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IMPLICIT PSYCHOLOGICAL CONCEPTS IN ARCHITECTS' KNOWLEDGE — HOW LARGE IS A LARGE ROOM?

RIKLEF RAMBOW and RAINER BROMME

Westfälische Wilhelms-Universität, Münster, Germany

Abstract

Architects create environments for human behaviour. Therefore they need — in addition to technical and design knowledge — some sort of "psychological" knowledge of the effects of their planning decisions on the occupant. The structure of this knowledge, which is only touched upon during architectural training, is the subject of an empirical study. Experts (experienced architects) and novices (students of architecture in their first or second year) were asked to judge the quality of the floor-plan layout of a four-room flat under three different conditions. From the expert–novice comparison, it is possible to gain insight into how professional experience shapes the knowledge of occupant needs and occupant behaviour. The results show remarkably few differences between the two groups. One possible reason lies in the special structure of architectural practice, which, due to a lack of feedback, makes it difficult to accumulate knowledge by evaluating experience.

Introduction

Architects' practical work considerably influences the environment in which human experience and behaviour develop. The nature of this influence has been the subject of a number of theoretical and empirical psychological studies, e.g., in the so-called ecological or environmental psychology (Kruse, Graumann & Lantermann, 1990). Architects make their design decisions more or less without regard to these psychological studies, which raises questions about the professional knowledge on which this design activity is based and, in particular, how far implicit or explicit psychological concepts are involved in the architect's thought processes.

The structure of architects' professional knowledge and the way it is related to experience, though rarely investigated in the past, is interesting for a number of reasons:

— It is obviously desirable to integrate the results of psychological research into architectural thinking more effectively and to increase the intensity and quality of interdisciplinary communication. Clarification of the conceptual structure of

Address for correspondence: Riklef Rambow, Psychologisches Institut III, WWU Münster, Fliednerstrasse 21, D-48149 Münster/Westf., Germany.

architectural knowledge would allow better adaptation of this research to the cognitive needs of the practitioner. This in turn would contribute to the heated discussion about theory and practice in ecological psychology.

— Architecture traditionally sees itself as multidisciplinary. Even now, the architect is asked to be equally at ease within artistic, scientific, technological and economic frameworks. This multitude of requirements is reflected in the great variation to be found in the curricula of architectural schools and the constant debate over these (cf., for example, Gutman, 1985; Lipman, 1970; Saint, 1983). The architect in his/her work is therefore constantly required to integrate theoretical knowledge and practical experience of markedly differing structures, that — at least partially — imply inherent contradictions. Research into this process of integration, and the role which increasing practical experience plays in it, should be equally relevant to reflection on other fields of activity in which the heterogeneous nature of the underlying knowledge base may be less obvious but no less acute (such as, for example, in medicine or teaching).

Professional Demands on the Architect

What does the professional knowledge of an architect encompass? This question cannot be answered simply by looking at the training content of the University course and the extracurricular preparation for the job. The discrepancy between theory and professional practice (an observation well known in all qualified professions) which both novices and experienced practitioners testify to substantiates this. But how then does one arrive at a description of the content and structure of professional knowledge? One possibility is an analysis of the demands with which the practitioner is confronted in his professional activity (Bromme, 1992). Limiting ourselves to the task of designing flats, we shall now attempt to outline these demands on the architect.

Four rough categories can be distinguished as follows:

— Technical demands. Apart from structural considerations, the building has to integrate various building services (water, electricity, heating and air conditioning, communications, etc.). In integrating these, the architect must take into account criteria such as simplicity of systems, durability, energy efficiency and ease of maintenance. Due consideration must also be given to the long-term effects.
— Economic demands. Construction and maintenance of the building should be as cheap as possible and in line with market conditions to guarantee sale or letting.
— Functional demands. Each flat should create a sense of well being. Occupants must be able to lead a contemporary lifestyle without problem or conflict. Their social and psychological requirements therefore need to be anticipated and satisfied as fully as possible by the design.
— Aesthetic demands. Not only the building as a whole, but also every flat and individual elements, should be aesthetically pleasing and harmoniously integrated into the surroundings. What is deemed "aesthetically pleasing" will vary considerably according to the architect, the client or the future occupants.

Even this rough and incomplete analysis of demands on the architect highlights two points.

— Demands can conflict to a greater or lesser degree (e.g., greater emphasis on functional and aesthetic criteria raises the building costs).
— The expertise an architect needs encompasses completely different scientific, technical and artistic disciplines with their different methodological approaches. While certain technical and economic parameters are easily quantifiable, this applies only rarely, or not at all, to the functional and aesthetic. Metaphorically speaking, there are large distances between the technical, aesthetic and economic "regions" on the "expertise map", upon which the architect should be able to draw.

This raises the question of how the cognitive integration of such differing types of knowledge can be achieved.

A promising hypothesis can be found in the case studies of the sociologist Donald Schön, who has described the professional knowledge of the architect as a repertoire of cases or, in concrete terms, of building designs. The architect ". . . makes sense of a situation he perceives as unique, he sees it as something already present in his repertoire. To see this site as that one is not to subsume the first under a familiar category or rule. It is, rather, to see the unfamiliar, unique situation as both similar to and different from the familiar one, without at first being able to say similar or different with respect to what. The familiar situation functions as a precedent, or a metaphor . . ." (Schön, 1983, p. 138). The knowledge gained from experience, which allows the architect to "see as", is referred to by Schön as his "repertoire of examples, images, understandings, and actions" (Schön, 1983, p. 138). This repertoire of cases provides an array of more or less explicit solutions to the conflicts outlined above.

The Structure of Architectural Training

Unlike many other professions such as engineering, physics or teaching, architectural training is already relatively case-related. The student is confronted with paradigmatic design solutions and the analysis of these enables him/her to build up a repertoire of cases of possible demand mastery from early on. It is true that the study of architecture — like other courses — also comprises the acquisition of theories and rules in the wider sense. This is done in the form of lectures and tutorials on subjects such as structural engineering or building regulations. In addition, the student is confronted with classical solutions from architectural history and exemplary current approaches, either as representations in books and magazines or by means of on-site visits. He/she has to work on design tasks in the studio. This design work is supported, to a greater or lesser degree, by the instructor, and is critically evaluated at the end. Ideally, this core architectural training comes quite close to the form of instruction which is currently being discussed as "cognitive apprenticeship" by educational psychologists (Collins, Brown & Newman, 1989; Gerstenmaier & Mandl, 1994). The instructor coaches the student, makes explicit his/her own cognitive operations in dealing with a particular task, shows alternative ways of handling a problem, gives active advice, and leaves the student room to develop his/her own abilities step-by-step. Architects, therefore, get used to articulating their experiences based on concrete cases early on and presumably to committing them to memory by referring to these cases.

Aims of the Study

In marked contrast to other professions such as medicine and teaching, the psychological literature on architects is not very extensive. There are studies which focus on creative achievement (MacKinnon, 1962; Schoon, 1992), on the design process utilising a problem-solving approach (Akin, 1989; Lawson, 1979), or on aspects of collaboration and organizational behaviour from a sociological or social psychological perspective (Blau, 1984; Cuff, 1989, 1991). But with the exception of Donald Schön's work, there are hardly any studies investigating the architects' professional knowledge.

The observations made by D. Schön[1], however, are still quite unsystematic. In particular, discussion of the fact that the architect's knowledge derives from very differing areas of scientific and aesthetic thinking remains open to a large degree. But above all, how is the theoretical knowledge brought into relation with personal experience? This question will be explored here using the example of psychological knowledge.

Psychological knowledge is interesting in this context since it represents an area of knowledge which, for the most part, is acquired only by experience. Psychological theories hardly ever crop up when architects are being trained. Looking through the lecture catalogues of all architectural faculties at German *Technische Hochschulen* and Universities shows that classes of any kind in psychology are offered by only a few departments. In addition, all these are optional. This means that it is possible to graduate without ever coming across psychology in the course of one's studies. The student must, therefore, acquire his/her knowledge of occupant behaviour largely from other sources, that is to say from lecturers who have themselves been trained as architects, and by falling back on his/her own experience as a user of architecture and the conclusions drawn from it (cf. Tzamir & Churchman, 1989). For the practitioner, the experience gained by communicating with clients (which mostly means owners, not future occupants of the flats designed by him/her) adds to this knowledge base. What part do the occupants (whom the architect can only speculate about) play in his/her deliberations? Does professional experience lead to an orientation towards a rather general abstract schema of the occupant, a kind of average set-up, or to a greater consideration of specific needs, i.e., does a differentiation take place?

Naturally the psychological aspects, in the widest sense, can play only a limited role in the development and evaluation of design solutions. With respect to which other criteria are traces of experience formation to be found? Even if the knowledge of architects consists to a large extent of images of concrete drafts and buildings, there must still be more general criteria for evaluating these, making it possible to recognize similarities in the various examples. These questions are to be studied empirically, based on the evaluation of the floor-plan of a flat.

In order to evoke knowledge of the experience significant for this partial area of the demands on the architect, the representational form of a floor-plan is particularly suitable. In contrast with other forms of representation in architecture (views, sections

[1]Schön's (1983, 1987) theory of reflection in action has recently become very popular in research on teaching and teacher education. In this connection, it is occasionally overlooked that the empirical basis of his theory is primarily composed of the — very readable — case studies of architects, psychotherapists and others (but not of teachers!) so that further empirical testing seems necessary.

and perspectives), it attracts attention to size allocations and the spatial relationship between individual rooms, as well as to the arrangement of certain specific elements such as windows and doors. On the other hand, it makes it virtually impossible to judge aesthetic aspects such as the overall structure of the building or the facade structure, and technical or economic aspects play only an implicit part. The result should be a focus on occupant needs based within a clear framework, i.e., that of an individual flat.

The following questions are to be explored based on the subjects' comments.

— What central — theoretical and pre-theoretical — concepts do novices and practitioners use to organize their experience? Are psychological concepts among these? If not, what could be the reason for this?
— Does spatial awareness become greater with increasing experience? In other words, are more individual features considered relevant or is the opposite the case — are things "reduced to the essence"?
— On what categorial level is the flat evaluated? Is the flat as a whole focused on, or are individual rooms or details analyzed? Are there differences between the experts and the novices in what they consider important?
— Does the inter-individual consensus increase with experience? Is there more consensus among experts than among novices because the former can draw on a socially-shared level of knowledge which the novice must first acquire? Or is the opposite to be found: do views differ because the design process does not require any socially-shared experience formation but only an increasing internal consistency of different views?
— Does experience lead the architects to take the specific context of a planning situation more into account, or is it more a case of doing without additional information, since this is deemed irrelevant for ones own schematic response?
— Does the experienced architect make different judgements when he/she knows his/her target group, i.e., when he/she has information on the future occupants? What kind of experience is drawn upon when gauging the needs of certain target populations?

In order to clarify how the professional experience of architects, acquired over many years, affects the perception and evaluation of a particular spatial situation, we chose an expert–novice comparison. With this widely-used, cross-sectional procedure we naturally run the risk of cohort effects, i.e., it is quite conceivable that effects interpreted as results of experience are in fact due to the transformation of training practices or to the rapid change of trends in the discourse of architectural theory. This problem cannot be avoided, since a longitudinal design, as a stronger alternative, can hardly be realized with professionals, who are difficult to recruit for participation in a psychological study.

We sometimes refer to our sample of architects as experts and to the basis of their professional performance as expertise. That does not mean that our study is to be understood as an extreme group design. In our opinion, the structure of professional knowledge should not be investigated exclusively with reference to the domain's peak performers. Therefore, we use the term expert — in marked contrast to that strand of research within the expert approach which concentrates on the conditions of peak performance — as a synonym for an experienced member of a highly qualified profession (cf. the Introduction of this article). We cannot make any statements about the quality of work of our subjects, which in the case of architects is difficult to measure objectively

anyway. What is of interest in the present context is the interaction between experience and professional knowledge, hence experience as a variable is controlled in this study.

Method

Design

Two groups of subjects participated in the study: experienced architects ("experts") and students of architecture ("novices"). Each subject dealt with one of three versions of a booklet (no information vs. standard family vs. student community condition) so that a 2 (group) × 3 (condition) factorial design resulted. Additional variables were age, gender and years of professional experience.

Material

A booklet was sent to the subjects or was distributed through personal contacts. It contained the copy of the floor-plan of a flat on a scale of 1:100, which was designed

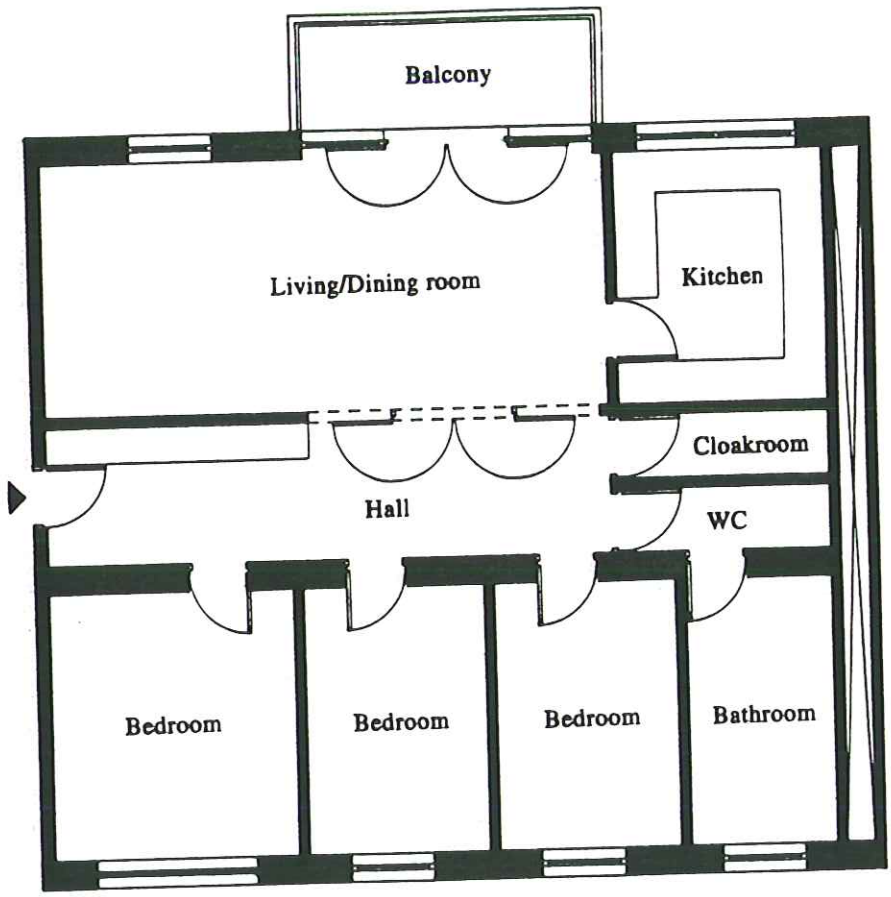

Figure 1. Floor-plan layout of a four-room flat used as a stimulus material.

by an experienced architect for that particular purpose. The same four-room flat was printed on the first page of all the booklets (Figure 1).

The accompanying text varied according to three test conditions. In the first, no information whatsoever was given on the future occupants of the flat. The text simply read: "Dear participant, below you will find the floor-plan of a four-room flat on a scale of 1:100. Would you please look at this floor-plan closely and then answer the questions on the following pages." (the no-information condition). In the second condition, the following information was added to the text: "A young couple with two children (seven and four years of age) is going to move into this flat. The father is a 38-year-old clerk, the mother a 36-year-old part-time nurse." (the standard-family condition). In the third condition, the following information was given: "This flat will be shared by three students, two women aged 22 and 27 years, and one man, aged 25." (the student-community condition). The subjects in all three conditions were asked to list (on additional separate sheets of paper) all those positive and negative features of the floor-plan which they deemed relevant. The exact wording of the question was: "Which strengths and weaknesses does this floor-plan layout show in your opinion? Which aspects of the solution do you approve of and where do you see problems? On the following pages, please list all the positive and negative features as completely as possible. Please use the reverse side of the page if you need more space." There was one lined page with the heading "Positive features:" and another headed with "Negative features:". On the next page, the subjects were asked to write down — in the form of questions — any additional information they would need in order to assess the plan in greater depth. Finally, they were asked to give a concise definition of a "good" layout in general terms, i.e., without regard to the user group described in the feature-listing task. The booklet ended with several questions about the person and his/her professional career.

The material was pretested for plausibility and clarity with a sample of 20 full-time architects. For the main study, a slightly different version of the floor-plan was designed and the wording of several questions was adapted, according to the remarks of the pretest subjects, to avoid any misunderstandings.

Subjects and Procedure

The material was completed by a total of 57 full-time architects and 57 students. These were evenly distributed on the three conditions, so that in each cell of the 2 (group) × 3 (condition) design there were $N=19$ subjects. Altogether, 240 booklets with an accompanying letter and a return envelope were sent to architects' offices, which were selected at random from the classified directories of six German cities, 23.8% being returned. 73.7% of the architects who returned the material were male, 26.3% female. Their ages varied between 25 and 67 with a mean of 42.6 years.

At the time of the survey, the architects had between three and 41 years of professional experience, or 15.2 years on average. All of them had a degree in architecture, either from a University or from a *Fachhochschule* (technical college).

The students, for their part, were all in their first or second year of the diploma course in architecture at a German *Technische Hochschule* (technical university). They were approached personally, given the booklet with the same accompanying letter, and asked

to send it back in the stamped addressed envelope. Of the 120 booklets distributed, 62 were sent back, i.e., 51.7%. Five booklets had to be excluded from the analysis, since they were incomplete or had deliberately been filled in incorrectly. Thirty seven of the students were male, 20 female. At the time of the survey, they were between 20 and 33 years of age, the mean being 22.9 years.

Results

Overview

The presentation of the results begins with an analysis of the quantitative differences in the feature-listing task. In this connection, correlations between the length of professional experience and differences between positive and negative features will be analyzed. Subsequently, the inter-individual agreement concerning these features is investigated and compared among groups. Apart from these questions of quantity and inter-individual agreement, there is reflection on the features themselves. Two separate content analyses were carried out: of the categorial level of the features (what elements of the floor-plan are being evaluated?); and of the evaluation dimension (what aspect of the evaluated element is considered to be relevant?). In this connection, special attention will be paid to those features which concern a supposed effect on the occupants and which, therefore, make clear psychological criteria of the architect in the wider sense. A separate analysis was made of all statements which contain an absolute judgement of size, in other words an evaluation of the size of a spatial element without explicit mention of the frame of reference used.

Subsequent to these analyses of the feature listings, it will be shown what additional information is deemed relevant and whether these information requirements vary systematically with the length of professional experience. The last question concerns the general definition of what, in the subject's view, makes up a "good" floor-plan. These definitions are examined for particular areas of content and they are cross-referenced with the feature listings.

Number of Listed Features

Two separate 2×3 factorial ANOVAs were computed for the number of positive and the number of negative features listed. Students mentioned more positive features than architects ($F(1, 108)=2.3$; $p<0.0001$); this effect was independent of the additional information about future occupants. In the case of the negative features, however, there was no difference between students and architects, although here an influence of the additional information was found ($F(2, 108)=3.3$; $p<0.05$). A Scheffé test showed that more negative features (7.46 vs. 5.79) were generated if there was no information given than if there was information about the student-community as future occupants of the flat.

Correlation with Professional Experience. The longer architects had been working in their profession, the fewer positive features they mentioned ($r=-0.35$; $df=57$; $p<0.01$); on the other hand, there was no correlation between the number of negative features and professional experience.

Inter-individual Consensus

To judge inter-individual agreement, a "consensus coefficient", n/N, was computed in accordance with Flammer, Riesbeck and Stadler (1985). N is the number of different features which were named by the 19 subjects of one cell. This can be referred to as the "objective scope of the feature space" within the cell. n, on the other hand, designates the "subjective scope", i.e., the number of those features which the respective individual subject named. Taking an average of all subjects of a cell, one obtains a measure of agreement with regard to the listed features within the cell. Table 1 shows means and standard deviations of these consensus coefficients. In the case of the negative features, the consensus was the same within all groups and conditions. On the other hand, there was a main effect for group ($F(1, 108)=10.96$; $p<0.005$) with regard to the positive features. The novices were more in agreement with the positive features of the floor-plan than the experts — the nature of the additional occupant information had no effect on the consensus whatsoever.

Table 1
Means and Standard Deviations (in Brackets) of the Coefficients of Consensus n/N

	Experts			Novices		
	No information	Standard family	Student community	No information	Standard family	Student community
n/N positive features	0.11 (0.07)	0.1 (0.07)	0.09 (0.06)	0.15 (0.1)	0.13 (0.06)	0.16 (0.07)
n/N negative features	0.15 (0.06)	0.14 (0.05)	0.14 (0.08)	0.12 (0.04)	0.15 (0.07)	0.12 (0.05)

Two further measurement figures were computed in order to determine more accurately the appearance of the distribution of the features within the groups. One of these measurement figures, the concentration measure R_{60}, has likewise been taken from the study by Flammer, Reisbeck and Stadler (1985). For this purpose, all the features named by the subjects of each cell were arranged in order of frequency, and subsequently it was determined up to which rank 60% of all the features mentioned were concentrated. The lower this value is, the more the mentions of this group were concentrated on a few generally shared features. For example: the 19 students who received the standard family information named 100 positive features altogether, distributed over 48 different features; the value of 16 for R_{60} designates that the 16 most frequent features were named 60 times altogether. The 19 students who received the student community information, on the other hand, mentioned 114 features altogether, distributed over 45 different features. In this case, the 10 most frequent features were named 69 times (i.e., 60% of 114) altogether. This indicates that in the latter condition, there are certain core features which are mentioned by a considerable proportion of the subjects, while in the former this is much less the case.

Table 2
Measure of Concentration of Listed Features, and (in Brackets) Proportion of Idiosyncratic Features, $\%_{1,2}$, in Percent of all Listed Features)

	Experts			Novices		
	No information	Standard family	Student community	No information	Standard family	Student community
R_{60} ($\%_{1,2}$) positive features	13 (52.7)	12 (57.1)	12 (66.7)	14 (29.6)	16 (29.5)	10 (29.8)
R_{60} ($\%_{1,2}$) negative features	11 (27.5)	12 (31.5)	12 (38.6)	15 (41.1)	14 (31.8)	11 (39.8)

In addition, another value was computed. This value refers to the percentage of all features named by only one or two out of the 19 subjects of the cell concerned, in other words, those which could be designated as largely idiosyncratic (This measure is designated as $\%_{1,2}$). The two values are compared in Table 2.

Two things in particular are conspicuous: first, in the case of the novices, the concentration of the listings on a few, inter-individually shared features in the student-community condition was greatest, whereas, in the case of the architects, no difference between conditions was found. Second, irrespective of the kind of information given, the share of idiosyncratic features for the positive features of the students was lower than for the positive features mentioned by the architects. This finding corresponded, therefore, with that of the consensus coefficients n/N. In fact n/N correlated significantly with $\%_{1,2}$ ($R=-0.924$; $p<0.0001$), whereas R_{60} did not show a correlation worth mentioning with either of the other two values.

Categorial Level of Listed Features

Subsequently, all the named features were checked by two independent raters (the inter-rater agreement, computed as Cohen's κ amounted to 0.89) to establish to which level of detail they referred. The category system used for this purpose was constructed and tested using the pre-test results; this applies to all other category systems referred to in the following passages as well. Four categorial levels were discerned: the flat as a whole; the arrangement of certain rooms in relation to each other; individual rooms; and details, e.g., doors or windows. Separate ANOVAs for all four levels showed that the difference between groups as regards the number of positive features could be confirmed on the level of flat, arrangement and room (all $ps<0.005$), but that there was no difference between groups at the detail level. However, more positive details were named in the no-information condition than in the other two conditions ($F(2, 108)=4.1$; $p<0.02$, Scheffé tests significant for both contrasts). In the case of the negative features, there were no group effects at any level, but here as well, more detail features were named in the no-information condition than in the other two conditions ($F(2, 108)=4.1$; $p<0.02$).

Dimensions of Evaluation

The analysis of the categorial level takes into account which elements of the floor-plan the subjects considered worthy of mention. The analysis of the evaluation dimensions, on the other hand, looks at which attribute of the element concerned was evaluated, in other words, whether it was a matter of shape, size or function of a room, a detail or the whole flat.

On the basis of the features named, a category system was drawn up which consists of 15 such evaluation dimensions. These dimensions were lighting, air ventilation, acoustics, furnishing, psychological effect, technology, economy, flexibility, circulation, relative size, absolute size, format, function, relationship (between rooms or functional units), presence (no attribute named).

All the features named were independently classified by two raters into one of the fifteen categories; the exact wording was the deciding factor, and the raters refrained from drawing conclusions as far as possible. For instance, a phrase such as "The bathroom has a window" was not classified as "lighting" or "air ventilation" but as "presence" since the talk was not explicitly of the window's effects on the bathroom's brightness or ventilation. Again, the inter-rater reliability was calculated with Cohen's κ, and was 0.89 and 0.87 for the positive and negative features, respectively.

For each of the 15 dimensions, it was counted how many of the subjects had used it at least once as a criterion for one of the floor-plan's features. Due to the fact that no significant differences between the three conditions could be found, all of the students (N=57) and all of the architects (N=57) were treated as two groups (students and architects) and — for positive and negative features separately — tested for differences. In case of the positive features, the dimensions lighting (χ^2=5.8; p<0.02), psychological effect (χ^2=4.0; p<0.05), circulation (χ^2=6.8; p<0.01) and relationship (χ^2=12.7; p<0.0005) were used by significantly more students than architects for evaluation. The flexibility dimension tended to be employed more frequently by the students (χ^2=2.8; p<0.1). In the case of the negative features, significantly more students evaluated in terms of lighting (χ^2=14.4; p<0.0001) and air ventilation (χ^2=5.4; p<0.02). Architects, on the other hand, rated more frequently according to the flexibility dimension (χ^2=4.6; p<0.05) and tended to rate more frequently according to function (χ^2=2.6; p<0.1; with all χ^2 and p-values corrected for continuity). All other dimensions were used equally often for assessment by both groups.

Those features which were classified under the dimension "psychological effect" could — on closer inspection — be further subdivided into three categories as follows.

- The first refers explicitly to constructs which derive from psychological research. Above all, the public/private distinction is used by 24% of all students and by 11% of all architects. Sixteen percent of the students and 4% of the architects mention — always in connection with negative features — the concept of social control.
- The second can be ascribed to a "naive" psychology of perception. Here, it is a matter of statements about how a certain type of element layout, e.g., the many doors in the hall or the combination of a small and a large window, will probably affect the occupants. These formal features are then annotated with certain experiential values: "has a depressing effect", "gives you the feeling of living in barracks".

— In the third, statements are made which do not refer to abstract constructs but to specific behavioural possibilities. The distance between kitchen and front door is seen to be too great ". . . because the crates of beer have to be lugged through the whole flat." In the architects' comments, such anecdotal references to certain modes of behaviour crop up almost exclusively in the case of negative features, i.e., with the intention to criticize. They frequently have an ironic undertone. The students, on the other hand, tend to mention positive behavioural possibilities such as "balcony allows a family breakfast on summer mornings".

Absolute Judgements of Size

All the named features were examined to see whether they contained an absolute judgement of size, i.e., a statement about whether a room or the flat as a whole was judged as "large", "small", "too large" or "too small". In this connection, it was important that such statements were not qualified by a comparison with or by a reference to size or functional characteristics. On the contrary, it was a matter of identifying those cases in which the judgement was obviously considered to be such a foregone conclusion that the subject believed he/she did not need to justify it or give any explicit frame of reference.

In the case of the positive features, no main effects for the number of such statements could be detected but an interaction of group and condition could ($F(2, 108)=3.4$; $p<0.05$). While the architects gave more absolute judgements in the no-information condition, the students tended to do so particularly in the student-community condition. In the case of the negative features, on the other hand, there was a main effect of condition ($F(2, 108)=5.9$; $p<0.005$); both groups expressed more negative absolute judgments with regard to size when they were judging the flat for its suitability for a student community. If one then looks more closely at which rooms were individually evaluated, it can be shown that the students concentrated more on the three individual rooms (bedrooms, see Figure 1) in the student-community condition and qualified them as being "too small" (47% of all subjects). For the architects, the judgements were more evenly distributed over all rooms. The individual rooms appeared here only four times (21%), which approximately corresponds to the frequency with which these rooms were evaluated by both groups as being too small (26%/16%) when there was no occupant information given.

The large number of positive absolute judgements in the case of the students, when judging the fit for a student community, is mainly to be explained by the fact that the size of the living/dining room area was given positive prominence 13 times (68%). In the case of the architects, the number was only five times (26%). If there was no occupant information available, the living/dining room area was judged as being pleasantly large by only one student and two architects.

Requests for Additional Information

Another 2×3 ANOVA was computed to test if there were differences in the amount of additional information which the subjects required in order to make a more thorough

judgment. There was a group-effect ($F(1, 108)=6.5$; $p<0.02$) as well as an effect of the information manipulation ($F(2, 108)=5.1$; $p<0.01$), but no interaction. The students would have liked more information than the architects and — not surprisingly — both groups wanted more information in the no-information condition. A categorization of the information requests according to nine areas of content, which was carried out by two raters independently of each other, shows that these differences are mainly due to the students' more frequent questions about the flat's immediate surroundings ($F(1, 108)=8.6$; $p<0.005$). Questions on characteristics of the occupants were — again not surprisingly — asked more frequently in the no-information than in the standard-family condition ($F(2, 108)=5.5$; $p<0.01$). Strangely enough, the Scheffé test, on the other hand, revealed no difference between the no-information and the student-community condition. In all other categories (construction, economy, orientation, wider surroundings, characteristics of the house, details of the flat, constraints on the designer), no significant differences either between groups or conditions were found.

Correlation with Professional Experience. The longer the architects had been active in their profession, the less additional information they believed they needed for a well-founded evaluation of the layout ($r=-0.28$; $df=5$; $p<0.05$).

Definition of a "Good" Floor-plan Layout

The answers the subjects gave to the question of which features, in general, a "good" flat layout should have were analyzed to see whether certain areas were touched upon or not. These areas were psychological effects on the occupant, flexibility/adaptability[2], functionality, light, orientation to the four cardinal points, and technical aspects.

Two raters, working independently, determined whether the subject's general definition contained a statement or not on the area concerned. Subsequently, every area was checked by means of χ^2 tests for frequency differences between architects and students. The results show that psychological criteria were mentioned more often by the students. At least one "psychological" aspect was mentioned by 52.6% of all the students, but only 33.3% of all the architects, in their general definition ($\chi^2=4.3$; $p<0.05$). From the point of view of the content, here too, the emphasis was on the concept of privacy/publicity and/or withdrawal/community (named 30 times in all). Other concepts, such as individuality, representation, protection, and security, were mentioned by only a few subjects.

The "functionality" of the layout was mentioned explicitly by 28.1% of the architects and by 17.5% of the students. This difference is not significant. However, it is noticeable that this concept was taken into account particularly frequently by those architects who had had a fairly long professional experience. If one considers only those architects with more than 10 years of professional experience ($N=32$), it can be ascertained that 40.6%

[2] "Here we should distinguish between 'adaptability', taken to mean 'capable of different social uses', and 'flexibility', taken to mean 'capable of different physical arrangements'." (Groak, 1992, p. 15). The corresponding German terms are *Variabilität* and *Flexibilität*. Although these terms designate clearly different concepts, the subjects in their statements obviously mixed their meaning to such a degree that a separate analysis did not seem to be sensible.

of this group considered functionality to be a generally valid criterion for a good flat layout. This is a significantly larger proportion than in the case of the students ($\chi^2=4.56$; $p<0.05$).

All other areas examined were mentioned equally frequently by both groups. The concept of flexibility/adaptability was the most frequently named thematic aspect (students: 49.1%; architects: 50.9%). Reference to the exterior, i.e., to the way of dealing with light, air and sun, was made somewhat less frequently. This aspect was considered to be an essential criterion by 50.9% of the architects and 45.6% of the students.

Discussion

Quantitative Differences: Less is (Sometimes) More

The results concerning the number of and the inter-individual agreement on the criteria which the experienced architects used to evaluate the flat's layout, are inconsistent with the everyday idea of an expert. Professionals are usually considered experts precisely because they have more knowledge at their disposal than novices (Bromme, 1993). The obvious hypothesis suggested by such a conception, namely that experts would mention quantitatively more features of a presented layout, must clearly be rejected. On the contrary, it was found that architects mentioned fewer features than students; however, this difference in frequency can be attributed exclusively to the smaller number of positive features (besides, this result shows that there is not a general tendency of students to answer more extensively).

With increasing professional experience, the number of positive features decreases further and the ratio of perceived advantages and disadvantages of the presented floor-plan shifts to the negative pole. Experts clearly evaluate more strictly than novices.

One could assume that expertise is not accompanied by the mention of quantitatively more features because professionals take a holistic view of the floor-plan instead of digressing into the pure listing of irrelevant details. However, this explanation must be rejected. On the contrary, there is an observable tendency for architects to mention an even higher proportion of details than students. The level of detail is the only area in which there is no frequency difference in favour of the students with regard to the positive features. The expert does not seem to partition the stimulus "floor-plan" categorically into more extensive units, thereby integrating a greater number of spatial details than the novice. If one can speak of an increasing "concentration on the essential" occurring in the course of professional experience at all, this could only be in the sense that experienced architects tend to restrict themselves to the critical, negative aspects of the presented layout.

These results admittedly contradict everyday ideas about experts, but they correspond with results of studies of other professions with different methodical approaches. The attempt to predict the diagnostic achievement of physicians on the basis of the number of hypotheses they were able to generate did, for example, not prove successful (Elstein, Shulman & Sprafka, 1978). On the contrary, while interpreting illness reports, physicians with greater professional experience mention fewer possible causal factors than advanced students or new practitioners (Schmidt & Boshuizen, 1992; Boshuizen, Schmidt, Custers

& van de Wiel, in this Volume). Moreover, hopes of predicting the instructional success of teachers by assessing the scope of their curricular content knowledge turned out to be unjustified (Bromme, 1994). Obviously the better performance of experts is more likely to be explained by means of qualitative differences concerning the content and the level of abstraction of the available knowledge.

Personal Styles

The everyday conception of an expert would further lead to the expectation that experienced architects agree inter-individually to a higher degree than students with regard to the relevant features of the stimulus. This supposition seems plausible if it is assumed that, in the course of professional education and practice, an increasing familiarization with a body of shared, "true" knowledge about the "correct" design of flats takes place. However, in the case of the architects, the self-restriction to relatively fewer features is not accompanied by a higher degree of homogeneity of criteria. On the contrary, experienced architects mention fewer, but highly varying positive aspects, while the students mention more features and they also agree more strongly among themselves on those features mentioned. Now here is a clear difference between the architects and the results obtained in research on other professionals such as physicians. Schmidt and Boshuizen (1992), in their studies of diagnostic reasoning and judgement, found an increasingly close approach to a "canonical model" of the respective illness on the part of the experienced professionals. One possible explanation for this discrepancy lies in the different structures of the respective tasks given. It is conceivable that the architects would show more agreement, should they detect, for example, actual errors in a building plan.

However, there would appear to be a substantial difference between medicine and architecture concerning the coherence of the respective specialist knowledge (understood as the range of theories offered by a scientific or technological discipline). For architects, there is no unified body of theories available which must be controlled as precisely as possible[3]. What makes up a good flat layout depends, to a crucial extent, on personal assumptions and convictions. It is, for instance, not possible to decide, for objective or absolute reasons, if the kitchen should be located in a separate room or is better integrated into the living and dining room area. The advantages and disadvantages of either solution depend chiefly on the occupant's lifestyle. In both cases, one can hardly speak of a "good" or "bad" solution. It is rather a matter of finding — based on the relatively arbitrary beliefs and value-judgments — a solution as consistent as possible, which integrates the diversity of partly contradictory demands in a sensible way[4].

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[3]The difference between physicians and architects in this regard is admittedly a gradual one. Even in professions which rely heavily on so-called "exact" sciences, many decisions and judgements cannot be traced back to basic theories, cf. for chemistry: Bromme and Bünder, in press.

[4]The leading architects of the modern movement did still believe they could shape and transform human behaviour and reform society by creating new forms of spatial arrangements (cf. Conrads, 1975). Architecture seemed to be a powerful tool for the education of the human race. If one has abandoned this belief, then the necessity arises of anticipating the needs of future occupants as precisely as possible and either finding solutions which avoid restrictions and guarantee the satisfaction of a diverse range of needs or of designing "made-to-measure" solutions for specific target groups.

Increasing experience therefore, in the case of the architects, obviously leads to the development of a personal, i.e., idiosyncratic, view of the flat layout, while the students rely on criteria which are not yet inter-individually differentiated to the same degree.

A possible reason could be that the students rely on their all in all shorter, and therefore more uniform, experience of life than on specific professional experiences. That could explain why the inter-individual agreement among the students was particularly high when they judged the flat's suitability for a student community. In this case, a comparison with a schema highly saturated with a diverse array of personal experience, often even with their own actual living conditions, might be made.

Two Types of Concepts "Soaked" with Experience

The professional experience of the experts seems to lead away from explicitly user-oriented considerations, which are superimposed by a more abstract way of looking at things. The students requested more additional information than the architects to give their evaluation a more thorough foundation, and the number of requests for information decreased with greater experience. This, too, indicates that the architects, in the course of their professional practice, develop more abstract schemata of a "good" flat layout — abstract in the sense of an increasing detachment from specific context characteristics.

Instead, the judgement of the experienced architects tends to be based on few, abstract criteria including a strong evaluative component, such as, for instance, the concepts of functionality or flexibility. Both concepts are embedded in far-reaching controversies within the discourse of architectural theory and with numerous concrete attempts at implementation. That makes it difficult to say what meaning is attached to the concept by each individual subject; what can be said, however, is that by using such concepts, the knowledge about occupant needs is integrated on a higher level and connected with a more or less extensive knowledge about concrete design alternatives.

What the individual architect understands by "functionality" might vary considerably between cases. Nevertheless, there seems to be no need for further explication. The abstract nature of the concepts, and at the same time their lack of precise explication, enable a continuous shift of meaning depending on the experiences subsumed under them.

The same applies to the development of frames of reference on which the absolute judgements of size are based. The subjects frequently qualified individual rooms as "too large" or "too small". Absolute judgements of this kind presuppose a subjective frame of reference (Luce & Krumhansl, 1988; Zoeke & Sarris, 1983), in which the relation to some standard is represented. The interesting point in this context is that experienced architects mention significantly more (positive) absolute judgements precisely if they have no additional information about the future occupants of the flat, i.e., if they lack references which could serve as an anchoring stimulus for their judgment. Therefore, they have to have an implicit frame of reference for the desirable sizes of rooms and the flat as a whole at their disposal. As there was no difference between the no-information condition and the standard-family condition found, one can assume that this frame of reference is oriented towards some sort of average nuclear family. The subjective certainty — clearly recognizable in the statements — with which this frame of reference is brought into use does not, nevertheless, mean that there is inter-individual agreement.

What one architect deems an appropriate size for a kitchen is rejected by another as too small with the same degree of conviction.

Thus — although still quite hypothetically — two kinds of mental representation of professional experience are outlined: abstract criteria of judgment (such as functionality); and frames of reference which enable absolute judgements of physical qualities (small/large, bright/dark, etc.). Here, however, the most important difference between experts and novices does not lie in a greater number of such criteria, but, on the contrary, in their economy[5] of use and therefore possibly in the subsumption of more information under the economically well-selected criteria of assessment.

Psychological Elements in the Professional Knowledge

Explicit psychological concepts were altogether rare. If psychological aspects were mentioned, then they were mainly used with reference to individual experience. Only the students used concepts which can be traced back to theories of social science to an extent worth mentioning (e.g., social control or privacy). But even in these cases, a qualitative analysis indicates that it is more a matter of a contemporary jargon for articulating everyday experiences and insights than an expression of the conscious application of theoretical social science concepts. On the part of the novices, personal experience and everyday observations form the most important basis for assumptions about the experience of the built environment. However, the perception and experience as a user of buildings does not remain unbiased after several years of specialist education (Groat, 1982; Pennartz & Elsinga, 1990; Wilson & Canter, 1990); they differ from those of an average user in a similar way as the physician's subjective perception of illness changes in the course of his training. With increasing experience, the significance of the pre-theoretical personal experience is reduced and gets replaced or at least amplified by a schema of "flat" which is less close to everyday conceptions. Psychological aspects are then preserved (if at all) only very indirectly in the frames of reference for quantitative physical dimensions and possibly in the abstract evaluative concepts such as functionality.

This partial replacement of individual experience by a more general schema certainly has advantages, but there are also inherent problems deriving from a lack of evaluation. As a schema becomes more general and its implicit assumptions become more firmly established, the recurring possibility for reality checks should become all the more important. However, under contemporary conditions of practice, the architect's assumptions about occupant behaviour and occupant needs are hardly ever subjected to any true reality check, because the architect as a rule gets no opportunity to meet the future users of his/her design. His/her work ends at the latest with the completion of the building;

[5]There are good architectural reasons to take even very differentiated characteristics of the cultural, social, economic and spatial context into account in the design of apartment buildings; however there are also good reasons to assume that such differentiation is hardly realistic under the usual conditions of practice and therefore might appear naive from the viewpoint of many years' planning experience. The question as to whether this restriction on a smaller set of relevant criteria actually leads to "better" professional decisions must be left unanswered for the time being.

at this point, the future occupants are usually not yet known at all. Besides, architects naturally hardly ever live in the flats they design. So at least in the design of multi-storey apartment buildings, there is usually no form of feedback about the correctness of the personal presuppositions and convictions. Here lies a crucial difference from other domains of the architect's knowledge (aesthetic, technical, etc.) in which a comparable "evaluation gap" does not exist.

Such systematic feedback would require successful communication with professionals from other disciplines (such as social scientists), and with the users of buildings, which means with non-professionals. If one looks at the concepts which we assume are the carriers of professional experience, then it becomes obvious why this communication is sometimes difficult. The concepts are inter-individually extremely variable with regard to their meaning, which means that they are semantically extensive, but communicatively vague. This vagueness is on the one hand a prerequisite for the "illusion of consensus" (Brown 1992, p. 14), i.e., for the impression of moving on firm common ground in discussions on an issue. But, on the other hand, if this illusion breaks down, as in the case of any conflict, this vagueness proves to be a disadvantage: The layman/laywoman neither understands the expert, nor can he or she express him/herself adequately.

We therefore see the desirable function of psychology in the course of architectural training not (or at least not only) in the provision of knowledge about psychological theories. It is neither realistic, nor by any means desirable, merely to replace the pre-theoretical experience of the architect by "scientific knowledge". Rather, to us, it seems necessary to enable a refinement of pre-theoretical experience and a fostering of insight into one's own implicit assumptions and convictions. However, one has to take into account what it is that is to be refined. This can only be achieved by means of a thorough investigation of the structure and development of the professional knowledge of architects and designers on the one hand, and of the user's view-point on the other. Such a research programme could shed light on the cognitive foundations of mutual perspective-taking of design professionals and users and thereby help to enable successful communication as a prerequisite for learning together from experience.

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