. March, P. Steadman. *The Geometry of Environment*, RIBA Publications Limited, London, 1972.
- [14] S. T. Rasmussen. *Experiencing Architecture*, Cambridge University Press, Cambridge, 1959.
- [15] J. Ylinen. *Arkkitehtoninen tila ja muoto*, TKK-A, Otaniemi, 1968.
- [16] S. Hesselgren. *The Language of Architecture*, University of Lund, Lund, 1969.
- [17] T. Oksala, A. Oksala. *Cognitonics Studying the Skills of Mind*, in M. Bohanec et al (eds), Proceedings of the 14th International Multiconference Information Society – IS 2011. Proceedings A, Kognitonika/ Cognitonics. Ljubljana, Jozef Stefan Institute; 349-350, 2011. <https://is.ijs.si/archive/proceedings/2011/>
- [18] T. Oksala, A. Oksala. *The Architecture of Personality and Personal Development*, in M. Gams, R. Piltaver, D. Mladenec et al (eds), Proceedings of the 16th International Multiconference Information Society – IS 2013, Proceedings A, Kognitonika/ Cognitonics, Ljubljana, Jozef

- Stefan Institute; 464-466, 2013.
<https://is.ijs.si/archive/proceedings/2013/>
- [19] T. Oksala, A. Oksala. The Conceptual Architecture of Modified Emotions, in Proceedings of the 18th International Multiconference Information Society – IS 2015, Volume F, V. A. Fomichov and O. S. Fomichova (eds), Kognitonika/Cognitonics. Ljubljana, Jozef Stefan Institute, 2015, 62-65, 2015. <https://is.ijs.si/archive/proceedings/2015>
- [20] L. Zusne. Visual Perception of Form, AP, New York, 1970.
- [21] A. Radford, T. Oksala. Creative Memories and the Finnish Sauna, in T. Oksala, G. L. Farre and G. Lasker (eds), Design: Emergence, Content, APS Ci, 106, 71-80, 1996.
- [22] E. Mikkola. Die Abstraktion Begriff und Struktur, Suomalainen kirjakauppa, Helsinki, 1964.
- [23] A. Aalto. Luonnoksia, (Sketches), toim. G. Schildt, Otava, Helsinki, 1972.
- [24] J. S. Gero, T. Oksala. Knowledge-Based Systems in Architecture, APS Ci 92, Espoo, 1998.
- [25] B. Linn. Arkitekturen som kunskap, (Architecture as Knowledge), Byggforskningsrådet, Stockholm, 1998.
- [26] I. Niiniluoto. Informaatio, tieto ja yhteiskunta, (Information, Knowledge and Society), Valtion painatuskeskus, Helsinki, 1989.
- [27] M. Bohanec et al. (eds). Proceedings of the 14th International Multiconference, Information Society – IS 2011, Jozef Stefan Institute, Ljubljana, 2011. <https://is.ijs.si/archive/proceedings/2011/>
- [28] E. Saarinen. The Search for Form, Heinemann, New York, 1948.
- [29] T. Oksala. Logical Aspects of Architectural Experience and Planning, HUT, Otaniemi, 1981.
- [30] H. Friedmann. Wissenschaft und Symbol, Beck, Muenchen, 1949.
- [31] H. Friedmann. Epilegomena, Beck, Muenchen, 1954.
- [32] T. Oksala. Electromediative Society, Challenges for Sustainable Development, in G. E. Lasker and K. Hiwaki eds, Sustainable Development and Global Community. Vol XII. IIAS, Baden-Baden, 3-7, 2015.
- [33] M. Z. Boznar, P. Mlakar, B., Grasic. Smart Villages vs. The Smart Cities Concept for E-Inclusion, in M. Bohanec, et al (eds), Proceedings of the 14th International Multiconference Information Society – IS 2011. Ljubljana, Jozef Stefan Institute; pp.191-194, 2011. <https://is.ijs.si/archive/proceedings/2011/>
- [34] F. Ll. Wright. On Architecture, MOMA, New York, 1941.
- [35] U. Conrads. Programme und Manifeste zur Architektur des 20. Jahrhunderts, Ullstein, Berlin, 1966
- [36] J. Majurinen, T. Oksala. Junaliikenteen informaatio keskuksen toiminta-tapa, (The Action way of the Information Centre of Train Traffic), Ratahallintokeskus, Helsinki, 2009.
- [37] E. Kaila. Inhimillinen tieto, (Human Knowledge), Otava, Helsinki, 1939.
- [38] V. Vomichov, O. Fomichova.. A Contribution of Cognitonics to Secure Living in Information Society; Informatica. An International Journal of Computing and Informatics (Slovenia). 36, 2, 121-130, 2012. www.informatica.si
- [39] R. Murphy. Modal logic for conceptual combination, In J. S. Gero, and T. Oksala, (eds), Knowledge-Based Systems in Architecture. APS Ci 92, Espoo, 39-48, 1989.
- [40] I. Niiniluoto. Todennäköisyyden lajeista, (On the Species of Probability), in R. Tuomela (ed), Yhteiskuntatieteiden eksakti metodologia, Gaudeamus, Helsinki, 22 -154, 1975.
- [41] T. Oksala. Asuinalueen visuaalinen laatu, (Visual Quality of Housing Areas), in J. Laapotti, I. Niukkanen and T. Oksala, Asuinympäristön laadun muodostumien, HUT-A, Otaniemi, 118 -148, 1976.
- [42] S. Toivanen. Framtidens Arbetsplatser, (The Workplaces of the Future), Goethe, Stockholm, 2015.
- [43] Cicero. De officiis, Lindh, Vesterås, 1813.
- [44] N. E. Wickberg. Arkitekturen och tidsandan, (Architecture and the Spirit of Time), Söderström & Co, Helsingfors. 1974.
- [45] B. Evers, Ch. Thoenes. Architectural Theory, Taschen, Köln, 2003.
- [46] J. Mänty. Principles of Architecture, DATUTOP 7, Tampere, 1985.
- [47] T. Eskola. Arkkitehtuuri käsitteenä, (Architecture as Concept), HUT-A, Otaniemi, 2005.
- [48] Aristotle. Nikomakhosen etiikka, (Nicomachian Ethics), trans. S. Knuutila, Gaudeamus, Helsinki, 1984.
- [49] T. Pakarinen. Space as Social Substance, TTK 25, Tampere, 1984.
- [50] J. Teller, Ch. Tweed, G. Rabino (eds). Conceptual Models for Urban Practitioners, COST, Bologna, 2008.
- [51] J. Teller, A.-F. Cuttling-Decelle, R. Billen (eds). Urban Ontologies for an improved communication in urban development projects, COST, Liege, 2009.
- [52] T. Pakarinen, Urban Planning, Then and Now; Planning Theory in History and Contemporary Planning Problems, TUT-A, Tampere, 1992.
- [53] Aristotle, Poliitiikka, (Politics), trans. A. M. Anttila, Gaudeamus, Helsinki, 1991.
- [54] R. Wilenius. Filosofia ja Poliitiikka, (Philosophy and Politics), Tammi, Helsinki, 1967.
- [55] E. Saarinen. The City, Its growth its decay, its future, MIT, Cambridge Mass. 1943.
- [56] S. Toullmin. Cosmopolis, The Hidden Agenda of Modernity, The University of Chicago Press, Chicago, 1990.
- [57] M. Bunge, Sosiaalisen rakenteen käsite, (The Concept of Social Structure), in R. Tuomela ed, Yhteiskuntatieteiden eksakti metodologia, Gaudeamus, Helsinki, 406-459, 1975.
- [58] S. Chermayeff, Ch. Alexander. Community and Privacy,

- Toward a New Architecture of Humanism, Pelican, Harmondsworth 1963.
- [59] Ch. Norberg-Schulz. *Intentions in Architecture*, Allen & Unwin, Rome, 1963.
- [60] G. E. Lasker, T. Oksala. *Design: Ecology, Aesthetics, Ethics*, DEcon '93 symposium, APS Ci 99, Espoo 1994.
- [61] J. Suolahti. *Antiikin ihmisen ympäristöestetiikka*, (The Environmental Aesthetics of the Humans of Antiquity), in A. Kinnunen, T. Oksala eds, *Antiikin estetiikka*, WSOY, Porvoo, 184 – 204, 1976.
- [62] R. Scruton. *The Aesthetics of Architecture*, Princeton University Press, Princeton, 1980.
- [63] P. Smith, *Architecture and the Human Dimension*, George Goodwin, Bath, 1979.
- [64] I. Niukkanen, T. Oksala. *Rakennuksen laatukiteerit*, (Quality Criteria of Building), Rakennushallitus, Helsinki, 1986.
- [65] V. K. Martikainen. *Concepts and Mind, As Dynamic Memory-Systems Structuring the Human Mental*, Edita, Helsinki, 2004.
- [66] W. Hess. *Städtebau*, in S. Giedion, *Architektur und Gemeinschaft*, Rowolt, Hamburg, 131-136, 1956.
- [67] Eaton, R. *Ideal Cities, Utopianism and the (Un) Built Environment*, Thames & Hudson, London, 2003.
- [68] L. Martin, L. March. *Urban Space and Structures*, Cambridge University Press, Cambridge, 1972.
- [69] A. Giddens. *Central Problems in Social Theory, Action, Structure and Contradiction in Social Analysis*, Macmillan, London, 1979.
- [70] P. von Bonsdorff. *The Human Habitat*, Gummerus, Jyväskylä, 1998.
- [71] L. Dean. *The Social Roles of Buildings*, Stockholm Studies in Sociology, New Series No. 65, Stockholm University, Stockholm, 2017.
- [72] T. Oksala, S. Toivanen, A. Oksala. *Architectural Cognition Sociology*, Proceedings of the 20th Multiconference Information Society - IS 2017, Volume D, V. A. Fomichov and O.S. Fomichova eds, *Kognitonica/ Cognitronics*, Ljubljana, Josef Stefan Institute, 57-60, 2017. <https://is.ijs.si/archive/proceedings/2017/>
- [73] J. Paasi. *Menetelmä arkkitehtonisen tilan havainnoimiseksi laboratorio - olosuhteissa*. (A method to perceive architectural space in laboratory-conditions), TKK, Julkaisu A 40, Otaniemi, 1978.
- [74] Ph. Quéau. *Lumetodellisuus (Le virtuel: vertus et vertiges)*, Art House, Helsinki, 1995
- [75] A. Gleiniger, G. Vrachliotis (eds). *Simulation, Presentation Technique and Cognitive Method*, Birkhäuser Verlag, Basel, 2008.
- [76] J. J. Gibson. *The Perception of Visual World*, Greenwood Publishing, Boston, 1956.
- [77] J. J. Gibson. *The Senses Considered as Perceptual systems*, Houghton Mifflin, Boston 1966.
- [78] K. H. Pribram. *Status Report: Quantum Holography and the Brain*, in G. E. Farre and T. Oksala eds, *Emergence, Complexity, Hierarchy, Organization: Volume 2*, APS Ma 98, Espoo, 33-59, 1999.
- [79] R. Harré, Ph. Tacka, *Melody as Emergent Property of Sounds*, in G. E. Farre and T. Oksala eds, *Emergence, Complexity, Hierarchy, Organization: Volume 2*, APS Ma 98, Espoo, 61-67, 1999.
- [80] T. Oksala. *Complex-City and the Emergence of its Organization*, in G. E. Farre and T. Oksala eds, *Emergence, Complexity, Hierarchy, Organization: Volume 1*, APS Ma 98, Espoo, 61-67, 1998.
- [81] A. Stenros. *Kesto ja järjestys*, (Duration and Order), TKK-A, Espoo, 1992.
- [82] M. W. Raphale. *Cognitive Sociology*, in Oxford Bibliographies Online in Sociology, Vol 187, New York, Oxford University Press, doi, 10.1093/obo/9780199756384-0187, 2017.
- [83] M. Foucault. *Tarkkailla ja rangaista*, (Surveiller et Punir), Otava, Keuruu, 1980.
- [84] K. Lapintie. *The So-Called Good Environment, Morality and Criticism in Architecture*, Tampere, DATUTOP, 1993.
- [85] S. Werner, P. Long. *Cognition meets Le Corbusier – Cognitive Principles of Architectural Designs*, in C. Frekka, W. Brauer, C. Habel, K. F. Wender eds, *Spatial Cognition III, Spatial Cognition 2002. Lecture Notes in Computer Science vol. 2685*, Springer, Berlin, Heidelberg, 112-126, 2003.
- [86] F. P. Rahimian, R. Ibrahim. *Impacts of VR 3D sketching on novice designer's spatial cognition in collaborative conceptual architectural design*, in *Designs Studies*, Vol 32, Issue 3, May (2011), 255-291, 2011.
- [87] A. Hautamäki, *The Main Paradigms and Challenges of Cognitive Science*, in P. Pykkänen and P. Pykkö (eds), *New Directions in Cognitive Science*, Saariselkä 4-9 August (1995), Finnish Artificial Intelligence Society, 25-31, 1995
- [88] L.-O. Routila. *Miten teen tiedettä taiteesta? (How to make Science from Art?)* Clarion, Keuruu, 1986.
- [89] D. Bruton, A. Radford. *Digital Design, a critical introduction*. Berg, London, 2012.
- [90] R. Coyne. *Logic Models of Design*, Pitman, London, 1988.
- [91] T. Oksala. *KAAD: Evolutionary and cognitive aspects*, in G. Carrara, Y. Kalay eds, *Knowledge-Based Computer-Aided Architectural Designs*, Elsevier, Amsterdam., 27- 44, 1994
- [92] T. Oksala. *Towards intelligence in CAAD by using quality knowledge*, in J. S. Gero (ed), *Artificial Intelligence in Design*, Springer, Berlin, 143-158, 1989.
- [93] T. Oksala. *Design intelligence: Evolutionary and cognitive aspects*, *Automation in Construction* 3, 105-111, 1994.
- [94] O. Wählström. *Sketching and Knowledge in the Design Process*, in T. Oksala ed, *Knowledge-Based Design in Architecture*, TIPS-86, TKK-A/ RYT, Otaniemi, 6-11,

- 1986.
- [95] T. Oksala. Tacit Skill, Emergence and Exploration in Art, in G. E. Lasker et al eds, *Art and Science Vol IX*, IIAS, Baden-Baden, 25-29, 2011.
- [96] W. W. Gasparski, T. Orel. eds. *Designology, Studies on Planning for Action. Praxiology, Vol 22*. Transaction Publishers, New Brunswick, New Jersey, 2014
- [97] T. Launis. Space, Time and the Virtual. *New Scientific, Practical and Representational Methods for Architecture and a Digital Modelling Experiment of the Built Environment*, TUT, Tampere, 2006.
- [98] N.-E. Wickberg. *Arkitekturen och Tidsandan (Architecture and the Spirit of Time)*, Söderström & C:O, Helsinki, 1974.
- [99] Ch. Norberg-Schulz. *Genius Loci, towards a Phenomenology of Architecture*, Academy Editions, London, 1980.
- [100] B. D. Josephson. A Trans-human source for music? in P. Pylkkänen and P. Pylkkö eds, *New Directions in Cognitive Science*, Saariselkä 4-9 August, 1995, Finnish Artificial Intelligence Society, Helsinki, 280-285, 1995.
- [101] P. Tuovinen. Ympäristokuva ja symboliikka, Ympäristökuvan ja siihen liittyvien merkitysten analysointimetodiikasta, (Environmental Image, About the analytic methodology of environmental image and meanings connected), TKK, YTK, 1992.
- [102] J. Seppänen. Mitä on ajattelu? What thinking is? In S. Stark, K. Tyystjärvi eds, *Ajattelevatko koneet? Tekoäly, tietotekniikka ja robotiikka, (Are Machines Thinking? Artificial Intelligence, information technology and robotics)*, Suomen Tekoälyseura, (Finnish Artificial Intelligence Society), Helsinki, 4-15, 1990.
- [103] B. R. Lawson. *How Designers Think?* Architectural Press, London, 1980.
- [104] H. Lehtonen. Perspektiivejä arkkitehtisuunnitelmien esityskäytäntöihin, Perspectives for the presentation usages of architectural plans, TKK – A 22, Esoo, 1994.
- [105] T. Oksala, G. L. Farre, G. E. Lasker eds. *Design: Emergence, Content*, DEcon'95 symposium, APS Ci 106, Helsinki, 1996.
- [106] T. Oksala. Cognitive paradigms for design: knowledge, will, feeling, skill, in M. R. Behesti, K. Zreik eds, *Advanced Technologies*, Elsevier, Amsterdam, 279-284, 1993.
- [107] J. Seppänen. Systems ideology in human and social sciences, in G. Altman, W. A. Koch eds, *Systems, New Paradigms or the Human Sciences*, W de G, Berlin, 180-302, 1998.
- [108] J. Seppänen. Feedback to the Future, *Systems, Cybernetics and Artificial Intelligence*, in H. Hyötyniemi ed, *Feedback to the Future*, Finnish Artificial Intelligence Society, Helsinki, 7-82, 2000.
- [109] I. Karanka ed. *Hyperteksti ja tekoäly, Hypertext and Artificial Intelligence*, Suomen Tekoälyseura ry. The Finnish Society of Artificial Intelligence, Espoo, 1989.
- [110] T. Oksala, *HYPERARCHITECTURES – A New Multi-dimensional and Humanistic Scheme for CAAD*, in G. Rzevski, R. A. Adey eds, *Applications of Artificial Intelligence in Engineering VI, Computational Mechanics Publications*, Elsevier Applied Science, London, 71-80, 1991.
- [111] E. Tarasti. Ympäristö, arkkitehtuuri, tietotekniikka, (Environment, architecture, IT), *Synteesi 3/ 1988*, Helsinki, 1988.
- [112] H. Meyer. *Bauen und Gesellschaft, Schriften, Briefe, Projekte*, Fundus-Buecher, Dresden, 1980.
- [113] T. Oksala, S. Toivanen. Architectural Project Sociology, in G. E. Lasker, K. Hiwaki eds, *Sustainable Development & Global Community, Vol XVIII*, IIAS, Baden-Baden, 43-48, 2017.
- [114] T. Oksala. Building Design Experiments in CAD: some theory and practice, in A. Radford ed: *Developments in Computer-Aided Design, Building and Environment, Vol 26, No 1*, Pergamon Press, Oxford, 41-48, 1991.
- [115] T. Oksala, S. Toivanen. Hyödyn arkkitehtoninen sosiologia (The Architectural Sociology of Utility), in A. Mutanen, P. Houni, J. Mätyvaara (eds), *Hyöty (Utility)*, Turku AMK, Turku, 153 - 162, 2018.
- [116] A. Giddens. *The Constitution of Society*, University of California Press. Bekeley and Los Angeles, 1984.