2013

APPLICATION OF GIS IN CONSTRUCTION PROJECT MANAGEMENT

جامعة الملك فهد للبترول والمعادن
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CITY AND REGIONAL PLANNING DEPARTMENT

CRP (514)

Section 1

TERM (122)

TERM PAPER

APPLICATION OF GIS IN CONSTRUCTION PROJECT MANAGEMENT

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May 12, 2013

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Introduction

In any construction project there is a large number of tasks and activities involved to it. The Construction Project Managers have a hard time monitoring the projects between site and office. They have to come on site to know the development of work and decide the order of work. The managers are confused on what to do next or what would be the changes faced by them in future. Therefore, the cost involved is large and it varies with respect to the finishing of the project.

The traditional approach for scheduling and progress control techniques such as bar charts and the critical path method (CPM) are still being used by the project managers for planning which a serious disadvantage for the decision is making purpose as the spatial aspects fail to provide the required information (Naik et al., 2011).We need a considerable improvement in the quality and efficiency of scheduling and progress reporting to shorten the delivery period of construction projects. For achieving this objective, the integration between construction project management and the Geographical Information System seems to be the effective tool. In addition , in mega projects, a visual representation of the schedule can be extended to monitoring not only the construction process itself, but also all the supporting activities, including onsite plant and equipment .

The application of GIS in construction project management will be new in the Saudi Construction industry. GIS will allow construction managers and different people involved in project with different backgrounds to get the information about the progress of the project and support “Decision Making”.it will enhance the communication between these people.

GIS is both a database system with specific capabilities for spatially referenced data, as well as a set of operations for working with the data (Chrisman, 1999). Visualizing construction progress in three dimensions provides the construction project manager with a more intuitive view of the construction sequence (Arditi, 2010).

3-D visualization allows the construction manager to view the construction activities during any stage of the construction process.

The GIS database will help in analyzing, improving, monitoring, decision-making and optimal planning. Its capabilities are embedded in its storing, manipulating, analyzing and presenting, which allow informed decision-making and optimal planning for construction (Sadoun, 2009).

Objective:

The objective of this paper is to demonstrate that GIS can be integrated with project management software for construction progress visualization and an integrated information system.

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PROJECT MANAGEMENT

The term Project Management is defined as "*The application of knowledge, skills, tools and techniques to project activities to meet project requirements*." (PMBOK)

"*The planning, monitoring and control of all aspects of the project and the motivation of all those involved in it to achieve the project objectives on time and to the specified cost, quality and performance*." (PRINCE2)

Project management processes can be organized into five groups of one or more processes each (PMP) as shown in Fig 1:

Initiating processes: recognizing that a project or phase should begin and committing to do so.

Planning processes: devising and maintaining a workable scheme to accomplish the business need that the project was undertaken to address.

Executing processes: coordinating people and other resources to carry out the plan.

Controlling processes: ensuring that project objectives are met by monitoring and measuring progress and taking corrective action when necessary.

Closing processes: formalizing acceptance of the project or phase and bringing it to an orderly end.

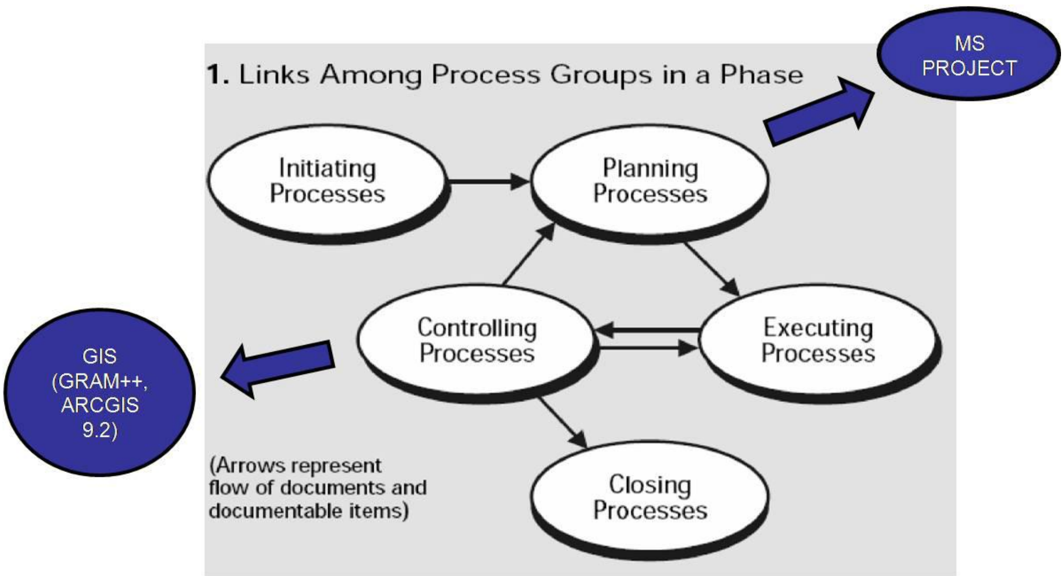

Fig. 1: Links among Process Groups in a Phase and the various applications in the processes

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GEOGRAPHICAL INFORMATION SYSTEMS (GIS)

In the past two decades, a host of professions has been in the process of developing automated tools for efficient storage, analysis and presentation of geographic data. These efforts have apparently been the result of increasing demands by users for the data and information of a spatial nature (Naik et al., 2011). This rapidly evolving technology has come to be known as "Geographic Information Systems (GIS)". Geographic information system goes beyond description; it also includes analysis, modeling, and prediction. According to the Environmental Systems Research Institute (ESRI), a GIS is defined as **"*an organized collection of computer hardware, application software, geographic data, and personnel designed to efficiently capture, store, update, manipulate, analyze, and display all forms of geographic referenced information*** (Naik et al., 2011)**"** Kang Tsung Chang describes GIS as a computer system for capturing, storing, querying, analyzing and displaying geographically referenced data. GIS is essentially a marriage between computerized mapping and database management systems. Thus, a GIS is both a database system with specific capabilities for spatially referenced data, as well as a set of operations for working with the data. Geographically referenced data separates GIS from other information systems. Let us take an example of road. To describe a road, we refer to its location (i.e. where it is) and its characteristics (length, name, speed limit etc.). The location, also called geometry or shape, represents spatial data, whereas characteristics are attribute data. Thus, a geographically referenced data has two components: spatial data and attribute data.

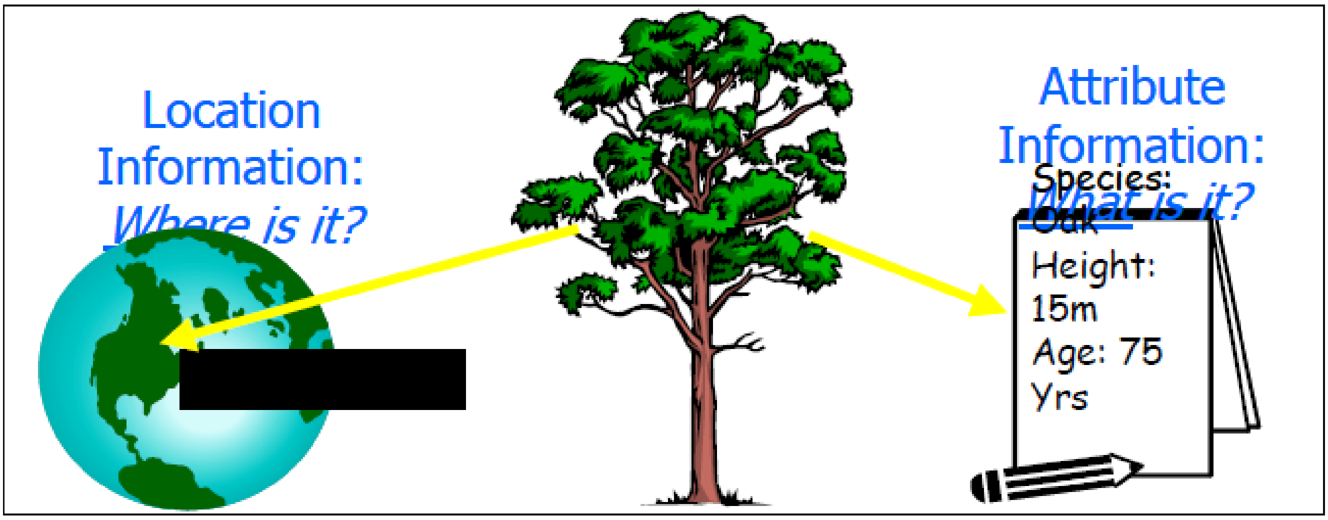

Fig. 2: Geographical Referenced Data

Spatial Data: Describes the *location* of spatial features, which may be discrete or continuous. Discrete features are individually distinguishable features that don't exist between observations. Discrete features include points (wells), lines (roads) and areas (land-use types). Continuous features are features that exist spatially between observations (elevation and precipitation) (Patra et al., 2008). A GIS represents these spatial features on a plane surface. This transformation involves two main issues: the spatial reference system and the data model.

Attribute Data: Describes *characteristics* of spatial features. For raster data, each cell value should correspond to the attribute of the spatial feature at that location. A cell is tightly bound to a cell value. For raster data, the amount of attribute data is associated with a spatial feature can vary significantly (Patra et al., 2008). The coordinate location of a Land parcel would be spatial data, while its characteristics, e.g. area, owner name, vacant/ built-up, land use etc., would be attribute data

GIS is a relatively broad term that can refer to a number of different technologies and processes. It is attached to many operations, in engineering, planning, management, transport/logistics and analysis.

GIS APPLICATIONS IN CONSTRUCTION MANAGEMENT

GIS applications have proliferated in the construction industry in recent years. This fact I illustrated by the growing number of articles finding their way into civil engineering and construction journals and conference proceedings (Naik et al., 2011)

GIS can be used for:

- Progress monitoring system in construction
- Networking solutions
- 3-D data analysis
- Site location and Client Distance
- Comparison of data
- Construction scheduling and progress control with 3-D visualization
- Government Regulations

EXAMPLE OF INTEGRATING PROJECT MANAGEMENT AND GIS:

The goal of this paper is to demonstrate the benefits of using Geographic Information System integrated with construction project management. In this paper, an example of the integration in introduced and the integration of GIS and Project Management is developed using ArcGIS, MS Project, AutoCAD.

Successful project control is a challenging responsibility for all construction managers. Visualization of information is an important benefit for any project.

The objective of this example is to display the progress and sequence of construction work in 3-D while synchronizing this information with a formal CPM work schedule. This would help all parties involved in a construction project to visualize the progress in a natural way, hence minimizing delays and cost overruns. In addition to monitoring the schedule, the system can also be extended to monitor quantities of materials, costs, and resources.

Fig. 3 shows the path of the project among the various applications in the system. It also shows the procedure that needs to be used in using the system. A building of G+20 storey building is selected as the study area. The progress reports are described in the following sections.

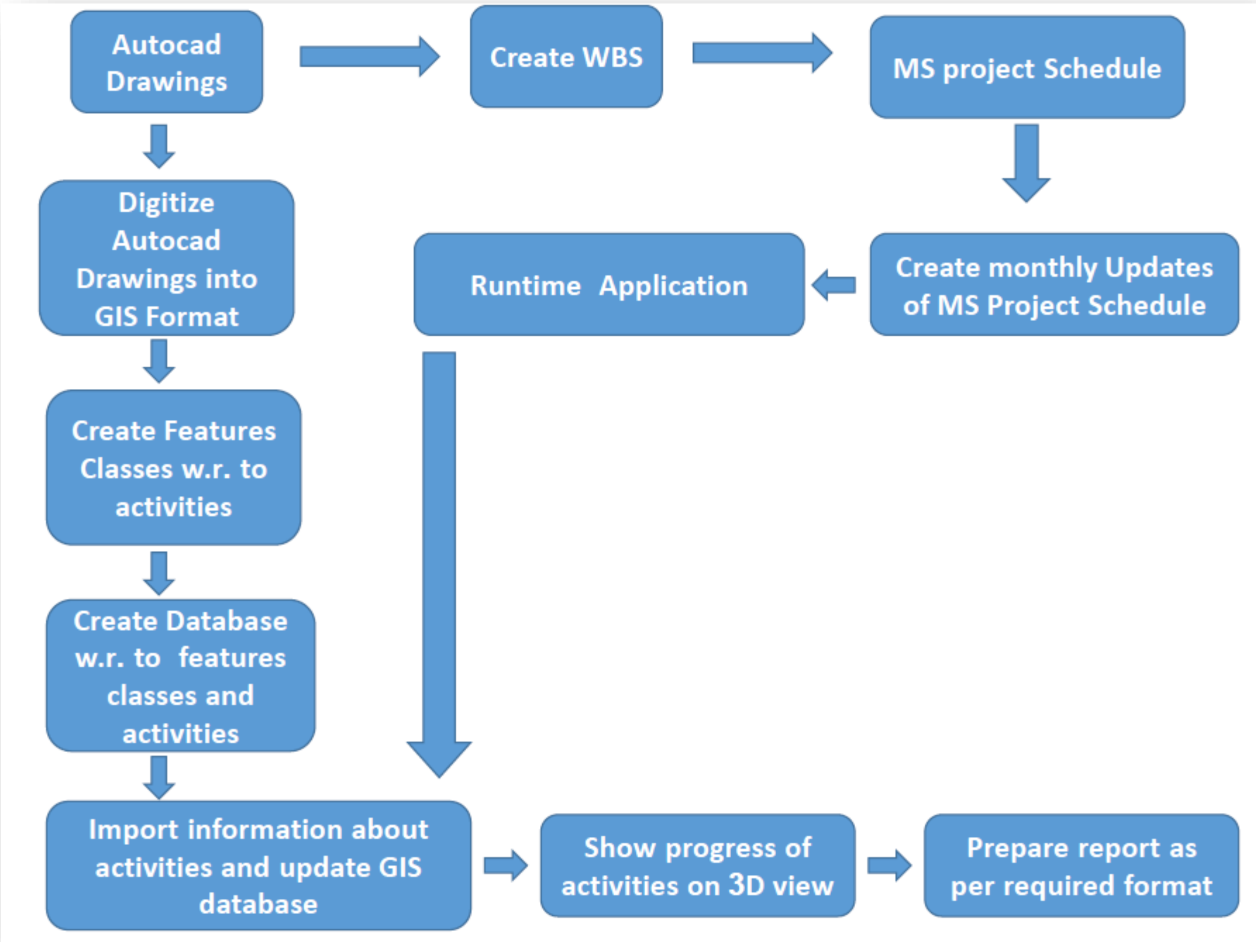

Fig 3: Flow Chart showing the Integration of Project Management and GIS

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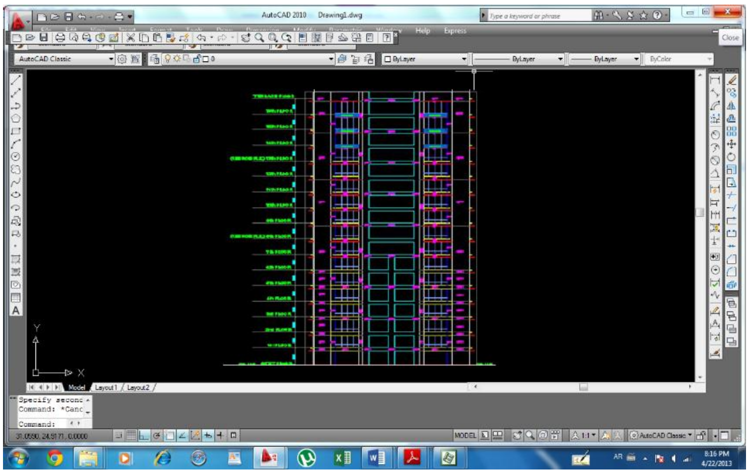
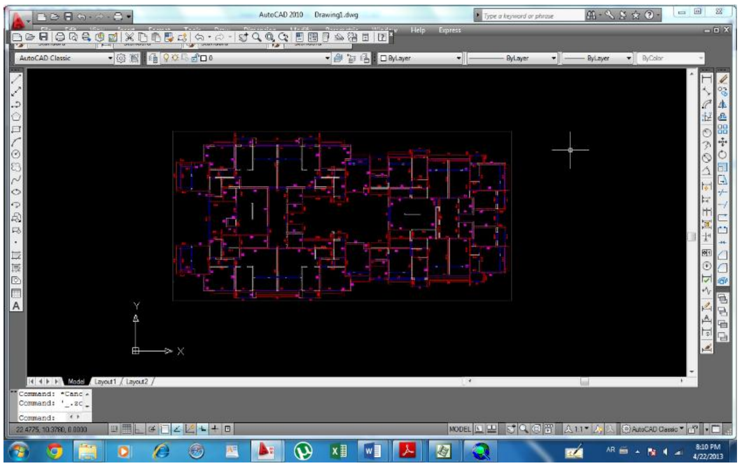
The following steps are required to generate the 4D model :

1: CREATING AUTOCAD DRAWINGS
2: CREATING WORK BREAKDOWN STRUCTURE
3: INITIATING SCHEDULING PROCESS
4: DIGITIZING AUTOCAD DRAWINGS TO GIS FORMA
5: CREATING FEATURE CLASSES W.R.T. ACTIVITIES
6: CREATING DATABASE W.R.TO FEATURE CLASS AND ACTIVITIES
7: CREATE UPDATES OF MS PROJECT SCHEDULE
8: RUN-TIME APPLICATION
9: IMPORT INFORMATION ABOUT ACTIVITIES AND UPDATE GIS DATABASE
10: SHOWING PROGRESS OF ACTIVITY IN 3-DIMENSIONAL VIEW

These steps are illustrated in the following figures:





STEP 1: CREATING AUTOCAD DRAWINGS

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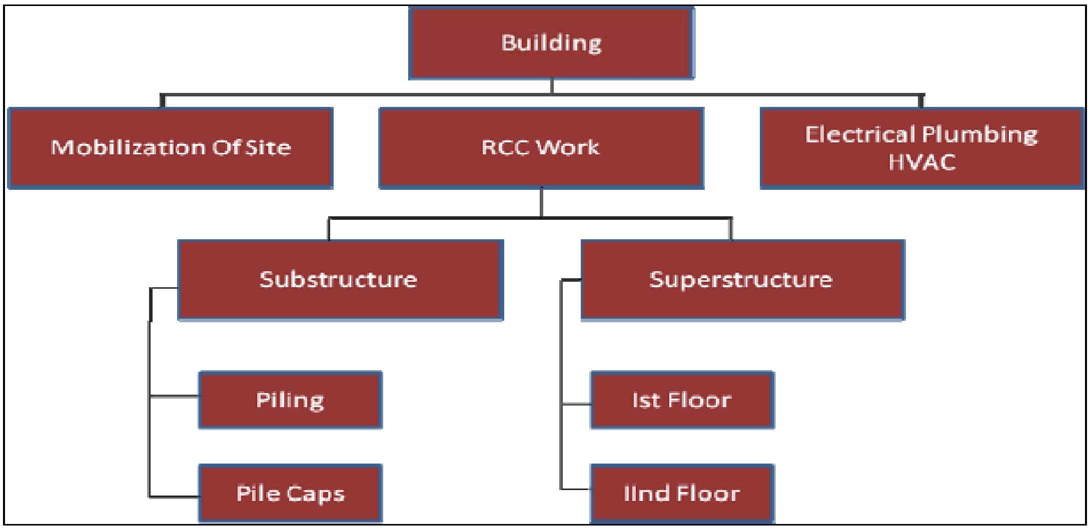
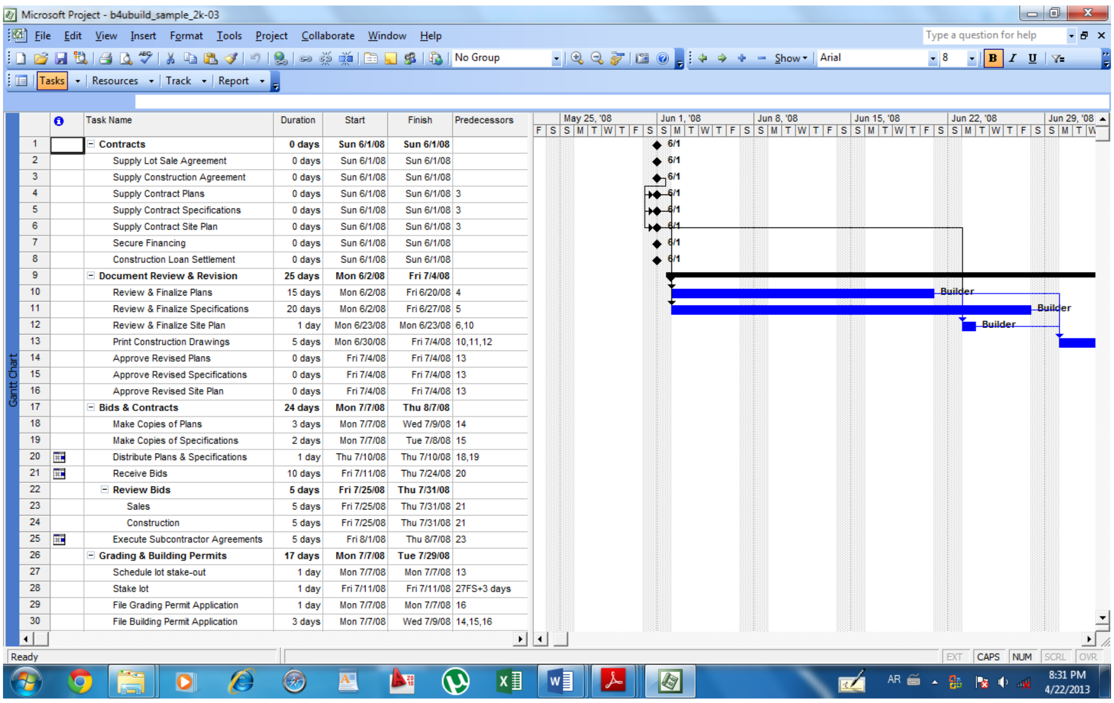
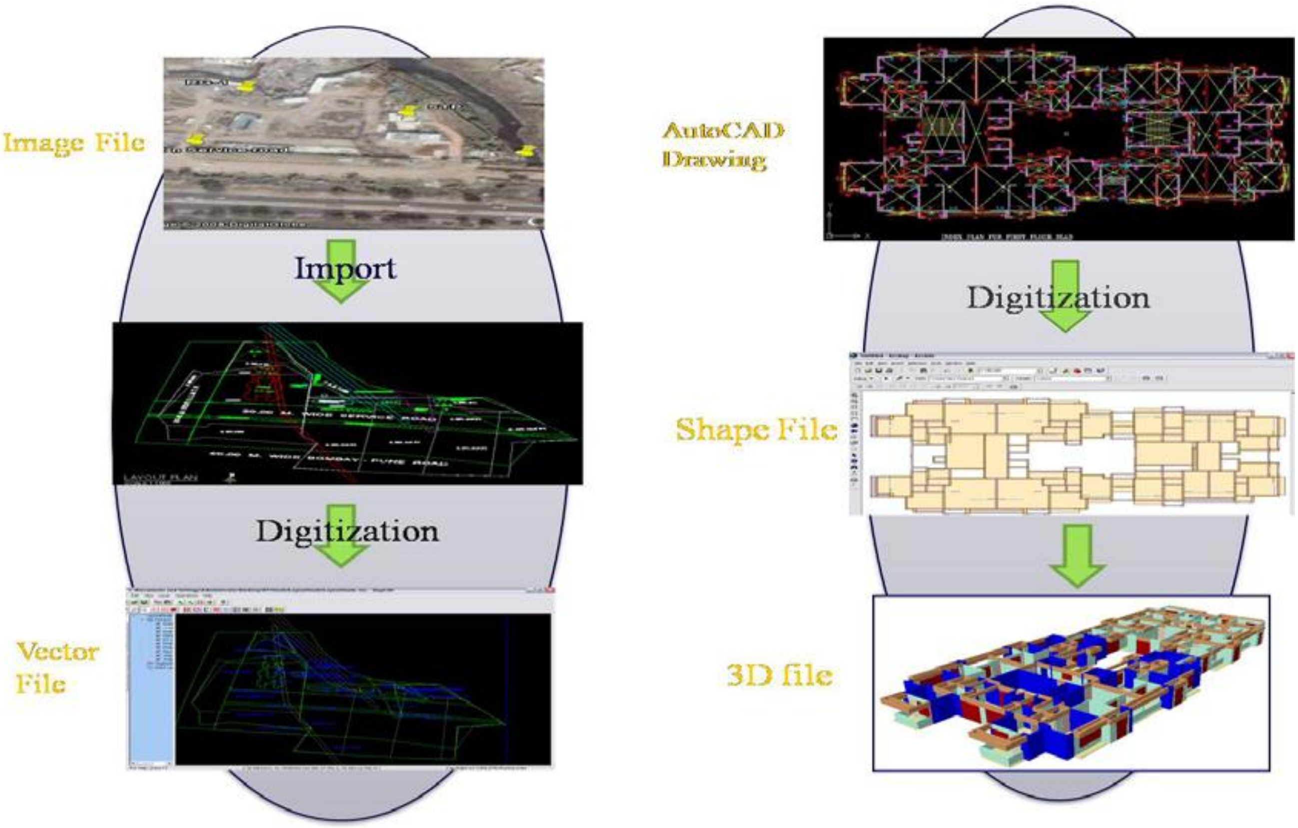
STEP 2: CREATING WORK BREAKDOWN STRUCTURE



STEP 3: INITIATING SCHEDULING PROCESS



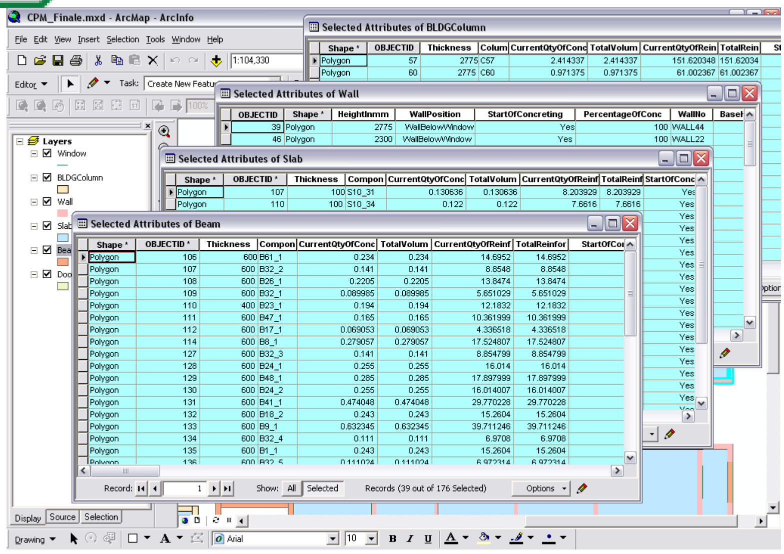
STEP 4: DIGITIZING AUTOCAD DRAWINGS TO GIS FORMAT



STEP 5: CREATING FEATURE CLASSES W.R.T. ACTIVITIES

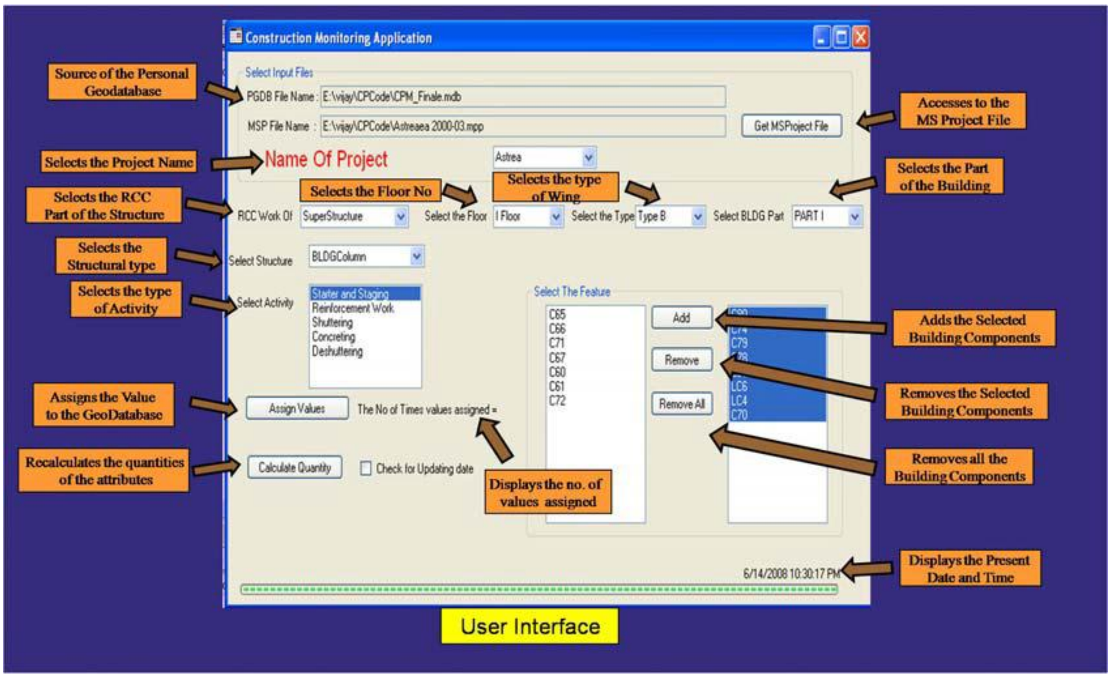
STEP 6: CREATING DATABASE W.R.TO FEATURE CLASS AND ACTIVITIES

STEP 7: CREATE UPDATES OF MS PROJECT SCHEDULE



STEP 8: RUN-TIME APPLICATION

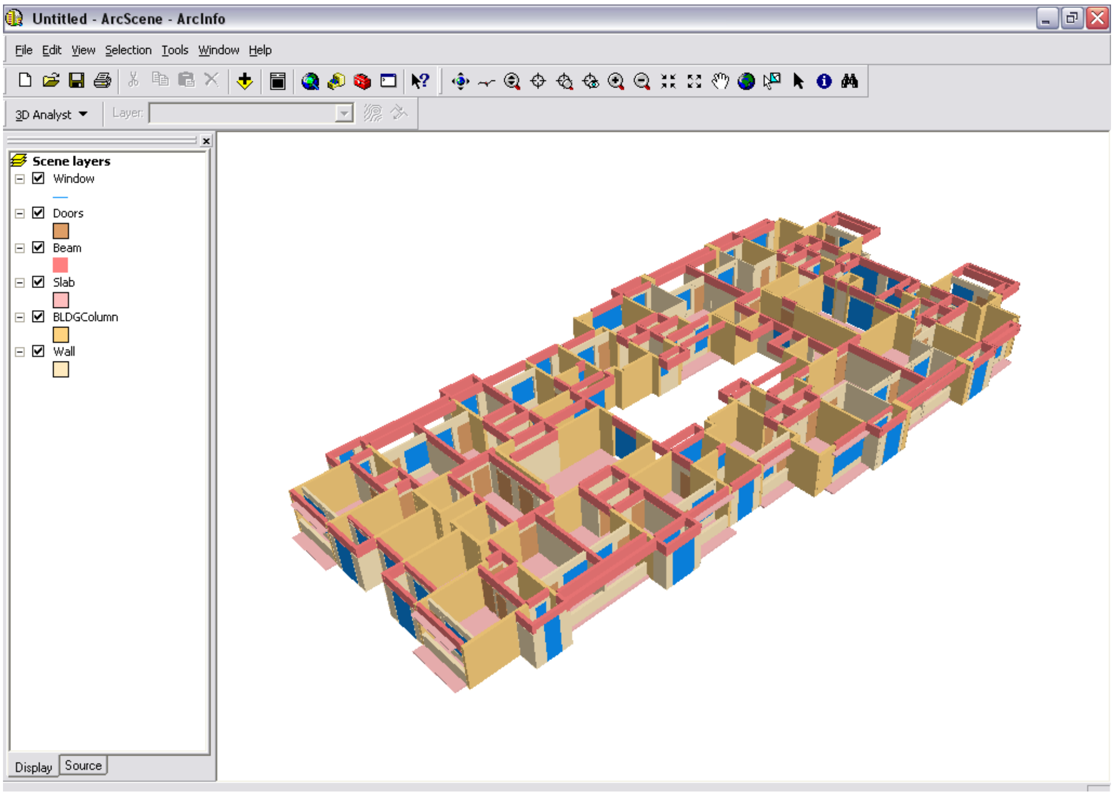
The run time application is developed using Visual Studio 5.0 in C# language. With the help of this run-time application a User Interface was developed. Here the user would come to know about the location of the source file. The user interface displays present date and time. It has drop down lists for the user to select accordingly. Fig.9 shows the User Interface Window.



STEP 9:
IMPORT INFORMATION ABOUT ACTIVITIES AND UPDATE
GIS DATABASE

The percent complete information is transferred with the help of custom run time application to MS Project every time a progress evaluation is made and the application is run. MS Project was run to generate the updated schedule network. The updated schedule shows the progress for all the activities as of the new date of the update (e.g. at the end of every month or daily updates) and the percent complete information.

STEP 10: SHOWING PROGRESS OF ACTIVITY IN 3-DIMENSIONAL VIEW



BENEFITS AND LIMITATIONS OF THE SYSTEM

Traditionally, the CPM schedule does not offer adequate information pertaining to the spatial aspects or context and complexities of the various components of a construction project (Jongeling and Olofasson, 2007). Therefore, to interpret progress information, project members normally look at 2D drawings and conceptually associate components with related activities. Different project members may develop inconsistent interpretations of the schedule when reviewing only the CPM scheduled (Bing and Wang, 2007). This causes confusion on many occasions and usually makes effective communication among project participations difficult. This system allows project planners and managers to see in detail the spatial characteristics of the project. All the project members should be able to visually observe the progress, which will help in effective communication of the schedule. The system has to be run periodically over the duration of the project.

CONCLUSION

This system will benefit project managers, site engineers and clients in the following manner:

PROJECT MANAGER

• Up-to date information about the progress of work

• Helps in controlling big project sites

• Comes to know about the Cost incurred/Spent and the quantity of materials used on site

• Reduces time for decision making as all information is in one system

SITE ENGINEER

• Controlling the project site by knowing the progress of work

• Helps in easy decision making for procurement of funds or materials

• Helps in informing the contractors beforehand about the start of their work

• Helps in knowing how much more material is required

• Helps in reducing wastage of materials

• Helps in ordering the ideal quantity of materials thus by reducing over ordering of materials

CLIENT

• Helps in knowing the exact status of the project

• Has a 3-D view of the progress of work thus knowing where large cost has been incurred.

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REFERENCES:

Balqies Sadoun. "*A GIS system for tourism management*", 2009 IEEE/ACS International Conference on Computer Systems and Applications, 05/2009

Bing Yao and Wang. "*Research on Work Flow Optimization and Visualization System*", 2007 IEEE International Conference on Automation and Logistics, August 18 - 21, 2007, Jinan, China

Gopal M. Naik, Aditya M and Suman B. Naik "*Integrated 4D Model Development for Planning and Scheduling of a Construction Project using Geographical Information System*", 2011 2nd International Conference on Construction and Project Management IPEDR vol.15 (2011) © (2011) IACSIT Press, Singapore

Kang-tsung Chang, "Introduction to Geographic Information Systems", 2006, Tata McGraw-Hill

Miles, S. and Ho, C. (1999). "*Applications and Issues of GIS as Tool for Civil Engineering Modeling*." *J. Comput. Civ. Eng.*, 13(3), 144–152

Nicholas R. Chrisman. "*What Does 'GIS' Mean*?", Transactions in GIS, 03/1999, (2),175-186

Prashanta Kumar Patra[1] Chittaranjan Pradhan[2] Animesh Tripathy[2] "*An Intelligent Framework For Distributed Query Optimization Of Spatial Data In Geographic Information Systems*" IJCSNS International Journal of Computer Science and Network Security, VOL.8 No.5, May 2008

PMBOK, Project Management -- Body of Knowledge as defined by the Project Management Institute — PMI

R. Jongeling, T. Olofsson," *A method for planning of work-flow by combined use of location-based scheduling and 4D CAD*" / Automation in Construction 16 (2007) 189–198

Websites:

http://www.globalknowledge.ie/courses/business-subjects/project-management/

http://en.wikipedia.org/wiki/Geographic_information_system