A Web Cooperative Application for Civil Engineering

Vanlande Renaud
Le2i – ACTIVe3D-Lab
r.vanlande@active3d.net

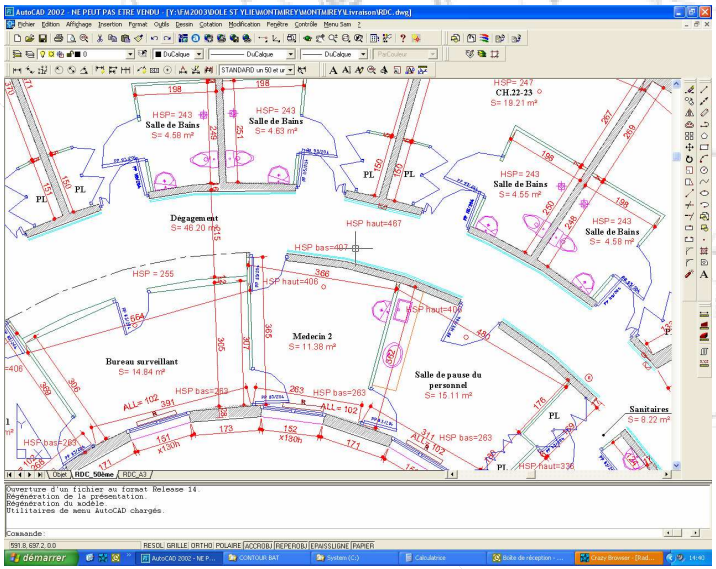
Cruz Christophe
Le2i – ACTIVe3D-Lab
c.cruz@active3d.net

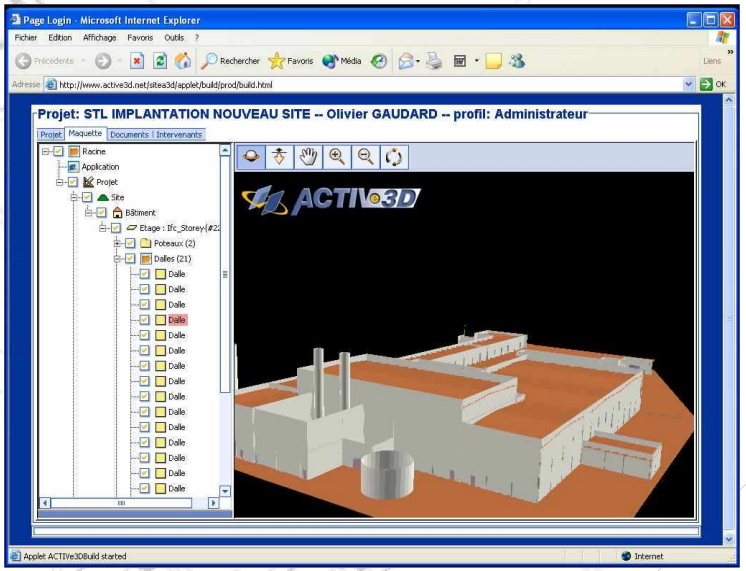
Nicolle Christophe
Le2i – ACTIVe3D-Lab
cnicolle@u-bourgogne.fr

INTRODUCTION

• In civil engineering projects, dedicated computer programs can't exchange data directly, even when the same team uses them. Buildings therefore take monger to design and build and cost more to construct and operate. Information sharing should be the starting point in applying information technology to building design, construction and use. Information sharing requires a software environment in which computer programs can exchange data automatically regardless of software and data location.

• We present an electronic platform, the *ACTIVe3D-Build,* for the management of civil engineering projects. This web-based platform allows all participants of a project (electrician, plumber, etc.) to directly use and exchange documents in the projects via an application. Moreover, a 3D-visualization of a building that is generated from IFC allows each participant to move around in the building being designed. In this 3D-environment, players will be able to query all objects that compose the building and thus obtain information about them from the IFC database. This platform is the result of a research that aims to represent semantics of computer graphics modeling within a relational database. The semantic modeling is involved at two levels. The first level corresponds to creation of two databases, the first one stocking the IFC, and the other one stocking compositions of 3D scenes. The second level represents the association of the semantics of the IFC with 3D-elements of the 3D database. In order to permit this association, we represent all information (IFC, 3D scenes and management information) as XML trees.





METHODOLOY AND RESULT

• The technology which permit this, is the IFC (Industry Foundation Classes). IFC is an initiative of IAI (International Alliance For Interoperability) and is an object model described with a specification language data EXPRESS. The IFC model is a complex model with 600 entities and the size of IFC file can reach 100 Mo.
• IFC files are cyclic graphs. This structure makes them difficult to handle. In the sharing of IFC files, one of the most significant questions for the handling of the IFC is "where to cut in the graph?";
• To address this problem we have developed a methodology based on graph analysis and tree classification. The first step is a loading of the IFC file in the computer memory. During this loading, each object and connection is analyzed and converted from the source file into acyclic graphs called contextual trees. This process is done using business rules. An example of a business rule is "*a door is in an opening element in a wall*". Resulting from this process, the main tree is the geometrical contextual tree which contains the topological relations between the various objects. Other contextual trees are built starting from the IFC files, such as the contextual tree of capacity defining the object composition (a building contains two floors, a floors contains beams, walls, and so on.) This step finishes when the trees replaced the IFC file in the memory model. Below the figure displays a snapshot containing the view of a tree of capacity. The second step is dedicated to the 3D modeling where all the geometry defined in IFC trees is converted into triangular surface model. During this conversion, the 3D objects are associates with the GID. The GID is the general identifier used to identify each business object of an IFC file. In the script 1, the GID of the IFCRELAGGREGATES object is #111032. This GID is used to link the 3D visualization with the information stored in the databases. All insertion of new data in any base is reference by a GID correspondent to an IFC object. All trees generated in the platform are XML trees. These trees and the component elements are stored in a relational database and manipulated using the SQL. From this database and the GID, all types of information can be attached to the 3D visualization of business Object.

```
ISO-10303-21;
HEADER;
FILE_DESCRIPTION (('ArchiCAD generated IFC file.'), '2;1');
FILE_NAME ('Karlstr.IFC', '2002-06-19T15:48:48', ('Architect'), ('Building Designer
Office'), 'PreProc - IFC Toolbox Version 2.x (00/11/07)', 'Windows System', 'The
authorising person.');
FILE_SCHEMA (('IFC2X_FINAL'));
ENDSEC;
DATA;
…..
#111029 = IFCRELCONTAINEDINSPATIALSTRUCTURE
 ('25wKeWex98fQp5Pukf_Ilc', #6, 'BuildingStoryContainer',
'BuildingStoryContainer for Building Elelements', (#111007), #110989);
#111030 = IFCRELAGGREGATES ('216Bv$yJj3tQjFeDohe6fQ', #6,
'BuildingContainer', 'BuildingContainer for BuildigStories', #30, (#34, #16236, #29699,
#56800, #62077, #67336, #72633, #91702, #110989));
#111031 = IFCRELAGGREGATES ('17XMUtNDr8FeFMtR6rOcy5', #6,
'SiteContainer', 'SiteContainer For Buildings', #28, (#30));
#111032 = IFCRELAGGREGATES ('0pMN8yq8vDRfwN_tnJREKC', #6,
'ProjectContainer', 'ProjectContainer for Sites', #26, (#28));
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END-ISO-10303-21;
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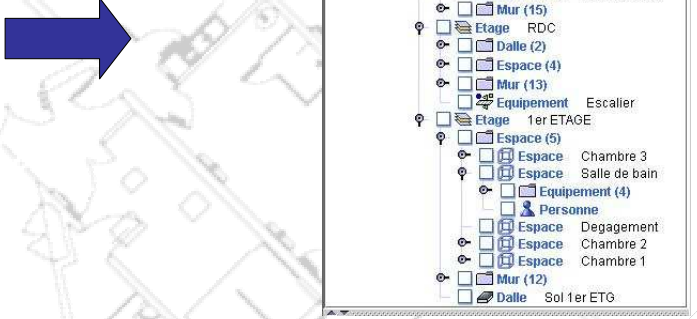

Script 1. Example of IFC file

DEVELOPMENT

- We're running the ACTIVe3D BUILD SERVER on a Dell dual-processor server (Pentium 4, 2.4 GHz, 512 Mbytes DDR RAM, 180 Gbytes disk space, Red Hat Linux 7.2 OS). An Oracle 9i relational database management system (RDBMS) manages the data layer. We developed the broadcast and behavioral layers in Java using Sun Microsystems' JDK 1.4.1) to facilitate development and ACTIVe3D BUILD SERVER porting to other operating systems [5]. We use Microstar's Sax and Sherry's Dom parsers for all XML streams. We're currently developing the 3D visualization module called the "IFC Viewer" in GL4JAVA using the NetBeans 3.4.1 development environment. The IFC Viewer represents both the IFC Tree and the 3D visualization of a Building. All objects composing the building are managed through the tree or dynamically using the 3D scenes, activating object by clicking on it.
- The IFC Viewer was certified ISO/PAS 16739 in May 2003 by the IAI. It allows the user to see the complete description of the building with an IFC tree view. Moreover, it lets participants move around in the building being designed and obtain information about the objects that compose it. This 3D is "semantically" dynamic. The structuring of the scene is calculated in real time from the IFC database according to geometrical features (distance from the point of view, object hides...) and semantic features (rights users, type of user, stage of visualization of the project...).