Object Based Modeling and Concept-Testing:
A Framework for Studio Teaching

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This chapter concludes with a proposal for a studio structure that incorporates computers as a creative stimulus in the design process. Three related experiences support this hypothesis: the role played in concrete designs by an Object Based Modeling environment, teaching with Computer Aided Architectural Design and OBM in the realm of documentation and analysis of architecture, previous applications of the Concept-Testing methodology in design studios. Examples from these three areas provide the framework for mutual support between OBM and a C-T approach for studio teaching. The central sections of the chapter focus on the analysis of these experiences, while the last section provides a 15 week, semester based, studio structure that incorporates OBM in the overall calendar and in key assignments.

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1. Practice, teaching and CAAD

Architectural practice, design teaching methodology and the usefulness of computers for the advancement of architecture are three fields that this chapter intends to correlate.

With the responsibility of guiding students in architectural studios and in drawing and housing theory courses, the teaching has been carried out at Carnegie-Mellon University, Pittsburgh Pennsylvania since 1984. The studio method relies heavily on the Concept-Testing, which is based on a cyclical application of the two fundamental intellectual actions that identify it.

The author’s interest in CAAD began in the mid-eighties. Since then, he has developed and taught university courses dealing with the study and the critical evaluation of contemporary architecture incorporating computers as an important tool in this process. The last course, the results of which will be presented in section two, was taught at the Swiss Federal Institute of Technology (ETH Zürich) during the winter semester of 1992. “Giuseppe Terragni Architecture. A Formal Analysis using CAAD” focused on a critical reconstruction of unbuilt projects by the most well known architects among the Italian rationalists (Figure 1). This course has shown the potentials of computers and Object Based Modeling in particular, in the realm of documentation and analysis of architecture.

The computer’s value as a creative tool in the design process (applied therefore at the center of the discipline and not only in the peripheral area of documentation and analysis), has become evident during the last two years of practice. It was the author’s experience that electronic aids are not merely advanced drafting tools, but rather have become an amplifier of architectural ideas.

This shift was due largely to the use of an OBM environment and thanks to its dynamic, hierarchical and incremental characteristics.

The central sections of this chapter explain the concepts that have been presented very concisely here. Section two clarifies what the basic characteristics of OBM are and what is meant by “dynamic” modeling (with examples derived from architectural analysis). The implications of “Incremental Modeling” are discussed in section three (with an example from practice, Figure 2). The Concept-Testing methodology is described in section four.

The ultimate goal of this chapter is to define “how” OBM can be incorporated into a design studio based on a C-T method. The last section presents a hypothetical studio structure based on the concepts and experiences presented in the various sections of the chapter.

Figure 2: Three houses in Rome. View from the top. Luigi Franciosini, Antonino Saggi architects
2. Dynamic modeling

What is an OBM environment? What are its advantages? How can it relate first to the analysis of architecture and second, to architectural design?

2.1 Object based modeling, basic characteristics

An Object Based Modeling environment, as it is described by Eastmann [2], requires representation of a design in terms of the parts that it is composed of.

In an OBM structure there is a fundamental difference between what is called an “object” and what is called an “instance”.

The object is a fully operating three dimensional volume, created with operations of extrusion and revolving applied to two dimensional polygons. Objects may be combined one within the other in a hierarchical structure. For example, a wall-object is created and then inserted and duplicated many times in a floor-object, which may be inserted and duplicated in a building-object. When the original object is inserted in another object at a higher level of the model hierarchy (for example the walls in the floor) it is referred to as an “instance”. Although each instance can be duplicated, proportionally scaled or distorted as a whole, real changes of its geometric properties (e.g. from a rectangle to a circle) can take place only at the level of its original “object” creation. The various parts of the overall structure of a model can be accessed and seen singularly or at their various level of combination.

2.2 Object based modeling in architectural analysis

OBM was applied successfully to teaching of architectural analysis. Students interpreted the projects by Giuseppe Terragni through readings, sketching, the instructor’s lectures and group discussions. (They used seven different software programs during the 15 week course to experiment, with: painting, digitizing, vector drawing, a graphic data base, solid modeling, surface modeling, animation and rendering).

The OBM re-construction of one of Terragni’s unbuilt projects represented the central effort of the students’ work. To build the model, students...
had to devise a hierarchical structure capable of expressing the architectural design concepts that they discovered in the architect's work. Some used a dichotomy between container and content, some used a distinction between structure and infill, others articulated the various functional parts of the project.

In all cases at the bottom level of the hierarchy, there are the different materials that the project is made up of. All the components of the project were created by these basic materials which became the primitive objects of the OBM organization. The real design analysis of the building was developed with a rich articulation of elements and spatial configurations that filled the gap between the primitive objects and the complete model.

The Danteum's model hierarchical organization, for example, is based on the functional difference between the various rooms of the temple and it had more than fifty different objects. This hierarchical structure allowed the depiction (as isolated elements or in connection with others) of the different chambers (Inferno, Purgatory, Paradise, etc.) located along the ascending path that connects them (Figure 3).

In the case of another large project by Terragni, the Competition entry for the Congress Hall of the E'42 Exhibition in Rome, the organization of the model is not functional but critical. It is based on the formal tension between the frame structure and the inner volumes. These two conceptual components, which live one within the other in the final project, can be separated in the OBM model to express the distinction between container and content, which is one of Terragni's favorite motives (Figure 4, 11).

As revealed by this course at ETH, the most relevant advantages of OBM for architectural analysis are:

— it allows the construction of a large and complex model even on a personal computer. Because of the separation between real object and instance, the file size is minimized (every time the program finds an instance it goes to the original object to read its properties which are therefore stored only once);
— since design and manipulation of the different parts of the hierarchy are controlled through "hide" and "show" commands rendering speed is increased. On the other hand this possibility allows to produce many critical drawing and a series of didactic frames which later can be incorporated in a computer movie;

— interactive architectural analysis is possible in this environment directly in the final model without returning to previous version of the model's file by activating or deactivating element;

— the hierarchical articulation of an OBM model (when exported to a dedicated rendering program) allows a realistic simulation and the detailed study of materials (Figure 1). This is achieved through a typical OBM capability known as an «instantiation». Since the transformation of color, maps and material properties (gloss, transparency, refraction, etc.) of the original object is automatically updated (instantiated) to all its occurrences (instances) at a higher level, it is possible to make many different hypothesis about those aspects of the building that were not exactly known from the original drawings.

The fundamental difference between traditional ways of analyzing architecture and the method that was followed in the course is that the process of de-construction and re-construction was not delegated to a set of different drawings. The critical concepts about how the project is interpreted are contained in the way the model is built. Therefore, critical understanding of the project and hierarchical construction coincide. In this framework, students work with a tool that does not exist in a traditional setting. It is a "dynamic model" able to follow his or her interpretation and to present critical ideas and discoveries to others with a series of sophisticated tools.

3. Incremental modeling

In addition to its dynamic modeling characteristic, when applied in design the OBM environment has another ingredient. Its capability to support "incremental modeling" consists of two interrelated maintenance of diverse alternatives within the same model and (ii) the support for further refinements of design elements already placed within a scheme.

A real project described below clarifies the relevance of these characteristics for the design process. It is the fourth project that has been developed by the author with the support of OBM. While the first three have been discussed in other occasions, this one is original because it develops for the first time the "incremental" aspect of OBM that could become a salient component for studio teaching.

3.1 Concurrent alternatives in design practice

In a site of 41 by 25.10 meters, with usable construction surface of 430.35 square meters, a single detached house existed. The only access was from the street located on the shorter side of the rectangular area of construction.

The developer asked for the substitution of the single house with three attached units while maximizing floor area, providing garages and family room below the ground level and a bedroom and bath underneath the sloped roof. The legal floor area was 75 square meters net per units, but with attic and family room, it doubled.

The working environment on this problem consisted of paper and pencil for sketching, a personal computer (8 megabytes of ram), a laptop computer (2 megabytes of ram), a dot matrix A3 and a laser A4 printers. The software programs were a two dimensional vector drawing package (VDP), a high rendering package (HRP) and an OBM. To make a comparison with a traditional setting, the reader has to imagine that the design was carried out in parallel in a drafting table (for exact orthogonal drawings) and in a cardboard model for development of volumetric ideas. Although software improvements will provide a live link between the two programs, the information from one to the other flew "manually", with electronic cutting and pasting.

The project started by designing what the developer had preconceived. Three cubes (aggregated to create a simple row and covered by a pitched roof) were generated in minutes in the OBM and a plan was drafted in the VDP (Figure 5a). While this scheme would satisfy the developer, it did not accomplish the goals that the author of this chapter and architect Luigi Franciosini, co-responsible of the project, had. A search for articulation of spaces and for a more
efficient plan started and a new scheme (based on the reciprocal sliding of the night and day zone of the unit) was laid out. Keeping the first block alternative, the model was enriched by the new rowhouse scheme. Several alternatives were studied to find out the best organization of the new scheme on the site and the interplay of elements from key view points (Figure 5b). Each of these sub-alternatives, was treated as a separate object in the overall model.

After these experiments, it was clear that a simple row house organization was not the best solution. A third site plan scheme (Figure 5c) was based on an "L" unit, which could receive natural light by two extra sides. This possibility allowed a 90 degree's rotation of the middle house providing a yard size comparable to the two end units and a cluster organization that is more appropriate to the site's suburban context. A typical unit plan was studied in details and drafted in the VDP and a new volume created in OBM. Elements such as windows, already prepared for the previous alternatives, were inserted in the new shape.

The design was ready to be submitted to the developer for evaluation. Each hypothesis was presented with unit plan and three dimensional views. With the help of the hide and show command, the developer judged directly on the computer the impact of the block, rowhouse and cluster alternatives. The cluster alternative, based on the "L" unit, clearly was the best one and was approved for further development.

A new file was created, objects of the previous alternatives were destroyed, and a more accurate and hierarchically efficient construction took place. The new model allowed a design search concerned with the impact of sloped roofs. It was the most difficult component of the design.
and different alternatives were studied and simultaneously present in OBM for several weeks (Figure 6). The final solution was developed on a diagonally symmetrical roof placed upon the square geometry created by the interconnection between the two arms of each "L" unit. Final legal drawing in VDP, and views of the model were ready to be produced (Figures 7, 8).

3.2 Achievements in design process

The OBM environment in this case not only provided a dynamic model able to support different critical analysis or automatic instantiation of parts through its hierarchical structure. It became a stimulating basis for an incremental development in design, which in the past was conducted by this author only with traditional tools [6]. At the beginning, its hierarchical organization permitted the concurrent maintenance of different schemes (block, row house, cluster), later it supported the study of different roof configuration within the accepted "L" unit scheme and finally it allowed the development of the final project with a progressive refinements of elements.

From a design process stand point, the concurrent maintenance of different hypothesis in various moments of design development was crucial not only for the communication with the client, but also to support further design explorations. The labyrinthine way of the design search was supported by the firm basis of the previous scheme, which could always be tested and confronted with the next hypothetical advancement. The OBM environment not only allowed this approach to problem solving, it stimulated it to a new, unexpected, level of sophistication. OBM in this context, became an intellectual engine for the development of the design.

4. Concept-testing approach to studio teaching

The use of OBM as a dynamic and incremental technique to develop and test design, shares one fundamental characteristic with the approach, which the author adopts, for teaching architectural design in a traditional studio setting.
Figure 7: Three houses in Rome. Site plan at 0.00 and North facade. DueEmme Constructions. Luigi Franciosini, Antonio Segato architects.
The Concept-Testing approach to studio teaching was used since 1984. The first experience was conducted jointly with Prof. Louis Sauer at Carnegie-Mellon. In three studios (conducted together with other instructors), C-T was used partially, but it formed the overall framework of five subsequent studios, independently conducted.

4.1 Concept-testing philosophy

This approach is fundamentally different from the methodology commonly used in Italy, which we may call Analysis-Synthesis. In A-S two phases create the studio structure. The first collects all relevant information to a given problem — Analysis. The second — Synthesis — is concerned with design development within the "area of feasibility" established in the first phase (Figure 9a).

Prof. Louis Sauer has developed an approach to studio teaching that is radically different from A-S. His approach is based on the theoretical work of scholars such as John Dewey, John Zeisel, Barry Korobkin12 and his own thinking and experience as a designer.13

The Concept-Testing approach bonds design decisions to analysis throughout the entire studio development. The need for new information comes at the moment that a design hypothesis is defined. The search for new information tests the hypothesis. Refinements of a scheme, or new search direction, are responses to various aspects and constraints presented by new pieces of information.

Design decisions result from two basic intellectual operations: "conjecturing and testing". These
activities are undertaken in a cyclical fashion that is powerfully described by John Zeisel as a spiral converging on a domain of acceptable responses progressively developed or discarded. The process of testing an hypothesis about information is illustrated in Figure 9b; the "+" represents a possible design decision and the dark line, the information that defines the feasible region. If the "+" is inside the feasible area, the test procedure produces a positive result and the student can go on to define the idea in another iteration. If it is not, the student has to discard it and find another solution. This process takes place many times during the course of a design studio. The feasibility area of a project becomes smaller and smaller as new analyses and information are added and new design decisions are made.

From the practical side, the application of this framework begins by asking students to respond to a site with generic goals in mind and practically no constraints. The first step starts the cycle by producing a first design hypothesis. New information in the form of guidelines, lectures by the instructor, comparable studies, client interviews, spatial, functional and compositional characteristics of the problem are incrementally added in each new cycle. In response to each input, students have to develop a new design hypothesis or elaborate on a previous one. The project therefore moves incrementally from abstraction towards reality in a continuous process of adding information, conjecturing about new design ideas and the testing of those ideas.14

4.2 Concept-testing evaluation

Concept-Test presents some disadvantages. Inexperienced students may be confused by the continuous cycle of Hypothesis-Verification. As new information and constraints are added, some students cannot keep a good solution because they are not well acquainted with new information. Other students are not able to set up a series of goals and criteria with which to test their hypothesis.

In the author's experience, advantages are far more significant than the disadvantages.

First, this method helps most students to find a creative and innovative solution to a problem. During the beginning phases of design, too much information is not hindering the students from exploring a large area of possible directions and solutions.

Second, the fact that new information is incrementally added, helps students to focus on its design implication. Since information has operative importance on a project's advancement, "information and constraints" tends to become "design opportunities".

Finally, this method is more in line with the normal sequence of documents that architects produce in practice. In the sequence schematic design, design development and construction documents, new information and constraints are added at each stage and ideas become more defined.

5. Concept-testing and object based modeling— a studio structure

It should be clear at this point, why OBM and C-T can be merged and mutually supportive. The usefulness of an OBM environment within a C-T studio structure, relies on the fact that both share a similar hierarchical and cyclical nature and on the fact that an incremental design process, which is typical of the C-T approach, can be supported and stimulated by OBM.
5.1 Mutual support

The potentials of an OBM environment in a C-T studio can be subdivided in three categories. The first is a common characteristic of every 3D model. That is the "Simulation" component that is crucial for the testing cycle in C-T. Simulation applies to two different areas: spatial tests and, within a CAAD environment, quantitative evaluations (not only of generic aspects, concerning surface and volumetric requirements, but also features such as cost, energy efficiency and structural feasibility).

The second characteristic has to do with "Interactive design" (or dynamic modeling as has been defined) as it is supported by the hierarchical structure of OBM. In this environment, the designer works with a tool that does not exist in a traditional setting. As we said, it is a model able to react to a designer’s input not only by performing spatial operations but also by facilitating and testing complex changes, even in advanced design phases, thanks to automatic instantiation.

The last, and most relevant, aspect is the incremental nature that OBM shares with C-T: both follow a process that goes from abstraction towards reality. One of the most interesting features of OBM is its capability to support incremental definitions of parts and the concurrent coexistence of different hypothesis during the design development (Figure 5, 6).

The next section describes the fundamental structure of a studio course that would incorporate OBM in the teaching of architectural design.

5.2 Studio prerequisites

The preconditions for such an experimental course can be summarized by the following five points:

(i) the basic functioning of the three dimensional environment. (Creating of volumes: extrusion, revolving sweeping; scaling; duplicating; three dimensional modifications; view controls; animation). The assignment consists of the creation of a 3D model of the first scheme;

(ii) the hierarchical structure of the OBM (Object characteristics, how to create a hierarchical organization, legal and illegal structures). Since this topic will be introduced before the students have a developed scheme, the reconstruction of an existing project is the theme of its application;

(iii) the concurrent maintenance of design alternatives in OBM. (The capability to have more than one design hypothesis available and the possibility to use some objects — for example the context or specific design elements — in alternative schemes.) With this level of knowledge about OBM, the assignment can refer again to design development. Students are asked to develop three site plan alternatives within the same three dimensional file.

After the first three weeks, which have been partially dedicated to the explanation of the OBM methodology, the course develops normally with
<table>
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<tr>
<th>Week</th>
<th>GOALS</th>
<th>INPUT</th>
<th>OUTPUT</th>
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<tbody>
<tr>
<td>1</td>
<td>Get acquainted with instructor and classmates</td>
<td>Loose program</td>
<td>First in class scheme &amp; grading scheme</td>
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<tr>
<td>2</td>
<td>Messing concerns</td>
<td>OBM Basic 20 functions</td>
<td>Simple mess scheme and four plans</td>
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<td>3</td>
<td>Different systems within housing design</td>
<td>OBM Hierarchical structure</td>
<td>Hierarchical model of a comparable housing project</td>
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<td>4</td>
<td>Generation of alternatives, Goals, criteria and test</td>
<td>OBM as an incremental tool</td>
<td>Design alternatives in messing and plans</td>
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<tr>
<td>5</td>
<td>Hierarchy of spaces in housing design</td>
<td>OBM, &quot;Analysis of a project&quot;</td>
<td>Generation of a site plan</td>
</tr>
<tr>
<td>6</td>
<td>Distribution systems and unit organization</td>
<td>OBM, &quot;Unit and distribution of basic schemes&quot;</td>
<td>Generation of unit design</td>
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<td>7</td>
<td>Form and materials</td>
<td>OBM, &quot;Basic formal grammar&quot;</td>
<td>Generation of a unit design</td>
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<tr>
<td>8</td>
<td>Architectural communication</td>
<td>OBM, &quot;Board layout &amp; presentation techniques&quot;</td>
<td>Mid term project presentation</td>
</tr>
<tr>
<td>9</td>
<td>Evaluation of strategic goals</td>
<td>OBM, &quot;Competition &amp; professional role&quot;</td>
<td>Goals, strategies and criteria for the new project</td>
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<td>10</td>
<td>Refinements and progress in design</td>
<td>OBM</td>
<td>First overall site strategies</td>
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<tr>
<td>11</td>
<td>Context and architecture</td>
<td>OBM, &quot;Housing in different contexts&quot;</td>
<td>Generation of a site plan</td>
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<td>12</td>
<td>The challenge of language</td>
<td>OBM, &quot;Master formal language, students' presentation&quot;</td>
<td>Generation of architectural composition</td>
</tr>
<tr>
<td>13</td>
<td>Adaptability and flexibility</td>
<td>OBM, &quot;Change, demand, unit's organization and distribution systems&quot;</td>
<td>Generation of unit design, flexibility and adaptability</td>
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<td>14</td>
<td>Design synthesis</td>
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<td>15</td>
<td>Design presentation</td>
<td>Final work, Questionnaire about OBM use</td>
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**Figure 10:** Studio structure based on a Concept-Testing model. Object Based Modeling is inserted in weeks two, three, four and ten.

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specific attention to housing and architectural issues. While learning of OBM should not take more than ten percent of the entire studio time, its use in design development should account for twenty-five - thirty percent of the time devoted to design development. (These tentative figures are based on the design experience described in section 3).

Week eight focuses on the mid term presentation. Students will submit a complete and clearly drawn proposal for the given site. It is expected that some of the three dimensional experiments be included in this presentation.

In week nine the cycle that leads to the final project begins. A new project's program for a larger site is provided and either context or construction play a relevant role in the design. If available and appropriate, a design competition could provide students with extra motivation to concentrate on the second part of studio. In any case, a formally detailed and rich program should be provided for this final phase.

Week ten addresses the fourth topic of OBM: incremental definition of elements. (The possibility of creating objects with a low level of detail that can be studied further in successive design phases. The original location in the model of the object is kept, but its new version is automatically updated in all its occurrences in the whole model). In this last sequence devoted to OBM, students will learn how to develop in detail an acceptable overall massing scheme, how to study different variations of the elements (windows, railings, chimneys, roofs, etc.) and how to verify the implications of the design decisions at larger and smaller scales.

A combination of traditional and computerized drawings will be produced for the final presentation. Other possibilities will involve the export of the model to high level rendering package, the creation of analytical animation and walkthroughs. It should be noted, that these options are secondary to the real goals of the studio, which primarily are concerned with architectural education and secondarily with the value of OBM to reinforce the design process.

It is crucial to ask students, at the end of the semester, to express their opinions about the inclusion of OBM in the studio structure. Identifying the tradeoffs between the OBM approach to three dimensional reasoning and traditional methods, the impact of learning and application time on the quality of the studio and evaluation of the difference between expectations and results can help determine the value of OBM in a studio setting.

The assumption that OBM can support a C-T approach to teaching design, can then be evaluated. Students' feedback will provide an important starting point for critical evaluation and adjustments and refinements for the next cycle of teaching a Design-Testing studio with the help of Object Based Modeling.

6. Conclusion

This chapter has tried to set up the framework for making a small step forward in teaching architectural design. It is a move towards a direction that is considered important by many educators. It is believed that computers can really help in the thinking process and amplify a way of approaching the solution of a problem.

The proposed teaching framework is based on a careful inclusion of a new tool in a conceptual structure that has revealed itself as successful in the past. This inclusion is based on direct architectural practice over the last nine years. In these experiences computers have moved gradually from the boundary towards the heart of the design process.

OBM is a tool that belongs to inventions (similar to the worksheet and the hypermedia) that do not have a traditional counterpart. Its intellectual relevance, for the author way of addressing design issues, is not that of a simple mechanical tool but of a real amplifier of a way of thinking.

Acknowledgments

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References


Notes

1 Italicized words will be discussed in the following sections.


3 The projects presented here are based upon the author’s activity as practitioner and teacher. The development of small and medium scale projects, particularly in the field of housing, and of larger projects submitted for competitions in Europe and in the United States, are the focus of a practice based in Rome since 1980. From the second half of Eighties, this design work was intended primarily as an experimental activity with the view to create synergies with teaching and research.

4 Crucial in analysis and in design developments is that certain parts (or elements) of the model can be shown or hidden to provide thematic views depicting specific design issues. While this aspect shares a degree of similarity with the layering function of many CAAD, the hierarchical structure and the dynamic update as a result of instantiations (which add exponential power to the hide and show function) are specific to the OBM environment.

6 The design theme was a small scale housing design on the periphery of Rome. The project was designed in summer 1991 and construction is scheduled to start in the second part of 1992.

7 Macintosh II and Macintosh portable produced by Apple Computers Inc. OBM: Aldus SuperSU™ designed by a team led by Michael Martin for Silicon Beach Softwares Inc.; VDF: Claris Cad™ designed by Craig Young for Claris Corp; HRP: StrataVision™ designed by Kenneth and Gary Bringhurst for Strata Incorporate.

8 A purely linear organization would have provided very large yards for the two end units (which take advantage of the set back area) and a very compressed outdoor space for the middle one. In addition, a row house organization perpendicular to the access street would have been a very illogical response to the context.

9 In this process the automatic control of floor area and the easy transformation of elements allowed by the electronic environment were crucial to develop in ease the different interrelationship between set backs, usable area, rooms and circulation arrangements.

10 From the developer’s point of view, this scheme provided larger exploitation of the underground area in the project. The backyard of the central unit was big enough to make it almost as marketable as the others. Other pluses were concerned with direct ventilation of bathrooms, compact and efficient unit layout and correct solar orientation. From the designers’ point of view, this scheme also provided a more logical response to the context than a row house one and a richer environment for volumetric and formal manipulations.

11 None of them was satisfactory from the designers’ compositional point of view and from the developer’s concerns about attic usable floor area.


13 A first documentation of these experiences is due to the work of Stefani Ledewitz, Assistant Professor at Carnegie-Mellon University, who also taught in the past with Prof. Sauer. See Ledewitz, S. “Models of Design in Studio Teaching”, Journal of Architectural Education, winter 1985 (38/2).

14 More particularly, each cycle consists of three fundamental components: input, processing, output. A design scheme, coming from the previous completed cycle, together with new and discrete piece of information, represents the input of each cycle.

The processing component corresponds to: i. the translation of the new information into design goals and quantitative criteria (e.g., unit surface requirements are incorporated into goal “flexibility of space” and then into criterion “each room can be furnished in three different ways”); ii. the development of several design alternatives. This requires the capability to process verbal and abstract goals into geometric and spatial layouts.

The output, which is the result of the testing activity, is the selection of the most appropriate design alternatives in the light of the specified criteria. The chosen design scheme goes to the next cycle and contributes, together with new information, to create the subsequent input and to reiterate the cycle.

15 The cluster has not to be located necessarily in the proximity of the studio room.

16 This figure can rise to thirteen hours if students have not previous knowledge of the personal computer operating system. On the other hand, it can decrease to seven hours if they are familiar with computers. The overall
reduction of design feedback will be, in the most pessimistic case, no larger than 10%.

17 Students will spend about nine hours with instructor in lectures, seminars, desk crits and class reviews and an average of eighteen hours of individual design development per week.

18 Based on previous experiences, the level of complexity of the housing theme and the intermediate expertise of students cannot bring to positive results if students are expected to respond in detail to too large a range of themes. The fact that ten percent of instructor time will be devoted to OBM's related matter, will be another factor for the choice of a small project in the first half of the course, and for the assumption that only a comprehensive contextual response or construction details can be provided in the second part.


20 The use of VDP for drafting, and of computer generated output is not part of the studio scope. It will depend solely on the student's initiative and on the required standards for presentation.