



# EVALUATION OF NEAR- TRANSPORTATION PRIVATE SECTOR ASSET MANAGEMENT PRACTICES

Project 01 – 02  
November 2002

Midwest Regional University Transportation Center  
College of Engineering  
Department of Civil and Environmental Engineering  
University of Wisconsin, Madison

*Authors:* Sue McNeil, P. S. Sriraj, Shaumik Pal  
Urban Transportation Center, University of Illinois-Chicago  
And  
Libby Ogard, Tioga Consulting

*Principal Investigator:* Dr. Sue McNeil;  
Professor and Director, Urban Transportation Center, University of Illinois-Chicago

**DISCLAIMER**

This research was funded by the Midwest Regional University Transportation Center, the Wisconsin Department of Transportation and the Federal Highway Administration under Project #0092-01-10. The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the information presented herein. This document is disseminated under the sponsorship of the Department of Transportation, University Transportation Centers Program, in the interest of information exchange. The U.S. Government assumes no liability for the contents or use thereof. The contents do not necessarily reflect the official views of the Midwest Regional University Transportation Center, the University of Wisconsin, the Wisconsin Department of Transportation, or the Federal Highway Administration at the time of publication.

The United States Government assumes no liability for its contents or use thereof. This report does not constitute a standard, specification, or regulation.

**Technical Report Documentation Page**

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No. <b>CFDA 20.701</b>	
4. Title and Subtitle <b>Evaluation of Near-Transportation Private Sector Asset Management Practices</b>		5. Report Date <b>November 16, 2002</b>	
		6. Performing Organization Code	
7. Author/s Sue McNeil, P. S. Sriraj, Libby Ogard, and Shaumik Pal		8. Performing Organization Report No. <b>MRUTC 01-02</b>	
9. Performing Organization Name and Address <b>Midwest Regional University Transportation Center University of Wisconsin-Madison 1415 Engineering Drive, Madison, WI 53706</b>		10. Work Unit No. (TRAIS)	
		11. Contract or Grant No. <b>DTRS 99-G-0005</b>	
12. Sponsoring Organization Name and Address U.S. Department of Transportation Research and Special Programs Administration 400 7 <sup>th</sup> Street, SW Washington, DC 20590-0001		13. Type of Report and Period Covered <b>Research Report June 2001- November 2002</b>	
		14. Sponsoring Agency Code	
15. Supplementary Notes <b>Project completed for the Midwest Regional University Transportation Center with support from the Wisconsin Department of Transportation.</b>			
16. Abstract  The focus of the transportation industry, both in the public and private sectors, has slowly been changing from construction and expansion to that of preservation because of various factors. The private sector industries have made strides in asset management that would be beneficial to the public sector. The purpose of this research is to identify private sector asset management principles and concepts that could form an integral part of any asset management program employed by state transportation agencies, public sector entities, and especially the state DOT's.  The core of this report consists of an overview of case studies in asset management in the private sector. Based on the synthesis of case studies "lessons learned" are identified. This analysis was completed by carefully examining the asset management practices of seven private sector companies in the infrastructure industry. Included are case studies from two railroads, two airlines, two energy companies and one shipping company. The case studies highlighted the need for communication, tools and education, and an information technology foundation from which asset management can be practiced effectively.			
17. Key Words  Asset Management, Private Sector, Near Transportation	18. Distribution Statement <b>No restrictions. This report is available through the Transportation Research Information Services of the National Transportation Library.</b>		
19. Security Classification (of this report) <b>Unclassified</b>	20. Security Classification (of this page) <b>Unclassified</b>	21. No. Of Pages 102	22. Price <b>-0-</b>



<b>TABLE OF CONTENTS</b>	<b>PAGE</b>
DISCLAIMER.....	2
<b>CHAPTER 1. INTRODUCTION.....</b>	<b>9</b>
1.1 SUMMARY .....	9
1.2 RELATING PRIVATE SECTOR EXPERIENCES TO THE PUBLIC SECTOR .....	10
1.3. OVERVIEW OF THE RESEARCH AND STRUCTURE OF THE REPORT.....	14
<b>CHAPTER 2. BACKGROUND AND RESEARCH METHODOLOGY .....</b>	<b>17</b>
2.1. BACKGROUND .....	17
2.2. RELATED WORK.....	17
2.3. RESEARCH METHODOLOGY .....	19
2.3.1. <i>Design of the Questionnaire</i> .....	19
2.3.2. <i>Conducting the Case Studies</i> .....	20
<b>CHAPTER 3. NEAR-TRANSPORTATION PRIVATE SECTOR CASE STUDIES.....</b>	<b>23</b>
3.1 PRIVATE SECTOR CASE STUDIES – RAILROAD INDUSTRY .....	24
3.1.1. <i>Wisconsin Central Transportation Corporation</i> .....	24
3.1.2. <i>Union Pacific (UP)</i> .....	26
3.1.3. <i>TTX Company</i> .....	28
3.2. PRIVATE SECTOR CASE STUDIES – AIRLINE INDUSTRY .....	30
3.2.1. <i>United Airlines Information Technology Assets</i> .....	30
3.2.2. <i>Midwest Express</i> .....	32
3.3 PRIVATE SECTOR CASE STUDIES – ENERGY .....	33
3.3.1. <i>Xcel Energy</i> .....	34
3.3.2. <i>Great Lakes Gas Transmission Company (GLGT)</i> .....	36
<b>CHAPTER 4. CONCLUSIONS AND FUTURE DIRECTIONS .....</b>	<b>39</b>
4.1. KEY MESSAGES FOR PRACTITIONERS .....	39
4.2. FUTURE DIRECTIONS .....	40
<b>REFERENCES .....</b>	<b>42</b>
<b>APPENDIX A - LITERATURE REVIEW .....</b>	<b>44</b>
A.1. HISTORY AND ORIGIN OF ASSET MANAGEMENT .....	44
A.1.1. <i>Definition of Asset Management</i> .....	45
A.1.2. <i>The Process of Asset Management</i> .....	47
A.1.3. <i>Benefits of Asset Management</i> .....	48
A.1.4. <i>Current Status of Asset Management in the Public Sector Transportation Industry</i> .....	48
A.2. INTERNATIONAL PERSPECTIVES ON ASSET MANAGEMENT .....	49
A.2.1. <i>The Australian Perspective</i> .....	49
A.2.2. <i>The Canadian Perspective</i> .....	50
A.3 ASSET MANAGEMENT IN THE UNITED STATES .....	51
A.3.1. <i>Need for Asset Management</i> .....	51
A.3.2. <i>Critical Success Factors for an Effective Asset Management System</i> .....	52
A.3.3. <i>Benefits of an Asset Management System</i> .....	52
A.4. RESEARCH ON ASSET MANAGEMENT .....	53
A.4.1. <i>Asset Management Model and Systems Integration Approach</i> .....	53
A.4.2. <i>The Value of Enterprise-Based-Financial-Reporting in Transportation Asset Management</i> ...	56
A.5. CASE STUDIES OF ASSET MANAGEMENT PRACTICE .....	57
A.5.1. <i>Burlington Northern Santa Fe (BNSF)</i> .....	58
A.5.2. <i>Union Pacific Railroad</i> .....	59
A.5.3. <i>Jackson County, Missouri</i> .....	60
A.5.4. <i>CSX Transportation</i> .....	62
A.5.5. <i>Privatized Highway Asset Management, Virginia</i> .....	63
A.6. CONCLUSIONS .....	64

<b>APPENDIX B - SAMPLE QUESTIONNAIRE .....</b>	<b>65</b>
<b>APPENDIX C - WISCONSIN CENTRAL RAILROAD (WCRR).....</b>	<b>71</b>
C.1 BACKGROUND: ABOUT THE ORGANIZATION .....	71
C.2 ABOUT WISCONSIN CENTRAL RAILROAD .....	71
C.3 GOALS OF ASSET MANAGEMENT: .....	72
C.4 ASSET MANAGEMENT PRACTICE IN WCRR.....	72
C.5 ASSET MANAGEMENT SYSTEMS IN WCRR.....	75
C.6 MANAGEMENT AND TRAINING: .....	75
C.7 BARRIERS TO ASSET MANAGEMENT.....	76
C.8 LESSONS FOR STATE DOTs .....	76
<b>APPENDIX D - UNION PACIFIC RAILROAD.....</b>	<b>77</b>
D.1 BACKGROUND: ABOUT THE ORGANIZATION .....	77
D.2 ASSET MANAGEMENT PRACTICE IN THE ORGANIZATION .....	77
D.3 GOALS OF ASSET MANAGEMENT .....	78
D.4 ASSET MANAGEMENT PRACTICE IN UP .....	78
D.5 ASSET MANAGEMENT SYSTEMS IN UP .....	80
D.6 MANAGEMENT AND TRAINING .....	80
D.7 BARRIERS TO ASSET MANAGEMENT.....	81
D.8 LESSONS FOR STATE DOTs .....	81
<b>APPENDIX E - TTX COMPANY (TTX).....</b>	<b>82</b>
E.1 BACKGROUND: ABOUT THE ORGANIZATION.....	82
E.2 MAJOR ASSETS OF THE ORGANIZATION.....	82
E.4 ASSETS AND THEIR MANAGEMENT .....	82
E.5 GOALS OF ASSET MANAGEMENT .....	83
E.6 ASSET MANAGEMENT SYSTEMS IN TTX.....	83
E.7 ASSET MAINTENANCE PRACTICE AT TTX.....	83
E.8 MANAGEMENT AND TRAINING.....	84
E.9 BARRIERS TO ASSET MANAGEMENT .....	84
<b>APPENDIX F - UNITED AIRLINES - INFORMATION SERVICES DIVISION (ISD) – THE RESEARCH AND DEVELOPMENT DEPARTMENT.....</b>	<b>85</b>
F.1 BACKGROUND: ABOUT THE ORGANIZATION .....	85
F.2 MAJOR ASSETS OF THE ORGANIZATION .....	86
F.3 OTHER INFORMATION .....	86
F.4 GOALS OF ASSET MANAGEMENT .....	86
F.5 ASSET MANAGEMENT IN THE ORGANIZATION/DIVISION.....	87
F.6 ASSET MAINTENANCE PRACTICE IN THE ORGANIZATION.....	88
F.7 MANAGEMENT AND TRAINING .....	89
F.8 BARRIERS TO ASSET MANAGEMENT .....	89
F.9 LESSONS FOR STATE DOTs.....	89
<b>APPENDIX G - MIDWEST EXPRESS AIRLINE .....</b>	<b>90</b>
G.1 BACKGROUND: ABOUT THE ORGANIZATION.....	90
G.2 ASSET MANAGEMENT PRACTICE AT MIDWEST EXPRESS.....	90
<b>APPENDIX H - XCEL ENERGY.....</b>	<b>92</b>
H.1 BACKGROUND: ABOUT THE ORGANIZATION.....	92
H.2 GOALS OF ASSET MANAGEMENT.....	93
H.3 ASSET MANAGEMENT PRACTICE IN XCEL ENERGY .....	93
H.3 ASSET MANAGEMENT SYSTEMS IN XCEL ENERGY .....	94
H.4 MANAGEMENT AND TRAINING .....	95
H.5 BARRIERS TO ASSET MANAGEMENT.....	97

H.6 LESSONS FOR STATE DOTs ..... 97

**APPENDIX I - GREAT LAKES GAS TRANSMISSION COMPANY (GLGT) ..... 98**

I.1 BACKGROUND: ABOUT THE ORGANIZATION..... 98

I.2 ASSET MANAGEMENT PRACTICE IN THE ORGANIZATION ..... 98

I.3 MAJOR ASSETS OF THE ORGANIZATION ..... 98

I.4 BARRIERS TO ASSET MANAGEMENT ..... 98

I.5 GOALS OF ASSET MANAGEMENT ..... 99

I.6 ASSET MANAGEMENT SYSTEMS IN GLGT ..... 99

I.7 ASSET MAINTENANCE PRACTICE AT GLGT ..... 100

I.8 MANAGEMENT AND TRAINING ..... 102

I.9 BARRIERS TO ASSET MANAGEMENT ..... 102



## CHAPTER 1. Introduction

Asset management principles and techniques are used by a variety of transportation-like organizations such as railroads, utility companies, transportation and logistics companies, airlines, and manufacturing organizations. Experiences and management practices in these industries can provide considerable insight as to how government transportation agencies can implement asset management strategies. The case studies of these firms serve as examples of asset management experiences and benchmarking concepts that may be useful for government agencies

The principal objective of this research was to document and synthesize asset management experiences in private industry to encourage public sector transportation agencies to draw on lessons learned by these organizations, and to assess critically their own approach to asset management. This report catalogues the asset management practices in railroads, airlines, shipping, and energy sectors using case studies. The report is intended to benefit public agencies developing asset management programs and provide insight to those agencies seeking to improve their asset management practices.

This chapters provides a summary of the case studies, and relates the case studies to public sector asset management. A final section provides an outline of the report.

### 1.1 Summary

Table 1 summarizes the features of each of the case studies. The table also illustrates the diversity of assets covered in our case studies. These observations can be further summarized as follows:

- Four of the seven case study organizations used a formalized asset management system.
- All case studies organizations used performance measurements.
- Five of the seven case studies describe their organization as undertaking proactive maintenance.
- Three of the seven case study organizations used an integrated information system.

Table 2 summarizes the value of the assets managed by each of the case study companies and compares the value with two selected states. The case studies vary significantly in size and complexity, as do the states. Clearly, Midwest Express and Wisconsin Central have fewer assets than a typical state but they may be comparable to a region or a district. The value of Union Pacific's and United Airlines' assets is the same order of magnitude as the Tennessee DOT. Similarly, Xcel Energy and TTX value their assets at the same order of magnitude as Texas DOT.

Several common themes can be identified from the case studies. These themes are consistent with recommendations made in the literature and the concept of asset management as presented by AASHTO and FHWA. The themes are:

- An accurate inventory is vital. In each case, it is essential to include pertinent information about the asset such as expected life, condition of asset, inspection

history, etc. All of the organizations included as case studies in this report followed this principle.

- An agency has to understand its overall objective with respect to embracing asset management. The private sector case studies all had a clear understanding of their mission/objective and were thus able to allocate resources accordingly toward asset management without jeopardizing the objective of the organization.
- As evidenced in the case studies, the most successful and proactive asset management approaches have been the ones that found a way to integrate the system objectives with the departmental objectives and where the performance measures of assets were linked to individual performance. This creates an incentive for every individual in the agency to strive towards maintaining and managing the assets effectively and efficiently.
- Asset management is a business process that is integrated throughout private sector organizations and is a critical component of the strategic planning process.
- Efficient management and asset utilization is a cornerstone of the private sector customer service strategies. Cost avoidance can be a strong incentive to support DOT investment in asset management.
- With increasing personnel constraints within state DOTs, the use of advanced technology and information systems becomes critical.
- Effective communication of information is needed between the various stakeholders, and coordinating mechanisms need to be established between various asset classes of the organization.
- Education and training is important in making asset management trade-off decisions. All companies interviewed stressed the importance of having complete and accurate information about all aspects of the business in order to make good decisions. While modeling is helpful, a basic understanding of the core business is essential.

Organizations that strive for a successful asset management process need to make sure that these areas of focus are addressed within their domain. The analyses of case studies have shown that an established asset management philosophy has been one of the contributing factors for effective maintenance and management of assets. They also emphasize the use of information systems to oversee their maintenance schedules. An important inference that can be drawn from this analysis is that most of the systems had proactive maintenance systems in place with emphasis on performance measurement. Perhaps, in the future, these two features should form the essence of any asset management process employed by the transportation agencies.

## **1.2 Relating Private Sector Experiences to the Public Sector**

At the outset of the research, we posed the following questions to address both the process of asset management and the institutional issues:

- Is asset management a computer-based system or a management concept?
- How frequently does the process change? Are there procedures for changing the process?
- Where does responsibility for asset management lie within the organization?
- How is asset management “sold” within the organization?

- How does the organization respond to technological change related to asset management?
- How do you measure effectiveness?
- How do you facilitate education and training?

Our responses to these questions relates how the private sector experiences can be applied in the public sector.

- **Approach to asset management: a computer-based system or a management concept?**

Of the seven case studies, four companies used a computer-based system to carry out asset management within the organization. The other three, while depending on computers for operational purposes, still view asset management as a management concept. This shows that there is still a learning curve with regards to asset management even in the private sector. Also, observed was the fact that among agencies that view asset management as computer-based, there was still a clear organizational philosophy with respect to the process.

Public sector transportation agencies need to embrace the concept of asset management and understand the philosophy behind asset management and proactive maintenance. The case studies included here reveal a pervasive organizational awareness of asset management irrespective of whether it is computerized.

- **Change agents necessary for asset management: how frequently does the process change? Are there procedures for changing the process?**

Most of the agencies interviewed would argue that they have always practiced asset management; the change has been the adoption of asset management as an organizing principle, a philosophy or a process. Rapid changes are more likely when there is a catalyst.

Deregulation of the airline and railroad industries had a profound impact on the asset management process at each of these carriers. Deregulation forced these transportation providers to evaluate asset utilization, service costs and geographic network design in new market competitive environment. The transformation forced these companies to be more customer focused and performance conscious. Shortly after deregulation there was a significant industry shakeout and a resulting wave of mergers and consolidations. The new networks forced each company to evaluate and rationalize their service area and related assets. Union Pacific had undergone a significant shift in the culture of the organization brought about by the merger of Union Pacific with Southern Pacific. This facilitated moving in a new direction that enabled the organization to tie individual performance evaluations to the overall system performance and thereby manage the assets. Xcel Energy undertook a major reorganization in conjunction with its adoption of asset management. Xcel Energy was in the practice of managing assets pertaining to the electrical and gas distribution separately until management decided to bring them together under one umbrella of asset management.

Typically, the public and private sector organizations do not adopt changes in the process or philosophy unless technology or assets become obsolete. Thus, a change in philosophy of asset management unless brought about by strong leadership can happen only with a paradigm shift in the organization's culture or in an economic shift related to a change in the external environment. Even then, the vision and the resolve to bring about change are necessary in the management structure. This is consistent with experiences in public sector organizations.

- **Where does responsibility for asset management lie within the organization?**  
The responsibility for managing the different assets within these organizations lies with the various departments and managers that are responsible for the assets. Agencies like UP and Xcel Energy have found a way to break out of this silo-type management style by embracing a more comprehensive approach. United Airlines has weekly meetings to share information and to evaluate the needs of the other departments while assigning responsibility within each department. TTX, while stating that asset management permeates the organization, still delegates responsibility of the assets to the individual departments

Although the private sector has made strides in asset management practices, there is room for development and refinement of their practice. State DOTs can learn from these case studies by acknowledging the need for efficient, proactive and continuous management of assets as practiced in the private sector. Xcel Energy and UP have demonstrated that responsibility can change either through reorganization, in the case of Xcel Energy, or improved accountability and ability to track performance, as in the case of UP. United has stressed the value of communications.

- **How is asset management “sold” within the organization?**  
The concept of asset management is often embraced by the organizations as a result of federal mandates, such as safety inspections pertaining to the assets. These organizations have come to realize the advantages of being proactive in the process while at the same time keeping an eye on the bottom line. In other cases, such as Xcel Energy and UP, upper management has demonstrated leadership and orchestrated the adoption of asset management. In the case of Xcel, management was able to cite the successful implementation of asset management in England. In the case of UP, the process grew out of a team-based approach to addressing asset management and the need to be more customer responsive. All companies recognize the clear linkage between asset management and financial performance. One underestimated, but important by-product of an improved asset management program is the improvement in customer service and satisfaction. TTX's asset management program grew out of a need to provide an economically viable national fleet and has evolved into an important customer focused program, which has improved utilization and economic efficiency.

In both the public and private sectors, a significant shift in organizational structure and priorities based on asset management is a tough sell. Accordingly, linking asset management to other drivers such as the Government Account Standards Board

(GASB) Statement 34 (Government Account Standards Board, 2000) or safety inspections becomes a real selling point.

- **How does the organization respond to technological change related to asset management?**

The private sector has been very receptive to technological change partly because of the competitive forces at play and partly because of the need for cost-effective ways of keeping pace with the federal requirements to monitor the assets. In the case of technological assets as in the case of United Airlines, maintaining up-to-date hardware is part of the asset management system. Technological changes also affect asset management processes that are computer-based, as in the case of UP, Xcel Energy, and Great Lakes Gas Transmission. This need to keep pace with technology comes with a price tag. The organizations trade off investments in technology with a conservative approach that ensures short-term profitability.

A critical lesson, with respect to asset management, came out of the United Airlines case study. The airline industry had either by design or by accident embarked on a path of incorporating information technology into its existence. This fundamentally strong base in information technology served them well in absorbing principles of asset management and executing them in their organization. Similarly, in Union Pacific, while the change in organizational culture allowed gravitation towards a more systematic asset management practice, the incorporation of a technological approach enabled them to quantify key issues and distribute them down to facilitate individual evaluation. This was a key factor in the success of the UP approach.

State DOTs more often than not are faced with similar dilemmas and can learn from the incremental advances made in these case studies on asset management.

- **How to measure effectiveness?**

The case studies did not shed much light on how to measure the effectiveness of the asset management approach. Union Pacific has a system that accounts for the system performance and distributes it to the individual level thereby ensuring efficiency and effectiveness. The other organizations do not have a clear recipe for effectiveness. In the case of Xcel Energy, the philosophy of “tending to the facilities the day before they fail,” suggests an optimal approach to ensuring effectiveness. GLGT’s goal is to ensure safety while at the same time being profitable. This struggle between the stated objective for asset management and the organizational objective of maximizing short-term profits is common in the private sector. In a dynamic marketplace the companies stock price and customer satisfaction are often the proxy for evaluating effectiveness. Companies who are effectively managing assets and networks are growing and can attract and earn capital for reinvestment. Companies with less skill in this area are often less competitive and have lower overall customer service ratings.

State DOTs have to approach asset management by acknowledging similar conflicting objectives.

- **How to facilitate education and training?**

Many of the private sector case studies had a structured training program and other educational avenues available for their employees, depending upon the type of asset that they are working with. These programs are generally scheduled once a year for the employees managing the different assets, and are in the form of seminars, workshops, and videos. The training enables employees to keep pace with the changes in technology and maintain the assets efficiently. There also seems to be extensive organizational structure and cultural norms that insure the asset management processes are maintained and preserved throughout the company. When new employees come in or after internal promotions, each department's processes seem to survive the transition.

State DOT's have a tradition of education and training that can easily be extended to asset management following the same principles as used in the private sector. There could be a concern if there is significant turn over or massive retirements concentrated in any one department or functional area.

### **1.3. Overview of the Research and Structure of the report**

This research documents seven case studies of asset management in transportation-like, private sector organizations. The transportation-like organizations are defined as having many of the common characteristics noted in the background section. Building on previous and ongoing research, a template for case studies was developed, a prototype case study completed and documented, the template modified, and the remaining case studies completed. On-site interviews, written materials including reports, and web-based resources were used to develop a comprehensive picture of the role of asset management in the specific organization and to infer how in general the specific organization compares with the larger industry it represents. Based on a synthesis of the case studies, lessons learned have been identified for the benefit of agencies in the public sector and other private sector entities.

The report consists of four chapters. The following chapter provides background material on asset management and an overview of the research. The third chapter summarizes the seven case studies. The fourth chapter presents some key messages for practitioners and directions for future research. There are also nine appendices. One on the literature review, an appendix on the template/questionnaire used for the interviews, and one on each of the seven case studies. The case study appendices document the interviews and written material related to each case study.

**Table 1. Attributes of the Private Sector Case Studies**

Industry	Case Study	Major Assets	Formalized Asset Management System <sup>1</sup>	Prime Objective for Asset Management	Performance Measurement	Proactive Maintenance	Integrated Information System <sup>2</sup>
Railroad Industry	Wisconsin Central	Tracks, Locomotives, Railroad R.O.W	No	Monitor Economic Performance	Yes	No	No
	Union Pacific	Tracks, Locomotives, Railroad R.O.W	Yes	Meet the demand in lieu of decreasing supply	Yes	Yes	Yes
	TTX	Railcars	Yes	Eliminate loss of revenue due to faulty maintenance	Yes	Yes	No
Airline Industry	United Airlines	Network Computers, Data Feeds and Software	No	Provide reliable assets for efficient network planning and scheduling	Yes	Yes	Yes
	Midwest Express	Jets, Turboprops	No	Improving system and economic performance	Yes	No	No
Energy	Xcel Energy	Coal plants, Nuclear Plants, Hydro-electric Plants, Other Distribution and Transmission Lines	Yes	To fix assets before they fail	Yes	Yes	Yes
	Great Lakes Gas Transmission	Pipeline, Gas Utility Plant	Yes	Improve system performance	Yes	Yes	No

<sup>1</sup> Refers to whether the organization has a structured asset management system with a fundamental philosophy associated with it.

<sup>2</sup> Refers to the role of information technology within the organization and its use in the activities of the organization.

**Table 2. Summary of Case Studies with Comparable States.**

<b>Industry</b>	<b>Organization</b>	<b>Value Of Assets</b>	<b>Magnitude of Assets</b>
Railroad Industry	Wisconsin Central	\$800 million (2001)	2,800 miles of track
	Union Pacific	\$31,551 million (2001)	33,000 miles of track
	TTX	\$5,374.3 million (2000)	129,078 railcars
Airline Industry	United Airlines (IT)	\$19,412 million (2000) - operations	Not Available
	Midwest Express	\$200 million (2000)	34 planes
Energy	Xcel Energy	\$6.4 billion (2001)	16,303 miles - electric transmission 73,098 miles electric distribution 29,704 miles natural gas pipeline.
	Great Lakes Gas Transmission	\$1.2 billion (2001)	2,000 miles of pipeline
State DOT	Texas (Sullivan and Graff, 2001)	\$2, 700 million (1999-2000) excludes ROW	14,375 interstate lane miles 7,164 freeway lane miles 151,709 non-freeway lane miles 32,000+ bridge
	Tennessee (Shinn, 2001)	\$44,637 million (2000)	13,777 miles of highway 7,992 bridges 186,484 acres of ROW

## **CHAPTER 2. Background and Research Methodology**

This chapter provides some background for the study. Subsequent sections outline related work, the research methodology, and an overview of the research. The final section describes the structure of the report.

### **2.1. Background**

The emphasis on global competitiveness and the more efficient use and provision of public and private facilities drives owners and operators to seek better ways to manage their existing assets. While individual sectors tend to be introspective, there are many success stories that demonstrate good practices or involve innovations that are more broadly applicable. To facilitate the best transfer of ideas, principles, and practices, we must first have a clear understanding of the individual sectors. This better understanding would result in the application of knowledge. Improved application would benefit the public sector and consequently the larger society.

Each state Department of Transportation (DOT) maintains that its organization is unique in terms of asset management. The differences result from the constraints imposed, the specific organizational structure, political climate, and the objectives regarding managing physical assets. The maintenance and operation of different types of infrastructures also have many features particular to a type of infrastructure.

Despite individual differences, all state DOT's share the following characteristics: ownership of physical assets, guiding principles and concerns for management. The common characteristics of major assets includes, but are not limited to: long time horizons, the need for investment and maintenance trade-offs, the expense involved, risks, organizational and operational barriers to overcome, and customer service and performance expectations.

The similarities found among public sector entities are also found among private sector industries. Nonetheless, one should be aware that there is one key distinction between the public and private sectors. In the private sector, the focus is on profits and customer satisfaction. The private sector thus makes an extra effort to understand whom its customers are to respond to their needs. In the public sector, there is considerable confusion as to which the customer is. It could be the traveling public, the politicians, the CEO, or upper management. Additionally, there is no profit motive so the emphasis is in providing service for minimum cost.

### **2.2. Related Work**

The initial exploration of asset management by the American Association of State Highway and Transportation Officials (AASHTO) and the Federal Highway Administration (FHWA) was rooted in the same basic premise as this study. In 1996 AASHTO and FHWA sponsored a workshop on Asset Management titled "Advancing the State of the Art into the 21st Century Through Public-Private Dialogue." The workshop brought together public and private sector executives involved in asset management to share experiences. Private sector participants included representatives

from Alliance Air Services, Conrail, Chrysler, and GTE Laboratories. York Thruway, the Port Authority of New York and New Jersey, and LS Transit Industries represented quasi-government organizations. While the workshop recognized the need to continue the public-private dialogue, few deliberate attempts have been made to do so until now. This project builds on the outcomes from the 1996 workshop as well as interest in private sector activities brought up at the subsequent workshops held in 1997 and 1999 (AASHTO, 1997; AASHTO 2000).

A literature review identified five other relevant asset management case studies. Of these, three case studies are based on railroads: Burlington Northern Santa Fe (BNSF), Union Pacific (UP) and CSX Transportation. However, these case studies either focus on a narrow aspect or do not reflect the current asset management activities. They are summarized in Appendix A. Two other cases studies are also included in the appendix. They document asset management practices in Jackson County, Missouri and privatized asset management in Virginia. The Jackson County case study provides insight into useful research practices since it compared asset management with and without a formalized asset management system. The Virginia case study is interesting as it recognizes the impact of risk. Although this issue is not addressed in depth in our study it is an important component of the process.

In addition, the literature review in Appendix A also documents the history and origin of asset management, international perspectives on asset management, current asset management activities in the United States, and research on asset management. The practice of asset management has been gaining impetus in the State Departments of Transportation (DOT) for many reasons. The DOT's have been struggling with the ever-increasing costs of maintaining an aging system of highways and other related infrastructure. The 1990's have also brought an increased expectation from the government by the public in the form of greater accountability of investment in and management of assets. This increased accountability has resulted in higher expectations regarding levels of service of critical infrastructure, especially in the transportation sector (USDOT-FHWA, 1999).

Some states have suffered significant staff reduction in recent years as a result of government reinvention and the accompanying downsizing. They are also finding it difficult to attract and retain capable professional staff to manage complex program areas, due to the competitive nature of employment market.

The DOT's are thus forced to prioritize their work functions, and to concentrate more on the management functions rather than on the technical responsibilities. This has paved the way for the initiation of a state-level asset management strategy.

In 1999, AASHTO conducted surveys of state DOTs to gauge the level of integration/application of asset management principles and strategies (McNeil, et. al., 2000). Although all of the agencies interviewed had management systems in place, very few utilized the concept of integration of maintenance and management practices. Furthermore, it was found that there was no state level GIS based information

management application and that the responsibilities were divided among different asset managers. Most of these management systems had collected technical and condition information pertaining to the assets. At the same time, information pertaining to a broad range of goals, policies, prioritization techniques as well as funding information was not part of their management strategies. Although performance measurement was being practiced by many DOTs, proactive maintenance and use of information technology was limited (McNeil, et. al., 2000). Background studies of the private sector asset management practices have revealed that information technology is an important concept in their asset management approach (Derocher, 1998). There are other critical concepts, which have helped the private sector to foster an efficient and stable asset management process. The following chapter elaborates on the asset management programs practiced in the near-transportation private sector institutions.

### **2.3. Research Methodology**

The research team set out to include four to six case studies from private sector agencies whose assets and functions were similar to that of departments of transportation. Organizations in the private sector with fixed assets and a network of assets were targeted as potential candidates. The research advisory panel and the Midwest Regional University Transportation Center were consulted and their input solicited in prioritizing relevant industries. The next step was to enlist representatives from within these organizations in these industries to provide the details of the asset management process.

The case studies included in this report are a combination of the needs identified by the advisory panel, the research team and willing individuals/organizations who participated in the research.

The research team developed a set of basic questions aimed at extracting the goals and objectives of the asset management process, management plans and programs, and information needs and data requirements necessary to support the asset management process.

#### **2.3.1. Design of the Questionnaire**

We reviewed the principles used in asset management to design the questionnaire that was used to guide the interviews with private sector asset managers. Several basic components are common to effective asset management, whether relying on a sophisticated computer system or human knowledge (Hudson et.al, 1994), (National Research Council, 1995) (USDOT-FHWA, 1999). These components include:

1. Setting objectives and goals
2. Identifying evaluation criteria
3. Inventory data (what facilities you have)
4. Evaluation data (what condition they are in)
5. Location data (where they are located)
6. Generation of strategies or alternatives (what are the options)
7. Strategy or alternative selection (how to decide what to do)
8. Analysis methods (how to evaluate the impact of a decision)

9. Reporting and monitoring, (how to keep track of a facility and interface with other units)
10. Performance prediction (how to predict the future)

While different systems and sectors may use different terminology, the basic principles have been found to be broadly applicable.

More recently the ongoing NCHRP 20-24(11) “Development of an Asset Management Guide” focused on four key areas:

1. Establishing policy goals and objectives.
2. Developing supportive information and analysis systems.
3. Developing plans and programs.
4. Fostering sound practices in program delivery.

The case studies included in this report are loosely structured around these key areas and focus on the asset management processes, the asset management practice, and other training programs within the organization.

The second part of the questionnaire focuses on implementation issues. While the asset management process, as represented by the four key areas, is a critical component, other factors influence its effectiveness, and successful implementation. Accordingly, it is important to address how asset management is used, who uses it within an organization, when is it used (ongoing versus discrete time intervals), how it was developed and how is it changing. These organizational issues may also divert attention from the substantive parts of asset management. Therefore, we will distinguish the organizational structure for asset management from the methodology.

Examples of questions addressed in this research:

- Is asset management a computer-based system or a management concept?
- How frequently does the process change?
- Are there procedures for changing the process?
- Where does responsibility for asset management lie within the organization?
- How is asset management “sold” within the organization?
- How does the organization respond to technological change related to asset management?
- How do you measure effectiveness?
- How do you facilitate education and training?

Based on this background information, a questionnaire was developed to serve as a template for collecting consistent information for each of the case studies. The questionnaire is included in Appendix B.

### **2.3.2. Conducting the Case Studies**

The case study organizations were identified and the interviews conducted using a common format. Typically, publicly available information on websites and from annual

reports was reviewed. Then an initial contact was made by telephone. Next, background material on the project was sent to the contact. Finally, a follow-up telephone call was made to schedule a visit and obtain additional background material on the organization. Participants were given the option to exclude company-identifying information and to review the case study summary prior to publication. In all cases, the identity of the specific respondent was not recorded on any of the responses. The questionnaire (see Appendix B) was used to guide the interviews in a structured format. This questionnaire was revised after use in a prototype case study and used in the other case studies.

Two companies declined to participate in the interviews but completed the questionnaire. In one case, the company provided extensive supporting materials.

For all companies, the material from the interview (or responses to the questionnaire), web-based published material, annual reports and other published materials were synthesized to form a written case study.



### **CHAPTER 3. Near-Transportation Private Sector Case Studies**

In the last few decades, both the public and private sectors have recognized the impact of the deterioration of their physical assets due to usage, age, and environmental impacts. As a result the transportation industry has shifted focus away from construction to preservation and maintenance and yield management of existing assets. Over the years many individual management processes have evolved, each with its own focus. Nonetheless, a system wide focus, which involves bringing a variety of assets under one single entity, has been absent in all cases.

In this age of competition, especially in the private sector, there is increased emphasis on the maintenance and management of valuable assets. As a result innovative ways of managing assets are being practiced. The increased emphasis placed on maintenance and management of valuable assets has highlighted the importance of asset management. Asset management can be defined as a “systematic process of maintaining, upgrading, and operating physical assets cost effectively” (USDOT-FHWA, 1999). It includes preservation, upgrading and timely replacement of assets, through cost effective management, programming, and resource allocation decisions.

The basic purpose of this research is to identify asset management principles and concepts in the private sector that should form an integral part of any asset management program employed by state transportation agencies.

The core of this report is an analysis of asset management in the private sector based on case studies. Based on a synthesis of the case studies, “lessons learned” are identified. This analysis has been done through careful examination of the asset management practices of seven private sector companies in the near-transportation arena. Included are two railroads, two airlines, two energy companies, and one rail car leasing company.

In the private sector a performance focused, customer-oriented approach with a proactive maintenance strategy have been at the heart of all asset management approaches (USDOT-FHWA, 1996). This has also been the case in the public sector in as far as emphasis is on maintaining and operating physical assets within budgetary limitations. However, a distinction can be made in the area of focus. In the public sector most of the work on asset management has concentrated on managing highway infrastructure.

In the private sector, the railroad industry has been one of the first industries to acknowledge asset management as it is termed today (Leatherwood, 1989, Wurtz 1994, Derocher, 1998). Privately owned railroads have focused primarily on the use of advanced software systems to improve both customer service and asset utilization. Airlines and energy related firms have also instituted formalized asset management processes. This study also looks at asset management practices in an information technology division of an airline, in which the emphasis has been on the software assets rather than the physical assets.

As discussed in Chapter 1, most of the information given in the case studies has been collected through interviews directly with company representatives. The research team also depended on secondary sources of information such as company web sites and annual reports to supplement the interviews.

The seven case studies are organized into three groups:

- Railroad industry
- Airline industry
- Energy

Within each group, the case studies are outlined in terms of general background, lessons learned, assets and their management, asset management practice and barriers to asset management. With the exception of the section entitled “lessons learned” each case study is based on the verbal or written reports of the respondent. With the exception of Midwest Express and Xcel Energy, the responses were obtained through face-to-face interviews structured around the questions outlined in Appendix B. Midwest Express and Xcel Energy provided written responses to our survey questions in Appendix B in lieu of an interview. Supporting details that document the reported information are included in Appendices C through I. In many case studies, the interviewees were unable or unwilling to reveal any specific details as they believed that their asset management process was key in their strategic advantage over their competitors. We were also unable to reveal the identities of the interviewees due to federally mandated protection of human subjects. All interviews were conducted between September 2001 and June 2002 in accordance with these regulations.

### **3.1 Private Sector Case Studies – Railroad Industry**

The railroad industry case studies represent very different organizations in terms of scale of operations and function. Wisconsin Central is a regional railroad and Union Pacific is a Class I railroad respectively. The third company, TTX, is a railcar leasing company.

#### **3.1.1. Wisconsin Central Transportation Corporation**

This case study documents asset management practices at Wisconsin Central Railroad (WCRR) prior to their acquisition by Canadian National Railway (CN). Wisconsin Central Transportation Corporation was a holding company, which operated a regional North American rail system in Wisconsin, northeastern Illinois, eastern Minnesota, and Ontario. It was owned by a group of 20 people who started the Wisconsin Central Railroad (WCRR) in 1987. Most of their clients were from the paper industry, from which 60% of their revenue was generated. In late 2001, the Canadian National (CN) acquired the Wisconsin Central system. This acquisition has helped to connect the Illinois Central (IC) rail line with the Canadian assets, both owned by CN (<http://www.cn.ca>).

#### *Lessons Learned from WCRR*

Wisconsin Central, prior to acquisition by Canadian National, had a complex set of asset management ownership arrangements and asset management responsibilities. Nonetheless, current asset management practices are similar to the techniques used when the railroad started in 1987. The organizational culture was built around safety,

specifically, avoiding derailments, and improving as much of the asset base as economically feasible. The railroad was as dependent on knowledgeable and responsible employees as it was on information technology and all of this still applies today.

Wisconsin Central Railroad's concerns with asset management mirror those faced by departments of transportation. WCRR had a spatially distributed network of assets, a similar regulatory environment related to safety, a diverse customer base, limited resources, and physical constraints in terms of weather and available track time for maintenance and upgrading. Like a DOT, the organization conscientiously monitored, maintained and upgraded as appropriate its physical assets given the limited resources. The railroad recognized that it did not have to deal with politically motivated requests for expansion and improvement, instead they needed to be flexible and responsive to their customers to ensure a steady revenue stream.

### *Assets and their Management*

The principle assets of the corporation are equipment and physical property that includes tracks, locomotives and railroad right-of-way. Other assets include block signals, boxcars and other infrastructure facilities. The company does not use the term asset management, although the responsibility of managing the assets is spread throughout the organization. Each asset has its own life cycle and performance measures, which is managed by different computer programs and systems.

### *Asset Management Practice*

Asset management was introduced to manage the most important and valuable assets of the organization. The main objective of the asset management process in WCRR is geared more towards monitoring economic performance and customer responsiveness than system performance, although safety is one of the primary concerns in the process. WCRR's frequent and regular testing optimizes the economic performances of the physical assets.

Of all the assets, perhaps track is one of the most expensive properties. WCRR documents its track inventory using track charts. These records are maintained in a CAD system and are updated every year. The charts include information on geometry, the year the rail was laid, temperature at which it was laid, signals, crossings, and speed.

The CAD system is also used in the case of other assets like bridges and signals. The frequency of track and bridge inspections is more than the FRA requirements. The FRA mandates that bridges with 10 million gross tons or more per year, are inspected twice a year. Bridges with more than 5 million tons per year are inspected once a year and those with less than 5 million tons are tested once every two years.

Heavily traveled segments are inspected five times a year and tracks with more than 10 million gross tons are inspected twice a week. In other cases they test at least twice as frequently as mandated by the FRA. Heavy equipment is managed for risk by inspecting them 5 times a year.

An important feature of an efficient asset management process is proactive maintenance. WCRR has been doing asset replacement and maintenance on a worst-first basis. They are moving towards a more proactive system. The company strategy on asset replacement is based on the current resources available Wisconsin Central identified rail replacement as a difficult issue because of the high cost of new rail. They have countered this by managing to “generate” rail from abandoned lines, and by replacing old rail with new at the rate of 5 to 10 miles every year. WCRR also indicated that access to high-density lines is a problem. It is difficult to get the necessary time to complete maintenance and replacements.

WCRR has individual management systems that deal with the different assets of the company. Within the organization, the responsibility for maintaining and managing the different assets lie within various departments. At present the railroad does not feel the need to merge these systems. These management systems include a car management system, a bridge management system, a signal management system and a phone management system. The information system/program used to manage the data is a modified version of CAD, and the Car Management System. Data for the rolling stock is managed through their Dispatch System. This tracks the cars, locomotives and crews.

#### *Barriers to Asset Management*

The asset management process is not perfectly smooth. One of the most significant barriers in the asset management process of a railroad is inclement weather. Weather adds uncertainty to the process as it can accelerate deterioration and disrupt the scheduled maintenance or replacement activities. Other barriers include financial constraints, scheduling difficulties especially regarding organizing inspections and maintenance during peak seasons when the volume of traffic is high, and other organizational obstacles.

#### **3.1.2. Union Pacific (UP)**

Union Pacific Railroad is one of the largest railroads in North America. It operates in the western two-thirds of the United States on more than 33,000 route-miles. The system serves 23 states, linking every major West Coast and Gulf Coast port. It also serves four major gateways to the east - Chicago, St. Louis, Memphis, and New Orleans. UP represents the primary rail connection between the U.S. and Mexico. Union Pacific is also one of the largest intermodal carriers in the United States (the transport of truck trailers and marine containers) (<http://www.up.com>).

#### *Lessons Learned from Union Pacific*

The concept of performance is integral to the organization. Managers at all levels of the organization understand that short term performance is directly linked to both short and long term asset management and that they as individuals are directly accountable for performance.

There are well-defined performance measures that attempt to recognize both customer performance and organizational performance in terms of safety, service, value and leadership. The performance measures are weighted to form an aggregate performance measure. The value of each measure and the aggregate measure is reported by geographic area (19 service units in 4 regions) and each unit is ranked on a regular basis. Performance measures are updated on a weekly basis and represent the month to date. Furthermore, the performance measures are correlated to a service delivery index and an index of customer satisfaction. These measures in turn are linked to revenue.

From an operational point of view, individuals focus on “six key questions” related to performance. These questions are the mechanism for linking individual actions to both short and long-term asset management goals. In short, UP focuses on performance.

### *Assets and their Management*

The major assets of the corporation include locomotives, railcars, highway tractors, track, and railroad right-of-way. UP has adopted an asset management program that balances its productivity and service performance objectives. The unique concept is that while the measurement and evaluation criteria are centrally determined, UP has made it possible with the help of the “six key questions” to percolate and distribute these measurement and evaluation criteria down to the individual employee.

For UP, an optimal mix of system performance and economic performance is an important part of their broad objectives in asset management. In spite of the emphasis on economic performance, safety is a broad concern.

### *Asset Management Practice*

The asset management practice at UP changed in 1996 partly because of its merger with Southern Pacific railroad. As a result of the merger, there were changes in the organizational culture. A new department, Network Design and Integration (NDI) was created. This department cuts across the organizational hierarchy and helps achieve overall business success. Prior to the formation of the NDI, various activities associated with asset management were dispersed across the Marketing, Finance, and Operating departments. These are now all part of the new department thereby establishing a better balance and efficiency for the operation.

As a result of adopting an asset management process, UP is working towards maintaining an automated data collection process. Track and locomotives are the main assets on which UP maintains a detailed condition information. Tracks are inspected daily on the main lines, three times a week on the secondary lines and once a week on all other lines. The inventory of assets is a key area in an efficient asset management system. The organization has maintenance divisions that are responsible for keeping condition measures. Although UP does not currently have performance prediction capabilities, it is working towards that end. Establishing correlations among performance measures at all

levels in the organization would be a first step. Asset management performance is evaluated on a daily level, although weekly, monthly and annual evaluations are also done.

The majority of the people involved in asset management, work at a senior level. Most of them are from the cross-functional management team. Every two years, UP brings in key analytical people in groups of 30 and trains them to focus on 6 key questions regarding their roles, responsibilities and the operations process. This is part of their asset management-training program.

### *Barriers to Asset Management*

Union Pacific faced hurdles from both an organizational and operational perspective. UP faced problems in changing the company culture and mindset. The measurement and evaluation system used judges not only system performance but also individual performance. People are ranked against one another in this approach and these rankings are directly linked to compensation. Thus, there has been considerable resistance to this approach. Another drawback of this system is that a manager will tend to optimize locally rather to improve individual performance rather than optimizing across the system. Thus UP is not functioning at its highest potential.

UP also considers information technology a barrier to the asset management process. One of the risks in the asset management process, as identified by UP, is that it requires too much information, the unavailability of which hinders the process to a great extent.

### **3.1.3. TTX Company**

As a railcar leasing company, TTX is a provider of railcars in pool service for use on railroads in North America. The company was incorporated in 1955 as Trailer Train Co. and began operations in 1956 with a fleet of 500 cars. TTX is fully owned by North American Railroads who are both the owners and customers of TTX. Non-owner railroads have access to TTX railcars through interchange agreements between the owner and non-owner railroads (<http://www.ttx.com>).

### *Lessons Learned from TTX*

TTX is in the business of leasing railcars to their customers, the railroads. Thus, asset management and maintenance is a crucial function. TTX's philosophy is that "asset management is inherent to the company and is the whole fiber of the organization". Their asset management is safety-driven and customer focused. They promote competition among the various divisions in the organization with innovative rewards to ensure overall safety of the products and within the organization.

While Departments of Transportation do not deal with leasing vehicles to their customers; they could benefit from adopting the healthy competition fostered within the various units of TTX.

### *Assets and their Management*

The major physical asset of the organization is the fleet of 129,078 railcars divided among three equipment types: intermodal, autorack and general use. TTX has a formal asset management process within the organization that “represents the fiber of the company.” This process is computer-based and supports the philosophy of proactive maintenance. Asset management is an ongoing process at TTX. The overall plan is updated annually to reflect strategic issues. Reviews are conducted six times a year to address operational issues such as equipment flows, network balance and utilization issues. An interesting feature of this process is that at the tactical level (every week); there is a change in the allocation of assets among the railroads, and a change in the use of assets on an hourly basis. Asset management links the strategic, operational and tactical management of the resources. Field operations, shops, and the car management system are viewed as an integral part of the asset management process.

### *Asset Management Practice*

Reliability of assets has been the primary focus in TTX’s asset management system, followed by availability and safety. TTX feels that reliable assets foster a safe environment. In order to have reliable assets, the company emphasizes proactive maintenance activities. TTX like WCCR maintains its assets using higher maintenance and inspection standards than dictated by the Association of American Railroads (AAR) and the Federal Railroad Administration (FRA) regulations. TTX also performs field maintenance and inspection services at a number of Field Maintenance Operations (FMOs) throughout North America.

TTX has been proactive in the maintenance of its fleet of railcars. TTX worked in conjunction with the AAR and the FRA to get approval to extend the useful life of autorack flat cars. This had been possible because of a well-maintained asset management process in their organization. It adheres to strict maintenance standards for their equipment. Furthermore, quality audits are performed to ensure that high standards set by TTX are met. Failure analysis has been an important part of their asset management process. It has helped TTX eliminate the loss of revenue associated with out of service equipment and faulty maintenance.

An effective information system is an integral part of an asset management system. In the case of TTX, there is no single information system to collect and manage information. Instead TTX has developed multiple customized information management programs. Every department manages its own areas of information. Tools, which are used to manage and update information, include GIS, trend analysis, custom software, and off-the-shelf products. Short courses, conferences and seminars are held in order to impart asset management training to the employees. All senior management associates are involved in the asset management process, while at the managerial level; about 80% are involved in the process.

The asset management process has been beneficial in bringing about a smooth and efficient decision-making management program. The support of computer-based programs has helped to make data analysis and modeling easier, and more precise and accurate.

### *Barriers in Asset Management*

In terms of barriers to the asset management system, the major constraint is derived from keeping the customer happy in spite of changing expectations and needs, or market fluctuations. This means that asset management practices must be built into business practices.

The physical movement of assets is also a barrier, because the company has to negotiate physical space and time. One of the concerns of the company is the proper asset allocation or keeping equipment supply ahead of changing demand. Fleet sizing and customer allocation are important areas where tradeoffs most likely occur.

## **3.2. Private Sector Case Studies – Airline Industry**

The following airline industry case studies represent different aspects of the airline industry. The United Airlines case study focuses on United's information technology assets. The Midwest Express case study focuses on the more traditional airplane assets of an airline. United is a full service carrier, which has many feeder carriers and an elaborate hub and spoke network. Midwest Express is a direct carrier which does not operate a hub and spoke network. Thus, the two case studies, while useful tools for examining asset management, are not directly comparable.

### **3.2.1. United Airlines Information Technology Assets**

In recent decades, United Airlines has been a leader in American. This case study focuses on the assets associated with information technology and its management within United Airlines. The Operations Research (OR) Division of the Research and Development Planning and Finance Department is part of the Information Services Division (ISD) and is instrumental in developing and refining the systems and processes for planning the airline investments and operations.

#### *Lessons learned from United Airlines*

Asset management of the information technology assets at United Airlines can be characterized as follows:

- Incorporation of information technology into the organizational culture over a long period of time.
- Individual units working towards a global optimum without compromising the unit's goals.
- An optimal mix of system and economic performance as the key towards effective asset management.
- Improvement of asset utilization by the effective and efficient use of information.

One of the most important aspects within United Airlines is the incorporation of a sound technological and information technology base in the organization's culture. This has helped spur and solidify the asset management principles. The various units achieve the global and unit specific goals through weekly meetings, which evaluate the situation within the organizational units.

The various units have a healthy understanding of other department's needs. This helps promote a partnership of equals within the organization. This atmosphere should be cultivated and promoted within state DOTs in order for an effective and efficient asset management practice to evolve.

### *Assets and their Management*

The major assets of the division are network computers, data feeds, and software. An interesting feature of this case study is that unlike previous examples, software is more important than the physical assets (hardware) such as the network computers. A major part of the resources is mobilized towards developing new software. The assets in this group are constantly monitored and refurbished in order to keep pace with the technological advancements and the sensitive needs of the organization.

The basic goal of this division is to provide reliable systems and decision support tools in order for workers to achieve efficiency in planning. An optimal mix of system and economic performance is the key to effective asset management for the division.

### *Asset Management Practice*

The airline industry has had a good, solid IT infrastructure from an early stage. This has proved to be an ideal platform for the models and decision support systems that have followed, especially with regards to asset management. The various assets are managed differently. The hardware assets have their own lifecycle and are managed differently from software and data. Management of the software and data are dependent on their needs of the division and the advance made in the software industry.

United Airlines has its own performance measures, which follow FAA regulations, and in many cases are stricter than the FAA regulations. Customer satisfaction is considered an important measure of performance. In this context, the customer includes any of the divisions within the company who need information. User input is normally attained twice a year through surveys. Evaluation of asset management performance is done weekly through meetings with the users. These meetings are held with all the directors, managers and managing directors. Detailed benchmarking is done at the end of life cycle of the projects. Status and future plans are also discussed during these meetings.

Technological assets, especially the software assets, do not have a fixed life cycle but most of them depend on the advances in technology. In many cases, the advancements demand asset replacement immediately as they become obsolete. Hence a constant monitoring of the technological developments is imperative to success in the field. As

part of the asset replacement strategy, an appropriation process is invoked. The process gives a broad outline of what works and what needs to be replaced. The replacement is generally done on a worst first basis with the aim of keeping United Airlines compliant with safety standards.

Use of newer, specialized and updated information tools is crucial to survival in the airline industry. In United Airlines, the development of specialized tools started in 1996. New tools have to go through a review process before they can be administered in the system. Detailed benchmarking is done on all the tools, as they are vital to the business. IT tools are critical for day-to-day operations of the airline. In the event of system failure, there is a Business Resumption Center at an alternate location. Key operational functions of the Operations Research division are part of the center.

There are basically three types of data, which are useful to the division. They are customer data, planning data, and operational data. Various models are used for integrating this information. The models used are SIMON, which is for schedule improvement, Advanced Reflecting Model (ARM), Fleeting Routing and Crew Scheduling Model, Profitability Forecast Model (PFM), Fleet Assignment Model (FAM), Airline Simulation Model (AIRSIM), Optimal Flight Planning (using SKYPATH), and Dynamic Operations Control Model (CHRONOS).

The company holds short courses, conferences, and seminars as a part of their employee training. This included in the asset management process. The company also encourages employees to give presentations and enhance their communication skills

### *Barriers to Asset Management*

There are few barriers as everyone acknowledges that IT is not a luxury, but a necessity for survival. Since it is vital to success, usability is crucial. Approval often cannot occur until months of use. Although there are no perceivable risks due to the asset management process, it does limit the flexibility of the system.

### **3.2.2. Midwest Express**

Midwest Express Connection is an airline company that provides nonstop jet service to major destinations throughout the United States. Its subsidiary, Midwest Express Airlines, serves 26 cities. The company's commuter unit, Skyway Airlines, serves 27 cities, mostly in the upper Midwest. Midwest Express, an offshoot of Kimberly-Clark started as an in-house air service for the paper company's employees (<http://www.midwestexpress.com>)

### *Lessons Learned from Midwest Express*

Midwest Express operates a well-defined set of assets with an even more clearly defined mission and customer base. Despite the relative homogeneity of the assets and operations, this case study stresses the role of asset management and its integration into the overall goals of the organization.

### *Assets and their Management*

Midwest Airlines has 34 McDonnell Douglas jets, while Skyway Airlines has a fleet of eight jets and 15 turboprops. Asset management was introduced to manage all the assets within the organization with the goal of improving system and economic performance. Safety, preservation, availability and reliability are all highly regarded in the company's asset management process. Midwest Express has a formal asset management system, which is more of a management concept than a computer-based system. The system is heavily reliant on a rich data stream.

### *Asset Management Practice*

Asset management is a centralized process. There is no formalized "training program" for employees. Instead each job has its own specific focus and business management objectives aimed to improving financial and operational performance. The main reasons behind the implementation of the asset management program were the following:

1. Improved inventory management
2. Improved financial management
3. Improved strategic management
4. Improved efficiency of assets
5. Improved operational performance

Asset performance is evaluated quarterly and is incorporated in the strategic depending on specific strategic objectives. One senior manager and one manager are involved in the decision and evaluation process.

Asset replacement strategy is driven by corporate profitability and market demand. Thus a balance is struck between customers' wants and capital planning restrictions.

### *Barriers to Asset Management*

Midwest Express has two concerns associated with the asset management program. First of all, the program has very limited flexibility, and second of all it requires large volumes of information from a number of data sources. Midwest Express does not outsource any asset management related functions. Asset management processes are applied uniformly across all divisions. Data collection and evaluation has not changed as a result of asset management practices.

### **3.3 Private Sector Case Studies – Energy**

The two energy sector industries operate at different. Xcel provides electricity and natural gas to residential and industrial customers. Great Lakes Gas Transmission Company is a distribution company that serves companies like Xcel Energy.

### 3.3.1. Xcel Energy

Xcel Energy Inc. is a prominent US electricity and natural gas company. It provides energy-related products and services to 3.2 million electricity customers and 1.6 million natural gas customers through its regulated operating companies. The company is based in Minneapolis, Minnesota and operates in 12 western and Midwestern states. (<http://www.xcelenergy.com>)

#### *Lessons Learned from Xcel*

Xcel's experience in implementing asset management is a success story linking organizational change and asset management. Xcel distinguished the asset management function from the service provider function just as a building owner separates the building maintenance from the leasing function. Previously, Xcel had been organized according to the type of energy (gas or electric) they were delivering.

In step with this organizational change, Excel revamped its asset management support software. This included rationalization of the legacy systems, purchase and implementation of off-the-shelf asset management software to support asset preservation, maintenance, rehabilitation and construction through work tracking, costing, access to information, and data integration.

Underlying these changes was a company-wide focus on asset management. The mantra: "facilities are fixed or repaired the day before they fail" captures the key ideas of asset management. Specifically, disruption/ failure is costly and should be avoided, but gold-plating or premature improvement is also costly and should also be avoided.

Xcel Energy is about the same size operation as a small state. Its customer base is 4.8m with \$6.4 billion in assets, BUT it has only 93 people doing asset management. Their successful transition from a stovepipe organization with independent units focusing on gas and electric rather than energy is rooted in an aggressive organizational change, a vision, and supportive information technology base. They have demonstrated that they could successfully implement OTS software to form an effective decision support system.

#### *Assets and their Management*

The major assets of the organization include generation facilities such as coal plants, natural gas plants, two nuclear plants, hydro-electric plants, refuse derived fuel plants and distribution facilities such as electric transmission lines, distribution lines and natural gas pipeline. All the assets are fully owned by Xcel Energy. This case study focuses on delivery assets within Xcel Energy. The company has a formal asset management process in place, which is oriented towards both economic performance and system performance. The responsibility for asset management lies within the asset management group of 93 people.

### *Asset Management Practice*

Xcel Energy takes a proactive approach in the maintenance. Xcel's philosophy is that "facilities are fixed or repaired the day before they fail". The asset management approach of Xcel Energy is modeled after Yorkshire Electricity in England. The approach focuses on the following two areas:

- Managing the \$6.4 billion in delivery assets that include all the lines, pipes, substations, town border stations, natural gas storage facilities, etc.
- Managing day-to-day activities related to the construction, maintenance, and operation of these assets.

Xcel energy initiated a work management system called PassPort work management (<http://www.indus.com/solutions/product/passport/>) to develop common business practices across the company and shift to an "off the shelf" software product. PassPort is a highly integrated work management, supply chain, and accounts payable software package. This package provides the following benefits to the Xcel Energy:

- A single work management system for all Xcel Energy delivery to use
- A common method for completing and tracking work with cost information
- The ability to approve work, track status of approvals, and send reminders
- Savings in training, communication and labor
- The ability to access timely and accurate information

The implementation of PassPort will help the employees perform the following types of work:

- Electric and Gas distribution maintenance
- Electric and Gas distribution new construction
- Transmission and substation maintenance
- Transmission and substation new construction

Inclusion of the work management aspects of asset management is important as many state DOTs see project delivery an important part of asset management (Cambridge Systematics Inc., 2002). The asset management group in the company has regular inventory schedules, which allow maintenance and asset replacement wherever necessary. The inventory is done using predetermined condition measures, but the performance requires ones own professional judgement. Condition of assets is monitored both by visual inspection and using automated technologies. Various trend analysis tools, software packages and GIS are used to analyze the inventory data from the different sources.

### *Barriers to Asset Management*

Under the current asset management system, the electrical generation, distribution and transmission, and gas generation, distribution and transmission, which were functionally

independent companies, is under one roof. Although it helped to have a system wide focus on asset management, operational barriers have come. In order to meet the needs of the asset owners, the asset managers have become functionally and geographically separate from the service providers. This major cultural shift required considerable adjustment.

### **3.3.2. Great Lakes Gas Transmission Company (GLGT)**

Great Lakes Gas Transmission Company (GLGT) is a gas transmission company, which provides more than two billion cubic feet of natural gas to USA and Canada. This represents about 5% of all gas consumed in North America. The company's primary business is gas generation and distribution via an interstate pipeline. GLTC is not involved in any kind of buying or storage of gas. (<http://www.greatlakesgas.com>).

#### *Lessons Learned from GLGT*

At GLGT, the primary consideration in doing asset management is safety and profitability. There is an ongoing battle between the two. The state DOTs deal with taxpayer dollars and are accountable for spending the limited monies wisely and can identify themselves with private sector organizations such as GLGT.

Before embarking on asset management, the organization performed a comprehensive inventory of assets. This enabled them to focus their resources on maintaining the most important assets while at the same time ensuring profit.

#### *Assets and their Management*

The primary asset of the company is 1000 miles of dual pipeline serving a gas utility plant. Other assets include intermediate stations with compressors and vents. All of the assets including the utility plant are fully owned by Great Lakes. It has a formal asset management system, which is more of a management concept than a computer-based system. They actively manage their assets within the framework established by government regulation. The company's goal in asset management is a fine balance between improving system performance and reliability AND economic performance. Asset management was introduced to manage the most important/valuable assets of the organization and was driven by an interest in improving profit

#### *Asset Management Practice*

The control for asset management is shared between three groups. The marketing division manages the facilities, the operations group controls the gas flow volumes and the Field is responsible for ensuring safety. Maintaining safety and financial success are the two main goals of asset management at GLGT. Reliability, capacity and availability, are secondary considerations. System preservation was not ranked very high with respect to the asset management process.

Before the implementation of the asset management system, Great Lakes did a complete inventory of their gas control operation. The asset inventory is a computer-based system, which includes maintenance history, soil conditions, steel manufacturing specifications and performance measures. A new industry risk model was recently introduced. It incorporates DOT and safety regulations. These computerized tools allow the company to address areas of greatest risk first. These models allow the company to predict conditions, identify the location of spare components, and monitor inventory levels. Condition measures are based on visual and mechanical inspection and often aided by automated technologies.

The decision to replace assets is also influenced by demand forecasts and maintenance trend analysis. Every two to three years an internal survey is completed to compare company performance to industry averages. New tools such as Geoconnect, a graphic computer model, has improved inventory capabilities. The asset management process has allowed management to determine the cost of failure of current assets and to scientifically assess and predict system failures.

Great Lakes use an internally generated performance system to manage the daily operations data. It was purchased from an outside vendor and customized to reflect the operating needs and facilities of the company. Information is evaluated based on specific departmental needs. Data is analyzed by trends and with specific software packages. Graphic information systems are critical to the fast and efficient operation of the network. The company believes that no single system can efficiently keep track of all the data and performance measures. While much has been done to coordinate and share data at high levels across functions, individual department efficiency has been achieved by allowing each group to collect and coordinate specific measures for micro evaluation.

#### *Barriers to Asset Management*

At Great Lakes, there are both organizational and operational barriers within the asset management program. Organizationally, engineers have different priorities than the sales and marketing staff. Engineers would prefer to defer services to maintain the plant, yet sales and marketing are driven to maximize profit meeting demand. The internal friction is the tradeoff between safety and profit. Operationally, weather, parts availability and labor availability across the 1000-mile system create challenges in performing necessary maintenance functions.



## CHAPTER 4. CONCLUSIONS AND FUTURE DIRECTIONS

The case studies on asset management examined in this report provide a basis from which one can propose actions for the U.S. public sector.

The main reason for adopting asset management is to ensure the most efficient allocation of resources. This coupled with the fact that there is a need to “sell” system preservation and preventive maintenance investments presents a hurdle encountered in both in the public sector and the private sector. The key lessons learned from the case studies of relevance to practitioners and their salient features are summarized here along with the directions transportation agencies in the public sector should follow in order to develop a proactive, systemic asset management process.

### 4.1. Key Messages for Practitioners

In Chapter 1 we summarized the features of the case studies, reviewed the common themes and described how the private sector case studies were relevant to public sector experiences. Here we distill our research even further to some key messages for practitioners in two areas: implementation and outreach.

#### *Implementation*

- Develop and maintain an accurate inventory including location of assets, expected life, condition of assets, inspection history, usage, and improvements.
- Use advanced technology and information systems to support the asset management process.
- Relate asset management to overall objective of the organization.
- Integrate the system objectives and departmental objectives using performance measures of assets. Where possible link organizational performance to individual performance through incentives and rewards.
- Relate asset management to other business processes including the strategic planning process.

#### *Outreach*

- Ensure that all levels of the organization know what asset management is.
- Recognize that asset management is not a static process.
- Use related mandates (for example, safety or accountability) to “sell” asset management.
- Stress the role of asset management in the efficient management and utilization of assets.
- Recognize the importance of information technology in addressing asset management and invest accordingly.
- Establish effective communication between the various stakeholders, and coordinate decision-making and information between the parts of the organization managing various asset classes.
- Develop appropriate and on-going education and training covering all aspects of asset management.

## 4.2. Future Directions

Based on the literature review and case studies we have identified four areas that require attention if asset management is going to be successful in public sector organizations:

*Communication:* Effective communication of information is needed between the various stakeholders and coordinating mechanisms need to be established between various asset classes of the organization. Thus vertical communication is essential in effective asset management. This will help overcome implementation challenges that occur when there are numerous senior managers. Vertical communication starts at the traditional asset management level and continues to the highest level executive decision-makers.

*Tools:* Although many tools are already available for better asset management practices including inventory and condition assessment, pavement and bridge management systems, and optimization methods, most of these are quite basic. Further steps could be taken to make the current practices better. Integration is required at the level of inventory and condition assessment. Also relational databases could serve as a useful way to link individual knowledge centers using common data definitions and requirements. Lastly, agencies should expedite the development and use of mechanized data collection methods and flexible data systems available to everyone within the organization.

Condition forecasting tools are in short supply, and tools that combine forecasts of cost and condition are almost non-existent. Methods for assigning asset value, measuring return on investment, and evaluating investment tradeoffs need to be developed. Yet, based on each company's unique purchasing strategies, man power unit cost and project scope, most of these programs need to be internally designed and implemented.

*Education:* Educating and training legislators, decision-makers, and public officials about asset management and the need for maintenance of assets are essential. None of the tools and techniques will be of any use if the people who make the decisions do not completely understand and appreciate the need for asset management and its place in the long range planning process. One way to promote awareness is by continuing to hold workshops and conferences on asset management and other related areas.

*Planning:* Companies and agencies would never plan to fail but many state departments of transportation have failed to include holistic asset management practices and performance measurements in their strategic plans. There is an increasing need to integrate asset management principles and strategic planning in order for agencies to be successful in the future.

These results are not surprising, as they are well recognized throughout the public sector. However, they are highlighted here as it is also easy to overlook these essential elements. The case studies also reinforce the idea that the main objective of asset management in the private industry is to enhance customer satisfaction. Performance measurement and proactive maintenance are critical aspect of the link between customer satisfaction and asset management in the programs discussed in this paper. The link between customers and assets is the most explicit in the case of Union Pacific and Wisconsin Central. However, it is inherent in the experiences of all case studies.

While few organizations institutionalized asset management programs that are radically different to what a state DOT does in terms of size and complexity, UP demonstrated that accountability is possible and Xcel Energy demonstrated that organizational changes may be necessary and appropriate. The real challenge is understanding how these concepts could work for a state DOT.

## REFERENCES

1. *21st Century Asset Management, Executive Summary*, Prepared by the Center for Infrastructure and Transportation Studies at Rensselaer Polytechnic Institute, Troy, New York, for AASHTO, October 1997.
2. AASHTO, FHWA, *Asset Management Peer Exchange – Using Past Experiences to Shape Future Practice*, Washington 2000
3. Austroads, “Road Asset Management Strategy in Australia - State of the Nation 1994/95”, 1995
4. Austroads, “Strategy for Improving Asset Management Practice”, 1997
5. Cambridge Systematics Inc., “Transportation Asset Management Guide, Task I – Synthesis of Asset Management Practice,” March 2002.
6. Derocher, Robert J, *Information Technology Comes of Age – Finally*, Progressive Railroads, May 1998
7. Grant, Albert and Andrew Lemer (editors), “In Our Own Backyard,” National Academy Press, Washington DC, 1993.
8. Government Accounting Standard Board, “Guide to Implementation of GASB Statement No. 34, Basic Financial Statements -- and Management's Discussion and Analysis -- for State and Local Government, 2000.
9. Hudson, Ronald and Stuart Hudson, “Pavement Management Systems Lead the Way for Infrastructure Management Systems,” Proceedings Third International Conference on Managing Pavements, Transportation Research Board, May, 1994.
10. Kane, J. R, *Why Asset Management is More Critically Important than Ever Before*, Public Roads, March 2000
11. Leatherwood, R.L, *Asset Management, CSX Style*, Progressive Railroading, April 1989
12. Masucci, N. J., *Privatized Highway Asset Management: A Road to the Future*, Transportation builder, January 2000
13. McNeil, S., Tischer, M. L., DeBlasio, A. J., *Asset Management: What is the Fuss?* Transportation Research Record 1729, TRB, 2000.
14. National Research Council, “Measuring and Improving Infrastructure Performance,” National Academy Press, Washington DC, 1995.
15. Roark, W. B., *Privatized Highway Asset Management: A Risky Future*, Transportation Builder, April 2000.
16. Roohanirad, Ali, *Asset Management Systems – Small Counties Can Prioritize Too*, Better Roads, June 2001
17. Shinn, M., “Tennessee’s Approach to Capitalization,” Tennessee DOT, April 2001 GASB 34 Peer Exchange meeting.
18. Stalebrink, O. J., Gifford, J. L., *Transportation Asset Management: The value of Enterprise based Financial Reporting*, Transportation Research Record No 1729, 2000
19. Sullivan, D. and J. Graff, “GASB 34- A Texas Approach,” Texas DOT, April 2001 GASB 34 Peer Exchange meeting.

20. Tao, Z., Zophy, G., Weigmann, J. *Asset Management Model and Systems Integration Approach*, Transportation Research Record No. 1719, 2000
21. Transportation Association of Canada, *Highway Asset Management Systems: A Primer*, 1999
22. USDOT-FHWA, *Asset Management Primer*, December 1999
23. USDOT-FHWA, *Asset Management, Advancing the State of the Art Into the 21st Century Through Public-Private Dialogue*, FHWA-RD-97-046, Washington DC, September 1996.
24. Wurtz, Joseph J Sr., *Better Asset Management*, International Railway Journal, September 1994
25. <http://www.cn.ca>, Canadian National Railway Company, Accessed October 22, 2001
26. <http://www.greatlakesgas.com>, Great Lakes Gas Transmission Company, Accessed June 10, 2002
27. <http://www.midwestexpress.com>, Midwest Express Airlines, Accessed May 25, 2002
28. <http://www.mrutc.org/definitions.htm>
29. <http://www.ttx.com>, TTX Company, Accessed November 5, 2001
30. <http://www.ual.com>, United Airlines, Inc. Accessed March 10, 2002
31. <http://www.up.com>, Union Pacific, Accessed February 5, 2002
32. <http://www.xcelenergy.com>, Xcel Energy, Accessed June 5, 2002

## **APPENDIX A - Literature Review**

The literature review is divided into five sections. The first part traces the history and origin of asset management. The second part provides an international perspective on asset management. The third section looks at the need for asset management based on the history and the international perspective. The fourth section examines the contributions of research to the development of asset management. Finally, case studies of asset management experiences taken from trade journals form the fifth section.

The period following World War II saw rapid expansion and growth in the infrastructure in the United States. This was true for the transportation sector as well, with transportation agencies focusing their attention on transportation related infrastructure. Over time, these infrastructure systems and other related assets have deteriorated because of use, age, and other environmental factors. This has increased the need for maintenance and reconstruction, particularly of older systems. Since the late 1980's, there has been a shift towards preserving and operating the \$1 trillion investment in highways and bridges (USDOT-FHWA, 1999) and other related assets. Various management systems have been used by civil engineers to manage and maintain this infrastructure since the late 1970s. Some of the well-known systems are; bridge management systems, pavement management systems, congestion management systems, intermodal management systems, safety management systems, and sign and signal management systems. These management systems have evolved to provide a more systematic understanding of the physical assets and infrastructure, thus giving rise to the term "asset management".

### **A.1. History and Origin of Asset Management**

Besides the need to preserve the existing assets, there have been other reasons for the emergence of asset management as it is termed today. The 1990's saw an increased expectation from the government by the public, demand for more accountability and thus higher expectations regarding levels of service of critical infrastructure especially in the transportation sector. On the personal travel side, system users now have higher expectations regarding safety, comfort, convenience, and security. On the commercial side, system reliability is critical, in the context of just-in-time delivery and other productivity-enhancing patterns of operation (USDOT-FHWA, 1999).

Some states have lost significant numbers of staff in recent years as a result of government reinvention and the accompanying downsizing. States are also finding it difficult to attract and retain capable professional staff to manage complex program areas, due to the competitive nature of the labor market. The Departments of Transportation (DOT) thus are forced to prioritize their work functions, concentrating more on the management functions rather than the technical responsibilities. This has necessitated the push for a state-level asset management strategy.

Finally, budget pressures have led to increasing constraints on the availability of funds. A number of legislatures have enacted provisions that direct that funds be spent in areas

outside transportation highway projects. On the demand side, increased usage, costs, and needed upgrade requirements strain limited budgets. This has forced agencies to reconsider their management strategies finding new and better ways to manage their physical assets. However, asset management is still an emerging concept, although there have been cases of successful implementation of effective asset management strategies. The next section explains the concepts of asset management along with a few accepted definitions of asset management.

### **A.1.1. Definition of Asset Management**

Asset management can be defined as a “systematic process of maintaining, upgrading, and operating physical assets cost effectively. It includes preservation, upgrading and timely replacement of assets, through cost effective management, programming, and resource allocation decisions. It has provided a solid foundation from which to monitor the transportation system. Asset management combines engineering principles with sound business practices and economic theory, and provides tools to facilitate a more organized logical approach to decision making” (USDOT-FHWA, 1999).

While for the purposes of this research we will use the USDOT-FHWA (1999) definition of asset management; some other definitions of asset management are presented.

1. *“...A methodology needed by those who are responsible for efficiently allocating generally insufficient funds amongst valid and competing needs.”*  
— The American Public Works Association Asset Management Task Force (USDOT-FHWA, 1999)
2. *“...A comprehensive and structured approach to the long-term management of assets as tools for the efficient and effective delivery of community benefits.”*  
— Strategy for Improving Asset Management Practice, AUSTROADS, 1997 (USDOT-FHWA, 1999)
3. *“Asset Management...goes beyond the traditional management practice of examining singular systems within the road networks, i.e., pavements, bridges, etc., and looks at the universal system of a network of roads and all of its components to allow comprehensive management of limited resources. Through proper asset management, governments can improve program and infrastructure quality, increase information accessibility and use, enhance and sharpen decision-making, make more effective investments and decrease overall costs, including the social and economic impacts of road crashes.”*  
— Organization for European Cooperation and Development Working Group, Asset Management Systems, Project Description, 1999 (USDOT-FHWA, 1999)
4. *“In the transportation world, asset management is defined as a systematic process of operating, maintaining, and upgrading transportation assets cost-effectively. It combines engineering and mathematical analyses with sound business practice and economic theory. The total asset management concept expands the scope of conventional infrastructure management systems by addressing the human element and other support assets as well as the physical plant (e.g., highway, transit systems, airports, etc.). Asset*

*management systems are goal-driven and, like the traditional planning process, include components for data collection, strategy evaluation, program development, and feedback. The asset management model explicitly addresses integration of decisions made across all program areas. Its purpose is simple—to maximize benefits of a transportation program to its customers and users, based on well-defined goals and with available resources.”*

Blueprint for Developing and Implementing an Asset Management System, Asset Management, Task Force, New York State Department of Transportation, April 22, 1998 (USDOT-FHWA, 1999)

*5. Asset management is a systematic process of maintaining, upgrading, and operating physical assets cost-effectively. It combines Engineering principles with sound business practices and economic theory, and it provides tools to facilitate a more organized, logical approach to decision-making. Thus, asset management provides a framework for handling both short- and long-range planning.*

*Asset management is a systematic process for maintaining, upgrading and operating the physical assets of a transportation system. Asset management employs engineering principles, economic theory, sound business practices, and information systems to determine short and long term resource allocations.*

- FHWA, AASHTO (<http://www.mrutc.org/definitions.htm>)

*6. Asset management is the programmed approach to operating, preserving, and restoring physical assets to meet predetermined standards.*

- VMS Inc. (<http://www.mrutc.org/definitions.htm>)

*7. Asset management is the systematic process of maintaining, upgrading, and operating assets, combining engineering principles with sound business practices and economic rationale.*

- UK Highways Ministry (<http://www.mrutc.org/definitions.htm>)

*8. The sum of all those activities related to an asset's life that result in a safe and efficient intermodal transportation system that contributes to the social and economic well being of its benefactors.*

- Darrel Rensink, Iowa DOT, 1997 (<http://www.mrutc.org/definitions.htm>)

-

*9. An integrated set of processes and systems to achieve optimal and cost-effective use of assets throughout their service life, including identification of the need for an asset, acquisition enhancement of assets, utilization-operation, maintenance, and improvement, and disposal of assets. (David Ekern, Minnesota DOT, 1999)*

- David Ekern, Minnesota DOT, 1999 (<http://www.mrutc.org/definitions.htm>)

Asset management is not only an engineering tool but it provides an opportunity for both vertical and horizontal integration within the agency, as it involves finance, planning,

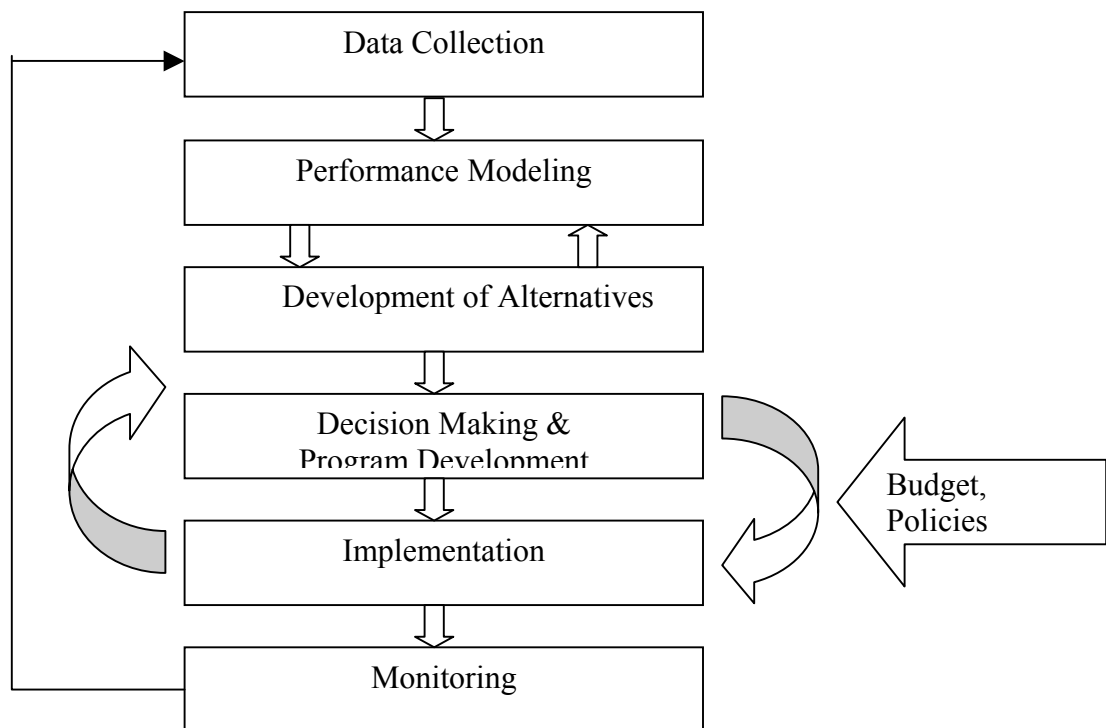
engineering, personnel, and information management. The challenge lies in bringing together all these perspectives to achieve an integrated asset management system.

### A.1.2. The Process of Asset Management

There are five basic principles that guide the asset management process. These are (1) customer focused, (2) mission driven, (3) system oriented, (4) long term in outlook, and (5) accessible, user friendly and flexible (USDOT-FHWA, 1999). The focus of asset management is with the assets (dollars, people and physical resources) and system performance. The assets are typically evaluated with principles such as return on investment, maximizing economic efficiency, accountability, opportunity costs, and future requirements.

Data collection and analysis, performance modeling, decision-making, and program development, implementation, monitoring, and feedback are major components of an asset management process. A generic process of asset management is shown in figure A.1.

Figure A.1. The Asset Management Process



Source: Asset Management Primer, 1999

Internal forces that influence the details of how asset management processes are implemented in an organization include: an organizational culture, technology, staff skills, system usage, and climate. External forces such as the demography of the region, public opinion, election cycles, fiscal status, regional economics, and environmental regulations have an indirect effect on the process. Some key elements that affect the asset

management process include assets, economics, potential users of information, and decisions/policies regarding the maintenance and replacement of assets.

### **A.1.3. Benefits of Asset Management**

Asset management allows decision-makers to focus on key issues in a rational manner. An efficient asset management system will enable better access to both qualitative and quantitative data needed for the analysis. Evaluation of alternatives is enhanced through what-if analysis, which is strengthened by asset management. It also aids the system users, stakeholders, state government officials, and managers concerned with day to day operations.

Accordingly we can say that the practice of asset management helps in the following ways:

1. Better and more objective information is available for the decision making process.
2. It provides the ability to clearly demonstrate the implications of all investment opportunities.
3. Decision-making is improved, which translates into savings of time and money.
4. It enables the agency to obtain maximum benefit from whatever level of funding the budget process provides.

### **A.1.4. Current Status of Asset Management in the Public Sector Transportation Industry**

Today most transportation plans include explicit policies and goals related to asset management. These policies and objectives regarding asset management and investment are intended to guide project selection and development within the organization. Currently, states are developing performance measures and targets to guide the overall decision-making process.

Management systems, such as pavement and bridge management systems have been under development for many years and these systems typically have investment analysis capabilities. Most states limit the application of their management systems to monitoring conditions and then plan and program their projects on a worst first basis. Existing management systems normally function at operations level and focus on one particular asset. The current asset management process is more general in nature and is more tactical than strategic.

Most agencies are already managing assets, but few have processes in place to systematically evaluate all the trade offs that must be made. Most agencies set explicit policies and goals and evaluate the success of their asset management based on trends in facility condition. New performance based measures and knowledge of associated economic implications is needed to support more strategic decision-making.

There are certain responsibilities that are more transferable than others. In spite of the difference between the public and private sectors there are certain private sector practices, which are most transferable to the public sector. These include the following:

1. Concept that “time is money” – although this is more applicable to the private sector.
2. Profit motive (managed competition, innovative contracting methods, privatization)
3. Innovative procurement methods
4. Concept of product and value

Asset management is still an emerging area as is evident from this section; there is no unanimity in how asset management is viewed. Thus there is a need for an agency/entity to provide the guidelines and draw policy statements about asset management. The three entities providing the impetus for the development of asset management in the United States are the AASHTO Task Force on Asset Management, the APWA Task Force on Asset Management, and the FHWA Office of Asset Management. Of these three, the AASHTO Task Force developed a strategic plan in 1999 with three specific goals. These are to develop and document an understanding of asset management, to communicate with and educate member agencies on how to utilize asset management, and to assist member states in assessing and implementing asset management within their states. The Task Force sent a survey to each of the 50 states to gauge the level of activity on the asset management front. McNeil, et.al, (2000) have discussed the results of these surveys along with the status of asset management in the United States. The FHWA Office of Asset Management apart from imparting training and guidance in related areas of interest is actively providing assistance to the AASHTO Task Force in developing asset management.

Thus we see that in the United States, a lot of work is going on regarding implementing domestic asset management strategies both in the public and private sector. The following section deals with some international experiences on asset management.

## **A.2. International Perspectives on Asset Management**

The United States is making great strides in asset management. There are also other countries where pioneering work on transportation asset management has been done. The prime examples are Australia and Canada. The efforts undertaken in these countries have been spearheaded by governmental agencies and do not necessarily add to this research. However, it is important to provide an overview of the asset management practice and principles as perceived in other parts of the world. Accordingly international perspectives are included.

### **A.2.1. The Australian Perspective**

Asset Management, as defined by Austroads, involves “a comprehensive and structured approach to the delivery of community benefits through management of road networks.” The asset management process, according to this definition looks at community benefits, road system performance, asset features, asset condition, asset use, physical treatments, and has a fundamentally sound asset management strategy.

The main streams identified by Austroads in asset management are:

- Identification of need of the asset.
- Provision of the asset, including its ongoing maintenance and rehabilitation to meet community needs.
- Operation of the asset.
- Disposal of the asset when need no longer exists or it is inappropriate to retain the asset.

The overall goal of adopting an asset management strategy is to assist road agencies, including local councils, to pursue a best practice in the management of road networks. The objectives identified by Austroads in adopting an asset management strategy are multiple. They wanted to provide a central focus for research and development on asset management of road networks and create a better understanding of the management of national, state and local road networks. The process aims to improve the consistency and effectiveness of alternative investment strategies for national, state and local road networks

The asset management process has several similar aims. First of all, it encourages improved inter-agency communication and communication with key stakeholders. Second, it values maintaining accurate inventories of assets. Lastly, it tries to help asset managers.

The above process takes into account the total community costs, as well as costs borne by road agencies. Related themes such as promoting awareness of asset management issues among decision-makers, better data management, and research and development of assets leading to identification of best practices in this area are also addressed by Austroads.

While the Austroads asset management strategy is comprehensive, it should be kept in mind that currently there is no enforcement of the strategy. In many ways their role is similar to that of AASHTO's in the United States, in the sense that they function in an advisory capacity and develop policy statements regarding asset management.

### **A.2.2. The Canadian Perspective**

Asset Management, as defined by the Transportation Association of Canada (TAC), is a comprehensive business strategy of employing people, information, and technology to allocate funds effectively according to priorities and needs. According to the TAC, effective asset management affects investment decisions. The impacts of these decisions can also be better assessed. In an effective asset management strategy, both technical and business perspectives are equally important.

*The components of an asset management system are as follows.*

- An asset inventory: a computer database, consisting of the asset type, asset location, condition, usage, and value
- The procedure to determine the value of assets

- A set of analysis models to develop and prioritize proposed maintenance treatments and schedules

Of these three components, keeping the database current is of prime importance. It is the only way to ensure that the best asset management principles are applied.

This chapter has thus far synthesized the history and the international perspective on asset management. The next section outlines the need for asset management as well as some of the key indicators for effective asset management.

### **A.3 Asset Management in the United States**

With the set of principles discussed in this chapter, we now catalogue the needs for asset management systems in the United States, particularly in the public sector.

#### **A.3.1. Need for Asset Management**

##### 1) Required for Preventive Maintenance

Preventive maintenance is extremely important because of its ability to prolong the asset life and reduce the frequency of maintenance requirements. The key element to note here is that it should cover all facility assets (Kane, 2000). It can be the basis for management strategies for assets identified as most crucial to company operations and financial performance.

##### 2) Asset Valuation

Asset valuation can be a very effective asset management tool. It is an excellent example of a private sector concept that can be usefully implemented in a public sector context.

##### 3) Accountability

As we discussed earlier, there is increased customer expectation for the public sector agencies. Hence there is a need for accountability and transparency in management and government spending. Users expect all levels of government to manage “their” assets in an effective, reliable and efficient manner.

##### 4) Financial Constraints

The transportation agencies have realized that despite the increase in federal funding authorized by TEA-21, they will have to satisfy an increasing demand for resources. Modern and integrated management strategies, which optimize future investments, are essential.

##### 5) Personnel constraints

It is increasingly difficult to attract capable professionals, to offset the loss of significant personnel. Some states have lost significant numbers of staff in recent years as a result of government reinvention and the accompanying downsizing. As a result of competition, states are finding it difficult to attract and retain capable professional staff to manage the complex program areas. The DOT's thus are forced to prioritize the work functions, concentrating more on the management functions rather than the technical responsibilities.

#### 6) Diversity and differences in regions

There are sharp differences between metropolitan areas and more rural regions. Hence the state DOT's are challenged by equitable allocation of limited resources among regions.

#### 7) Size of public transportation agencies in big cities like Chicago and New York

#### 8) Need for ability to optimize network or system level improvements and investment strategies in addition to analyzing individual projects

The needs highlighted in this section spawn a set of criteria for the asset management system to be successful. These are discussed next.

### **A.3.2. Critical Success Factors for an Effective Asset Management System**

To increase the likelihood of an effective asset management system, the following ideas should be considered:

1. Determine whether or not the organization is financially and strategically ready to invest in asset management
2. Develop a strategic vision for asset management
3. Obtain an organization-wide commitment from top management to front line staff
4. Keep development in the hands of system users, and the organization staff
5. Keep all business areas of the organization informed and involved throughout all phases of development
6. Develop and deploy the system properly in order to create a sense of ownership among staff
7. Identify all business processes and stakeholders that are required in order to sustain the asset management process in the long run
8. Communicate the changes in business standards, policy, data collection and other processes to all staff
9. Survey staff periodically to ensure the benefits of asset management are being realized and to keep policy in line with user needs.
10. Develop and promote a learning culture within the organization

### **A.3.3. Benefits of an Asset Management System**

The international perspectives of asset management as well as the history of asset management in the United States help outline the benefits of adopting an asset management system within an organization. Following are the benefits that can be achieved by following the asset management principles discussed above. It will help to do the following:

1. Optimize the management of maintenance and rehabilitation budgets
2. Provide a powerful negotiation tool to justify overall budget
3. Provide the ability to justify intervention programs for maintenance and rehabilitation
4. Improve the credibility of public sector decision making process
5. Reduce fragmentation of information within an organization
6. Provide the ability to assess the implications of using specific network level performance measures
7. Provide the opportunity for the staff to improve their technical skills and business knowledge

The need for asset management stems from deficiencies in technology, financial constraints, and in general from asset age and use. As a result, it is important to have a good understanding of these multiple constraints before implementing any asset management system.

#### **A.4. Research on Asset Management**

Various researchers have studied asset management throughout the last two decades. Since it is impossible to include every contribution to the knowledge base, this section provides a synopsis of a couple of research papers. This section summarizes research about integrating asset management via a systems integration approach and about the value of enterprise based financial reporting in asset management.

##### **A.4.1. Asset Management Model and Systems Integration Approach**

**Introduction:** Although most infrastructure management programs involve elements of asset management strategies, most of them fail to have a system-wide focus. They focus on individual assets rather than the long-term asset management needs of the entire organization. A few researchers have illustrated ways to accomplish this. Tao, et.al (2000) in their paper describe a systems integration approach combined with an asset management model. This model illustrates the basic asset management goals, strategies, principles, and analysis methods and also demonstrates how component asset management systems can be integrated at different stages of their development life cycles. The approach is divided into five phases:

1. Business integration
2. Systems requirement integration
3. Logical design integration
4. Physical design and development integration
5. Implementation integration

This research illustrates how key strategies and higher order asset management needs can be accomplished by an effective asset management model supported with a systems integration lifecycle approach. The following subsections discuss the research done in conceptualizing this model and the related integrated approach.

**The Asset Management Model:** Few organizations have an asset management strategy that optimizes asset value over the complete asset life cycle. The following table (Table A.1.) shows the steps required for an effective and ideal asset management process that is system-wide.

Table A.1. Asset Management Model (Source: Modified from Tao et al, 2000)

<b>Step</b>	<b>Description</b>
Development of Asset Management Strategy	Knowledge of past performance history that reflects deployment, functional condition, capacity of assets, etc. is important. It is the basis for estimating future cost benefit relationships and future expectations.
Determining Asset Mix and Inventory Information	Inventory and condition information is the basis for determining the need for future investments and directly supports service delivery functions.
Analyzing the Value of Investments	An important link has to be made between asset investment and value produced for customers. Although investments are easy to measure, customer benefits are difficult to assess due to its subjectivity.
Asset Management Life Cycles	Various business areas of transportation agencies have to be integrated for life cycle transportation asset management to be effective.
Performance Measuring	Productivity, effectiveness, net value to customers, and maximum net value are the four levels of performance measurement which determine the investment in assets.
Allocating Asset Investments	This is at the heart of the challenge. Two basic kinds of decisions need to be rationalized: first, allocation across similar assets and the second, allocation between different assets. Asset management allocation decisions are made with all manner and combinations of probabilistic, deterministic, engineering, and holistic criteria.

**The Systems Integration Lifecycle Approach:** Integrating all the key systems in an asset management process is a very formidable task. Each component system or asset

follows a similar development life cycle. But integration is rarely carried out through the life cycle of the asset. The underlying concept of this approach, according to this paper is that the “*integration should start right from the beginning of the component systems’ development life cycles and should systematically continue until all component systems are implemented*” (Tao et al, 2000). The paper divides the system integration approach into two phases – the business integration phase and the requirements integration phase.

**Business Integration Phase:** The goal of this phase is to provide a single business model that can be shared by all the asset management component systems within the organization. This will help provide a consistent view of the business model across all systems and act as a basis for the integration of these systems. The products of this phase include high-level business strategies and detailed process information.

**Requirements Integration Phase:** This phase identifies the roles and functions of each system in the entire asset management program. It helps to establish the integrated requirements of all systems. The Requirements Integration phase has three distinct modules as discussed here.

*a) Logical Design Integration Phase*

It aims to coordinate the logical design activities of each asset management system by providing a common logical basis such as an integrated asset management data model and a system interfacing architecture. The two key products of this phase are the integrated asset management data model and the interfacing architecture of the asset management system.

*b) Physical Design and Development Integration*

The aim here is to develop an overall system integration architecture that can support the physical design and development of individual systems. The technical standards are to be enforced through this type of integration.

*c) Implementation Integration*

The implementation of asset management systems involves business process changes. The goal of this integration is to develop the necessary tools to support the implementation of the asset management system from both the business and systems perspective. The integration products from this phase are the business implementation plan and the system implementation plan.

**Conclusions:** This paper seeks to give managers and administrators insight into the components required for a successful asset management model within an organization. Given the generalized nature of the literature, it can be applied both in the private sector and the public sector without too much difficulty.

#### **A.4.2. The Value of Enterprise-Based-Financial-Reporting in Transportation Asset Management**

**Introduction:** Stalebrink, et.al (2000) identify the value of enterprise-based-financial reporting (EBFR) practice and its potential to facilitate the use of profitability analysis in infrastructure asset management. This concept of using enterprise based financial reporting is gaining popularity, particularly with the emergence of Government Accounting Standards Board (GASB)-34 which requires both the state and local transportation agencies to report their financial statements with a more comprehensive picture of the value of their infrastructure assets.

Two key issues arise while discussing this concept. First is the potential usefulness of applying EBFR practices to the actual management of public transportation infrastructure. Second is the extent to which this can be applied in the area of asset management (Stalebrink et al, 2000). The paper looks at the concept of enterprise based financial reporting in the context of its relevance to asset management principles and in helping assess the results of asset management.

**Relevance:** With increased public expectations, changing user demands and legislative changes there has been a growing emphasis on the development of organizational and programmatic performance measures. The most important legislative change, pertaining to transportation, in the last decade has been the Intermodal Surface Transportation Efficiency Act (ISTEA), which mandates, among other things, transportation agencies to develop and use performance measures to evaluate transportation projects.

It is in this context that Enterprise-Based-Financial-Reporting (EBFR) assumes significance and helps make transportation facilities more efficient through innovative methods for reporting of finances. The adoption of EBFR will “*expand the scope to emphasize profitability measurements by allowing analysis of the overall contributions of an entity’s individual sections as if these sections were separate entities*”(Stalebrink et al, 2000).

The authors state that if transportation agencies are to adopt EBFR, they must move to a system that puts greater emphasis on recognizing, in financial terms, the benefits or services provided by individual transportation agencies.

**Assessment:** A major challenge for the successful implementation of asset management is the ability to generate what GASB refers to as satisfactory system input values in a public setting. Since market prices are not generated in these environments they have to be simulated. In order for EBFR to work, two possible approaches have been identified thus far for generating measurements - benefit cost analysis and econometric studies of the productivity impacts of the infrastructure investments. Although both approaches suffer from several weaknesses, ongoing methodological advances in both approaches indicate that the generation of such values will be possible in the future.

Hence the authors suggest that one should not be too quick to dismiss the use of EBFR in infrastructure investment analysis.

Several countries have implemented financial reporting systems in the public sector; the systems are structured primarily on enterprise based approaches. Countries such as New Zealand, Canada, Sweden, and Spain have replaced their cash based accounting with accrual systems. Accrual accounting is a system whereby financial flows are recognized in financial reports during the period in which they occur.

Three major benefits have been reported from this transition. First, the approach has changed. Instead of deciding how much to spend on new assets now, management focuses on whether to retain and upgrade existing assets. Second, “management by results” has become a more viable option for public managers. With the new system performance can be measured more reliably assuming accurate estimates of full costs are provided. And finally, accrual accounting provides useful information about the actual level of governments liabilities.

Therefore, despite the need for more theoretical research in this area, experience gained from these countries appears to indicate that the implementation of a partial system is practical. As soon as insights are gained into the pricing of public settings, the transition to full fledged EBFR can be effectively completed.

#### **A.5. Case Studies of Asset Management Practice**

The previous section dealt with the fundamentals of asset management, while this section deals with specific cases in which asset management principles and practices have been incorporated in both the private and public sector. Most of the cases are from the railroad industry. However, there is one from highway/roads and one from the management of bridges. Table A.2. gives a summary of the case studies included here and the salient features of each case study. The individual cases are explained in detail in sub-sections A.5.1 through A.5.5.

Table A.2. Attributes of the case studies

S.no	Company	Industry	Computer Based	Prime objective	Remarks
1	Burlington Northern Santa Fe (BNSF)	Railroads	Yes	Scheduling	Customer focussed approach
2	Union Pacific Railroad	Railroads	Yes	Increased return of assets	Emphasis on developing an information system
3	CSX	Railroad	No	Provide optimal capacity in the most economic form, while meeting customer needs	Customer oriented approach
4	Jackson County	Roads	No	Increased coordination between engineering, planning and road maintenance divisions	Emphasis on proactive maintenance
5	Virginia DOT	Roads	No	Privatized maintenance of the Highway system	Effective process if attention is paid to detail.

### A.5.1. Burlington Northern Santa Fe (BNSF)

The railroad industry was one of the first industries to acknowledge asset management as it is termed today. The railroads have emphasized the use of advanced software systems to improve both customer service and asset utilization. In 1998, Burlington Northern SantaFe (BNSF) railroad completed a successful implementation of Interline Service Management (ISM). It was a pilot project for Adolph Coors Brewing Company and the Association of American Railroads. The prime purpose of an ISM is to help freight railroads better manage their businesses while meeting increased customer demands (Derocher, 1998).

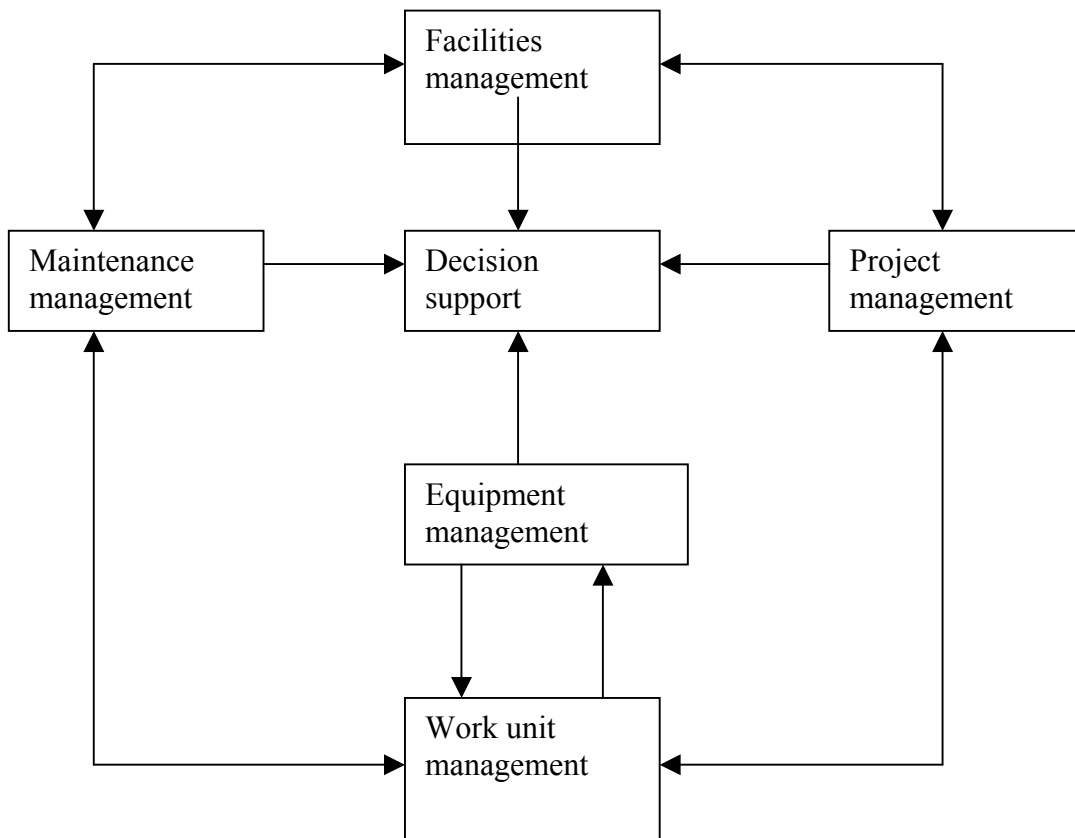
ISM protocols are established to allow the Class I's to exchange information with each other when shipments cross from one railroad track to the other. The information included in Interline Service Agreements (ISAs) between railroads is: the time a train is expected to arrive at an interchange; the need for locomotive or fuel; the need for an end of train device, and information regarding responsibility for providing necessary help at the interchange. As part of its customer focussed approach, ISM gives railroads the ability to develop trip plan schedules that can more accurately predict when a rail will arrive. Paul Martin of CIT group has rightly said (Derocher, 1998), that information systems needed to support the rail industry are the most complex of any transportation industry. This asset management system is not for maintenance of physical assets alone,

but for promoting better coordination among different management systems and managers.

### A.5.2. Union Pacific Railroad

Managing railways is an information intensive activity and information systems have an enormous potential when used in the area of infrastructure management. Hence Union Pacific Railroad (UP) has given high priority to the development of information systems to transform its infrastructure organization. This includes the maintenance of physical assets and facilities, project management, and decision support systems. The UP system for infrastructure management is called the Engineering Control System (ECS) (see figure A.2.). It is a comprehensive set of systems each aimed at key business areas and functions, such as projects, maintenance, equipment, facilities, and decision support (Wurtz, 1994). ECS also provides cross-functional capabilities between the aforementioned areas.

Figure A.2. Engineering Control System



Source: Wurtz, 1994

The design of ECS includes functions of engineering project management system (EPMS) which:

- Define projects in detail, including cost, location and facilities
- Develop and updates complete cost estimates
- Include a comprehensive bill of materials
- Use production standards for labor, materials and equipment
- Provide for advanced project scheduling and resource allocation
- Enable comprehensive project monitoring, incorporating earned value methods

UP has been allocating about 5 - 6% of their total budget on maintaining an effective information system. Although it is not clear how productive information systems affect asset return, it is evident, however, that during the five year period from 1988 to 1993, UP's return of assets was superior to any other railroad.

The shift to dependence on information systems for asset management means comprehensive data about all facilities, short and long range plans, and the resources used must be available. However, the ultimate test is how ECS copes with rapid reviews and adjustments to plans. As a customer driven railway, the current environment is radically different from the "old style" railway in which the organization controlled the changes (Wurtz, 1994). Although it is difficult to delineate the role of an information system in asset management, a good example always helps improve the process.

### **A.5.3. Jackson County, Missouri**

Local governments typically strive for providing comfortable roads with the meager resources available to them. This process requires balancing priorities and making difficult decisions to manage public infrastructure effectively. Asset management is emerging as one of the major techniques to manage infrastructure and other physical assets in an efficient, effective manner. Jackson County, Missouri has recognized the importance of asset management. In the past two years, the county has customized an asset management system (AMS) for use by its Public Works Department. This AMS was developed for use in the eastern portion of the county, which predominantly contains a rural type of infrastructure (Roohanirad, 2001). The main objective in using this system was to achieve more effective internal coordination among engineering, planning, construction, and road maintenance. It was decided to develop an innovative, customized AMS specifically for Jackson County's local government. The three basic steps involved in the asset management program were:

- 1) Development of a complete inventory of facilities
- 2) Periodic evaluation of the condition of facilities
- 3) Evaluations to choose strategies for preventive maintenance and rehabilitation

AMS includes the collection of data and assessment of several facility characteristics including roughness, surface condition and distresses (type, extent and severity), surface skid characteristics, and structural consideration. As recently as ten years ago, Jackson County did not have a preventive maintenance plan to extend the service life of a facility,

but with the use of AMS Jackson County saves more than \$1 million every year because it is performing the most economical yearly maintenance. The AMS helped in:

- 1) Evaluation of projects by use of objective data
- 2) Custom developed programs to fit county needs
- 3) Immediate access to geometric, performance, condition, and historical data
- 4) Quick and efficient analysis of objective data for planning, scheduling, resource allocations, and budgeting
- 5) Elimination of duplication of effort
- 6) Improving overall performance level (measured by the Pavement Condition Index - PCI)
- 7) Establishing short and long term budgetary requirements
- 8) Comprehensive assessment of current status of networks
- 9) Ability to assign priorities on an objective basis in spite of limited funding

Several factors helped Jackson County improve facilities' conditions. These include:

- 1) Availability of sound and objective facility condition index data
- 2) Being able to plan, and prioritize maintenance improvement programs
- 3) Performing current and most cost-effective yearly routine, preventive, reconstruction and maintenance procedures on roads.

The cost of implementing AMS was substantially repaid by the improved facility condition, maintenance cost savings, and increased staff productivity. Table A.3. gives an overview of the Jackson County Maintenance program.

Table A.3. Comparison of activities with and without AMS

<b>Without AMS</b>	<b>With AMS</b>
<b>Budget Preparation:</b> prepared based on capital expenditures, roadway as a whole including bridge, right of way, and other actions	<b>Budget Preparation:</b> prepared based on needs, specific projects to be constructed considering detailed project information
<b>Cost estimates:</b> Approximate cost per mile	<b>Cost estimates:</b> Precise cost per square yard for each type of action
<b>Access to existing condition:</b> No access to facility condition and historical data	<b>Access to existing condition:</b> Immediate access to geometric, historical and facility condition
<b>Pavement Evaluation:</b> No facility evaluation	<b>Pavement Evaluation:</b> Use of objective data to evaluate projects, describe current facility condition, and to determine rehabilitation actions
<b>Maintenance Planning:</b> No facility improvement or budget planning	<b>Maintenance Planning:</b> Quick analysis of objective data for planning, scheduling, resource allocation, and budgeting most cost effective method.
<b>Coordination:</b> No coordination with other divisions	<b>Coordination:</b> Good coordination with other divisions
<b>Maintenance action:</b> No plan for routine and preventive maintenance (Reactive maintenance)	<b>Maintenance action:</b> Sound plan for routine and preventive maintenance (Proactive maintenance)
<b>Performance Evaluation:</b> No control over how improvements are performing	<b>Performance Evaluation:</b> Excellent control over how improvements are performing
<b>Program Justification:</b> Inability to justify capital and maintenance program	<b>Program Justification:</b> Ability to justify capital and maintenance program

Source: Roohanirad, 2001

#### A.5.4. CSX Transportation

Freight cars are perhaps the most difficult assets to maintain. This is becoming even more difficult with increasing economic and competitive forces. CSX transportation was one of the first organizations in the railroad industry to identify and apply asset management principles toward managing their freight car fleet. Although there are a small number of components that carriers can manage, there are limitless ways to combine those assets. This results in numerous options for meeting customer needs.

Historically, declining rail industry traffic levels and the need to improve productivity result in low demand for freight cars and a surplus situation. This occurred in the 1980's, when car fleets shrank. The effect was felt by CSX. But in 1987, the American economy reached a strong position. This caused resurgence in the manufacturing sector. However, due to the aging of the national fleet, the demand exceeded supply. Hence the carriers

explored ways to satisfy customer needs. In the end, CSX chose heavy repair as its primary method to provide capacity to meet customers' equipment needs.

Heavy repairs are typically slanted toward the freight car types used for long-term commitments in core markets. This program is directed at the customers who prefer rail transportation delivered as a quality product. Customers are directly involved in the repair program. Many changes suggested by customers have been adopted by CSX. Car acquisition was also included, based on customer feedback, as a strategy to meet demand. CSX thus moved towards the first dimension of customer quality requirements, that is, car availability. Once CSX fulfilled the fleet requirement issue, the process of placing the right car in the right place and at the right time needed to be addressed. The aim was to select cars in a way that minimized empty movements before loading and idle time between trips. An effective demand forecasting system tracks the progress of each order. Customers can significantly enhance the demand forecasting system by providing accurate information on the shipment patterns. The new system should generate performance statistics that also help to better gauge long-term needs (Leatherwood, 1989).

CSX has been working hard to achieve a harmonious balance between effective asset management and meeting customer needs. The CSX car fleet has been growing through aggressive repair and acquisition programs. Pro-active demand forecasting is emphasized.

#### **A.5.5. Privatized Highway Asset Management, Virginia**

Departments of Transportation have been struggling with the ever-increasing costs of maintaining an aging system of highways and other related infrastructure. The Virginia DOT has developed an innovative scheme by which they hand over the responsibility of maintaining 20% of the state's interstate system to a private firm under a fixed price contract (Masucci, 2000).

Asset management in the Highway industry is similar to that in a private industry in the fact that the emphasis is on maintaining and operating physical assets within budgetary limitations. While there are many ways and tools to perform this function in-house, certain DOTs are outsourcing this function to private contractors. It allows the DOT to save monies from their maintenance budget. For example in the case of Virginia DOT, the privatized asset management contract will allow the DOT to save \$22 million over a five and a half year period on its maintenance. According to VMS, Inc., this number will increase to more than \$100 million per year in savings if the DOT were to hand over the responsibility of maintaining all of its interstate system to private contractors. This process also ensures that the risk issue is transferred totally to the private sector (Masucci, 2000). At the same time, the contractors are bound to uphold the quality of their work and meet pre-qualified standards for asset performance.

In spite of the good news, this process is not as risk-free and transparent, as it seems. There are issues that still need to be resolved before privatization of asset management becomes a healthy proposition. The contracting system followed in Virginia was not a

competitive bid system. In the absence of competitive bids, a number of questions with regards to the legality and the transparency of the process come to the surface (Roark, 2000). The governmental agency opting for privatization of its functions needs to devise a foolproof, competitive process to ensure that privatization does not lead to corrupt practices. Also, the government agencies will know for sure about the potential savings only if they keep an account of how much they were spending to do the maintenance in-house. Thus, more accurate accounting procedures, and a more open, competitive bidding process are needed to ensure that privatization of asset management indeed becomes a success.

#### **A.6. Conclusions**

The literature review has traced origin, history, and evolution of asset management through the use of case studies. The needs and future directions that need to be pursued provide a better understanding of the ingredients required for a successful asset management process. The case studies to be presented, as part of this research will look into how these ingredients have been included by the various organizations interviewed. The case studies are picked from industries such as the railroads, utilities, shipping, and the airline industry.

## APPENDIX B - SAMPLE QUESTIONNAIRE

### Background

1. Financial Information
  - a. 1999 and 2000 Revenues
  - b. Return on assets
2. Number of employees
  - a. Number of employees in the central offices \_\_\_\_\_
  - b. Number of employees in in field locations \_\_\_\_\_
  - c. Total number of employees \_\_\_\_\_
  - d. What is your current employee turnover rate? \_\_\_\_\_
3. Tell me about your asset base? (Overview question)
4. Describe the characteristics of the assets that you currently manage:
  - (a) Asset description: \_\_\_\_\_
  - (b) Asset value: \$ \_\_\_\_\_
  - (c) Asset ownership: (% owned \_\_\_\_\_ %leased \_\_\_\_\_ )
  - (d) Life cycle of the asset: \_\_\_\_\_.

### Establishment of Goals and Objectives

5. Why was asset management introduced?
  - (a) To manage all assets within the organization
  - (b) To manage the most important and valuable assets of the organization
  - (c) To provide a better planning process
6. Please rank order the following three asset management approaches:
  - (a) System performance
  - (b) Economic performance

(c) An optimal mix of system and economic performance.

7. What factors/goals were important in your asset management process? Please rank on a scale of 1(low) – 5 (high)

(a) Safety                    1        2        3        4        5

(b) Preservation            1        2        3        4        5

(c) Availability            1        2        3        4        5

(d) Reliability            1        2        3        4        5

(e) Other: (Explain)

8. What were the risks of an asset management program, check all that apply.

(a) Limits flexibility

(b) Limits decision making process with too many constraints

(c) Slows down decision making process.

(d) Requires too much information

(e) Requires new business processes and analytical tools

(f) Increases staff requirements.

9. What barriers did you run into during the asset management process?

(a) Organizational barriers:

(b) Operational barriers:

11. Is asset management a centralized or a decentralized function? Please give me an example of each.

10. What types of training accompanies asset management?
- (a) Short courses
  - (b) Conferences or Seminars
  - (c) Training Videos
  - (d) Computer-based programs
  - (e) Other \_\_\_\_\_
11. How did the decision making process change because of the asset management program?
12. What problems were you trying to solve with an asset management program?
- (a) Incomplete Inventory of assets
  - (b) Inefficient management of assets
  - (c) Other (specify) \_\_\_\_\_
13. What concerns do you have about asset management?
14. Did you perform an initial assessment of current operations before you embarked on the process?      (a) Yes      (b) No.

### **Development of Plans and Programs**

15. Please describe the life cycle of the assets you manage:
- (a) Service life
  - (b) Technological life
  - (c) Economic life

16. How frequently do you evaluate asset management performance?

- (a) Weekly
- (b) Monthly
- (c) Quarterly

17. How is asset management incorporated into your strategic plan?

(a) How many associates are involved in asset management?

- (i) Senior management
- (ii) Manager level

(b) Did you develop new tools to monitor the process? (a) Yes (b) No.

(c) How do you evaluate asset management performance?

- (i) Inventory systems updated as-needed
- (ii) (ii) Inventory systems updated according to a schedule
- (iii)(iii) Very little evaluation done.

(d) How are asset replacements/acquisitions included in the budget?

(e) How is customer satisfaction evaluated in asset management decisions?

- (i) By trend analysis of demand
- (j) (ii) By survey
- (k) (iii) Not evaluated.

18. How do you inventory assets?

(a) Do you have condition measures?

(b) Do you have performance prediction capabilities?

- (i) No prediction made
- (ii) Professional judgement is used \_\_\_\_\_
- (iii) Expert systems are used to model future performance
- (iv) Other

(c) Do you have productivity measures associated with individual assets?

- (i) Yes
- (ii) No.

If yes, what are the key factors you measure?

(d) How do you track the condition of your assets?

- (i) Not done
- (ii) Measured based on visual inspection
- (iii) Measured using mechanical devices
- (iv) Measured using automated technologies
- (v) Other

19. Do you outsource any functions associated with asset management?

- (a) Yes (b) No.

20. If yes, what functions are outsourced?

21. What is your asset replacement strategy?

- a) worst first
- b) to comply with safety standards
- c) to achieve corporate profitability
- d) to improve asset performance

22. How are cost analyses performed when faced with system versus project optimization?

**Information**

23. How did your data collection efforts change as a result of asset management?

25. Does asset management require more data or new reports? If so what changed?

26. As a result of asset management processes how did your information technology department change to meet the demands?

27. Do different departments manage assets differently. What common data is necessary for strategic planning decisions?

28. What recommendations would you have for State DOTs considering asset management programs?

## APPENDIX C - WISCONSIN CENTRAL RAILROAD (WCRR)

### C.1 Background: About the Organization

- History – Wisconsin Central Transportation Corporation was a holding company, which operated a regional North American rail system in Wisconsin, northeastern Illinois, eastern Minnesota, and Ontario. It owned minority interests in the management of rail operations in the United Kingdom and Australia, and ferry and rail operations in New Zealand. (<http://www.wclx.com>). This case study documents asset management practices at WCRR prior to their acquisition by Canadian National (CN) in late 2001.
- Ownership – owned by a group of 20 people who started the Wisconsin Central Railroad in 1987, and was a publicly traded company.
- Clients – Most of their clients were from the paper industry. 60% of their revenue is wood and paper related. The Wisconsin River Valley was one of their heavily traveled corridors serving the paper and paper related industry in that region.
- Asset description – Equipment and physical property, as well as locomotives, block signals, box cars, and railroad right-of-way were the principal assets of the railroad along with infrastructure facilities such as the International bridge at Sault St. Marie.
- Asset value - \$800 million in assets, and \$400 million in debts. In late 2001, Canadian National bought the company for a total of \$1.2 billion. The deal was finalized on 10/9/01. WCCR's revenue for the last year of operation was \$370 million.

### C.2 About Wisconsin Central Railroad

The Wisconsin Central Railroad and Transportation Company was formed in 1987, after the Staggers Act. The original owners did an asset purchase of the Green Bay Western and Fox Valley Western Railroads, parts of the Union Pacific in northwest Wisconsin, and parts of the Union Pacific in northern Michigan in different years (1993, 1995, and 1998). They also made huge consolidations in various towns in the states of Michigan, Minnesota, Wisconsin, and Illinois. The company began as a 2,500-mile railroad, and grew to 2,800 miles of railroad. Most of the increase came from either abandoned or renovated railroads.

The Wisconsin Central Railroad had about 500 vehicles in their fleet. Wisconsin Central bought used equipment, while most of their vehicles are leased. The issue of whether to lease or to buy usually boils down to the best financing deals available to the organization. They buy a lot of their equipment on the used market and buy only a quarter of their equipment new. They do the maintenance of their assets, even for the ones that are leased. The maintenance shop in Fond du Lac, Wisconsin is used to overhaul old locomotives as opposed to building new ones.

The company has an ore facility in Michigan and a bridge in Sault St. Marie, MI, and other small pieces of property. The railroad owns all their work equipment – with 10 tamping gangs, 4 sets of rail and tie equipment, cranes, etc. The organization has one of the largest boxcar fleets in the country, which is interesting at a time when boxcars usage has reduced significantly. Most of these boxcars were bought in the past 10 years. Canadian National will probably retain them.

Some of the main assets within the organization, are track and track-related infrastructure. The physical property is the main responsibility of the organization. As far as track management and related infrastructure is concerned, the railroad has one road-master for every 300 miles of track. They have a car management system, a bridge maintenance system, a signal system, and a phone system in place to monitor, maintain, and manage the different assets of the organization.

The company has always found capital to build customer facilities within their domain. The organization tends to capitalize asset investments as much as possible and leave maintenance with operations.

### **C.3 Goals of Asset Management:**

The goal of asset management varies depending on the asset being managed. Asset management was introduced to manage the most important and valuable assets of the organization. The asset management process is oriented to monitor first economic performance primarily and then system performance. Safety is an over-riding concern. The main goal of the asset management is to reduce risk by frequent testing. One of the other objectives that is addressed with this process is that of ensuring safety. The strategy with respect to replacement and maintenance of the various systems is to replace and maintain starting with the worst first. As the years progressed and they were able to take care of the worst first with the limited dollars, they have slowly moved into a position to being proactive with asset management. One of the main problems identified was the fact that rail replacement was and is a difficult thing to manage. This was because they could not afford to replace the rails because of their high cost. They got around this by managing to generate rail from abandonment, and by typically replacing old rail with new at the rate of 5 to 10 miles every year.

### **C.4 Asset Management Practice in WCRR**

- Is there an asset management practice? Yes, the responsibility for managing the assets is spread throughout the organization. However, the term “asset management” is not used
- Are different types of assets managed differently? Yes, each asset has its own life cycle and performance measures. Different computer programs and systems manage these assets.

As mentioned before, the main assets of WCRR are the Right-of-Way/property, rails, tracks, cars, locomotives, etc. As far as immovable assets are concerned, WCRR own a

facility in Michigan, a bridge at Sault St. Marie, along with other small pieces of property. The goals of asset management vary with the type of assets being managed. Equipment is the biggest cost variable, while property is the largest asset expenditure. The most expensive property is the track. The railroad has a road-master assigned for every 300 miles of track. The budget for capital needs is not fixed and is negotiated depending upon the need.

The WCRR documents its track inventory using track charts. The track charts are maintained in a CAD system and updated every January. The charts not only include geometry but information of year rail was laid, temperature at which it was laid, year in which the program was complete, and signals, crossing, bridge, and other data such as speed.

As far as asset specifications are concerned, WCRR follows both the specifications prescribed by the Federal Railroad Authority (FRA), as well as its own customized standards in metal type, wooden ties, concrete, and steel ties, etc. All tracks are inspected at frequencies exceeding the FRA requirements. Track inspection is the single-most valuable tool for managing risk in terms of both safety and convenience (preventing disruption of service). Heavily traveled segments are visually inspected five times a year, and on an average 600 miles per year are covered with the defect detector car. On key routes that carry hazardous materials, the track geometry car conducts inspection twice a year. The whole railroad was profiled in about 1995 and select sections were covered earlier in 2001.

The railroad has 90% single tracks, which operates in excess of 30 trains per day. In the Chicago region, Metra operates 10 trains a day and is planning to increase this to 22 trains a day in the near future. It will thus predominantly be a double track railroad, with some single-track stretches.

The organization does not use the term asset management as such, but does maintain and manage its assets in its own way. They have a computer system to monitor track usage and related problems. This CAD system is updated every January. They have the Norfolk Southern (NS) system to manage their property. The inspections of their assets are according to FRA regulations. In some instances, they go beyond the FRA mandate in order to make sure their assets are up to standard. They test at least double the minimum requirements. The bridges are inspected once every 5 million tons a year and bridges less than that are to be inspected once every two years. Heavy equipment is managed for risk by inspecting them 5 times a year. The FRA mandates that bridges with 10 million gross tons or more are to be inspected twice a week. Bridges with more than 5 million tons per year are inspected once a year and those with less than 5 million tons are tested once every two years. Over a span of 15-years, the railroad has performed two tie passes, and replaced 1200 ties per mile. Tracks with more than 10 million gross tons are inspected twice a week. In all 600 miles of track are tested every year out of the 2800 miles of track owned by the company. The railroad has complete testing history since its inception. Their management philosophy is to be proactive and to adopt a worst first strategy with respect to repairs. As far as rail renewal is concerned, there has not

been any new rail in the last 14 years. Instead the railroad has “generated” rail through consolidation and abandonment. The asset replacement strategy is “whatever they can afford”. They rarely do Return-On-Investment (ROI) type analysis.

The signals for crossing are owned by the state and installed and maintained by the railroad. Block signals are owned by the railroad and the dispatching is done from Stevens Point in Wisconsin. Track charts were done by hand for the first few years before the adoption of the CAD system. The CAD system does not cover the complete railroad. At this point in time the various maintenance and management systems used by the railroad are separate and independent. The railroad does not feel that there is a critical need to merge these systems into one entity.

The railroad contracts out for grinding for about \$1 million a year. Surfacing is done twice as frequently as the cycles. The rails are lubricated once every 100,000 tons traveled using 3 grease trucks. It is the organization’s opinion that maintenance is an art rather than a science.

The organization has realized the impact of technology on the life cycle of assets and has made efforts to extend the life of assets. With proper maintenance and the right technology, the life cycle of rail had increased to billions of gross tons traveled. Similarly, the life cycle of the ties depend on tonnage, speed, and environmental factors. The lubrication of rails is done once for every 100,000 tons traveled. The railroad keeps track of every detail related to the track such as defects per mile, ties per mile etc. This detailed inventory lets them maintain their assets efficiently. They also do bridge inspection but not as frequently as track inspections.

Being a small outfit, capital-planning program does not focus heavily on maintenance. WCRR typically structures a budget, with certain amount of capital dollars. Then evaluates the capital requests, prioritizes them and spends based on needs. The Capital Budget program maintains a list of projects categorized according to needs. These are divided as those that the company (a) wants to do (b) wishes to do and (c) may be required to do. This lets them prioritize the projects and attend to their most immediate needs. In doing this, WCRR tries to maintain a certain level of utility in the key corridors. Another unique feature of WCRR is that industrial development is part of the engineering department. Apart from track, assets such as signals, bridges, property and environmental assets are all part of the engineering division. This gives the Vice-President of Engineering a good sense of the state of the various assets integral to the growth and longevity of the railroad.

The Vice-President of Engineering controls the capital budget. Management has always found capital to cater to customer need in the form of customer facilities and track renewal. WCRR’s capital has always been driven by customer growth. Thus, utility and upgrade of facilities are a top priority. Apart from these, tie renewal and rail replacement also fall under the capital budget. The organization tries to use capital to reduce maintenance expenses. In other words, they try to capitalize as much as possible in order

to take advantage of the tax codes with the help of generally accepted accounting principles.

The capital program aims to promote capacity for growth by making use of property that has been built including siding/signals etc. As far as maintenance expenses are concerned, the railroad tries to use capital to reduce maintenance costs or to improve utility. They do have a maintenance budget and try to squeeze as much out of it as. Also, since the organization is small it has the flexibility to start the capital program budget for the year 2002 as late as July 2001. To put this in perspective, CN had asked WCRR for the capital program budget for 2003 as early as August 2001.

### **C.5 Asset Management Systems in WCRR**

The WCRR has individual systems that deal with the different assets. Within the organizational structure, the responsibility for maintaining and managing the different assets lies within various departments. These are (1) Track and property with Engineering Division, (2) Cars with Marketing Department and managed using the Car Management System and (3) Locomotive maintenance with the Transportation Division and handled by the Dispatching Office. The information system/program used to manage the data are the Dispatch System, which is a modified version of CAD for train tracks, and the Car Management System. The car management system was originally contracted through UP-Tech in 1987. The property management system was developed in 1995; the Cars/Track system in 1994; and the Dispatching system in the early 1990s. Many of the systems were developed in the past 10 years and as the railroad does not have many turnovers in personnel, training of personnel is not a major concern. They have 8 roadmasters, with 2 university students in training, along with a section foreman.

The engineering division is primarily responsible for the physical property. They own a car management system, a customer service/assistance system that deals with the customer, movement of cars etc., a signal system owned and maintained by the WCRR, and a phone system. The most important assets are the most expensive assets – physical property such as track. Track costs the most and has the most dollars put back into it.

### **C.6 Management and Training:**

The current management structure within Wisconsin Central allows for 4 people at the senior management level, and about 20 mid-level managers who have input into the capital budget from the engineering/track side. The organization also keeps bringing 1 or 2 trainees every year, straight from college to get them interested in the railroad industry. There are 8 road-masters employed by Wisconsin Central in the track management section. Of these 5 are section foremen, and 1 or 2 are at the managerial level. The remaining two are the trainees aforementioned who are given in-house training. The railroad has 8 managers of maintenance – 2 from universities, 5 former section foreman, 1 or 2 are managers from other walks of life. All of them receive in-house training. They aim to have typically 20 or 25% of the managers with university background, and they get the practical knowledge from people with the practical

experience and vice versa. To encourage this, every year they bring in 1 or 2 from the university for training. The ideal workforce would be a combination of formally educated and “hands-on” educated workers, with the formally educated representing about 25% of the managers.

Training needs continually change. With the advance of technology, the decisions are becoming more complex and easy at the same time. WCRR switched to a new dispatching system in the early 1990s. This has helped in routing and scheduling trains in a better and efficient manner. On the locomotive side, slip controls and load controls are becoming advanced with the help of circuit boards. Previously they were hard wired. On the signal side, the maintenance people are sent for a 2-week class every year. All maintainers have laptops and are advanced on the field side. They are all interlocking and they report their own problems by using the dial-up set up. It is all automated. These practices have been in place for at least the past four years. There has been a large push towards modernization because it improves performance

### **C.7 Barriers to Asset Management**

- Weather conditions
- Financial constraints
- Maintenance during peak usage

The barriers to proper, adequate, timely maintenance were the weather, access, and the seasonality of traffic variations.

Customer satisfaction with the asset management is reflected in the fact that for the past 14 years *Logistics Management and Distribution Magazine* has rated Wisconsin Central as the number one railroad. The railroad has consistently catered to its customers’ needs. Furthermore, the WCRR has continually succeeded in finding enough capital to provided customer improvements and customer add-ons on a frequent basis.

### **C.8 Lessons for State DOTs**

One of the suggestions for governmental agencies trying to develop good asset management practices is that they develop ways to extend the life of the asset as opposed to bowing to political pressure and paying attention to “low-priority” projects. This means that DOTs would have to start thinking “out of the proverbial box”. It was also recommended that transportation departments learn to manage capacity/flow in order to extend the life of their assets, and that they abandon low-density, less traveled roads/lanes.

## **APPENDIX D - UNION PACIFIC RAILROAD**

### **D.1 Background: About the Organization**

- History – Union Pacific Railroad was formed in 1862 with the passing of the Pacific Railroad Act to unite the nation with a transcontinental railroad. Today, Union Pacific owns more than 33,000 route-miles of lines covering almost 2/3rds of the Western part of the United States. It provides links to both Canada and Mexico. It serves all major West Coast ports. In 2001, Union Pacific transported more than 550 million tons of freight. The average haul length is roughly 900 miles. Its traffic is diversified and roughly balanced between consumer goods, industrial products, chemicals, coal, automobiles and parts, and agricultural products. 2001 gross revenues were \$11.9 billion, and profit (net income) was \$950 million. Today, Union Pacific owns and maintains its track infrastructure, as well as 6,800 locomotives and 104,000 freight cars. Total employment is roughly 50,000 people. The freight transportation marketplace is very competitive in both service and price. The challenge to Union Pacific’s management is to leverage its asset-intensive operation and resources across a wide geographic area in order to deliver high-quality, low-cost transportation service.
- Ownership – Union Pacific Railroad is the major component of Union Pacific Corporation, which is publicly traded (NYSE: UNP) and held by several thousand shareholders.
- Clients – The primary customers include international steamship lines, automakers, major electric utilities, agriculture producers, and chemical manufacturers. UP is consistently recognized as a top performing rail carrier.
- Asset Description - Assets include locomotives, railcars, highway tractors, work equipment, and maintenance shop facilities, as well as railroad track, right of way, bridges, rail yards, buildings, and signal and communications infrastructure.
- Asset Value – The net value of Union Pacific’s assets is \$31,551 million, as of year-end 2001.

### **D.2 Asset Management Practice in the Organization**

Union Pacific has adopted an asset management system that balances productivity and service performance objectives, and connects them at all levels across its large, geographically dispersed organization. The uniqueness of the asset management concept at UP is that while the measurement and evaluation criteria are centrally, the asset management system percolates through out the organization down to the managerial and employee level. This enables the organization to hold everyone accountable for his or her actions and in turn ensures that the performance of the system as a whole meets organizational goals.

### **D.3 Goals of Asset Management**

Union Pacific's operating management system is structured around the goals of safety, service, value, and leadership. Because safety is so important, the measurement system is designed to place extra emphasis on safety behavior and results. Asset management is mostly affected by the service and value components of the management system. These objectives are measured with a set of system-level outcomes that percolate throughout the organization. At the same time, different assets have different factors/goals that are targeted with the help of asset management. For example, maintenance and utilization are high on the agenda for tracks; availability is a key issue with respect to locomotives and cars, etc. Also, return on investment is a key underlying criterion that drives activities within the organization.

The objective of asset management is to improve system performance. Over the past few years, Union Pacific has developed a measurement system to link production and performance. Individuals and work units receive rewards when system assets and productivity meet or improve upon performance goals. The drive for productivity is created at the local operating level. This is true of the fundamental service performance activities, such as running the trains on time. Key decisions associated with the locomotive and freight car fleets, as well as the vast physical plant, are made centrally. But the core activities that move the locomotives and cars, serve the customers, and operate the terminals and trains are decentralized across the wide geography of UP's operation.

The measurement, goal, and evaluation structure is defined and maintained centrally.

### **D.4 Asset Management Practice in UP**

The asset management practice at UP took new direction around 1996 as a result of several factors. After merging with Southern Pacific, Ups scope of operation expanded by approximately 50%. It became more of a true network, with increased operating and route options and more complex interdependencies. Difficulties in integrating the merged operations caused ripple effects throughout the network, which adversely impacted asset productivity and service performance. Asset management was redefined within this context.

Changes occurred in the organizational and individual culture. A new department, Network Design and Integration (NDI), was developed to report directly to the president of the company. NDI includes a group that designs the operating plan (Service Design), a group that manages the freight car fleet (Car Management), and an operational planning and analysis group (Network and Capital Planning). NDI's domain cuts across the organizational hierarchy and plays a vital role in integrating the Operating, Marketing, Finance, and Information Technologies functions within the organization. The Operating function includes all transportation operations across the railroad, dispatch, train crew management, locomotive management, maintenance of the physical plant, and car and locomotive maintenance operations. These operating functions account for roughly

three-fourths of the total Union Pacific organization. NDI helps bring a greater balance to achieve overall business results.

The Network and Capital Planning group within NDI includes economic analysis and forecasting, resource planning, capacity planning, measurement and analysis, and process engineering. This model has helped UP enact an objective analytical body that is accountable for developing quantitative measures to evaluate system performance. The measurements and management systems are designed to evaluate local performance. However, there are constant tradeoffs between individual or local performance, and network performance. UP employs a system of measurement and review that includes a comprehensive measurement system and a performance ranking system based on the measurement system.

A set of six questions is used to measure and evaluate performance. These questions start and end with safety related issues, and provide the required framework for performance evaluation. These questions provide a critical mechanism for measurement and review. They are easy to remember, provide a framework for the process, and are posted throughout the organization.

Of course, any evaluation is only as good as the information systems that support it. UP has a strong information systems support that provides status, history, and analysis at all levels for all indicators through menu-driven inquiries. This management structure is critically reinforced through management review mechanisms that occur daily, weekly, and monthly. In addition, these studies transcend system-region-local boundaries.

A bi-annual formal performance review process is in place for all managers based on the safety-service-value-leadership criteria and the supporting indicators. Performance in the indicators determines compensation awards.

The Network and Capital Planning group is comprised of 40 people divided into five teams.

- The Economic Analysis and Forecasting team develops business forecasts and sensitivities in conjunction with the marketing function. They translate the market forecast into geographical train and car activity.
- The Resource Planning team handles planning and analysis of the mobile resources – locomotives, freight cars, and train crews. They also do maintenance planning at the strategic level (greater than 30-day time period), as well as network simulation.
- The Capacity Planning team deals with the fixed resources, such as line and terminal capacity. They develop economic analyses of expansion projects for the physical plant, as well as evaluate routing and other operating alternatives. In this work, they employ dispatch simulation tools.
- The Measurement and Analysis team is in charge of performance analysis with regard to both service and resource productivity. They are the keepers of performance measures within the organization.

- The Process Engineering team performs industrial engineering within the operation.

Prior to formation of NDI, these various activities were dispersed across the Marketing, Finance, and Operating functions.

### **D.5 Asset Management Systems in UP**

Relatively few of UP's asset management functions are outsourced. Track and infrastructure maintenance is performed in-house, as is most maintenance of the locomotive and freight car fleets. Certain tools (such as simulation) used in planning and analysis have been developed outside the company.

Asset management decisions are made in two ways. If the proposed investment concerns safety, the adjustment is made. If, however, the investment regards anything else, careful analysis is done before the decision is made. UP seeks to upgrade its assets by order of greatest impact on performance. All asset investments must be economically justified. UP's Finance group prepares formal authority-for-expenditure (AFE) documents for asset investment decisions. These include analyses of net present value and return on investment for the shareholders. The AFEs must be reviewed and signed by senior management and/or the Board of Directors.

The organization has undergone a major cultural change in the way it operates and also in the way it collects data. It has automated data collection as much as since data collection is an intense process, with more data requiring more information and thus more automation. With growing emphasis on data collection and manipulation, the Information Technology group's role has assumed greater significance.

### **D.6 Management and Training**

Training of Operating personnel is accomplished by bringing in groups of 30 managers and teaching them the elements of the operations management system, accountabilities, the six key questions structure, and the associated measurements and analytical tools. This type of training occurs once every two years.

The enhancement of asset management practices at UP has affected the decision making process within the organization. It has unified the management team in achieving service and asset productivity results, and it has significantly improved those results. The practice of ranking individuals and work units has driven significant individual effort, but has sometimes produced behavior that enhances local results at the expense of the desired network outcome.

The dilemma of local versus network performance is a concern to management. The measurement system is being revised to include greater emphasis on individual contribution to network results. This requires development of more sophisticated measurements. An ongoing area of concern is maintaining balance between asset productivity and service performance. Certain efforts to optimize asset utilization can damage the service product.

Life cycles of UP's critical assets range from 10 to 50 years. Freight cars and locomotives have typical lives of 20 to 30 years. Components of the track infrastructure range in life from 10 to 50 or more years, depending on traffic volume and climate.

A significant portion of the UP organization is devoted to productively utilizing the massive assets base. Performance results are evaluated daily, weekly, monthly, and annually. Customer satisfaction is evaluated regularly with the help of surveys. The condition of the assets is updated on an ongoing basis by the mechanical maintenance group (locomotives and freight cars) and the engineering group (track, bridges, buildings, and signal systems). Performance prediction capabilities have been developed, and are continually enhanced. The use of on-board diagnostic equipment and predictive modeling is also being expanded.

#### **D.7 Barriers to Asset Management**

While the organization has embraced asset management practices and has integrated them into every facet of its operation, this has not occurred without difficulty and risk. Issues cited by the organization include significant expansion of data and information collection, establishing analytical tools and processes, establishing information systems to enable inquiry and analysis by managers, and improving business processes to leverage the information and drive results. A significant risk lies in creating local incentives and behavior that are opposed to the goals of the overall organization.

Additionally, there are organizational and operational barriers in implementing an asset management process. The measurement and evaluation system adopted by UP is used to judge not just system performance but also individual performance. People are ranked against one another. Compensation is tied to it. There has been considerable resistance to this approach. Thus, the culture and mindset of people is a barrier to overcome. By persisting over a period of several years, UP has successfully overcome this barrier.

On the operational side, interpreting and communicating indicators to the various divisions within the organization is a barrier because the company is geographically dispersed. Information technology or lack thereof, can also pose barriers to successful asset management.

#### **D.8 Lessons for State DOTs**

Because of the many benefits of asset management, the state DOTs need to embrace asset management. This calls for a change in organizational culture. A change in the organizational culture can be more easily introduced if there is a paradigm shift of some sort. A funding crisis to state DOTs would be sufficient. The organization will be more likely to change direction and embrace new principles. Such a change must be driven by a clear commitment from leadership.

## **APPENDIX E - TTX COMPANY (TTX)**

### **E.1 Background: About the Organization**

- History - TTX Company provides railcars and related freight car management services to the North American rail industry. Pooled railcars are for service in the intermodal, automotive, lumber, machinery, building materials, steel, and other commodity groups where flatcars, boxcars, and gondolas are required. TTX Company's stock is owned by North America's leading railroads who are also our primary customers. Cars are provided to railroads at competitive car hire rates. Over the past five years, TTX has invested \$2.2 billion in new railcar purchases (55% for intermodal cars). TTX Company is a provider of railcars in pooled service for use on railroads in North America. The company was incorporated in 1955 as Trailer Train Co., and began operations in 1956 with a fleet of 500 cars.
- Ownership - TTX is 100% owned by North American railroads. Thus, these railroads are both owners and customers of TTX. Non-owner railroads have access to TTX railcars through interchange agreements between the owner and non-owner railroads. TTX owns three maintenance facilities and has arrangements with numerous contract shops that perform program maintenance and modifications to TTX and non-TTX railcars.
- Clients - The primary customers are the leading railroads in the US and Canada
- Asset Description – Rail cars are their primary assets. While they do have maintenance shops and other infrastructure, they are not viewed as assets because they do not generate revenue for the company.
- Asset Value – The value of transportation assets (equipment, including cars) for the year 2000 was \$5374.3 million.

### **E.2 Major assets of the Organization**

- Operational: Railcars - Boxcars, and Flat cars
- Other: Maintenance divisions in Acorn in Jacksonville, Florida, Calpro in Mira Loma, California, and Hamburg in North Augusta, South Carolina.

### **E.4 Assets and their Management**

The major physical asset of the organization is the fleet of 129,078 railcars. They can be divided into three equipment types: intermodal, autorack, and general use. More than 35,200 are in intermodal service, 57,000 are in automotive service, more than 22,500 cars are in general commodity service, 13,300 boxcars, and more than 1,100 gondolas (all of which are leased). The asset management system is computer-based. Asset management

is considered an ongoing process. The process of asset management is updated constantly and reviews are done six times a year. Every week there is a change in the allocation of assets amongst the railroads, and every hour there is a change in the use of the assets amongst the railroads.

The main goal of asset management, in TTX, is to ensure reliability as well as availability and safety. TTX maintains higher maintenance and inspection standards than FRA/AAR regulations. To promote efficiency in the industry, TTX also performs field maintenance and inspection services at a number of Field Maintenance Operations (FMOs) sites throughout North America

### **E.5 Goals of Asset Management**

The primary goal of the organization is safety. This is driven home through repetitive training. The organization encourages and fosters competition between divisions with some monetary recognition to promote safety. While safety is the key in asset management, preservation is also recognized as important. TTX has a comprehensive system to monitor and capture the consumption of consumables on the railcars. This drives their maintenance program. The miles accumulated on rail cars dictates the replacement of wheels etc. There is also pre-planned maintenance to extend the life of assets. The organization also pays attention to availability and reliability with the latter taking importance in the maintenance arena.

Ranking is not feasible due to the relationships among the attributes of the assets. Within departments, the goals may change and may have different sets of ranking. Availability and reliability are the most important attributes in decision making if safety is not involved.

### **E.6 Asset Management Systems in TTX**

TTX possesses standard management and maintenance systems for a shipping companies. While the organization does not have one single information system to collect and manage information, it has developed multiple customized information management programs. The various divisions manage their own areas of information. The information is not analyzed from a global perspective GIS, trend analysis, custom software and off the shelf products are used to manage and update information.

### **E.7 Asset Maintenance Practice at TTX**

- Is there an asset management practice? Asset management has been inherent to the company.
- Are different assets managed differently? Each division in the organization has its own goals with respect to its assets. They follow a top-down asset management approach within the division.

TTX has been proactive when it comes to maintenance of its fleet of railcars. TTX worked in conjunction with the Association of American Railroads (AAR) and the

Federal Railroad Administration (FRA) in getting the approval to extend the useful life of autorack flat cars. The useful life for autorack cars was increased from 50 years to 65 years as a result of this effort. This move, spearheaded by TTX, can end up saving millions of dollars not just for TTX but for the entire railroad industry.

TTX strives to supply well-maintained, low cost rail cars to the railroads. This is achieved by adhering to strict maintenance standards for their equipment. Quality audits are performed to ensure that the high standards set by TTX are met. These audits are performed at a number of locations – at suppliers, independent repair shops, and company-owned repair facilities. In 2000, ninety-nine suppliers, fourteen car builder plants, and twenty repair shops were audited. With methods such as failure analysis, TTX has managed to eliminate the loss of revenue associated with faulty maintenance and the current maintenance cost per unit is 60% of what it was ten years ago.

### **E.8 Management and Training**

- Every division has its own plan and annual goals with regards to asset management. Hence, asset management responsibility is shared. Each division follows a top down approach
- 100% of the senior level managers are involved in asset management, while 65-80% are involved at the managerial level.
- Training
  - TTX goes to individual rail carriers to instruct maintenance practices
  - Conferences and seminars are held in classroom style settings
  - Videos are used to help in instruction
  - Online support is provided to help in procedures and car information

### **E.9 Barriers to Asset Management**

- Changes in customer expectations and demands
- Limitations of the market place
- The physical movement of assets is a barrier, because they have to overcome physical space, and time.

Organizational barriers: As a result of the unique ownership relationship, one of the major organizational barriers is that TTX cannot dictate asset management terms to the railroads since they are also the owners of the organization. TTX cannot pass edicts on how well the assets should be utilized. TTX is in a marketplace where the operating plan has to address this. Currently, there is a surplus of equipment. IT has to be addressed to avoid net income loss. Thus to a great extent the needs of the customers, and the limitations of the market place, are barriers for the success within the organization.

Operational barriers: Telecommunication has increased the ease of issuing directives that may be consistent with asset management practices. The physical movement of assets is also a barrier, because physical space and time must be overcome. The time lag between the supply and demand achieving equilibrium can at times be costly.

## **APPENDIX F - UNITED AIRLINES - INFORMATION SERVICES DIVISION (ISD) – THE RESEARCH AND DEVELOPMENT DEPARTMENT**

### **F.1 Background: About the organization**

- History – United Airlines is a leader in American aviation. While the asset management process within an airline offers valuable insight, this case study focuses on the assets associated with information technology and its management within United Airlines. The airline industry has been a pioneer in incorporating information technology to meet its needs. The role Information Technology (IT) has played in the airline industry started increased with the deregulation of the airline industry in 1979. The Research and Development (R&D) - Planning and Finance department at United is part of the Information Services Division (ISD) and is instrumental in developing and refining the systems for planning the airline.
- Ownership – UAL Corporation is the holding company for United Airlines, the second largest air carrier in the world (<http://www.ual.com>). With hubs in Chicago, Denver, Los Angeles, San Francisco and Washington, D.C., and key international gateways in Tokyo, London, Frankfurt, and Miami, United flies to some 117 destinations in 26 countries. United's 80000-plus employees worldwide bring people together safely, conveniently, and efficiently more than 1800 times a day. United Airlines' customers also enjoy access to more than 729 destinations around the world through Star Alliance, the leading global airline network.
- Clients – The clients for the organization as a whole are the passengers who fly the planes, and for the Information Services Division, the clients of the other divisions within United that depend on the systems and decision support tools developed by ISD. The R&D-Planning and Finance department supports the entire planning and finance division.
- Asset Description – The major assets for the organization are the fleet of aircraft and other related equipment. The major assets of the Information Services Division, besides the human resources, are network computers, data feeds, and software. Of these assets, software is the most essential, important and often overlooked asset.
- Asset Value – The value of operating assets including the flight equipment in 2000 was \$19,412 million.

### **F.2 Asset Management Practice in the Organization**

- Is there an asset management practice? Yes. The assets in the R&D – Planning and Finance group are constantly monitored and refurbished in order to keep pace with the technological advancements and the sensitive needs of the organization.
- Are different types of assets managed differently? The hardware assets have their own lifecycle and are managed/replaced differently from the software and data, which are dependent on the need for those within the organization, and upon the advancement in those areas within the industry.

## **F.2 Major assets of the Organization**

- Operational: Flight equipment, facilities
- IT: Hardware, Software, Network and Data

## **F.3 Other Information**

There are about 1400 employees in ISD. The R&D-Planning and Finance has 100 employees out of which about 15-20 people are working to support the Aircraft Scheduling department in the Planning division.

In the airline industry, the economies of scale are very large leading to high fixed costs. An advantage that the airline industry has over other industries is that the airlines have had a very good IT infrastructure right from an early stage (e.g. reservation systems), which has facilitated the development of complex decision support systems. The use of operations research techniques to develop models for the airline industry was first recognized by American Airlines and has since been adopted by all other leading airlines.

The R&D department of ISD develops and maintains all systems used by the planning and finance divisions. The systems use advanced operations research techniques, statistical modeling and simulation among various analytical techniques to model the business process and optimize the airline profitability.

## **F.4 Goals of Asset Management**

The basic goal of asset management in this division is to provide reliable and stable systems and decision support tools for people to use and achieve efficiency in planning the airline. An optimal mix of system performance and economic performance is the key to effective management for the IT division.

For the Aircraft Scheduling department, the key tasks are to plan the network and develop the optimal flight scheduling. The issues considered are:

- Location and type of markets
- Number of flights
- Traffic and Revenue forecasting
- Building effective flight connections to maximize revenue

- Type of equipment to be used on flight legs
- Building aircraft routings
- Determining operation feasibility of schedule
- Dissemination of schedule to CRS systems for getting reservations and to internal groups for operations

The ultimate goal is to match capacity with demand. This goal is achieved with the help of good forecasts provided by the R&D-Planning and Finance department of ISD. The reports utilize the decision support tools coupled with the optimal allocation of capacity using the advanced operations research based decision support tools. Some examples of the decision support tools are Profitability Forecast Model (PFM), Schedule Improver (SIMON), Fleet Assignment Model (FAM) and Airline Simulation Model (AIRSIM).

### **F.5 Asset Management in the Organization/Division**

The major assets of the division are hardware, network, software and data. Of these assets, software is most critical. A number of resources are mobilized towards developing and maintaining software. The sustenance of software deployed is of vital importance to the organization and hence regular updating and modification is necessary. Hardware is typically a one-time investment and is typically kept for a fixed amount of time or until it is superseded by technological advances.

The life cycle of an asset depends upon the business requirements. As the business environment changes, the decision support systems have to be adapted to ensure that the organization is able to make the best decisions in the new environment. There is also a dependence on advances in technology. In certain instances, these advances will tend to make the assets obsolete and thus necessitate asset replacement immediately.

A substantial overhaul of IT assets takes place for one of three reasons:

- (1) changes in business process
- (2) current hardware/software has reached limits with respect to the business process or
- (3) a fundamental shift in the technology/techniques of modeling that warrants a reconsideration of the systems.

Whenever, there is an overhaul of IT assets and new systems are developed, detailed benchmarking is carried out. The new systems go through an extensive review process before they are deployed in a production environment.

The IT systems are extremely critical for day-to-day operations in the airline. United has a Business Resumption Center, at an alternate location, equipped with all the hardware and software necessary to keep functioning in case of an emergency in their main facilities. This level of redundancy, despite the high cost, highlights the importance of these systems to the survival and functioning of the airline.

## F.6 Asset Maintenance Practice in the Organization

The asset management practiced in ISD is significantly different from the way traditional assets are managed. The changes occur on multiple levels and are described as follows.

- Performance measures

United Airlines has its own performance measures to evaluate the costs/benefits of IT systems.

- Outsourcing functions

United Airlines has a healthy and on-going relationship with a few universities. This allows them to get creative input into research problems. Other outsourcing functions include maintenance and support of legacy systems is performed by an offshore organization.

- Levels of support

There are basically three levels of support. The first level of support is for identifying and logging system problems. The second level of support is related to issues arising from hardware/network related matters. The third level of support focuses on application issues in the decision support systems.

- Asset replacement

An appropriation process is involved in determining the asset replacement strategy. It includes a broad outline of the future work being proposed, and what needs to be replaced. Detailed cost-benefit estimation is performed to justify return on investment.

The systems developed by ISD are a combination of “build and buy.” While most software is developed in-house, some of it is purchased from external vendors and customized to suit the business process.

- Involvement

The user groups have representatives who are directly involved with ISD in defining and monitoring the development of the systems. This ensures that there is constant interaction, integration, and cooperation between the two sides. At the managerial level, everyone is involved in the asset management process.

- Risks of asset management

Although there are no perceivable risks due to the asset management process, it does limit the flexibility of the system.

- Evaluation

Evaluation of asset management performance is done periodically through meetings with the end-users. Managers and directors of ISD and business groups attend the periodic meetings. Status and future plans are discussed during these meetings.

Apart from the weekly meetings, an assessment of customer satisfaction is done through conducting regular confidential climate surveys. These are typically done twice a year.

### **F.7 Management and Training**

The company holds short courses, conferences and seminars as part of the training of their employees, as a part of the asset management process. They also encourage people to give presentations and enhance their communication skills.

### **F.8 Barriers to Asset Management**

The models and demand forecasts developed within the division are complex in nature; hence validation is necessary from the users themselves. The sensitive nature of the models and the high stakes leave very little room for error. As a result, these models and systems sometime are tested and refined for months together before they are actually implemented. Thus turnaround time is a barrier in effecting changes. While the costs associated with the technological assets are high and would seem at first glance to be barriers, everyone acknowledges the fact that IT is not a luxury, but a necessity for the organization.

### **F.9 Lessons for State DOTs**

Perhaps the biggest lesson that an IT division like this one can give to the state transportation agencies is that: **“it has to be a partnership of equals”**.

## APPENDIX G - MIDWEST EXPRESS AIRLINE

### G.1 Background: About the organization

- History - Midwest Express Holdings is a “champagne airline in beer country”. From hubs in Kansas City, Milwaukee, and Omaha, subsidiary Midwest Express Airlines serves 26 cities. Passengers (mainly business travelers) get wide leather seats, fresh-baked cookies; entrees served on china, and free champagne aboard the company's 34 McDonnell Douglas jets. Midwest Express has a code-sharing agreement with American Eagle Airlines. The company's commuter unit, Skyway Airlines, serves 27 cities, mostly in the upper Midwest. Skyway is adding Fairchild regional jets to its fleet of eight such jets and 15 turboprops. Midwest Express, a spin-off of Kimberly-Clark, began as an in-house air service for the paper company's employees.
- Ownership - Midwest Express Airlines features nonstop jet service to major destinations throughout the United States. Astral Aviation, Inc. – its wholly owned subsidiary – operates Skyway Airlines, The Midwest Express Connection offers connections to Midwest Express as well as point-to-point service between select markets on regional jet and turboprop aircraft. Together, the airlines fly to 50 cities. More information is available at [www.midwestexpress.com](http://www.midwestexpress.com)

Midwest Express Airlines 1999 revenue was \$447.6 million with a 14.7% return on assets. For 2000 the airline reported \$480 million in revenues and a 1.7% return on assets. There are approximately 300 employees in the central offices and approximately 700 employees in field hub locations. Midwest Express reports approximately 2,950 total employees and anticipates less than 5% turnover per year.

The airline agreed to participate in our survey and discuss their management of their aircraft fleet, which is valued at approximately \$200 million. Midwest Express owns approximately 65% of the fleet and leases 35% of the aircraft that they operate. Airplanes typically have a service life of 10-20 years and a technological life of 30 years. Aircraft is typically depreciated over a 10-15 year period. There are many FAA standards about aircraft operations and maintenance. Planes have strict service schedules and maintenance windows. Many components are rebuilt and completely overhauled during the lifecycle of an airplane.

### G.2 Asset Management Practice at Midwest Express

Asset management was introduced to manage all the assets within the organization with the goal of improving system and economic performance. Safety, preservation, availability and reliability are all ranked extremely important to the asset management process. Midwest Express reported that they have two concerns about risks associated with an asset management program. The discipline often limits flexibility, and requires too much information.

Once the decision to implement an asset management program was agreed upon, there were few organizational or operational barriers. Asset management is a centralized function. There is no formalized “asset management training program” for employees involved in the process. Midwest Express adopted the asset management program to address the following issues, listed in order of importance:

- 1) Improved inventory management
- 2) Improved financial management
- 3) Improved strategic management
- 4) Improved efficiency of assets
- 5) Improved operational performance

Asset performance is evaluated quarterly and is incorporated in the strategic plan on an as needed basis depending upon the specific strategic objective. One senior manager and one manager are involved in the decision and evaluation process. Assets are acquired and replaced based on the capital-planning budget. Customer Satisfaction is a key determinate in their strategic planning process and is measured and evaluated. In the end, asset replacement strategy is driven by corporate profitability.

Midwest Express does not outsource any asset management related functions. Asset management processes are applied uniformly across all divisions. Data collection and evaluation has not changed as a result of asset management practices.

## APPENDIX H - XCEL ENERGY

### H.1 Background: About the organization

- History - Xcel Energy Inc. is a prominent US electricity and natural gas energy company with annual revenues of \$11.6 billion. Based in Minneapolis, Xcel Energy operates in 12 western and midwestern states. Xcel Energy has a strong portfolio of other businesses. Among them are Xcel International, NRG Energy Inc., a leading independent power producer that operates in 28 states domestically and 17 countries worldwide; Seren Innovations, a leader in the broadband communications industry; and Xcel Energy Utility Engineering, which provides engineering, design and construction management to utilities and other industries.
- Ownership - Formed by the merger of Denver-based New Century Energies and Minneapolis-based Northern States Power Co., Xcel Energy provides a comprehensive portfolio of energy-related products and services to 3.2 million electricity customers and 1.6 million natural gas customers through its regulated operating companies.
- Asset Description – They deal in gas and electricity generation, distribution, and transmission. They also are involved in providing local and long distance telephone services, broadband, wireless and other communication technologies such as Cable TV, and high-speed Internet access over a new hybrid fiber-optic network. This case study focuses on the delivery assets.
- Xcel Energy has a healthy balance of energy supply, delivery and retail assets. Domestically, they serve 3.1 million electric customers and 1.5 million natural gas customers, and own 15,450 megawatts of electric generating capacity, making them the eighth largest utility generator in the U.S.A. Their generating facilities include 16 coal plants, 16 natural gas plants, two nuclear plants, 28 hydroelectric plants, six oil-fired plants, four refuse-derived fuel plants and one wind farm. They also own 16,303 miles of electric transmission lines, 73,098 miles of electric distribution lines and 29,704 miles of natural gas pipeline.
- Asset Value - \$6.4 billion in delivery assets.
- Barriers to Asset Management -The electrical generation, distribution and transmission, and gas generation, distribution and transmission have now come under the one umbrella of asset management. Although this has helped provide a system wide focus on asset management, operational barriers have come up as all the assets are now managed jointly. In order to meet the needs of the asset owner, the asset managers and the service providers have now become functionally and geographically separate. This major cultural shift has proved to be one of the organizational barriers during the early stages.

## H.2 Goals of Asset Management

Their asset management system is both computer-based system, and a management concept. The company's goals for asset management are oriented toward ensuring better system and economic performance within the organization. The factors/goals that are utmost within the organization are preservation, availability, and reliability of assets. The asset management process is tailored accordingly. Asset management was introduced to manage the most important and valuable assets of the organization. The vision statement of the organization is "To create and prove the model that redefines the Energy delivery business". The organization's mission is twofold. First is the effective and efficient management and operation assets – those they own and those they manage for others. Second is to provide earnings growth to the parent organization.

Xcel Energy has adopted the asset management philosophy that "facilities are fixed or repaired the day before they fail." If predictive tools and models are inaccurate or lack sufficient data to be reliable, one may miss the opportunity to repair the asset before it fails resulting in the fail-fix method of repair, which is not economically, advisable.

## H.3 Asset Management Practice in Xcel Energy

Xcel Energy introduced an asset management model that was patterned after Yorkshire Electricity in England. Yorkshire power is considered one of the best utilities in England, if not the world. Xcel Energy was part owner of Yorkshire Electricity until 2001. Tom Petillo, the president of Delivery Services spent two years working at Yorkshire Electricity, thus allowing for a smooth adoption of the Yorkshire Electricity's asset management program.

The asset management approach at Xcel Energy focuses on the following two areas:

- 1) Managing the \$6.4 billion in delivery assets or all the lines, pies, substations, town border stations, natural gas storage facilities, etc.
- 2) Managing day-to-day activities related to the construction, maintenance, and operation of these assets

With the adoption of an asset management program, the decision-making process within the organization changed. The asset management group took responsibility for resource allocation. Thus, service providers no longer have to decide how or when to allocate resources to various assets. The service providers in the simplest terms provide a service to the asset owner i.e., they construct, maintain, and operate, and remove the assets. The asset management group decides where and what resources will be allocated. A phrase commonly used to describe the new asset management group is the "thinkers" and the service providers are the "doers."

The organization meets the minimum requirements set by federal legislation and also develops its own standards in some cases. For example, the DOT CFR Part 192 sets the minimum specifications/standards. Xcel Energy develops policies and procedures to meet the minimum requirements.

Xcel Energy tracks the condition of its assets based on visual inspection, using mechanical devices, and by using automated technologies such as smart pigging. The company also conducts failure analysis where necessary. One of the concerns with asset management is that the predictive tools may not work and that organizational groups do not have clearly defined roles and precisely demarcated tasks at the daily level.

The organization is in the process of developing new tools to help with the asset management process. Unit projects and blanket projects are budgeted every year for a two-year cycle or on a biannual budgeting process. The organization makes use of professional judgement in order to perform performance prediction.

### **H.3 Asset Management Systems in Xcel Energy**

The asset management process at Xcel Energy is a series of systems that serve as an asset data repository, data providers and decision-making tools. The overall process is shown in Figure H.1 The Delivery Asset Management System (DAMS) is<sup>3</sup> “an integration and consolidation of information systems applications to enhance delivery’s core capabilities to manage and operate assets to improve financial performance.”

The business case rather than technology was the driver for the development of DAMS. It involved rationalization of two GIS systems to one, rationalization of two legacy outage management systems to one and integration of multiple disparate databases including five SCADA systems. The basic approach has been to focus on integration and rationalization including the acquisition of some commercially available off-the-shelf software.

Xcel Energy implemented the PassPort work management system (<http://www.indus.com/solutions/product/passport/>) to develop common business practices across Xcel Energy and to migrate to an "off the shelf" software product. Business process improvement sessions (BPI’s) were held with Xcel Energy Delivery personnel from across the company to develop common business practices. PassPort was selected as the "off the shelf" product. PassPort is a highly integrated work management, supply chain, and accounts payable software package developed by Indus. Working with common business practices and with PassPort Work Management provides the following benefits to Xcel Energy:

- A single work management system for all Xcel Energy delivery to use.
- A common method for completing and tracking work with cost information.
- The ability to approve work, track status of approvals, and send reminders.
- Savings in training, communication, and labor.
- The ability to access timely and accurate information.

---

<sup>3</sup> Presentation at the Excel Energy 2002 Leadership Conference “Delivery Asset Management System,” by Tim Taylor, Director IT.

The implementation of PassPort Work Management impacts all Energy Delivery employees who initiate, prioritize, schedule, design, construct, assign, track, or complete the following types of work:

- Electric and Gas Distribution Maintenance
- Electric and Gas Distribution New Construction
- Transmission and Substation Maintenance
- Transmission and Substation New Construction

Certain functions of asset management are outsourced. Major construction projects are outsourced, as are limited number of design and engineering work. As far as information technology is concerned, 100% of it is outsourced.

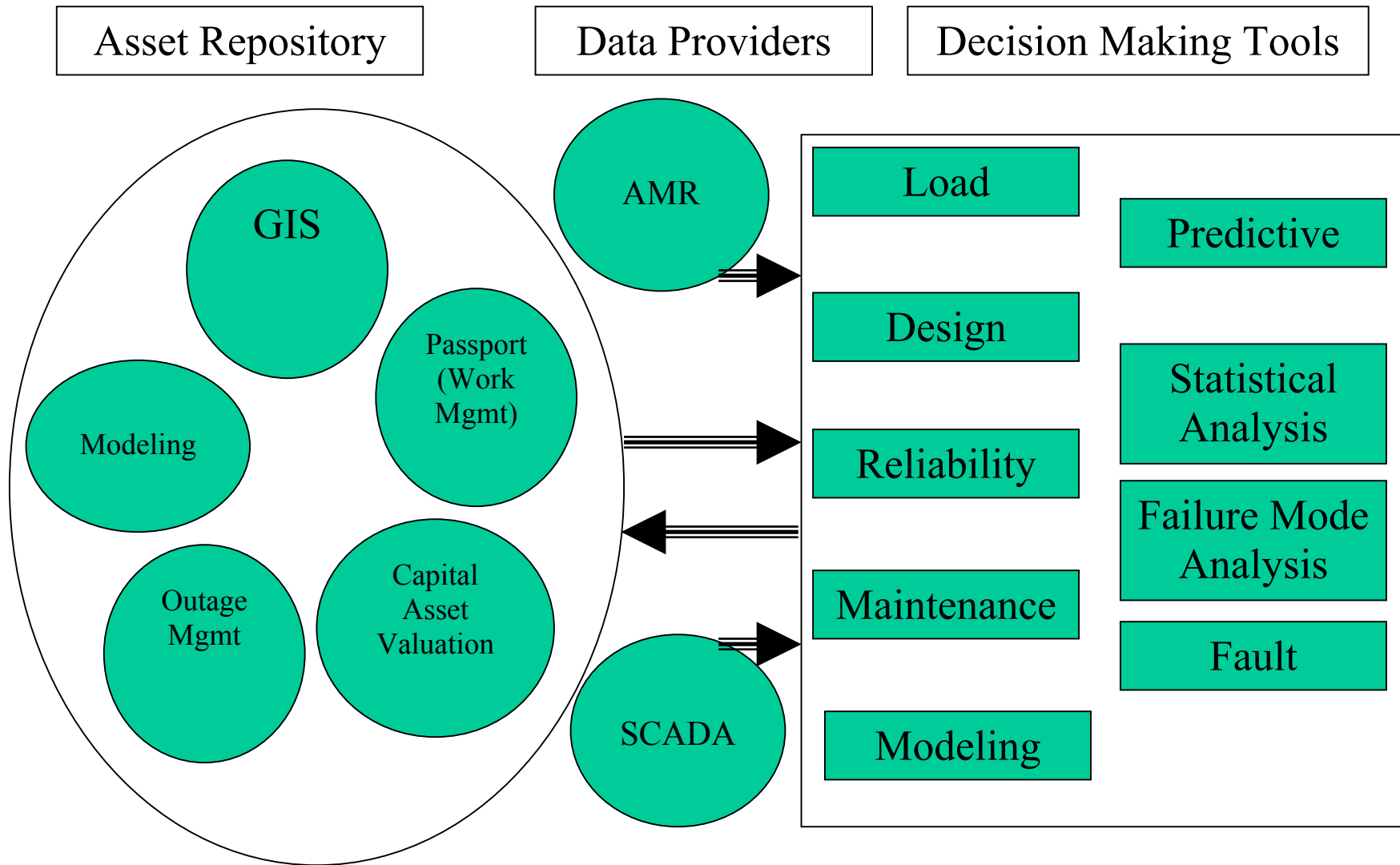
The DAMS system is scheduled for completion Fall, 2002, although several pieces are already in place.

#### **H.4 Management and Training**

The responsibility for asset management lies within the asset management group of 93 people. Within senior management, approximately 20 executive officers are responsible for asset management.

As far as the training of employees, Xcel Energy does not have short courses or seminars. They instead rely on top-down communication via employee newsletters and emails to convey necessary information.

Figure H.1: Asset Management at Xcel Energy



## H.5 Barriers to Asset Management

(a) Organizational barriers:



Meeting the needs/requirements of the asset owner (corporate officers/share holders) by functionally and geographically separating the asset managers from the service providers is a major barrier. This is a major cultural shift for the organization. High-level system prioritization is now the responsibility of the asset manager and not that of the service providers. Asset management sets the guidelines and the service providers implement them.

(b) Operational barriers:

Prior to implementing the asset management concept, the electrical generation, distribution and transmission, and gas generation, distribution and transmission were functionally independent companies. Under the asset management system, the electric and gas utilities are combined and all assets are managed jointly. This new hierarchy allows for a smoother and more efficient way of managing the assets as a whole, rather than having various divisions looking at them from their own viewpoint.

## H.6 Lessons for State DOTs

Carefully consider processes before implementing an asset management system. Employees need to know how to do their day-to-day jobs in the context of a formalized asset management system.

## **APPENDIX I - GREAT LAKES GAS TRANSMISSION COMPANY (GLGT)**

### **I.1 Background: About the Organization**

- History – Great Lakes Gas Transmission was incorporated in 1963 by TransCanada Pipeline. It was commissioned to provide a shortcut pipeline route through the U.S. and to link eastern Canada. It owns and operates an interstate natural gas pipeline system. (<http://www.glt.com>)
- Ownership – It is owned by TransCanada Pipeline and The Coastal Corporation and is a limited partnership company.
- Clients – GLGT transports natural gas for delivery to customers in the midwestern and northeastern United States and eastern Canada. They have about 50 customers in all, representing other gas transmission companies and many local distribution companies (LDC).
- Asset description – The pipeline is the principal asset of the company.
- Asset value - \$1.2 billion in plant assets, and 100% of it is owned.

### **I.2 Asset Management Practice in the Organization**

- Is there an asset management practice? Yes, they do manage their assets but it is a management concept than one computer system that integrates all their management practices.
- Are different types of assets managed differently? Yes, each asset has its own life cycle and performance measures. Different methods and standards are used to manage these assets.

### **I.3 Major Assets of the Organization**

- The Interstate Transmission pipeline is the major asset of the organization.

### **I.4 Barriers to Asset Management**

- Weather conditions
- Limited manpower
- Organizational constraints

**H.5 Other information from the Interview:** (such as practices of other competitors, other industries, etc.)

Great Lakes Gas Transmission Company was incorporated in 1963 to provide a short cut route for TransCanada Pipelines in order to serve better the growing demand for natural gas. American Natural Resources became a 50% partner with Great Lakes in 1965. The Coastal Corporation took over from American Natural Resources in 1985 and became a 50% partner with TransCanada. They have around 2,000 miles of pipeline. The primary asset category that Great Lakes manages is 1,000 miles of dual pipeline serving a gas utility plant, which generates \$1.2 billion in revenues annually. The pipeline is fully owned and operated by Great Lakes.

The annual gross transportation revenue for Great Lakes remained at 283 million in 2000. This is approximately the same as the year before. Return on assets improved from 10.5% in 1999 to 11% in 2000. Great Lakes' primary business is gas generation and distribution via an interstate pipeline. Great Lakes Gas Transmission does not do local distribution. Great Lakes pumps two billion cubic feet of natural gas a day and distributes 5% of all gas consumed in North America. The company serves 30-40 shippers and are strictly a transporter of gas. They do not buy and sell gas or provide storage. Their network is divided into three pricing zones and 13 operating zones. Pipeline construction specifications are mandated by the DOT but the maintenance specifications are not. The company owns between seventy-five and two hundred feet of the land around the pipeline as right of way. Compressors are stationed approximately 75 miles apart, vents are located every 15 miles and are located above ground in a fenced area.

### **I.5 Goals of Asset Management**

Asset management is a management concept; the company actively manages their assets within a framework of government regulation. Asset management is focused on improving system performance and reliability. Economic performance is a secondary priority. The company proactively looks at scheduling annual maintenance during times of slowest demand; this allows them to optimize economic returns. Management ranks safety concerns first closely followed by financial motivation as key factors in their asset management system. Reliability, capacity and availability, are secondary considerations. System preservation was ranked as the least important consideration in asset management.

### **I.6 Asset Management Systems in GLGT**

Asset management is incorporated into the strategic plan in the annual budget process. All levels are involved in the discussion about capacity, efficiency, safety and operations. Managers begin the process, which is overseen by the Vice Presidents and senior leaders. A task team charged with network efficiency has developed new tools. Inventory systems have been updated to look at daily estimates of sales and capacity. Code requirements mandate complete performance evaluations every 18 months.

The decision to replace assets is made based on forecasts and trend analysis. Every two to three years an internal survey is completed to compare company performance to industry

averages. New tools such as Geoconnect, a graphic computer model has improved inventory capabilities.

The asset inventory is a computer-based system, which includes maintenance history, soil conditions, steel manufacturing specifications, and performance measures. A new industry risk model was recently introduced and incorporates DOT and safety regulations. These computerized tools allow the company to address areas of greatest risk first. These models allow the company to predict conditions, identify the location of spare components and inventory levels. Productivity measures such as availability, reliability, safety, customer demand history, compression statistics, and planned and unplanned maintenance activities are all captured. Condition measures are based on visual and mechanical inspection, often with the aid of automated technologies.

Due to the customization of the compressors and pumping equipment, some of the functions are outsourced to the original equipment manufacturers. These companies help the field operators with device inspection and certain performance readings. Other examples include the aircrew, which does visual flight inspection of the network. Assets are replaced on a worst first basis. Safety is a primary motivation with profit motives as a strong secondary consideration. Great Lakes cannot afford the lost opportunity if two or three compressors go down.

### **I.7 Asset Maintenance Practice at GLGT**

Asset management was introduced to manage the most important/valuable assets of the organization and was driven by an interest in improving profit. Control for asset management is shared between three groups. Marketing manages the facilities, Operations group controls the gas flow volumes and Field has the overarching concern of ensuring safety. Safety is of the utmost importance and has many regulated requirements.

When assessing risks of asset management, system costs and headcount were the most vulnerable variables in the process. Their asset management system has allowed GLGT to determine the cost of failure and to scientifically assess and predict system failures. Technology has made significant improvements in field-testing.

Since Great Lakes has assumed their own dispatching function, they have proactively chosen to seat the pipeline controllers next to the sales people. This helps the team make better decisions about the tradeoffs between pumping and maintenance shutdowns. Asset management practices have tried to improve capacity and increase profit through improved efficiency. Great Lakes is still somewhat concerned about the number of team decisions, which override their pumping plans. Automation has improved their efficiency to the point they are interested in knowing if they could gain another level of operational improvements. They have also achieved a level of comfort with the current technology and are curious about the next layer of efficiency slipping through the cracks.

Before Great Lakes embarked on the initial implementation of asset management, they did a complete inventory of their gas control operation. They analyzed the operation, formerly operated by their parent company in Calgary with the help of cross-functional task force. The task force looked at the interfaces between the field and dispatch. They weighed tradeoffs between centralization and decentralization and looked at the dynamics of the sales and operational decisions about capacity. Technology has replaced the 24-hour manpower requirements at each pumping station, and centralized decisions have improved capacity on a network basis.

The pipeline building began in 1965 and was completed in 1998. Typically the service life of pipes can vary between 15-60 years depending upon soil conditions. Technological life is more perishable. The system is currently running at state of the art efficiency and the compressors are electrically driven. Due to the customization, the manufacturing support is very thin, often resulting in a wait time for spare parts. The compressors are not unlike DC7 airplanes, where the components are overhauled on a regularly scheduled and predicted basis. This is another strong supporting reason for improved asset management. The economic life of the equipment is stated at 36 years with a 2.75% annual depreciation.

Customer specific projects and system cost analyses are performed separately. These plans come together in the annual budget process. Asset specifications, while regulated to some extent, are driven by the company to mirror existing facilities. It is important that the network is standardized to allow for common maintenance procedures and a common inventory. Having a standardized network also improves network performance modeling and prediction capabilities. Contractors played an important role in the initial development of the network with a few internal resources to guide the process. Great Lakes now controls their asset specifications to ensure optimal performance.

Great Lakes uses an internally generated performance system to manage the daily operations data. It was purchased from an outside vendor and customized to reflect the operating needs and facilities of the company. Different milestones flag maintenance horizons along the pipeline. Information is evaluated on a departmental basis to manage performance and compliance issues. Data is analyzed by trends and with specific software packages. Graphic information systems are critical to the fast and efficient operation of the network. They are not simply “nice to have’s” they are “must have’s” and have improved safety and reliability. No single system can efficiently keep track of all the data and performance measures. Each department has its own methods and performance measures to manage. Due to the size and complexity, the entire system is not integrated. Information is critical to performance issues. While much has been done to coordinate and share data at high levels across functions, individual department efficiency has been achieved by allowing each group to collect and coordinate specific measures for micro evaluation.

Fifteen employees and seven consultants are employed in information technology. Eighteen are involved in logistics, eight are directly involved in transportation and control, and ten are involved in analysis, simulation studies and dispatching functions.

Prior to automation the company employed 350 people. Today the total workforce is approximately 265. In 1998 dispatching was done in Calgary, Alberta. Today, Great Lakes controls their own dispatch from Troy, MI. Half of the employees are located in the field and the other half are located in headquarters. These centralized functions include sales, accounting, lawyers, and executive leaders.

In summary, Great Lakes feels that centralized decision-making has benefited their operation. Their labor strategy is to distribute workers regionally, with a conscious effort to locate labor near stations. Standardization across the network has simplified training and inventory processes. The development of risk models has significantly improved network efficiency and improved profits. GLTC learned that outsourcing is an important concept in managing certain advanced technologies and systems. Due to the rapid change and high costs in this area, there has been a recognition that they cannot afford to stay on the “leading edge” of technology.

### **I.8 Management and Training**

Training is approached in a multifaceted way. There is a short course offered to train new hires about the gas industry. Training videos are offered to introduce new procedures in the field; seminars and conferences are held annually to provide hands on learning experiences. Computer based learning courses are offered to improve performance. Turnover has been an issue recently and has placed a greater emphasis on training. Typically new hires come from the industry and have some understanding of the concerns for safety and the common trade offs between operations and sales efforts.

### **I.9 Barriers to Asset Management**

At Great Lakes, there are both organizational and operational barriers within the asset management program. Organizationally, engineers have different priorities than transportation. Engineers would prefer to defer services to maintain the plant, yet sales and marketing is driven to maximize profit by making as much capacity available as possible to handle the demand. The friction internally is the tradeoff between safety and profit. Operationally, weather, parts availability and labor availability across the 1000-mile system create challenges in performing necessary maintenance functions.