From Barcelona. Chronicle and provisional evaluation of a new course on architectural solid modelling by computerized means.

Javier Monedero, Antoni Casaus, Jaime Coll
Universitat Politècnica de Catalunya,
ETS Arquitectura, Barcelona

1. History. A Summary of the different phases which followed ...

The first step made at the ETSAB in the computer field goes back to 1965, when professors Margarit and Buxadé acquired an IBM computer, an electromechanical machine which used perforated cards and which was used to produce an innovative method of structural calculation. This method was incorporated in the academic courses and, at that time, this repeated question "should students learn programming?" was readily answered: the exercises required some knowledge of Fortran and every student needed this knowledge to do the exercises. This method, well known in Europe at that time, also provided a service for professional practice and marked the beginning of what is now the CC (Centro de Calculo) of our school.

In 1980 the School bought a PDP1134, a computer which had 256 Kb of RAM, two disks of 5 Mb and one of 10 Mb, and a multiplexor of 8 lines. Some time later the general politics of the UPC changed their course and this was related to the purchase of a VAX which is still the base of the CC and carries most of the administrative burden of the school.

1985 has probably been the first year in which we can talk of a general policy of the School directed towards computers. A report has been made that year, which includes an inquest addressed to the six Departments of the School (Graphic Expression, projects, Strictures, Construction, Composition and Urbanism) and that contains interesting datas. According to the report, there were four departments which used computers in their current courses. while the two others (Projects and Composition) did not use them at all. The main user was the Department of Structures while the incidence of the remaining three was rather sporadic.

The kind of problems detected in this report are very typical: lack of resources for hardware and software and for maintenance of the few computers that the school had at that moment, a demand (posed by the students) greatly exceeding the supply (computers and teachers). The main problem appeared to be the lack of computer graphic devices and proper software.

In a rather spontaneous response to this situation, and due to the initiative of a student, Felix Arrariz and the commercial interest of Apple, the "MacSum" Laboratory has been created in 1988. It became a School Laboratory and worked on a mixed basis. The Macintosh Enterprise took advantage of the irruption of the Apple Macintosh in the market and of its interest in maintaining some kind of connection with the University. This Laboratory became quite successful during two years despite their limited resources, (two "big" computers, MacII and six "small" ones) organizing courses and selling their products to teachers and students. After this year the original founders were substituted by another group which continues at the school on a similar basis.

Around that year started a debate which turned up as a rather surprising radical opposition between the "pro-Mac-users" and the "pro-compatible-users", the most interesting side of this debate (which had other less interesting sides), was probably the opposition between the "pro-a-friendly-and-really-graphic-computer" and "the others". This debate, very well known in other places, still continues although it has evolved and is now directly related with the current discussion about the degree in which our school should be involved in general with computers.

The first answer to this situation was given by the director of the school at that moment, Fernando Ramos, and turned up as the establishment of a policy which might be qualified as "hard" even from a "pro-computer" point of view. It consisted in the creation of an experimental work-shop which could only be used by a selected group of 30 students that would follow their complete academic curriculum exclusively with computers. This group of students, which came to be known familiarly as "the mutants", entered the school of architecture in 1990. But this experience was truncated by a change of director in the school and the establishment of another approach.

The new director, less enthusiastic about the computer revolution, created a Commission that was asked to study other alternatives. And so, in 1991, started a new episode in this story, in which the incidence of computers in the academical curriculum is channeled through 4 different workshops, which are, starting with the oldest:

1) The CC (equipped today with 16 computers, i386, 4 Mb RAM, 80 Mb HD), opened to any student which has a note written by his professor in order to prove that he needs x hours of practice to do a specific assignment. He then sets an appointment for doing so
2) The "Macs" (classroom A18)
3) The 1st Cicle workshop (1st, 2dn, 3rd and 4th year courses, A17 classroom, equipped similarly to the CC), opened to all teachers which are interested in giving, an experimental course based on computers
4) The 2nd Cycle workshop (5th and 6th year courses, A16 classroom, equipped similarly to the CC and the A17).

This is what we have at the moment, not to say anything about the internal equipment used for research in the Departments (which is not very impressive).

2. Actual Situation

From the point of view of the general opinion on the introduction of computers in education and in the professional practice of the architect, the 300 teachers of the School of Barcelona could he divided into 3 large groups (leaving aside one group that I wouldn't dare quantify and whose opinion on this or any other subject is a mystery). The first group would consist of the "indifferents" , the second of the "vehements" and the third of the "reluctants". The first group, the "indifferents", which probably represents the majority, consists of architects very involved in the professional practice but hardly present in the school. They consider the computer another tool it would be convenient to adapt to, preferably by delegating. This group is starting to feel threatened by the growing authority and the annoying mobility of their delegates (students or young architects with a solid knowledge in computers, able to produce 2 or 3 times more than those coming from the old school). The second group, the "vehements", a minority, consists of an heterogeneous mixture of mature excentrics and young radicals. They consider that the computer has revolutionized everything it possibly could, including of course the way production and knowledge of architecture is applied and acquired. They believe that whatever academic subject that cannot be included in its course outline is sentenced to death: a death only delayed by the power still exercised by the "indifferents".

The third group, "the reluctants", (to which pertains the most mature member of the team, who signed this paper: a fact which assures a description as impartial as one can expect from such circumstances) considers, with wisdom, that computers will have the healthy effect of renovating obsolete techniques but that this will keep intact the essence of "what really matters" in architecture (we hope that no one will be so impolite as to ask us what this exactly means, as one would not ask Alexander to define what is "a quality without a name"). This group is regarded with mistrust by the two other groups but, because there has been a series of crisis in the policies favoured by those two groups, the "vehements" and the "indifferents" (the absence of any sort of computer policy in the ETSAB until 1985 was obviously a triumph for the "indifferents", and the "Mutants Plan" a triumph for the "vehements"), the third group has found the opportunity to organize a course, without any grand ambition, but at least one that aspires to give a reference point for a posterior debate. What follows must be seen in this general context: a schematic summary of the role played by computers in the ETSAB.

3. Academic Context of the new course

This course, originally intended for a period limited to 4 years, but carried out until now, originated with the experimental reorganization of an elective course in the 6th year, "Dibujo III", which up to now worked as a drawing and painting workshop using watercolours as a basic technique (there are examples of previous works as well as more details on this subject in the paper entitled "Electronic collage" , of the same conference). This course is given once a week, in sessions of 4 hours, for a period of four months. This sums up to 60 hours, to which 40 hours of individual practice must be added. The basis of this course is, therefore, 100 hours of essentially practical work; the theoretical lectures are very synthetic and are directly related to practical work. For example, only those CAAD commands which are used in the current exercise are explained, and only at the appropriate moment. Given the total lack of previous official basis (the 6th year students do not have any previous experience with computers in the school) and the lack of infrastructure that would need to limit the number of students to 18, the course was set up with restrictive conditions. It required a basic minimum of computer knowledge (acquired of course on an individual basis), which forced more than half of the students enrolled to quit the class. We do not face a very satisfactory solution but one that is imposed by a demand continuously greater than the supply and by the slowness with which our school keeps up to date. In any case, the experience of this course reveals that probably 90% of the 300 students enrolled in the 6th year had never used computers in their work, a figure that would be interesting to confirm and to compare with other similar figures in other schools.

4. Programmatic content of the course

The course has set up elementary objectives that will only he attained, if things go well, in the years 1994-95, that is, three years after its beginning. The final objective is to stop using painting as a 2D rendering technique by the end of a sequence that will reproduce electronically the classical process of generation and communication of architectural ideas. This sequence is developed in three steps:

a) 3D modelling (with Autocad and Autolisp)
b) Color representation of the model, with light and shadow, using inexpensive programs (Autoshade, Renderman or 3D Studio)
c) Retouching and mixing the results with an image processing program (Photostyler, Photoshop, Picture Publisher or Lumena)

It is obvious that such an approach can be criticized by a "vehement" on the basis that it falls openly into a classical mistake: wanting to introduce a new technique in the framework of a classical one. First, we do not investigate new ways of formal generation on the basis of new procedures. Second, we do not consider the connection of the model with performance programs of structural calculations, lighting, analysis of thermic or economic factors, etc. And third, we do not regard animation as one of the results to be attained for the presentation of the model. To answer to the first critique, we are still dealing with a new course, and we have a certain doubt with respect to the real "creative" capacity of any media. To answer to the second critique (the implicit criticism of being too "formalistic"), we are willing to accept this criticism as far as our critics are willing to accept the corresponding criticism of being too "functionalistic". We could sum up like this: let us say that both parts, our critics and ourselves, undertake an analysis starting from two different extremes, and that, hopefully, they should converge somehow, somewhere, in a synthesis. We recognize that we are far from attaining, at the present moment, a collaboration in an integral workshop with our colleagues from other departments. It is a proposal that cyclically reappears in our school and vanishes rapidly in a few weeks.

With respect to the third hypothetical criticism, the first thing that has to be replied is that the fact of ignoring animation as one of the results to be obtained does not mean that it excludes it. As a matter of fact, one of the students from last year presented an animation made with MacroMind, and he got a high mark. But this reward was given taking into account the interest and effort that were put into the work. Conceptually we did not find that animation brought anything that meant a potential contribution to the analysis of the proposed topic. And we have serious doubts about this possibility, which does not mean that we are not disposed to change our opinion at any time. But to conceptualize implies, by definition, to abstract, to freeze the animated into a stable notion. How the animation could contribute to this objective does not seem to be clear. In any case, only the memory of the animation would be used to do any conceptualisation. But then, is this memory of the whole animation or of a part of it? And if, it seems obvious, it can only be of a part of it, a part which is then separated, abstracted, why has it been brought out as being more important than the other parts? Is it not precisely the purpose and raison d'être of the analysis to freeze what has intuitively been brought out as outstanding?

Obviously, the raison d'être of the animation, apart from its appeal as a new technique, a factor that one has to bear in mind, does not lie in its contribution to the analysis but rather in its contribution to the synthesis, to the extent that it favors the intuitive apprehension of the object. This perfectly valid finality requires an effort and a time consuming dedication that is worth considering in function of the objectives that are pursued: the principal addressee of the animation is not for the architect that studies some architectural work in depth, but rather for the spectator that has not studied it. The course which we are talking about is not set up as a course in presentation techniques. It does not want to favor the communication with the client or, if desired, the communication of the architect with himself, it is set up as a course in 3D modelling techniques, as a potential instrument of creation of works of architecture.

5. Description of the development of the course

The course proposes, as a simple and instrumental objective, to look for the most efficient and quick way to model an architectural topic and, from this basis, to select a sequence of images that summarizes visibly the formal aspects considered as the most revealing aspects of the proposed architectonic form. This approach carries with it a relatively simple sequence of steps, each of which requires different techniques that must be optimized and that imply problems of a very different nature. The general process can be described as follows.

5.1 Data input

The steps 1 and 2 are relatively trivial but still depend on techniques that could ease and accelerate the flow between the different required software and hardware. The objective is to be able to go as fast as possible from a traditional given drawing to a vectorized drawing that could constitute an adequate starting point. This actually requires several steps that slow down the process even though they suppose a considerable advance with respect to the previous tasks that implied looking for the scale of the original drawing and drawing it element by element. The process that we have followed in some eases is to read the original drawing, plan, elevation, section, etc., with a scanner DinA4, send the file in TIF format to a conversion programme, transform this file to a DXF file, read this file from Autocad, eliminate the unnecessary information and adjust the scale and the orientation of the various lines. The time required for a drawing like the plan of the Villa Cook by Le Corbusier, taking into account rather unimportant technical problems, was approximately the Same than the time required to draw the whole thing from the beginning! But we hope this can be improved if we can get a better conversion programme. For the time being we are suggesting our students to draw the whole thing up forgetting about scanners "because it is a very good exercise", 5.2 Structure of data

The third step is the most laborious one and is the one that reveals a critical zone in the modelling process. Each element obtained in the previous phase must remain unified, symbolized and located. This implies a reductive analysis that freezes the different elements in the composition into an irreversible structure that does not imply any particular problem in a process of representation, but that poses quite an important one in a process of generation. With this appears a question of theoretical importance on which we initially have adapted a position that did not coincide with other investigations in this field, and that will be tackled in a forecoming paragraph. Undoubtedly, one of the principal preoccupation of the architects who have been working with computers, in the recent years, has been trying to preserve the fertile ambiguity of the traditional drawings in which, to quote an example of Stiny, two intersecting rectangles could be seen equally as three, four or five juxtaposed rectangles, etc.

Our position, on the opposite, accepts the affirmation of Sutherland which states that "the best use of a computer comes from its ability to structure data", with all the serious limitations that this implies. This statement maintains a certain distance with respect to the works of Mitchell, Stiny or Fleming, amongst others. This distance is deliberately polemical and we will come back to it later on. These limitations are related to the fact that the organization of the data requires a considerably complex structural process, which seems to be difficult to avoid. In our work, all the principal elements of the model must remain identified by a root (a figure and its principal profile). This root must remain assigned to a layer (it must belong to a class of nominations) and must occupy a determinate position in space.

The result of this process is a structure of virtual planes in space which incorporate the enclave of the diverse elements. As everyone knows, the main problem posed by a process of architectural modelling is to keep trace of these complex structures in an effective way.

5.3 Modelling

When the previous steps are correctly completed , the modelling, in most cases, is practically resolved. The modelling, in architecture, is mainly based on extrusions, an obvious fact but not always considered important. This is due, once more, to the fact that the CAAD programs are produced by engineers and, in the world of engineering, more complex problems are raised, which require the capacity to generate complex surfaces rarely common in the world of architecture. On the opposite, the problem of spatial organization that interests the architect does not coincide with the type of problem tackled by the engineers.

The principal exception consists of windows and doors. Because of their usually perfect regular shapes, they can be inserted, using a parametric function and asking for the dimensions of the principal elements. This can be carried out using a general Autolisp routine that could be further developed in connection with an external data base, that would include data of current industrial sections or of a larger variety of generic types.

Any other singular element should be developed in a singular way and, in general, the use of the AME module of Autocad is reserved for these particular cases. The experience of this course has shown us that, in general, for reasons of memory optimization and posterior connection with rendering programs, it is preferable to use a construction based on facets, with all the limitations that this implies particularly regarding the construction of forms with boolean operations. All this obviously implies a discussion, which we will obviate, on the ideal platform for architectonic applications of a determined level.

5.4 Data output

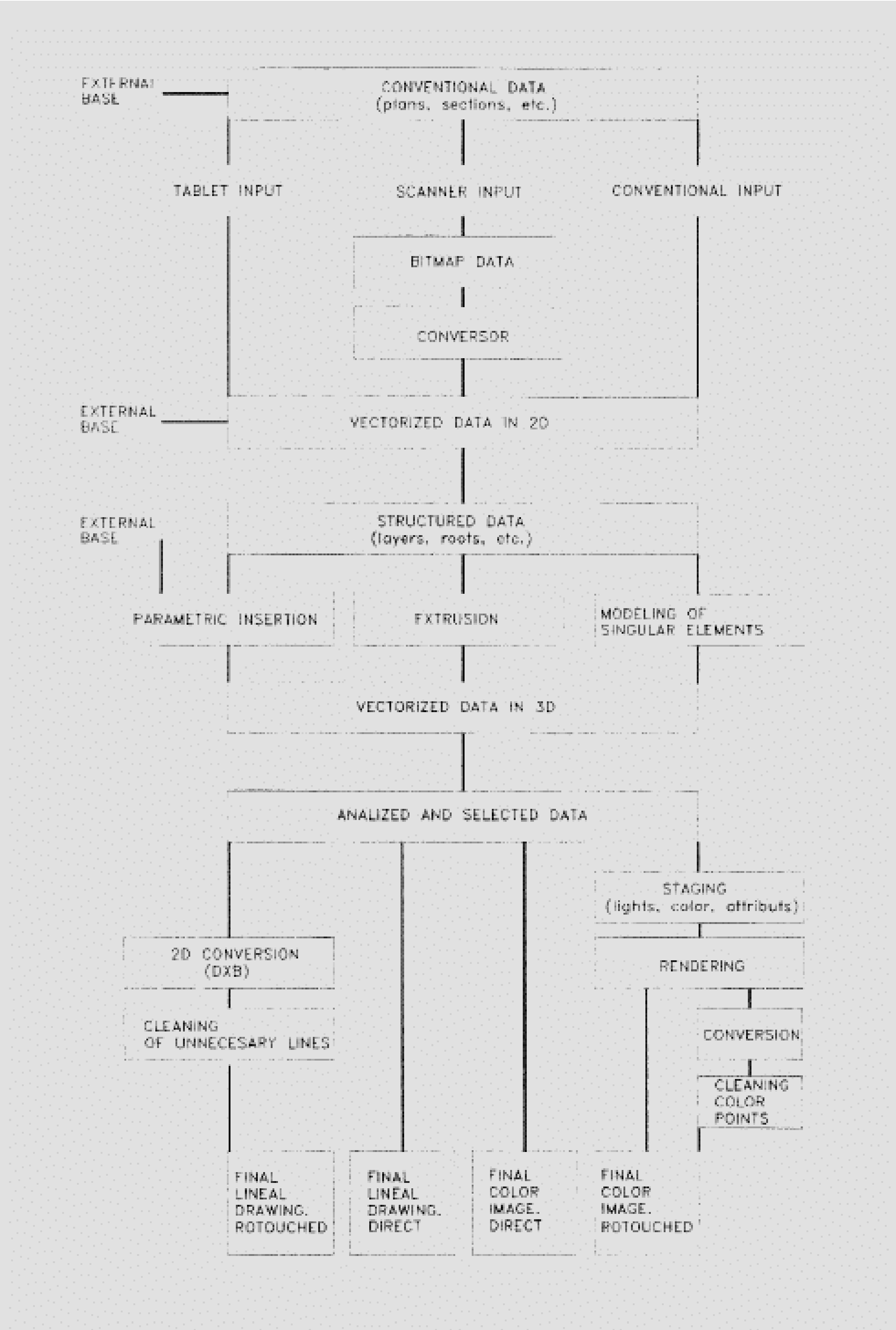
As has been indicated at the beginning, the short term aim is to produce final color images with various degrees of reality, images that imply an analysis and a formal judgment on the work studied or proposed. With respect to this we refer to the explanation given in the lecture "Electronic Collage". Nevertheless, there is an intermediate data output that is important to consider to the extent that it connects with the traditional process of communication of the results.

When all the modelling has been completed, we find ourselves with a virtual object which can he viewed from various points and, on the contrary to the way in which we look at real objects, that can be shown in different forms. For instance, taking off its external envelope, or taking part of it, etc. This implies an analysis, that we cannot carry out in this paper, but that is of considerable importance, about the wide range of possibilities which are opened for the **analysis of data** in this new type of visualization structure; a range of possibilities that, we must say, we have not fully explored, although we have not found many examples which seem to go deeply enough in this open field.

Now that we have made a new and interesting analysis and selection of the object fixed in a series of images, we still have a lot of different possibilities concerning the type of images that need further considerations. We can be satisfied with a collection of images that show, in a linear drawing, selected configurations; we can add light, color and texture to this object; and we can also take the rendered image, send it to an image processing programme and retouch its form, colour and texture and even merge it with another image : a result to which we can refer conventionally as our "final" or "more distant" output.

But, again, all these possibilities cannot yet be considered as a "final output" because it supposes that we have been doing all these operations while working in front of the screen: in the case of which they will vanish as soon as we turn off the computer. To get a hard copy we have, again, a whole range of possibilities that should be analysed, from printers and plotters working at 300 dpi to digitalizing cameras filming at 8000 lines. And these are not secondary choices because there is a mixture of conceptual questions (how the object is going to be torn apart, how is this to be shown, why have we chosen precisely this kind of decomposition and this kind of presentation) that relate directly to these technical questions (what kind of hard copy do we need, what kind of resolution is required, what level of quality, how many grays or colours are we looking for).

To get more deeply into all these questions would imply writing another paper on that matter. We just want to stress a point: that, for us, these are questions we are interested in and that we do not consider as solved. We do not regard them as secondary, on the contrary, we regard them as more important than some other topics which are regarded with higher respect by our scientific community.


EXTERNAL BASE
CONVENTIONAL DATA
(plans, sections, etc.)
TABLET INPUT
SCANNER INPUT
CONVENTIONAL INPUT
BITMAP DATA
CONVERSOR
EXTERNAL BASE
VECTORIZED DATA IN 2D
EXTERNAL BASE
STRUCTURED DATA
(layers, roots, etc.)
PARAMETRIC INSERTION
EXTRUSION
MODELING OF SINGULAR ELEMENTS
VECTORIZED DATA IN 3D
ANALIZED AND SELECTED DATA
STAGING
(lights, color, attributs)
2D CONVERSION
(DXB)
RENDERING
CLEANING
OF UNNECESARY LINES
CONVERSION
CLEANING COLOR POINTS
FINAL LINEAL DRAWING. ROTOUCHED
FINAL LINEAL DRAWING. DIRECT
FINAL COLOR IMAGE. DIRECT
FINAL COLOR IMAGE. ROTOUCHED

6. Incidence of the selected Topic

As we have already mentioned, the selected topic is the modelling of buildings, with similar programs and volumes, and built during the same historical period by different architects of notorious personalities. These architects were, in our case, Loos and Le Corbusier. Previously, and to better pinpoint the differences, a study on two of their works enclosed in a virtual cube was conducted: the dice house by Loos (1929) and the Villa Cook (1926) by Le Corbusier.

The cube, as a volume guiding the solid model, in which no dimension is privileged and where no internal figure stands out, appears as a formal background which allows to detect immediately the meaning of the differences. The works of Eisenman constitutes a recent reference point for this approach, as an example of baroque logic stimulated by the infinite possibilities of a game of internal transformation, set up initially as an arbitrary game of displacements in search for a meaning to he found a posteriori.

In the case of Loos and Le Corbusier, we found this meaning given a priori, either because it was as such in the proper formulation of their works, or because the historical distance has clarified our vision. In the case of Loos, the notion of Raumplan, of planes that constitute a play of organic levels, unified by a central rigid core, and connected to a closed envelope on which we find apertures which emerge directly from the internal needs, this notion adheres tightly to that of the cube, displaying a bareness and an asceticism which contrasts effectively with the qualities of the materials employed in its interior. And through this contrast we also find an outspoken intention of critically linking this vision with the essence of a cultural tradition, with the history of the house, understood from the point of view that Architecture (with a capital A) is as much a good to preserve as a threat to fight.

For Le Corbusier, on the other hand, the notions of free plan, pilotis, roof garden, wide windows, planes that fly autonomously, some on top of each other, others side by side, ascetic materials and bareness of the formal structure, these notions adhere to that of the cube as a symbol of this same purist asceticism, open to an olympic future with all the intellectual aggressiveness, the will of proselytism and of pedagogic action of somebody who considers necessary to redo a colossal deviation in the Mediterranean world, a redoing in which architecture will play the principal role, which corresponds to its prominent position over other Arts.

It is obvious that these different meanings, already assimilated by our historical Situation, also imply, from the point of view that interests us, a strategy of modelling that, in appropriating the cube as a "formal background", for a similar program, should necessarily imply different routines which would affect the very structure of the data and the way in which it is introduced.

The initial work related to these two examples was developed without any other initial ideal than, starting from the very logic of the programme routines, trying to find out which would be the ideal route in order to arrive to the final form. A first observation, quite predictable, was that, in the case of Loos, it was wiser to follow a route that would lead us to articulate the different levels, in order to obtain in the end the facades and sections. On the opposite, in the case of Le Corbusier, only when the "tracé regulateur" of the elevations and of the horizontal window strip had been established was it possible to fix, with confidence, the vertical section, through the staircase, with its intermediate levels. After the establishment of these two master plans, perpendicular to themselves, the modelling was practically concluded. We are obviously facing two different ways of making architecture which both require different modelling strategies. It is also obvious that both require modelling strategies different from those used by the engineers and, consequently, from those used for the CAD programs currently available. In both cases the important thing is not the operation of modelling itself, which is totally trivial, (Bezier surface, B-splines, NURBS or other type of parametrical bicubic surfaces) but the particular method of structuring the data.

In the case of Loos the modelling must build the different levels rigorously, erecting them gradually, so that their articulation would be correct. The problem will be to find the most efficient way to develop this construction by layers and the most efficient way (from the point of view of designing) to give, if possible, parameters to these operations in such a way that the variation of one level does not force us to start all over again.

In the case of Le Corbusier there is a wider support on geometric operations in 2D, on a complex strategy based on the "tracé regulateur" which might be developed in a very interesting way by computerized means. These planar geometries are related with each other by inversions and transpositions which could also be articulated by parametric control. The rest of the modelling depends on a root structure which could be automatized with relative ease.

The development of details in these examples (for instance, an important casuistry that is worth analysing to a deeper extent, on the parametric insertion of holes and standardized carpentry, as well as its connection with external data bases) would mislead this paper into a direction which, for the moment, we are not interested in following since it seems to establish a position, whereas some general principles orienting the detail works seems to be more imperative.

7. A final disgression on shape grammars and fractals

"A shape can be described as a set of lines". This affirmation by Stiny or Mitchell is so absolutely true that we prefer to say that it is simply tautological. So is its derivative: "a shape can be described as a set of shapes", But if this has any interest, it is so to the extent that it alludes to a mental capacity, not a physical one. It is not an essential property of the thing, it is an essential property of the interprete of the thing. And it is an old aspiration of humanity, several times doomed to failure, to pretend that things acquire properties that are essential to the interprete as, in this case, the capacity to **freely** discriminate a configuration out of an image that appears in front of our eyes as indeterminate. Some of the methods of analysis of shape grammars derive from a quite characteristic confusion between the thing and its representation. The thing is 3D. Its representation is 2D. And we conventionally refer to 3D as what is located in a real world whereas we refer to 2D as what is located in a symbolic world. There is not a common measure between both **as long as** we take the 2d image as a representation of the 3D thing.

The 2D image, by definition, is unreal. If someone answers that a drawing is real he is once again mistaking the thing with its representation. A drawing, considered as a thing, is also 3D (look at it closer, please, and if necessary with a magnifying glass). The 2D image does not exist or, rather, we do not take the 2D image as we take the 3D thing which is also symbolic, but quite in a different way. The former belongs to its own symbolic space , and for this reason, as it happens with words, it is opened to the infinite. If we consider this, we will take into account the dangerous ambiguity which surrounds certain researches on shape grammars: a fertile ambiguity, which may become trivial when one tries to really explain it outside of a very restricted context. We also do not believe, as does Fleming, that an architectonic language can be given by a series of syntactic rules; amongst other things because we also consider the notion of architectonic language as a dangerously equivocal metaphor: the spoken languages have a vocabulary that can be enumerated and construction rules that can be formulated; dictionaries and current grammars are currently sold and used due to this fact. It is true that from there emerge countless slangs and idiolects, but that is the point: **from** there. This relation is reversed in the case of the architectonic languages and it is doubtful that such an inversion preserves the properties of the former, spoken languages.

Similar reasonings can be applied to another topic that arouses a justified interest but of which maybe is expected more than the expectable. The fascination" in the case of fractals, comes from the fact that they lack rooting in a determinate plane of reality, which is equivalent to say that they lack a hierarchy that we could assimilate to our scale of values. This makes them particularly suitable for simulating certain natural structures **considered from a determined point of view.** But this remarkable property makes us forget that its effectiveness comes precisely from the value added by a hierarchy which is projected upon them from this particular point of view, and that it is precisely this intentional determination, this projected expectation, that gives after all the key for its effectiveness.

8. Conclusions

From the point of view of the technical development, and as we have said in paragraph 5.3, the critical stage of the modelling, in the case of architecture, is not the strict transition from a 2D figure to a 3D form but the organization in space of a structure of roots, of 2D figures, located in different layers and in different spatial positions that contain the seed of the 3D form that they are on the way to define. Obviously, the complexity of the operation, the critical phase of modelling resides here, not in the generation of continuous forms but in the determination of discontinuous enclaves.

The question is: is there a way of accelerating this step? We believe that the answer, if we don't want to fall in sophisms that avoid the nature of the problem, is "practically not". A typical sophism would be to answer that this could be achieved through the use of an assignment of positions given, for instance, by a 3D grid or a semiregular spatial mesh. But the election of a semiregular mesh as a media for controlling space, is, in itself, already a design decision, an architectonic election, it is **already** the beginning of a particular form.

To conclude, and from the point of view of the general organization of the process, we are interested in emphasizing the following general aspects.

With respect to **communication**, there is a series of questions which require a major development. The **internal** communication of the data structure could be considerably reinforced if we could establish a rapid and efficient link with a data base that could allow us to insert premodeled elements. The **external** communication should, on the other hand, maintain some distance with traditional medias for data output (printers, plotters) since we run the risk of wasting output energies that still would not have known how to get out of traditional unnecessary conventions. This has affected the results of our first course whose translatation onto paper appears to us as totally devoided of interest, and far beyond the real experience of modelling the proposed topics.

With respect to the **control** of the form, it is obvious that computer modelling allows a major accuracy and efficiency with respect to all sorts of technical aspects, including those with which we are presently dealing with, those strictly formal. But this can be considered as much a "gain" as a "handicap" and it is necessary **in each case** to make a subtle consideration of the current state of the project, of the working scale required and of the aim pursued. If this ponderation is not established with clarity, the modelling may turn out to be a waste of time.

With respect to the **conception** it should be carried out a thorough debate that has not been initialized or that, as far as we know, has badly started. Our position, very different from others which we perceive as being dominant in this field, can be resumed in this way. The computer, like any other tool, old or new, affects the conditions of possibilities, the frame of reference in which the project is produced. But, to argue that it influences essential aspects of the conception of the project is to resurrect an old polemic, which we believe is already solved in the field of the theory of arts: the idea that the material or the instrument affects the form in an essential way. The discussion is vain: a form is given on one material and viceversa: an idea is realised on a form that requires a support. None of these three elements -material, form, idea- can be separated but through an intellectual analysis that impairs them, if a restitution is not carried out a posteriori. Louis Kahn drew with charcoal, pastel and soft graphite pencils. These are techniques which incorporated the formal qualities of his architecture: mass, gravity, round and heavy forms. Alvar Aalto drew with flexible pens and soft pencils that allowed the drawing of delicate curves, that we see in his walls or arquitectonic details. Material, form and idea were treated together; none of these was "influencing" the others.

The rigour required in computer processing is a characteristic of the media that can, or not, be suited to determine types of arquitectonic conception from its most essential beginnings. In this sense, the computer is a graphic tool that, like all graphic tools, incorporates a formal predetermination: to know this does not mean, from the point of view of the arquitectonic conception, any other thing than an enlargement of the range of resources an architect has at his disposal: something that is not only desirable but necessary. But there is not, in a strict sense, any essential "aid" to the conception of the project.

Summing up: to think is not to reason. To conceptualize neither. It is appropriate to allow space for intuition, recognition and discovery, something that has nothing to do with reasoning but with valuation and elective affinity. The computer does not bring anything **essential** to the architecture although it is obvious that it modifies the frame of reference in which are produced certain works, and that it can favour some forms of designing at the expense of others. The principal reason for using a computer is the same as for using a car: we gain probably as much as we loose but everyone uses it. Therefore we must evaluate very well the investment: how and when we are going to use and learn how to drive in the most efficient way, to preserve life and life quality.