NETWORK-BASED DYNAMIC EVALUATION PROCESS FOR URBAN LANDSCAPES

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Abstract. When designing large-scale projects that affect urban landscapes such as the construction of power stations, it is important for a designer, to be able to predict how the landscape will be changed and public opinion in regard to the design stage. In order to support the communication between the public and the designer in the design process, authors have proposed a Network-Based Dynamic Evaluation Process (*NDEP*) for urban landscapes with WEB. This process can achieve a consensus decision, by applying the interactive cycles of proposal and evaluation to the design process. In this paper the authors outlined the framework of the process, the evaluation method by AHP, and a case study of an experimental production system.

1.Purpose and background

In recent years, digital technology such as multimedia, Internet and the information superhighway have become increasingly popular. Digital technology is giving birth of a fundamental revolution to our society, culture and our life style. Even in the construction field, public participation in the city planning through the Internet has been increasing in recent years. In designing landscapes that are connected to the natural status, climate and culture of an area, a consensus with various groups such as residents or local government is necessary. In consensus decision making, a designer needs information sharing and collection tools. These tools can be effectively done with network and multimedia technology. However, there are the following problems in consensus decision making in the present landscape design stage.

1) One-way communication

Consensus decision making is necessary when there are plural groups such as planners, citizens and administrators in the design of a landscape.

The role of the designer is to prepare a proposal and present it, and the role of the other groups is to express, or approve proposals. This is the "structure of one-way communication". An adviser or citizen may participate in the design process only in regard to comments on final plan that a designer has presented or on a psychological evaluation.

CAADRIA '98 : Proceedings of The Third Conference on Computer Aided Architectural Design Research in Asia.
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2) Lack of a place to share information
The processes called "information collection", and "information transmission" have become important of the groups around a designer in the large-scale projects. However, a place, where a design concept and a plan can be analyzed, is lacking. Also, there is not even a place where participants can review the design process.
3) Development of logical evaluation methods and tools
Landscape evaluation is difficult to quantify because people's impression of a landscape is subjective. In addition, evaluation is dependent upon the knowledge and experience of the evaluator. A designer needs to grasp the trend of the evaluations to the proposal by each group of evaluators and reflect the results in a design. A logical evaluation data collection method is needed.

Taking these problems into account the authors have proposed the Network-Based Dynamic Evaluation Process (*NDEP*) for the purpose of a landscape design support in a large-scale facility project. In accordance with this process, an evaluation system was experimentally produced by WEB interface on the Internet. The system was tested through the landscape design of a power station that will be constructed in the Yokohama bay area.

2. Framework of the NDEP for Landscapes

In consensus decision making in a landscape design, the authors examined the problems that mentioned above. In this section, the authors have presented a framework of a decision making process among planners-citizens/administration (experts-non-experts) or planners themselves. A fundamental concept of this process is to exchange information interactively among designers and the public (who are generally non-experts) who comment and give their evaluation to a designer. The purpose of the process is to reach a consensus starting at the design stage in a project.

The Network-based Dynamic Evaluation Process is composed of the following 5 steps:

Step 1. Landscape information sharing
Step 2. Landscape Modeling
Step 3. Interactive Evaluation
Step 4. Data collection
Step 5. Statistical processing and decision making

This process is a cycle, in which the modifications and evaluations are repeated alternatively between designers-evaluators. The dynamic landscape evaluation system is constructed on WEB in accordance with this process. (*fig. 1*)

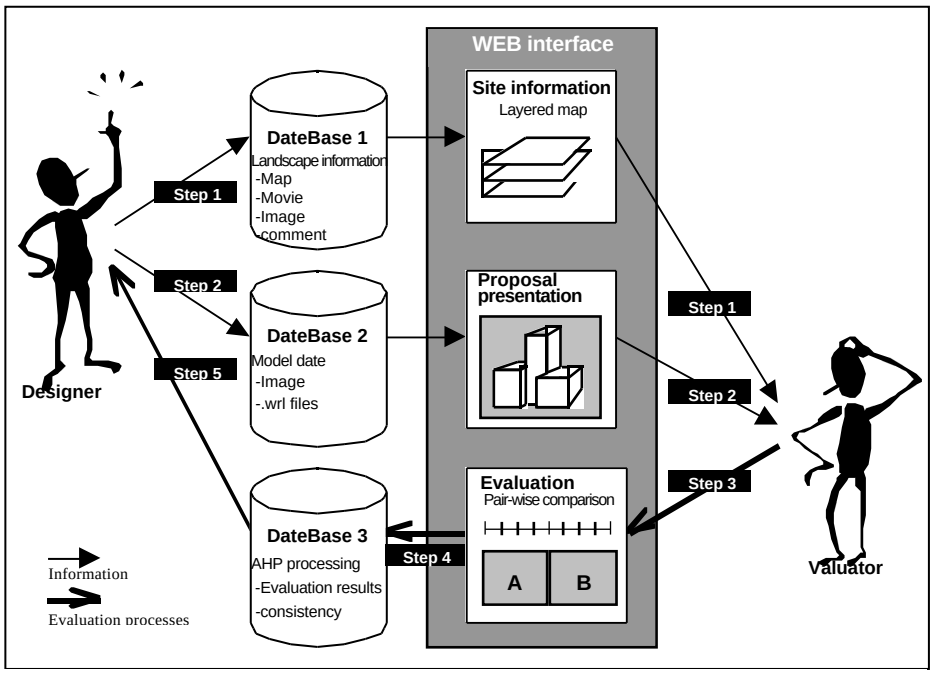


fig.1 Network-based Landscape Evaluation Process

2.1. Step 1. Landscape information sharing

In consensus decision making about landscapes "common comprehension", "common recognition", and "common knowledge" are necessary among designers, planners, the administration, and residents. If there is not common recognition, it is pointless to evaluate a landscape tat has been changed by a facility plan and to reflect the evaluation result in a project is not realistic. Therefore, as the first step, we propose the construction of a landscape information WEB with map information. This landscape information WEB allows the design team to share landscape information and present condition to an evaluator. To understanding the present environment, information that was obtained by a site survey is controlled by using GIS as map information. A place where information can be shared created, by preparing a landscape information map on WEB. The supply of the visual information with multimedia such as a landscape photographs and videos on WEB becomes possible. By linking these multimedia data and map information, a landscape can be understood geographically and visually. GIS of a network correspondence is necessary in order to materialize this map. This network correspondence GIS is composed of display functions. (for example improving layer function in HTML3.2.)

2.2. STEP 2. LANDSCAPE MODELING

There are two kinds of models for a landscape evaluation.
a) A representation model from fixed viewpoints
b) A representation model from dynamic viewpoints
A representation model a) is a montage image that synthesizes a background photograph and a perspective model from a fixed viewpoint. This is necessary for landscape evaluation from a significant perspective. The preparation of this image is done in regard to the distance to the site, the direction, sea level and the camera position. In order to compare and evaluate plural projects from the same viewpoint on WEB, their images are displayed with layers of the fore/background as a synthetic photograph, and a project image is exchanged. A representation model b) is an interactive three-dimensional model that can evaluate a proposal from dynamic viewpoints. In evaluating a landscape model on WEB, this model is described in VRML (Virtual Reality Modeling Language) with JAVAScript for understanding a three-dimensional landscape model. In addition, the perspectives need to be arranged beforehand for VRML file preparation.

2.3. STEP 3. INTERACTIVE EVALUATION

Interactive evaluation is sends the results of evaluations of a proposal to a planner. The process consists of the following four procedures:

1) Input by an evaluator
2) Collection of the evaluation result
3) Analysis with the AHP (Analytic Hierarchy Process) method
4) Output analysis results

Procedure 1) is a questionnaire input-form on WEB with multimedia such as motionless pictures, animation and VRML. Procedures 2) & 3) are processed through the Internet server. The server accumulates data, which an evaluator inputs through a network to RDB (Relational Database), and the analyze it.
fig. 2 is a system image of an interactive evaluation process.
The results of the evaluation and analysis are presented in the side of a planner through this system. A planner re-designs a proposal by considering the results. In addition, a planner allows an evaluator to re-evaluate the amendment once again.
To repeat this process, an evaluator is assumed to have participated indirectly in a design process. This repetition contributes to a consensus on the project. In this evaluation process, the application of the AHP method is used as a landscape evaluation method. AHP enables subjective evaluations by assigning values to evaluation items. It guides logical evaluation by using the eigenvalue of a pairwise comparative matrix and calculating the weight of the evaluation subject.

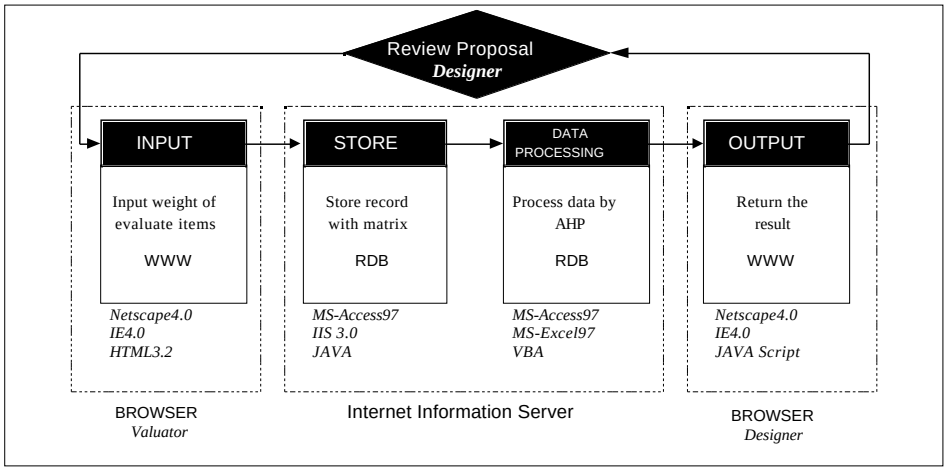


fig.2 Interactive Evaluation

2.4. STEP 4. DATA COLLECTION

The evaluation data that an evaluator inputs on WEB is transmitted to the Internet server from a browser. A server is equipped with can input the data into a table using the attributes of an evaluator. Using SQL (Structured Query Language) the data is inputed-outputed to RDB directly. This processing can be used by many different participants in the process because it is on the Internet.

2.5. STEP 5. STATISTICAL PROCESSING AND DECISION MAKING

Data which was accumulated in the database in step 4, is analyzed on the server's side. This process returns the result to client's side. This result supports decision making for designers.
By 1) Offering information that a designer requires 2) Expressing the design using a graphical material. For decisions about alternate proposals by the AHP method, the analysis results are displayed with a table and also by a radar chart by using HTML, JAVA and JAVAscript.

3. Development of an experimental system

In accordance with the framework of *NDEP*, the WEB system was experimentally produced. The purpose of the system is the evaluation and selection of proper proposals in reference to the volume and colors of a facility. This system uses the AHP as an evaluation method.

3.1. LANDSCAPE EVALUATION STRUCTURE WITH AHP METHOD

In volume and color evaluation of facilities from a certain viewpoint, the evaluation structure of AHP is composed of layers of the following 4 levels.

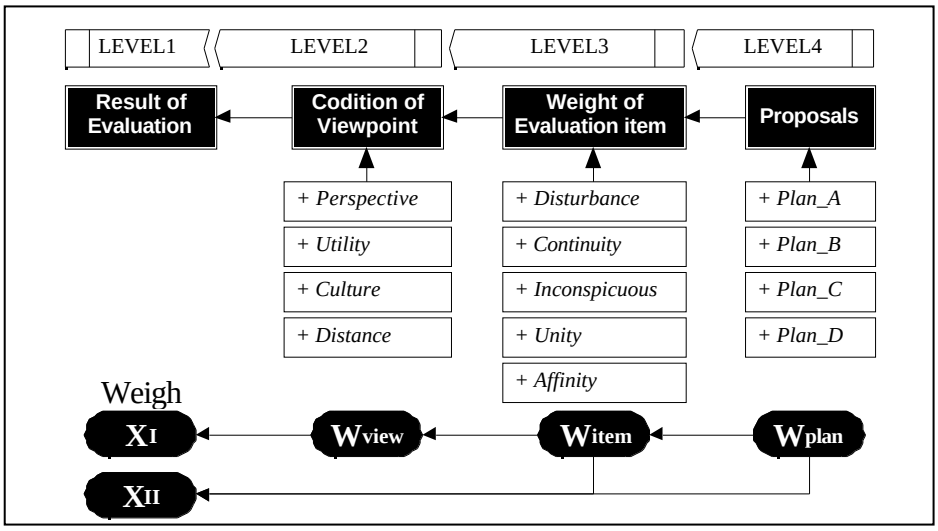


fig. 3 Evaluation Construction in AHP

3.2. DEFINITION OF EVALUATION ITEMS

The weight of level 3 is the evaluation items for the landscape. In AHP, any evaluation item is available. In this study the following 5 items were selected:

1) Disturbance: How the facility does not disturb the current situation
2) Continuity: Continuity of the skyline and colors of the site with the facility
3) Inconspicuous: How the facility is not conspicuous on the site
4) Unity: Unity of the building elements of the facility in regard to its form and colors
5) Affinity: Affinity of the facility to the site

3.3. EVALUATION AND ANALYSIS WITH THE AHP METHOD

The following result are obtained by multiplying the weight of viewpoint: $\mathbf{W_{view}}$, the weight of evaluation item: $\mathbf{W_{item}}$ and the weight of proposal on each evaluation item: $\mathbf{W_{plan}}$

1) Total weight of each proposal ：$\mathbf{X_I}$

$$\mathbf{X_I = W_{vp} \times W_{vb} \times W_{plan}}$$

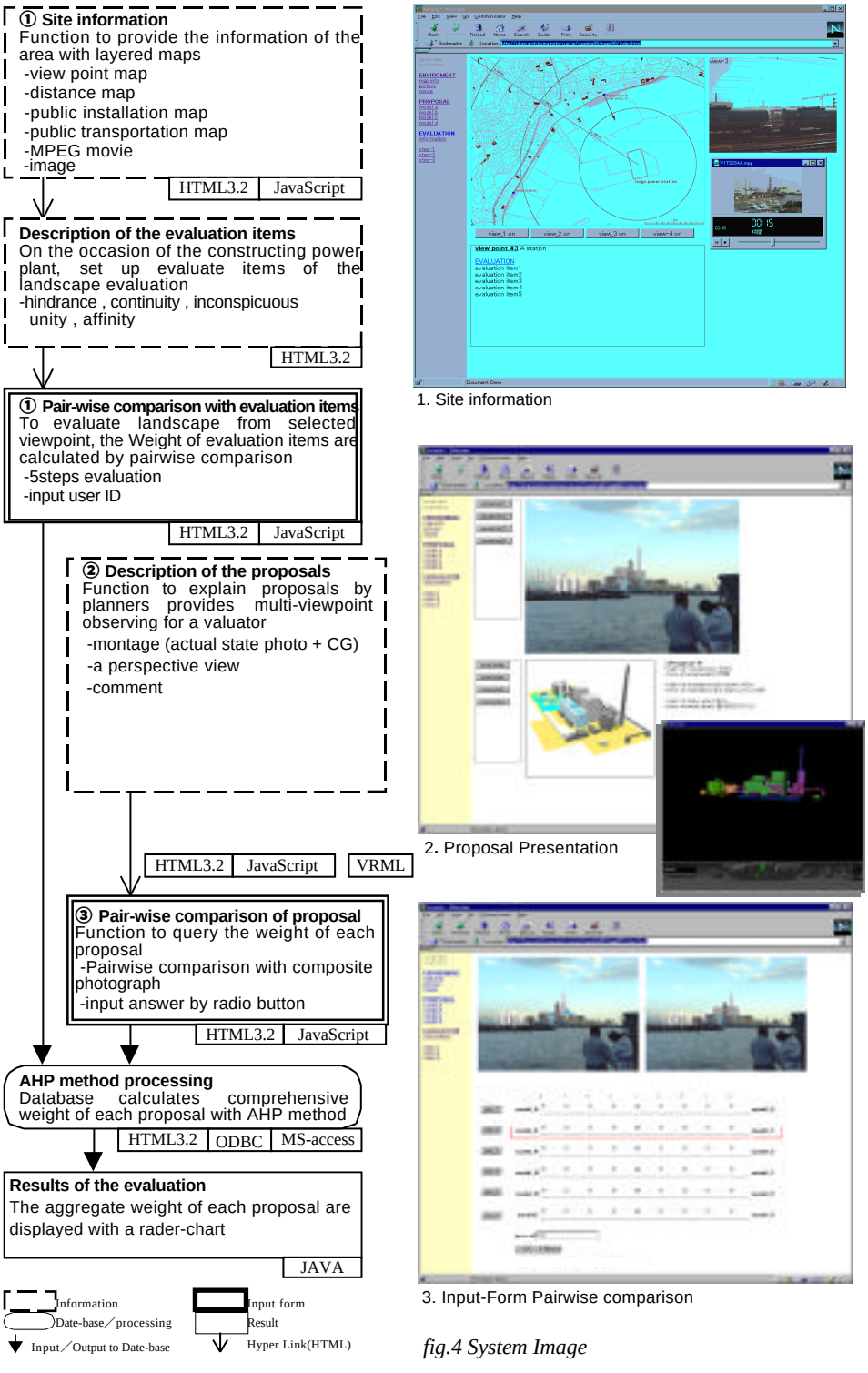
2) Total weight of each proposal on each viewpoint：$\mathbf{X_{II}}$

$$\mathbf{X_{II} = W_{vb} \times W_{plan}}$$

3) Total weight of each proposal by attributes of the evaluator groups

3.4.SYSTEM IMAGE

The constitution for an experimental system using the AHP method was illustrated, including the system flow and interface, the input items, the expression medium and the WEB tool. (*fig. 4*)



1. Site information

2. Proposal Presentation

3. Input-Form Pairwise comparison

fig.4 System Image

4.CASE STUDY

In a case study, “a development plan of a large-scale power station facility of a harbor site”, the trial system was evaluated. A designer prepared 4 variations in a volume and color. 4 proposals evaluated about impressions to periphery of the site in following items. As the result, matching weight to the site and balance of impressions about 4 proposals, are shown. 5 evaluators evaluated with this system through the Internet.

4.1. ALTERNATIVE PROPOSAL

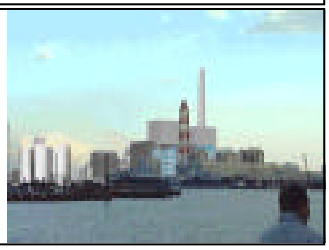
The following proposals are examples that were designed by the author to test the system. They are not part of an actual building project.

+Project Site：the port city near Big City
+Evaluation Viewpoint：North-West 1.5Km from Site, Dock

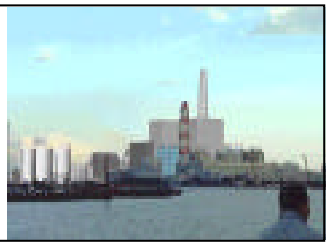
SH: Height of Smokestack SF: Form of Smokestack
TH: Height of Turbo generator TF: Form of Turbo generator
BH: Height of Boiler BF: Form of Boiler

Proposal_A
SH：200m
SF：Pier with 3-steps
TH：100m
TF：2-Segments
BH：80m
BF：Multi-form

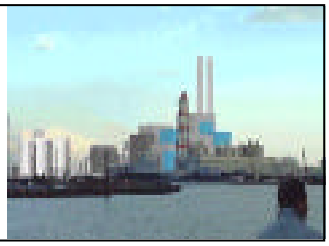
Proposal_B
SH：200m
SF：Column
TH：100m
TF：2-Segments
BH：80m
BF：Grid Facade



Proposal_C
SH：200m
SF：Pier + Column
TH：100m
TF：2-Segment
BH：100m
BF：Grid Facade
3-Segments 100m H



Proposal_D
SH：200m
SF：2-Columns
TH：100m
TF：2-Segments
BH：80m
BF：Multi-form



4.2. EVALUATION RESULTS

Table 1 shows the result of a pairwise comparison of evaluation items. Evaluators value *Disturbance* and *Unity*, and said that *Continuity* is comparatively not important. Balance evaluation was obtained by multiplying this value to each weight of a proposal.

Table 1 Weight of evaluation item

Item	Continuity	Inconspicuous	Unity	affinity	Disturbance
Witem	0.134	0.182	0.251	0.178	0.255

Although *inconspicuous* is low, *disturbance* and *affinity* are high in each item. The overall weight of *proposal A* is comparatively high at 0.339. As a result, *proposal A* is a good one with a good balance of evaluations.

Table 2

	Continuity	Inconspicuous	unity	affinity	Disturbance
Proposal A	0.061	0.040	0.058	0.084	0.096

The weight of *disturbance* and *inconspicuous* are high while the weight of *affinity* is low. The overall weight of *proposal B* is the highest at 0.342 of the 4 proposals. This proposal is adequate, although it is not very conspicuous.

Table 3

	Continuity	Inconspicuous	unity	affinity	Disturbance
Proposal **B**	0.034	0.087	0.093	0.035	0.092

As for *proposal C*, the overall weight is low at 0.160 and all items had low values. In particular, the *affinity* here is the lowest. For that reason, the boiler is higher than other proposals. In addition, dividing the volume into 3 segments was not effective.

Table 4

	Continuity	Inconspicuous	unity	affinity	Disturbance
Proposal C	0.017	0.037	0.055	0.019	0.032

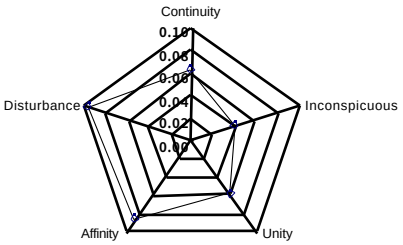
The overall weight of *proposal D* is the lowest at 0.159 of the 4 proposals. In addition, all items had low values. Although *proposal* D is very similar to *proposal* A, to change from one to two smokestacks could affect the evaluation.

Table 5

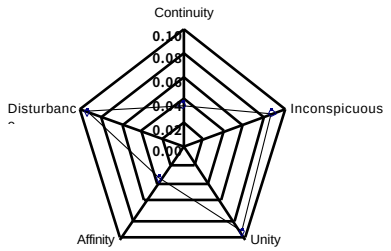
	Continuity	Inconspicuous	unity	affinity	Disturbance
Proposal D	0.023	0.017	0.044	0.039	0.036

Finally a ranking of the evaluations of the proposals are as follows: The results are divided into two groups although the weight of *A* is the same as *B*, and C is the same as D. An analysis of these result shows that keeping the *TH* and *BH* lower and using one smokestack resulted in good impressions from evaluators.

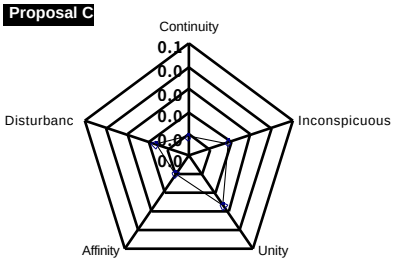
Proposal A



Proposal B



Proposal C



Proposal D

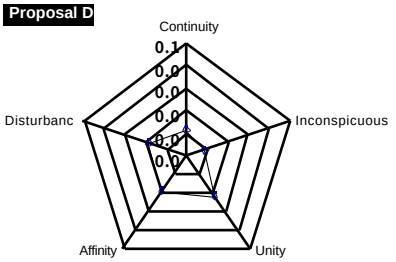


Table 6 Overall weight

Proposal	A	B	C	D
Total Weight	0.339	0.342	0.160	0.159

5. Conclusion

1) As a result of the case study, an experimental system that conformed to *NDEP* demonstrated sufficient performance on the Internet under present conditions.
2) By applying AHP as an evaluation analysis method, this system processed evaluation that contained ambiguous statements systematically.
This system was able to comprehensively present the result to designers.
3) In addition, this system comprehensively presented a proposal to an evaluator by utilizing static synthesis CG and dynamic VRML.
4) Because data from evaluators is accumulated to the database automatically, an efficient survey is possible.

6. Considerations for the future

1) Because the explanation of the evaluation items may affect the results, an adequate online manual is necessary.
2) It is difficult to have consistent pairwise comparison evaluations in the AHP method.
3) Evaluations under the same conditions were not obtained consistently, because the display environment is different depending on the evaluator. A system that can consider the environment evaluator will be necessary in the evaluation through vision expression with the network.
4) Future areas of study are the development of landscape modeling methods that correspond to a change in a design by a designer instantaneously, a visual presentation method on WEB, and the expression method for geographic environments.

7.Reference

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