

SOIL AND WATER CONSERVATION ENGINEERING USING A 3-D GIS

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ABSTRACT:

Taipei Water Resource Commission is in charge of soil and water conservation for the headwater in Taipei City. 90% of drinking water for a four-million population is controlled by the Commission. A 3-D GIS has been developed in the last three years. This paper discusses how soil and water conservation engineering can be facilitated by the GIS. A 80% to 90% automatic process was pursued. 3-D drawings, calculations, and paper work can be obtained from a personal computer. All drawings were then built into the 3-D data base. 3-D animation of a proposed conservation engineering can be obtained as well.

KEY WORDS: Soil and water conservation engineering, 3-D modeling, Animation.

1. INTRODUCTION

Taipei Metropolitan is an area with population exceeding 4 millions. About 90% of its drinking water is provided by the Taipei Water Resource Commission. Water and soil conservation at Taipei Water Resource Commission is a very important task. A 3-D GIS has been developed in the last three years (Wu, 1990). Remote sensing can be implemented to monitor landslides and landuses in the two watersheds (Wu, 1991). However, water and soil conservation engineering is still a time consuming process, especially in the design process. Both drawing and calculations are labor intensive. This paper will discuss how a GIS can make the drawing and calculation process a semi-automatic process. Site selection of a water and soil conservation engineering can be reviewed by a GIS to insure that its benefit can be at a very high level. Solid modeling and animation can be performed before the construction taking place.

2. METHOD

2.1 Field Surveying

Field surveying is performed by a traditional approach. Its drawing and calculation process is very easy. Digital contour maps and slopes as well as a road map can be extracted from the existing data base. Those survey data can be inserted into the contour map for further interpolation in order to generate a very large scale contour map and digital terrain model. The whole process can be automatic because of the digital terrain model software packages which are components of a self-developed GIS.

2.2 A Design Process

A drawing has to be digitized or redrawn as a new CAD

drawing file. Then an interface will be developed to make an automatic drawing process. A designer can change several parameters which were controlled by an interface program in order to get a drawing with a specific width, height, and thickness. All interface programs were written in C and Visual BASIC. All interface programs were made in an order-only process. That is, it is only made by request from an engineer.

Calculations were performed by a CAD package or by C and BASIC programs with human interactions. Areas of cross sections, cutting, and banking require that a user delineates the boundary, then an automatic process can be performed.

3-D, front view, and side view drawings are automatically performed and stored into a predefined drawing format. Dimensioning is an editing process.

Paper work at the final stage is performed by a word processor in a windowed environment. Interface programs to make the whole process automatic are now easy to write because of the Visual BASIC. One user can add new functions to the interface programs in a very short period of time.

2.3 Three-Dimensional Modeling

Three-dimensional modeling is performed by a commercial animation program. A proposed site and its water and soil conservation engineering can be displayed in three dimensions. This process requires a little bit of practice. All solid models are stored as image files which can be displayed on a color monitor by mouse clicking. Solid models were generated as a single frame in an animation process. Irregular triangulated networks of a site or construction body must be generated firstly either by digital terrain model packages or by a self-developed program.

2.4 Animation

Commercial animation programs are now very powerful and a personal computer can perform animation jobs very smoothly. This is an advanced procedure of the solid modeling process. Not only a little bit of practice are required but also over and over retrying are needed. The final products are very easy to display on a color monitor.

3. RESULTS AND DISCUSSION

Figure 1 is a proposed new dam shown in two different viewpoints. Usually a little bit of modification is required if another new dam will be constructed. Its total width and height can be automatically modified that a designer only required to input a new width and height. It is possible to modify some other parameters as well. A designer provides width and height, then a new dam will be automatically drawn by a CAD package and a new drawing file can be stored. It is 5 meters in height, 38 meters in the upper width in figure 1.

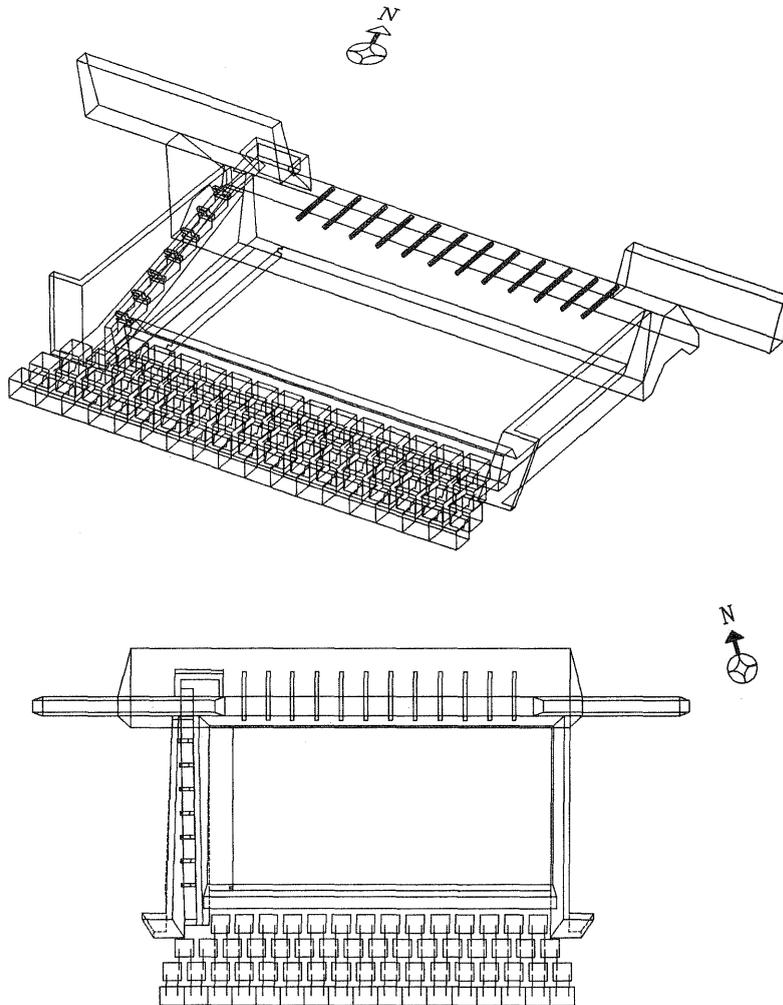


Figure 1. Two different viewpoints of a proposed new dam.

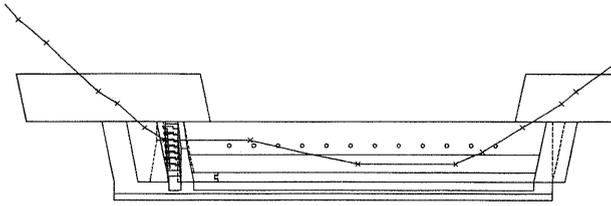


Figure 2. Front view of a proposed new dam superimposed with a river cross profile.

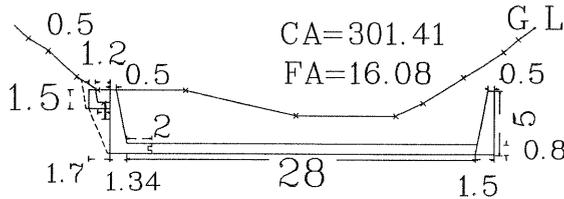


Figure 3. A cross section at a given direction.

A designer has to insert a new drawing file into its proposed site on the digital terrain model. Then, figure 2 will be generated for calculations of cutting and banking. Figure 3 shows a cross section at a given direction. These given directions can be defined in advance. Cutting and banking calculations at a cross section require a designer to make a polygon in a close form. It is not user friendly but is very easy.

Solid models of the proposed site along the river has been made. All solid models are suitable shown in colors. Animation of the proposed new dam and its site are also produced. It is better shown on a color monitor or a VCR. Animation of two same types of dam along the river is also performed to see what if a second dam is required.

Budget compilation of a new dam is also performed by a word processor in an all Chinese mode. Paper work was performed semi-automatically. Picking items and filling tables are two procedures needed for all paper work.

GIS analysis was reviewed by overlay associated maps in the existing data base. It is very simply because all maps and drawings have a common coordinate system.

4. CONCLUSION

Soil and water conservation engineering usually can be categorized into several types. This paper only discussed one type of dam at Taipei Water Resource Commission. It is possible to make the design process semi-automatic. The most difficult part of the whole process is to write the interface programs in order to make it an automatic process as much as possible. There are several new programs on the market that generate interface programs very easily. This paper used only one of them. Although more research required to be pursued in the near future, it has been shown that a 80% to 90% automatic process of soil and water conservation engineering, especially in the design phase, can be performed. And a GIS can facilitate the soil and water conservation.

5. REFERENCES

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