STUMBLING BLOCKS IN NOVICE BUILDING DESIGN

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Abstract

Many houses in Finland are designed by novices who have little design or construction training. However, design of one's own house is economically and personally a very important process to people. It is also a multistage process with some complexity, and novices can encounter problems at any stage. To avoid these problems it would be important to develop good instruction and counselling services. To improve such work, we decided to investigate the stages which became stumbling blocks for novices in their projects.

We conducted in-depth interviews with nine self-help novice builders who were able to complete their building projects and then compared them with nine who failed. The results of this comparison were complemented by a survey containing several questions aimed at obtaining information about the problems encountered by novices in designing houses. We found a number of typical reasons, including personal and/or financial problems, lack of skill, altered financial circumstances, etc., which had caused failures. We conclude with a number of suggestions to decrease the risks involved in novice design and construction processes.

Key words: design, architecture, expert, novice, task-necessary, decision, error, risk

Introduction

One goal of architectural design research is to describe, explain and predict the phenomena that emerge during the design process (see Oksala 1981, pp. 7-8). The ultimate goal is to improve the means of achieving rational design and avoiding errors. In the current approach, a number of ways to do this have been developed.

The commonly used architectural design approaches can be divided into two broad classes, which can be termed goal-normative and designer-oriented. The first refers to all the theories which postulate some ideal for design, and the second refers to those theories which aim to give a description of the design process as seen through the eyes of the designer, that is, design as a mental process. These two approaches emphasize the two principal conceptual activities that come together in the process of architectural design.

The core of goal-normative design-theoretical thinking is dominated by the idea that a planning process can be guided by giving norms defining ideals for any product. Functionalists, for example, had their ideals. They put form in the service of function, which in essence meant a search for the necessary and sufficient conditions for a humane life (Aalto, 1931; Le Corbusier, 1924/1987). Typical examples of goal-normative thinking are such historic ideas as the schema for Gothic cathedrals or ones more familiar to contemporary designers like the official building standards of today. Another example is empirical research into social expectations of design, which greatly help designers in their goal-setting (see Alexander, 1979, 1985; Alexander, Ischikawa & Silverstein, 1977).

Though a very important part of design theoretical thinking, the goal-normative approach does not provide a fully comprehensive basis for a design theory. Goal-normative ideals do not provide us with a description of creative design. This is why architects often oppose the setting of normative ideals for expression (e.g. Cullen, 1961, 1971; Harvey, 1989; Jencks, 1984, 1985; Jencks and Chaitkin, 1982; Lynch, 1960, 1972, 1981; Norberg-Schultz, 1975, 1984/1985; Pallasmaa, 1994; Venturi, 1968; Venturi, Brown, and Izenour, 1972). Existing norms cannot predict the setting of new norms. This means that there are other important aspects in design besides normative control.

A natural way of extending goal-normative thinking when developing a design theory is to call attention to the designer and the design process. Instead of stating goals, ideals and norms for designers, the control of design can be looked at from the point of view opened by the minds of designers. This point of view can be called designer-oriented. In fact, much goal-normative design thinking should be built on a deep understanding of the design process.

Designer-oriented thinking can be divided into two types. By and large, mental aspects of design are discussed in the reflections of famous architects on their own actions and thoughts, and these reflections can be taken as descriptions of design processes. Aalto, for example, described his thought process as follows (Schildt, 1984):

> … the architectural planner operates with countless mutually discordant elements. … All of these form a tangled web, which cannot be straightened

> out rationally or mechanically. … This is what I do - sometimes quite instinctively - in such cases. I forget the whole maze of problems for a while, as soon as the feel of the assignment and the innumerable demands it involves are fully engraved on my subconscious.

In this quote the designer acts within the framework of his intuitions regarding the design process on the basis of his own experiences of design and its social constraints (see Aalto, 1931; Le Corbusier, 1924/1987). Here, Aalto gives a description of his thinking to make explicit what takes place in his mind. This allows us to understand what happens in the minds of designers, and the information provided can naturally be used to improve the quality of design. This approach to the analysis of mental processes can be called introspective. The problem with this approach is its subjectivity and poor access to subconscious mental processes.

Nevertheless, the designer-oriented approach can be developed by using objective psychological methods. In this way, one can investigate the skills and capacities required in design in a more objective manner than by using biographical procedures (see e.g. Akin, 1986; Heath, 1984; Jones, 1963, 1970; Lawson, 1997; Luckman, 1967; Maarttola, 1998; Markus, 1967; Newell and Simon, 1972; Wade, 1977). By means of this psychological approach, it is possible to avoid many problems caused by introspective aspects of memoirs and obtain accurate knowledge about the mental requirements of design (Watson, 1919).

From a modern cognitive psychological point of view, architectural design involves thinking or problem solving, and decision making (Akin, 1986). It can be seen as

constructing plans by generating sequences of mental representations and deciding between relevant and irrelevant elements. Architectural design is an ill-structured and highly creative process, but it can be described as a tree of possible states and operations manipulating these states, which is commonly known as a problem space (see de Groot, 1965, 1966; Newell and Simon, 1972; Saariluoma, 1995). Typical operators could include the location of a house, its materials, its colour, its orientation, the room arrangements, etc. The notion of operator refers to any architectural idea which advances the planning process.

The theoretical problem spaces opened by applying any imaginable operator to any imaginable state of the plan would not be possible to search comprehensively. This is why human thinking and design are based on the apperceptive abstraction of problem subspaces (Saariluoma, 1990, 1992, 1995, 2001, Saariluoma and Kalakoski 1998). The process of selecting small networks of plan-relevant operators is based on the contents of the plans. Failure in this kind of approach is manifested in the inability to construct a complete sequence of rational actions from the initial stage to the goal stage (Newell and Simon 1972, Saariluoma 1995).

Here we focus specifically on novice house design. This is an economically important process. For example, in Finland, a nation of five million people the self-help builders' investments were worth approximately one milliard € in 1998 (Statistics Finland 1999). In spite of this, there has been very little research focusing directly on the subject after the groundbreaking work in the modern construction context by Haahtela and Kiiras (1980, 1994), Karinen and Kiiras (1978) and Kukkonen (1984). Maarttola (1994, 1998) has developed the theme further.

In Finland, some amount of participation by the future owner in the design, construction, and management process of a detached house is regarded as almost a given. This is in contrast to many other countries, where self-help is mostly associated with low-income housing (see e.g. Harms, 1982, 1992; Perotti 1996; Seelig, 1978; Turner, 1982; U.S. Department of Housing and Urban Development 1974; Ward 1982). This is why a comparative analysis with practices in other countries is not our focus.

House design and building is also personally important, as so many life goals and hopes are normally associated in building one's own house. Nevertheless, the design and construction of a house are complex tasks and entail many stumbling blocks. In order to minimize risk of errors, it is important that we have a solid understanding of this process. This is the best way of minimizing the risks of failures.

Method and subjects

The empirical material was acquired by carrying out interviews and surveys. Interviews of 18 households were made in 1997. Surveys of 250 self-help builders and people with abandoned building tasks were conducted in 1996. The results presented here are based on an additional analysis of the data gathered in a study of home acquisition (Maarttola, 1998).

The interviews were conducted in 9 households of self-help builders and with 9 people who abandoned building tasks within the province of Uusimaa in southern Finland. Subjects were picked for both groups selected for this purpose from a sample

of 50 which was taken from a larger nationwide sample of 750 people. The subjects were 4 couples, 1 female, and 4 males in the self-help builders' group, and 2 females and 7 males in the group of people with abandoned building tasks.

The interviews were recorded on C-cassettes and transcribed, resulting in 198 pages of text data for the self-help builders' group and 192 pages for the group of people with abandoned building tasks. The interview texts were qualitatively analysed by first abstracting cognitive plans of each of the 9 completed building projects (Dey, 1993).

Results

To understand the reasons for novice planning failures in realizing their construction projects, we investigated the systems of task-necessary actions (Saariluoma 1984). This means those actions which are necessarily required to finish the building project. They can be seen in each finished project and as a consequence they provide us with a good set of milestones for measuring how far projects have been carried. Later the results of interviews and surveys can provide us with more accurate knowledge concerning the reasons for failures.

Eight task-necessary actions were found. The first, 1) preference, implies a desire to choose a detached house in preference to the many apartment types. 2) Securing resources means acquiring a reasonable amount of time and funds. 3) Building place refers to the decision to acquire a building site. 4) Design covers in this case the actual design process of the house, not necessarily the project. 5) A building permit is compulsory. 6) Contracts usually refer to entering into at least those contractual agreements that involve work determined by law or statute to be performed by

professionals. 7) Construction refers to the actual production of the artefact, and 8) use, refers to living in the house. It turned out that the presented set of task-necessary actions of a home acquisition process developed here fits well with earlier models describing the design process, even though small house design and construction is often a less detailed process than that of a larger building (see Akin, 1986; Lawson, 1997; Maarttola, 1998; Schön, 1983; Wade, 1977).

The interview texts were compared with the idealized procedure. Occurrences of task-necessary actions were divided into two categories. ‘Explicit’ refers to a clear statement of the presence of the action. ‘Implicit’ means that action is evident either from the interview or from the state of affairs. The fact that the percentage of successfully managed task-necessary actions is high until the point of signing contracts points to the fact that entering this stage is the critical issue. The failures to enter the following stages result from not having performed the previous task-necessary action. The observed occurrences of task-necessary actions in abandoned projects are presented in Table 1.

Table 1

Occurrences of Task-Necessary Actions in Abandoned Projects

	Action							
	Preference	Resources	Building place	Design	Permit	Contracts	Construction	Use
Explicit	100	100	100	78	78	11	22	0
Implicit	0	0	0	22	22	11	0	0

Note. All figures in percentages.

The quota of abandoned tasks was high. During the period between July 1995 and June 1996, 2910 building permits were granted for self-help builders and 1035 had become void due to no construction having been started within five years of being granted (Population Register Centre, 1996). The data was found to be somewhat biased, because the building permits for the abandoned tasks had been applied for during the last months of an economic growth period, whereas the still valid building permits were granted during an economic recession.

Nevertheless, two of the 9 abandoned building projects studied here had progressed to actual construction. This indicates a relatively high percentage of failures also at the actual construction stage. Because of this, one must conclude that with two dropped projects out of nine, the amount of wasted funds is considerable. Of course, acquiring the design and especially the plot involve considerable costs. Reasons for abandoning the studied building tasks are presented in Table 2.

Table 2

Reasons for Abandoning the Building Tasks

Case number	Reasons
1	Recession-induced risk aversion, expectation of a costly divorce process
2	Need to do a lot of work oneself combined with husband's lack of skill, and an attractive alternative option
3	Disappointment at not getting a government-backed loan because of a relatively small gap in financing, need for change of occupation
4	Recession-induced high payments on principle and interest rates
5	Recession-induced risk aversion, diabetes, injured foot
6	Recession-induced risk aversion, aging during the process
7	Recession-induced retirement cuts resulting in not being able to make any payments on the principle, only on interest payments
8	Costly divorce process, asthma
9	Recession-induced loss of work opportunities, asthmatic child

The reasons for having abandoned the building tasks did not belong to the core of design and construction activity, but were often outside its scope. The recession of the early 90's, sickness or accidents, or all of these factors combined had stopped the projects. At each stage there was a multitude of options to choose from. The logic of task-necessary action implies that a failure in any of the sub-tasks could result in complete failure of the building project. Even though these have been known to happen, they occur rather infrequently (see Crocker, 1990; Kaminetzky, 1991;

McKaig, 1962). According to our data, the actual reasons for abandoning the building project were both serious (such as illness) and up to a point unpredictable (such as the economic recession).

Analyzing the survey data complemented the information provided by interviews. Besides questions of normal background issues, the survey consisted of Likert-scale propositions among which there was a survey containing propositions designed to test the knowledge of people concerning building and construction matters. The scores of correct answers were counted with a maximum of eight. Subjects were also asked about their rate of participation in design. A between-groups analysis was performed with an independent samples t-test, which compares the mean scores of the two groups with no prior assumption about the direction of the difference. Statistically significant differences are shown in Table 3.

Table 3

Statistically Significant Differences Between Self-Help Builders and People with Abandoned Building Tasks

	Self-Help Builders			People with Abandoned Building Tasks			Comparison between groups
Source	*M*	*SD*	*n*	*M*	*SD*	*n*	*t*
Age (years)	40.18	11.46	107	46.66	12.03	38	2.955**
Level of knowledge	3.56	1.38	110	2.89	1.84	38	2.047*
Rate of design participation[a]	3.71	1.06	99	3.13	1.18	31	2.577*

Note. [a]The scale was: 1 = designed alone, 2 = designed according to specifications provided by the client, 3 = designed by discussing with the client and making sketches, 4 = designed according to client's sketches, 5 = designed by the client alone. *p < .05, two-tailed. **p < .01, two-tailed.

The rate of self-participation was also measured on a nominal scale depending on whether the person did or did not report that he had participated. The approximate Goodman and Kruskal's tau significance based on a chi-square approximation was significant at a level of .042. This measure is different from the first one, as it is based on one's own initiative instead of a readily available option. Nevertheless, it does provide corroboration for the first measure.

The results show that the difference in the level of knowledge concerning building-related issues, though statistically significant, is not very great. Whether one gets five

or six answers wrong out of eight in a questionnaire of design and construction-related tasks points to a potential for a poor result in design as well as on the building-site.

Discussion

Our main goal was to understand why self-help builders fail to carry out their plans. This understanding is necessary because the personal and economic costs of failure in self-help building are large (Maarttola, 1998). By understanding the mechanisms of failures, it is possible to discover the reasons and explanations for them and to develop preventive strategies. As already mentioned, the number of failures is relatively high. In fact, the rate of abandoned self-help projects amounted to about one in every seven projects during the one-year sample period. Clearly, the losses are great and it is rational to search for preventive measures. Approaches based on the psychology of thinking provide a good basis for these measures.

Cognitive errors are often caused by illusory contents (Saariluoma 1990, 1992, 1995). A number of these error types have been presented in Table 4. Of course, as most errors are by no means unique, one way of preventing them is to make builders aware of the possible dead ends. This knowledge would presumably help to prevent some, though not all, potential failures.

This requires knowledge of the problems before they arise. Builders should have a sufficiently detailed picture of all the task-necessary actions, including their fine-grained and implicit demands. This means that any novice builder should be in contact with professionals who can explain and discuss the pros and cons of each possible solution at each stage. Another option is that professionals should develop good

expert software packages that could control the planning process. They should include all the basic information a novice planner needs about the most vulnerable points. This would save anyone who uses this kind of a program from being ignorant or forgetting details that must be taken into account during the planning process.

Classic cost estimates are generally based on three cost categories: the scope of the task, circumstantial issues related to the site and the chosen design solution (see e.g. Haahtela and Kiiras, 1980, 1994). The essence of this Construction Economic Design Theory is contained in the insight that costs cannot be guided; instead, the guidance must be focused on design. The cost of a building task is mostly created on the site, but almost completely worked out in the design (Dixon and Duffey, 1990).

The guidance of building tasks using theories of construction economics does not stand in the way of creating differing designs. Instead, the aim is to control the allocation of resources needed to create the preferred attributes of the task and, hence, especially the creation of the meanings the client desires to convey. However, if this fails for some reason or another the completion of all task-necessary activities can be ensured only by increasing the resources or by down-scaling some attributes of the original design. After the contracts have been signed the only other option is abandoning the project. Our finding is that building tasks are mostly abandoned at the point of signing contracts. This would indicate that some people get a wake-up-call at the point when they are about to commit themselves.

Table 4 summarizes potential reasons for abandoning a building task and the possible preparations that can and should be considered beforehand. It thus provides us with a minimal example of the way counseling activities could be organized.

Table 4

Preparatory Measures in Stages of a Building Task.

Action	Potential Reason for Abandoning the Task	Preparatory Measures
Preference definition	Not recognizing problems as dwelling-related	Consultation and alternative designs, consideration of options and cost estimates
	Decision to renovate current dwelling to meet desires	
	Renting or other alternative not based on ownership	
Resource evaluation and gathering	No or little savings; no loan; inadequate funds from sale of former dwelling	More savings, loans, or own work, considering other financing sources: relatives, liquidation of property
	No or little time	More savings, loans, or own work
	No or little experience	More savings or loans
Building place evaluation and purchase	None available	Considering other locations, increase in savings, own work, or loans
	Too expensive	
	Too distant	

	Disadvantageous circumstantial factors	
Design process	Disadvantageous local restrictions	Possible changes in lot or design
	Unsatisfactory design	Possible change of designer
	Disadvantageous conditions, e.g. additional costs as a result of poor soil or grading	More savings, loans, or own work
	Desired design too costly	Possible changes in design, more savings, loans, or own work
Permit process	No permit granted	Possible changes in design
	Excessive changes required	Changes in location
Contract making	No contractors reached	Waiting and new attempts
	No reasonable tenders	From extensive redesign to no changes combined with more savings, loan, or own work
Construction	Building errors	Repairing, rebuilding, or demolition
	Delayed construction	Additional financing or lower overheads / higher building costs, depending on contract
	Sickness or injury	More loans
	Contractor abandons project	Seeking another contractor
Use	Facing reality	Making the best of the situation /

	coping
	Alterations
	Moving

Our recommendation is that knowledge about problems and their cures should be given to the people who plan to begin a self-help design and construction project. There are several points in administration and business in which this could be done. The most fitting one would be in the beginning of the building permit process. In principle, the earlier the stage, the greater the effect in guiding the process would be. Ideally, the start-up meeting of the participants of the building project in the recent legislation (Maankäyttö- ja rakennusasetus, 74§) could be removed from its current place at the beginning of the actual construction and could instead be held in the beginning of the design process.

This procedure would serve both the goal-normative as well as the designer-oriented view of the design process by confirming that the norms will be followed and that the starting-point is clear. It would also enable the self-help builders to experience themselves as competent actors in control of the task that is intended to fulfil a significant part of their life goals and hopes (see Alexander, 1979, 1985; Alexander, Ischikawa & Silverstein, 1977; Helander, 1988; Kukkonen, 1984). In this way, the relatively costly novice planning errors could be reduced. People would become more conscious of the risks and would have better means to assess the possibilities of success.

References

Aalto A (1931) Asuntomme probleemina [Our house as a problem]. *Domus 8-10*/1930.

Akin Ö (1986) *The Psychology of Architectural Design.* London: Pion.

Alexander C (1979) *The Timeless Way of Building.* New York: Oxford University Press.

Alexander C (1985) *The Production of Houses.* New York: Oxford University Press.

Alexander C, Ischikawa S, and Silverstein M (1977) *A Pattern Language*. New York: Oxford University Press.

Cullen G (1961) *Townscape*. London: Architectural Press.

Cullen G (1971) *The Concise Townscape*. London: Architectural Press.

Crocker A (1990) *Building Failures: Recovering the Cost.* Oxford, UK: BSP Professional Books.

Dey I (1993) *Qualitative Data Analysis. A User-Friendly Guide for Social Scientists.* London: Routledge.

Dixon JR and Duffey MR (1990) The neglect of engineering design. *California Management Review* 32: 9.

de Groot AD (1965) *Thought and Choice in Chess*. The Hague: Mouton.

de Groot AD (1966) Perception and memory versus thought: Some old ideas and recent findings. In B Kleinmuntz (Ed.), *Problem Solving.* New York: Wiley, pp. 19–50.

Haahtela Y and Kiiras J (1980) *Rakennuttajan ja Suunnittelijan Kustannustieto* [Cost-manual for the developer and the designer]. Helsinki: Insinööritieto Oy.

Haahtela Y and Kiiras J (1994) *Talonrakennuksen kustannustieto 1994. Uudisrakentaminen.* [Cost-manual for house construction. Newbuilding]. Helsinki: Rakennustieto Oy.

Harms H (1982) Historical perspectives on the practice and purpose of self-help housing. In P Ward (Ed.), *Self-Help Housing. A Critique.* London: Mansell, pp. 17-53.

Harms H (1992) Self-help housing in developed and third world countries. In K Mathéy (Ed.), *Beyond Self-Help Housing.* München: Profil Verlag jointly with London: Mansell, pp. 33-53.

Harvey D (1989) *The Condition of Postmodernity.* Oxford: Basil Blackwell.

Heath T (1984) *Method in Architecture*. Chichester: Wiley.

Helander M (Ed.) (1988) *Handbook of Human-Computer Interaction.* Amsterdam: Elsevier Science Publishers B.V.

Jencks C (1984) *The Language of Post-Modern Architecture.* London: Academy Editions.

Jencks C (1985) *Towards a Symbolic Architecture.* London: Academy Editions.

Jencks C and Chaitkin W (1982) *Current Architecture*. London: Academy Editions.

Jones JC (1963) A method of systematic design. In JC Jones and D Thornley (Eds.), *Conference on Design Method*s. Oxford: Pergamon Press, pp. 53–73.

Jones JC (1970) *Design Methods: Seeds of Human Futures.* New York: John Wiley.

Kaminetzky D (1991) *Design and Construction Failures: Lessons from Forensic Investigations.* New York: McGraw-Hill.

Karinen E and Kiiras J (1978) *Omatoimisen Pientalonrakentamisen Kustannukset ja Työmenekit* [Costs and Amounts of Labour in Self-Help Small House Construction]. Asuntohallituksen pientalotutkimus. Helsinki: Asuntohallitus.

Kukkonen H (1984) *A Design Language for a Self-Planning System.* Acta Polytechnica Scandinavica. Civil Engineering and Building Construction Series No. 82. Helsinki: The Finnish Academy of Technical Sciences.

Lawson B (1997) *How Designers Think. The Design Process Demystified.* 3rd ed. Oxford: Architectural Press.

Le Corbusier (1924/1987) *The City of To-morrow and its Planning*. London: The Architectural Press.

Luckman J (1967) An Approach to the Management of Design. *Operational Research Quarterly, 18, 4.*

Lynch K (1960) *The Image of the City*. Cambridge, MA: MIT Press.

Lynch K (1972) *What Time is This Place?* Cambridge, MA: MIT Press.

Lynch K (1981) *A Theory of Good City Form*. Cambridge, MA: MIT Press.

Maankäyttö- ja Rakennusasetus [Land Use and Building Act]. 2000.

Maarttola I (1994) *Omatoimisen Rakentamisen Suunnittelun Päätöksentekomalli* [A Decision Making Model for the Design of Self-Help Construction]. Licentiate thesis, Teknillinen korkeakoulu. Arkkitehtiosasto. Otaniemi.

Maarttola I (1998) *Participant-Contingent Design Decisions. A Theory of Novice Decisions in Home Acquisition.* Acta Polytechnica Scandinavica. Civil Engineering and Building Construction Series No. 112. Espoo: The Finnish Academy of Technology.

Markus TA (1967) The Role of Building Performance Measurement and Appraisal in Design Method. *The Architects' Journal* 20 December: 1567.

McKaig TH (1962) *Building Failures. Case Studies in Construction and Design.* New York: McGraw-Hill Book Company, Inc.

Newell A and Simon HA (1972) *Human Problem Solving.* Engelwood Cliffs, NJ: Prentice-Hall.

Norberg-Schulz C (1975) *Meaning in Western Architecture*. New York: Praeger.

Norberg-Schulz C (1985) *The Concept of Dwelling.* New York: Rizzoli International Publications, Inc. (Original work published in 1984).

Oksala T (1981) *Logical Aspects of Architectural Experience and Planning.* Helsinki University of Technology. Research Papers 66. Otaniemi.

Pallasmaa J (1994) Identiteetti, intimiteetti ja kotipaikka - huomioita kodin fenomenologiasta [Identity, intimacy, and domicile. Notes on the phenomenology of home]. *Arkkitehti* 1: 15.

Perotti G (1996) *From Self-Help to Participative Planning. The Architect's Role Under the Latin American Experience.* Stockholm, Sweden: Department of Architecture and Townplanning. Royal Institute of Technology.

Population Register Centre. (1996). *Communication 9.8.1996*. Helsinki.

Saariluoma P (1984) Coding problem spaces in chess. *Commentationes scientiarum socialium, vol 23*. Turku: Societas Scientiarum Fennica.

Saariluoma P (1990) *Taitavan Ajattelun Psykologia* [The Psychology of Skillful Thinking]. Helsinki: Otava.

Saariluoma P (1992) Error in chess: Apperception restructuring view. *Psychological Research* 54: 17.

Saariluoma P (1995) *Chess Player's Thinking. A Cognitive Psychological Approach.* London: Routledge.

Saariluoma P (2001) Chess and content-oriented psychology of thinking, *Psicológica* 22 (1): 143.

Saariluoma P and Kalakoski V (1998). Apperception and imagery in blindfold chess. *Memory* 6 (1): 67.

Schildt G (1984) *Alvar Aalto. The Early Years.* New York: Rizzoli.

Schön DA (1983) *The Reflective Practitioner. How Professionals Think in Action.* London: Maurice Temple Smith Ltd.

Seelig M (1978) *The Architecture of Self-Help Communities.* New York: Architectural Record Books.

Statistics Finland 1999. *Rakennustilastot 7.6.99.* [Construction statistics 7.6.99]. Helsinki.

Turner JFC (1982) Issues in self-help and self-managed housing. In P Ward (Ed.), *Self-Help Housing. A Critique*. London: Mansell, pp. 99-113.

U.S. Department of Housing and Urban Development. (1974). How to Build a House… Using Self-Help Housing Techniques. Como Fabricar Una Casa… Usando Tecnica Ayuda Propia. Office of International Affairs, HUD-345-IA. Washington, DC: U.S. Government Printing Office.

Venturi R (1968) *Complexity and Contradiction in Architecture*. NY: The Museum of Modern Art.

Venturi R, Brown DS and Izenour S (1972). *Learning from Las Vegas.* Cambridge, MA: MIT Press.

Wade JW (1977) *Architecture, Problems and Purposes. Architectural Design as a Basic Problem-Solving Process.* NY: John Wiley & Sons.

Ward P (1982) Introduction and purpose. In P Ward (Ed.), *Self-Help Housing. A Critique.* London: Mansell, pp. 1-13.

Watson JB (1919) *Psychology from the Standpoint of a Behaviourist*. Philadelphia: Lippincott.

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