



**Implementation of Advanced Technologies in  
Rural Transit Service for the State of North Dakota**

***Final Report***

**FTA Report Number ND-26-7011-2009.1**

**June 30, 2009**

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# **Federal Transit Administration**

## **Implementation of Advanced Technologies in Rural Transit Service for the State of North Dakota**

**FTA Report Number ND-26-7011-2009.1**

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## **ACRONYMS**

ADA	Americans with Disabilities Act
ATIS	Advanced Traveler Information System
CAP	Community Access Program
CSCC	Children’s Services Coordinating Committee
FHWA	Federal Highway Administration
FTA	Federal Transit Administration
ITS	Intelligent Transportation Systems
MSAA	Mobility Services for All Americans
NDDOT	North Dakota Department of Transportation
SURTC	Small Urban and Rural Transit Center

## Foreword

This document, the final report for the Implementation of Advanced Technologies in Rural Transit Service for the State of North Dakota project, describes the motivation for, development and operation of, and lessons learned from an Internet-based trip planning system. The system was developed as an addition to an existing human service website, NDInfo.org. The new transportation module consisted of a searchable online database of transportation services available within North Dakota. The transportation module was available to online users from November 29, 2004, until the spring of 2006. In the summer of 2006, project resources were transferred to the Small Urban and Rural Transit Center (SURTC), a program of the Upper Great Plains Transportation Institute, at North Dakota State University. Under contract with the North Dakota Department of Transportation, SURTC redesigned the transportation module which remains operational.

The final report is intended to meet a number of objectives. In addition to describing the effort and outcomes for reasons of accountability, the document is also meant to be an educational tool to provide information for those involved in Internet-based trip planning systems development as well as the broader Intelligent Transportation Systems and transit communities.

The final report includes background information; a description of the project process and outcomes; and the evaluation framework, methods, and findings. The report should be of value to a wide range of transit industry professionals including federal and state program managers, transit agencies, and those involved in advanced public transportation systems engineering especially in small urban and rural communities.

## **Acknowledgements**

This evaluation was sponsored by the Federal Transit Administration, United States Department of Transportation, and conducted by the Small Urban & Rural Transit Center within the Upper Great Plains Transportation Institute at North Dakota State University. Contributing to the preparation of this document was David Ripplinger.

The assistance of Tim Cox, president of Northland Health Alliance, and Bruce Fuchs, director of public transportation at the North Dakota Department of Transportation, is acknowledged. The guidance of Jill Hough, Director of the Small Urban and Rural Transit Center, is also acknowledged.

## **Disclaimer/Notice**

The evaluation framework presented in the final report was designed after the completion of other project tasks. Data, in the form of site-use statistics and system user surveys as outlined in the project's scope of work, was not collected during the course of the project. This limits the evaluation to qualitative measures, especially as they pertain to organizational, management, and technological issues.

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# 1. INTRODUCTION

Accurate, accessible information is necessary for planning trips. For trips by modes other than personal automobile, knowledge of timetables, fares, and service requirements is essential. While information on these topics is readily available for some modes, for others, such as small urban and rural transit, it may be difficult to access.

The development and results of the transportation module of the NDinfo.org website project, a statewide Internet-based trip planning system, are presented in this report. The groundwork for the project began in 2003, a much different time, technologically, than when this final report is being written. During this time, other Internet-based trip planning system projects have been conducted, and systems engineering processes and principals have become more widespread under the leadership of the U.S. Department of Transportation through the Federal Transit Administration's (FTA) Mobility Services for All Americans (MSAA) program.

The transportation module was developed and operated as an addition to the existing NDinfo.org website project which served as an online human services directory. Born of the joint recognition of the importance of mobility to individual well-being and the need for accurate, accessible information for trip planning, the transportation module was expected to complement the existing site with a searchable database of transportation service providers. This effort, conducted with funding provided by the FTA and others, is the subject of this report.

A second version of the system, which focuses solely on transportation services and was commissioned by the North Dakota Department of Transportation, was designed on the foundation of the previous effort. This website is currently maintained by the Small Urban and Rural Transit Center, a program of the Upper Great Plains Transportation Institute, at North Dakota State University.

## 1.1 Objective and Methodology

The objective of the report is to provide the transit industry with an understanding of the project and its results and provide accountability for the resources committed. By identifying the relative successes and shortcomings of the transportation module, the document can serve to educate many parties. This includes individuals and organizations involved in its development and operation, others involved in the development of Internet-based trip planners, or those with a general interest in Intelligent Transportation Systems (ITS). It is also intended to meet the FTA requirements for a final report.

The initial project scope of work provided for the collection of website use statistics and surveys of system users including transportation agencies that provided service information to the system and systems users looking for trip planning assistance. Unfortunately, this information was not collected. While this raises concerns and limits, to some extent, the level and type of evaluation that can occur, this report investigates the organizational, management, and technological issues.

## **1.2 Scope of Study**

The study is formally limited to the effort resulting from the use of FTA dollars and other contemporaneous activities. However, additional information on more recent developments including work completed by the Small Urban and Rural Transit Center are included to provide context and to demonstrate the additional, ongoing benefits that have resulted from the initial effort. The project officially commenced in the spring of 2004, but significant planning occurred prior to this time. The transportation module of the NDinfo.org website was launched in November 2004 and remained operational until the spring of 2006.

## **1.3 Organization of Content**

The study begins with background information; evaluation framework; a description of the project process and results; lessons learned; as well as conclusions, findings, and opportunities for further research.

## 2. BACKGROUND

An understanding of the need that motivated the creation of the NDinfo.org transportation module and the environment in which a system will operate are necessary to provide context for later decisions and outcomes. In this section, background information on the transportation module of the NDinfo.org website is presented. The section begins with a brief description of the geographic characteristics of North Dakota. Next, the existing online human services directory NDinfo.org is described. Finally, a brief overview of systems engineering terms is presented.

### 2.1 North Dakota

North Dakota is a sparsely populated state with more than 635,000 residents. Although the majority of its residents reside in rural areas, a large and growing number make their homes in the state's three metropolitan areas of Fargo, Grand Forks, and Bismarck (Figure 2.1). The city of Minot, located in the northwest part of the state, is an urban area home to approximately 35,000 residents. With an area of 68,000 square miles, the population density of rural areas of North Dakota is 4.1 persons per square mile.



**Figure 2.1** Map of North Dakota

With certain services located only in larger communities, long-distance trips are regularly made by many rural residents of North Dakota. Given the financial and temporal cost of these trips, efficiency in trip planning for individuals, businesses and other organizations is necessary. Conversely, the provision of services, be they private or public, can be equally challenging because of the high cost of service and relatively sparse demand.

### 2.2 A Human Services Directory

To meet residents' need for information on human services available in North Dakota, the Northland Healthcare Alliance developed a Community Access Program (CAP) grant in 2001. The objective was to leverage the capabilities of the Internet using an online directory of human services that would be accessible to individuals and organizations throughout North Dakota and beyond. The result was the NDinfo.org website.

Under the leadership of the Region VII Children's Services Coordinating Committee (CSCC), a new organization, Community Connections, was incorporated to guide the development and management of technology projects and other community programs, including NDinfo.org. In addition to these objectives, the organization aimed to assist non-profits, government agencies, and private business in the delivery and coordination of services. The NDinfo.org website was developed for CSCC by Cybersites, LLC.

The original NDinfo.org site was designed to serve as an information portal for individuals needing information on services available in the state including those provided by non-profits, government agencies, tribes, schools, churches, media, and business. In addition to its core search engine functionality, the NDinfo.org site also contained a calendar of events, and job and volunteer bank. Also available on the website was a placement module intended to serve as a clearinghouse for day care, nursing home, treatment center, hospital, group home and homeless shelter openings.

The transportation module of the NDinfo.org site was born out of the recognition of the essential role of transportation in the delivery of human services. In response to the Olmstead decision by the U.S. Supreme Court, meetings across North Dakota were held to identify the needs of individuals with disabilities (Ripplinger and Peterson 2005). High on the list was the need for transportation, including both local and regional service.

To address the need for information on transportation services available in North Dakota, a group led by Northland Health Alliance envisioned an online searchable database of transportation providers. This database would be accessible via the Internet and allow users to find information by agency name, location, mode, and keyword. Focus was placed on trips for medical, human service, educational, nutritional, employment, and day care purposes. The system was expected to be integrated with human services agencies, tribes, and transportation providers as well as the existing NDinfo.org website. The transportation module, like the existing NDinfo.org website, was projected to be sustainable through membership fees, grants, and corporate donations.

## **2.3 ITS Architecture and Internet-Based Trip Planning**

Given the amount of resources required and the relative risk involved in developing and operating new systems that rely on advanced technology, considerable effort has been expended and leadership provided by the U.S. Department of Transportation in promoting and refining systems engineering principles and processes in transportation. Before proceeding, the definitions of key terms from systems engineering and Intelligent Transportation Systems (ITS) are provided. Systems engineering can be defined as the interdisciplinary field of engineering related to the design and operation of complex systems. Part of the systems engineering process involves identifying and adopting or modifying system architecture which defines the structure of a particular system especially as it pertains to how parts of the system interact with one another. Systems architecture also defines how the system will interact with other systems. Market packages present how parts of the system work together to provide specific services, for example online trip itinerary building capability.

The Final Rule on ITS Architecture and Standards Conformity was enacted by the Federal Highway Administration (FHWA) and FTA in January 2001. The Final Rule requires that ITS projects using funds from the Highway Trust Funds, which includes the Mass Transit Account, conform to National ITS Architecture and applicable ITS standards. This includes the development of regional ITS architectures and using a systems engineering process for project development.

The transportation information service envisioned by Northland Healthcare Alliance and its partners aligns with the current National ITS Architecture Internet Service Provider Trip Planning and Route Guidance Market Package (ATIS-05). This market package provides users the ability to generate trip plans based on preferences and constraints. The system may utilize transit fare and schedule information and allows for transit trip requests and confirmations where available.



### **3. EVALUATION FRAMEWORK**

In this section, the evaluation framework including hypotheses, frame of reference, data needs, and method of analysis for the transportation module of NDinfo.org project are presented. The original project plan provided an evaluation framework including the type of data that was to be collected and analysis that would be conducted. Unfortunately, no information was collected. This limits the type and amount of evaluation that is possible and necessitates the construction of a new evaluation framework.

Data that was to be collected included origin and destination, mode, and ADA accessibility requests during the operation of the website as well as user surveys. This information would have been beneficial in quantifying the effectiveness of the project and would have provided the ability to present a more complete picture of the benefits of the transportation module of the NDinfo.org website. In spite of this, other equally important issues including organizational, management, and technological issues can still be investigated.

#### **3.1 Hypotheses**

The post hoc construction of the evaluation framework and the existing knowledge of the system by the report's author make the construction of unbiased hypothesis difficult. In light of the situation, a single hypothesis is posited: adherence to systems engineering processes and principles, when practiced, resulted in positive benefits for the project.

Systems engineering principles had been prevalent in ITS projects for some time prior to the development of the transportation module and had been required by the Final Rule as of January 2001. Systems engineering processes are comparable in many respects to those employed in other project management fields. As a result, many technology projects that don't explicitly follow a systems engineering process may be conducted similarly to how they would if they had.

It should be noted that to hold the transportation module project to a standard after the completion of the project may appear unfair. The intent is not to provide undue criticism but rather to build the case that adherence to systems engineering principles and processes can result in completing complex projects and developing complex systems on time, on budget, and with the intended capabilities that meet the users' needs. At the same time, valuable insights can be gained as the hypotheses motivate a thorough investigation of, and systems engineering provides a refined framework for, reviewing organizational, management, and technological issues.

#### **3.2 Frame of Reference**

The frame of reference for the project is the period before the launch of the transportation module on November 29, 2004. Prior to the development of the transportation module, there was no existing Internet based trip planning system, nor was there a comparable non-electronic resource with equivalent transportation service information.

#### **3.3 Data**

To conduct the project evaluation, especially as it pertains to the hypothesis of the impact of the systems engineering process, project management documents, meeting agendas, white papers, marketing materials, the backside database, and associated information were assembled.

### **3.4 Method of Analysis**

The evaluation is limited to a qualitative analysis and critique of organizational, management, and technological issues. The process followed by the project is compared to that agreed upon in the original project plan and the systems engineering process as outlined by in the *Systems Engineering Guidebook for ITS* (2002).

In the next section, the project process and an overview of the resulting transportation module are presented. Also included is information about the interagency/multimodal trip planning function and the transition of the project to the Small Urban and Rural Transit Center.

## **4. PROCESS AND RESULTS**

Having recognized the importance of transportation and the benefits of using the Internet to disseminate service information, a project advisory committee led and oversaw the development of the transportation module. Effort was made to provide a tailored solution that took into account local needs and available services. In this section, the development process and resulting transportation module are described. The section concludes with a description of the transfer of the system to the Small Urban and Rural Transit Center and changes that have been made since.

### **4.1 System Design and Development**

Development of the transportation module was conducted under the direction of a project steering committee that consisted of 12 members. The membership included four individuals from transit agencies, the state director of public transportation, six members from government and non-profit human service agencies, as well as a representative of the developer of the existing NDinfo.org website, Cybersites, LLC.

Following the vision and project plan, development of the transportation module occurred in an incremental manner. During the development phase, meetings were held approximately once a month. Similar to a general business meeting, the agendas included discussion of developments since the previous meeting, alternatives for next steps, and decision making. As such, the project steering committee was intimately involved in all portions of the project, while relying heavily on the developer for technical guidance and updates regarding progress on the development of the module.

Early in the project a series of four public focus groups were held at locations across the state to identify Internet availability and use in that area. The meetings also identified the types of transportation services available and gaps between service and need. This information was used to guide the design of the website and the transportation service information needed.

The transportation module of the NDinfo.org website was designed and developed by Cybersites under the direction of the project advisory board. The Tango software application was used to program the site. This same application was used to program the original NDinfo.org site.

It was decided early in the project that individual organizations would be able to update their information using password-protected access to the transportation module database. Initially; however, transportation service providers completed paper forms whose information was later entered manually. Volunteer staff was used to enter information about other transportation services.

Considerable effort was placed in marketing the transportation module. A statewide marketing push that included television and radio was conducted. A live launch event was held in Bismarck with real-time video connecting to three other remote sites on November 29, 2004.

### **4.2 Website User Interface and Functionality**

The transportation model was seamlessly integrated into the NDinfo.org site, following the same design and style of the existing site. A screenshot of the NDinfo.org Homepage is presented in Figure 4.1. A link to the transportation module is located on left side of the page alongside those to the human services directory, the calendar, job bank, and other pages.

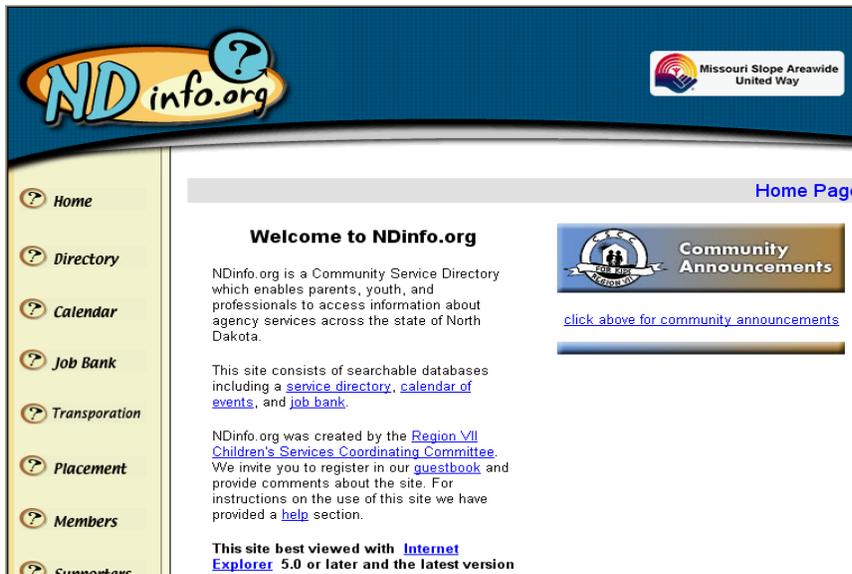


Figure 4.1 NDinfo.org Homepage

Clicking the transportation link led a user to the transportation module homepage (Figure 4.2). The transportation module homepage gave the user the ability to search the NDinfo.org database using one of two options. A quick search required either the name or location of the service provider or the city served. An advanced search allowed the user to further pare down potential providers by identifying the county or region of service, payment options, reservation requirements, as well as Americans with Disabilities Act (ADA), bike rack, geri chair, and pet constraints.

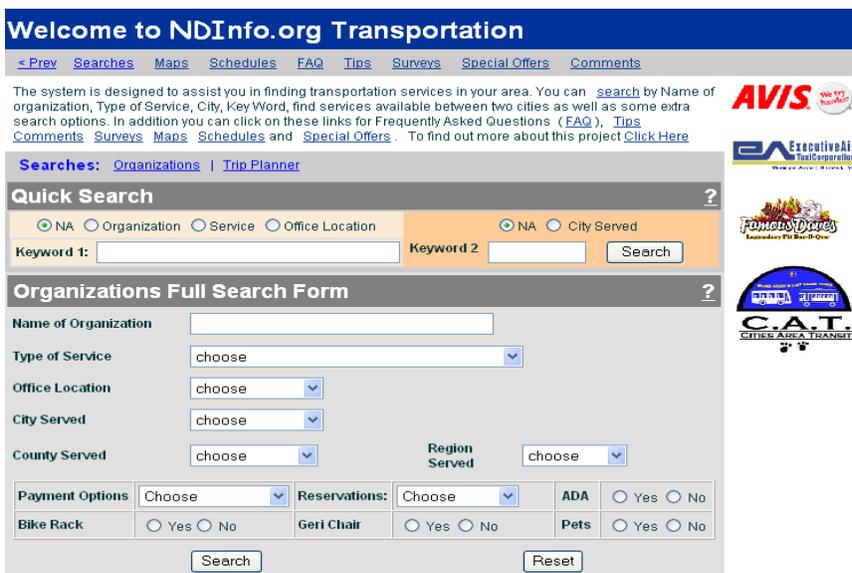


Figure 4.2 NDinfo.org Transportation Module Search Form

Agencies that met the requirements of the parameters provided by the user appeared in a list on a page that automatically opened. The user could then peruse the list. Upon identification of a potential service, an agency profile could be accessed by clicking the corresponding link. A service profile from the Burleigh County Senior Adults Program is presented in Figure 4.3. The service profile provided contact

and service information including type and hours of service, and payment information. For many users, especially for those seeking information about available transportation service in a particular locality, the search function and service profile provided sufficient information to make trip plans.

**Contact Information**

**Burleigh County Senior Adults Program**

Address: 315 N. 20th St. [Click to a MAPQUEST](#)

City: Bismarck Zip: 58501

Contact uid: 198 Ellen Owen Contact Ext:

Phone: 701-255-4648 Fax: 701-222-3890

Phone2: TDD/TTY:

Phone3: Toll Free:

Email: [bcasapi@btinet.net](mailto:bcasapi@btinet.net)

Website:

Hours/Days of Service: 8:00 am - 4:30 pm Monday - Friday Administrative Office Hours/Days: 8:00 am - 4:30 pm Monday - Friday

Primary Service Provided: (12) Medical Cities Served by this Service are: Bismarck, Arena, Baldwin, Driscoll, Lincoln, McKenzle, Menoken, Mofft, Regan, Sterling, Wing.

Types of Service Provided: Medical State Served: ND, ND,

**General Information:**

Rates and Fees: Donations Appreciated

Payment Options: Cash, Check Reservations: Required

Recommended Advance Time for Reservations: 24 hours in advance

Call for Reservations: 701 255-4648 For Reservations:

Licences: Register Nurse

Certifications: CPR & First Aid

Insurance:

Figure 4.3 NDinfo.org Transportation Agency Example Profile

For agencies that provided the necessary information, an image file containing the agency’s timetable was also available (Figure 4.4). The existence of timetables was noted on each agency’s service profile page. As is evident in the figure, service in many rural areas is regularly scheduled but somewhat intermittent.

[< Prev](#) [Searches](#) [Maps](#) [Schedules](#) [About](#) [FAQ](#) [Tips](#) [Surveys](#) [Special Offers](#) [Comments](#)

### Tioga Public Transit

	Tioga	Ray	Williston	Minot	Stanley
Monday	2 <sup>nd</sup> & 3 <sup>rd</sup> Monday				
Tuesday	Every Tuesday 10:00 - 3:00				
Wednesday		2 <sup>nd</sup> & 4 <sup>th</sup> Wednesday	2 <sup>nd</sup> & 4 <sup>th</sup> Wednesday	3 <sup>rd</sup> Wednesday	
Thursday					Every Thursday
Friday	Every Tuesday 10:00 - 3:00				

**Suggested Fares: (No one will be denied a ride if unable to pay fare.)**

Local Tioga \$ .50 per boarding  
 Tioga to Minot \$10.00 + \$1.00 per in town ride  
 Tioga to Williston \$ 6.00 + \$ .50 per in town ride  
 Tioga to Stanley \$ 3.50

Figure 4.4 NDinfo.org Transportation Agency Example Table

### **4.3 Interagency Trip Planning**

One of the expected functionalities of the transportation module was the ability to generate multi-agency, multi-leg trips. However, the development of a practical interagency trip planning tool was difficult because of two issues. First, the level of service in North Dakota limited the number of alternatives available, if any. Second, assembling the necessary data and developing the necessary algorithm to accommodate such a task was too ambitious for the project. This issue was identified early on in the development of the module, but after initial planning had been completed.

Using the transportation module, a user could identify potential legs of trips and then construct his or her own itinerary. Given the limited number of alternatives, this was a manageable task for some users. However, the process might require some amount of prior knowledge of North Dakota geography and transportation services. Many users might prefer to contact operators by phone to inquire or verify the availability of trips.

### **4.4 Website Operation and Transfer**

While considerable effort was expended in attempts to make the entire NDinfo.org website including the transportation module sustainable through membership fees, grants, and corporate support, the site went offline in spring 2006. Unfortunately, no information on the number of users was collected during the time of operation. The site, currently maintained by the Small Urban and Rural Transit Center, has approximately 200 unique users each month. It is plausible that the transportation module of the NDinfo.org website had an equivalent number of users during the time of its operation. No documentation of any challenges to maintaining and operating the site are available.

While offline, the North Dakota Department of Transportation (NDDOT) realized the value of the current and potential functionality provided by an Internet-based trip planning system and contracted with the Small Urban and Rural Transit Center (SURTC) to redesign and maintain the site. The project server and related resources were transferred to SURTC in the fall of 2006. The new project included a critical review of the previous site and making the necessary changes to make the site operational.

Upon review of the resources provided, project managers at the Small Urban and Rural Transit Center and Web designers with the Upper Great Plains Transportation Institute decided that it would be most effective to rebuild the site using modern Web design and development practices. A new website, including a new search page, was developed. A new database consisting only of transit agencies was constructed. The site was launched in the fall of 2007 and has been operational since that time.

## **5. LESSONS LEARNED**

In this section, lessons learned as a result of the development and operation of the transportation module of the NDinfo.org website are presented. This includes the benefits of having third-party expertise and phased implementation. Lessons directly related to system engineering including needs assessment; Concept of Operations; requirements, architecture, and design; and data issues are also presented.

### **5.1 Third-Party Expertise**

The project relied upon the developer of the original NDinfo.org website for all technical advice. The remainder of the board consisted of individuals from transit agencies, government, and non-profit organization. As a result, there was no one to offer alternative views or to critique technical comments.

One significant shortcoming of the project was its use of Tango software to program the site. Tango software was not sold after 2000 and support for the application ended soon after. As a result, Tango was not in common use at the time of the development of the transportation module. This issue would have made maintenance challenging, especially if new programmers were to be hired and trained. It also hindered the ability of the system to evolve. This issue arose when the site was transferred to the Small Urban and Rural Transit Center where the site was eventually completely reprogrammed using alternative script. The presence of a third-party expert with a background in web development would have immediately identified the risks associated with the use of an obsolete technology.

Neither the developer nor anyone on the project steering committee was intimately familiar with ITS. A third party with experience in technology projects, especially one with experience in ITS, would have likely directed the effort to more rigorously follow systems engineering methods.

### **5.2 Phased Implementation**

While the development of the transportation module did follow an incremental approach, what transpired could be better considered a fluid design. The steering committee was regularly required to adjust its expectations, usually downward, as the complexity of the initial vision became evident. This situation was aggravated by the aggressive development schedule. This may have been the result of the inexperience of the advisory group members who likely had little experience managing technologically innovative projects.

### **5.3 Systems Engineering**

Systems engineering is a discipline for managing complex projects. It is used to reduce risk, ensuring that projects are completed on time and on budget. It requires increased participation and results in increased satisfaction of stakeholders with the final product. System engineering ensures that a system is amenable to new technology and that the system is able to evolve over time.

A formal systems engineering process was not employed in the development and operation of the initial transportation module of the NDinfo.org website. However, many of the key activities in the systems engineering process including needs assessment and Concept of Operations were completed by the project although in a relatively informal manner. However, departure did occur in some areas.

## **5.4 Feasibility Assessment**

The sustainability of the system was identified as a goal early on by the project advisory group. The project hoped to keep costs low by relying upon agencies to provide updates to their own service profiles. It was also anticipated that membership fees in combination with grants and corporate assistance would provide the income necessary to sustain the service.

In practice, information in the transportation module database was entered manually from hard documents by those involved in the project, not those providing transportation services. Also, no additional funding sources arose during the operation of the NDinfo.org site. The North Dakota Department of Transportation continues to provide support for the transportation module.

The systems engineering process includes a feasibility analysis appropriate to the size and sophistication of the project under consideration. A formal feasibility analysis including the explicit identification of funding sources and levels of support necessary to operate the system might have resulted in a different funding model for the transportation module. However, the project advisory group did investigate the feasibility of operating the system at a level arguably commensurate with the scale of the project.

## **5.5 Needs Assessment**

One of the first steps in the systems engineering process is to conduct a needs assessment. A needs assessment defines the needs of a system as agreed upon by stakeholders. A needs assessment is intended to clarify the situation and potential solutions. It is the first step toward system requirements and often requires the development of consensus when conflicting needs exist.

No formal needs assessment was conducted as part of the development of the transportation module of the NDinfo.org website. However, the original motivation for the project resulted from a statewide effort parallel to that which would be conducted during a needs assessment. Given the scope of the project, which included all personal transportation in the state, it was not possible to elicit the involvement of all shareholders.

Most importantly, the absence of the development of a formal needs assessment document prevented the project steering committee from identifying needs as opposed to wants. The shared vision of the committee was bold, but unrealistic, given the complexity involved and the resources required. A formal needs assessment would have tempered the expectations of those involved in the project. Also, a prioritization of wants did not occur because they were not identified.

## **5.6 Concept of Operations**

A Concept of Operations is a document that describes the operation of a system from the viewpoint of various stakeholders. The transportation module of the NDinfo.org project did not produce a Concept of Operations document. However, many of the important portions of a Concept of Operations were discussed by the project steering committee, which included many of the relevant stakeholders. This included a shared understanding of roles and responsibilities for the organizations involved in the process by project steering committee members who came from many groups. However, not all stakeholders, the large group of transportation providers, were involved with or were aware of the roles and responsibilities that their organizations would have.

For example, the project advisory group determined that each agency would be responsible for its own information presented on the website and would have the ability to update its service information at any time from anywhere. Ongoing success of the system would have required timely updates of service information. Given the breadth of scope of the project and the absence of prior knowledge, there was no way to ensure that transportation service providers, especially private, non-profit, or personal ones, would update their information.

Operational scenarios, which describe the operation of systems under various conditions and by different entities, were presented as part of the launch event in November 2004. The first scenario involved users searching for service in a particular location. The second scenario involved users constructing a multi-leg trip using the system. However, it is unknown if these particular cases were identified before the transportation module was developed or were simply descriptions of the functionality of the product as it happened to occur.

## **5.7 System Requirements and Architecture**

No regional or project-level architecture was built for the transportation module. System requirements were never formally developed. If the more ambitious goal of allowing for reservations and fare payment were ever to be achieved utilizing the Internet, these shortcomings would have become significant as integration with other systems would have been difficult. It is worth noting that at the time of the report there were only a few transit agencies in North Dakota that would be able to integrate with a centralized system.

## **5.8 Internet-Based Trip Planning Systems**

The use of Internet-based trip planning systems show promise of great benefits. Since the initiation of the NDinfo.org transportation module project, a number of other efforts have commenced with varying degrees of success. These efforts include Google Transit, Oregon Department of Transportation's Trip Check, and Modoc Transportation's Rural Trip Planning Tool in California. It would be a misnomer to identify the transportation module of the NDinfo.org website as a trip planner, as the system did not generate multi-leg trips as is the usual expectation. However, its function as an online searchable database of service providers was likely a valuable tool to many users.

As noted earlier, the transportation module of the NDinfo.org website as initially envisioned aligned with the Internet-based trip planning market package. Being able to use that market package and associated architecture would have likely proven valuable to those involved in the project, if it had been utilized during the early stages of the study. The market package not only provides a basis for design, but also demonstrates the need for the system's ability to interface with others.

## **5.9 Data Needs and Quality**

The success of a trip planning system is dependent on the underlying data that must be accurate, timely, and accessible. Prior to the NDinfo.org transportation module project, a database of service provider information did not exist, with information available only locally or compiled in paper form at the state level. One success of the transportation module project was in motivating the creation of an electronic database.

The information necessary to construct a multi-leg trip itinerary was never assembled. This is understandable given the demands of such a task. However, this limitation should have been recognized during system planning. Also, timetable information for service providers was saved and presented as picture files. While this information was likely of value to some users, maintaining the information in this manner was likely cumbersome to the Web master. Anytime a trip time changed, a new timetable would need to be created, saved as an image file, and then uploaded to the system server.

## **6. SUMMARY**

The transportation module of the NDinfo.org website set out to provide users with the ability to access information on available transportation services in North Dakota. The project did not succeed in achieving its ambitious vision of providing an Internet-based trip planning system. However, it provided an online searchable database of transportation services available in North Dakota. It also laid the foundation for a successor system which remains operational.

### **6.1 Summary of Findings**

The project evaluation hypothesis set out in Section 3 is that adherence to systems engineering processes and principles, when practiced, resulted in positive benefits for the transportation module of the NDinfo.org project. To evaluate the hypothesis, those findings and lessons learned that relate directly to systems engineering, feasibility assessment, needs assessment, Concept of Operations, and system requirements and engineering are considered. While some consideration was given to topics similar to feasibility and needs assessments and Concept of Operations by those involved with the project, no formal documentation of any of the five areas was created or maintained.

There were a number of efforts that align with systems engineering that had positive effects on the project. The project did consider sustainability of the transportation module and NDinfo.org website as whole, similar to a feasibility assessment. The project was well-motivated and did include regional meetings to identify gaps in transportation service, as is required for a needs assessment. Operational scenarios, as found in a Concept of Operations, describing the use of the system were presented during the project launch.

At the same time, there were serious shortcomings - departures from systems engineering that either did or likely would have significantly limited the transportation module from meeting its expected goals. The sustainability of the project was questionable. No additional funding sources arose during the operation of the NDinfo.org site in its entirety. This included the absence of local or agency level funding, such as membership fees, which were expected to sustain the system. Also, the willingness of transportation providers to maintain their service information was questionable, as individual organizations never agreed to that model as would have been done during the development of a Concept of Operations.

The biggest deficiency was the lack of acknowledgement or adherence to system architecture or the development of system requirements. The module developers could have used existing knowledge in these areas to improve the design of their system and its backside database. It might also have led to an earlier realization of the complexity of developing an Internet-based trip planning system than was actually the case. The lack of system architecture would have made future integration of the transportation module with other systems difficult.

### **6.2 Conclusions**

The hypothesis that adherence to systems engineering processes and principles, when practiced, resulted in positive benefits for the transportation module of the NDinfo.org project is supported by the evidence. All of the lessons learned related to systems engineering processes and principles support the hypothesis to some degree. When efforts similar to those prescribed by systems engineering occurred, positive benefits resulted. When departures from systems engineering were made, potential weaknesses were created.

## 6.3 Implications and Recommendations

The acceptance of the hypothesis further validates the work of the U.S. Department of Transportation on ITS by demonstrating the shortcomings that resulted in the development of a specific program that did not strictly follow now-required systems engineering principles. It also provides support for those involved in relatively small ITS projects, especially those that involve members of the transportation community with limited exposure to systems engineering, to budget the appropriate amount of total project resources to systems engineering.

The absence of data on site visits and surveys of organizations providing transportation in North Dakota or those investigating trip alternatives limited the scope and rigor of the evaluation. It is hoped that other projects in Internet-based trip planning do collect and report this information in the future. This is currently being done with the present version of North Dakota's online searchable transportation service database.

## 6.4 Summary

The transportation module of the NDinfo.org website was envisioned to provide an online searchable database of transportation providers in North Dakota. Given the state's low population density and the long distances to be traveled for many rural residents for basic services, trip planning takes on a unique dimension. The module was intended to complement the existing NDinfo.org website which provided information on human services available in the state.

Under the direction of a project steering committee, meetings were held across North Dakota to identify the level of internet access and identify transportation needs. The transportation module was developed by Cybersites LLC, the same organization that designed and maintained the NDinfo.org site. The transportation module was launched in November 2004 and remained operational until the spring of 2006.

The transportation module allowed users to identify potential transportation service providers by searching the system's database by location of service or agency name. Users could conduct an advanced search to refine the search to include parameters like fares, reservation requirements, or wheelchair accessibility. Users were able to build trips by manually identifying agencies that were able to provide service across legs of multi-leg trips. During the summer of 2006, project resources were transferred to the Small Urban and Rural Transit Center which redesigned the system under contract with the North Dakota Department of Transportation. This new site remains operational.

The project provides many useful lessons for those involved in developing an online searchable transportation service provider system, more elaborate Internet based trip planning system, or ITS in general. These lessons include involving a third-party technical expert on the project advisory committee and breaking up complex systems development into phases, if practical. Also identified was the need to conduct a feasibility assessment commensurate with the scale of the project to ensure the sustainability of the system. In the context of the study, this includes the financial cost of ongoing operations and the willingness and ability of transportation providers to maintain up-to-date service information.

The project evaluation hypothesis that adherence to systems engineering processes and principles, when practiced, resulted in positive benefits for the transportation module of the NDinfo.org project is supported by the evidence. Neither a formal needs assessment nor a Concept of Operations document was produced, although the project did undertake related efforts. However, the project did not include buy-in from all members, but rather representatives from certain groups. The project did not follow a systems engineering process, no system requirements were formally established, and no effort to identify

an existing or develop a new system architecture were undertaken. This would have formally limited the system if it had again tried to pursue development of an Internet-based trip planning function. Finally, the database did not have the information or structure necessary to facilitate multi-leg trips. While the transportation module of the NDinfo.org website fell short of its goal of providing a sustainable, Internet-based trip planning system, it did lay the foundation for its successor system, which remains operational as of the date of this report. There are number of lessons that can be learned from the project. Hopefully, these lessons will assist in the development and operation of other Internet based planning systems and other ITS projects.



## 7. REFERENCES

Ripplinger, D., and D. Peterson. *ITS Transit Case Studies: Making a Case for Coordination of Community Transportation Services Using ITS*. Departmental Paper 171. Upper Great Plains Transportation Institute, North Dakota State University, 2005.

ASE Consulting, LLC, Knowledge Systems Design, and Siemens ITS. *Systems Engineering Guidebook for IT, Version 2*. Federal Highway Administration and California Department of Transportation. 2007.