# Analysis of information management for large-scale bridge construction

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**Abstract:** This paper describes the development of a standard for managing the geotechnical engineering practice of a large-scale bridge engineering investigation and survey. It is important to establish an information management system in such a project to aid in the decision making and enhance the management quality and work efficiency. Based on the analysis of information characteristics and management deficiencies in current geotechnical engineering investigations and surveying, the framework of the information management system was developed. The project of Runyang Yangtse River Highway Bridge has been used as an example. The survey information was classified, data flow and development process were designed, as well as the key technologies employed in the kernel modules were analyzed. Through the application in Runyang Yangtse River Highway Bridge project, it is shown that this system is feasible and practical, as well as provides an efficient and scientific tool for survey information management, as well as aiding decision making of large-scale bridge engineering investigation and surveying.

**Résumé:** Ce papier rend compte du développement du standard de la gestion moderne des travaux géotechniques au cours de la prospection des ponts de grandes dimensions. Afin d'améliorer la qualité de la gestion d'information et d'élever l'efficacité du travail, tout en aidant la prise de décision, il est important d'établir un système de la gestion d'information, surtout pour des grands projets géotechniques. Le présent texte a développé la structure du système de la gestion d'information, basé tant sur les caractéristiques de l'analyse d'informations que sur les déficiences de l'actuelle gestion dans la prospection des travaux géotechniques, et a pris exemple comme le pont Runyang d'autoroute traversant le Yangsté, y compris classification d'informations de la prospection, projet sur les données de débit et la procédure du développement, analyse de technologies-clés utilisées dans les modules principaux. Durant l'application du projet du pont Runyang, il est claire que le présent système est à la fois faisable et pratique, qui fournit un outil scientifique et efficace et qui aide beaucoup dans la décision stratégique de la prospection des ponts de grandes dimensions.

**Keywords:** large-scale bridge, engineering investigation and surveying, data flow, information management, aiding decision making.

## 1. INTRODUCTION

With China joined in the WTO, foundation work especially the traffic engineering met some chances and challenges which have never been encountered. Now in china, it is inevitable to change the phenomenon that attaching importance to hardware and construction while ignoring the software and management in all kinds of foundation works and engineering constructions. So a modern engineering quality management system must be established. Traditional ways for engineering investigation and surveying are facing the requirement of reform, standardization, infomatization and internationalization are the inevitable tendency of engineering investigation and surveying. At present, in front of the continually increasing investigation and surveying departments and competitors, it is an important subject to solve how to keep the competing dominance of the investigation and surveying field and realize the continuable development. So, new technology, new idea and new method should be use to realize the informatization and modernization of investigation and surveying field in order to meet the rapid development of engineering construction (Bao & Hu 2002, Gong 2000).

There are many forms to represent the investigation and surveying results because of the long linked-line of large scale bridge and the complexities involved landform and geologic elements. Besides large numbers of structural data such as bore data, there are also masses of text data, for example, text, hypertext, image data, graphic data, audio data, video data and so on.

Because of the characteristics of engineering investigation and surveying, the investigation and surveying data have close relation to geographic position. Lots of data related to the geographic positions are absolutely necessary when the efficiency of engineering investigation and surveying need to be improved, especially when the macro-decision need to be made. So the investigation and surveying information can be integrated with the geographic map by combining the managing technique based on GIS (Geographic Information System) with the database technique (Star & Estes 1990, Parker 1988). In this paper with the project of Runyang Yangtse River Highway Bridge serving as an example, the basic idea, data flow diagram, functional module and system integration technique are introduced to

 

realize the engineering investigation and surveying information management system for large-scale bridge (Huang 1997).

## 2. ACTUALITY AND DEFICIENCY OF ENGINEERING INVESTIGATION AND SURVEYING INFORMATION MANAGEMENT

Based on analysis and researching, some deficiencies were found in the current investigation and surveying and related industries. For example, the imbalanced development of information management, the representation of the investigation and surveying data are simple and the data circulation is blocked, these problems embody as follows:

### *(1) Diversity of information management mode*

At present, paper-text is the main preservation for engineering investigation and surveying data, the data are managed by dint of file management software and database system. Because of the diversity of the technique level and the method for investigation and surveying management, it is difficult to share and exchange the data between departments (Huang 1997).

### *(2) Low utilization of investigation and surveying data*

Because of long division between investigation and surveying and design, these departments did the work respectively, there are not enough communications between designer and investigation and surveying engineer. Moreover the establishment of investigation and surveying criterion and the application of new technique and method lag behind the request of the construction development, the particularity of the engineering investigation and surveying itself and some other reasons, which result of the phenomenon that mentioned above.

### *(3) Limitation of investigation and surveying designing software*

At present, the software of CAD is commonly used in engineering investigation and surveying design. The numerical calculation, the compiling of designing files and protracting the schedule drawing are the main task of CAD. However the software of CAD which is commonly used are far more to be competent for some experiential work such as the project design and comprehensive evaluation (Liu & Zhang 2001, Chen, Zhang & Sheng 1998) .

From the present engineering investigation and surveying field we can see that the development of data management system is too slow to realize assistant decision-making function, which result in the investigation and surveying department is separated from design and decision-making department, and it is also imperfect for the function of investigation and surveying designing software.

## 3. CHARACTERISTICS OF ENGINEERING INVESTIGATING AND SURVEYING INFORMATION FOR LARGE-SCALE BRIDGE

The large-scale bridge usually has a long linked-line, the correlative landform and geologic elements are different, the link-line of the bridge spans many geomorphy elements such as alluvial flats by river and hillsides and so on, and it is more complex for geologic condition. It is well-known that the area where river travel through is active, there are many faults existing and earthquake is also frequent.

### *3.1 Investigation and surveying steps compartmentalizing and tasks*

There are four steps in large-scale bridge investigation and surveying, narrating simply as follows:

#### *3.1.1 Engineering geology investigation and surveying for pre-feasibility step*

The main purposes for this step are demonstrating the practicability and rationality from the engineering geological conditions and providing necessary engineering geological gist for regimenting pre-practicability researching report by analyzing and researching the existing data. To realizing these purposes, it should be also according to the programming of society development, national economy, programming of road net and constructing plan of roads

#### *3.1.2 The site investigation and surveying*

In order to provide the geological information for the selection of the route direction, the position of the bridge, the location of the tunnel project which could be chosen and the compilation of feasible research report, the site investigation and surveying step is necessary. The characteristic of engineering geology, the common geological condition of the engineering project and the main geological problems which control the engineering project were known during the site investigation and surveying.

#### *3.1.3 The preliminary investigation and surveying*

The purposes of the preliminary investigation and surveying are providing engineering geological gist for the primary choosing of the site of project, design scheme and compiling the primary design paper on the basis of the feasible research report and the request of the contract.

### *3.1.4 The detailed investigation and surveying*

The purpose of detailed investigation and surveying is to provide exact and integrated engineering geological data for the route direction, the position of the construction and the compilation of the shop drawing on the basis of the build principle, the design scheme and the request of the technique in the primary design paper.

There are a lot of content in the management of the bridge engineering, not only caused by the complexity of the investigation and surveying but also because of the increase of the investigation and surveying work since more than one bridge positions should be investigated in the construction. Take Runyang Bridge for example, there are three positions which should be investigated in the preliminary investigation and surveying, they are the Shiyezhou Position, Ferry Position and the Middle Position.

## *3.2 The production form of the engineering investigation and surveying*

### *(1) Classified by the data representation*

a. Structural data: this includes the form data which have regularity, such as the boreID, the builder, the date of construction, the bore altitude and so on in the bore information. The characteristic of these data is in a uniform configuration.

b. Document data: including the data that can be used as the entire file in the process of the memorizing and displaying.

### *(2) Classified by the document form*

a. Text: the texts include all kinds of data such as investigation and surveying reports, dissertations which describe the achievement of each step including table and graph, Word text and TXT text and so on.

b. Hypertext: the homepage which exist hyperlink.( Html•Htm file).

c. Image data: grid file acquired from scan, digital photo or other approaches, including JPG•BMP•TIF and so on.

d. Figure data: mainly including vectorgraph of DWG and DXF which are protracted by AUTOCAD for the engineering investigation and surveying. Considering the use of GIS technique, GIS spatial data processed by CAD file are also included.

e. Audio frequency and video frequency data: record and kinescope data.

### *(3) Classified synthetically*

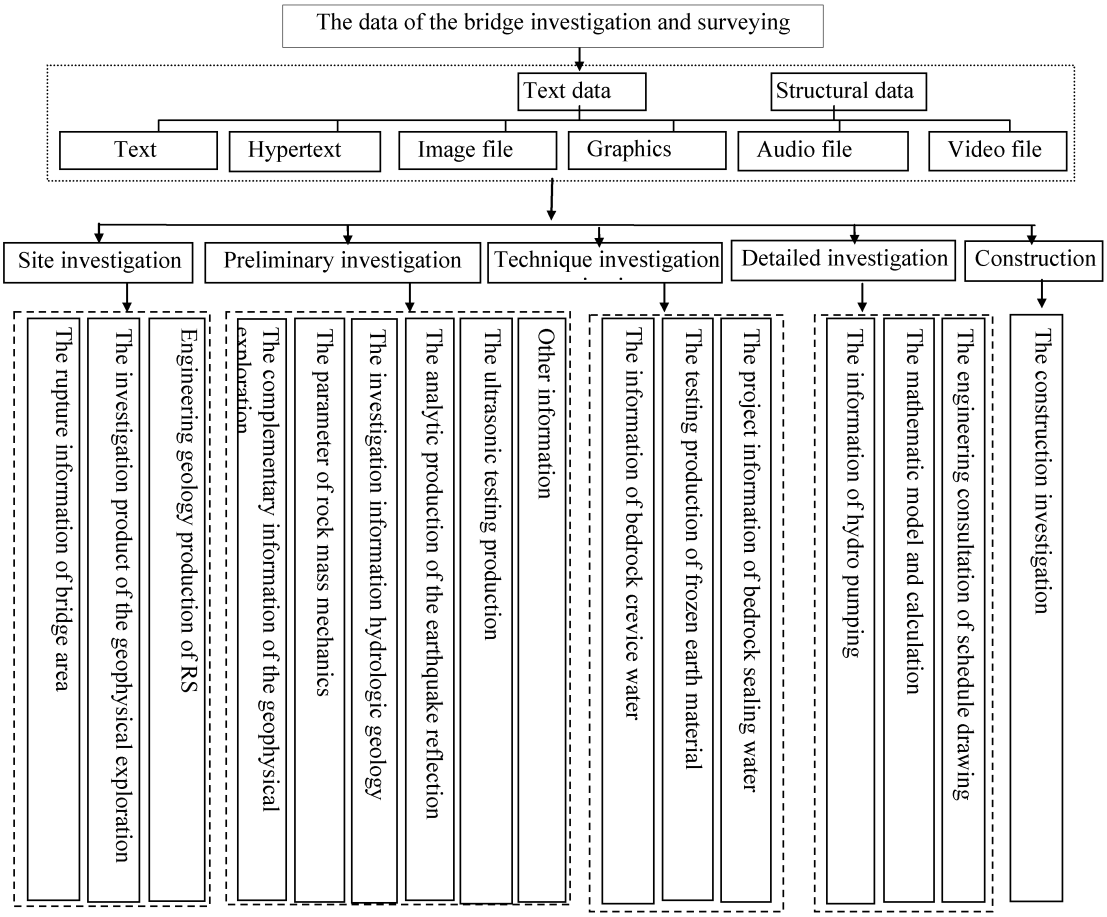


**Figure 1.** The information classification of large-scale bridge engineering investigation and surveying

In order to correspond the content of investigation and surveying with different steps, usually we classify the data synthetically in practice, that is to classify the text by the investigation and surveying steps except their own types, as is shown in fig 1.

# 4. SYSTEM DESIGN

## *4.1 Process of system development*

The process of the system development is shown in Fig 2. The design can be made in detail bases on analyzing and researching the detailed technique in the general outline. The detail design phase is important to the project, in this phase, the requirement analysis and research need to be repeated and the user's ultimate request should be found out. After the detailed design, the group begin to develop the archetype of the software. In fact, archetype development is a model developing in small scale for the entire project. The problem relating to the important technique must be studied in the course of development, and then the developer should make a further communication with the consumer to make sure whether the user are satisfied with the products, the final archetypes are affirmed after the opinions of consumer returned in time. At last, the system is perfected and processed.

In this paper, with the project of Runyang Yangtse River Highway Bridge serving as an example, after inputting the data of engineering investigation and surveying, all kinds of modules include interface design, function compartmentalize and code compilation and optimization were processed. The system integrating and technique text compiling were accomplished in the end.

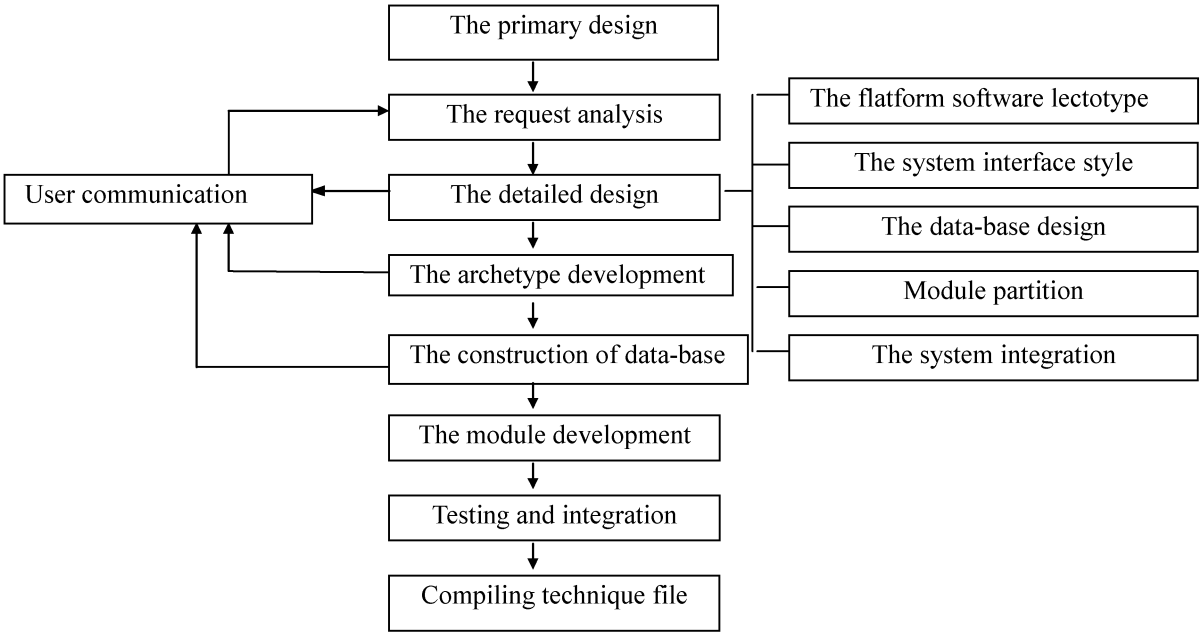


**Figure 2.** The development process diagram of the system

## *4.2 The data flow of the system*

The designed data flow chart is shown in Fig 3.The content on the top in dashed form shows the original data of investigation and surveying. The data were saved in the data-base server and client separately based on different objects and characters. The content in the data-base server could be shared by many registered clients and the clients can decide which data they need, and download from the data-base or acquire from other channel, such as network downloading, scan inputting, keyboard inputting and so on. The content in the client can also be sent to the data-base of the server (the warrant user).

Most of the decision-making analyses are based on the bore information, so in the module which uses GIS as the user's interface, the data of bore spatial locations and bore properties are the kernel of the GIS layers. If there are no other layers but the bore locations, the user can not obtain the concept of relative location, e.g. the bore locates in Shiyezhou Position or the Middle Position. So the bore locations must be included in the layers as well as background layers as follows:

The layer of Yangtse River area
The layer of contour (the part)
The layer of Yangtse River purse net
The layer of bridge site
The layer of burying depth of the bedrock

The layer of village and the important construction
The layer of fault distributing

The layers show above only be considered as the reference of the place and prettification of the interface, so the attribute data correspond to the special data can be neglected during the construction of the data-base.

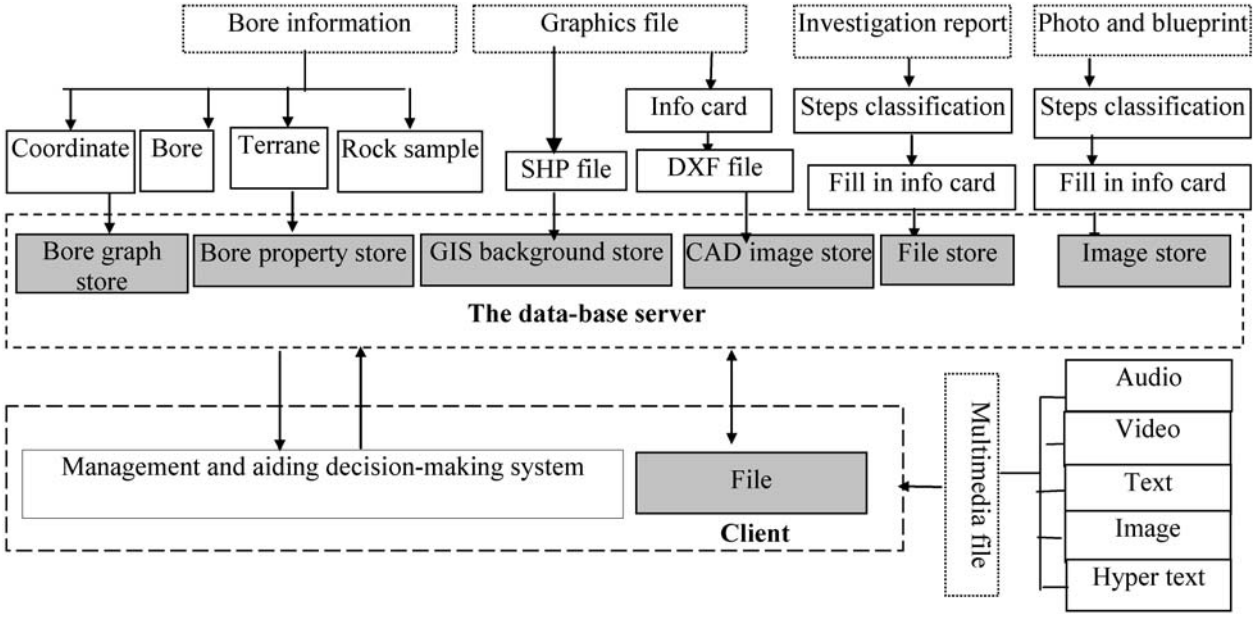


**Figure 3.** The data flow diagram of the system

## *4.3 The kernel module and the technique.*

There are many current techniques including data-base accessing, searching and displaying when the information systems were developed. Because these are widely used, so this paper will not give the details here. Then, the characteristic core module and the technique realization of the MIS (management of information system) of engineering investigation and surveying will be introduced mainly based on the characteristic of the large-scale bridge construction investigation and surveying.

### *(1) Interface designing with GIS*

The information of the engineering investigation and surveying can not only be described by the simple form such as table, text and photo, because the area of the site of the bridge construction is very large and the visual requests of the bore position, landform and the geologic condition are also strict. However, all these mentioned above can be settled by GIS. From the role of GIS being used in the large scale-bridge construction investigation and surveying and the well syncretizing with the traditional information systems we can see that it is feasible to realize the visual map of investigation and surveying area by GIS. The interface sentence for calling GIS program in Visual Basic as follows:

Define the variable: Dim dCon As New DataConnection
Dim gSet As GeoDataset
Import the layers: dCon.Database = *basepath*
"basepath" is the file path of the layer file
Set gSet = dCon.FindGeoDataset (*ShapeFile*)
"ShapeFile" is the name of the layer file (no extending name)

After loading the map control in the interface of Visual Basic, the electronic map can be displayed when the above codes are input to the code windows.

### *(2) The text interface*

Besides the investigation and surveying report, how to realize the management and display of the investigation and surveying report text is also an important task in the engineering investigation and surveying. It is necessary to make use of the existing software of WORD as well as the control, since it is very difficult to develop the reading module for WORD as the whole existing investigation and surveying reports are the WORD format. Firstly, the investigation and surveying report should be input using binary representation to the data-base, secondly, using WebBrowser to browse the investigation and surveying report. When the text is resumed to the WORD format, the control of WebBrowser can be loaded in the Visual Basic interface and the following code should be input:

WebBrowser1.Navigate FileName
"WebBrowser1" is the name of the control's name.
"FileName" is the file name of the investigation and surveying report.

### *(3) Interface with CAD file*

There are a lot of engineering blueprints such as section plan, bore histogram and bore arrangement plan in the engineering investigation and surveying. These are often memorized using AutoCAD format (*.dwg or *.Dxf), and displayed in two ways, one is to translate the vector blueprint into grid file and display in manner of the picture in the system, the other method is to setup the software of AutoCAD on each client who can use this software to display the vectogram. The more reasonable method need to be adopted because the former will reduce the distinguishability of the blueprint and the latter will take up large numbers of system resources. Although the MapObjects which is chosen as the GIS module in the system designing can support the format of CAD, the CAD file should still be open in a different way, the following are the key codes to open the file:

Define the variable: Dim dCon As New DataConnection
Dim gSet As GeoDataset
Import the file:
dCon.Database = "[CADArea]*FilePath*"
Set gSet = dCon.FindGeoDataset ("*FileName*")
dCon.Database = "[CADLine]*FilePath*"
Set gSet = dCon.FindGeoDataset ("*FileName*")
dCon.Database = "[CADPoint]*FilePath*"
Set gSet = dCon.FindGeoDataset ("*FileName*")
dCon.Database = "[CADText]*FilePath*"
Set gSet = dCon.FindGeoDataset ("*FileName*")

The word of FilePath and MapObjects are the file's path and blueprint's name. It is shown that four layers need to be loaded when one blueprint was loaded, and MapObjects load the polygon, line, point and label characters from the CAD files every time. The loaded files in MapObjects are still the vector format, they can be zoomed or panned discretionarily.

## 5. CONCLUSION

In this paper, the holistic thinking and the function realization of the MIS of large-scale bridge construction investigation and surveying were studied, the data type were analyzed, the corresponding construction plan of data-base were designed, the integration of MIS of large-scale bridge engineering investigation and surveying were carried out by combining GIS and computer technique. This system's feasibility was examined by the data of the project of Runyang Yangtse River Highway Bridge, and it has obviously obtained social and economical benefit. This system supply a gap of the information managing and aiding decision making system in China. With the development of this system in practice, it will make bigger and bigger function in large-scale bridge engineering investigation and surveying.

**Acknowledgements:** The authors thank technical contributions from Liu Yihuai, Wang Xiaoming and Cai Yi.

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