GIS-T Use in ITS

Intelligent Transportation Systems (ITS) is the optimal integration of different devices, methods, and pathways used to control different aspects of transportation in a network area. It has been an ever-developing field of public works that began back in the 1970’s. The main reason behind its structure and architecture is to enable cohesion between signals, different methods of transportation, and daily traffic with the use software and hardware devices to predicate and estimate future use of the system. This allows for the network to increase efficiency for vehicle flow, rather than increasing supply for the demand on the network level (Hurwitz, et al. 2011). Previous to the development of ITS, Geographical Imaging Systems for Transportation (GIS-T) was being used by the Census Bureau to organize populations by streets and roadways with the advent of Dual Independent Mapping Encoding (DIME) studies in the 1960’s (Goodchild, 2000).

As mapping and imaging evolved, so did GIS-T. Land use mapping started to become more detailed and the ability to clearly map and examine transportation systems lead to the development of the Intermodal Surface Transportation Efficiency Act (ISTEA) 1991 and then succeeded in 1998 by the Transportation Equity Act for the 21st Century (TEA-21). Both of these acts had to conform originally to the Clean Air Act Amendments (CAAA) of 1990 for environmental efficiency. They were put in place to examine and explore different relationships between land use and transportation systems, mainly to focus on environmental and economic affects. Based on certain decisions in a sector, different outcomes could occur to different aspects in the surrounding land (Shaw, et. al, 2003).

These decisions in many cases on made based on predictions and evaluations by ITS software. Models are created in order to make a decision support system (DSS) which enhances policy standards in a specific area. The DSS is created as a means of realistic integration of multi-modal databases to give a mapped visualization of certain aspects of management (Arampatzia, et. al, 2004). Different modes of transportation are examined in different traffic situations for their affect on system as a whole. This can range from the amount of heavy vehicles that cross through intersection to how many times a day a train runs through a station. Vehicles can be measured on the ground by a variety of means, be it closed loop detection on the roadways, to Closed Circuit TV (CCTV) surveillance for real time data collection (Hurwitz, et al. 2011). Space-time accessibility measures have become a large part of quantifying vehicle pathways on a mapping level. This type of measurements directly relate to positive interactions with vehicles in the system, such as how many cars in a queue can pass through a green light. The measurements can be used with GIS-T software to add to spatial database as a means of managing independent traffic decisions (Miller, et. al, 2000).
This kind of combination can be stated as a spatial decision support system (SDSS), an offshoot of a DSS that relies more on geographical properties and techniques for model analysis. Those using these kinds of techniques can bring certain problems when modeling transportation properties. When estimating the travel demand in an area, modifiable areal unit problems (MAUP) can arise when trying to define limiting boundaries. ITS tries to increase efficiency and performance in an area and travel demand is one of the properties that are used to grade an area. If the demand for a zone is being examined, boundaries should be made so that every zone is equivalent, but if MAUP arises and changes the zoning boundaries, 2 of the same demands can look quite different if one crossed a larger area than the other (Miller, 1999).

Development of predictive modeling is trying to evolve from these systems to create a more reliable projection of traffic analysis. The Urban Transportation Model System (UTMS) is one such projection that delves into detail on traffic generation and demand in an area. It is traditionally split into 4 concurrent steps; trip generation and attraction, trip distribution, modal decision, and network decisions. Trip generation is the based on the number of trips to be made and trip distribution is the end location of the trip. Modal decision is how it sounds; what mode of transit will be used? And network decision is pathway or routing choice. GIS-T software enables user to track and organize trips that occur in a given system. Analysis can then be made to find probabilities for certain decisions based on other decisions and so forth. ITS software can then be used to enhance this analysis further, by asking why certain decisions were being made. With these predictions being made, an ITS can be programmed to achieve peak efficiency for an area depending on the demand of certain variables in a system (Waters, 1999).

So what does the future hold for the combination of GIS-T and ITS? Many different agencies already implement programs for the use of GIS-T, such as CAD or ARC based software. Then same can be said for ITS decision based programs, which depend on multiple programs running at once based on complex algorithms. Further combination of the two is already leading to the development of Intelligent Vehicle Highway Systems (IVHS). These types of systems allow for real time tracking with the use of intelligent vehicles (Waters, 1999).

Many modal fleets implement this technology already, with the use of GPS locator beacon on vehicles to track speed and location. This type of tracking allows for a more detailed look into pathway decisions. With the use of newer surveillance systems, these same vehicles can be located in real time on the ground. The decisions of drivers can then be tracked through the entire transportation network to create large mapped database. These types of decisions help paint a detailed picture of the driver population in the network area. The more decisions that can be documented, organized, and examined helps with creating a GIS-T data base, and ITS prediction models, which in turn make the entire transportation network better for the public that accesses it.
Annotated Bibliography


There are many different methods to analyze transportation policies and practices, and this paper is based on the use of Decision Support Systems (DSS) models with the use of Geographical Information Systems (GIS). As like many other models, this analysis is done to optimize the performance of transportation policies in place and to help in the development of future ones. In this paper it describes the three different levels of analysis; on the first level the transportation network is analyzed, then the energy and emission affects on the network, and finally the policies in place are examined. For each of these levels, GIS is used as a central database were different variables can be examined and used with estimation equations for a realistic view on a network. Also it allows for common data communication between sub-models.


This paper delves into growth and integration of GIS and Transportation systems (GIS-T). It begins with a short historical review on the subject that dates the beginning of the integration of GIS in university studies during the 1950’s. The author then goes on to explain how the Census Bureau’s interest in GIS databases leads to the development of different structure that can be used in analyzing transportation systems. He then continues to split the subject of GIS-T into three different perspectives: map view, navigational view, and behavioral view. The map view pertain to static transportation applications, such as sectional topography and uses GIS for inventoring. Navigational view estimates and records route decisions and pathways. Using newer software and equations, the behavioral view looks at driver dynamics and the interactions between different objects in the system.


In this article the subject of thoughtput is explained and examined with the use of analytic software that is enhanced with the use of GIS databases. The basis of thoughtput is the amount and type of flow though a system that can be realistically measured. This is done by implementing space-time accessibility measures (STAMs) to model driver planning and decision
making. These type of measurements displays the positive outputs in a given transportation system. Accessibility is a large part of these positive outputs as it is an easily followed quantitative measurement. These types of models can then be applied to computer software to develop driver routines during different time periods in urban settings.


Miller examines and compares the different GIS related technologies and methods used in the transportation industry. This is especially so when comparing GISci, spatial analyses, and GIS-T fields. Issues within these field cross over in many ways, and similar software can be used to develop different theories on environmental area impacts. For these matters GIS is used as a spatial database management system for mapping and organizing different variables and geographical information. In this paper Miller mainly focuses on the different spatial aspects and uses, more specifically he breaks the issues down into 4 different topics; boundary topics, alternative representation of geographical environments, spatial sampling, and modifiable area units.


Transportation systems encompass large areas of land that interact with their surrounding in different dynamic situations depending on the type of systems in place. Empirical studies have shown that variations in a transportation system can occur due to geographical constraints and GIS can be used to organize and compute different traffic patterns. Mainly this paper focuses on the studies that have been taken place on new transportation hub developments and how they affect and interact with their surroundings. To do this, temporal and spatial dimensions were examined to map and organize a database of certain variable aspects that can be used to grade interactions. Development of a structured framework to analysis these interactions and explore new relationships is focused on for the conclusion of this paper.


In this chapter from the book titled “Geographical information Systems,” N.M Waters discusses the field of Geographical Information Systems in Transportation (GIS-T) generally. He begins with a brief introduction to how GIS-T came to be, including the development of the main architecture of the system, and the integration of spatial databases for analysis. Analysis was explained using different modeling techniques, as well as different practices from various
agencies. The use of GIS-T can be seen as a generalized system that can be applied to many situations or in some cases an extremely specialized program that is only used to examine a certain aspect of transportation system. He also goes on to explain the use of GIS-T for different automated vehicle systems.