χ-House game

A Space for simulating a Collaborative Working Environment in Architecture

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The research consists of the set up of a game simulating a e Collaborative Working Environment – CWE – in Architectural Design. The use of a game is particularly useful as it makes it possible to simplify the complex terms of the problem and, through the game itself, makes it easier to study knowledge engineering tools, communication protocols and the areas of an ICT implementation of a general model of collaborative design.
In the following several characteristics of the game are given (also with reference to other games) such as; participating actors (Wix 1997), the "pieces" (construction components) used, the modular space employed, the PDWs/SDW dialectics, the screenshot of the interface prototype, the score.

Keywords: *Architectural Design; CWE; Game; Representation Model; KBs.*

Current Architectural Design condition

The process regulating the design of architectural works has gradually attained a high level of complexity in the industrialized countries. The strongly interrelated reasons for this change must be sought in the greater complexity of the works of architecture themselves, in the increased number of specialist skills involved in developing the project, the need to increasingly reduce the time elapsing between the conception and the construction, and the greater performance demanded of the buildings.

One direct reflection of this change in professional practice is the adoption and development of the first solution to the detriment of alternative, innovative and potentially better solutions. The latter however would demand more in-depth analysis in the early stages, as well as the involvement in the very early stages of skills that are normally utilized only later, with an increased cost in the preliminary phase and a lengthening of the time required.

The CWE and the architecture

There are some exceptions to this modus operandi which may generally be traced back to the work of distinguished architects designed in collaboration with large engineering companies. The increased overall design costs are absorbed by the lower cost of construction, management, and by enhanced enjoyment. All of this can be obtained by the skillful use of materials, by the enhanced efficiency of the structural and energy form and by a greater functionality of the building itself.

In essence this situation is the result of the lack

of methodologies (and of suitable tools) for guiding such a complex process. Other sectors of industrial production on the other hand have successfully developed techniques to manage the complexity of the design process; through the paradigm of Collaborative Computer Aided Architectural Design – CollCAAD, often referred to in the various FPs of the EU as a Collaborative Working Environment – CWE – for Architectural Design.

We define this paradigm (Carrara and Fioravanti 2001; Woo et al. 2001; Kvan 2000; Gross et al., 1998; Jeng and Eastman, 1998; Kolarevic et al., 2000) as a process characterized by a high degree of interdisciplinarity, the delocalization of activities, the subdivision of activities, the timely use of information and the correct use of the more advanced methods and technology. According to us it is such when the IT tools include also Intelligent Assistants (I.A.s) and Knowledge Bases (K.B.s) which may partly or fully replace the human actors and allow a much more diachronic development of the project itself.

That involves on the one hand the possibility of assessing from the outset the design developments of a range of possible solutions and, on the other, a continual exchange of information among sectoral specialists (and their respective IAs, and KBs) during the various phases.

While collaboration has always existed in architecture CWE (that should be integrated with "computer assisted" aspect) in Architectural Design has yet to be applied.

CWE provides an information science support capable of highlighting the design objectives, of getting the specialists in different sectors to discuss among themselves, of translating into comprehensible terms the needs and constraints each of them imposes on the others during the various phases of the project. The various actors work towards the modification of the project and in doing so may assign to it physical and sizing characteristics that are mutually incompatible; aim of the CWE is also to identify the conflicts automatically and displays them to the actors concerned (Carrara and Fioravanti 2004).

In order to study this paradigm we are developing a game to simulate, on a reduced scale and with some simplifications that are inessential from the conceptual point of view but of use in focusing the research on relations among actors and between them and the process, a possible CWE for architectural design.

Several different games have been developed in the field of architectural design by scientific community, just a few are mentioned.

Summer Game (Woodbury et al. 2001, 2001a), enhances in the student 'reflection-in-action' and 'design making': the first objective is attained through training in judgement criteria made explicit from the outset; the second through the construction of images then linked to the geometry of the architectural work – the teachers have the role of clients and the students that of designer-constructor grouped in a team; the game lasts one week. StringCWE (Moloney 2002, 2005), focused on the rapid prototyping of the architectural work inserted in a landscaping context in which the student-actors present play the role of architects, all designing on equal terms, and teacher-actors guiding the evolution of the process and evaluate the design solutions. Cube Game (Kalay 2003), focused on the financial return from the lots and on the costs of construction of single family homes in which three actors are present: the client, the architect, the builder.

χ-House

Our game, which we have called χ-House, aims to study and simulate knowledge engineering tools, communication protocols and the areas of an ICT implementation of a general model of Collaborative Design. Moreover, the game will throw into relief the mechanisms governing collaboration among the different operators in a group designing architectural works.

A non secondary use of our game is as a tool for e-learning. This game will actually have great teaching value as it induces students to develop an apti-

tude for group work in a "Design WorkSpace" – DW – to interact in different roles, to be subjected to continuous evaluations on the fly, for the attainment of an improved jointly developed project.

χ-House - the actors participating

The group in the simulation consists of a client, an architect, a structural engineer, and an energy-plant engineer, who discuss around a virtual table thanks to the web support. Each actor works in his own Private Design WorkSpace – PDW – and subsequently publishes the results of his processing in a Shared Design WorkSpace – SDW – the virtual table (Carrara and Fioravanti 2002). Together with the other actors in the working group, each actor comments on his own and the others' published projects.

Each actor recursively imports the agreed project from the SDW to his own PDW and on this basis re-elaborates his own. In this way the satisfaction of the client, of the architect, of the structure engineer and the energy engineer all together increase along the design process.

We point out that:

- not all the material produced by an actor is of interest to other actors. In fact out of the "private" production of each individual actor, a small part of her/his own knowledge will be really necessary to make available to the working group, that is, must be published in the SDW (Carrara et al. 2004);
- the language used by the various actors will not be the same. A structural engineer, in addition to the calculation report, will produce also drawings of the structure; the energy-plant engineer will be concerned rather with indicating the ideal position for certain equipment, solar orientation; the architect will trace out a formal definition of the buildings, its rooms and its component parts.

One of the innovative aspects consists of the opportunity given to each of the actors to propose alternative solutions to the one they are called upon to express. The other innovative aspect is linked to data and knowledge transmission and "translation" between the PDW of the individual designer and the SDW that can be perceived by each actor through the Perspective/Filter mechanism.

χ-House - the score

Each actor, both during the development and in the final result, gives a mark. The score assigned to each individual project aspect is computed as the mean of the scores assigned according to criteria previously defined in a simplified and conventional manner by the individual actors. As described in a previous paper (Carrara and Fioravanti 2005), studying the rules governing the design process in a briefing session, the assessment criteria and consequent scores achieved can vary in time and place, and are therefore highly contextualized. To satisfy this need different "weights" may be assigned to the scores. The scores allocated by the four actors are in accordance with criteria determined by the desire to give priority to certain aspects of the design, e.g. the aesthetic value is weighted by the architect's evaluation criteria; the economic factors by energy engineer's ones, and so on.

The various assessments are conventional and scores assigned by the various actors are purely indicative although reasonable. The score for each actor ranks from 1 to 10. For example, for the structure engineer actor: value is assigned to: no. of (pillars + plinth + foundations); no. of (beams + r.c. volume); net floor slab span < 5 m score 8, 5m < slab < 6 m score 7, 6m < slab score 5.

The group wins when the overall score it reaches is over a minimum threshold related to the degree of difficulty selected; if several groups are present, the one obtaining the highest score wins.

Apart from its limitations, this game retains a general validity regarding the results to which it can lead through the study of various simulations. It is intended to be a design "space", a sort of "incubator" (Carrara and Fioravanti 2005), which allows the expression of creativity linked to the overcoming of points of view from different design sectors which

are the result of diverging needs or short-sighted egotism.

Another strong point of the game, is to guarantee solutions indicative of a good integration among the various aspects contributing to the definition of architectural organisms (through the capacity to promptly identify conflicts and incompatibilities at the right time with a lower incidence on the costs).

One particular result that it is desired to extend to general cases is the definition of the SDW and the PDW. The former, shared by all operators, must be intelligible and accessible to each of them and therefore the language used for communication will have to cope with conceptual meanings, geometries, attributes and properties of the building components represented; it must be related to the language of relevance of the PDW of the individual operator. The assessment of the conflicts arising in the publication mechanism and the sharing of the work of the individual actor and their resolution by means of the definition of compatible solutions is a second area of special study, the results of which could be extended to a general process model.

χ-House – the house and the components

The house is a two-storey house with two blind sides so as to be able to define an array. The need for simplicity leads us to define a finite number of pieces that can be used by the designers, sized according to the rules of modular dimensional coordination; a simplified method for schematizing the objectives of the design process in terms of cost and performance and consequently an index to assess the partial attainment of each of them; a system of rules that must be observed by individual operators.

The abacus of construction elements is made up the schematic elements (walls, walls and windows, walls with doors, beams, pillars, etc. all in the shape of a parallelepiped).

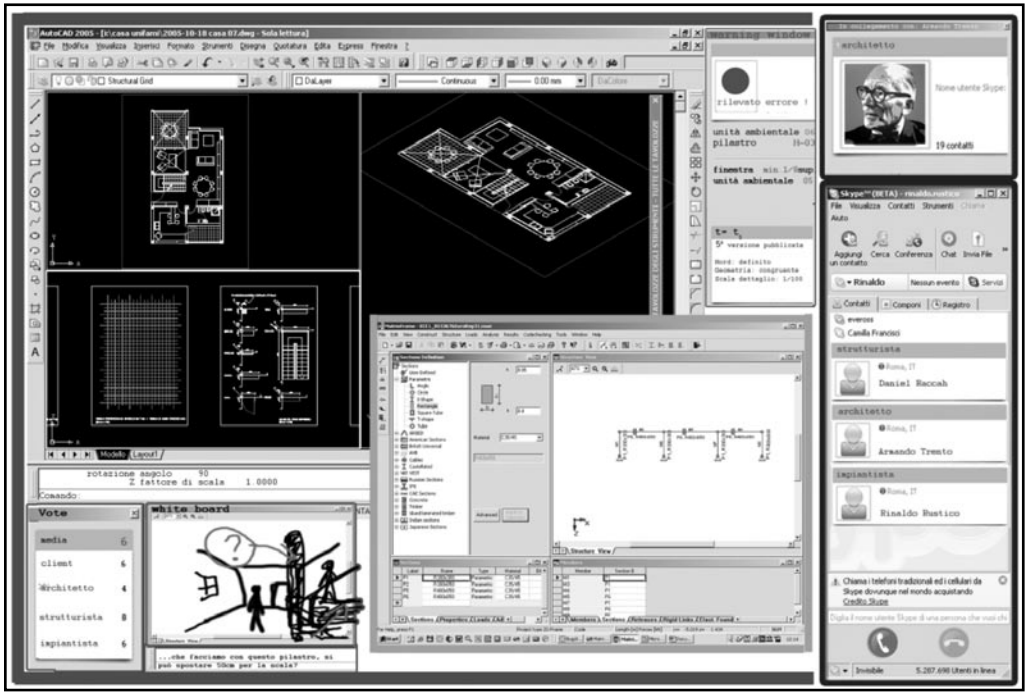

Figure 1
View of prototype graphics interface of an actor in c - House.

χ-House - methodological invariants and conventions

Method used by the structure engineer actor to define his/her preliminary structural work project in his/her own PDW. This method is similar to that used by other CWE actors.

1) Approach for the construction lines
1a) Construction lines for each actor
    - of spaces
    - of plants
    - of structures
1b) Construction lines of the actor
    - Different orientation
    - Different spacing
2) Identification of solid and empty spaces in layout
   Ignoring spaces identified by previous actors
2a) Identify solid and empty spaces in elevation (from plan)
   Ignoring spaces identified by previous actors
3) Alignment of construction lines of solid spaces (solid wall)
3a) Alignment of construction lines of empty spaces (glass walls)

IMPORTANT: Continuous transition from volumes to surfaces, by means of internal Filter/Perspective, and vice versa in order to simplify the work in each private space

4) Find "certain" construction lines, that is, which clearly do not gives rise to conflict (level 1)
4a) Identification of critical areas = non aligned critical area
4b) Alternativeness of critical lines
5) On construction lines fix certain points and other variables
5a) Now that the interaxis is known I can predimension the sections
6) Secondary "patch up" beams or…
6a) Reassess strategic choices
7) Move construction lines and spaces in order to clean up of the field "squaring" (orthogonal geometric regularity)
7a) Insert another pillar to avoid "patching" and "cleaner" squares

Limitations and conventions of game

Limitations of game: the components are arranged on an orthogonal three-dimensional modular grid, the planes in which the components lie are orthogonal.

Conventions used: the combination of the various construction elements takes place by simple juxtaposition, as if there were a perfect adhesion that determines the continuity between the members.

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