Effect of Web-Based Engineering Information on Asset Management

by

Thomas Austin Eckles, E.I.T.

B.S., Civil and Environmental Engineering (2002)
The Citadel, The Military College of South Carolina,

Submitted to the Department of Civil and Environmental Engineering
in partial fulfillment of the requirements for the degree of

Master of Science in Civil and Environmental Engineering

at the

Massachusetts Institute of Technology

May 2003

© 2003 Massachusetts Institute of Technology
All Rights Reserved

Signature of Author

Department of Civil and Environmental Engineering
May 9, 2003

Certified by

Fred Moavenzadeh
Professor of Civil and Environmental Engineering
Thesis Supervisor

Accepted by

Oral Buyukozturk
Chairman, Departmental Committee on Graduate Students
Effect of Web-Based Engineering Information on Asset Management

By

Thomas Austin Eckles

Submitted to the Department of Civil and Environmental Engineering on May 9, 2003, in partial fulfillment of the requirements for the degree of Master of Science in Civil and Environmental Engineering.

Abstract

For decades, infrastructure in the United States has been developed with little or no regard to the long-term cost of its maintenance and operation. As of June 1999, state and local governments in the United States are subject to new accounting measures contained in the Governmental Accounting Standards Board’s Statement 34. These new guidelines relate to the method that infrastructure assets are accounted for in annual financial statements. In addition, with the release of the American Bar Association’s 2000 Model Procurement Code, these governments are now authorized to explore the benefits of using alternate project delivery methods for capital programs as well as maintenance and operation for infrastructure assets.

A variety of asset management tools have recently been developed to ease the passage into GASB 34 compliance for local governments to include a web-based program called Barchan. My goal as part of a two-person research team was to implement and test Barchan in a sample town, Winchester, MA. During this process, and after research into the current project-delivery environment, further applications for such programs were realized and discussed. Such programs provide a public procurement agency with a wide variety of easily accessible and updateable engineering information. This engineering information can be used to facilitate decisions to utilize alternate project delivery methods and provide a benchmark to evaluate their effectiveness.

Thesis Advisor: Fred Moavenzadeh

Title: Director of Center for Construction Research and Education
# Table of Contents

CHAPTER 1  INTRODUCTION ........................................................................................................................................... 5  
1.1  BACKGROUND .................................................................................................................................................. 5  
1.2  SUBJECT AND HYPOTHESIS OF THESIS ..................................................................................................... 7  

CHAPTER 2  HISTORY OF INFRASTRUCTURE MAINTENANCE AND INTRODUCTION OF GOVERNMENTAL ACCOUNTING STANDARDS BOARD STATEMENT 34 ................................................... 9  
2.1  FIVE DECADES OF NEGLECTED INFRASTRUCTURE MAINTENANCE .......................................................... 9  
2.2  GOVERNMENTAL ACCOUNTING STANDARDS BOARD ............................................................................. 10  
2.2.1  GASB Background .................................................................................................................................. 10  
2.2.2  GASB Statement 34 .................................................................................................................................. 11  
2.2.3  Requirements of GASB Statement 34 ..................................................................................................... 12  

CHAPTER 3  INTRODUCTION TO BARCHAN ............................................................................................................. 14  
3.1  LAYOUT OF BARCHAN ...................................................................................................................................... 14  
3.1.1  Barchan Administrator Page .................................................................................................................. 14  
3.1.2  Preliminaries ............................................................................................................................................ 14  
3.1.3  Assemblies ............................................................................................................................................. 15  
3.1.4  Assets .................................................................................................................................................... 15  
3.1.5  Scenarios: ............................................................................................................................................... 16  
3.1.6  Activities: .............................................................................................................................................. 16  
3.1.7  Reports .................................................................................................................................................. 16  

CHAPTER 4  META SEGMENT CONFIGURATION AND CLASSIFICATION ........................................................................ 17  
4.1  INITIAL INFORMATION GATHERING .......................................................................................................... 17  
4.2  META SEGMENT CONFIGURATION ............................................................................................................. 18  
4.2.1  Meta Segment Configuration Process .................................................................................................. 18  
4.2.2  Meta Segment Configuration Discussion ............................................................................................. 19  
4.2.3  Meta Segment Configuration Recommendations .............................................................................. 20  
4.3  META SEGMENT CLASSIFICATION ............................................................................................................. 21  
4.3.1  Meta Segment Classification Process .................................................................................................. 21  
4.3.2  Meta Segment Classification Discussion ............................................................................................. 24  
4.3.3  Meta Segment Classification Recommendations .............................................................................. 25  

CHAPTER 5  META DATA, MAINTENANCE, AND CONDITION ASSESSMENT ........................................................................ 26  
5.1  META DATA CONFIGURATION .................................................................................................................... 26
5.1.1 Meta Data Configuration Process: ................................................................. 26
5.1.2 Meta Data Configuration Discussion: .......................................................... 28
5.1.3 Meta Data Configuration Recommendations: ............................................. 29
5.2 Meta Segment Maintenance: ............................................................................ 30
  5.2.1 Meta Segment Maintenance Data Input Process: ....................................... 31
  5.2.2 Meta Segment Maintenance Recommendations: ...................................... 32
5.3 Meta Segment Condition Assessment: ............................................................. 33
  5.3.1 Meta Segment Condition Assessment Process: ......................................... 34
  5.3.2 Meta Segment Condition Assessment Discussion: .................................... 36
  5.3.3 Meta Segment Condition Assessment Recommendations: ....................... 37

CHAPTER 6 SCENARIO ANALYSIS ............................................................................ 38
  6.1 Scenario Analysis Methodology: ................................................................. 38
  6.2 Scenario Analysis Process: .......................................................................... 40
  6.3 Scenario Analysis Creation and Discussion: ................................................. 42
    6.3.1 Reference Scenario I ................................................................................ 42
    6.3.2 Exclusion of Private Roads, Scenario II .................................................... 43
    6.3.3 Effect of Choosing Certain Repair Methods, Scenarios III-VII ................ 44
    6.3.4 Scenario VIII ............................................................................................ 46
    6.3.5 Other Possible Scenario Investigations: .................................................... 46

CHAPTER 7 ABA 2000 MODEL PROCUREMENT CODE DEVELOPMENTS AND BARCHAN
   APPLICABILITY ................................................................................................. 48
  7.1 The Impact of Flexible Procurement Options and Good Engineering Information 50
  7.2 Examples ........................................................................................................ 50
    7.2.1 Introduction of Operations and Maintenance as an Accepted Project Delivery Method 50
    7.2.2 Barchan Applicability to Example Situation One .................................. 51
    7.2.3 Benchmarking Strategies ....................................................................... 52
    7.2.4 Privatization of Highway Maintenance in Virginia.................................. 52
  7.3 Bulk Purchasing/Cooperative Purchasing Among Governments .................... 53
    7.3.1 The Implications of Good Engineering Information on Cooperative Purchasing 54
    7.3.2 Example Scenario ..................................................................................... 55

CHAPTER 8 CONCLUSIONS ...................................................................................... 58
REFERENCES ......................................................................................................... 59
Chapter 1 Introduction

1.1 Background

The United States has developed over ten (10) generations the most extensive collection of infrastructure networks in the world. A tremendous advantage to its economy, these networks are under constant pressure – pressure that comes from heavy use and from obsolescence in both physical and technological terms. How to maintain these networks is just a starting question (that has plagued the US since its inception)? How to institutionalize the steady and never-ending rehabilitation and improvement of these networks – both economically and environmentally – is the unfortunate, but inevitable, heritage of today’s generation of America’s infrastructure users. For decades, the federal and state funding of infrastructure systems has occurred with little or no thought to the ongoing cost and the related resources needed to maintain such assets. Brilliantly conceived and executed infrastructure improvements have deteriorated quickly, and many would argue, prematurely, for lack of dedicated maintenance, preservation, and repair efforts. Rather than receiving incremental updates and repairs, the condition of these assets is allowed to spiral downward until complete replacement is needed, thereby qualifying, under existing federal and state grant programs, for “new construction” money. State and local governments are characteristically the agencies faced with making up this increasing gap in funding and manpower in support of ongoing maintenance and preservation of existing infrastructure assets.2

Other developments, outside the narrow confines of public infrastructure funding and politics, appear to be influencing this dynamic for the better. First, the Governmental Accounting Standards Board (GASB) approved new financial funding requirements in June 1999 that are designed to encourage state and local governments to “become better stewards of their infrastructure.”3 In short, these new standards will require state and local governments to

---


2 Dorman, Daniel, Asset Management and GASB-34-Challenge or Opportunity?, Infrastructure Management Group, Inc.

3 Dorman, Daniel, Asset Management and GASB-34-Challenge or Opportunity?, Infrastructure Management Group, Inc.
account for both the value and condition of infrastructure assets located in their jurisdiction for inclusion in annual financial statements. Governments will be penalized in municipal bond markets, through lower bond ratings, for infrastructure that is not maintained to self-determined conditions. ⁴

Second, technology is steadily improving, and offering new management tools to attack the problem of managing large, complex, infrastructure networks. In response to the new GASB regulations, new asset management tools are being developed and released to ease the transition of local governments toward compliance with these new accounting requirements. One such program, Barchan, was in the final stages of Beta testing in Winchester and Milton, Massachusetts at the time our research was conducted. To explore the effect of web-based information tools on infrastructure managements, we were given permission by the Town of Winchester to explore how their use of this tool in a real infrastructure planning and budgeting context is helping to shape and change how complex infrastructure networks are being managed in the United States.

Finally, the regulatory frameworks that control the expenditure of public funds on design, construction, operation, and maintenance of American infrastructure networks are also changing, again, for the better, and toward increased flexibility. The American Bar Association’s 2000 update to its original 1979 Model Procurement Code for State and Local Government⁵ has incorporated several new project delivery methods as authorized procurement strategies for local and state governments. Included in this list, and of direct importance to the subject of this thesis, are the identification of operations and maintenance as an accepted project delivery method and the authorization of cooperative purchasing and staff sharing between government procurement agencies.

---


⁵ The 2000 Model Procurement Code for State and Local Governments, American Bar Association, 2000, Chicago, IL.
1.2 Subject and Hypothesis of Thesis

This thesis focuses on what I believe to be the most important precursor to the development or deployment of any sound asset management strategy – reliable, current engineering information as to the status, condition, extent, and cost of the various elements within an infrastructure network. To explore this subject in a real context, two researchers from MIT’s Master’s program in Construction Engineering and Management were allowed to assist with data input and analysis in the completion of beta testing of the Barchan asset management system in a sample town, Winchester, MA.\textsuperscript{6} The purpose of this research was to explore the environment and to draw lessons that may be of more general application to the effective use of web-based engineering information in public infrastructure asset management.

To set the stage for this exploration, this thesis will first briefly describe the history of infrastructure management practices in the United States, and then discuss the specific new requirements introduced by GASB. Following a description of the required methodology to enter the required information for a sample town into Barchan, the thesis then examines how web-based engineering information can be effectively used in the new procurement environment to improve best practices in asset management.

The working hypothesis of this research (when it commenced) was that reliable, current information about infrastructure networks is, currently, the most significant barrier to better infrastructure management. What we learned from the research is that web-based systems like Barchan can be effectively used as a tool to develop, store, and quickly present the engineering information needed to manage a local municipality’s infrastructure. The Barchan system, and others that will undoubtedly follow, have significant additional potential as providing the factual foundation that can facilitate appropriate public and private sector combinations of contributions to effective and efficient infrastructure preservation and maintenance, and the emergence, and

---

\textsuperscript{6} Winchester, MA is a relatively small town about 10 miles northwest of downtown Boston, with a population of approximately 18,000 and an annual operating budget of approximately $55M. The town is managed by a professional Town Manager and staff, with a five member elected Board of Selectman, and elected representatives that comprise a typical New England Town Meeting form of government.
adoption of consistently innovative practices that improve continued public maintenance of infrastructure networks.
Chapter 2  History of Infrastructure Maintenance and Introduction of Governmental Accounting Standards Board Statement 34

2.1 Five Decades of Neglected Infrastructure Maintenance

Over the past several decades, the bulk of funds budgeted for infrastructure systems has gone towards the development of new construction rather than maintenance of current assets. This phenomenon began during the mid 1950's when the federal government was most interested in creating the Eisenhower System of Interstate and Defense Highways. During this period, the federal government stipulated that the Highway Trust Fund be restricted to funding new infrastructure construction, thereby leaving state and local governments to use their own resources for maintenance. The almost complete lack of federal funding allocated for maintenance created an inherent bias towards capital projects and lead state and local governments to neglect maintenance activities as a method of conserving local resources.\(^7\) The effects of federal funding limitations and the resulting bias towards new construction are that many assets developed during the past few decades have since deteriorated prematurely and have either been replaced or in dire need of severe overhaul.

Although this problem is readily discussed and noted, the imbalance of funding between new construction and maintenance has improved very little. For the 2000 fiscal year, the Federal Highway Administration reported that on average, government agencies of all levels spent almost twice as much on capital projects as on operation and maintenance. Specifically, state governments spent 60\% of their highway funds on new construction while maintenance activities received only 18\% of the budget. In a positive light, local governments have begun to spend larger percentages, almost 40\%, of their annual infrastructure budget on maintenance. The following graph illustrates the disparity between capital and maintenance spending over the past three decades.\(^8\)

\(^7\) Dorman, Daniel, Asset Management: Management Fad or Prerequisite for Solving the Fiscal Challenges Facing Highway Infrastructure?, Infrastructure Management Group, Inc

2.2 Governmental Accounting Standards Board

2.2.1 GASB Background

Facts about GASB:


- Develops standards that guide the preparation of external financial reports for state and local municipalities.

- Mission: “To establish and improve standards of state and local governmental accounting and financial reporting that will result in useful information for users of financial reports and guide and educate the public, including issuers, auditors, and users of those financial reports.”

To accomplish its mission, GASB seeks to do the following:
- Issue standards that improve the usefulness of financial reports based on the needs of financial report users; the primary characteristics of understandability, relevance, and reliability; and the qualities of comparability and consistency.

- Keep standards current to reflect changes in the governmental environment.

- Provide guidance on implementation of standards.

- Consider significant areas of accounting and financial reporting that can be improved through the standard-setting process.

- Improve the common understanding of the nature and purposes of information contained in financial reports.  

2.2.2 GASB Statement 34

The GASB released Statement 34 in June 1999 to address increasing demand by citizens and private sector industry for better transparency and reporting by local governments relative to infrastructure assets. For example, the Governmental Research Association, a national organization of citizen research and taxpayer groups, drafted a letter to the GASB which stated, "As intensive users of financial information, we believe that infrastructure reporting is an essential element in improving the accountability of governments to their citizens...[P]ossessing information about capital asset costs or condition is important in helping policymakers and citizens make better informed choices about the expenditures of public funds and appropriate levels of taxation." Also, the National Federation of Municipal Analysts (NFMA), composed of thousands of brokers, fund managers, insurers, and rating agencies, cites the importance of infrastructure information to municipal credit analysis, saying, "By their nature, most municipal bonds finance 'capital assets' and as such, the relevance of this information to public finance professionals is paramount."
The fact that current and future generations will be required to fund the construction and maintenance of infrastructure projects dictates that accurate and transparent financial reports be produced by local governments detailing capital and recurring costs for infrastructure assets. Of primary importance is documentation that current infrastructure assets are being maintained such that their useful life is maximized, reducing the financial burden on taxpayers in replacing these assets.

2.2.3 Requirements of GASB Statement 34

Despite the significance of infrastructure asset costs in the long-term financial responsibilities of local governments, current governmental accounting methods and financial statements omit the costs of infrastructure-related services. Instead, government reporting is limited to short-term considerations for capital investment. Statement 34 seeks to remedy this problem.

The long asset lives associated with infrastructure often make depreciating these assets meaningless, since the annual depreciation amount would be negligible in many cases. The guidelines of Statement 34 allow governments to report their expenses for maintaining and preserving infrastructure assets instead of depreciating them, provided that the government can demonstrate that infrastructure assets are maintained at some consistent level. In this case, local governments are required to disclose the following information:

- The assessed physical condition of infrastructure assets
- Methodology used to assess and report asset condition
- The condition level at which the government intends to maintain the assets
- A 5-year comparison of the estimated annual dollar amount to maintain and preserve the assets at the condition level established by the government and the actual expenditures required to maintain the assets over that same 5-year period

The above described modified approach to GASB 34 compliance was championed by AASHTO and state DOTs. Not only does the modified approach allow governments to avoid having to incur depreciation costs, it also has the significant byproduct of fostering close
cooperation between finance/accounting and engineering/maintenance departments within an agency via the common objective of GASB 34 compliance.\textsuperscript{11}

If governments elect to use this approach, these disclosures will give financial statement users (and citizens in general) information that most have never had. The new information should help the public better assess the job their governments have done building and maintaining infrastructure. The users of this new information should then be able to communicate more clearly to government officials the level of infrastructure investment, maintenance and condition they prefer.

Although the standards developed by GASB in Statement 34 do not have the force of law, governments must follow the standards to be eligible to receive clean audit opinions from their certified public accountants. It is practically impossible for state or local governments to issue bonds to finance infrastructure improvements without clean audit opinions. Thus, most state and local governments are likely to follow the rules promulgated by GASB. In addition, a poor infrastructure condition rating will result in a lower bond rating.\textsuperscript{12} Those municipalities with low bond ratings will have to pay a higher interest rate on bonds, resulting in increased debt-service spending that will limit funds available for actual construction and maintenance. Municipal bonds are used extensively to fund infrastructure development and maintenance by local governments. Chicago, a characteristic municipality, reports that over 98\% of its local “Neighborhood Infrastructure” development and maintenance budget is created by the sale of municipal bonds while state and federal contributions account for less than 2\%.\textsuperscript{13}

\textsuperscript{11} Elliot, Bill, Meeting GASB 34: An Integrated Software Approach For Transportation and Public Works Departments, Exor Corporation.

\textsuperscript{12} Thelen Reid & Priest LLP, New Accounting Rules Require States, Local Governments to Track Value of Their Infrastructure, June 1999.

\textsuperscript{13} Neighborhood Capital Budget Group, City of Chicago's 2002-2006 Capital Improvement Program, 2002.
Chapter 3  Introduction to Barchan

Barchan is a remote-hosted, web-based capital asset management tool developed to assist public works officials and town and city managers in meeting the requirements of GASB Statement 34. Though the research contained within this thesis is focused on beta-site testing for road and highway management only, future production versions of Barchan\textsuperscript{14} will have the capability to simultaneously manage multiple "layers" of infrastructure systems, such as water, sewer, and stormwater networks. Barchan accesses local Geographic Information System (GIS) mapping networks to display the most current infrastructure system layout available within the client's specific planning area. Using the GIS network, meta segments of infrastructure assets are constructed. Individual roadway segments can be grouped into meta segments based on a number of criteria, including spatial layout, traffic flow/type, and maintenance schedules.

3.1  Layout of Barchan

Barchan directs the client to follow a logical path through data input and eventual reporting mechanisms. A series of seven tabs are located across the top of the Barchan screen, labeled Overview, Account, Assemblies, Assets, Scenarios, Activities, and Reports. The order of these tabs illustrates the chronological path of data input required by Barchan.

3.1.1  Barchan Administrator Page

The Administrator page provides an overview of the process required to enter appropriate data and generate reports in Barchan.

3.1.2  Preliminaries

The Preliminaries section of the Overview tab provides initial instruction and information for new clients. Included is a list of the five types of users that Barchan recognizes: Administrators, Managers, Data Entry, Assessor, and Updater. By defining several types of users, the client is able to limit access to the different aspects of the application.

\textsuperscript{14} Go to www.Barchan.net for more information on Barchan. The application can be launched by authorized users from the web page.
3.1.3 Assemblies

The creation of a series of assemblies is the first stage of data entry. A typical town road network consists of a variety of road types with different widths, base construction, and surface type. In addition, the presence of sidewalks, curbing, and medians also varies. An assembly describing each applicable combination of these variables is created in Barchan for future assignment to roadways. Cross Sections made here are assigned to GIS lines, turning them into meta segments that represent 3-d physical objects in the real world.

3.1.4 Assets

The vast majority of data entry takes place under the Assets tab. Several different levels of entry are required, as illustrated below. Here, separate GIS lines are grouped together and assigned an appropriate assembly to form a meta segments. These meta segments are then assigned to a group, generally by ownership -- either public, private, or state --and/or road type --either improved or unimproved.

- **Assigning Assemblies to make meta segments**: Individual GIS lines are grouped together and assigned an appropriate assembly to form a meta segment.

- **Group Assignments**: Each meta segment is assigned to a group, generally by ownership (either public, private, or state) and/or road type (either unimproved or improved).

- **Placing into service**: Once the client is satisfied with the assembly and group assigned to a meta segment, it is placed into service whereby it can then be assigned additional information.

- **Maintenance Activities**: Barchan is informed of the maintenance activities (street sweeping, centerline painting, catch basin cleaning, etc.) that each meta segment regularly receives.

- **Meta Data Entry**: Additional information about each meta segment is assigned, including the road’s initial service date and the number of manholes and storm drains located in the pavement.
- **Condition Assessment**: The current condition of each meta segment is entered based on a 0-100% scale. Any recommended repairs and change activities are noted for future use.

- **Maintenance Activities Stored and Reported**: A report detailing the necessary maintenance activities for each meta segments is produced.

3.1.5 **Scenarios**:

Under the Scenarios tab, the client may develop a series of scenarios where he can vary the allowable budget, target overall condition, or vary the recommended change activities. These scenarios can be used for budgeting and planning of future maintenance and repairs. Once the client develops a scenario that he wishes to follow, it is committed, and becomes the basis for future

3.1.6 **Activities**:

After the client commits a scenario, a list of required activities is created. When those activities are completed, they can be checked off under the Activities tab and the current overall condition of the town will be updated appropriately.

3.1.7 **Reports**

*Barchan* allows the client to produce a variety of reports for his own use as well as to create GASB 34 compliant financial reports. Such reports include inventory lists and the status of condition distribution.

As a remote hosted tool, *Barchan* allows local governments to satisfy the requirements of GASB Statement 34 without expending large amounts of resources or time to implement an in-house accounting and management system. This is particularly advantageous, given that Statement 34 has been openly criticized as a good intention with serious feasibility and cost-related implementation hurdles.
Chapter 4  Meta Segment Configuration and Classification

The field work portion of our research described in Chapters 4, and 5 was conducted jointly with James Steven Gourley. Past thesis research by Thomas Messervey and others serves as background research for these chapters.

4.1 Initial Information Gathering

On March 12, 2003 researchers for this project met with Winchester DPW officials to discuss expectations and requirements for Winchester’s participation in beta-site testing for Barchan. DPW officials confirmed that Winchester meta segments were to be classified as one of five options: public (local) roads, improved private roads, unimproved private roads, state roads, or Metropolitan District Commission roads. Researchers for this project also decided at this time to name meta segments according to street name, corresponding house number, and state-assigned Road Inventory Number (RIN). This strategy promotes efficiency and simplicity in system management, as local street names and numbers are familiar to DPW staff, while also satisfying state and GASB accounting standards by incorporating RINs into meta segment descriptions.

Researchers for this project also collected several documents at this meeting to be used in the Barchan configuration and input stages for Winchester’s infrastructure assets. These documents have proven to be most helpful in configuring Winchester’s infrastructure profile, and are noted here in an attempt to foster similar efficiency in meeting future client needs. These documents include:

- Massachusetts Highway Department, Bureau of Transportation Planning and Development, Road Inventory Printout, January 30, 1997, Town of Winchester
- Massachusetts Highway Department, Bureau of Transportation Planning and Development, Description of Road Inventory Printout, September 1996
- Massachusetts Highway Department, Bureau of Transportation Planning and Development, Alphabetical Street Listing, January 30, 1997, Town of Winchester
- Massachusetts Highway Department, Bureau of Transportation Planning and Development, Fully or Partially Unaccepted Street Listing, January 30, 1997, Town of Winchester
RIN Checkplot (Plan-view drawing) for Winchester, Massachusetts, February 13, 1997, Executive Office of Transportation & Construction, Massachusetts Highway Department, Bureau of Transportation Planning and Development

Plan-view utility map of Winchester, Massachusetts (utilized as named roadway map)

4.2 Meta Segment Configuration

4.2.1 Meta Segment Configuration Process

* Barchan configuration and input procedures began on March 12, 2003. Researchers, unfamiliar with Barchan commands and utilities, first practiced configuring the system and generating maintenance scenarios until a general comfort level was achieved. It should be noted that the system’s user interface is quite straightforward and user-friendly.

System configuration and input for Winchester’s infrastructure assets began March 13, 2003. The configuration process involves: selecting an area within the GIS mapping window in which meta segments are to be built, scanning the roadway segments of the selected area in the data columns below the mapping window, selecting those roadway segments to be grouped as meta segments (which are highlighted in the GIS window when selected), and selecting the “group as new meta segment” command from the right-click command list. Researchers utilized the documents listed above to configure meta segments from the road inventory list. Meta segments were decided upon by Barchan administrators and Winchester DPW officials, and marked on a town roadway map. Researchers for this project utilized this map and town road inventories to configure meta segments within Barchan, naming segments according to the nomenclature discussed earlier. It was discovered that combined use of a roadway map listing street names, the Mass Highway BTPD RIN checkplot drawing, and the roadway inventory list resulted in the most efficient and effective configuration process. The GIS mapping window within Barchan is not full-screen, and the GIS mapping network does not contain Road Inventory Numbers. As such, caution must be exercised in selecting roadway segments to be grouped and transferring RIN’s into Barchan when configuring meta segments. Problems and issues of note relative to the configuration process are further discussed below. An example
constructed roadway extensions. To verify this assumption and ensure accuracy in constructing the roadways, it was assumed that these streets were private driveways, commercial entrances, or recently constructed roadway extensions. The light blue dotted square denotes the area of the town under investigation. The dark blue streets are those that are already grouped into meta segments and listed on the right side of the screen. The red street illustrates the meta segment that has been selected from the list on the right side of the screen. The data listed below the GIS window consists of segments that have not yet been grouped into meta segments.

**Figure 2** Mea Segment Configuration Screen Shot

### 4.2.2 Meta Segment Configuration Discussion

Several streets within the GIS mapping network, MapCiti, were labeled as “unnamed streets”. It was assumed that these streets were private driveways, commercial entrances, or recently constructed roadway extensions. To verify this assumption and ensure accuracy in constructing meta segments, these unnamed streets were driven by Barchan administrator to assess their layout, geometry, quality, and assign names to these meta segments.
In addition to several unnamed streets within the GIS network, researchers for this project also discovered some erroneous roadway data in the MapCiti database. These errors include incorrectly named streets, incorrect roadway layouts, and several streets not shown at all. A MapCiti database update was carried out from March 21 through March 24, 2003. While it is assumed that this update will solve the mapping anomalies experienced during Winchester beta-site testing, Barchan administrators and clients should monitor mapping accuracy on a regular basis. As in the case of Winchester configuration, Barchan administrators and Winchester DPW officials were able to quickly detect many of these mapping errors and correct them. Clearly, client input and coordination at the configuration phase, as well as all other critical stages, is an efficient and effective way to accurately configure and productively run the system to generate maintenance scenarios.\textsuperscript{15}

4.2.3 Meta Segment Configuration Recommendations

Researchers for this project would like to make one recommendations for Barchan system improvement relative to the meta segment configuration process:

Incorporate an option to view the GIS map in full-screen rather than just a zoom-in command. As discussed earlier, the small map window makes it difficult to configure meta segments from streets that are broken by many intermittent intersections, as these streets contain many individual segments. A detailed view is necessary to ensure that segments are accurately selected and incorporated into meta segments. The zoom-window provides this detailed view. However, many major arterials extend through several neighboring townships, and these neighboring segments are selectable in the GIS mapping window. Thus, a large view of the mapping area is necessary to ensure that these remote segments are not selected by mistake. The combined requirements of a large view and level of detail suggest that a full-screen window would be more appropriate and efficient than just a zoom-in command.

\textsuperscript{15} Many times while trying to use the zoom command in the GIS map screen, the researchers were kicked off of the system. This resulted in frustration for the researchers, and increased the time needed to configure the meta segments. In response, the researchers sent tickets to the software developer. This problem was eventually corrected when the software developer switched from Oracle 8 to Oracle 9.
4.3 Meta Segment Classification

4.3.1 Meta Segment Classification Process

Data input for constructed meta segments began on March 17, 2003. Researchers for this project utilized the Town of Winchester Road Inventory Printout and accompanying Description to assign classifications and geometries to Winchester meta segments. The process used by the project researchers for assigning properties to meta segments is detailed below:

- Under the “Assets” tab, a view is selected in the GIS window, thus listing the meta segments located in that view in the list located on the right-hand side of the screen.

- Each meta segment is selected with a right-hand mouse click, displaying a menu for further inputs entitled “Meta Segment Properties.” In this menu, researchers are required to make two entries based upon information located in the document entitled “Massachusetts Highway Department Bureau of Transportation Planning and Development Road Inventory Printout, January 30, 1997.”

- First, the road must be placed in one of the following designated groups: Improved Private Road, Unimproved Private Road, Public Road, MDC Parkway, Public Driveway, Public Unimproved Road, or State Road.

- Second, the road receives a classification. The researchers choose this classification from a list of typical cross-section assemblies developed by a Barchan administrator. This list of assemblies is found under the “Assemblies” tab.

- Barchan automatically completes the Cross-Section data input under the “Meta Segment Properties” menu based upon the previous classification entry.

A sample screenshot that illustrates the “Meta Segment Properties” dialogue box for a particular meta segment, Albamont Road, follows:
The Administrative System (Ad Sy) column in the Road Inventory list was used to group meta segments. The Description of Road Inventory Printout details this Administrative System heading. Meta segments were grouped as follows:

<table>
<thead>
<tr>
<th>Administrative System</th>
<th>Description</th>
<th>Barchan Classification</th>
<th>Miles</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Unaccepted by City or Town</td>
<td>Private</td>
<td>13.22</td>
</tr>
<tr>
<td>1</td>
<td>Massachusetts Highway Dept.</td>
<td>State</td>
<td>2.07</td>
</tr>
<tr>
<td>2</td>
<td>City/Town Accepted Road</td>
<td>Public</td>
<td>72.52</td>
</tr>
<tr>
<td>3</td>
<td>Metropolitan District Commission</td>
<td>MDC</td>
<td>4.17</td>
</tr>
</tbody>
</table>
There are numerous other Administrative System groupings listed in the Description of Road Inventory Printout. However, none of these other groupings are present in Winchester’s infrastructure system.

The Surface Type (Sf Ty) heading in the Road Inventory List was used to determine whether private roads were improved or unimproved according to the following chart:

<table>
<thead>
<tr>
<th>Surface Type Description</th>
<th>Barchan Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No Data</td>
</tr>
<tr>
<td>2</td>
<td>Unimproved road</td>
</tr>
<tr>
<td>5</td>
<td>Gravel or stone road</td>
</tr>
<tr>
<td>6</td>
<td>Bituminous surface-treated road</td>
</tr>
<tr>
<td>8</td>
<td>Mixed bituminous road (high type)</td>
</tr>
<tr>
<td>9</td>
<td>Bituminous penetration road (high type)</td>
</tr>
<tr>
<td>11</td>
<td>Bituminous concrete sheet or rock asphalt road (high type)</td>
</tr>
</tbody>
</table>

As with the Administrative System groupings, there are numerous Surface Types listed in the Inventory list, but only those listed above are applicable to Winchester roadways.

Meta segments were also classified according to information contained in the Road Inventory Printout. Classification involves the following determinations:
Determine paved surface width. This is the sum of the Surface Width (Sf Wd) and the corresponding Left and Right Side Shoulder Width and Type (LSh W&T, RSh W&T) data from the printout according to the following designation:

<table>
<thead>
<tr>
<th>Shoulder Type</th>
<th>Description</th>
<th>Barchan Paved Width</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>Hardened bituminous mix or penetration</td>
<td>(Sf Wd)+(LSh W&amp;T)+(RSh W&amp;T)</td>
</tr>
<tr>
<td>S</td>
<td>Stable-unruttable compacted subgrade</td>
<td>Sf Wd</td>
</tr>
<tr>
<td>U</td>
<td>Unstable shoulder</td>
<td>Sf Wd</td>
</tr>
<tr>
<td>-</td>
<td>No shoulder</td>
<td>Sf Wd</td>
</tr>
</tbody>
</table>

Determine status of curbs and sidewalks. The Curb (Cb), Left Sidewalk (Lt SW), and Right Sidewalk (Rt SW) headings in the Inventory Printout are self-explanatory. However, project researchers and Barchan administrators encountered problems associated with meta segments with varying sidewalk and curb characteristics. A description of this issue and resulting solution is included in the Classification Discussion section of this report.

4.3.2 Meta Segment Classification Discussion

The researchers were required to make several assumptions while assigning properties to the meta segments in order to alleviate some inconsistencies in the provided documents. For example, several times the documents stated that portions of the same meta segment were private roads while others were public roads. In these situations, the Barchan administrator field checked this erroneous data, and separated these segments into multiple meta segments to better reflect their assembly and improve accuracy of the system. Also, there were several roads that contained sidewalks and/or curbs on only one side of the street while there is no such classification available in Barchan. Rather than create a new cross section for each of these anomalies, the Barchan administrator recommended that the researchers use a “best fit”
classification for such meta segments. Often times, when portions of a meta segment varied in width or in sidewalk or curb presence, the researchers assigned a classifications that represented the majority of the meta segment's properties. The researchers were again kicked off of the system while assigning properties to the meta segments. This problem was corrected with the switch from Oracle 8 to 9.

4.3.3 Meta Segment Classification Recommendations

During the classification of the meta segments, the researchers noted one recommendation for the Barchan administrator relative to meta segment classification:

The researcher is unable to view all of the meta segments formatted for the town at one time. Instead, he must select a portion of the town, and then work only with the meta segments in that area. The availability of an alphabetical listing of all meta segments for a town would greatly reduce the time needed to assign classifications to meta segments, and would also allow the client to pick a meta segment from the list and immediately access the location and characteristics of that meta segment.
Chapter 5  Meta Data, Maintenance, and Condition Assessment

5.1  Meta Data Configuration

5.1.1  Meta Data Configuration Process

Upon completion of configuring various independent street segments into meta segments and assigning the resulting meta segments cross sectional properties and functional classification, the researchers then assigned each meta segment an individual initial service date and the number of sewer manholes and potable water valves located in the pavement of the respective meta segment. The Barchan administrator assigned the meta segments the appropriate number of storm drains. The process for entering this data into Barchan is as follows:

- Under the Assets heading, select an area of the map, thereby displaying the list of meta segments contained in that region in a list on the right-hand side of the screen.

- Right-click on a selected meta segment and choose “Metadata” from the pop-up menu.

- Enter the initial service date and the number of manholes, gate valves, and storm drains into the appropriate spaces.

An example screen shot showing a selected meta segment, Albamont Road, and its corresponding meta data configuration dialogue box follows:
Initial Service Date

The information required for the initial service date assignments was compiled from two separate documents provided to the researchers by the Town of Winchester on a 3 1/2 inch computer disk:

- A spreadsheet containing a log of initial service dates reflecting when the road was originally accepted by the city. This document is included in the appendix for this chapter, and is entitled “WinStreetsInServiceDates.”

- A spreadsheet reflecting the most recent complete resurfacing date of each street in Winchester’s street inventory. This document is also included in the appendix for this chapter, and is entitled “Town of Winchester DPW Street Resurfacing Alphabetical Street Inventory.”
Number of Sewer Manhole, Potable Water Gate Valves, and Storm Drains

The information required to enter the number of manholes and gate valves was compiled from sanitary sewer and potable water supply maps and lists of sewer and potable water information exported from a database created by previous GASB 34 researchers. Dr. John Miller, a Barchan administrator, provided this information to the researchers.

When entering the numbers of manholes and gate valves for each meta segment into Barchan, the researchers had to pay special attention to those streets that were broken into several meta segments. Information for meta segments that consisted of entire streets could be retrieved directly from the sewer and potable water databases. However, the researchers could not take information for those meta segments that consisted of partial streets directly from the data bases, and instead retrieved such information by physically counting the numbers of manholes and gate valves on the respective maps.

5.1.2 Meta Data Configuration Discussion:

The researchers used the document entitled “Town of Winchester DPW Street Resurfacing Alphabetical Street Inventory” as their primary reference for determining the initial service date for the meta segments because it contains the date that the streets were last completely resurfaced and brought to a “like new” standard. If the particular street under investigation was not found on this list, the document entitled “WinStreetsInServiceDates” was utilized. Because this reference only lists the date that the street was first officially accepted by the town, the dates range from the 19th century to the late 20th. The researchers were advised that 1960 was to be used as the earliest possible initial service date because any road constructed before then and not completely resurfaced would have depreciated to a negligible present value regardless of its true initial service date.

The researchers relied on the Barchan administrator to provide Barchan with the number of storm drains located in each meta segment. Judgment calls were often required when counting the number of manholes and gate valves that were to be assigned to a particular meta segment. Specifically, when two streets intersect, and a manhole and/or gate valve is located in the middle of the intersection, the researchers used their best judgment as to what street that item
would be assigned. Because the researchers gleaned much of the manhole and gate valve quantity information from databases created by previous researchers, they depended upon the judgment of others. A comparison of the numbers of manhole and gate valve numbers assigned to each street by the previous researchers and the numbers shown on the respective maps led the current researchers to trust their predecessors’ judgment. Following the apparent precedent set by the previous researchers, items located in intersections were generally assigned to the longer road to avoid accounting for the item twice and to provide continuity to the assignment process.

5.1.3 Meta Data Configuration Recommendations:

Recommendations to Barchan Developer:

The researchers noted several recommendations that should be taken into account by the Barchan administrator to ease the meta data configuration process. These recommendations are listed below:

- As mentioned before as a recommendation to ease meta segment classification, it would be extremely helpful if Barchan users were able to view all of the meta segments located in the research area in one alphabetical listing. Because Barchan requires the user to first “zoom in” on a window of limited maximum size and then work with the meta segments located within the boundaries of that window, it is difficult to complete the meta data configuration of a street that consists of multiple meta segments without choosing several different views.

- The meta data configuration dialogue box should be updated to include a distinction between sanitary sewerage and storm water drainage manholes. Manholes are required for both systems whenever a change in grade or direction is necessary. Because both systems generally follow road right-of-ways, manholes for both are prevalent in street pavement. Therefore, an input box for both items should be available in Barchan. The researchers only accounted for sewer manholes during the meta data configuration process to avoid confusion between the two systems.
• The meta data dialogue box does not allow the client to simply type the initial service date into the appropriate input window. Instead, he must scroll through a listing of years from 2003 to 1800. While this may seem minor, when considering the time it takes to scroll through the list and the fact that a town such as Winchester contains over 300 meta segments, rectifying this situation will save the client undo frustration.

**Recommendations to Future Barchan Clients:**

The researchers approached this portion of the project with a trial and error mentality. As always, hindsight is 20-20, and the researchers have developed the following list of helpful ideas for maximizing the efficiency of meta data configuration:

• Data entry works best with a team of two people: one person looking up and calling out the information to the second person who then handles the inputs into the dialogue box.

• Clients should verify all information (numbers of gate valves, manholes, etc) presented to them as a database compiled by others by first comparing it to the appropriate map and then driving around the town and inspecting several streets to ensure accuracy.

**5.2 Meta Segment Maintenance:**

The next stage of data input provides Barchan with the schedule of maintenance activities performed by the town. Such activities can include street sweeping, centerline repainting, litter control, maintaining ground cover, tree and brush trimming, grass mowing with a tractor, and catch basin cleaning. Winchester DPW provided the researchers with four lists of roads included in special plow routes. These roads are the main roads of the town, and therefore DPW sweeps them three times a year, repaints the centerlines twice a year, and cleans the catch basins located along them once a year. These lists were consolidated into one document by the researchers, and included in the appendix. Those roads not included on this list are only swept once a year, do not have centerlines, and have catch basins cleaned once every other year.
The before-mentioned maintenance activities, in general, do not increase the service life of infrastructure. However, the municipality must account for these activities when developing an accurate representation of their expenses.

5.2.1 Meta Segment Maintenance Data Input Process:

The process required to input the maintenance data into Barchan is as follows:

- Under the Assets heading, select an area of the map, thereby displaying the list of meta segments contained in that region in a list on the right-hand side of the screen.

- Right-click on a selected meta segment and choose “Maintenance” from the pop-up menu.

- In the maintenance dialogue box, check the boxes beside the appropriate maintenance tasks that the town provides. Then enter the number of times per year that those items are done into the appropriate spaces. For catch basin cleaning, the number of catch basins located in that meta segment must be entered as well.

An example screen shot showing a selected meta segment, Albamont Road, and its corresponding maintenance dialogue box follows:
5.2.2 Meta Segment Maintenance Recommendations:

The researchers offer two suggestions to the Barchan developer:

- The client is required to enter the number of gate valves located in a meta segment twice: first during the meta data input process, and again during the maintenance data input process. If possible, the developer should incorporate a link between the two dialogue boxes so that the client only needs to provide Barchan with the information once.

- Barchan will not accept a fraction as the number of times per year that a maintenance activity as performed (the fraction is automatically rounded when the
client chooses to save changes). Therefore, the client cannot accurately account for activities such as catch basin cleaning that may only occur once every other year. If possible, the developer should incorporate the ability to enter fractional inputs into dialogue boxes.

5.3 *Meta Segment Condition Assessment:*

Following the maintenance schedule input process described above, the *Barchan* administrator and researchers for this project began to develop a methodology for first condition assessments of Winchester's streets. These condition assessments will be transferred to a quality degradation curve under the Assessment tab in *Barchan*, along with observed repair requirements and recommended activities. This assessment is then used to determine the current value of individual infrastructure assets and to generate maintenance scenarios for resource optimization, according to the requirements of GASB Statement 34.

The *Barchan* administrator and project researchers drove a small portion of Winchester's road network together on April 28, 2003 to understand how the condition assessment process worked and to enter a small number of initial condition assessments. *Barchan* personnel entered the balance of the condition assessment information between April 28 and May 7, 2003.

Assessment logs were used to record observed conditions, repair items, and recommended activities. Assessments were assigned a quality percentage, with 100% being a "perfect" road with no perceptible defects. In general, the goal of *Barchan*’s infrastructure management capabilities is to allow local managers to maintain a 70% condition rating across their infrastructure portfolio. This condition level allows for sufficient roadway conditions to be maintained while still enabling a broad and efficient allocation of maintenance resources. Assessments are grouped into the following categories:

- Maintenance – Condition rating of 70% to 85%. Roads in this category are free from major defects, and therefore no activity recommendations are made. Repair and maintenance items observed include isolated crack sealing, isolated patching, isolated pot hole repair, isolated full depth repair, as well as regularly scheduled activities such as street sweeping.
• Light Preservation – Condition rating of 50% to 70%. Whereas roads in the Maintenance category are in a general state of good repair with isolated anomalies, roads in the Light Preservation category are in a general state of declining quality. This is characterized by rutted, uneven pavement surfaces requiring widespread crack sealing, patching, and shoulder leveling. Recommended activities for this category include sand sealing, fog sealing, or rubberized asphalt sealing. Performance of these recommended activities results in a quality assessment adjustment to 75% in Barchan’s inventory condition.

• Heavy Preservation – Condition rating of 25% to 50%. The quality of roads in this category is severely diminished, such that patching repairs would offer little to no solution. In this case, recommendations must be made for segment-wide change activities. These activities include cold milling and leveling overlay, chip sealing, and open graded friction coursing. Performance of these recommended activities results in progressive adjustments to Barchan’s condition assessment, as displayed in the appendix of this report.

• Addition Reconstruction – Condition rating of 0% to 25%. Roads in this category are virtually un-drivable. Recommendations for this category involve construction of additional lanes and reconstruction of the street altogether. Performance of these recommendations will result in an adjustment in condition assessment to 100%, as these will be “new” streets.

5.3.1 Meta Segment Condition Assessment Process:

The process for transferring condition assessment data from field assessment logs to Barchan is as follows:

• Under the Assets heading, select an area of the map, thereby displaying the list of meta segments contained in that region in a list on the right-hand side of the screen.

• Right-click on a selected meta segment and choose “Assessment” from the pop-up menu.
On the condition graph located on the left-hand side of the dialogue box, click on the appropriate condition assessment percentage. This will become the "Initial Condition," and will be noted at the top right corner of the dialogue box.

If any repairs were noted on the field assessment log, enter the quantity of each and the respective condition percentage deduction in the appropriate input boxes. The initial condition will be automatically adjusted according to the deductions, and an "Adjusted Condition" will be displayed directly below the "repairs" section of the dialogue box.

If any recommended change activities were noted on the field assessment log, choose the appropriate one from the scroll down menu located below the repair input boxes. When actually completed, these activities will improve the condition assessment of the meta segment. Therefore, in Barchan, when a change activity is noted in the "Assessment" dialogue box, the adjusted condition is automatically increased, and becomes the "Resulting Condition," displayed directly below the Recommended Change Activity portion of the dialogue box.

After all inputs are complete, the client must click on the "Create" button. This causes another pop-up box to appear, asking the client, "The assessment will become permanent and unchangeable, create segment?" If the client chooses the continue option, the condition is saved.

An example screen shot showing a selected meta segment, Albamont Road, and its corresponding assessment dialogue box with accompanying create pop-up follows:
This screen shot shows that Albmont Road was given an initial condition assessment of 63%. In addition, it was noted that the meta segment required 40 m of full depth asphalt repair, a problem that decreased the initial condition by two percentage points, creating an adjusted condition of 61%. Furthermore, it was recommended that the meta segment receive a fog seal. Upon completion of this, the assessment of the road would increase to the resulting condition of 75%.

5.3.2 Meta Segment Condition Assessment Discussion

The development of and adherence to a standard condition assessment methodology is critical to the accuracy and usefulness of maintenance scenarios and resource allocation schedules generated through Barchan. For example, Barchan allows local governments to explore maintenance scenarios based on the distribution of condition and distribution of value of infrastructure assets across their respective towns. To ensure that these distributions accurately
reflect actual conditions, the same markers of condition assessment must be applied to every evaluation to achieve a level of precision among assessors.

While this directive is very straightforward, the process of developing and implementing a standard condition assessment methodology is in no way a simple task. The condition categories described above are very broad, and it is relatively easy to assign individual streets to one of the four categories. However, condition assessments and quality ratings within the categories are critical to the development of an accurate profile of infrastructure condition and value.

In a typical town, most infrastructure assets will fall within the Maintenance and Light Preservation categories. As such, their ratings will likely be within 10 to 20 percentage points. However, the condition assessments of streets within the same category can vary dramatically. This means that condition assessment variations of as much as 2 or 3 percentage points could indicate significant differences in actual roadway conditions. A proposed methodology to ensure precision in condition assessment is discussed in the next section.

5.3.3 Meta Segment Condition Assessment Recommendations:

Researchers for this project propose the implementation of quality control mechanisms in the condition assessment process to achieve a level of precision among different assessors for a given infrastructure inventory.

First, all assessors should perform an initial assessment as a group, discussing individual observations and resulting condition assessments for a given street. This allows identification of a common set of markers to be used in an agreed upon rating system. Individual assessments can then be carried out independently using the common rating system. After all streets have been assessed, a sampling of these streets should be evaluated by a different assessor, and the results compared with the original assessment. Discrepancies can then be discussed and resolved cooperatively. This quality control procedure will help ensure that assessments accurately reflect even the smallest differences between street conditions in the client’s infrastructure portfolio.
Chapter 6  Scenario Analysis

After the initial configuration of a town's inventory within Barchan is complete, users can then use the Scenarios function to develop a maintenance, repair, and action item log. By providing Barchan with a proposed budget and the desired overall inventory condition, the researcher is provided with a summary of suggested activities that will achieve the desired condition. Before developing a scenario in Barchan, the client should determine a proposed budget and the desired overall condition of the town's assets. After this decision is made, Barchan can be used as a tool to map out what improvements should be made to the infrastructure inventory to achieve the desired overall condition within the budget constraints. These improvements relate directly to the initial condition assessment and maintenance schedules entered earlier in the configuration process. The improvement activities prescribed during the scenario analysis are based on the initial condition, the needed repairs, and the recommended change activities input by the client.

6.1 Scenario Analysis Methodology:

Barchan is not a probabilistic program, meaning that it will not use a variety of complicated algorithms to decide where an available budget should be spent to optimize the resulting overall condition. Instead, it is a tool that allows the client to easily display the cumulative effect of maintaining, repairing, and performing change activities to certain roads on the overall available budget and total infrastructure condition. When developing a scenario, the information that Barchan uses to create a scenario comes directly from the client's previous inputs during condition assessment and maintenance scheduling. Regardless of the budget and target condition requested by the client, the program will automatically account for all maintenance, repair, and change activities previously input, and determine the cost to perform them and the condition that will result from their completion. For the town of Winchester, maintenance refers to activities such as centerline painting, street sweeping and catch basin cleaning. While these activities do not affect the condition of a road, they require funding, and therefore are accounted for in a scenario analysis. Repair and change activities are input during condition assessment, and refer to activities like full depth repairs, crack sealing, and surface course patching for repairs and fog sealing, rubberized asphalt sealing, and cold milling for change activities. After displaying all of these recommended activities in a new scenario, Barchan will calculate the total cost of each category (maintenance, repair, and change activities) and both display that sum and deduct it...
from the client-provided budget. Remaining funds will be shown as a positive or negative amount, depending upon whether the budget was enough to cover all recommended activities.

There are four variables that the client can manipulate when developing a series of scenarios: money, timing, level of service, and choice of fix. The owner can vary the amount of money used by providing Barchan with a series of different budgets to determine the required funding to complete the needed activities. Changing the budget as a sole variable will only affect the remaining funds shown in a scenario analysis. Barchan will still calculate the funds needed to complete the activities input during condition assessment and maintenance scheduling, and display the difference as either positive or negative in the remaining funds box. Similarly, simply changing the target condition, or the desired overall level of service, will not affect either the remaining funds or recommended activities because Barchan will still account for all activities input during condition assessment. Therefore, the client must change the requested maintenance, repair, and change activities (choice of fix) in order to affect the required budget and the resulting overall condition. The most direct changes can be made to change activities by simply clicking on the displayed activity in a scenario and choosing an alternate fix. If the client wants to manipulate the timing of certain activities, he can delay that action by choosing “none” from the drop-down menu. Choosing to not perform a suggested change activity will immediately increase the remaining budget and decrease the overall condition. However, that activity’s affect on the overall condition may be so fractional that it will not decrease the percentage by a whole point on its own. Rest assured, if several more change activities are changed to “none”, the program will respond by lowering the overall condition rating. Rather than choose to do nothing to a road, the client can also examine the affect of choosing an alternate change activity in the scenario analysis. Barchan recognizes both the cost of each change activity and the condition of the road that will result from its completion. While several activities may increase a road to a condition of 75%, and therefore have the same affect on the overall condition, they will have different costs, and thus different affects on the remaining budget. The client can also alter the remaining budget and resulting condition by changing the maintenance and repair activities. However, this process is much more involved than manipulating the change activities because Barchan does not allow the client to alter these activities inside the scenario analysis window. Instead, the client must make new condition assessments to change the recommended repair activities, and a new maintenance schedule to
change the required maintenance activities. After these changes are made, the client can then examine the affect of increasing or decreasing the maintenance routine on the remaining budget, and changing recommended repair activities on both the remaining budget and overall condition.

A typical client will develop a wide variety of scenarios to decide how he should spend his budget most effectively. For example, if the client is faced with a budget constraint, as he most likely will, he may want to investigate several different approaches to utilizing this budget. He can decide to focus on those roads that have an extremely low initial condition in an effort to improve the town’s overall infrastructure condition. On the other hand, he could decide to let those roads continue to deteriorate until they need to be completely replaced, and instead focus on keeping acceptable roads at an optimal level of service via regular crack sealing. He can also focus on a certain change activity such as rubberized asphalt sealing or open-graded friction coursing, and determine the effect of its sole usage on the overall condition of the road and the remaining budget.

6.2 Scenario Analysis Process:

The following steps are required to develop a scenario in Barchan:

- Click on the Scenario tab at the top of the Barchan screen and create a new scenario by choosing the appropriate command button with a mouse click.

- A “New Scenario” dialogue box will appear. Enter a scenario name, a proposed budget, and a target condition in the respectively named input boxes. Choose the create command to proceed.

- Barchan will produce a log showing all meta segments located in the town, the costs to complete the normal maintenance input during maintenance scheduling and the needed repairs and recommended change activities noted during the condition assessment, the cost to complete those change activities, the total cost to improve the meta segment, and the condition that will result when those changes are completed.
The total funds required for maintenance, repairs, and major changes are noted at the top of the screen. If the budget exceeds the funds required to increase the condition to the target, the remaining dollar amount is shown. This number will be negative if the budget was insufficient.

- The original (current), target, and new conditions are also displayed. The new condition will be realized once all of the recommended repairs and change activities are completed.

- The client can either increase or decrease the remaining funds, and therefore the new condition, by adding, altering, or removing change activities for the various meta segments.

A sample screenshot displaying a draft scenario follows:

Figure 7  Example Scenario Screenshot
6.3 Scenario Analysis Creation and Discussion:

To demonstrate the various scenarios that a Barchan client may develop to determine an appropriate budget request and allocation program, the researcher created several mock scenarios for the town of Winchester. These scenarios illustrate how a town manager can conduct several studies and decide how he might make the best use of budgeted funds. To avoid changing the condition assessments and maintenance scheduling for Winchester's meta segments, the researcher did not alter the recommended repair and maintenance activities. Instead, the researcher focused on altering change activities because Barchan allows a client to directly experiment with different change activities in a scenario analysis without affecting the previously input information.

6.3.1 Reference Scenario I

The first scenario created by the researchers was to be used as a point of reference. By entering a budget of zero and a target condition of 71%, the researchers sought to find the funding required for normal maintenance and needed repairs for all roads in the town, regardless of whether they are public or private. No changes were made to the change activities previously recommended during condition assessment. In the resulting scenario analysis report, it is noted that the budget needed to perform all of the regular maintenance activities, repair items, and recommended change activities noted during condition assessment is about $2.51 million and the resulting overall condition is noted as 73%. The required maintenance budget for all roads in the town is about $169,000, or about 7% of the total budget. The remaining 93% is needed for repair and change activities. Barchan immediately totals the funds required to complete all maintenance, repairs, and change activities entered during condition assessment, regardless of the budget entered. If the town manager chooses to complete all of these activities, the overall condition of the town will increase from a rating of 70% to 73%. Any changes made to the scenario in the form of modifying the suggested change activities will alter the overall resulting condition and required budget. From this scenario, the researcher learned what budget is required to complete all initially recommended maintenance, repair, and change activities ($2.51 million) and the resulting overall condition (73%). From this benchmark, the researcher could then explore the
effect of altering the change activities for some or all of the town’s roads on the budget and the overall condition.

6.3.2 Exclusion of Private Roads, Scenario II

It is important to note that the budget of $2.51 million accounts for activities pertaining to private roads as well as public and state roads. Barchan does not recognize the difference between ownership of infrastructure when developing a budget. Therefore, acting as a public agency that does not want to account for the funds needed to maintain and repair private roads, the researcher developed a scenario where no change activities were applied to private roads. This was accomplished by giving Barchan a budget of $2.6 million and a target condition of 73%. Barchan allows the client to manually adjust the recommended change activities within the scenario analysis, so the researcher changed all change activities for the private roads to “none”. The resulting overall condition for Winchester decreased to 72% when no change activities were applied to private roads and savings of $120,317 were realized when compared to the reference scenario. Using total meta segment lengths, the researcher calculated that private roads account for approximately 26.2 kilometers, or 16.6%, of the total Winchester road network of about 157.5 kilometers. Therefore, it can be estimated that 16% of the maintenance and repair activities needed throughout the town, approximately $270,350, is contributed to private roads. Expounding upon this information, a client could state that residents of private roads should be billed approximately $390,000 for the cost of private road maintenance, repairs, and change activities. These residents could be given the choice of having those actions completed or allowing their roads to deteriorate. Regardless, the client would also know that he needs a budget of approximately $2.12 million to complete all maintenance, repairs, and change activities recommended during maintenance scheduling and condition assessment. If this budget is not available, he could manipulate the change activities until he reaches an acceptable budget. Because the current edition Barchan still accounts for the condition of private roads when determining the resulting overall town road condition, the client can not accurately account for the effect of altering change activities for public roads on the overall condition of public roads without deleting private road meta segments from the inventory.
6.3.3 Effect of Choosing Certain Repair Methods, Scenarios III-VII

A town manager might decide to explore the cost savings and resulting condition assessment of utilizing various different repair activities. To illustrate this ability, the researcher developed several scenarios focusing on a single repair activity. To minimize variable, all budgets were given a budget of $2.6 million, a target condition of 71%, and were compared against a standard control scenario that accounted for the change activities recommended during condition assessment. Because of the inability to easily differentiate between public and private ownership for budgeting during scenario analysis, all roads that already had a recommended change activity, regardless of ownership, were subjected to the experiment. The researcher used rubberized asphalt sealing, fog sealing, cold milling, double chip sealing, and open-graded friction coursing as options that a town manager may decide to solely use. The results of this methodology are shown in the following table.

<table>
<thead>
<tr>
<th>Focus Change Activity</th>
<th>Remaining Budget ($)</th>
<th>Total Cost ($)</th>
<th>Change Total ($)</th>
<th>Savings Over Control (%)</th>
<th>Resulting Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (Using Recommended Change Activities)</td>
<td>92428</td>
<td>2507572</td>
<td>817880</td>
<td>0</td>
<td>73</td>
</tr>
<tr>
<td>Cold Milling</td>
<td>-1347929</td>
<td>3947929</td>
<td>2258237</td>
<td>-57%</td>
<td>74</td>
</tr>
<tr>
<td>Double Chip Seal</td>
<td>494208</td>
<td>2105792</td>
<td>416100</td>
<td>16%</td>
<td>74</td>
</tr>
<tr>
<td>Fog Seal</td>
<td>785014</td>
<td>1814986</td>
<td>125294</td>
<td>28%</td>
<td>73</td>
</tr>
<tr>
<td>Open-Graded Friction Course</td>
<td>365820</td>
<td>2234180</td>
<td>544488</td>
<td>11%</td>
<td>73</td>
</tr>
<tr>
<td>Rubberized Asphalt Seal</td>
<td>623998</td>
<td>1976002</td>
<td>286310</td>
<td>21%</td>
<td>73</td>
</tr>
</tbody>
</table>

Figure 8   Single Change Activity Summary

As shown in the table, the same resulting overall condition can be achieved with a wide variety of budgets. For example, a client could decide to use either cold milling or double chip sealing for all change activities, both of which will provide an overall condition of 74%. However, while cold milling will cost 57% more than using the change activities recommended during condition assessment, double chip sealing will save 16% over the control scenario’s required budget. The following graph compares the cost of using only one type of change activity to the resulting overall condition of the town.
Figure 9  Effect of using a sole change activity method on total change activity cost and resulting overall condition.

While a town manager most likely would not decide to use only one method to increase the condition of infrastructure assets, such as study illustrates the fact that there are a variety of approaches, with a wide range of costs, to reaching a desired overall condition. Although several change activities may provide similar resulting conditions, some methods will produce much longer-lasting results than others. It is often said that every dollar spent in timely pavement maintenance will save four to five dollars in future rehabilitation costs.\textsuperscript{16} Therefore, a client has two ways of viewing the information gleaned from the above analysis. First, he can use the cheapest possible change activity, fog sealing, on all roads needing work to bring the overall condition of the town up to 73\%, thereby using the smallest possible budget, thereby providing the taxpayers with short-term satisfaction. However, such an approach will not be a long-term fix as cold milling the entire road and replacing it. While this is a very expensive process, it will

not have to be repeated nearly as often as other change activities. Thus, a client may decide to utilize his budget by only cold milling as many roads as possible over several years.

6.3.4 Scenario VIII

The researcher developed Scenario VIII to illustrate other possible methods that a town manager may take to asset management. If forced to comply with a budget of $1.9 million the client will obviously have to make severe cuts since $2.5 million is needed to complete all recommended maintenance, repair, and change activities. The researcher decided to attempt to comply with this budget by not committing any change activity funds to roads with less than a 60% initial condition assessment. A client may make such a decision because attempting to maintain the condition of such roads is like throwing money into the proverbial bottomless pit. Therefore, instead of spending money on these roads, the client could wait until they need to be completely replaced at a later date, thus bringing them to a 100% condition. The researcher started with a budget of $1.9 million and a target condition of 72%. After changing all of the change activities to “none” for those roads with a current condition of less than 60%, the researcher noted that the overall condition of the roads decreased to 71%, and the remaining budget was $58,635. Thus, by ignoring the already declining roads, the client is able to continue to improve those at a decent condition and stay within his allotted budget. The remaining budget could be used to increase the condition of several other roads in the town. Because the problems associated with those roads with a condition greater than 60% have been alleviated, the client could begin to focus on the deteriorated roads with following years’ budget allotments.

6.3.5 Other Possible Scenario Investigations:

There are a variety of other scenarios that a client could explore while either requesting a budget allotment or trying to satisfy one. A town manager will obviously be very knowledgeable of the traffic patterns, most heavily traveled roads, and of various politically important infrastructure assets. If given a set budget, the manager could use Barchan to develop maintenance, repair, and change activity options for the city council to choose between, thereby alleviating himself of the final decision. It has been said that a good engineer does not tell his client exactly what they should do with their money, but rather gives them several viable options that they can then choose from. In this matter, programs such as Barchan serve as a good tool for the engineer to
illustrate to his clients their options. For example, the town manager can choose to aggressively maintain the most heavily traveled roads and ignore those that are seldom used or to constantly apply rubberized asphalt sealing to those roads in an effort to maintain their current condition as long as possible without investing heavily in reconstruction. In this manner, the most heavily traveled roads will have consistently high conditions corresponding to their usage. Because these are the roads that most taxpayers will see, public contentment will be maintained while the lesser-traveled roads are reconstructed slowly over several years. A client could also use Barchan to focus on certain areas of a town at one time. The roads in one quadrant of the town could be identified for change activities, and a corresponding budget developed. By focusing on a single quadrant per year, the manager could isolate the impact of construction by year.
Chapter 7  ABA 2000 Model Procurement Code Developments and Barchan Applicability

Regulatory frameworks covering the private sector delivery of infrastructure facilities and services have been undergoing a major change since 1990.17 “Public infrastructure “ is increasingly understood by researchers, policy makers, and (public and private) construction industry practitioners as a mixture of private sector contributions in initial design and construction, followed by various combinations and mixes of public and private operation and maintenance contributions.18 The American Bar Association originally developed its recommendations for governmental procurement strategies and placed them in the 1979 edition of the ABA Model Procurement Code for State and Local Governments. This Code was fully adopted by sixteen states, and by a wide variety of local municipalities across the United States. The basic principles of this code became “bedrock notions in the American law associated with public procurement.”19 For decades, the basic project delivery method for public procurement has been traditional design-bid-build.20 This sequential process requires the public agency to first develop a complete design for a project by either using in-house designers or by contracting with a design firm to produce the necessary plans and specifications. Once this design process is complete, the purchasing agency may then seek construction bids to have the project realized. While this delivery system is adequate for many projects and encourages fair competition among construction firms, it also has a variety of shortcomings. These shortcomings are addressed in the 2000 update of the procurement code developed by Margaret E. McConnell, former Director of Procurement for Arizona, and MIT Professor John B. Miller. The revised code adds several new authorized project delivery methods. Included in this list of newly authorized methods are design-build,21 design-build-finance-operate-maintain,22 design-build-operate-maintain,23 and

17 Miller, Principles of Public and Private Infrastructure Delivery, supra, Chapter 3, pp. 79 et seq.
18 Miller, Principles, supra, Chapter 5, pp. 281 et seq.
20 The 2000 Model Procurement Code for State and Local Government, supra, Overview, at pages xiv and xv. The Overview also provides a good summary, along with the Reporters notes contained in Article 5, as to how the various project delivery and finance methods can now be simultaneously used to address the long-term problems associated with managing large, complex, infrastructure networks.
operations and maintenance. The general characteristics of these project delivery methods, as described in the 2000 Code, are shown below:

- **Design-Build:** The Purchasing Agency enters into a single contract for design and construction of an infrastructure facility.

- **Design-Build-Finance-Operate-Maintain:** The Purchasing Agency enters into a single contract for design, construction, finance, maintenance, and operation of an infrastructure facility over a contractually defined period. No state funds are appropriated to pay for any part of the services provided by the contractor during the contract period.

- **Design-Build-Operate-Maintain:** The Purchasing Agency enters into a single contract for design, construction, maintenance, and operation of an infrastructure facility over a contractually defined period. All or a portion of the funds required to pay for the services provided by the contractor during the contract period are either appropriated by the [State] prior to award of the contract or secured by the [State] through fare, toll, or user charges.

- **Operations and Maintenance:** the Purchasing Agency enters into a single contract for the routine operation, routine repair, and routine maintenance of an infrastructure facility.

By making the above-mentioned project delivery methods available to government procurement agencies, the 2000 Model Procurement Code has largely decentralized the decision making power for infrastructure maintenance. Rather than being forced to rely upon a single approved procurement strategy, local municipalities now have the authorization to choose between a variety of delivery methods, picking the one that best suits the specific situation in question. A town in need of infrastructure development and maintenance is now able to develop its own

---


unique strategy of mixing and matching six different procurement strategies that will give its citizens the best value for their tax dollars.

7.1 The Impact of Flexible Procurement Options and Good Engineering Information

With the availability of new procurement options, local governments have increased flexibility when deciding how to maintain their infrastructure. With this flexibility comes the need for easily accessible information for intelligent decision-making. These local governments can strongly benefit from having a single source of information pertaining to their current assets, available budgets, and needed improvements. By having this information readily available, they can better decide how to combine various delivery methods to maximize the return on taxpayer money. The availability of this engineering information provides transparency for the basis behind procurement decisions both internally and between other similar agencies and potential privatization corporations.

7.2 Examples

Two of the newly authorized procurement methods, Operations and Maintenance and Cooperative Purchasing are particularly applicable to local-level asset management. The author has developed two examples that illustrate the applicability of Barchan to facilitating clients who wish to utilize one of the new procurement methods authorized in the 2000 Code.

7.2.1 Introduction of Operations and Maintenance as an Accepted Project Delivery Method

If Operations and Maintenance is now recognized as an accepted project delivery method and web-based services like Barchan are supplying reliable information about the current status, condition, and cost of an infrastructure network, its public managers will have the information at their fingertips to tailor how public employees combine with private contractors to more efficiently manage public assets. In the ABA Code, Reporters, Miller and McConnell define Operations and Maintenance as “a project delivery method whereby the Purchasing Agency

---

26 There will always be public employee and private contractor components to public infrastructure management. Neither a public nor private sector monopoly in this field has proven to be stable, efficient, or wise. See, Miller, Principles, supra, Chapter 5, A Path Through.
enters into a single contract for the routine operation, routine repair, and routine maintenance of an infrastructure facility.” Traditionally, public agencies have relied upon the design-bid-build procurement strategy for infrastructure development, and their own in-house maintenance departments for the operation and upkeep of the infrastructure. This revision to the Code allows municipal management officials the flexibility to adjust the mix between maintaining infrastructure with their own personnel and using competitive sealed bidding to out-source operation and maintenance to private sector organizations.27

7.2.2 Barchan Applicability to Example Situation One

A town such as Winchester traditionally spends a significant amount of its maintenance budget on the repair and upkeep of private roads. Some residents may argue that because they pay taxes, the town should maintain these private roads; however, the town does not accept such roads and, therefore is not legally bound to maintain them. Using Barchan, a town manager can create a scenario where he filters the assets by either public or private ownership. Then, the manager can inform residents who live on these private roads exactly how much the town spends to maintain these unaccepted roads each year. After being told that the town will no longer foot the bill to maintain the private roads, the residents of each street can vote to pay the town additional stipends to continue the maintenance, or request to contract for upkeep independently. This information can then be added to Barchan, and town officials can decide if they want to dedicate their personnel to private road maintenance, or out-source such duties to an independent operations and maintenance contractor. The town official is able to develop and illustrate choices to offer to residents using Barchan as a tool. The client could easily create other scenarios within Barchan to determine other options that the town could explore to economize its maintenance routines. For example, the manager may decide that he no longer wants to use his own personnel to paint centerlines, street sweep, or clean catch basins. After creating a scenario that illustrates how much the town spends on such activities, the manager could then post a request for bids for privatization of those maintenance items. If a private firm enters a bid for

27 Again, the dividing line between public and private has constantly moved over time, as advances in knowledge, materials, equipment, and construction techniques have evolved. This evolution is not new! What is new is the potential to make this evolution transparent, and, in the end, to make better decisions that are enabled by flexible procurement laws and better engineering information.
less than what the town currently spends, a contract could be issued for a specific time period, and town maintenance personnel could devote more of their time to repairing potholes and other more serious problems.

7.2.3 Benchmarking Strategies

Before entering into privatization contracts, a local government should first understand its current abilities and limitations. Such benchmarking provides the agency with a basis for deciding on a proper procurement strategy. If the agency fully understands the amount of maintenance it is required to supply, and its current cost to do so, it can accurately access the benefits of outsourcing such work. Without proper benchmarking, it is impossible for the agency to know whether or not privatization is beneficial to the government. In addition, maintaining proper information about the requirements and capabilities of the agency will enable the agency to properly function if the privatization contract is terminated.

7.2.4 Privatization of Highway Maintenance in Virginia

Programs such as Barchan are not only useful to public agencies seeking to be more efficient in their maintenance routines and methods. Barchan provides the benchmark data from which decisions can be made on whether or not it makes sense to enter into operation and maintenance contracts with private firms. As illustrated by the privatization of the maintenance of a portion of Virginia’s highway infrastructure, the company to whom the O&M contract is issued can also greatly benefit from an asset management tool. VMS, Inc was awarded a contract for operation and maintenance of 250 miles of interstate highway for an initial five years. Virginia has estimated that over the five-year contract, it will save 17% of its normal budget allocated for maintenance. VMS also has highway asset management contracts in Alaska, Florida, Oklahoma, and Texas.28 Central to the success of this privatization effort has been an asset management program developed by ERES, and named Highway Quality Management System (HQMS). Like Barchan, HQMS utilizes inventory condition data to establish priority programs and plan

short- and long-term budget needs. A company using such information to manage a municipality's infrastructure has an obvious competitive advantage over one that does not.

While this privatization contract has worked well for Virginia during the past five years, there is no way to foresee the future. In addition, even though VMS is contractually obligated to maintain the highways under its jurisdiction to a certain condition, because of GASB 34, and for its own knowledge, Virginia should still maintain its own database of infrastructure condition and maintenance requirements using a program such as Barchan. Ideally, the State and the contractor could jointly operate the system whereby Virginia maintains the database, and VMS is required to accurately update conditions. Therefore, Virginia could still easily report the condition of its infrastructure as part of its financial statements. Also, upon fulfillment of the contract or replacement of the contractor, Virginia would always have an up-to-date assessment of its infrastructure to use as a basis for current and future decision-making.

7.3 Bulk Purchasing/Cooperative Purchasing Among Governments

A second important development in public procurement acknowledged in the 2000 Model Procurement Code is the authorization of cooperative purchasing. In Article 10, the new Code defines a public procurement unit as any public agency that is allowed by law to expend public funds to acquire supplies, services, and construction. The new Code stipulates that a group of public procurement units may join together and create a cooperative purchasing group that will act as a single procurement unit. These cooperative-purchasing groups can then contract a vendor to provide all included parties supplies, services, and/or construction. An obvious benefit of such a relationship is that a small, under-funded jurisdiction can band together with other similar municipalities, and receive economy of scale pricing.

In addition to allowing local municipalities to form cooperative purchasing groups, the new Code also allows the individual procurement units to behave as service providers to other units. The new Code specifically dictates that, pursuant to the agreement between two or more public

---

29 Eye on ERES Magazine, Privatized Highway Asset Management and Maintenance, Volume 5, Number 3
procurement units, one may provide personnel to the other(s), and will in return receive the direct and indirect cost of furnishing the personnel.

Cooperative purchasing of information technology is currently or in the process of being implemented throughout the United States. For example, the entire State of Texas is involved in the Texas Cooperative Purchasing Network (TCPN). All public and private schools, colleges, universities, cities, counties, and other government entities in the State of Texas are authorized to join. Upon becoming members of this cooperative purchasing group, the members benefit from state of the art purchasing procedures that insure the most competitive contracts, price solicitation and bulk purchasing that yield economic benefits unobtainable by individual entities, quick and efficient delivery of goods and services by contracting with "high performance" vendors, and equalized purchasing power for smaller entities that are not able to command the best contracts for themselves. In addition, TCPN maintains credibility and confidence in business procedures by sponsoring open competition for purchases and by complying with purchasing laws and ethical business practices and assists its entities in maintaining the essential controls for budget and accounting purposes.31

It is important to note that the authorization of cooperative purchasing in the code applies to the procurement of supplies, as implemented by TCPN, but also to construction activities. Therefore, using TCPN as an example, the obvious next step is for individual municipalities to create cooperative purchasing agencies that will both utilize their size to demand more attractive contracts and to develop a larger pool of available talent and resources.

7.3.1 The Implications of Good Engineering Information on Cooperative Purchasing

Cooperative purchasing has a great potential to decrease the burden of supply procurement and providing maintenance activities on a single agency by spreading the responsibilities out between several municipalities. However, an agency that has become quite used to being self-reliant may have difficulties expressing its current needs and constraints to members of a cooperative purchasing group. If each member of a cooperative purchasing group were able to first accurately assess its current needs and capabilities, and then compare those requirements and

31 http://www.tcpn.org/
abilities with the other members, a prosperous relationship would ensue. Systems such as Barchan can and should be used to ease the transition into cooperative purchasing and resource sharing.

7.3.2 Example Scenario

Assume the following scenario.

Three neighboring counties decide to create a cooperative purchasing group with the hopes of creating economies of scale and increased efficiency in maintaining the infrastructure located in the combined area. The individual counties felt that choosing neighbors for their cooperative purchasing group would be most beneficial because of the ease in personnel transfer and because many segments of the existing infrastructure network crossed their mutual boundaries. Because of a burgeoning population, inadequate funding, and understaffing, the current infrastructure in the tri-county area was in need of not only normal repair and maintenance, but also replacement and addition. County A has an excellent engineering staff whose design output ability far overshadowed the available funding. County B has an operations and maintenance department with few rivals. The supervisors are some of the best in their field, but are limited in their effectiveness by a shortage of affordable supplies. County C has connections to several enterprising suppliers who are willing to reduce prices in exchange for a considerable increase in business. After the competitive sealed bidding process described in the ABA Code is completed, the new cooperative purchasing group first contracts with the supplier currently serving County C to provide enough supplies for the entire tri-county area. Second, the engineers from County A are given the duties of designing needed improvements to the infrastructure of the tri-county area. The supervisors of the County B operations and maintenance staff will combine their personnel with those of the other two counties, form and train specific task groups, and oversee the maintenance of the tri-county area's infrastructure. Specifically, County B may be given the duty of repairing all potholes within the tri-county area. Using Barchan, all needed pothole repairs could be identified, and an appropriate schedule mapped out. Upon the completion of the repairs, each county would be summarily billed for those repairs undertaken within its boundaries. Because the needed upkeep activities would be identified in Barchan and agreed upon before any action were taken, all members of the cooperative purchasing group would
understand how and where budgeted funds were spent, thereby hopefully preventing any misunderstanding.

In competing the work, the group of Counties uses the Barchan estimated costs as the ceiling price vis a vis bids submitted by private sector contractors. In other words, in order for the work to be privately performed, the bid prices received from the private sector must be x% lower than the cost estimated from the Barchan asset management system. In essence, the engineering information supplied to the managers from systems like Barchan provides the benchmark for making public/private decisions with known economic and performance impacts on the existing network.\(^{32}\)

While the members of the cooperative purchasing group agree to utilize each other’s abilities to increase the efficiency of infrastructure maintenance throughout the tri-county area, there are bound to be misunderstandings and resulting conflicts relating to favoritism to one’s home county. For example, the citizens of one county may complain that the infrastructure of that county is being ignored while that of another county is receiving more than its fair share of improvements. A second issue relating to cooperative purchasing and inter-municipal personnel exchange is that, despite agreements to work as a team and seemingly ignore county boundaries, each town is still responsible under GASB 34 regulations to account for its assets individually.

An asset management tool such as Barchan can be useful to public procurement units choosing to join a cooperative purchasing group and/or participate in an personnel exchange program. Just as Barchan can be used as a tool to monitor asset maintenance and its associated budget in a single municipality, it can also be utilized when managing the infrastructure of multiple agencies at once. Having a single source for the current infrastructure condition, recommended maintenance schedule, needed improvements, and required budget for a cooperative purchasing group will greatly reduce the above mentioned issues from becoming problematic. The member municipalities can each determine the budget allocated for infrastructure maintenance in their

\(^{32}\) For example, it may be the policy of this group of Counties that for particular categories of work, public sector employees will provide the necessary services unless the cost of equivalent services in the private sector are more than 15% less than currently experienced in the public sector. The rationale for such an approach might be that the Counties never want to be in the situation where temporarily “low” private sector prices are accepted, only to discover that these low cost levels cannot be sustained.
respective jurisdiction and stipulate what the target condition for their infrastructure. With minimal changes to Barchan, its cooperative clients should be able to utilize the system as a tool to provide a transparent report to any interested party detailing how and where the group budget is expended.

While in a perfect world, all contributing members of a cooperative purchasing and maintenance group would have the same amount of infrastructure inventory, available budget, and current and target conditions, this is much too optimistic. Therefore, any tool used for cooperative management practices should be able to differentiate between the funds allotted and the services required of its member agencies. Just as the researchers recommended that Barchan developers allow the client to differentiate between public and private infrastructure when developing a scenario, cooperative clients could separate scenarios by jurisdiction while still creating a maintenance schedule for the entire group. Barchan has the potential to offer enough flexibility to allow cooperative jurisdictions to combine their efforts while still maintaining their individuality for reporting purposes. Using such a web-based asset management system, the clients could quickly show any dissenters the portion of the cooperative budget contributed by a specific jurisdiction and the corresponding level of attention paid to improving that jurisdiction’s infrastructure. However, by also allowing the group to schedule maintenance and repair activities as a single entity, joint operations teams can determine the best method for applying their skills and resources to the benefit of all members of the cooperative group.
Chapter 8 Conclusions

_Barchan_ has a variety of possible uses, from easing the transition into GASB 34 compliance to facilitating cooperative purchasing, and improved practices for asset management. With the authorization of new project delivery methods in the 2000 ABA Model Procurement Code, public owners have a variety of new strategic options to effectively and efficiently maintain their infrastructure assets. Asset management systems such as _Barchan_ provide unbiased, transparent information to clients, regardless of their business affiliations or if they are members of the public or private sector. Just as a public agency can utilize such a tool to facilitate decisions on what delivery method to use for a specific maintenance or construction activity, a private sector business could and should have access to the same information to decide whether or not it believes that entering into an operations and maintenance contract would be profitable. The private sector has a great capacity for innovation, specialized knowledge, and efficiency, contributable to its ability to concentrate on specific areas of expertise. On the other hand, the public agencies have an obligation to the citizens of their jurisdictions to manage a wide variety of infrastructure systems to the best of their ability. In many circumstances, a public agency has the ability and knowledge to handle the operations and maintenance of infrastructure, and may decide to continue to do so. However, with the availability of multiple delivery and finance methods, an agency can now match project characteristics to procurement strategy to best allocate funds and resources for infrastructure preservation, renewal, and maintenance. Tools like _Barchan_ allow a government to focus on its strengths as a policymaker, standard bearer, and regulatory agent by providing the client the ability to explore a variety of combinations of authorized project delivery and finance methods and to then examine the pros and cons of outsourcing some or all of maintenance activities. Easily accessible engineering information provided by programs such as _Barchan_ can and will provide government procurement agencies an invaluable service. Such information can be used to evaluate the benefits of utilizing alternate project delivery methods and facilitate the transition into the new procurement environment. Because neither public nor private delivery of infrastructure maintenance is the most efficient mechanism in all cases, a transparent market aided by readily available information will maximize the return on taxpayer money.
References

Dorman, Daniel, *Asset Management: Management Fad or Prerequisite for Solving the Fiscal Challenges Facing Highway Infrastructure?*, Infrastructure Management Group, Inc.


Federal Highway Administration Office of Highway Policy Information


