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Architectural Design Studio as Research Paradigm in CAAD

The series of three papers accounts for the unfolding of a computerized architectural design studio, an elective course in the architecture undergraduate program at Laval University, and the association of the graduate students' realizations in the CAAD concentration (Computer Architectural Aided Design). The first motivation for this integration was to understand and look at the project of architecture, and in particular its process, as a support, an approach to scientific research in the field of architecture. More specifically, the intent was to expose the data generated by the studio to analyses and scientific observations, but mainly to a systemic approach adopted in our researches on representation and visual simulation of 3D architectural models. Moreover, the papers identify the "distance" between, on the one hand, what was planned and carried out during the semester and, on the other hand, what we now wish to achieve. With that in mind, the known "scene graph" model was adopted and presented as the representation and unifying element of our three research orientations: the representation of the architectural knowledge associated to a scene, the interaction with that scene, and the visual simulation both of the scene and within the scene.

The Research Context

Interpretation of architecture history can lead to pastiche. The object is the mirror of a time period, a taste, a point of view, subject to the interpretations of the historian. A reading of history can thus lead to a limitation of the architectural project, which is a good definition of pastiche. To avoid falling into that trap, it is necessary to resort to the context memories to recycle history in the architectural process of conception, in the project, and to generate the "restitution". The knowledge of architecture, according to Pirazzoli, is based simultaneously on an objectified and a

critical knowledge of the object. The objectified knowledge reveals the physics of the object, while the critical knowledge delivers the knowledge accumulated on the object in the "discourse" constituted by the numerous interpretations of the object. Those two levels of historical knowledge form the mental representation of all the encrypted states of an object, a site, or a building. Therefore, "the critical knowledge brings to light and feeds the objectified knowledge part to lead us to the state of grace that is the restitution" in the architectural project. These assumptions about restitution, drawn from Luc Noppen, were the starting point of subsequent research investigations and uses of the design studio as a way to define and use systemic approaches to design, which could support the project restitution.

The Studio

Thus, as a practical consequence, the CAAD Studio of the winter 2001 semester followed. The motivations of the CAAO studio project of that semester began with the desire to associate the works of undergraduates with those of graduate students within the studio. The objective was to open the data (in particular 3D data) generated by the studio to analyses and observations, but more important, to the adopted systemic process.

The studio aims at developing, by practical activities, the understanding and the expression of the ideas necessary for the elaboration of an architectural project by means of a computer system (computer + software + 3D data base), while taking into account an existing urban context - a site located in the Québec City Saint-Roch neighbourhood. These activities comprise: (1) the analysis, (2) the synthesis, (3) the judgment (the evaluation of qualities/alternatives), (4) and the graphic/oral/written communication of the student's projects. The emphasis was put on the conception and the realization of architectural propositions by means of the computer system in a context of design by collaboration. The projects were modeled and visualized by means of CAD software, and presented in HTML format with web and VRML browsers.

The Project

To design a Centre for Virtual Realities in the Saint-Roch neighbourhood: The site, located at 440 de la Couronne Street, is at the northwest intersection of Charest Boulevard and de la Couronne: it is right in the core of the neighbourhood. This project is an investigation of the building as "interface" to virtuality. It questions and investigates all the forms of the concept of virtuality, through the building, its materials, architecture, technologies, etc. Also, the Centre was to be a place to develop and broadcast

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the concept of the “virtual” and its related technologies. Thus, it is a place to rent specialized equipments and support virtual technologies such as: virtual room, virtual table, projection screen, “Cube”, etc.

The graduate students’ motivations were to consider the studio as a scientific and systematic process, to understand the structure of the design process in order to foster collaboration between the students, to compile the material as a result of the design process: photos of the site, 3D modeling and textures (photos), realization and cleaning of VRML files, and finally to be part of the evaluation and selection processes of the projects.

The Model for 3D Representation, Interaction, and Visualization

The VRML Scene Graph was chosen as the base model to support a reflection on our three research orientations and hypotheses:

V : visualization of the scene: image inlay, panoramas, animations

I: interaction with the scene, manipulation of the scene

S: representation of knowledge, the semantics² of the scene

The hypotheses are developed from the possible relations between V, I, and S:

- Semantics (S) feeds and defines the manipulation and the visualization: S - I and S - V (those are defined as primary [seed] relations)

- Visualization and interaction modify semantics: I - S and V - S
- Interaction modifies visualization: I - V, and visualization modifies the interaction: V - I

That leads to a graph with bi-directional relations between V, I, and S, which is what is needed in our research program to document and explain.

The Use of VRML

The VRML is a language of description and representation of a graphic scene—it is not a programming language; that gives it some qualities and advantages, but limitations also. Originally conceived to establish a format of presentation of 3D information on the Web, VRML was also developed as a file format for the exchange of 3D information necessary for the description of a scene. The VRML holds several characteristics derived from its connections to the Web, the composition of a scene, and the exchange of information:

- A legible and publishable (editable) ASCII file format.
- A not compiled, but compressible language; compressed VRML files accelerate their downloading, it is the viewer who

does the extraction.

- A graph of the scene; a hierarchical tree structure consisting of similar parent and children nodes.

- A system of routes that allows the passing of messages between nodes and thus modify the topology of the graph of a scene and the nodes behaviour.

- A concept of PROTO that allows the creation of new nodes.

- A set of predefined nodes that include basic geometrical forms (cube, cone, cylinder, and sphere), define the appearance of the forms, and allow transformation of the forms and interaction with the scene through sensors.

The VRML scene graph allows a representation of a scene and thus one of an architectural or urban landscape. It is that capacity of representation that results in a representation of the knowledge bound in the composition of a landscape or even in an architectural restitution. These aspects of knowledge representations are developed in Hassoun Karam’s paper.

Another very important aspect of a 3D representation of a scene is the capacity to interact with it and to modify it. VRML offers many features to develop that aspect during the presentation of the 3D model, but also during the design process. The possibility, for example, to modify in real time the appearance (textures) or the geometry (forms) of an object in a scene, and to see it being transformed, becomes a powerful tool in displaying and suggests new information about the context. That very proficient dimension of the VRML is presented and developed in Melina Giannakis’ paper.

All the capacities of representations and interactions offered by the VRML cannot make sense without the notion of visualization. The quality of the visual representation constitutes the third research aspect and Louis Saint-Pierre’s paper goes through the use of images in an architectural design context.

Notes

1. At the end of the 2000 fall semester, Luc Noppen made a presentation on the restitution of architectural projects as a process of creation, which was the starting point of the use of a CAAD Studio (Computer Architectural Aided Design Studio) as a vehicle for architectural research.

2. Based on Simon, we define semantics as all the possible interpretations of a symbol or its

representation; thus, if the symbol (or its representation) changes, interpretations will change, so will the set and semantics. The question then arises: where is situated the significant threshold that distinguishes two sets (how many elements have to change)? Simon, Jean-Claude, 1984, *La reconnaissance des formes par algorithmes*, Paris, Masson, 251 p.