# Construction of A Support System for Environmental Design

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*The technique described here can be used to support the design process. To do this we constructed a system as follows:*

*First, to obtain resources of design, a semi-structured database was constructed to be share among designers; second, to collaborate in operations, an XML-based collaborative information system using a semi-structured database was defined; thirdly, to re-compose the 3DCG model parts, a re-compose system which can compose scenes in a visual space, were constructed; and finally, to support architects at the conceptual stage, a sketch VRML system which can compose 3D sketches, was constructed.*

**Keywords***: environmental design, re-composition 3DCG, and database*

## Introduction

### *Environmental Design*

Environmental design is a re-creative activity aiming at maintaining and improving the living environment as far as possible. A comfortable space can be achieved by well harmonizing water, greening, roads, man-made constructions, parks, town spaces and so forth. In this present study, we focus on public space of open environment. As determined by the environmental design, cooperation is inevitable in the designing activities. It also requires both the thinking of wide range environments and the points of view from a detailed environment.

Because of the wide use of computer in environmental design, construction of computer support system in various stages of the environmental design becomes increasingly important. Computer graphics has been developed to support not only presentation but also design development and conception of construction. For construction of computer graphics, various computer techniques are needed. With the rapid development of computer and network techniques, the quality of the computer graphics has accordingly improved, and the methods for its construction are becoming efficient. The aim of the present study is to efficiently improve the method for 3DCG resources creation, presentation, and their management based on current computer and network technology.

### *The processes and the workflow of the design*

Our study group is carrying out research on computer graphics for environmental design. The environmental design involves the following activities:

- Making and examining conception and plan;
- Making CG and examining the effect;
- Discussion and arranging among architects and experts; and
- Obtaining the agreement between the planers and local residents who are affected by the project.

The design process is an implementation from forming concepts to constructing details. The results of the design with the concepts and contents are transmitted by presentation. Therefore, the workflow of the design is developed for examining reaction by presentation. As shown figure 1, the plan is confirmed by reviewing and examining the works at each stage of the design. Previous stages can be returned if an amendment is necessary. Otherwise, next stage is proceeded.

### *Presentation, Development and Conception for Environmental Design using computer graphics*

Computer graphics is used for the presentation of design. Recently the CG technique can represent the pictures or animation with extreme reality. Therefore, the 3DCG presentation is becoming a convincing method. Varied software current sold in the market is able to carry out this task well.

When a plan is been developing in the middle of design development stage, it is important to keep the continuity of thinking. Computer graphics can be used to record the thinking for communication, evaluation, and presentation through saving each version into a semi-structured database automatically. The versions created in previous days can be easily referred at any time, and the referring does not interrupt the thinking. We also tried to make a real-time virtual space that can be constructed by assembling the 3DCG parts for continuous thinking.

At the early stage of design, architects normally need to create a "shape" which means the object becomes clearer from an idea in the mind of the architects. An idea is an image floating on a mind with intuition. It needs to be represented by setting up on



the basis of the image. Therefore, that image should be illustrated by form. The tools of our support system can be used to construct a virtual space for making the image real time by assembly 3DCG parts, or transform a 2D image of sketch to a 3D image. There are useful tools for initiating conception in the process of environmental design.

## Support System for Environmental Design

In the present study, a support system for such process of environmental design is developed. To support the design process with a virtual space, we constructed the system as follows:

### *Semi-structured database*

To obtain resources for design, a semi-structured database has constructed to be shared among architects. This database was able to manage various resources such as 3DCG model parts, schedule, workflow, etc.;

The workflow of 3DCG made by the design team is drifting as shown Figure 1. During the design, a variety of resources are generated. The resources contain the reference material, photograph, model, 2D or 3DCGs, animation of 3DCG of each version, etc. The amount of these resources increases along with the design process. They may be labeled with different names and saved to various machines as files by different people. Moreover, architects create new ones when referring to them, or modify and adjust them to generate new versions. For example, we have investigated and analyzed a project of a harbor's reclamation, which is still going on. One goal was to decide how to create a landscape of rocky islands resembling a natural rocky scene from a popular viewpoint. Another one was how it can be designed as a public park. For this project, we used a 3D grid surface model generated by fractal method for the shape of this island, designed a public park, and then constructed some scenes seen from a real distance by CG to examine the effect. 3 members of our design
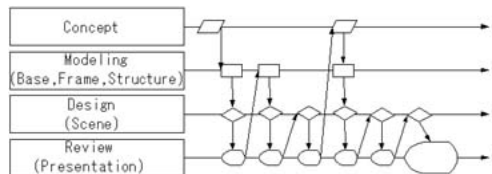
*Figure 1 (left). Work flow of design work*

team took 3 months, and made more than 1,000 files for the final submission of 11 CG pictures. For such extensive work, how to develop it efficiently and how to manage the resources are obviously important, and the use of semi-structured database is a powerful method. It can collect and classify the resources automatically and can retrieve the resources quickly.

### XML-based collaborative information system

In environmental design, cooperative activities among the organizations related to the project and among each member of the design team occur frequently. For example, for the harbor project mentioned above, our team members contacted with each other every day for discussions of opinion, division and integration of the project parts, and adjustment of the schedule, etc., and also communicated other organizations frequently for information exchange, situation confirmation, and summoning meetings. To manage these collaborative operations and control the process of design, XML-based collaborative information system with the semi-structured database was constructed. XML stands for Extensible Markup Language, by which information sharing can be achieved and a flexible, active and powerful workflow can be defined.

XML is an important markup language which may become a standard for exchanging or distributing the documents and data through internet. It has added some functions that HTML could not do. HTML is a language, which is for describing the data of browse. It is difficult for describing the data of outside web page. But XML can process the various data like the following:

- To exchange the data between the web and database
- To restrict condition of who can read the web page

Therefore, the application can understand the contents and means of data itself by XML. XML understands and processes the data by the form of describing which in accordance with the purpose.

Let us compare some typical characteristic among HTML and XML:

HTML:
- Tags of fixation are used for layouts;
- The contents and means of data are not understood;
- The data can not be extracted by programs; and
- The data are structured by layout.

XML:
- The tags are defined by person who is making the XML page;
- The contents and means of data are defined by tags;
- The data can be extracted by programs; and
- The data are structured by contents.

Our semi-structured database was managed by XML for saving and retrieving the design resources, and communication among the people who is affected the project.

### Re-composition of 3DCG model parts

To re-compose 3DCG model parts, it is necessary to constraint and degree of freedom between the parts, i.e. the mutual connecting formation, position and possibility of connecting each other. One of the advantages of using computer for environmental designs is that an architect can put 3D objects in the precise positions directly in a virtual space. The area which will be designed can be composed by 3D sketch or 3DCG parts such as models of buildings and their surrounding area. The modeling and rendering of the designed objects are then performed concretely to complete the plans. Our aim is to build a system realizing the above process.

### Sketch VRML

Sketch is a draft containing the representations that can be analyzed visually. The idea is recorded by sketch on paper. Sometimes, a sketch and an idea are further matched with each other. The problems which may be caused from shape, color, surrounding area, and balance etc., are then revealed from the sketch. To adjust the sketch is a solution to them. The architects must read the 3D space from sketch that has written by pencil. When a plan of sketch is proposed, matters for consideration are not only the spatial position but also imaginations about flow of people and their activity, the 3D spatial spread, the structural construction and the volume, colors and texture, etc. as if walking around the space. Architectural training is therefore necessary to image the space from a sketch. We have invented a method that can compose sketch into a 3D space by VRML, which is helpful for imagining the space by 3 Dimension.

In this paper, we mainly describe our research on (2.3), and demonstrate the use of the system through a design project.

## Re-composition of 3DCG model parts

### Types of 3DCG parts

**Topography models**

Information derived from topography is essential for the actions of various development and construction. For example, in the project of national foundation maintenance, Geographic Information System (GIS) is developed and used. Basic topography information can be obtained easily from a variety of databases. However, for construction of 3DCG in a concrete project, certain degree of details is necessary. For example: the maps with numerical values of 250m and 50m mesh, which can are commercially available, are used routinely for the preliminary model, and then further detailed modeling for the central part is carried out by using contour maps. Parts of scenes can be represented in simplicity for wide range representation, but for the close ups, model with details must be made. Models made in the past for other projects but for the same or a near area are often recalled in our topography.

**Existing building models**

In topography modeling, existing buildings and other objects such as cars, tree and so on, must be included to represent the environment of surrounding area. For situation inspection, it is also necessary that the environment is represented in details. For example, Okayama project is a project of urban renewal that is still going on. For the presentation of situation inspection, we made very detailed area scenes in some ranges in the 3DCG. Many buildings, roads, cars and trees were made. Although it took a lot of people and time, Such database with each part and object of the urban space is very useful as the resource for the environmental design.

**Structures to be designed**

As already explained, computer graphics can be used for presentation, development and conception in the design process. The last step in this process is to generate 3DCG model of new buildings and landscapes. When the new models are created, the method for construction and that for operation are as follows:

- Creating by plan drawing. This is used for the presentation to people of liaison and local residents for showing the idea of architect, the results and the effects.
- Creating during the design process base on various references and obtaining final results through a variety of versions. Several versions are constructed to show the development processes of the architect's ideas. So architect can inspect the effect, and use these versions as references for the next version.
- Creating by referring parts and other elements to construct of conception. This method is

used to fix the idea in an image.

Collection and classification of the resources for the database

It is necessary to extract information from the resources while they are being accumulated in the network. The extracted information is constructed as Semi-structured database which has executable control with generalization. The classified parts have the class structure. Therefore, various classifications are made for saving and retrieval an extensive resource such as by the function, the shapes, the contents, the stages of design process, frequency of use, degree of detail, degree of importance, range of distribution, and so on for purpose which differ to using in design process

The ideal classification should be able to be retrieved based on need. However, it is too troublesome to be practical if all the classifications are carried out by hand operation. We therefore considered automatic collection method by referring

from filename, extension, directory names, timestamp, file size, tree structure of the directory etc. A semi-structure database was accordingly constructed in order to extract a necessary resource at the retrieval point in time. The system chart can be seen below.

The semi-structured database was managed for collection and use of the resources with XML-based collaborative information system. In this paper, we describe only about re-composition of 3DCG model parts by using the resource in the semi-structured database.

### The roles of 3DCG parts in the environmental design

To conceive new scenes to fix architects' idea or show architects' idea to other people, we use a method that re-composes the 3DCG model parts. When an architect wants to record and develop his/her ideas at the initial stage of design, sketch, perspective drawing, block, photomontage etc. are useful tools. It is also important to refer relevant articles. All these
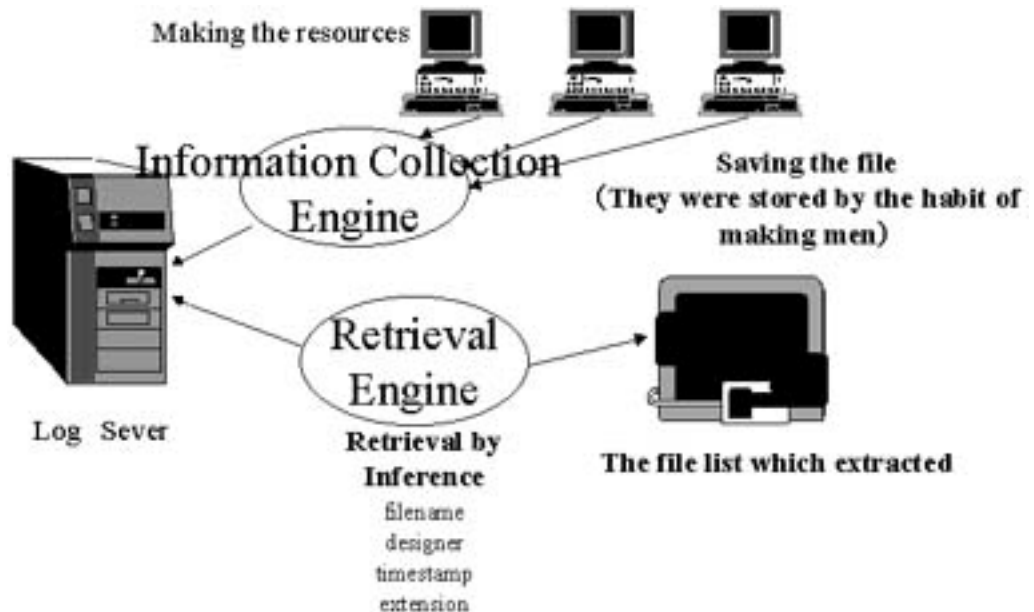


*Figure 2 (right). The Semi-structured database system*

tools are frequently employed for showing the architects' image but each of them is particularly suitable for certain uses.

### Construction, use and management of 3DCG parts

#### Construction

Various software is used in architecture for constructing model, render, pictures, animations etc. These software packages have numerous features, but certain functions and operation methods differ for difference purpose. Training is necessary to use them with acceptable speed in application, even for people who are used to modeling. The main problems are different platforms and versions. The efficiency of computer is also an issue. For example, it is difficult to move heavy data at some machines. Through the construction of many 3DCG parts for our particular projects, we have obtained experience to use this software. For sharing data and rapidly composing a scene, use of VRML and semi-structured database are powerful methods. VRML is a file format for describing interactive 3D graphics and multimedia. VRML may be used in a variety of application areas such as multimedia presentations, web pages, and shared virtual worlds. Most modeling software can save the modeling files to VRML easily. Therefore, models can be constructed by either other software or VRML itself. Because VRML does not depend on a platform and is applied on the web widely, it is possible to take the models from the semi-structured database shared among architects and managed by XML to re-compose 3DCG model parts and construct 3DCG scenes in a virtual world.

#### Use

Use of re-composing system at presentation stage: when you explain your idea about a plan to people or collect opinions from people such as the clients, residents, or other relevant people by CG, you can make changes immediately to get their responses. By comparing the changed one with original CG, you can easily discover what is different and whether the change is good or not. You can also easily make it clear why you decided to use the version originally presented not the changed ones during the explanation.

Use of re-composing system at development stage: You can obtain the 3DCG parts from the semi-structured database to compose the area which surrounds a building site to be designed. So you can check if your plan can fit the surrounding environment quickly.

Use of re-composing system at conception stage: it is important for architect not to have preconception image. For example, when you design an elementary school, you should abandon an image of the school that you know very much. By re-composing 3DCG scenes rapidly, new images can be discovered while fixed images are thrown away.

#### Management

Because re-composing structured system can help architects conceive images rapidly, and different people construct different resources and share them with other people through network, a lot of resources are remained and referred frequently. To save and retrieve them automatically without stop the flow of ideas, the management system is configured by semi-structured database and XML, and shared with people jointly connected. The system also manages the schedules and various items of information about people. It is particularly useful for management of teamwork and that of major cooperative designs.

## Conclusion

In the present paper, we report an interactive system for supporting environmental design. The objectives pursued are automation, increased speed, convenience, and visualization by using this support system to help design activity. Our system can improve substantially the efficiency of environmental design, as compared with traditional methods. The efficiency will be further increased with the fast development of computers and network technique. On the other hand,

*Figure 3 (right). A scene of making by re-composing system*

the techniques and the installation of the present system will quickly become old. The databases and the resources must also be renewed rapidly. Various new problems may emerge not only for the accumulation of resources, but also for deletion of resources no longer in use as well as renovation of resources need to be re-used etc. In the future, we will continue to investigate how to improve efficiency further and solve new problems in our system.

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