Alabama Bridge Management System Plus (ABIMS+): Phase 2 Final Report

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This project was to enhance the Alabama Department of Transportation (ALDOT) Alabama Bridge Information Management System (ABIMS) by providing budget and network-level rating forecasts given specified rehabilitation and/or replacement actions. This project was to extend the usefulness of ABIMS to allow bridge maintenance analysts to examine alternative future bridge replacement decisions by assessing the potential impact of varying annual maintenance budgets and annual maintenance costs. Thus, this project was to provide data intensive modeling to support:

- Quantitative decision planning through the use of alternative rating systems ( Sufficiency, Deficiency, and GASB metrics),
- Analysis of bridge sets based on an extensive set of filters (funding limits, route type, geographic location, division, type of maintenance action, and other exclusionary constraints),
- Report generation for network-level maintenance assessments, and
- Predicted bridge network ratings and improvements costs.

During the execution of this project (Summer of 2008) the ALDOT decided to replace the ABIMS with Pontis™. Pontis™ is the nation’s standard Bridge Management System. Pontis™ has component suites to provide the features outlined above. To facilitate the transition from ABIMS to Pontis™, this project objective was revised to:

- Provide mapping between ABIMS data elements to Pontis™ CoRE elements, which has resulted in the following three categories of elements mapping:
  - Direct deterministic relationships (1 to 1 mapping),
  - Heuristic relationships (1 to many mapping) that provide a set of data element value alternatives, and
  - Elements that were not mapped.
- To assist in developing strategy and procedures for transition to Pontis™, which included a review of the implementation plan by ALDOT’s vendor, and
- To perform analyses and simulations of Pontis™ components, an objective which has not been met due to a prolonged deployment schedule for the Pontis™ system.

The project performance period expired in March 2010. At that time The University of Alabama did not seek a no-cost extension. At the time of project expiration, 63% of the budget was not expended.
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Executive Summary

This project was to enhance the Alabama Department of Transportation (ALDOT) Alabama Bridge Information Management System (ABIMS) by providing budget and network-level rating forecasts given specified rehabilitation and/or replacement actions. This project was to extend the usefulness of ABIMS to allow bridge maintenance analysts to examine alternative future bridge replacement decisions by assessing the potential impact of varying annual maintenance budgets and annual maintenance costs. Thus, this project was to provide data intensive modeling to support:

- Quantitative decision planning through the use of alternative rating systems ( Sufficiency, Deficiency, and GASB metrics),
- Analysis of bridge sets based on an extensive set of filters (funding limits, route type, geographic location, division, type of maintenance action, and other exclusionary constraints),
- Report generation for network-level maintenance assessments, and
- Predicted bridge network ratings and improvements costs.

During the execution of this project (August, 2008) the ALDOT decided to replace the ABIMS with Pontis™. Pontis™ is the nation’s standard Bridge Management System and includes component suites to provide the features outlined above. To facilitate the transition from ABIMS to Pontis™, this project objective was revised to:

- Provide mapping between ABIMS data elements to Pontis™ CoRE elements, which has resulted in the following three categories of elements mapping being:
  - Direct deterministic relationships (1 to 1 mapping),
  - Heuristic relationships (1 to many mapping) that provide a set of data element value alternatives, and
  - Omitted elements.
- To assist in developing strategy and procedures for transition to Pontis™, which included a review of the implementation plan by ALDOT’s vendor, and
- To perform analyses and simulations of components of the Pontis™, an objective that has not been met due to a prolonged deployment schedule for the Pontis™ system.

The project performance period expired in March 2010. At that time The University of Alabama did not seek a no-cost extension. At the time of project expiration, 63% of the budget was not expended.
1. Introduction

Rather than implement the nationally developed bridge management model, Pontis™, senior ALDOT leadership supported the extension of the current Alabama Bridge Information Management System (ABIMS) which provides the ability to conduct trend analysis using historical data. As part of this extension, ALDOT had developed a standard annual process for a Bridge Replacement Program (see ALDOT 930-662; Appendices A and E), which is compliant with the guidelines set forth by the Federal Highway Administration and American Association of State Highway and Transportation Official (AASHTO).

The Alabama Bridge Information Management System (ABIMS) was created over a decade ago, prior to most states adopting the AASHTO AASHTOWare Pontis™ Bridge Management System. ABIMS provided a means of collecting, processing, and updating condition data, but did not provide automated support for the remaining major tasks. Supporting these activities is increasingly more critical as the state’s bridge inventory ages and the backlog of bridges due for maintenance continues to grow, thus increasing the urgency behind the rehabilitation and replacement of bridges.

An extension to ABIMS, referred to as ABIMS+, was to be the next step in fulfilling AASHTO’s recommendations for Bridge Management Systems. Benefits derived from this project were to include:

- Improved decision-making process to enhance the management of the bridge maintenance backlog.
- Enhanced support for the determination of the relationships among the network condition states and funding needs, given specific maintenance actions for the current year.
- Enhanced support for current year budget allocation decisions between replacement & rehabilitation alternatives.
- Compliance with FHWA funding guidelines and provision of information necessary to facility consistent, effective funding allocation decisions for bridge maintenance.
- Development of a stable foundation for future functionality that will achieve ALDOT’s objective of meeting AASHTO’s guidelines for a comprehensive BMS.

The goal of this project was to design an extension to the existing Alabama Bridge Management Information System Plus (ABIMS+), which provides budget and network-level rating forecasts given specified rehabilitation and/or replacement actions.

The ABIMS+ extensions were to allow bridge maintenance analysts to examine alternative future bridge replacement decisions by assessing the potential impact of varying annual maintenance budgets and annual maintenance costs. Thus, this project was to provide data intensive modeling to support:

- Quantitative decision planning through the use of alternative rating systems (Sufficiency, Deficiency, and GASB metrics),
• Analysis of bridge sets based on an extensive set of filters (funding limits, route type, geographic location, division, type of maintenance action, and other exclusionary constraints),
• Report generation for network-level maintenance assessments, and
• Predicted bridge network ratings and improvement costs.

2. Background

The FHWA requires funding allocation to be based on bridge management policies developed in accordance with strict guidelines. ASHTO has been cited as an acceptable source of such guidelines. To facilitate effective bridge management, AASHTO defines the following activities that must be included within a comprehensive bridge management system:

1. Collect, process, and update condition data
2. Predict deterioration
3. Identify alternative actions
4. Predict costs
5. Determine optimal policies
6. Perform short- and long-term budget forecasting
7. Recommend programs and schedules for implementation with policy and budget constraints

Unfortunately, ALDOT’s Bridge Replacement Program requires the use of considerable ad hoc information system requests and spreadsheets that reside on a series of personal computers. To formalize support for the Bridge Replacement Program and more generally the Bridge Management System, the first extension to ABIMS (Appendix A) includes a set of tools that provide a systematic approach, for a single year projection, to identify and prioritize bridges in need of rehabilitation, replacement, and preventative maintenance action. Refinement of requirements, development of pilot information system implementations, user testing, and deployment of enhanced features have been conducted through ALDOT project 930-662 (Turner, et al.).

To support the ALDOT Bridge Replacement Program, ABIMS+ Phase II: Providing Budget and Cost Sensitivity Analysis was undertaken to decrease the alternative analysis cycle time, increase the number of alternatives that can be analysed, and create a standardized tool that will be maintained by the Computer Services Bureau. ALDOT’s Bridge Replacement Prioritization Committee and the Maintenance Bureau are responsible for annually establishing a prioritized list of bridges for replacement that spans at least five years into the future (this step is represented by step 4a in Appendix E). ABIMS+ Phase II would have provided the Committee and the Maintenance Bureau with the increased functionality to evaluate alternative bridge replacement decisions over a time horizon up to 10 years into the future. This capability would have provided ALDOT with the systematic means to determine the set of bridges in most need of replacement while factoring in budget and cost constraints on condition rating impact.

In summary, this project would have enhanced Alabama’s Bridge Management System and Bridge Replacement Program to systematically support compliance with AASHTO
standards and FHWA requirements. Using the sensitivity (what-if) analysis capability provided by this proposed project would have allowed ALDOT to determine the most effective and efficient use of ALDOT Bridge maintenance dollars which, in turn, will enable ALDOT to more quickly address its Bridge Maintenance backlog.

The ABIMS+ phase 2 project potentially would have extended the capabilities of the ABIMS+ tool to prioritize the bridges most in need of rehabilitation and replacement actions by examining the consequences of alternative decisions up to 10 years into the future. The proposed project would have also delivered the ability to determine the funding amount for rehabilitation and replacement required to reach a desired network rating for up to 10 years into the future.

3. Project Work Breakdown and Deliverables

The proposed research activity extensions to ABIMS were to be accomplished through the following major work tasks.

A. **Major Task:** Evaluate suitability of the recently released NBI network analysis program from FHWA for possible incorporation (full or partial) into ABIMS+ application tool set as the network analysis engine.  

**Proposed Deliverable:** Evaluation and walkthrough with ALDOT bridge maintenance staff and Computer Services Bureau of cost and benefits of using the FHWA tool set when compared with other available solutions.  

**Work Completed Prior to the decision to convert to Pontis™:** The UA team:  
- confirmed leading practices and current state of practice;  
- developed initial mapping between Pontis™ and ABIMS data elements  
- acquired, implemented and began studying the capabilities of the network analysis tools,  
- started development of a prototype for ABIMS+ Phase II  
- Automatic Network Simulation Report (ANSR): In the ANSR, current condition ratings would have been used to generate a list of bridges sorted by bridge maintenance analyst (user) specified criteria, network constraints, and maintenance costs. The bridge maintenance analyst will provide annual bridge network budgets, maintenance cost factors, and the number of years for the simulation. Once completed the system would then have automatically prioritize bridges for maintenance actions and improve bridge network condition ratings based on the action in a year-by-year, step-wise fashion until the network budget is exhausted. After each year the network condition ratings will be adjusted and the bridges re-prioritized for the following simulated year. Once this is done for each year for the evaluation period, a report would have been generated which would have detailed the maintenance decisions for each year, the resulting improvement in condition ratings, and the cost associated with the maintenance actions taken.   
- Manual Network Simulation Report (MNSR): The MNSR would have followed the same process as the ANSR with the exception that the annual
bridge decisions would have been bridge maintenance analyst-defined instead of system-defined. In the MNSR current condition ratings would have been used to generate a list of bridges sorted by bridge maintenance analyst (user) specified criteria, network constraints, and maintenance costs. The bridge maintenance analyst would have provided yearly network budgets, maintenance cost factors and the number of years in the evaluation period. Once completed the bridge maintenance analyst could have refined the analysis by selecting specific bridges to receive (or not receive) specified maintenance actions during the first year of the evaluation period. The tool was to updated user-specified cost- and budget-constraints, calculate the network condition rating improvement and re-prioritize the bridges for the next year in the evaluation period. This iterative process could have then been repeated for each successive year. At any point in this iterative process, the bridge maintenance analyst was to generate a report that would detail the user-specified maintenance decisions up to that point, the resulting improvement in network condition ratings and the cost associated with the maintenance action taken.

B. **Major Task:** Enhance ABIMS+ application tools to enable ALDOT to generate a series of future year Bridge Replacement Program decisions.  
**Deliverable:** Manual Network Simulation Report (NSR) – The bridge maintenance analyst is responsible for selecting yearly bridge maintenance actions.  
**Deliverable:** Automatic NSR – The system is responsible for automatically selecting yearly bridge maintenance actions.  
**Work Completed Prior to the decision to convert to Pontis™:** Information systems extensions to support the manual network simulation report (NSR) had gone through discovery steps.

C. **Major Task:** Develop documentation for training at ALDOT  
**Deliverable:** User Manual for the bridge maintenance analyst - Documentation that supports bridge maintenance analysts by providing information related to how to operate and troubleshoot the application.  
**Deliverable:** Administrator (Computer Services Bureau) Manual – Documentation that supports administrators in installation, application setup, troubleshooting, updating, and modifying the application.  
**Deliverable:** Administrator (Computer Services Bureau) Training – Training session for computer services personnel to cover application architecture, software environment settings and requirements, required links to other ALDOT software, etc.  
**Work Completed Prior to the decision to convert to Pontis™:** Nothing was done for this stage before the conversion decision halted project work.

During execution of this project and informed by this project’s findings, ALDOT senior leadership decided to licence Pontis™ and begin planning for its implementation rather than continue the development of ABIMS+. The initial mapping between ABIMS (done as part of the first workstep in this project) and Pontis™ CoRE elements, and analysis of the
functionality to be added in the upcoming 5.2 Pontis™ release were the basis of this decision.

Dr. Daniel Turner, The University of Alabama Project Principal Investigator requested a revision to the scope of the project at that time (Appendix D). To facilitate the transition from ABIMS to Pontis™, this project’s worksteps were revised to the following:

D. **Major Task:** Provide mapping between ABIMS data elements to Pontis™ CoRE elements.
   *Deliverable:* Excel worksheet mapping the data elements between Pontis™ and ABIMS. Portions of the spreadsheet are presented in Appendix B
   *Work Completed After to the decision to convert to Pontis™:* Completion and knowledge transfer of the Excel spreadsheet mapping to ALDOT. The mapping evaluates each CoRe Element and attempts to create a one to one mapping to the ABIMS data elements. The Excel spreadsheet tool includes four worksheets:
   1) CoRe Elements mapped to their corresponding ABIMS elements,
   2) ABIMS elements and their corresponding CoRe Elements,
   3) Summary of CoRe elements that are unmapped to ABIMS, and
   4) Summary of CoRe Elements that are directly mapped to ABIMS.
   The last two worksheets (3 and 4 above) breakdown CoRe elements into sub-elements. Color coding is used to highlight sub-elements that were not precisely mapped; Appendix B and C provide overviews of the tool.

E. **Major Task:** Assist in developing strategy and procedures for transition to Pontis™
   *Work Completed After to the decision to convert to Pontis™:* The Migration Strategy From ABIMS to Pontis™ – Discussion Draft.doc was reviewed by both Drs. Hale, Sharpe, and Turner, followed by a discussion between Maintenance Bureau staff and the UA project team.

F. **Major Task:** Perform analyses and simulations of components of the Pontis™ System
   *Work Completed After to the decision to convert to Pontis™:* none due to a prolonged deployment schedule for the Pontis™ system.

The project performance period expired in March 2010. At that time The University of Alabama did not seek a no-cost extension. At the time of project expiration, 63% of the budget was not expended.
Appendix A: ABIMS+ Phase 1 Bridge Replacement Procedure Outline

As an integral part of ALDOT’s standard and repeatable process for determining bridges in need of maintenance action within the State of Alabama (Appendix E), ABIMS+ provides further standardization of step 4-A and provides ALDOT with a prioritized list of bridges pulled from the ABIMS database.

Through user-interface controls, ABIMS+ ensures that prioritized lists of bridges are created in a standard and repeatable fashion. To generate a Network Prioritization Report (NPR), a report displaying a ranked list of bridges within a user-defined geographic network, a user must first determine the various geographic and network constraints to be used in generating the prioritized list of bridges. Once the user defines the geographic and network constraints, selections are inserted into a standard query template, ensuring uniformity in report generation. Using this standard query, the ABIMS database is queried and the results are formatted into a standardized report. This standardized report displays all the geographic constraints used in determining the list of bridges; which aids in ALDOT’s ability to successfully repeat the results of the report.

The ABIMS+ Phase I tool provides a standardized repeatable process, compliant with state and federal standards, for use in identifying and prioritizing bridges in need of maintenance action. ABIMS

• Bridge replacements to be established.
• Bridge replacement budgets are established for each fiscal year.
  • Office Engineer provides Maintenance Bureau the funds available each fiscal year of the programmed period.
  • Maintenance Bureau estimates amount of BR funding needed for Bridge Painting Program for each fiscal year.
  • Chief Engineer approves BR funds to be set-aside for Bridge Painting.
  • Remainder of BR funds available for replacement projects.
• A prioritized list of bridges to be replaced is produced by the Maintenance Bureau.
  • Initial list is produced by ABIMS+ with bridges ranked by their deficiency score. Higher numbers represent bridges in worse shape; lower numbers represent bridges in better shape.
  • Bridges are reviewed by the Maintenance Bureau for compliance with HBR eligibility requirements.
  • Initial bridge priorities are reviewed by the Maintenance Bureau and may be adjusted for reasons that include the following:
    • Bridges that have an adverse impact on ALDOT’s ability to issue overweight permits are raised in priority.
    • Bridges that can be removed are raised in priority. An example is a bridge that overpasses an abandoned rail line.
    • Bridges that do not meet HBR eligibility are reduced in priority.
  • Maintenance Bureau assigns bridges to each fiscal year.
• Prioritized list from Step 3 is distributed to the Divisions.
  • Divisions are asked to review replacement estimates and develop more refined estimates where appropriate.
  • Each Division is asked to submit comments and recommendations for changes in proposed prioritization.
  • Maintenance Bureau and Office Engineer adjust assignment of bridges to fiscal years based on adjusted replacement cost estimates.
• Committee meets.
  • Approves selected Division recommendations for change.
  • Makes own recommendations for changes as needed.
  • Approves prioritized list.
• Maintenance Bureau produces final prioritized list.
  • Bridges for Year 1 through Year 3 are signed off by Chief Engineer and Director
  • Lists for all years are distributed.
  • Changes to Year 1 through Year 3 must be approved by the Committee and signed off by the Chief Engineer and Director.
Appendix B: Introduction to Core Element Mapping Tool

Figure 1. Introduction to Core Element Mapping Tool
Appendix C: Example Core Element Mapping

Figure 2. Example Core Element Mapping
Appendix D: Request to Revise Project Scope

August 27, 2008

Mr. Jeffery W. Brown
Research and Development Engineer
Alabama Department of Transportation
1409 Coliseum Boulevard
Montgomery, AL 36110


Dear Jeff:

This is a request to revise the scope of the cited project. The need for this change was generated when ALDOT decided to transition from the Alabama Bridge Information Management System (ABIMS) to the Pontis® bridge management system. Pontis is significantly more complex than ABIMS, including the use of Core element data collection and use.

Original Objective: The objective is to enhance ABIMS in the formulation its bridge preservation strategy by providing budget and network-level rating forecasts. It will provide data intensive modeling to support quantitative decision planning; analysis of bridge data based upon extensive filters like funding limits, type of maintenance action, etc; predicted bridge network ratings; and report generation.

Proposed Objective: The objective is to document the mapping of ABIM Core Elements to similar concepts within the current version of ABIMS, to assist in developing strategy and procedures for transition to Pontis, and to perform analyses and simulations of components of the transition.

This request has already been discussed in depth with Mr. George Conner, ALDOT Maintenance Engineer. Mr. Conner supports the change in scope.

Thank you very much for your consideration, and I look forward to hearing from you.

Sincerely yours,

Daniel S. Turner, PI

cc: Mr. George Conner, ALDOT Maintenance Engineer
    Dr. David Hale, Director of AISCE
    Ms. Lisa Joiner, UA Office of Sponsored Programs

Figure 3. Request to Revise Project Scope
Appendix E: ALDOT Bridge Replacement Program
Outline of Annual Operations  Last Revised: January 23, 2007

1. Establish Bridge Replacement Prioritization Committee. Members to include:
   a. Chief Engineer
   b. Asst Chief Eng., Ops.
   c. Maintenance Engineer
   d. Bridge Engineer
   e. Office Engineer
   f. Planning and Multimodal
   g. Asst. Maintenance Engineer-Bridges
   h. FHWA (ex-officio)

2. Establish bridge replacements period.

3. Bridge replacement budgets are established for each fiscal year of replacement period.
   a. Office Engineer provides Maintenance Bureau the funds available each fiscal year of
      the programmed period.
   b. Maintenance Bureau estimates amount of BR funding needed for Bridge Painting Program
      for each fiscal year.
   c. Chief Engineer approves BR funds to be set aside for Bridge Painting.
   d. Remainder of BR funds available for replacement projects.

4. A prioritized list of bridges to be replaced is produced by the Maintenance Bureau.
   a. Initial list is produced by ABIMS with bridges ranked by their deficiency score.
      Higher numbers represent bridges in worse shape; lower numbers represent bridges in
      better shape.
   b. Bridges are reviewed by the Maintenance Bureau for compliance with HBR eligibility requirements.
   c. Initial bridge priorities are reviewed by the Maintenance Bureau and may be
      adjusted for reasons that include the following:
      i. Bridges that have an adverse impact on ALDOT's ability to issue
         overweight permits are raised in priority,
      ii. Bridges that can be removed are raised in priority. An example is a
         bridge that overpasses an abandoned rail line,
      iii. Bridges that do not meet HBR eligibility are reduced in priority.
   d. Maintenance Bureau assigns bridges to each fiscal year of replacement period.

5. Prioritized list from Step 4 is distributed to the Divisions, Bridge Bureau, Design Bureau
   (especially Environmental) and M&T.
   a. Divisions are asked to review replacement estimates and develop more refined estimates
      where appropriate.
   b. Each Division is asked to submit comments and recommendations for changes in proposed
      prioritization.

6. Maintenance Bureau and Office Engineer adjust assignment of bridges to fiscal years based on:
   a. adjusted replacement cost estimates
   b. Comments and recommendations from Divisions
   c. Comments and recommendations from Bridge, Design and M&T Bureaus

7. Advance copy of adjusted prioritized list is provided to committee members for review.

8. Bridge Replacement Prioritization Committee meets to:
   a. Make own recommendations for changes as needed.
   b. Approve prioritized list

9. Maintenance Bureau produces final prioritized list.
   a. Bridges for Year 1 through Year 3 are signed off by Chief Engineer and Director
   b. Lists for all years are distributed.

10. Subsequent changes to Year 1 through Year 3 must be approved by the Bridge Prioritization
Committee and signed off by the Chief Engineer and Director.