Full-Scale Modelling
a Tool with many Forms and Applications

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Abstract
The significance of the full-scale mock-up as a tool depends, among other things, on the type and finish of the mock-up, the purpose of its use and the user. The qualities of the tool affect the way it can be used. By working with a new group of users, architecture students, and by supplementing our building system with blocks we now have gained new experience.

In the first part of this paper we present the projects that we carried out in teaching, partly inspired by the collaboration with EE4A-members. In the second part, we try to compare this experience with our previous work with laypeople. Since the outcome of full-scale modelling means different things to these two categories of users, it affects their relationship to the mock-up. A consequence of this is that the mock-up has to fulfill various demands and it is important to be aware of these and adjust the mock-up and the full-scale modelling procedure according to them.

Introduction
The theme of the Full-Scale Conference, Beyond Tools for Architecture, offers us the opportunity to ask the question what qualities tools should have to work in planning and what criterion their significance and value should be based upon. Concerning the full-scale media there is a risk that we treat it as the same tool irrespective of its user, its purpose and the different performances of the models.

Our modelling kit includes wall panels and our most significant experience comes from using full-scale models to exchange ideas with laypeople in participation projects (Hornyanzick Dahlholm and Ryberg Mitchell, 1992), though, during the last two years, our ambition has been to develop the application of the full-scale method in the training of students at the School of Architecture in Lund. Furthermore, to eliminate the defectiveness of our panel-system we procured a small set of blocks developed in Lausanne and tried to combine the two systems. In this paper we will present our experience and discuss some of our thoughts about the many shapes of the full-scale media. We also will discuss their significance for the application of the full-scale method.
What happened since the last conference?

Since the autumn of 1992 we have finished the full-scale study that we presented at the conference in Lausanne. The twenty single family houses developed in collaboration with households in Laröd, Helsingborg, about 35 miles north of Lund, have been built. We have summarized our experience from the project in two reports. Our practical full-scale work was in the last years restricted to the teaching of architecture students at our school.

In earlier teaching the lab was mainly used by teachers from our department to give the students insight into people's environmental requirements in terms of physical size and movement. Smaller exercises, in which they had to adapt different spaces to different physical activities were carried out. Although a few students also used the lab to build models to exhibit their diploma projects, there were no systematic efforts to develop full-scale modelling as a tool to gain architectural insights.

Inspired by the conference in Lausanne we had the intention to introduce the full-scale method in teaching in a new way. As we did not ourselves have any responsibility for teaching we tried to "sell" the idea to the teachers of the school. We invited them to a presentation of our own full-scale projects and experience of using 1:1 models in teaching among EFA-members. Our intention was to introduce the method at different stages of architect's education. In this way we hoped we would learn how modelling could give the students the most valuable experience.

We did not find many ready listeners to our ideas and because of its abstract character the model was on the whole criticized. Despite the general lack of interest, we were successful in getting the financial means from the School of Architecture to buy a small set of "lego"-blocks from LEA Lausanne. We then turned to one teacher, who was willing to plan his teaching including certain tasks of an architectural nature that could be worked on with full-scale studies. We offered to be available to work with small groups of students in the lab.

Since the full-scale modelling was only a part of a more extensive exercise, we had restricted influence on the parameters of the studies and the follow-up. Only in the first year course we had the entire responsibility for planning an introduction to the exercise.

Introduction exercise in the first year

This exercise was addressed to all first year students during their first week at the School of Architecture. During half a day in groups of about five, the students had to build a specific space in a dwelling; a hall, a bathroom, a kitchen, a home office or a teenager's room. The full-scale work started straight away without any preparations, such as preliminary sketches.
As the space of the lab is limited, the students built the walls of panels almost immediately. Walls meeting with obnuse angles were connected with pieces of wood. The bathroom got its form and character partly from the interior equipment, that was then enclosed by the wall panels. The students enthusiastically put windows above the bath.

The construction of the kitchen mainly consisted of cupboards, lower cupboards on wheels and upper cupboards made of polystyrene. The surrounding panels could be moved easily. The students also experienced them as flexible.

The students designed the home office as a small studio for an architect. Apart from the panel's suitability, the students did not hesitate to shape any kind of angles or walls.

Besides panels and some furniture, wardrobes were used to form the teenager's room. The flexible qualities of the panels apart, the students were uninhibited in their designing, introducing angles and placing walls freely.

A dwelling in a cube 8m x 8m x 8m
Our next occasion for teaching appeared when the first year students had to build a dwelling in the shape of a cube. The side of the cube was eight meters. This time the laboratory work was based on drawings.

The size of the laboratory did not admit the model to be built in its actual height. As the lego-blocks were not yet available, we had some difficulties to solve this problem. Although there was a possibility to use the platform as an upper floor, the first floor was built and tested on the ground floor. The platform was exclusively used to get an overview of the space connections between the two storeys. Apertures from floor to ceiling were shown by leaving space between panels. Despite the fact that the model appeared to be rough and sketchy in character, the students experienced it as a useful tool complementing their own sketches.

When this exercise was carried out in the same class during the next year the full-scale study was merely a performance, showing how the sense of space changed depending on the placing of windows. As a starting point the light was only allowed in from one wall in a room. After this a corner was opened on the opposite side. Because of practical reasons the side of the cube had been reduced to three meters, so the volume was built in the correct proportions although not in correct size. Thanks to the blocks available this year, the walls could easily attain the height of three meters. Panels were placed upon a lower wall built of blocks. This exercise was quite similar to the demonstration shows at LEA by Tobi Stocki and Benz Weber (1992).

The design of the kitchen
The next full-scale study was also in the first year course. The students' original task was to design a kitchen and present detailed drawings after one day's work. We estimated there would be time to work with a maximum of four groups, one after the other, two hours each. This scheme implied that the sketches represented different stages of finish. The only limits in the exercise were the actual area of the kitchen and the dining-area.

As the first group of students started their work without any sketches, all discussions took place in the lab and we were able to accompany them. The students considered using the lego-blocks to build a long wall, of low level window sections. They soon realized however that they could work more efficiently if they built the wall with the special panels with "windows" at 60 cm height that were available. Thanks to the panel's design with covered upper parts and vertical division, they gave the impression of being real windows making the group very pleased.
They managed to finish the exercise in time with good margin. The second group of students had made simple drawings representing their visions before they entered the lab. Though they were not entirely content. The conflict was foremost about the shape of the wall with windows at the dining-area. Since one student wanted it to be curved and the other straight with right angles they agreed to build with the blocks. In doing this, they could easily change the form of the wall by pulling and pushing the chain of blocks. They eventually made up their mind to keep it straight and they replaced the blocks with panels.

The sketches of the two last groups were a lot more advanced. One pair of students wanted the walls and the interior to have rather irregular forms. This demanded a certain amount of “workmanship” to adapt the fitting made of cardboard to the walls. This kind of work did not only cause intense discussions but also required a lot of time. The second last pair of students had also done some prepar- tive work for the full-scale modelling. They had made a complete drawing but still they used the full-scale lab to try different loca- tions of the walls. Only panels and mock-ups of cupboards were used, a method which seemed most adequate.

To summarize, it seemed as if the students, who started their exercise by modelling in the full-scale lab could agree on a design more rapidly. Students who had used most of the day to make sketches and drawings did not seem to experience enough to be able to reject bad solutions.

The design of large working spaces
Already during the second year the students learn to make programmes for and to design big, complicated buildings containing work- places. This year, 1994, they could choose to design a library or a ferry terminal. During one week the full-scale lab was accessible to build a part of this building, that was specifically problematic or important to work on in detail.

All but one of the six students, who wished to try the full-scale method to refine their designs, had chosen to model big areas and volumes. The projects were several times the area and the volume of the full-scale hall affected the choice of problem to be worked on. The full-scale hall which therefore mainly worked as a reference to give an idea of the dimensions of the buildings. Lego-blocks and panels were combined to mark or to build straight and curved sections of walls and the platform was used as a high ceiling. The models thus appeared excep- tionally abstract and the students found it hard to work with them. The blocks seemed to be the most concrete element of the models while performing fittings.

The single family house of the future
The equipment of the lab can in some ways be insufficient and inadequate. This was shown in an exercise addressed to the students in the senior years. In the 3rd and 4th year there is a kind of project-teaching. This means that a group of students works on a specific, rather complex problem, that should be dealt with in different ways. When about 30 students should design their personal idea of “The single family house of the future” we were asked to contribute with our experience of
the self-planned dwellings in Larod. To show the possibilities of the lab we planned a small exercise. The intention was to help the students, who were interested in the full-scale method, to carry out this test. The result was that the teacher also got very interested in the full-scale method and he instructed all the students to make either a full-scale model or a technical model of a part of the entire dwelling. At this time we did not have the blocks. It was difficult to build very unconventional flats including for instance a sleeping-loft and half-storcks with only the panels. Therefore the students had difficulties in presenting their colleagues with a fair picture of their ideas.

Almost all the full-scale exercises we have carried out with students implied the possibility to choose their individual problems to be investigated by the full-scale method. We have had the opportunity to test both the method and the building system on diverse examples. Yet all examples deal with interior design, we hardly have any experience of working with exterior problems. The type of demonstration exercises that has been used in Lausanne (Stöckli e.a. 1991) was only performed once, although we believe it would be interesting to develop this kind of exercises. Simultaneously we are convinced that students gain most from models if they have treated the problem well in advance.

Full-scale modelling in teaching and participation

The users of the tool and their purpose

It is claimed that the nature of the task decides which tool is the most appropriate. This is quite true, but it is also important to emphasize that the same tool might be used for various purposes. That is something that has become obvious in our previous conferences, where the diverse possibilities of application of the full-scale medium have been illustrated.

The researcher, who wants to test the general validity of a design, e.g. to elaborate norms for the handicapped, uses the full-scale mock-up in a different way than the architect, whose aim is to communicate with laypeople participating in a design process. To the researcher, the mock-up is a substitute for reality and to fulfill this purpose it should correspond to reality as much as possible. The architect and the laypeople, using the mock-up for exchange and development of ideas, might accept a more abstract mock-up if it in return is more flexible (see also the paper by the Venezuala team in these proceedings).

Correspondingly, full-scale modelling in architectural training has its specific demands and can even be used for many objectives. While our colleagues in Lausanne (LEA) aim to teach their students fundamental principles of architecture, we and some other labs (e.g. the lab in Venezuela) use the full-scale medium for more concrete design purposes, where more emphasis is placed on the actual function of the building than in LEA. The importance of the function might be even more stressed in the exercises carried out with the students in Wageningen. While the blocks used in LEA are more appropriate for the goal that they have set up for, we have found that our panel system has its advantages for some of the exercises we are carrying out.

Another reflection is that if the main objective of teaching architecture is to enlighten as many aspects of building qualities as possible, it could be reasonable that the full-scale mock-up gives a very detailed representation of the reality imagined. The students might be less concerned with the consequences of their design than laypeople, who must live with the result. On the other hand, the former will never have the opportunity to experience the result in reality. You might even vindicate that the students need a more concrete mock-up with which to learn than the laypeople need to create with. A full-scale
mock-up that also shows the flow of light, colours and textures could contribute to a significant experience.

Comparing how laypeople and students of architecture use the full-scale medium, we can also see differences among groups of laypeople. Usually laypeople are cautious when they are confronted with the mock-up for the first time; old people are very quiet and modest and even young people need time to get acquainted with the environment and the way we work. The students are more enterprising and can more easily take initiatives.

Laypeople also expect us, researchers and architects, to be active in the design process. We should not only put questions and induce their visions and intentions but also suggest solutions and alternative designs. Also the students need help, although not to the same extent, which might depend on the fact that they mainly use the lab in a late phase of their work when they have already considered their design carefully and had it criticized.

In projects with laypeople we are mostly free to plan the full-scale activities according to our intentions while our possibility to influence the exercises with the students is very limited. The consequence of this is that the application of the method on education has been less strict and more dependent on the conditions of the exercise. Some students, designing "the single family house for the future", didn’t discuss their mock-ups with us and didn’t work actively with them, which would have given them more experience and knowledge. Two projects i.e. the library and the ferry terminal were too complex tasks for students in the second year. They dealt with general design problems, most of them requiring extensive spaces. This prevented them from using the lab properly.

The qualities of the tool
In existing full-scale laboratories some type of blocks or panels are used as building components. But the choice of building system in influences the use of the mock-up and how people experience the built environment. Our building system, with panels representing walls and openings (doors and windows), has turned out to work well for participation studies. The panels are big and can easily be handled and connected to spaces. Laypeople have no difficulties understanding how the building system works and they fairly quickly overcome their fear to change the mock-up, once they realize how easy it can be changed.

One of the more serious deficiencies of our panels is that windows are presented without frames, arches and bars. The consequence is that laypeople in our participation studies find it difficult to decide the sizes of the windows; they don’t know whether the opening represents the size of the window-pane or the whole window. We chose to use the blocks from LEA as a supplement to our panels partly to overcome this problem since that building system is provided with wooden window-arches.
Our collaboration with laypeople and students has also shown the necessity of a simple and flexible manner to visualize different shapes of ceilings. In one of our studies with laypeople we tried to visualize a limited part of the ceiling. We used a bolt construction covered with a cloth but most of the participants thought it was difficult to get a real experience of space in that way.

In our studies we also experienced that the use of real kitchen fittings is too heavy and inflexible. Therefore we have developed light polyurethane cupboards which have turned out to work very well, both for participation and educational purposes.

The importance of visualizing staircases in three dimensions has also become evident though our participation projects. Earlier we used to tape the contours of the staircase on the floor. Since we found it too expensive to buy a flexible but stable staircase, we developed a polyurethane staircase made in sections. These can be combined to create different straight and curved staircases. Even if you cannot use the staircase, it gives a good impression of the space needed and how it will be experienced. c.f. paper in these proceedings by Bob Maringe

Flexibility

If the full-scale mock-up is going to be useful as a design tool it should be possible to change it easily and rapidly. The advantage of our panels, compared to different types of blocks used in other laboratories, is that changes can be performed without preparation. This, we think, is an important issue when the mock-up is used for participation as well as for certain types of educational purposes.

Another issue is that the person, who is using the mock-up, should easily learn how to handle it. This is particularly important since our experience is that the participation of laypeople in the building activity stimulates their creativity.

The meaning of abstraction

An essential issue is how realistic a full-scale mock-up has to be to function well as a design tool. Most laypeople have difficulties interpreting an abstract representation of a building, i.e., a floor plan or a section. Therefore you could easily imagine that a mock-up used for participation should be as close to reality as possible. We have experienced that a rather abstract full-scale mock-up can be used to develop a layout with laypeople, although we will not state that an abstract mock-up is always preferable. In a project that we carried out with old people, we found that many of them had more difficulties interpreting the mock-up than younger laypeople in other participation projects. If this was a consequence of their age or should be explained in another way is difficult to say. It is obvious though, that the interpretation of the mock-up depends on individual qualities, skills and probably also cultural and socio-economic background.

Our experience also shows the greater need of realism the closer you get to the final design. Previous studies of working places have also shown that you need a more realistic mock-up if you intend to simulate a working activity. But there are also arguments against increased realism. One is that its flexibility and value as a design tool decreases and that realistic mock-ups are expensive and more time-consuming to erect.

The level of abstraction is also related to the aim of the full-scale modelling activity. If the only purpose is to inform about a certain design and not to encourage proposals for changes, a realistic mock-up might give more information than an abstract one.

In spite of this, we think that the full-scale mock-up should be rather abstract when used as a tool for participation. Simultaneously, it should be emphasized that laypeople must be conscious of the consequence of its abstract nature, i.e., for which type of design problems
it can be used. Our experience is that laypeople rapidly perceive which spatial aspects the mock-up visualizes. But it is important that it visualizes the spatial elements correctly, i.e., all spatial restrictions in plan and height.

When the spatial elements are not presented correctly, you can get wrong perception of the space.

In education it is easier to ignore the abstract character of the mock-up, the full-scale modelling activity shouldn’t end up in a real building and the main purpose is to teach principles and not ready-made solutions. In the type of exercises that are carried out in LEA, the mock-up, as Stöckl and Weber (1993) point out, is identical to the architectural qualities that the exercise should represent.

Another characteristic is that when the full-scale modelling is used for education or participation there is a guide (a teacher, architect or a researcher) who can explain the difference between the mock-up and reality. In research experiments the aim to develop general solutions to design problems, the mock-up speaks for itself, which means that it must contain as much information about reality as possible.

Who should build the mock-up?
From our first study with presumptive dwellers, we experienced that laypeople more often tended to change the full-scale mock-up if they participated in the building activity themselves than if the mock-up was built by us or our technical staff. Now we have revised our opinion according to experience from later studies. They have shown that laypeople, who are given opportunity to work on their layouts continuously throughout the design process, on the contrary can experience the spaces of their dwelling more intensively, if they are built in advance. They experience the dwelling as a whole and as the laypeople enter the mock-up they can be more to the point than if they build it step by step.

As "guides", we can rebuild the mock-up and show alternatives and in doing so, we inspire the laypeople to suggest their proposals.

When it comes to the use of the full-scale mock-up in education, our experience is similar; the students only used the flexibility of the mock-up when they were inspired by their teachers to test various design alternatives.

The use of different media in various phases of a design process
We have also tried to compare full-scale mock-ups with other media in communication between people such as drawings and small-scale mock-ups. As we expected the 1:1 mock-up turned out to be superior in many
respects. It is obvious that most laypeople find it difficult to produce their own floor plans and to interpret those made by other people. Therefore some laypeople participating in our projects would have preferred to use our model on scale 1:10, instead of making sketches on a paper at an early stage of the design process. However, they also thought it would be meaningless to return to the small-scale mock-up after they had seen their dwelling on scale 1:1. This indicates that the procedure in projects with participation should be similar to the one an architect performs, i.e., that the scale and closeness to reality is gradually increased the more the design process proceeds.

We have also found that students show more creativity and express more satisfaction in their work when they start their full-scale activity in the lab without any sketches or drawings. On the contrary, laypeople found it difficult to start from scratch, working with the model on scale 1:1 as well as on scale 1:10. Our experience is that if laypeople should design on scale 1:1, the task (if it is a whole flat) must be developed step by step and the full-scale modelling start in a space that they have a clear mental image of. On the other hand, our teaching experience is based on exercises where the students were supposed to design small spaces. This might imply that the application of the method must be adjusted in a similar way to them.

Combining blocks and panels
As already mentioned, our experience from teaching the full-scale method by combining blocks and panels are limited. When students are short of time they obviously prefer to build whole panels instead of blocks, as this is less time-consuming. On the other hand it is easier to visualize for instance wall-heights over 2.4 meters (the height of the panels), irregular shapes of walls (not right angled, curved) and interior details like fire places, pillars, reception desks using the blocks. To achieve greater understanding of the significance of the building system an interesting study would be to compare two identical rooms built of panels respectively blocks.

To measure the effects and results of various media
Our studies have shown that it can be very difficult to evaluate in what ways different tools affect the outcome as it is also influenced by other circumstances. The frames, in particular the economical ones, determine very much the result, irrespective of the intentions of planning.

There is also a question concerning what should be evaluated. Should it be the laypeople’s way of using the tool (the method) or should it be the product (the building)? Who should evaluate the product? Should it be judged by the teacher or the student in teaching and by the laypeople, the constructor or the architect in participation projects?

We have been funded by the Swedish Council for Building Research to estimate the significance of the full-scale medium in the housing projects made in cooperation with the users. This will be completed in 1994. We already visited the dwellings. Therefore we have already established that the loss of colour and texture in the lab had a significant importance when the participants considered the size of windows and quality of daylight. Concerning the ceiling, it is obvious that the construction made by board (rips) and cloth was not good enough to give a sufficiently realistic vision of the rooms. On the other hand we think that the abstraction of the model gave the right distance to avoid too much interest in unimportant details and gave imagination extra nourishment. Laypeople also have considerable ability to supplement the differences between model and reality by using former experience and by referring to existing environments. It is possible that laypeople use this possibility more than students do because they are in the position to create a real environment. The students might have less responsibility for their creations.
Conclusions

Full-scale modelling is a complex tool for creating architecture. Comparing our experience of the application in teaching and participation, we found that the building components influenced the way the mock-up worked; practical aspects like lack of time decided which type of component was the most appropriate for the user. The flexibility of the mock-up was one of the most important qualities in relation to the kind of problems examined in teaching as well as in participation. The abstract character of the mock-up is not advantageous on all occasions; in some training situations and at the end of a design process with participation it would be favourable if the mock-up could be closer to reality. Even if the mock-up has an abstract character it is important to visualize the spatial elements correctly, i.e., all spatial restrictions in plan and height.

Though both students and laypeople needed guidance to take the opportunity to test alternative solutions, laypeople were unwilling to start their full-scale modelling without a drawing. students on the other hand turned out to be more creative and accomplished their tasks faster when they had no sketch as a basis for their mock-ups. This was especially the case when they worked with problems familiar to them, i.e. a kitchen or a bathroom. To use full-scale modelling for more difficult tasks in the most appropriate way needed more preparations. Laypeople were more inclined to view the mock-ups objectively when these were completed by others and not built by themselves.

In the laboratory, our main concern is to develop the full-scale medium as a tool for laypeople but also for other groups of users. To be able to fulfill this objective, we need information about the influence of aspects like the building system, the user, the purpose and the application and a method to evaluate the importance of them. The practical result can be used as a tool for evaluation but it has to be discussed on whose values it should rest upon.

We have already tried to investigate some aspects, using concepts like flexibility and concrete-abstract. Though the task is so complex and involves so many different aspects. Therefore we believe the research concerning the full-scale medium should be carried out more consciously and in close cooperation within the European Full-Scale Modelling Association. We would suggest that the topics of the future conferences should be more specific and reflect our common ambition to develop our tool.

REFERENCES

