Appalachian Transportation Institute (ATI) Research Project Description

Project Number: ATI TRP 99-32
Project Title: Develop GIS Implementation Strategy for WVDOT

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Project Objective: This project will review the current uses of Geographical Information Systems by other state DOT's and identify the steps that should be undertaken for the WVDOT to consider implementation of this technology with emphasis on the WV Division of Highways.

Abstract: A central concern of any organizational analysis is to make certain that the analysis reflects the needs of the organization. Our approach is to examine the role of GIS within WVDOT by analyzing GIS applicability to WVDOT responsibilities. In particular, we propose to address the following applications of GIS to Transportation:

1. GIS's role in asset analysis and inventory
2. Use of GIS to aid in corridor analysis
3. Condition Assessment
4. Planning, Maintenance, Construction
5. Data consistency

Task Descriptions:
Task 1) GIS Needs Analysis

The needs analysis will include the following three (3) subtasks:

A) Determine the high level architecture of WVDOT's technology and work processes within and among the seven divisions (or agencies) of WVDOT

The work processes and technology used by each of the seven divisions of the WVDOT will be analyzed. The interaction of the work processes and technology among the divisions and organizational units will be determined.

This effort will begin with a review of existing analyses, e.g. past analysis by WVU. The findings of the analyses will be incorporated in AEGIS as appropriate.

Subtask A will be accomplished primarily through interviews with WVDOT personnel at appropriate levels within the organization. Note that a successful AEGIS will require that a steering committee made up of senior management personnel meet with the AEGIS team on a periodic basis. The steering committee will review progress, guide the direction of the project, and provide high level support of AEGIS.

B) Determine the current implementation and utilization of GIS within WVDOT and the extent and nature of outsourced GIS efforts

Subtask B will provide the current status of GIS usage and availability within the WVDOT. This information will provide the baseline conditions for the development of a strategic approach toward the integration of GIS. In addition, within Subtask B the level of GIS integration that is desired by WVDOT will be determined. Subtask B will provide the current status of GIS usage and availability within the WVDOT and the current nature and extent of outsourced GIS efforts.

Subtask B will be accomplished primarily through interviews with WVDOT personnel at appropriate levels within the organization.

C) Identify those WVDOT organizational units with a high potential to benefit from GIS integration.

Based on the results of Subtasks A and B and with the information gathered from Task 2, Subtask C will identify and prioritize those organizational units that can benefit from GIS integration. The benefit may be either an efficiency benefit (GIS decreases cost of a work process) or an effectiveness benefit (GIS increases value of a work process).

Subtask C will be accomplished through the knowledge of WVDOT work processes gained in Subtask A and the knowledge obtained from other state DOT's in Task 2.

D) Analyze state and federal GIS applications

We will identify a few states, similar to West Virginia, that have developed GIS within their DOT. The similarities will include population, funding availability, organizational structure, geographic region, etc. We will conduct

a study of how GIS is applied in these states and federal DOT to determine both state of the art and cost effectiveness of GIS applications. We may also use recent implementations in New York as the basis of a case study.

In the study of the applications of GIS in states identified we will examine how federal GIS efforts helped in the applications. We will invite a representative from at least one state to give a presentation to WVDOT

Timetable for Task 1: Subtask A and B will begin at project start and will be conducted concurrently. Subtask C will begin upon the completion of both Subtask A of Task 1 and Task 2. The duration of Subtask A and B is expected to be three and a half (3.5) months while the duration of Subtask C is expected to be one and a half (1.5) months (based upon a 8 month project).

Subtask D) is expected to take 1 month and may be done in parallel with the other subtasks.

Note: Task 1 will include evaluation of the required data for a WVDOT GIS, the required functionality of the GIS and the suitability of GIS to meet the needs of WVDOT. The subtasks DO NOT include developing and/or populating any existing or recommended databases.

Task 2) Based on the results of the findings of Task 1 we will develop a GIS Data flow and Integration Analysis.

We will investigate the structure and flow of data through a selected department or division of WVDOT. The analysis will cover multiple layers of responsibility and the department (division) will be selected in consultation with the steering committee. The goal will be to optimize the benefit to WVDOT consistent with the scope of the AEGIS project..

Sub-Tasks:

A) Based on tasks 1C and 1D, identify the major data flows and processes. These may be at the department, division, or district levels.

B) Create a top-level process mapping of the items identified in sub-task 1.

This documentation will include the input data, work processes, and output data. This will be accomplished by referencing existing documentation, interviews with process personnel, and observation of workflow activity.

C) Perform GIS integration into current workflow analysis.

This analysis will address how the current work procedures and data flows would be modified to incorporate relevant and effective GIS technologies that were discovered in Task 1.

D) Conduct a study of vendor capabilities with respect to GIS integration, e.g. integration of GIS with word processing and spreadsheet technologies to support report generation and analysis.

We will identify GIS vendor (e.g. ESRI) and third party vendors that provide integration capabilities. Integration will include Web integration and general report generating programs such as word processing, spreadsheet, databases, etc

E) Analyze the training requirements associated with vendor tools and WV DOT needs.

Subtask E) will provide an analysis of the anticipated training requirements for WVDOT staff and determination of potential training sources for GIS. Long and short term training requirements and costs will be determined for appropriate GIS software and assorted related software applicable to the needs of the WVDOT.

Duration of work:

Sub-task A: 4 weeks
Sub-task B: 10 weeks
Sub-task C: 10 weeks
Sub-task D 3 weeks
Sub-task E. 2 weeks

Task 3) Data Availability and Adequacy Analysis

Despite the apparent focus on GIS hardware, software and human-ware issues in many recent publications and conferences, the availability of suitable geo-spatial data lies at the core of almost any GIS project. It is estimated that on average data can comprise between 80-85% of the total cost of a GIS project. Furthermore, significant issues arise concerning not just the availability of data but that it must be at a suitable spatial and temporal scale and be adequately attributed to meet the needs of an agency. The development of primary spatial data can be very expensive and a time consuming task and thus there is a need to explore already available digital spatial data as a means of populating a GIS database. The use of inherited data certainly has significant advantages but it is also fraught with pitfalls. Metadata is central to identifying and recording such information about data accuracy, availability, and suitability and it is proposed to use metadata standards and the ‘data about data’ in the compilation of the base digital data outlined below. As such this proposal seeks to:

1) identify available digital spatial databases suitable for use by WVDOT
2) examine the advantages and disadvantages of that data from the perspective of the WVDOT needs with regard to spatial and temporal scale and attribution
3) identify the levels of accuracy and content inherent in these data sources
4) review newly available satellite imagery and databases currently under proposed development such as E911 that would support DOT needs
5) explore the use of Object-Oriented GIS as a potential mechanism for multiple data integration and error identification.

Task 3 will provide information on the current availability and adequacy of transportation related data required by the WVDOT. There are two subtasks

A) Analyze existing data.

The analysis will include a review of existing data within the WVDOT, other West Virginia State governmental agencies, local governmental agencies and organizations, federal agencies and commercial vendors. In addition, various GIS data issues such as data conversion, translation, transformation, and accuracy will be examined with regard to the available data.

The USGS has available terrain information at 30m and 90m resolutions and for some locations has 10m resolution data available. Elevation data may also be obtained from hypsography garnered from the Digital Line Graph (DLG) data. Digital Line Graphs represent the digital versions of both 1:24,000 and 1:100,000 scale USGS topographic map sheets. These quads are currently being converted for the entire state at the State GIS Technical Center and the proposed availability of hydrological, transportation, and hypsographic data will be of value to WVDOT. However, the temporal currency of the maps is problematic for many date back to photorevisions undertaken in the 1970s if not earlier. It is thus important to consider means by which these data may be enhanced, updated, and revised to meet current needs. The availability of Digital Orthophoto Quarter Quads (DOQQ) to one meter resolution promises to contribute much to providing a means for bringing the geography of DLG's and, indeed, other data sources up to contemporary standards. The State has recently entered an aggressive phase of DOQQ development and complete state coverage based on the National Aerial Photographic Program series will provide a recent base against which to compare and update available digital feature data. The use of advanced optical scanning techniques and semi-automated raster to vector conversion associated with heads-up digitizing promises to permit such work to be undertaken more efficiently than previously possible. This proposal will simultaneously explore and identify these associated data conversion and data processing technologies. The use of automated elevation extraction from paired aerial photographs will also be explored based on the recent release of ERDAS image processing software capable of performing this intricate operation.

In recent years there has been considerable excitement about the use of satellite imagery in support of GIS operations. The availability of high resolution imagery holds considerable promise for GIS operations and not least for acquiring online current high quality land cover data. The ability to georectify the data on the fly and for the data to be both panchromatic and multispectral is another important facet to the data. It is proposed to review these data sources and to identify their potential utility to WVDOT uses and for merging with other spatial data sources. In similar manner the development of E911 road data based on Global Positioning System data to a very accurate levels for the state promises to provide yet another potential source for augmenting or replacing coarser scale feature data.

B) Develop recommendations for the unification of diverse data sets.

The continued development of a WVDOT GIS database will necessarily be based on data that originates from a variety of sources to varying levels accuracy and temporal currency. It is proposed that in seeking to integrate these data that Object-Oriented GIS (OOGIS) be explored as a way of automating the identification of error and for automating the data cleaning process. OOGIS is only recently becoming available but this GIS data model will undoubtedly be the standard by which GIS databases will be handled in the future. Its use of feature based data operations is particularly suitable to WVDOT needs. Similarly, the ability to develop reflex methods that are automatically triggered to operate on spatial data as it is integrated into the GIS database could remove a considerable load from the GIS operator and contribute in a very significant manner to the efficient and rapid integration of multiple data sets.

We will develop recommendations for unification of diverse data sets, matching the resulting data set to the WVDOT application(s). We will describe how the WVGIS will receive and merge information from a variety of sources.

Milestones, Dates, Schedule: Start Date Jan 1, 2001 End Date August 31, 2001

Yearly and Total Budget: Total: $100,000

Student Involvement: The project will provide employment support for at least 1 undergraduate and 1 graduate student. The student workers will support the Principal Investigator as project assistants. This project is not anticipated to lead to a student thesis directly.

Relationship to Other Research Projects: None at this time.

Technology Transfer Activities: Final reports will be available on the ATI website. All, ATI Principal Investigators will present findings through the ATI Transportation Seminar Series to invited guests from WVDOT, USDOT, other ATI Principal Investigators, students and other invited guests. Other opportunities to present the project results will be explored including conferences and peer reviewed journals, etc.

Potential Benefits of this Project: This project will provide the WVDOT a roadmap to instituting GIS capability to address key goals of the organization. In particular, it will provide analysis for improved data repository functionality, improved capability with respect to applications such as corridor analysis, intelligent travel advisories, and support of maintenance functions

TRB Keywords: GIS, maintenance, corridor analysis, traveler support