"Plausible Design of Floor Layouts. A Computer Aided Floor Planning System"

This current research is related to the following areas

CAAD Areas
- Architectural Design
- Professional Tools
- Collaborative Design

And results are intended for:
- Architectural Studios
- Design Courses (Universities)
- CAAD Research.

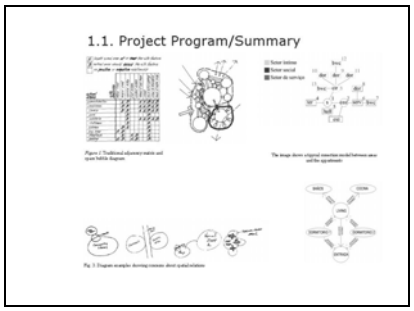
The objective is the creation of a Computer Aided Floor Layout Planning System that helps in the early stages of an architectural design of a high-rise housing building located in a urban site.

In Chile a large amount of building areas belong to high-height house buildings. The proposed system includes concepts that provide the architect an appropriated information stage during the planning process, thus obtaining a plausible, reasoned and understandable solution; and it also fulfills demands and constraints, which means a plausible design (Donath, Loemker, Richter, 2002).

According to the definition of Architectural/Engineering Services from the International Building Code, our tool will support the stage called "Schematic Design Phase", which consumes 15% of total assigned time for achitects, and it is also the stage where the most important and irreversible decisions are made. We propos to sub-divide it into 4 sub-stages considering the current IT Tools suitable for each stage, and those we will develop in the future.

1. Project Programm/Summary

Our client informs us so that we know what he exactly needs: USE of the building (in this case is Housing); we have to go through an exhaustive listing of ZONES, ROOMS and SIZES. An architect will be able to interpret these needs and re-arrange them, to group and put them in a work schedule. We propose to add all of the spaces areas to obtain the projects TOTAL AREA.



2. Searching for a plot

In this second sub-phase where we have to find out which plots in the city allows this USE (in this case a Housing use) and allows this TOTAL AREA.

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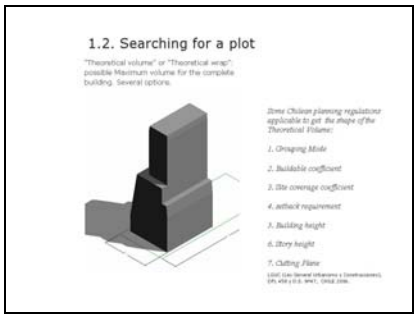
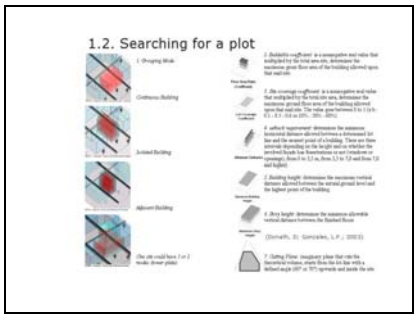


To get to know the area to-be-built allowed in a site in Chile, actually the Architect must ask for the "Informaciones Previas" of each site (according to the Chilean Building Law): this is a brief and precise report made by each local government (commune) and it shows the constraints for building in an individual site. By using this information we have to model all possible scenarios and maximum area to-be-built, the results of the application of the urban code is a 3D volume and it is officially called "Maximum Allowable to-be-built" but commonly known as Theoretical Volume or Theoretical Wrap. In a site we always have several options, in other words, several possible theoretical wraps. The most important planning regulations of the Chilean building code to be considered in this sub-phase are:



1. Grouping Mode: it refers to the modality in which the buildings will be placed respect to the existing buildings of the adjacent sites. Three modalities are possible: "Isolated Building", Continuous Building" and "Adjacent Building". One site could have 1 or 2 modalities.

2. Buildable coefficient: is a non-negative real value that multiplied by the total area site, determines the maximum gross floor area of the building allowed upon that aboved-mentioned site.

3. Site coverage coefficient: is a non-negative real value that multiplied by the total site area, determines the maximum ground floor area of the building allowed upon that aboved-mentioned site. The value ranges between 0 to 1 (z.b.: 0.1 - 0.5 - 0.6 or 10% - 50% - 60%)

4. Setback requirement: determines the minimum horizontal distance allowed between a selected lot line and the nearest point of a building. There are three intervals depending on the height and on whether the involved façade has fenestrations or not (windows or openings), from 0 to 3,5 m, from 3,5 to 7,0 and from 7,0 and higher).

5. Building height: determines the maximum vertical distance allowed between the natural ground level and the highest point of the building.

6. Story height: determines the minimum allowable vertical distance between the finished floor of each story.

7. Cutting Plane: imaginary plane that cuts the theoretical volume, starts from the lot-line with a defined angle upwards and inside the site.

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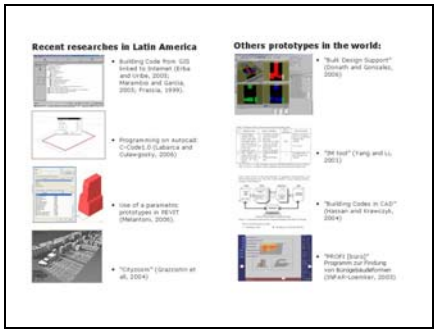
Actually this process is made by manual methods (drawings, scale models, 3d CAD models without programming) in most architectural studios and it takes several days, but recent researches in Latin America have demonstrated the advantages of using ICT Tools in this process, obtaining the following features:

a. Obtaining a Building Code from GIS linked to Internet (Erba and Uribe, 2005; Marambio and Garcia, 2005; Frassia, 1999).
b. Programming on Autocad: the automatic generation of guided-style theoretical volumes in different sites (Labarca and Culawgosky, 2006)
c. Use of a parametric prototype in REVIT: the Urban Code is turned to a computable data (input) and the tool shows an automatic theoretical volume (output) in real time (Melantoni, 2006).
d. Others prototypes: “Bulk Design Support” (Donath and Gonzalez, 2006), “IM tool” (Yang and Li, 2001), “Cityzoom” (Grazziotin et all, 2004), “Building Codes in CAD” (Hassan and Krawczyk, 2004), “PROFI [büro]” Programm zur Findung von Bürogebäudeformen (INFAR-Loemker, 2003).



Once the 3d models are made we have to choose the most suitable plots. If there is more than one, our client can choose the appropriated one by using the Rules of the Real State Bussiness (Theory of Location, Opportunities, Cost, etc) (Erba and Uribe, 2005)

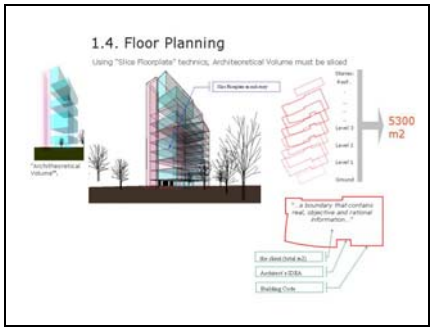
The final resul of this search is ONE site and ONE theoretical volume coming from the application of different planning regulations.

3. Architect´s Idea (Arch-I)

Inside this theoretical volume, chief architect models his idea applying differents styles and creativity. The architect has to reduce the total mass of the theoretical volume as less as possible so that not to break the profitability of clients. This new and final volume will be called “Architheoretical Volume”.

4. Floor Planning

Using Slice Floorplate technics, available in several commercial softwares, Architeoretical Volume must be sliced according to the number of stories and height allowed by the Building Code, obtaining the boundaries of each floor (at first sight it is very simple), our contribution is to present a boundary that contains real, objective and rational information: from the client (total m2), from Building Code (Theoretical Volume) and from the Architect (architheoretical volume)



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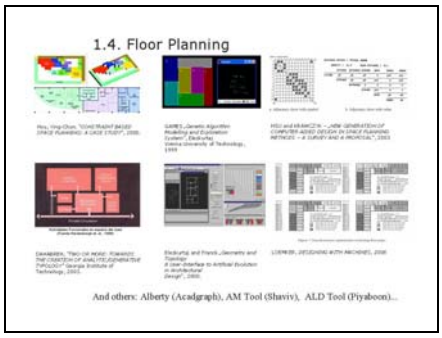
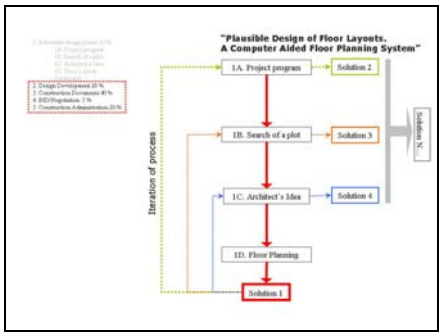
Once all of the boundaries are obtained, the spaces can be distributed inside of them, using Automated Floor Planning techniques (Planning Support Systems) (Li, Frazer, Tang, 2000; Hsu, 2000; Hsu and Krawczyk, 2004; Elezkurtaj and Franck, 2000; Loemker, 2006 and others).



Finally a Floor Layout is obtained -our possible solution - and it will be called “Plausible Floor Layout” because it contains confidential, rational and understandable information (Donath, Loemcker and Richter, 2002).

The process can be refined (iterations) by optimizing the distribution or going back to some steps and change the parameters of any sub-phase to obtain a new layout. Once the final layout is chosen itr will be ready to be developed in any BIM software to move onto the next stages:



Conclusions

The results of this proposal show that the use of specific ICT Tools in the early stages of a building design helps to reduce the working time, increases the confidence on the generated solution and it also contributes to the exploration of several alternatives in the short term.

In none of the sub-phases we have moved away from the architectural issue, neither the architectural design, nor the real factors; we have supported the architect starting from asking the client’s needs, finding a plot from the Web and we have finnally provided a a floor layout ready to become Plausible BIM model, quickly, giving more time to architects to think about the project or his ideas.

The possibility of using IFC codes in each stage must be mentioned, it helps to exchange information among all software platforms and applications used in each stage and all of the the involved actors of the building process.

Unlike traditional CAD systems, the future applications will have to solve specific tasks, abstracted of other mechanisms and deeply related to real problems of the architectural design. (Donath, Loemker y Richter, 2002).

Currently the comparison of the state-of-the-art papers related to each proposed sub-phase is carried out, finding the similarities and differences between them and our proposal.

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And also making a cadastre (in a comparative schedule) of current commercial tools for each stage, including the most known softwares and their appropriated existing tool or commands, and the real possibilities of create some new specific tools.

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Weimar, May 2007

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