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Some Years' Experience Teaching CAAD

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Introduction

In the conventional way of teaching architecture, it is common to think of design as the final synthesis of an intellectual process (composizione in Italian) integrating different elements from different curriculum subjects: history, structural analysis, technology, regional and urban planning, and so on. These elements, being comprehensive of their specific domains, together build *the project*.

This process is supported by a long tradition[1] that cannot easily be modified; however, we must not consider it to be the only one. Architectural practice should be much more. The *Scuole di Architettura* has walked a long and difficult road in the last thirty years, with a significant widening of interest in social, political, and economic issues. There have been recurring attempts at epistemological reformulation in some areas. There has been an acknowledgment of a crisis in contemporary town planning and a dimming of several certitudes that had developed with the birth and growth of the modernist school. And there has been a weakening of the promises that had given life to the vigorous discussion about town and regional planning. All of this leads to a reconsideration of the meaning and the deeper assumptions that *the project* implies, a question mark at the center of the human sciences that architectural practice involves.

The old tradition, which assigned composition a central role in the project, is no longer sufficient because it is related to a reductive reading of epistemology that views human sciences as defining segments of *physical knowledge of the actual world. Contemporary reflection on the difference between understanding* and *unfolding,* together with the attention given to

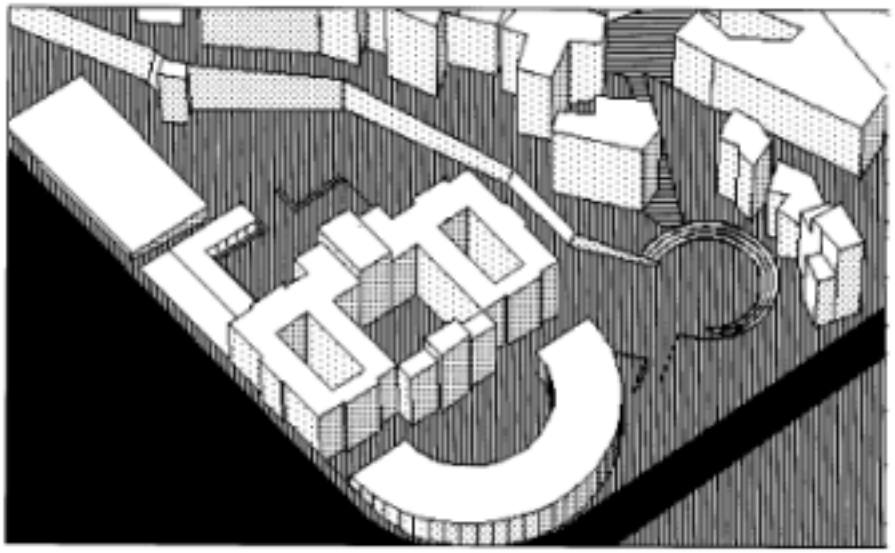

Figure 1 New use of a public building-Heliodonic perspective (perspective from the point of view of the sun), drawn by means of Space Edit and Full Paint. Example of verification of the disposition of masses to the scale of a neighbourhood.

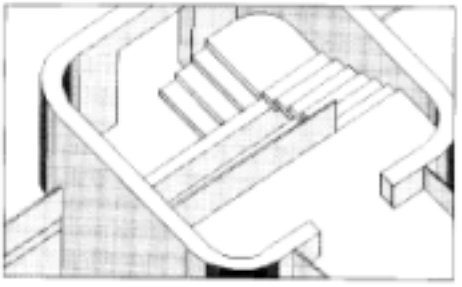

Figure 2 Design of a railway station, Genoa-Nervi. Axonometric of the internal part of a communication tower, drawn by means of Space Edit and Full Paint.

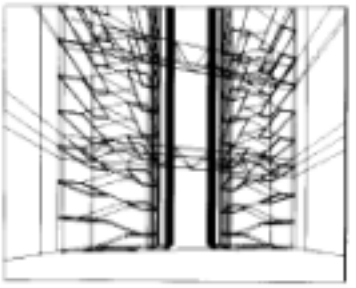

Figure 3 Study of the vertical circulation paths for a students' residence.

interpreting a moment as compared to purely *describing* one, gives to the project the task of inquiry instead of solution.

Choice of CAAD

This idea of architecture requires particular attention in teaching. Our didactic objective is to teach an organizational method addressed to the problems of evaluation, identification, definition, and control of the spatial qualities of a design, as well as to provide the instruments required to carry out the verifications of the design. It is within this context that we felt the necessity to include the organized teaching of CAAD techniques.[2]

From Research to Didactics

This research originated in our interest in using a digital computer in architecture merely as a technical tool, as happened more-or-less in the whole architectural world. These first experiences and interests go back to the early 1970s, when one of the authors, Roberto Cipriani, was working on his graduate thesis. For several years, work on the computer was confined to a very few theses, which, as a result of the availability of ever more advanced and suitable machines and programs, were able to focus on specifically design-related interests in meaning, communication, and language that today find clearer expression in our didactics.

The first thesis carried out with the aid of the computer as a drawing machine was completed by G. Rossi, under the guidance of R. Cipriani, in 1979. The study looked at the graphic possibilities offered by the state-of-the-art equipment at that time. Rossi drew the hull of a sailboat by, for the first time in Italy, developing algorithms[3] and writing the necessary software in FORTRAN for the PDP 11/45 with a Tektronics storage-tube graphic terminal and a plotter. This thesis demonstrated that it was possible to process complex objects from a formal point of view; the work was published in the Italian magazine Domus in 1980.

Later theses studied the organization of databases necessary to describe buildings, in particular to produce the drawings of spatial structures. The most interesting result, obtained from consideration of all this work, was to convince us that an architecture department is not the right place to write software; rather, it is the right place to write the performance specifications to be met by the programs that software specialists create. This realization has been confirmed by the fact that an increasing number of programs suitable for design are becoming available (even though many were not conceived for architectural design). Therefore, our focus has shifted to analyzing and evaluating available software, especially the software available on small machines-the ever improving personal micro-computers.

Figure 4 Design of a university campus in Genoa. Perspective showing relationship to context. Unlike the previous images, this drawing was been obtained from amathematical model, which contained all information relevant to the design.

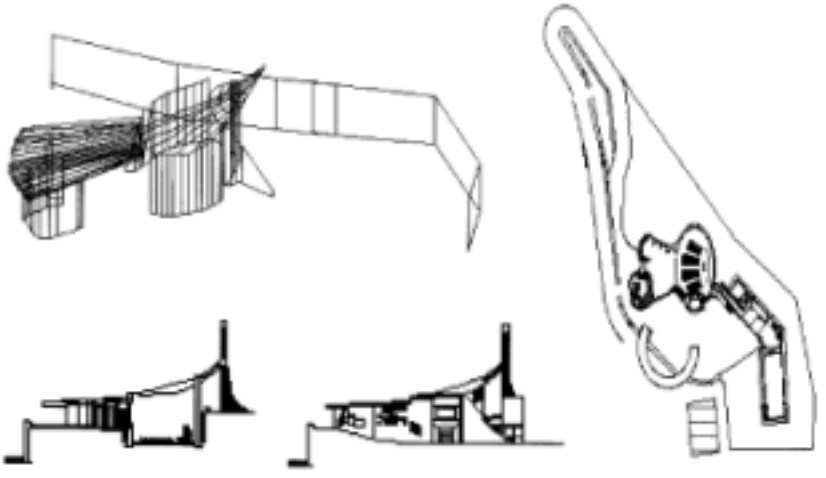

Figure 5 Representation of a Church by means of Space Edit

One of the authors, Anna Decri, completed a thesis in 1986 that offered our department the opportunity to obtain its first Macintosh. The thesis analyzed the software available at that time, and so guided the subsequent choices. Moreover, it clarified and defined precisely the meaning and the implications of CAAD through a comprehensive bibliographic search of the most important international texts and the leading work being done in Italy, using as a basis W. J. Mitchell's work. Documenting this experience at the Fourth European Conference on Teaching and Research Experience with CAAD, held in Rome in 1986, we presented a paper entitled 'Approaching CAAD at Facoltà di Architettura, Genova."

Subsequent work, particularly the theses of Alfio di Bella and Paola Gualeni in 1989, explored in depth the possibility of using for architectural design the several programs available for the various models of the Macintosh. They sought to evaluate the limits of this software. At the same time, and recognizing the maturity of these systems, we tackled mass teaching with an institutional course on architectural computer-aided design.

Programs and Themes

In our department there are five design courses, one for each year. Every teacher takes a turn at being in charge of each of the courses, in the following order: second, third, first, fourth, fifth. The sequence keeps a student from having the same teacher for more than two consecutive years. The syllabi of the architectural design courses include design theory and practice; however, given the nature of these subjects,[4] what is taught, and how it is taught, varies according to the cultural position, within the current architectural debate, of the individual teachers. Our approach focuses on the language of architecture and the meaning of the project. To achieve our objectives and to meet a high standard of quality, we use the CAAD techniques that we teach in our other technical courses.

Organization of Our Teaching

During the last academic year, our course was offered to fifth-year students. We taught at the same time architectural design and the use of CAAD programs. As far as we know, this was the first time that such an experiment had been tried in any Italian department of architecture; in fact, the teaching of CAAD has always been separate from the teaching of design.

Taking for granted that the fifth-year students had already reached a certain specialization of interests, we allowed them to choose freely their design theme, though we encouraged them to concentrate on meaningful three-dimensional space. Besides critiques of their work, we also gave a series of theoretical lessons on the language of modern and contemporary architecture.

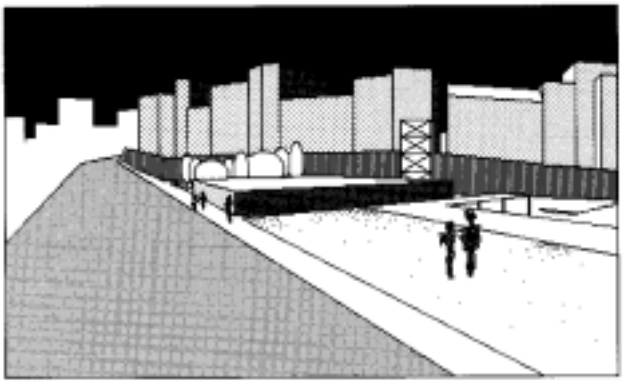

Figure 6. Perspective drawn by means of Space Edit and Full Paint

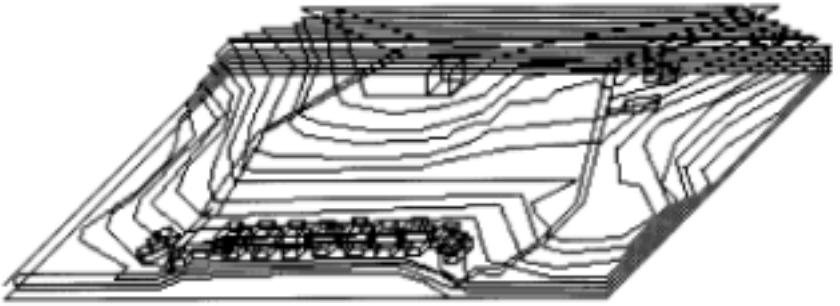

Figure 7 Axonometric of a sloping site drawn by means of Space Edit in order to study the siting of the project

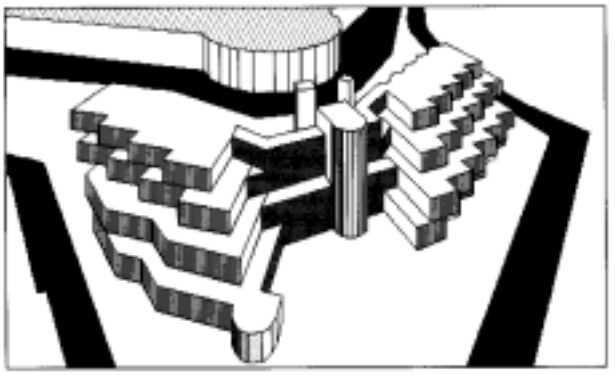

Figure 8 Old people's home in Genoa. Perspective, drawn with Space Edit and edited with Full Paint in order to correct the hidden-line removal errors

This year we are in charge of a second-year design course, which we will continue through the end of the students third year. In the part of the course that strictly concerns design, we give a basic training in design, identifying certain fundamental elements[5] and developing a more in-depth approach from the theoretical point of view. In the part of the course concerned with computers, we proceed in parallel, teaching a course suitable for the hardware and software we have chosen, with the objective of having the students acquire familiarity with the system and independence in handling it. Next year we shall try to integrate the two aspects of our teaching, with a more in-depth approach to theoretical aspects of the design methodology. We will attempt a design that is drafted entirely by means of CAAD.

Choice of Hardware

We selected Macintosh personal computers four years ago, at the same time as programs of architectural interest began to be available. We are interested in personal computers because they may be accessible to an average Italian architectural office, both with respect to the scale and the quantity of work.

We also chose the Macintosh because the man/machine relationship is more attuned to the architect's way of working, particularly since it communicates through graphic images. Moreover, the CAD programs for MS-DOS, at least the programs such as AutoCAD that are normally used and tested by other groups in our department, are more suitable for mechanical drawing, which of course is very different from architectural drawing: it is in fact the drawing of symbols. We are not interested in the mechanical accuracy of the description of the object, but rather in the expressiveness of the detailing, in its capacity to make the whole architectural design into an organism that speaks.

At present, we use five Apple Macintosh personal computers for these exercises: three Pluses and two SEs, all with 1 Mb RAM. This quantity of memory is sufficient only for carrying out simple exercises: we envison upgrading to 2.5 Mb for each computer. The two SEs are each fitted with a 60 Mb Rodime hard disk, while two of the Pluses are fitted with an external floppy disk drive, and one with an internal floppy disk drive alone. These five computers are linked by an AppleTalk network, using Tops 2.1 software and using the operating system of 6.0.2. level.

Special configurations of the system allow us to have enough free storage space on the disk so as not to hinder the normal printing operations, especially for the Mac Plus computers that are not fitted with hard disks. Printing is carried out by means of an Apple ImageWriter LQ printer, which is also linked

Figure 9 Perspective made in order to study the relationship with the surroundings of the designed mass (at the centre of the image). The impossibility of highlighting the mass, together with the lack of precision of the algorithm for the removal of the hidden lines, make this image of little use.

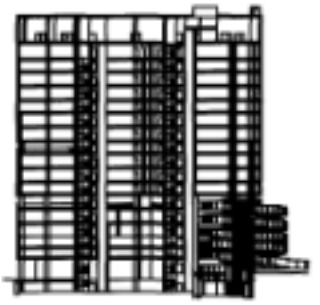

Figure 10 Cross section of a building, drawn by means of RadarCh. Since this program is a true 3D solid modeller, it is possible to obtain cross sections drawn cut at any plane.

Figure 11 Axonometric of a detail of the building shown in figure 4. These are different views of the same mathematical model.

with LocalTalk. It is supplied with a large quantity of fonts in many sizes. We also have a Kodak DataShow liquid crystal screen that may be used for overhead projections. On these computers, we use Diehl Graphsoft's Minicad+ 1.0 as graphic software and MacWrite 5.1 for wordprocessing.

For research, which takes places mainly through the writing of graduation theses, we use a Macintosh II with 2 Mb RAM, a 40 Mb hard disk, and a monochrome monitor and a Macintosh IIcx with 5 Mb RAM and a 40+60 MB hard disk and an 8-bit color monitor, also linked to an Apple scanner. The whole system is linked over a LocalTalk network and uses as printers an Apple Imagewriter LQ and a Laserwriter II. 6

Choice of Software

Since we mean to teach that architecture is essentially a creation and a use of spaces, we chose to use only three-dimensional software. We prefer, in this category, the less specific and more general programs, so that it is possible to carry out effective exercises without having to bring definition of the object to a final stage; that is, the situation in which the designer, and even more so the student, finds him or her self during the conception stage. Since if it is true, as we believe, that the architect must think in terms of assemblies of actual objects, it appears to us that it is limiting to decide beforehand the characteristics of these objects while the spaces are being conceived: one is still in the first stages of the design.

Several very specialized packages, each for a particular market, have appeared since the old days of MacDraw. For instance, RadarCh (also known as ArchiCad outside Italy) was devised exclusively for the design of buildings, MGM Station for industrial design, and MacCad for the design of printed circuits. We have been able to test in depth SpaceEdit, RadarCh, and MiniCad, and we have seen the operation of such programs as Swivel 3D, PowerDraw, and Mac3D.

SpaceEdit is a professional drafting package that permits drawing and representations in both 2D and 3D. Objects may be viewed from any vantage point. It can show the three Monge projections (plan and elevations) together with an axonometric view, all at the same time on the same screen. It provides powerful zooming features, exploded views, and walkthroughs.

RadarCh is a powerful program for the design of building objects. Actually, although RadarCh is a superb program for final presentations, it is necessary to begin and prepare the design using traditional pencil and paper methods, since it is not possible to leave details incomplete. This program is the one preferred by professional offices for producing final drawings, but it is not very useful for the beginning stages.

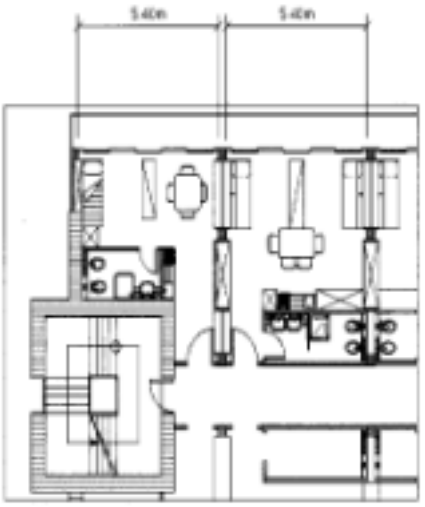

Figure 12 Another image obtained from the same database from which figures 4 and 11 were obtained. Drawn by means of Minicad+ 1.0.

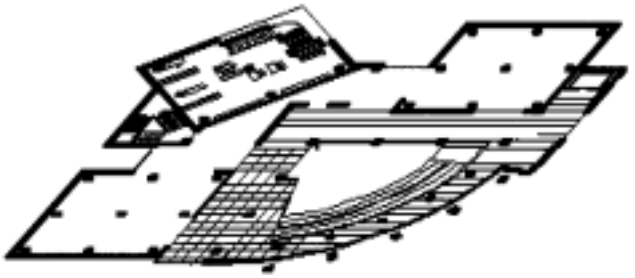

Figure 13 Example of unsuitable use of a 3D program: plan of a project for a museum. It would have been better to create a three-dimensional object.

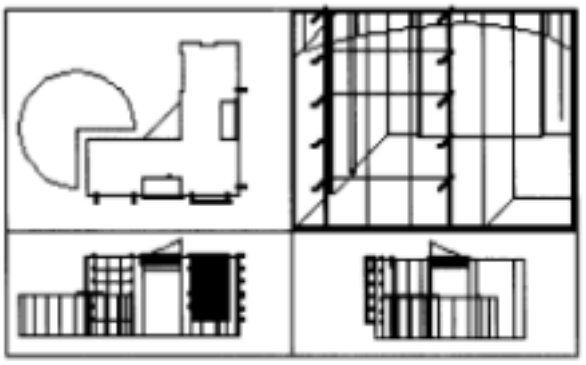

Figure 14 Example of suitable use of a 3D program: unlike the previos image the object is here described in three dimensions, even though without full details

Minicad+ is a complete program for generic drawing, although only partially oriented to architectural drawing. It is three-dimensional, it employs color, it is object oriented and it supports calculations through a built-in spreadsheet. Moreover, the ability to program it in Pascal and to export the data in various formats makes it a flexible and powerful tool.

The students learned SpaceEdit first but then moved on to Minicad+, because SpaceEdit permitted no more than the definition of masses and the embellishing of the drawing with FullPaint, a paint system. Only a very few students, with very considerable effort, managed to describe their building objects in much detail.

CAAD Teaching Methods

In the two courses that we have taught so far, we have dealt with two different types of student. The first course was for students in their last year before the graduation thesis; they were at the end of their course of studies and had four years of study in the traditional methodologies of design and drawing. Students of this type are convinced that they have their own method and language; they are attached to traditional forms of drawing and verification of the ideas they are developing, such as the freehand sketch and the scale model. With the second course, the situation was different. This was a two-year course, which allowed us to plan a much more gradual learning of the new techniques, and had students with only one experience of design according to traditional techniques.

None of our students had any specific training in nor any previous experience with the use of computers. They had these different attitudes because of their past experiences; therefore, we attempted two different teaching strategies, both affected by the characteristics of the Macintosh world, which above all requires personal experience.

In our first experiment, we gave three lessons to each of 46 working groups, into which the 146 students of the course were divided. The idea was to give students a hands-on experience. This approach seemed to be effective; however, problems developed as soon as the students were left alone to work with the machines.

In our second experiment, we gave theoretical lectures followed by direct, hands-on experience for the students, which was reinforced during the following lesson by feedback questions and further explanation of the software. This was much more useful for students who had already tried to use the software. This global question-and-answer type of teaching, according to the first results, appears to be much more effective, because the Macintosh is best learned by experience rather than through theoretical explanations.

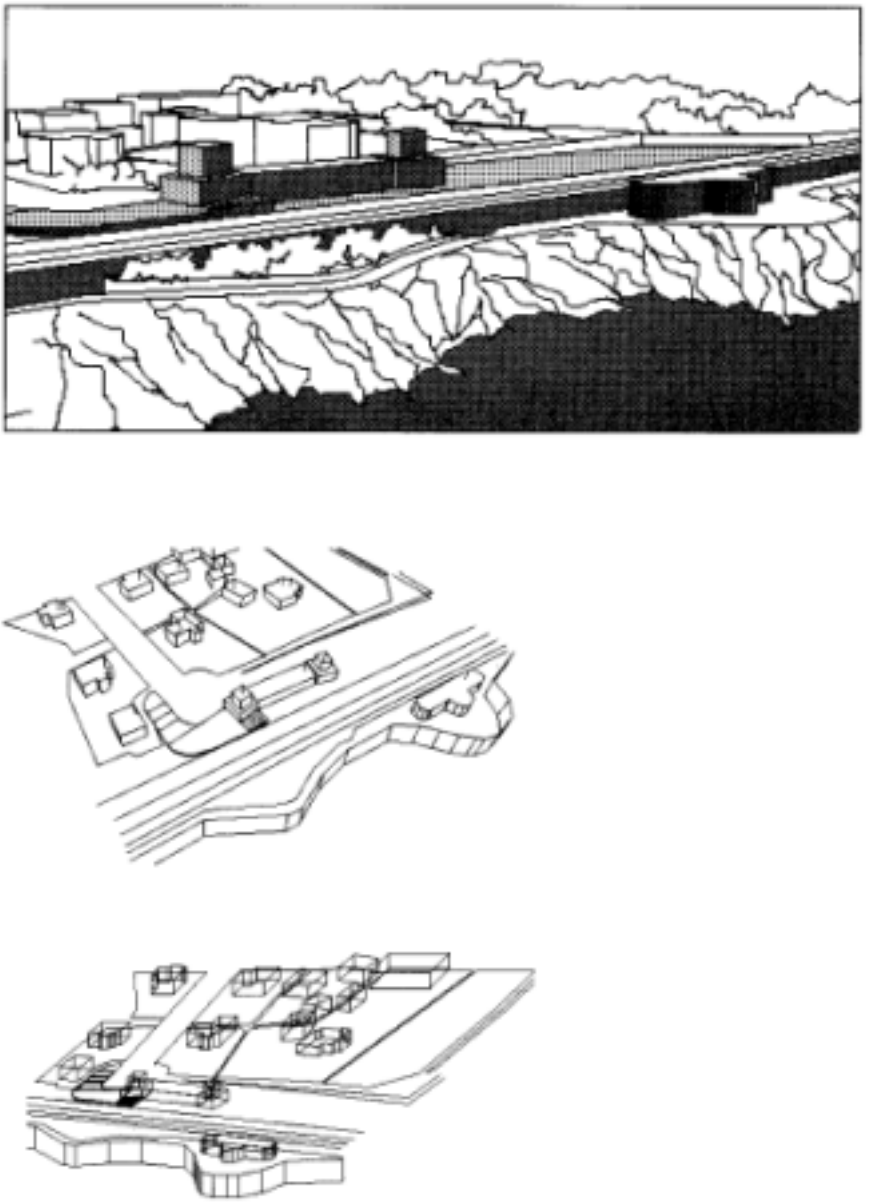

Figure 15 To study of the relation of the project in its surroundings the students preferred a traditional representation

Conclusions

One result of the application of CAAD to the teaching of architecture is that we diminished the importance of the graphical sign on paper, thus obliging a more intense concentration on architectural content rather than on the formal aspects of representation. Also, we compelled the students to conceive the building object in three dimensions, reducing their tendency to confuse the spatial object with its representation in two dimensions.

Fundamental to the acquisition of CAAD techniques is the interest in them shown by the students. Interest is a key learning factor in all fields, but it is especially important with computers, since the computer is able to amplify the defects or skills of the users. This is one of the reasons many architects, especially those who minimize design time to the detriment of quality, find CAAD unattractive. CAAD apparently affected students on three levels.

First, designers who had no interest in, or did not trust, new possibilities used the software for two-dimensional drawing (mainly of the pictorial type) only, and then only after the design had been decided with a pencil alone; for them, verifying the design by computer was not even considered. It is true that the lack of suitable facilities, and thus lack of computer time for the students, resulted in most of the design work being done without the aid of CAAD, but it is also true that we requested only a part of the students' final presentation on the machine, as long as the portion of the project was interesting and complete. In fact, the use of the Macintosh for the whole design process has been possible only at the level of theses done on computers reserved for this purpose.

Second, students who were more interested in the possibilities of CAAD used the machine in a way that was more in keeping with our design philosophy. They used the computer for parts of the design in three dimensions, even though problems of time and software limited study to the relationships between the external masses or, less frequently, between the internal details.

Third, the enthusiasts responded with passion, devotion, and curiosity. In particular, they became curious about the three-dimensional world. It is important to note that young people in 1989 are much more familiar with the world of computers than are members of our professional world. Even if they have never used computers, they take them for granted and are not afraid of them.

Finally, we reached the comforting conclusion that the quality of the work produced on a computer in the architectural field, in terms of both graphics and design, remains directly linked to the professional skill of the architect who uses it.

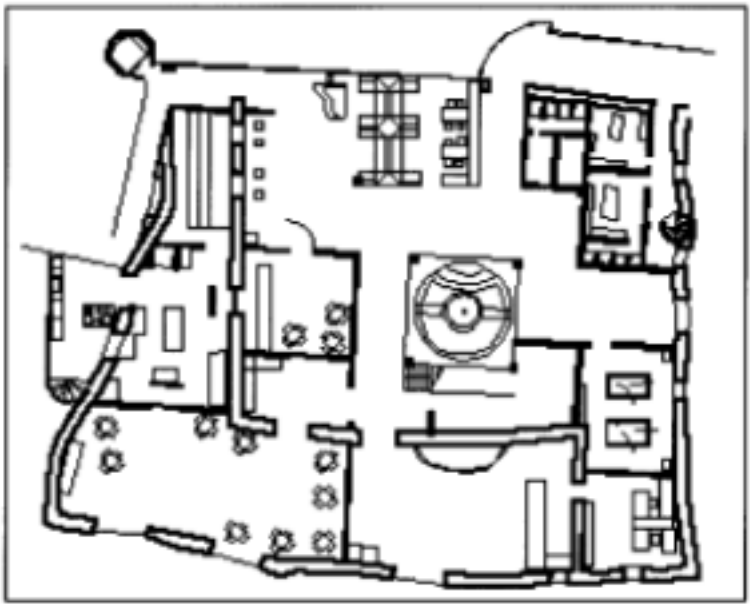

Figure 16 With just some willingness and knowledge of the program one is not limited in use of shapes. Plan of a 3D model drawn by means of Space Edit.

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Notes

1. From the experience of architecture academies to the teaching of Ecoles Polytechniques.

2. As teaching the use of CAAD and not teaching through the use of CAAD.

3. Using in particular the Yamaguchi spline interpolation algorithm and several algorithms for the removal of the hidden lines.

4. We may in fact try to describe architectural design (composizione in Italian) not as a technical, specialized discipline, with its own rules for achieving precise objectives, but as a process, open to creativity, with multiple aims in different fields (therefore with considerable interdisciplinary characteristics) and with many different ways to compose into the design the requirements and the contradictions of the problem.

5.

Meaningful space: the architecture that speaks.
Dimensioning the space: the measure of architecture.
Delimiting the space: the boundaries of architecture.
Moving through the space: to approach, to orientate oneself, to perceive architecture.
Sound, light, matter: substance of architecture.
The space continues: architecture does not live alone.
Meaningful space: the architecture that speaks, again.

6. The students of the course do not usually have access to these machines,.