MONDAY, DECEMBER 10, 2001

TRB CONFERENCE ON REMOTE SENSING

STATE DOT TECHNOLOGY EXCHANGE MEETING

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REMOTE SENSING AND SPATIAL TECHNOLOGIES FOR TRANSPORTATION

ROUNDTABLE FOR STATES AND MPO'S

WASHINGTON, D.C. DECEMBER 10, 2001

DRAFT REPORT ON RESULTS AND CONTENT OF THE ROUNDTABLE

I. INTRODUCTION

Prior to the Transportation Research Board Conference on Remote Sensing and Spatial Technologies for Transportation, held in Washington, D.C. December 10-12, 2001, the Steering Committee for the Conference sponsored a "roundtable for States and MPO's". The roundtable was an opportunity for transportation organization staff to share experiences and strategies in the use of remote sensing in an informal setting. Topics included current programs and funding, new initiatives, successful strategies and partnerships and barriers. The states in attendance were asked to make a short presentation and to prepare a short paper on their current program regarding remote sensing and spatial technologies. Copies of the papers are attached to this report.

Dave Gorg, Minnesota DOT, Roger Petzold, FHWA, and Val Noronha, University of California, Santa Barbara organized the session. In the introductory remarks from the organizers, the following points were made:

- There is tremendous interest is this subject as the number of tools available is increasing and the cost is decreasing.
- AASHTO has a new subcommittee on Spatial Information
- All four NCRST consortia are preparing Guidebooks for DOT's and MPO's on the use of remote sensing in various aspects of transportation.
- The 4 University Consortia funded by RSPA and NASA are in their second year of the four year research program. The results were presented at the full conference and are available directly from the Consortia.
- 3 states, Minnesota, Iowa and Wisconsin met in August, 2001 to share experiences. The exchange was very successful to the parties and identified a number of joint concerns including; vendor contracting, data ownership (licensing), common specifications, computer server and network capacity problems, getting enterprise buy-in to remote sensing, and data sharing within the organization.

II. STATE PRESENTATIONS

DOT staff from 15 states were present at the roundtable and 14 gave presentations and prepared short summaries of their programs (attached). In alphabetical order the states were:

1. Arkansas
2. California (no presentation)
3. Florida
4. Iowa
5. Kansas
6. Maine
7. Maryland
8. Massachusetts
9. Minnesota
10. North Carolina
11. Oklahoma
12. Pennsylvania
13. Utah
14. Virginia
15. Washington

From the 14 state presentations and the subsequent discussions it is possible to present a number of observations for further discussion on several items including:

A. State of the practice with respect to remote sensing and spatial technologies
B. New initiatives
C. Types of partnerships evolving with states and others
D. Barriers to implementing remote sensing
E. Issues for further discussion and research

A. State of the practice with regard to remote sensing and spatial technologies

The state of the practice in state transportation agencies appears to be digital photogrammetry, GIS and GPS. Only one state (Virginia) reported on the integration of remote sensing (LIDAR) into everyday activities. 6 additional states have some ongoing activities related to LIDAR and 3 states have projects involving satellite imagery (IKONOS and LANDSAT7)

B. New Initiatives

There is a great deal of experimentation occurring at the state level. A total of 29 new initiatives are included in the state write-ups. As mentioned previously, 6 involve LIDAR and 3 involve satellite imagery. Many of the new initiatives are done in coordination (partnership) with other agencies. Internal new initiatives are generally in the data sharing and data accessibility areas.

C. Partnerships

One of the major drivers in the progression of new technologies is the use of partnerships. There are a number of different types of partnerships mentioned:

- State/county
- State inter- agency or statewide
- State/federal
- State/university
- State/private sector- data providers and utilities
- Combinations of the above

D. Barriers to implementation

1. Funding including budget and staff reductions was the most frequently mentioned barrier
2. Time pressures to produce work on a known schedule and lack of time to investigate new ideas
3. Lack of agreement on common formats
4. Lack of understanding and buy in from staff and top management
5. Data size, data sharing and data retention related to server and network capability
6. Licensing

E. Issues for further discussion/research

Following the presentations a number of issues were raised and discussed including:

1. **Marketing.** There is a need to document and market successful applications of the use of remote sensing information. A number of possible venues were suggested including state transportation conferences, state GIS conferences, regional meetings between state DOT's and users groups. There are 3 different audiences and the marketing should be designed for each audience; users, practitioners and policy makers.
2. **Accuracy.** There is a need to sit down with the ultimate users of information to determine the necessary accuracy required and to match the necessary accuracy to the most cost-effective method of data collection. There is a sense that the current accuracy requirements are more traditional and not based on detailed tradeoff analyses (trading off accuracy for time and cost advantages).
3. **Partnerships.** Most of the successful projects involving remote sensing have come through some sort of partnerships. States need to continue to explore partnership arrangements with a variety of different groups.

4. **Time Pressure.** The time pressure faced by states to reduce the time from planning to construction is both a barrier and an opportunity. It is a barrier because the photogrammetry sections are under time pressures to produce

products with known accuracy on a predictable time schedule. This leaves little time for experimentation. States don't have time to make mistakes. It is an opportunity because if it can be shown that remote sensing can speed up the project delivery schedule, agencies would be willing to invest in the technology.

5. **Measuring Benefits.** There is a need for good information on the accuracy and benefits of using remote sensing data in the project development process. There are several side-by-side comparisons under way which will help provide this needed information.
6. **Private Vendors.** Several vendors are proposing complete data packages using remote sensing techniques. States need help in evaluating these proposals and need to share information on the use of these packages.
7. **Remote Sensing Applications.** To date the use of remote sensing information has been limited to right-of-way appraisal and acquisition, wetlands mapping, preliminary design and detail design.
8. **Data Sharing, Data Integration and Data Fusion.** Experience is showing that remote sensing information usually is not "stand- alone" information. Remote sensing information must be "fused" with other data to both calibrate and complete the data set. This raises a number of compatibility issues including multiple data, multiple projections and documentation (metadata)
9. **Intermodal/multimodal.** To date most of the development of remote sensing applications has been in the highway project development process. There are a number of desirable applications which should be pursued in the intermodal/multimodal arena.
10. **Funding for Remote Sensing.** Funding is an issue raised by most states in their papers. Since most of the funding for remote sensing information currently comes from project sources, there is a concern that the use and needs for other transportation purposes is not being considered. Planning and MPO needs were examples cited. Remote sensing information may also be valuable for facilities management as well as facility design.
11. **Regulatory Agencies.** There is a concern that regulatory agencies will not accept information coming from remote sensing sources.
12. **National Security.** The events of 9/11 have changed the balance between the privacy of information and the desire to develop information databases which can be readily shared. No one can currently predict where the balance point will ultimately rest. Again this issue can be both an opportunity and a barrier for remote sensing.
13. **Utilities.** States have a number of issues when dealing with utilities on remote sensing projects including accuracy and liability. The State of Georgia appears to have developed a cooperative program with their utility.
14. **Staffing.** Most states have problems training staff in new techniques, and retaining the staff. Many states are outsourcing data collection and existing staff needs training in contract specifications and contract management.

15. **Computer Networks.** Capacity and speed issues of servers and networks exist when handling the large amounts of data which come from remote sensing sources. Dealing with these issues needs to be part of the equation when considering using remote sensing data.

III. Next Steps

In the summary of the meeting a number of next steps were suggested for states including;

1. Continue to look for partnerships and continue to participate in the current RSPA research effort with the University consortia
2. Use the new AASHTO subcommittee on Spatial Information and the existing TRB committees to share information and advance the state-of-the- art
3. Pursue pooled-funded studies through AASHTO
4. Conduct additional regional meetings similar to the one held this summer between Minnesota, Iowa and Wisconsin.
5. Create a website/discussion forum
6. As part of the reauthorization of TEA21 in 2003, ensure that remote sensing is sanctioned and that funding is provided for demonstrations and other activities to advance the state of the practice.

Arkansas State Report of Remote Sensing Usage

TRB Remote Sensing and Spatial Information Technologies for Transportation
State DOT Technology Exchange Meeting
December 10, 2001

The following is a brief overview of the use of remote sensing and spatial information by the Arkansas Highway and Transportation. Also included is information related to efforts by other state government agencies as it pertains to the AHTD.

Current Programs/Funding

AHTD

- Photogrammetry
- GPS – Extensive use of both static and RTK
  CORS – 1 Cooperative NGS
  3 AHTD
  5 (min.) additional scheduled

State Agencies (with County Government participation)

- Development of statewide GIS that is WEB accessible with spatial data that includes:

Aerial Photography	Geology	Soils
Cadastral	Government units	Telecommunications
Census	Hydrography	Transportation
Centerlines	Land Use / Landcover	Vertical Control
Critical Infrastructure	Digital Orthoimagery	
Geodetic Control	Public Land Survey System	

New Initiatives

GIS – State

- Upgrading positional accuracy roadway centerlines for the GIS base maps. This has been requested by utility locators (AR Onecall) to be able to better determine the location of a specific utility. The desired precision is +/-5 feet. But, survey grade RTK (GPS) is not considered practical. A pilot project is under development using digital orthophoto quads (DOQQs) to digitize positions; ground truth using some level of GPS; and, "warp" other existing mapping data produced by the AHTD to that map.

AHTD

- Scanning AHTD aerial photography and making it available on the state GIS website.

Strategies

- Centerline Accuracy Upgrade -Public/private teams to perform the testing and develop a implementation plan based on the results (if successful).

- I-Teams – Participation in the federal The I-Team Initiative address the institutional and financial barriers to the development of the National Spatial Data Infrastructure (NSDI). It aims to offer a coherent set of institutional and financial incentives to make it easy for all levels of government and the private sector to collaborate in the building of the next generation framework data.

Partnerships

AHTD - Outsourcing county mapping aerial photography

Barriers

- Funding
- Staffing
- Time
- Multiple disciplines involved using multiple formats and agreeing on the ultimate format displayed.
- Time/staff to investigate newer remote sensing techniques such as LIDAR.

User Issues

- Data accessibility
- Proper use of the data

Kit Carson, PE, PLS
Division Head, Surveys
Arkansas Highway and Transportation Department

Remote Sensing and Spatial Information Technologies for Transportation
Florida Department of Transportation State Report
Surveying and Mapping Perspective

State DOT Technology Exchange Meeting
December 10, 2001

Russell G. Daly, PLS, State Surveyor
December 7, 2001

Current Programs and Initiatives

1. State Aerial Photography and Photogrammetric Mapping Program
2. County general highway mapping. (Land use/land cover mapping eliminated.)
3. "Generation of Spatially Correlated Multi-Purpose and Seamless GIS Base Maps for Florida" Research Project ➔ (ALSM, ADP).
4. Global Positioning Systems (GPS) Statewide Network

Funding for Remote Sensing and Spatial Information

1. Federal, state. ~ 2 million dollars.
2. County mapping primarily funded by FHWA. ~ 0.5 million dollars.
3. State. 10.5 million dollars. Five-year contract started in 1999.
4. State. 3.7 million dollars. Originally, five-year project started in 1997.

New Initiatives and Drivers

1. Digital photography and digital photogrammetric mapping program driven by technology changes and digital product demand.
2. Improving digital county mapping processes driven by internal management.
3. Evaluating remote sensing tools and technology for applicability and business decisions.
4. None.
5. RCI Program Improvement initiative.

Successful Strategies

1. Photography and county mapping program cost-benefit study completed June 2001.
2. (County map field verification activities outsourced.)
3. To be determined (TBD).
4. TBD.
5. TBD.

Partnerships

- FHWA, NGS, NOAA, NWS, FAA.
- FDEP, FDOR, FDOT, FDMS, other state and local agencies.
- University of Florida.

Barriers to Implementation

- Budget cuts and staff reductions.
- Lack of remote sensing technology marketing within FDOT.
- Buy-in from key internal customers and executive management.
- Education.

User Issues

- Unfamiliarity with remote sensing tools and technology.
- Data usability, accuracy, and timeliness issues.
- Cost.

Remote Sensing and Spatial Information Technologies for Transportation
Florida Department of Transportation State Report
Planning/Data Collection Perspective

State DOT Technology Exchange Meeting
December 10, 2001

The Florida Department of Transportation has several initiatives ongoing related to the use of remote sensing to improve business processes. This report summarizes the activities surrounding the improvement of the collection of transportation data. It will discuss an overall statewide effort as well as several pilot projects which support the goal of improving the accuracy of transportation roadway feature data.

Roadway feature and characteristic data is collected in several areas of the Department to support critical project development and operations management functions. Examples of these types of data include traffic lane width, pavement condition, traffic signs, and shoulder types. Most of this data is currently collected in the field and its useful accuracy is relative to its application. It is acceptable for some preliminary design work, maintenance, planning, and traffic operations uses, but its not accurate enough for roadway design or survey level work. At the same time, aerial photography is being flown for several purposes across the state and the potential for redundancy in this effort is great. Therefore, the Planning and Survey and Mapping groups joined together to establish a task team. The mission is to investigate the potential for collecting data in the planning stages at an accuracy level suitable for preliminary design work. Other benefits include more accurate, easier to collect data for maintenance operations as well as the ability to improve GIS basemaps through accurate centerline extraction. The benefits of the overall effort include improved data integration, reduced redundancies in data collection, safer data collection, wider use of data and therefore increased efficiency in production and potential long term cost savings.

The intent of the task team is to make recommendations to executive management regarding how remote sensing should be used to collect data in the planning area. This will expand to be applicable to data collection in maintenance, traffic operations and safety offices as well. The main activities of the task team are as follows:

a) Investigation of issues such as data accuracy needs – This is being accomplished by working closely with data customers such as environment, project development and design engineers.
b) Investigation of the need for a system to store and provide access to all potential aerial photography and associated data.
c) Management of several statewide pilots – Data is collected at the district level, so district involvement in the investigation of methods is critical. Several district pilots have started which involve developing applications to extract feature data from existing aerial photography. The most noteworthy pilot started prior to the involvement of the central office. It started in the district comprised of the 16 counties in the panhandle of Florida. They currently use remote sensing (2000' aerial photography, color film, x,y,z specification accuracy not greater than 6 inches, and 3.4 inch resolution) to collect 31 roadway inventory office and field features--all from a desktop PC in stereo (3D--x,y,z) mode. Videologs are also integrated with the software tools. They have linked their linear referencing system (mileposts) with the GPS coordinate system (x,y,z) and they produce an accurate centerline which accommodates the vertical and horizontal undulations of the roadway. The accuracy of the field features is anywhere from 2 inches to 6 inches in x,y,z. They have also initiated a pilot program to see if other units in the District (Maintenance, Construction, Traffic Operations, Safety, Design, Environmental Management, Emergency Operations, Production, Right-of-Way, Public Transportation, and Bridge Structures) can use the data. Several units are very interested in the software tools and methodology. This pilot is being presented in several statewide forums along with the statewide task team efforts and the concepts have been well received.

The Department is also involved in a national Consortium on Remote Sensing in Transportation project. This project will investigate the feasibility of using commercial remote sensing technologies combined with GIS mobile mapping and GPS to develop accurate and comprehensive databases of roadway features and characteristics. The project will make recommendations regarding cost/benefit applicable to Florida's data collection process as well as make recommendations applicable to other states.

All the above work will be completed next year and will allow the Florida Department of Transportation to successfully move ahead and begin incorporating new standards for data collection based on remote sensing technologies.

By: Anita Vandervalk, Manager, Transportation Statistics Office, Florida Department of Transportation
November 6, 2001

Iowa Department of Transportation Remote Sensing Projects

December 2001

The Iowa Department of Transportation (DOT) has several remote sensing projects that are currently underway. The projects include initiatives to obtain, distribute and analyze remotely sensed data. Other remote sensing projects that the DOT has been involved with are also included.

Internal Initiatives

Light Detection and Ranging (LiDAR) – The Photogrammetry Section acquired LiDAR data for a project on US 30 in Linn, Cedar and Clinton counties from the Lisbon Bypass to the city of DeWitt. The project includes seven bypass areas. The corridor covered 26 square miles across hilly terrain. Acquisition of LiDAR data was acquired to evaluate the potential benefits of this technology throughout the highway corridor development process.

The LiDAR was flown at 3000 feet above ground in June of 2001. LiDAR deliverables were:

- MicroStation files with 10-foot digital elevation model generated from the LiDAR and breaklines.
- MicroStation files of the LiDAR bare ground DEMs. These files were generated from raw LiDAR data modified by software to remove the vegetation canopy.
- ASCII files containing bare ground LiDAR data. These files were generated from raw LiDAR data modified by software to remove the vegetation canopy.

The intent is to use this information to evaluate various alignments and establish a final alignment along the forty-five mile corridor. The selected alignment will be reflown at 2000 feet and detailed photogrammetric and field survey information will be added to the LiDAR data for the final design phases. The Iowa DOT will make some comparisons of the LiDAR and photogrammetric products.

Image Cataloging Web System – The DOT is acquiring a large amount of digital aerial photography for planning and engineering. Often the same imagery was obtained by different parts of the DOT and was redundantly stored on DOT computer systems. The DOT developed a system, under the guidance of its Aerial and Satellite Imagery Task Force, to acquire, catalog, and distribute aerial photography. The United States Geological Survey (USGS) Digital Orthorecitifed Quarter Quadrangles (DOQQ) and Digital Raster Graphs (DRG) were obtained in georeferenced digital files in tiff format. The files were reprojected and compressed to make them more usable in a production environment. Each file was then spatially cataloged (automated process) and a GIS-enabled web page was developed to query available imagery. Higher accuracy imagery from individual counties and from the Iowa DOT Photogrammetry Section is being included in this image catalog as well.

Acquisition and Evaluation of IKONOS Satellite Imagery – Iowa DOT contracted with Space Imaging to obtain 1-meter resolution digital imagery of a wetland mitigation bank area. The imagery was obtained from the IKONOS satellite in the summer of 2001. We purchased the 1-meter panchromatic/4-meter color bundled product and obtained imagery in 4 bands: NIR, R, G, B. The project is 700 acres in size. Our plan is to use the satellite imagery as a seamless overhead view of the project area and also to perform some simple analyses of the project area using the spectral bands. Specifically, we would like to look for the presence of hydrology, wet soils, and/or wetland vegetation and to learn what general trends may be observed from this type of imagery. Another application of

the data will be change detection. We will be able to remotely monitor the site and, along with some ground truthing, quickly determine the changes in vegetation and hydrology over time. This could produce significant cost savings over a large area.

Projects External to DOT

Acquisition of New Statewide Imagery – The Iowa Geographic Information Council Remote Sensing Committee, under the leadership of the Iowa Department of Natural Resources, is developing partnerships with federal, state, and local governments and the private sector to secure funding and requirements for acquisition of new statewide aerial imagery. The primary product will be second generation color infrared (CIR) DOQQs that will be certified by the USGS. Additional products will include panchromatic images generated from the CIR image and compressed format imagery for more efficient general use with Internet and network applications. Funding has been secured for the project and a contract is being negotiated. The Iowa DOT is partnering in this process by providing funding and technical support.

University of Northern Iowa (UNI) - Remote Sensing is one part of the UNI **S**cience center for **T**eaching, **O**utreach, and **R**esearch on **M**eteorology (STORM) project. Under this project, UNI has provided a two-week long short course on remote sensing, acquired and distributes ERDAS imagery on its web site (http://www.uni.edu/storm/), and provides other teaching, outreach and research related to remote sensing.

Iowa State University GIS Support and Research Facility – ISU, in partnership with the Massachusetts Institute for Technology and Natural Resources Conservation Service, developed the Iowa Geographic Image Map Server. This server provides Iowa LandSat, DOQQs and other imagery to the public. The server merges image tiles and provides output to users in several different resolutions and formats (http://ortho.gis.iastate.edu/).

DOT Research Partnerships

Iowa State University Center for Transportation Research and Education (CTRE) – CTRE has worked with the DOT on several remote sensing projects. Projects include:

- Assessment of aerial photography for parking and travel demand validation
- Assessment of aerial photography for collecting data elements for our linear referencing system
- Assessment of stereo video logging imagery for identifying roadside features
- Assessment of aerial/satellite for collecting inventory and access management
- Assessment of LiDAR for location studies and preliminary design
- Assessment of LiDAR for highway safety studies, bridge and culvert flooding risk and pavement performance evaluation

Mississippi State University – Mississippi State University and the Iowa DOT are cooperating in a hyper-spectral remote sensing research experiment. The objectives of the research focus on helping solve environmental issues using remotely sensed hyper-spectral data. Of particular interest are wetland related issues frequently encountered during the development of transportation corridors.

IMAGERY PURCHASE ISSUE PAPER SUMMARY SHEET

I. Issue

Participation in purchase of up-to-date remotely-sensed earth imagery data.

II. Indication Of Issue's Existence

Imagery presently used is outdated (1991). Current, up-to-date data are needed for applications and to take advantage of newer technologies.

III. Other Background Information

Examples and users of identified categories of imagery uses include, but are not limited, to:

- Analysis and evaluation: corridors; accident locations; discovery phase applications
  - Traffic Engineering, Transportation Planning, Design
- Data validation: state system, non-state system, and rail networks; GPS points
  - Transportation Planning, Design: Coordinating, Traffic Engineering
- Data capture: networks, inventories
  - Transportation Planning, Local Projects, Design: Coordinating
- Visualization tool for public involvement, litigation
  - Public Involvement, Chief Counsel

Selection criteria for imagery purchase, all of which impact cost, can include:

- Capture device (type of camera) and source (airplane v. satellite)
- Spatial resolution (how fine of detail is the image)
- Accuracy (how close is an object in the image to its actual location)
- Age of data and update and maintenance schedule
- Type of imagery (black-and-white v. multispectral)
- Size (area of coverage)
- Storage location (data storage and serving of data will occur at DASC)
- Licensure / ownership / distribution
- Value-added services (geocoding, orthorectification, network digitizing)
- Cost sharing with others participating via the GIS Policy Board)

IV. Options

1. Use 1991 imagery data and use traditional methods to fill data gaps.
2. Elicit Requests For Proposals (RFPs) from vendors (GIS Policy Board).

V. Recommendations

Option 2.

VI. Fiscal Impact

Cost ranges from $1.3 million to $8.5 million. KDOT share would be 50% of total cost, not to exceed $650,000 for initial purchase. The other 50% would be provided by GIS Policy Board and from non-Kansas sources such as National Aerial Photography Program (NAPP), Natural Resources Conservation Service, and the United States Geological Survey.

VII. Policy Impact

Positive impact to KDOT will be realized. The enterprise approach provides opportunities for use of a common, standardized data source for unified GIS development, applications, and solution-building and could yield the synergy that results from a collaborative effort.

REPORT FOR THE DECEMBER 2001 –TRB/NCRST MEETING

In late 1999, the Maine Department of Transportation (MDOT) started working with Technology Service Corporation (TSC) in the Commercial Technology Applications Program in Support of the Department of Transportation Program on Remote Sensing Applications in Transportation (DTRS56-00-BAA-0005). The partnership was created to investigate remote sensing applications that could assist the Maine DOT in determining alternative route location possibilities for new highways and also to automatically update road networks within the GIS system using remotely sensed information.

The primary research involves the automation of route location analysis and cost estimation done by highway engineers when determining corridors for new highway location studies. Currently MDOT uses traditional methods of route determination. These methods are time consuming and labor intensive and involve the possible use of USGS quad sheets, aerial photogrammetry, national wetland information and other existing paper and electronic data. TSC's research involves the use of current IKONOS imagery, USGS DTED's, and National Land Cover information. Aerial photographs and specific user cover layers can also be incorporated into the program that has been created. A result of the work that Steven Jaroszewski and the team at TSC have done to date, is an astonishing program that can automatically generate highway corridors using the above mentioned layers and cost estimates for constructing the highway, purchasing the right of way rights, mitigating wetlands and building bridges.

MDOT provided TSC basic information about the existing Brewer/Holden I-395 extension project that is being developed traditionally by MDOT and their consultants. TSC was shown the take off point and was tasked with providing highway alternatives that would either upgrade the existing highway network or create a new highway connecting I-395 to Route 9. During a recent presentation to MDOT, Steven Jaroszewski of TSC was able to automatically generate highway corridors using the software developed that very closely resembled corridors that took the consultant engineering firm months to develop. In addition to the corridors, the program also generated cost estimates for each alternative. When MDOT changed parameters of the base information, the program was able to create new data within minutes. The results of this research could revolutionize the way highway location studies are accomplished in the near future. Mr. Jaroszewski will be presenting the results of the study during this TRB/NCRST meeting.

MDOT is also involved with using Airborne GPS Photogrammetry for all of its new photogrammetric mapping projects and using aerial photography layered with design data for public hearings. The photogrammetry unit is working with the public hearings unit to merge USGS DTED data, detailed survey and design information, graphic information and aerial photography to create drive thru and fly over presentations for public hearings about planned highway construction. The department has investigated the use of close range laser survey technology for bridges and is currently looking into the potential of close range digital photogrammetry for bridges. The photogrammetry unit has begun to look towards LIDAR information for a large project that needs digital terrain data only to study the hydrology.

The Utilities section of MDOT is working on a Subsurface Utility Engineering (S.U.E.) pilot project to accurately identify the location of underground utilities. As a side benefit, they were able to verify the accuracy of Ground Penetrating Radar (GPR) that was demonstrated within the limits of that same project a couple weeks ago. The data is now being processed and the reference points are being located by Survey. Shallow gas and telephone lines were among the findings. In several areas, the consultant doing the S.U.E. pilot project showed where the marks provided by the utility, or their contracted locator, were off by several feet.

TRB

TRANSPORTATION RESEARCH BOARD
REMOTE SENSING and SPATIAL INFORMATION TECHNOLOGIES FOR TRANSPORTATION

STATE DOT TECHNOLOGY EXCHANGE MEETING

MINNESOTA DEPARTMENT OF TRANSPORTATION
SURVEYING AND MAPPING SECTION
PHOTOGRAMMETRIC UNIT

PROGRAM & FUNDING for REMOTE SENSING and SPATIAL INFORMATION.

- Minnesota is experiencing a program spike due to special funding for Inter-Regional Corridor (IRC) initiatives. In FY 2001 $3.0 M was invested in photogrammetric products and services. It is anticipated that $2.8 M will be invested in FY 2002. Internal MN/DOT resources consume approximately 30 – 34% of this budget: the balance is outsourced to private partners.

NEW INITIATIVES and DRIVERS.

- MN/DOT continues to migrate from analytical to digital photogrammetry. Three soft copy workstations have been added to the equipment arsenal in the last 24 months (1 Z/I Imagestation IV, 1 LH Systems DPW (NT) and 1 Z/I SSK system). Orthophoto production now accounts for almost 25% of MN/DOT's photogrammetric product market. MN/DOT will make another significant investment into digital photogrammetry in the next 90 days by purchasing a photogrammetric scanning system.
- Coarse DEMs are being introduced to hydraulic, planning and preliminary design personnel. MN/DOT has completed 13 DEMs utilizing LIDAR technology. Test data for these projects are anticipated this winter (in accordance with NSSDA standards).
- MN/DOT IT support staff has recently installed a multi-terabyte server with fiber links to two of the digital workstations to satisfy the large memory appetite of digital projects. The next installation of fiber links to mass memory will be added to the scanning system and SSK system.

SUCCESSFUL STRATEGIES.

- MN/DOT is currently outsourcing a larger portion of work to private partners to meet current program delivery expectations. Senior technical personnel within the photogrammetric unit have been realigned into a new Technical Specialist class and are helping with overseeing the consultant program. The new technical specialist positions are primarily technical, with added project management duties.
- MN/DOT has recently produced a "product poster" to educate users about current photogrammetric products that are available, including information regarding accuracies, costs and lead times of these products.

PARTNERSHIPS.

- Countywide Orthophoto and a DTM to support a 2' C.I. in Washington County.
- Opportunities in Ramsey, Hennepin, Olmsted, Chisago and possible other counties in Minnesota.
- Minnesota DNR has recently brought together many government agencies in Minnesota to investigate the idea of developing a Minnesota 2' Statewide DEM. This initiative is still very preliminary; but could have huge positive implications for photogrammetry and remote sensing in Minnesota. A statewide 2-4' DEM would open the door for many remote sensing projects that are currently cost prohibitive or too intimidating to potential users.

BARRIERS to IMPLEMENTATION.

- Funding. Decision makers that are in the "heat" of the program delivery battle control funds for photogrammetric products. The "process" forces decision makers to worry about today's program and not potentially be aware of the benefits of investing in products that could help future projects. Also, "Facilities Management" needs are perceived lower priorities than "Program Delivery" needs.

USER ISSUES.

- The MN/DOT Photogrammetric Unit is currently designing a "corridor mapping" strategy in lieu of the existing "project specific program". The concept would propose aerial photography collection at the corridor level and assembly of products that would be of value to facility management, GIS, planning and preliminary design personnel. The corridor-wide products would be designed to carry MN/DOT through the construction limit phase of a project and would also be suitable for detail design mapping (with additional vertical control). The big picture is to have a product on the shelf in probable locations to establish construction limits and allow concurrent production of detail design level mapping. The increased investment would minimize project startup time and allow photogrammetric data to be used by other disciplines before the terrain is changed and the aerial photography becomes outdated.

Anyone wishing for further details about the items discussed, should contact Mike Leegard, MN/DOT Photogrammetric Engineer at (651) 296-1079 or mike.leegard@dot.state.mn.us .

Thanks Mike L… 12/3/2001.

December 10, 2001

Highway Design Branch
Photogrammetry Unit

REPORT TO THE STATE DOT REMOTE SENSING EXCHANGE MEETING

The NCDOT is participating in USDOT Project DTR56-00-T-0011 entitled "Airborne Sensor Fusion: A Fast-Track Approach to NEPA Streamlining and Environmental Assessment" with private and university sector partners. EarthData International is coordinating the study effort and has partnered with NCDOT, ITRES Research Limited, and Mississippi State University. The goal of the study is to demonstrate where remote sensing technology can be used to expedite environmental studies, transportation planning, preliminary design, and permit approval.

Remote sensing techniques employed in the study included: acquisition of hyperspectral image data, acquisition of GPS/IMU controlled B/W film aerial photography, and acquisition of LIDAR terrain data. ITRES Research Limited acquired 14 band one-meter resolution and 11 band 60-centimeter (cm) resolution hyperspectral image data using their Compact Airborne Spectrographic Imager (CASI) system in June 2000. EarthData International acquired "leaf-on" LIDAR terrain data in June 2000, and "leaf-off" LIDAR terrain data and GPS/IMU controlled aerial photography in March 2001. Mississippi State University is fusing several of the data sources in an effort to delineate wetlands for the project study area.

Product deliverables include 25-cm resolution digital B/W orthophotography; one-meter resolution natural color, color infrared, and classified digital orthophotography; bare earth LIDAR terrain data; GPS/IMU control data for the B/W aerial photography; and wetland delineation based on the classified hyperspectral imagery and collateral sources.

NCDOT's role in the study was to provide in-kind contributions for analysis and evaluation of the deliverable products. NCDOT selected Transportation Improvement Program (TIP) Project R-2606 in Randolph County near High Point for the study project. At the time discussions began to undertake this study, the R-2606 project corridor had been selected and preliminary design was nearing completion. Topographic mapping was available to use in the data evaluation process, and surveys for final design for each portion of the project were being scheduled. Field wetland delineation data had already been collected and was also available for comparison. Much of this data was utilized in the deliverable product evaluation.

EarthData International delivered the majority of the products in late September 2001. NCDOT staff has concentrated their efforts performing tests of the bare earth LIDAR terrain data using ground and photogrammetric survey data for comparison. Some results of these comparisons are: approximate 12-15 cm elevation bias and 11-13 cm elevation random error on natural ground surface; approximate 34-44 cm elevation bias and 3-6 cm elevation random error on paved roadway surface; contouring with bare earth LIDAR terrain data is improved with breakline data; and bare earth LIDAR terrain data volumetric quantities match final mapping quantities within 2% for an 11,000 meter segment of the R-2606 project.

Mississippi State University has been using the classified hyperspectral imagery, hydrologically corrected terrain data, and soils data to predict wetland locations. The work on this portion of the project is still underway. NCDOT's goal for the study was to obtain vector wetland delineation polygons from these remote sensing techniques. This has not been realized to date.

Issues that NCDOT sees with using LIDAR terrain data for transportation preliminary design involve understanding its accuracy over different surface covers and conditions, computing and storage issues, and the cost scalability to typical transportation corridor study size projects.

Other remote sensing activities in North Carolina include the NC Floodplain Mapping Program (NCFMP). The NCFMP is a multiyear program to produce Flood Insurance Rate Maps (FIRMs) statewide. The State of North Carolina, through the Federal Emergency Management Agency's (FEMA) Cooperating Technical Community partnership initiative, has been designated as a Cooperating Technical State, meaning that North Carolina will assume primary ownership and responsibility for its FIRMS.

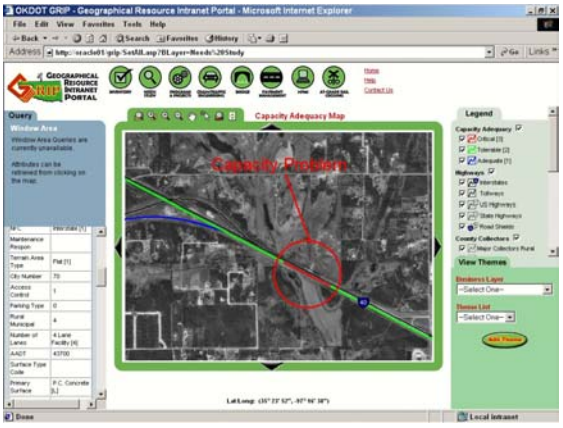
As part of an overall program to update and maintain FEMA Flood Insurance Rate Maps, the NCFMP has employed LIDAR technology and conventional photogrammetric survey methods to collect, process, and conduct quality control on full coverage, statewide, elevation data. The work is prioritized by river basins, of which there are seventeen in North Carolina. LIDAR data has been collected in six eastern river basins and is currently being processed and validated for accuracy. This territory is approximately 24,000 square miles and includes the following river basins: Lumber, White-Oak, Tar-Pamlico, Cape Fear, Neuse, and Pasquotank. Delivery of the initial data is expected to occur over a period of several months beginning in January 2002.

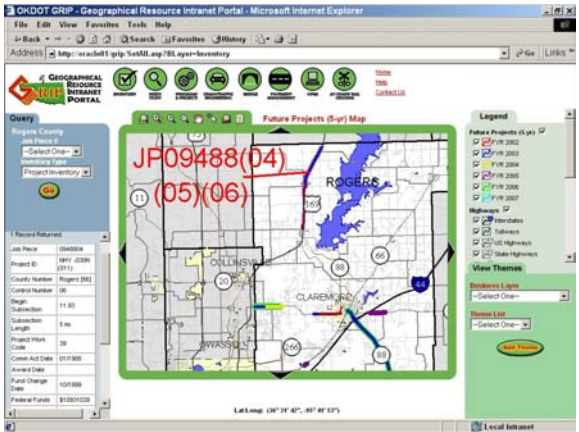
Collection of elevation data for subsequent river basins is subject to continuing state budget appropriations and/or cost share contributions from other sources. The map on the below illustrates the original planned phases of LIDAR collection for the Floodplain Mapping Program.

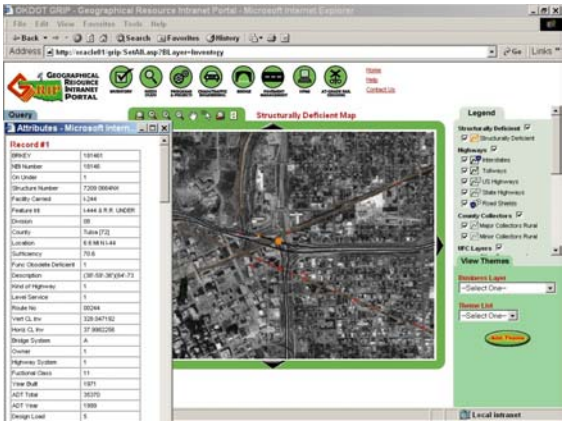
GRIP is a web browser application that provides easy access to ODOT business data through a map interface. GRIP is being developed as a three-year project with the first year focusing on eight different business layers, thirty-two different map themes and statewide access to digital imagery. GRIP is an intranet application and therefore is only available to users with access to the ODOT computer network.

GRIP was developed to provide a single source whereby transportation professionals could retrieve information needed to make better decisions. The geographical component of GRIP helps to quickly visualize relationships between data and projects. The GRIP application will enable quick responses to internal and external information requests by providing easy access to information, maps and digital imagery.

GET A GRIP ON OKLAHOMA'S TRANSPORTATION INFORMATION







COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION
H.I.A., Bldg. 28
Middletown, PA. 17057

December 10, 2001

Transportation Research Board – Remote Sensing and Spatial Information Technologies for Transportation

PENNDOT

Bureau of Design - Photogrammetry & Survey Division

- Working with NGS to develop Harrisburg International Airport as a test site for LIDAR.

Geodetic Surveys

- Operate four CORS sites and installing two new sites. This will give us statewide coverage.
- Setting up a test Virtual Reference System south of Pittsburgh. If preliminary testing goes well the system will be expanded statewide.
- In the past two years have outfitted all District survey crews with RTK-GPS, robotic and reflectorless total stations.
- Operating two Cyrax scanners to provide the state with high density 3D modeling capabilities of difficult to survey structures and land features such as expansive bridges, rock face walls, historical buildings and limited roadway surfaces.

Administration

- We have completed phase two of five phases of our web-based archival and project management system. This will provide our customers an easy access to our photo and survey information.

Web site www.penndotpams.org
Login: user
Password: pams

DCNR

- As part of the National Map Project with USGS TopoGeo is putting together a seamless digital map at 1:2400, 2' C.I.
- Working with NASA to start a LIDAR/RADAR project.

DEP

- Purchased colorized 10m SPOT data.

Respectfully,

L. Bradley Foltz, P.L.S.
Chief - Photogrammetry and Survey Division
Bureau of Design
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Transportation Data Related Projects in Utah

Utah has a long history of collaborative development of geographic information related to the State's transportation infrastructure. The goal has always been to cooperatively develop and share the best (most accurate, current, and complete) information about transportation related themes. This long-term effort was further defined and focused in the Data Sharing Memorandum of Understanding signed by Governor Leavitt and nine federal agencies in October of 1998. This MOU specified that "the participating agencies agree to share data for mutual benefit, in order to minimize duplication of efforts and expenditures, and to enhance intergovernmental cooperation". Below are listed the current projects which contribute to the ultimate goal of a comprehensive transportation database for the state.

1:24,000 Single Edition Quad Mapping: In 1995, the State of Utah and the US Geologic Survey signed an agreement to cooperatively fund the development of a transportation data base for the state derived from published 1:24,000 maps. The Forest Service has since joined this collaborative effort. Initially all 1540 quad sheets were digitized. Because these published maps average 23 years old, a revision process was began in 1998. Revisions are being done using Digital Orthophoto Quads and NAP photography. Approximately 700 quads have been revised to date. Starting with the revisions done in 2000, GPS data acquired by the counties were incorporated into the product. The Forest Service is currently working directly with the counties to include roads they have GPSed that are to be shown on future published maps.

RS2477 Inventory Project: Starting in 1999, the counties have been funded to participate in the RS2477 Rights-of-Way inventory and mapping project. Although a few counties had begun prior to receiving funding, the majority of the work has been done over the last three years. Almost $3,000,000 has been distributed to the counties so far. All rural counties have received funding to purchase necessary equipment, hire additional personnel, and receive training and technical assistance. In return, they are to create data compliant with the Utah Transportation Data Model and make that data available to the SGID for general state uses. The counties have been focusing on the class B and D roads, which make up the majority of the roads in rural counties.

Federal Aid Eligible Routes: The Utah Department of Transportation distributes funds for class B and C roads in Utah. The counties submit reports annually for their share of these funds. UDOT spot-checks reports by GPSing some of the routes, but typically complete coverage within small areas. UDOT has completed GPSing several hundred miles of B and C roads, which they will make available to AGRC for other related projects.

State and Federal Routes Mapping: The Utah Department of Transportation has GPSed all state and federal routes (Class A) in the state. They will make this available to AGRC for related projects. These represent approximately 10,000 miles of the estimated 125,000 miles of roads in the State.

County 1:100,000 Sheet Maps: The Utah Department of Transportation maintains 96 cartographic products, at 1:100,000 scale, representing the roads in the state. These maps

currently use the transportation features from the SGID but UDOT would like to start incorporating the GPSed data from the counties and the cities.

BLM Resource Management Plans: The Bureau of Land Management was appropriated $19,000,000 nation-wide to update their Resource Management Plans (RMPs). Several of these are in Utah covering all or parts of our east central counties. Next year, the BLM will move to resource management areas south and west from these. Part of the planning process includes improving the GIS data used by the BLM for this effort. They are currently working with the counties to procure the best available transportation data for these plans.

National Map Pilot Project: The US Geological Survey has initiated a new program to develop a national database for framework layers including transportation. We will identify one urban (Salt Lake) and one rural (Grand) county to participate. The goal is to transactionally update this national database from data generated by state and local entities as change occurs. This database will be the primary source for all federal agency geographic information needs.

TIGER Modernization: The Census Bureau is beginning a process to increase the accuracy and currency of their TIGER database. Again, because of Utah's lead in digital transportation data, we have been asked to participate as a pilot on this initiative also. They have asked us to identify one county that has complete road coordinate and attribute data that they can use to test their modernization and attribute conflation processes.

State-wide Addressing Project: This is the most comprehensive of all current transportation related activities in the state. The State of Utah, Blue Stakes, the Bureau of Census, U. S. Department of Transportation, Utah Department of Transportation, and Comprehensive Emergency Management have initiated an effort to create a high accuracy road centerline (with addresses) database for the State. This will initially be used for an application for utility companies "one-call" notification. We also anticipate a subsequent use to aid local E911 efforts. There is no central source for E911 data coordination within the State of Utah. Due to the method of funding distribution, local E911 providers develop their own standards and procedures. Currently there are no standards for addressing or geographic data needed for emergency vehicle routing. This project, funded by USDOT and the State of Utah, will use the most accurate road coordinates available, fully attributed to the Utah Transportation Data Model. It will benefit the One Call system, E911, wild fire efforts, and many other applications of a complete transportation database.

December 3, 2001

Virginia Department of Transportation
Report to the Transportation Research Board

Remote Sensing and Spatial Information Technologies
For Transportation
State Dot Technology Exchange Meeting

The Virginia Department of Transportation (VDOT) formed its own photogrammetric unit in 1957. Since those early days, and for the past forty-plus years, the department has operated a very traditional photogrammetric unit. Remote Sensing techniques have been incorporated in our everyday activities since 1957. Today, VDOT utilizes satellite and airborne imagery for many of its projects and has recently employed LIDAR as another remote sensing tool.

The department's survey unit initiated it's first LIDAR project in 1998 to determine the adequacy of this data for a route location study. The project was located in the mountainous and heavily wooded terrain of southwest Virginia. Due to the steepness and ruggedness of the terrain, GPS-controlled photography was utilized to produce stereo models that were used to quality check the LIDAR data. Photogrammetric breaklines were added for all major and some minor breaks, and LIDAR spots edited as necessary. The majority of the data was LIDAR derived. Field cross sections were secured in areas that were not visible by photogrammetric methods.
(See the attached report for project 0058-095-E12, C501).

The survey unit's second foray into LIDAR was for another route location study in the southwestern portion of Virginia. This project, which covered 60 square miles, was initiated in the summer of 2000 and utilized LIDAR in conjunction with airborne GPS controlled photography for editing. Requirements included digital orthophotos and a digital terrain model that would support 4' contour accuracy. The DTM data, which was field checked, met the accuracy requirements of the mapping project. (See the attached report for project 0077-098-104, PE100).

The department has just completed two more LIDAR projects near Williamsburg, Virginia. One project was to determine the best approach to widen Interstate 64 from four to six lanes in the historic Williamsburg area, while the other was for the final design of a nearby section of I-64. For the final design project, airborne GPS-controlled photography was utilized to produce stereo models that were used to quality check the LIDAR data. Photogrammetric breaklines were added for all major and minor breaks. Field survey breaklines were added for hydraulic features. LIDAR spots were closely reviewed and edited within VDOT right-of-way. Ninety percent of point-only data was LIDAR derived. Twenty field profiles were read to verify the accuracy of the LIDAR/Photogrammetry data. Detailed quality reviews are currently underway to determine if this data meets accuracy requirements for final design. (See the attached reports for these two projects along I-64).

VDOT will continue to evaluate the latest remote sensing techniques and then determine their role in supporting the department's massive transportation program.

Donald W. Little
Program Manager
Surveys and Photogrammetry

LIDAR Project Summary.doc

Virginia Department of Transportation
Remote Sensing and Spatial Information Technologies for Transportation
December 2001

1. Virginia Transportation Research Council and Virginia Commonwealth University have joined together on a research project. The goal is three fold:
    a. Test technical feasibility of using multi-spectral imagery for monitoring wetland mitigation sites and areas affected by the presence of acidic soils.
    b. Educate state and federal regulatory agencies on capabilities and limitations of this approach
    c. Acquire regulatory approval

   Results: (a) was completed successfully and (b) and (c) are in process.

2. VDOT is a new Technology Application Project (TAP) in conjunction with NCRST-E and Mississippi State University. The goal is to demonstrate how the use of multi-spectral imagery can be incorporated into an enterprise GIS and automated as a viable planning tool for environmental assessment. The subject area is wetland identification for proposed construction sites. The end result will be a "cookbook" methodology for potential use by other DOTs.

3. VDOT is starting the third year of a three-year effort to acquire and implement a new, more accurate and comprehensive statewide centerline file. Digital orthophotograhy is used extensively for quality assurance and in some cases (where available) data collection. This involves many data sources including local GIS data and digital orthophotography, but primarily data collection is undertaken using a van equipped with GPS and inertial navigation collecting photolog information every hundredth of a mile. This data is then developed into centerlines using terrestrial photogrammetric techniques.

4. At the state agency level, Virginia has a Request For Proposal on the street to fly the entire state at a 1":200', 1":400" scale. VDOT is being consulted for technical specifications as well as being asked to serve on the selection committee

5. VDOT sees tremendous potential in the use of remote sensing for asset management. We will be following the results of these partnerships and may be interested in pursuing this further.

Washington State Department of Transportation (WSDOT)
State DOT Technology Exchange Report
Transportation Research Board
Remote Sensing and Spatial Information Technologies for Transportation
December 10, 2001

Current Programs and Funding:

The agency supports substantial in-house aerial photography, geodetic survey, and photogrammetry programs that generate all revenue through the sale of products and services, at cost, to customers within WSDOT, other government agencies, and the public. Most work comes from highway and modal projects, and typically consists of flying a data collection mission, creating any needed geodetic control network points, then processing the data into 3D Microstation design files and high resolution orthophoto mosaics used by project engineers. Photogrammetry is now 100% softcopy and airborne GPS is used with the aerial photo platform.

The Washington Remote Sensing Consortium is cooperatively acquiring Landsat7 data from EROS for the entire state. The funding is arranged as an annual subscription, then the "bank account" is used to acquire regular updates. Current rate is $5000 per agency, with 16 or 17 federal, state and local or tribal partners. EROS is currently producing the first dataset. The group is associated with a similar national organization.

New Initiatives and Drivers:

The Environmental Affairs Office has become one of USDOT's Technology Application Project partners with cooperative funding to compare the costs and benefits of using remote sensing technologies for environmental information development versus traditional methods within a highly urbanized corridor under going programmatic National Environmental Policy Act evaluation. Image fusion will be used to create land use / land cover information from Landsat7 and high-resolution orthophoto data. The $150,000 USDOT contribution is part of a total $438,000 effort.

The Environmental Permit Streamlining Act (2001) directs the state environmental regulatory agencies to work with WSDOT to improve the permitting process (www.wsdot.wa.gov/eesc/environmental). Using best available information is key to this process. WSDOT is partnering with other statewide efforts to sponsor information sets that fill information gaps. These data are often required by regulatory agencies to get permits approved. This investment in data gets WSDOT credit toward environmental protection. Remote sensing is a key data source and technology for developing several needed information sets such as current land use and land cover, the built environment and other watershed characterizations. It's advantages are currency and spatial extent (statewide consistency). Most success is expected during early environmental documentation processes such as programmatic corridor analysis. At the project site-specific stage remote sensing is more challenging - data collection costs and processing time don't fit into the project schedule, and/or the technology has problems in certain local site conditions.

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