

**1994**  
**GEOGRAPHIC INFORMATION SYSTEMS**  
**FOR TRANSPORTATION (GIS-T)**  
**SYMPOSIUM**

**D. David Moyer**

**Norfolk Waterside Marriott**

**Norfolk, Virginia**

**April 11-13, 1994**

**I. INTRODUCTION**

The seventh symposium on Geographic Information Systems for Transportation (GIS-T) was held in Norfolk, Virginia April 11-13, 1994. A list of the dates and locations of earlier symposia can be found on the inside of the back cover of this report. The 1995 GIS-T Symposium will be held in Reno, Nevada on April 2-5, 1995.

This summary report provides an overview of the activities that took place at GIS-T 94. In addition to this summary report, a proceedings containing many of the papers presented at the 1994 symposium has been prepared. The proceedings are available from:

American Association of State Highway and Transportation Officials (AASHTO)  
Attn: Jack Stanton  
444 North Capitol Street, NW  
Suite 225  
Washington, DC 20001

The cost is \$25.00. A complimentary copy has been provided to all registered attendees.

The remainder of this summary report is laid out as follows. Section II describes the background for GIS-T 94. Section III provides an overview of the symposium and how it was organized. Section IV contains a summary of the plenary sessions and an outline of material contained in the concurrent sessions. Section V provides a listing and brief discussion of the major transportation GIS issues identified at the conference. These issues, summarized in the final plenary session of the symposium, are intended to provide a guide for planning future symposium programs, suggestions for research needs in the GIS-T arena, as well as suggestions for future activities that individual states and transportation agencies may wish to undertake.

## **II.BACKGROUND**

The 1994 GIS-T Symposium is the seventh in a series of conferences that have now become a regular, annual event. The GIS-T conferences focus on opportunities for the application of GIS technology to transportation agencies and the problems they face. Sponsored by AASHTO, the symposium is co-sponsored by five supporting organizations and agencies: the Highway Engineering Exchange Program (HEEP), the Urban and Regional Information Systems Association (URISA), the Federal Highway Administration (FHWA) in the U.S. Department of Transportation, the Transportation Research Board (TRB), the Alliance for Transportation Research, and the National Association of Regional Councils (NARC). The symposium is intended to provide:

- education
- information sharing with other transportation agencies
- vendor displays of current technology available
- information as to individuals who are facing similar problems in other states.

Pre-conference workshops have been part of the GIS-T Symposium for several years. Until 1993, these workshops focused on providing an introduction to geographic information systems for transportation. In 1993, two pre-conference workshops on more advanced topics were held. Again in 1994, two intermediate workshops were held. One workshop dealt with the role of GIS-T in integrated transportation systems, with David Fletcher and Myron Bacon as instructors. A second workshop, on linear referencing systems and dynamic segmentation as a data base design and implementation issue, was led by Simon Lewis and Roger Petzold.

In addition to plenary sessions each day, four paper sessions ran concurrently during the remainder of the day. Subject areas for these four session groupings included:

- Management and institutional issues
- Technical issues
- Data and database issues
- Applications

The program organized around these topical areas included sessions on: databases and database design and creation, systems planning and integration, transportation GIS applications, transportation planning and modeling, management issues, integration and sharing of data, GIS-T support for transit systems, real time visualization, temporal dimension of GIS-T, Global Positioning Systems, and national initiatives (including the National Highway System).

### **III.SYMPOSIUM STRUCTURE**

GIS-T 94 began with two one-day pre-conference workshops. About 140 people attended the workshops, down slightly from 1993 attendance. The workshop evaluations indicate that workshop content should continue to focus on intermediate and more advanced topics.

The symposium itself ran for two and one-half days, from Monday morning through Wednesday noon. The 425 attendees came from 44 states and the District of Columbia, 3 Canadian provinces, and 2 countries outside North America. Total attendance leveled off this year, after increasing by about 25 percent in each of the last two years.

In addition to state and provincial departments of transportation, attendees represented federal agencies, non-transportation state agencies, metropolitan planning organizations (MPOs), universities, and numerous vendors of hardware, software, and related services. Interest in GIS-T use in the transit area continues to increase, with additional 1994 presentations and attendees with transit as a primary interest.

A sold out exhibit hall, with 33 booths provided displays for 20 companies to display their latest offerings throughout the conference. The number of exhibitors increased slightly over 1993, with space being a limiting factor once again, as it was last year.

Attendees had opportunities to visit vendors during morning and afternoon breaks, as well as during luncheon periods. In addition, receptions sponsored by the vendors were held in the exhibit area on

Sunday, Monday, and Tuesday evenings. Both attendees and exhibitors indicated that the exhibit show is a strong and important part of GIS-T conferences.

A continuing emphasis of the symposium is to facilitate informal interaction among participants. In addition to the breaks and lunch periods, a reception and banquet on Monday evening and a dinner cruise aboard the Spirit of Norfolk on Tuesday evening provided opportunities to visit with colleagues in similar situations facing common problems.

### Formal Program

The formal program of the symposium contained a mix of both plenary sessions and concurrent sessions. The program opened each day with one or more plenary sessions, with topics of general interest to all participants. During the remainder of the day, four or five concurrent sessions were on-going, providing attendees the opportunity to select sessions and speakers that were of greatest interest to them. In total, the program included four plenary sessions and twenty-two concurrent sessions. Concurrent sessions were expanded by 10 percent in 1994, in an attempt to at least partially accommodate the large increase in the number of abstracts submitted for proposed presentations. In spite of the increased number of sessions, the program committee still found it possible to only accept about 50 percent of the proposed abstracts. During the conference, 70 speakers made formal presentations in sessions presided over by 26 moderators.

As part of the direction given to moderators before the conference, all moderators were asked to prepare and present a short summary of issues that were raised and/or discussed during their session.

These summaries were presented during the final plenary session on Wednesday morning.

Therefore, rather than being summaries of the concurrent sessions, these issue summaries were intended to indicate the current status of GIS-T and provide direction for future research, education, and conference programs for GIS-T. Highlights from these summaries are included in Section IV of this report.

Attendance at GIS-T 94 was up less than 5 percent over 1993, but never-the-less was at an all-time high. Based on an analysis by the program committee and a review of the conference speaker evaluation survey, the content of GIS-T continues to improve in quality and usefulness to the participants. Plans are already underway to provide the support necessary to continue this trend at next year's meeting in Reno, Nevada. Also, because the size of the conference is making it more difficult to find suitable meeting space, the Steering Committee is working on multi-year plans to cover future conferences. Following Reno, Nevada next April, tentative plans have been made to hold the 1996 conference in Missouri (probably in conjunction with Kansas and Nebraska), the 1997 conference in North Carolina, and the 1998 conference in Utah. Of course the out years are contingent on space availability and sufficient host state support.

## **IV.SUMMARY OF PRESENTATIONS AND ISSUE IDENTIFICATION**

### Pre-Conference Workshops

Two workshops were held immediately preceding the conference. Workshop I was an intermediate

level workshop presenting a strategic view of integrated transportation information systems. Led by David Fletcher and Myron Bacon, the workshop included the following material on defining and managing the next generation of transportation computing systems:

- why integrated transportation information systems (ITIS) are important
- a new vision for ITIS
- a strategic framework for ITIS
- creating the ITIS framework

Workshop II was on linear referencing systems and dynamic segmentation, led by Simon Lewis and Roger Petzold. The outline of the material covered in workshop II is as follows:

- introduction of spatial data and location reference systems
- linear referencing systems
- top level review of GIS-T
- concepts and techniques of dynamic segmentation
- comparison of alternatives used by three state DOTs
- relevant work in FHWA
- Future developments in dynamic segmentation

Both of these workshops were intended to provide material needed by system developers and users as the GIS-T system in their agency matures.

#### Day 1 - Symposium Program

The first plenary session was scheduled for the entire morning of day one. Plenary I was devoted to a roll call of states, provinces, MPOs and other attending agencies. This session (along with similar sessions held at each GIS-T symposium) provides an opportunity to learn about the status of GIS-T programs throughout the country, as well as progress that has been made in the last year.

To facilitate this session, a form was prepared and mailed to registrants before the conference, outlining the kinds of information that most attendees would like to know about each state, province, MPO, or other agency (see Appendix A). Additional detail, in the form of a matrix table, is available from:

Diane Pierzinski  
California DOT  
1120 North St., Room 4400  
Sacramento, CA 95814

Among the conclusions gleaned from the oral and written summaries from this session are the following:

Forty-three state, provinces and the District of Columbia provided responses to the request for written information. In addition, one country in addition to the U.S. and Canada provided a

response, along with several federal agencies, regional councils and commissions, cities, municipal planning organizations (MPOs), and councils of governments (COGs).

In the states and provinces, Intergraph hardware still dominates, with over half of the jurisdictions reporting this hardware vendor. Over one fourth of these jurisdictions reported they have combined Intergraph hardware with PCs as well. DEC was the second most frequently reported hardware platform.

Arc/Info and MGE software (by ESRI and Intergraph, respectively), continue to be dominant in state and province DOTs. However, other packages were also reported more frequently than last year, with GDS, in-house, Microstation, MAPINFO, GIS PLUS, and Arc/View also being reported.

The number of PCs and workstations varied widely among the states and provinces.

10 or less	15
11-19	5
20-49	5
50-99	5
100-249	2
250 and over	2

Nearly two-thirds of the reporting jurisdictions report less than 20 PCs and workstations devoted to GIS-T activities. Some of those states and provinces in the higher frequencies seem to have moved toward an agency-wide approach to the handling and use of spatial information.

Stage of GIS development in transportation agencies continues to vary widely, from just beginning to operational to starting over. This variation is also reflected in budgets and staff dedicated to GIS-T activities. Budgets ranged from zero to seven million dollars.

Less than \$100,000	1
100,000-249,999	5
250,000-499,999	4
500,000-999,999	6
\$1,000,000 or more	6

Likewise, number of staff devoted to GIS-T varied widely among the state and province DOTs reporting.

1	4
2-3	6
4-5	4
6-9	11
10-19	3
20 or more	4

Over three-fourths of the agencies reported less than 10 staff devoted to GIS-T.

Job classifications continue to vary widely, with only five states reporting the use of the term "GIS" in position descriptions, the same number as reporting in 1993. Other commonly reported classifications were cartographer, engineer, planner, system and program analysts, and information resource specialist. The lack of attention to development of specific "GIS" job titles and position descriptions appears likely to continue to result in relatively high turnover rates in many transportation agencies.

Nearly all states and provinces indicated that GIS activities are located in one or more divisions or bureaus at the state or province headquarters. A few jurisdictions reported distributed GIS activities throughout their jurisdiction.

#### MPOs, Cities, Regional Commissions, and COGs

Eleven municipal planning organizations, cities, regional planning commissions, and councils of governments reported on the status of their GIS efforts. Nearly 90 percent of these jurisdictions reported PC-based systems, with one report each for RISC and Intergraph hardware. Software used was split about equally among Arc/Info, GIS Plus, and software developed in house. Number of seats ranged from one to eight and staff ranged from one to seven. GIS was used more often in job descriptions than was the case with states and provinces, with about 40 percent reporting such use.

#### Base Maps

Thirty-two states and provinces reported the existence of statewide base maps. Nearly two-thirds reported a map scale of 1:24,000, with the other third reporting a 1:100,000 scale. About 15 percent reported that multiple scales were being used for base maps, with 1:24,000 and 1:100,000 being the most frequently based scales reported.

Forty-nine applications were reported by roll call presenters. The great majority of applications were reported only by one or two jurisdictions. Applications reported by four or more states and provinces included (in order of frequency of reporting):

- mapping/display
- planning
- accident
- ISTE A
- environmental
- facilities management
- noise barriers
- project tracking
- traffic operations
- transportation planning

Obtaining and keeping funding and GIS staff continues to be a major issue in many jurisdictions. The ISTEA legislation has added needed support to GIS activities in several states. However, added competition for trained employees from other agencies and other levels of government also is causing difficulty for many states. Statewide GIS legislation in some states is helpful to publicize needs and focus support needed for GIS activities.

The afternoon of Day 1 was devoted to a series of concurrent sessions, the content of which is described later in this document.

## Day 2

The Tuesday morning plenary session featured two keynote addresses. Larry Ayers, the Executive Vice President of Intergraph Corporation made a presentation on Decision Support and Technology in a Rapidly Evolving World.

Ayers and his co-author Clifford Kottman suggest that in trying to do more work with less resources, we tend to acquire more and more data, in an attempt to bridge the resource gap. However, they argue that lack of standards results in information being less useful than it could be -- meaning that the support available for decision-making is still deficient. They further suggest that the solution to this dilemma is certification of GIS. Ayers suggests that certification should go beyond the hardware and software, and include the data and processes of the end users GIS-T as well.

Ayers specifies the forces that he says are driving us toward certification, and then outlines the various parts of the certification of information, including scope, accuracy, and the process itself. He concludes that the standards, process guidelines, and technologies necessary to carry out the certification are already available, but that finding the time to implement the certification process is very difficult.

In the second keynote address on Tuesday morning, Michael Cleary, the Chief Information Officer of the Michigan Department of Transportation, presented a paper on Implementation of Management Systems from an Open Systems Point of View.

Cleary indicated that the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) has required massive changes, due to the ISTEA management system process. Such changes are organizational, cultural, and process oriented. The challenge to most states, including Michigan, is to carry out these changes at the same time many additional challenges are facing the department. These challenges include: staff reductions, retirement of key personnel, existence of a largely paper-based information system, and expanding transportation program responsibility.

The Michigan Department of Transportation (DOT) faces many of the typical barriers to change, including uncertainty, fear, job security, resistance to change and key person dependency in many technical areas. To overcome these barriers, Michigan DOT has relied on improved communication, heavy staff involvement in planning and change, education, training, establishment of specific expectations, establishment of a new (non-mainframe) system environment, and the addition of many new tools.

Michigan DOT's objectives for their ISTE A program go beyond the federal mandates to include re-engineering the entire business process, providing management with decision support tools, building an information infrastructure, establishing integrity of information, and empowering their customers.

To reach these objectives requires a specific strategic direction for information technology in the state. Michigan DOT's strategic direction for information technology includes: upper management involvement and support, business driven technology (not just functional areas), a shift to strategic systems, business process re-engineering, customer service orientation, open systems, a development methodology that focuses on maximizing benefits while minimizing effort, and looking at information as an asset/strategic resource

Cleary posited a number of reasons for using the open systems approach for Michigan DOT's ISTE A management systems. These reasons included a better ability to meet the changing business needs of the state (e.g. taking advantage of new technology), ability to communicate with legacy systems, retaining the benefits of existing information systems, vendor independence, lower technology costs, and greater acceptance in the market place.

The remainder of day 2 was devoted to 13 concurrent sessions .

Tuesday evenings program included a vendor-sponsored reception and a dinner cruise on the Spirit of Norfolk.

### Day 3

The final day of the symposium was devoted to two plenary sessions. These sessions are designed to provide a summary of the symposium and develop suggestions and plans for future GIS-T activities. In the first session, presentations were made by each of the 22 moderators, summarizing the key issues that had been identified in their session. Rather than summarizing the papers in their session, moderators were asked to distill the key points that would be useful in moving GIS-T activities to the next level.

### **Major GIS-T Issues**

Among the issues and concerns identified were the following:

- Integrated highway information systems (as opposed to transportation)
- Integration of cell-based modeling and vector based tools
- The role of imaging systems in GIS-T ( e.g. in handling document storage, satellite imagery, aerial photos, and photo logging)
- Importance of delivering products along timeline as GIS-T is developed
- Strategic plan is needed to guide GIS-T development
- Migration plan is needed to move between phases in system development
- Substantial time commitment is needed for project team (6-8 hours per week minimum)

- Important to keep expectations of users under control
- Test system before delivery to system users.

- Cell based technology provides users with ability to move back and forth between raster and vector data
- Cell based structure has the advantage of storage of points, lines, polygon, and surfaces in a uniform manner
- A transportation profile, based on the SDTS topological vector profile (TVP), is probably needed
- A location referencing system is needed to facilitate data sharing among GIS-T and IVHS users
- Cooperative efforts are needed to development, monument, and support the Global Positioning System (GPS) geodetic networks that form the foundation of GIS-T and IVHS users
- GIS can provide much valuable information for decision makers regarding demand for transit services and efficiency in meeting this demand, but accuracy of address information is still a large, and sometimes unmet need.
- GIS-T for developing Environmental Impact Statements
- Combining GIS-T with established engineering systems for dealing with environmental issues.
- GIS needs to better serve urban transit including:
  - better standard than vector topological format
  - matrix handling capabilities for basic modeling software
  - temporal display capabilities
- GIS must be integrated into corporate strategy of DOTs if we are to use spatial information effectively
- Managing airport infrastructure and property with GIS
- Variability in cost and technology needed for real-time versus post-processing of GPS data
- GIS as a tool for planning data collection, organizing data, and presenting results
- More sophisticated models to take advantage of flood of spatial data
- Using spatial data to validate and improve traffic management models
- Use of Census data and 1:100,000 mapped data for comprehensive statewide transportation plans
- Necessity of clean-up of TIGER data before use
- The necessity of automating each step in development of large automated systems such as the National Highway System (NHS)
- Quality checks are needed in all automation efforts to minimize human error
- Metadata should be provided when sharing mapped data with other agencies
- The level of expertise required for "bottom-up" applications development
- GIS applications development based on CASE-based systems analysis and information engineering
- Need for recognizing GIS as an organizing principle for all data
- The potential for Rapid Application Development, based on user interview and joint application development
- Application development is most likely to be successful when it is based on a well- defined, stable data architecture
- GIS is a key tool in transportation modeling
- Importance of visualization in presenting GIS output, particularly realtime data

- Time is an important dimension in GIS-T and IVHS
  - transportation is movement in space, over time
  - most things change over time
  - much work in other fields regarding time is transferrable to GIS-T
- GIS is both an integrator of data and a way to communicate among organizations
- Successful GIS-T systems are based on careful attention to the institutional aspects of planning, implementing, and operating them
- Coordination efforts must include clear delineation of who responsible for what
- Executive level support critical for coordination and communication improvements
- Coordination and cooperation need to be broad in scope and given continuous attention
- Improving communication necessary in order to improve data access
- User interaction to assure agreement on data base design
- Linear versus coordinate referencing
- Variations in file structures
- Multiple operating systems
- Plans, standards, and documentation for managing attribute data
- End user involvement as a key to successful applications
- Standards that are needed to ensure data base consistency, data integration, data exchange among users, and maximum cost efficiency
- Communication a key factor in successful GIS-T system development
- Good communication depends on management support, budget support, and recognition that there are new ways of thinking that can significantly improve the operation of any business or agency
- Sharing of experiences is useful in developing solutions to common problems

### **Suggestions for Future Activities**

The final plenary session was devoted to determination of appropriate future activities to aid in the development of GIS for transportation agencies.

The session began with short presentations by four panelists (James Gruver, Rolf Schmitt, Todd Smith, and David Fletcher). Each panelist provided suggestions and an example of how their ideas might be implemented. Following the panel, all participants were invited to add their suggestions and comments on how to facilitate GIS development and use, as well as foster sharing of experiences about these efforts.

Some of the ideas and suggestions related to the organization and mechanics of the symposium itself. Others were of a more general nature, identifying priority issues in need of further study and discussion.

The following is a summary of the major items suggested by panelists and other attendees. The Steering Committee plans to consider these items in preparing for the 1995 symposium in Reno.

1. Expand efforts to foster a National Geospatial Data Clearinghouse, to facilitate data sharing.
2. Since GIS-T and IVHS have similar goals, structures, and data needs, efforts should be combined

- to develop an integrated GIS-T/IVHS system.
- 3.IVHS groups can benefit from the expertise and experience of GIS-T developers and managers.
  - 4.There is a need to enhance our real time GPS data collection abilities.
  - 5.Broader representation of GIS-T colleagues from all levels of government and the private sector should be attending this conference.
  - 6.Need to focus on data acquisition tools and procedures.
  - 7.Field personnel need to understand the quality of data needed to provide the quality of product desired.
  - 8.Need to target on processes, identifying problems, solutions, and limits of GIS.
  - 9.Need more emphasis on data collection as an input to processes.
  - 10.Need to improve understanding in GIS community of how applications benefit specific users, such as traffic engineers.
  - 11.GIS is a wonderful tool, but we need a better job of selling it to the operations people in our departments.
  - 12.Need to continue to remove mysticism from GIS-T (by using easy to understand language and software).
  - 13.Distributed computing environment needed to facilitate GIS-T development and use.
  - 14.Need clearly defined migration strategies (e.g. for moving from central to distributed system).
  - 15.Keep conference much the same "since this is one of the very best conferences ever attended, bar none".

The Steering Committee and the Program Committee will consider these and any other suggestions received as plans are made for 1995 and subsequent years. Additional ideas are invited and can be sent to the 1995 Symposium Chairman:

Jim Dolson  
Florida Department of Transportation  
605 Suwannee St., MS43  
Tallahassee, FL 32399

## **GIS-T SYMPOSIUM LOCATIONS**

- 1987 Tempe, Arizona
- 1989 Orlando, Florida
- 1990 San Antonio, Texas
- 1991 Orlando, Florida
- 1992 Portland, Oregon
- 1993 Albuquerque, New Mexico
- 1994 Norfolk, Virginia
- 1995 Reno, Nevada
- 1996 Missouri (\*)
- 1997 North Carolina (\*)
- 1998 Utah (\*)

\* = Tentative sites

**1994**  
**GIS SYMPOSIUM STEERING COMMITTEE**

James Dolson, Chair  
Florida Dept. of Transportation

Barry Larson  
Wisconsin Dept. of Transportation  
Bureau of Automation Services

Ralph Basile  
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Wende O'Neill  
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