Executive Summary

The efficient and effective movement of freight is a critical component in the transformation and growth of the Alabama economy. The Alabama economy has experienced dramatic changes in composition and structure over the past five decades. In recent years, the changes have been most evident in the rapid growth of the automotive, aerospace, and life science industries and declines in the textile, apparel, agricultural, and natural resource industries. All of these trends are very likely to continue. As an example, approximately 240,000 automobiles were assembled in Alabama in 2003. By 2006, that number is expected to grow to almost 800,000 arising from the expansion of the Mercedes and Honda plants and the construction of a new Hyundai plant.[1] In addition to the rapid growth of the automotive industry, tomorrow's economy will likely include biomedical, robotics, advanced logistics, and other knowledge-based industries. In a very real sense, over the past twenty years, Alabama has transitioned rapidly into a manufacturing economy from an agricultural and natural resource economy while simultaneously beginning the additional transition to a knowledge-based economy. The continued transition and growth of the Alabama economy cannot occur without adequate and appropriate transportation infrastructure.

During a hearing of the U.S. House Subcommittee on Highways and Transit (June 2002), the following was included in the background statements prior to witness testimony: "No matter how functional the individual parts of the system may be, the effectiveness of the overall system depends on the interconnectivity of the different parts and modes…Connections now must reach beyond a single mode, to foster an integrated and efficient transportation system."[2] The focus of this project is the research and development of an integrated systemic approach to infrastructure planning for dynamic economies in transition.

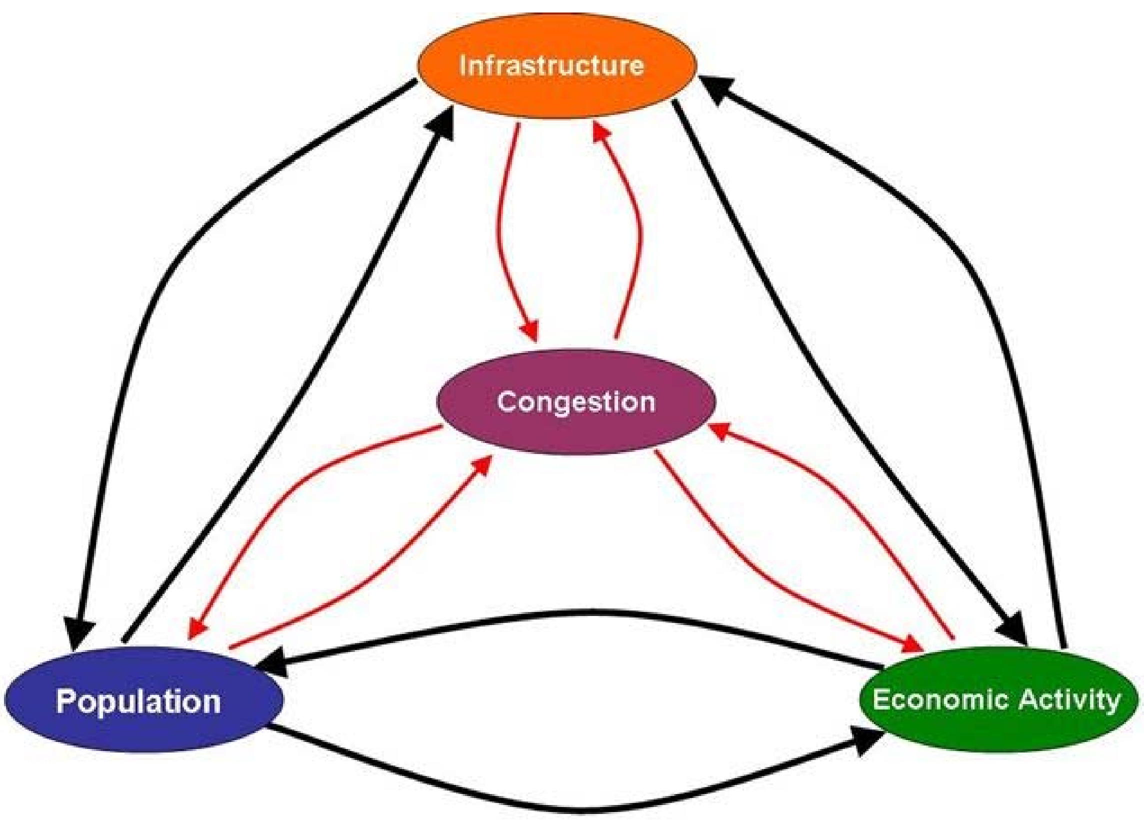
Such an approach must incorporate the interaction between economic activity, infrastructure, population, and congestion. As an economy grows, it generates traffic from both workers and freight shipments, increasing levels of congestion. Similarly, economic growth tends to attract workforce and increase population. Both phenomenon, again, tend to increase congestion. In turn, congestion tends to constrict economic growth and population growth within a region. Each of the interactions occurs with differing strengths and response or delay times. Finally, pressures from congestion and economic growth can lead to additional infrastructure, leading to what is often a short-term reduction in congestion.

Figure ES-1 depicts the interrelationships between population, infrastructure and economic activity. As later sections of this report will detail, the interconnectivity of the factors and congestion combine to determine the outcome of decisions on resource allocations made previously. For example, without infrastructure to support economic activity, congestion will eventually impede growth and population will cease to increase. A decreasing population will have a negative effect on economic activity and thus congestion will be reduced. Therefore, the decision not to provide infrastructure eventually affects population growth and economic activity.

The focus of the current effort is a result of the research finding that common freight forecasting methods rely heavily on trend analysis and averages to develop transportation infrastructure plans. In many, if not most cases these tools are not adequate due to the fact they ignore dynamic interrelationships between system factors. There are interrelationships between transportation infrastructure, population and economic activity that, if not considered as a system, can skew decisions away from more desirable solutions. Additionally, industry specific trend analysis and averaging do not take into account the broad composition of industry clusters.

The transportation networks in Alabama are challenged in several areas by congestion, deteriorating infrastructure and a diminishing highway maintenance and improvement budget. The preliminary findings of this research indicate the very real possibility that lack of adequate transportation infrastructure may constrain and limit the growth of Alabama's economy. Moreover, these infrastructure limitations may constrain regional growth opportunities as well.

Figure ES-1
P-I-E Interrelationship Model



All is not bleak. Opportunities abound for those with the foresight to establish a position to take advantage of global trade and freight developments. With growing congestion at major United States east and west coast ports, alternative ports such as Mobile, Alabama now have significant opportunities for growth. Alabama, with a deep water port, inland waterways, intermodal facilities, and a well-established international cargo airport could very well take advantage of this opportunity and thus become a major component of the global supply chain and a major contributor to regional economic growth. This regional opportunity, along with in-state economic growth, may be foregone due to inadequate infrastructure.

What transportation infrastructure is needed to both support the growth of the Alabama economy and serve as a stimulus for regional growth is the fundamental question to be addressed. The eventual goal of this research is to answer this question by developing analytical tools, investigating benefits of alternative investments and formulating specific infrastructure plans.

The Office of Infrastructure, Logistics, and Transportation was established at the University of Alabama in Huntsville in 2003 with the mission: “To increase prosperity and economic development in Alabama by identifying, promoting, and supporting the development of the transportation and information infrastructure necessary to support the long-term growth and transformation of the Alabama economy.” The objectives of the Office are:

- To identify the infrastructure needs and future requirements of the major business clusters in Alabama.

- To evaluate alternative means for improving the infrastructure and meeting future needs.

- To assess the infrastructure needs of the rural and underdeveloped regions of Alabama and to assess how infrastructure can promote economic development of these areas.

- To identify infrastructure strategies that will promote business cluster growth.

Following the structure of Figure ES-1, this report presents an assessment of the current status of:

- Transportation Infrastructure
- Population
- Economic Activity
- Likely Future Congestion

Transportation Infrastructure

The components of the transportation infrastructure system researched in Alabama are highways, rail, inland waterways, ports, airways and the intermodal combinations of each.

Highways

Alabama has 29,209 miles of Federal Aid Highway, of which, 906 miles are interstate. In total, there are 94,311 miles of all weather roads in the state.[3] Highways in Alabama have experienced steadily increasing volume for the last three decades. For example, at mile 260 of Interstate 65 in Birmingham, Alabama, which is approximately one mile south of the I-65/I-59 intersection, traffic volume has grown from an Annual Average Daily Traffic Volume (AADT) of less than 40,000 vehicles per day in 1970 to almost 150,000 in 2002, a growth rate of nearly 275%. The graph of this mile marker is shown in Figure ES-2.[4] Similar data is available for the other major highway facilities in the state.

Figure ES-2

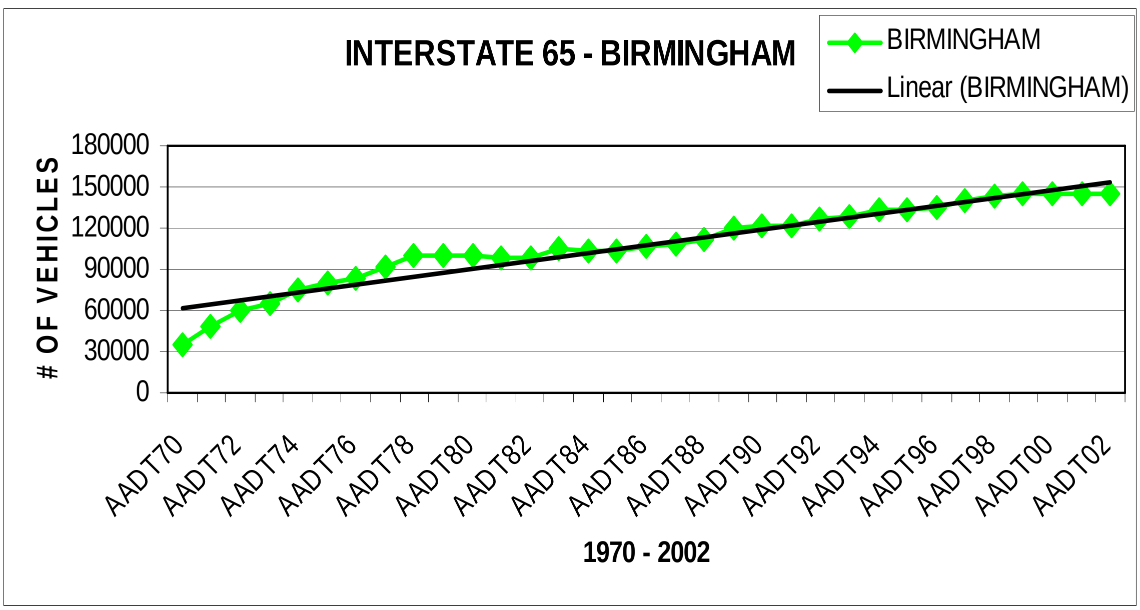
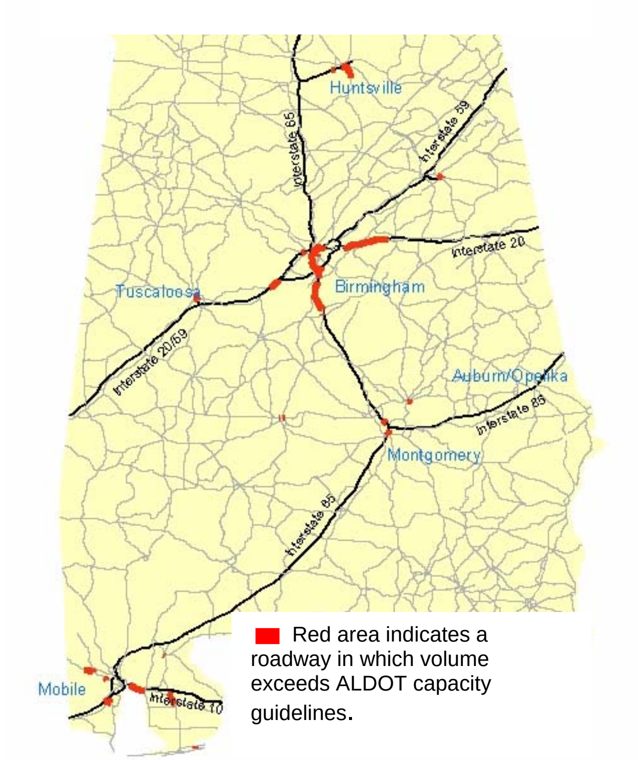


Figure ES-3 is a visual depiction of the congestion on Alabama highways based on 2002 volumes. This figure is output from the traffic demand model which is described later in this report. The wide, dark red areas indicate a congested facility during an average day. A congested facility, in the context of this model output, indicates that the volume of vehicles attempting to pass through the area exceeds the capacity guideline of that segment of road as defined by the Alabama Department of Transportation (ALDOT).

Figure ES-3
Congested Locations 2002
Alabama DOT Volumes



<u>Rail</u>

There are approximately 3,687 miles of railroad lines in Alabama hauling 150 million tons of freight annually. By a significant margin the highest volume commodity moved by railroads in Alabama is coal, more than 36 million tons annually.[5] The railroads work to fill their available capacity, but the incentive to grow beyond their current capacity is limited due to the significant capital investment required and the potential risk of return.

Container freight, domestic or international, has not yet become a significant portion of the rail activity in the state. There are several reasons this situation exists. The seaports in Mobile, Alabama and surrounding states have not yet become a force in the international container business, which would be a source of business for the railroads in Alabama. The railway system in Alabama is extensive yet it lacks a north-south intermodal designated track. With all north-south rails designated for merchandise, it can take longer for a container to get from Mobile to Huntsville than it takes a container to get from Long Beach, California to Huntsville. To designate a track from Mobile to Huntsville as intermodal, the railroads want assurance of a certain amount of freight (usually 50 to 70 containers per day) but manufacturers want the assurance of intermodal timed delivery before they will commit to the freight volume. The railroads are currently functioning at the upper end of capacity, and have no incentive to increase that capacity. The situation is a model Catch-22.

Inland Waterways

Alabama has 1,270 miles of navigable inland waterways that are underutilized.[6] The traffic on Alabama's inland waterways has been dropping steadily since the peak between 1995 and 1998. The Tennessee-Tombigbee Waterway has never reached its potential freight capacity. The Coosa River has experienced a significant reduction in river traffic due mainly to the lack of ability to maintain a nine foot depth to allow barge traffic. The Apalachicola-Chattahoochee-Flint river system in east Alabama has seen waterborne commerce come to a complete stop with the last barge company ceasing operations in 2002.

There is a perception within the waterway shipping industries that it is not possible to support a Just-In-Time manufacturing environment with inland waterway freight shipping. There is not currently a Third Party Logistics (3PL) service provider that works using the waterways of Alabama as the preferred mode of transportation. Alabama does have abundant natural resources in the inland waterway system but has not yet been able to fully utilize it to enhance economic growth. A study of the waterways in Alabama should be initiated to determine the efficiency and operating constraints of the waterway lock and dam system and the operating parameters by which it is managed.

Seaports

The Port of Mobile is a strategic link in the transportation infrastructure of the state and region. The port is currently executing a plan to develop Choctaw Point, a container port operation capable of handling 250,000 to 300,000 TEU's (Twenty Foot Equivalent Units, a container) annually; an increase from the 50,000 TEU's handled today. The Port of Mobile is in position to become a major player in the container freight business in addition to being a major port for bulk materials, but the port must overcome cost and delivery obstacles to succeed. This success, though, will result in an issue of how to move the freight out of the Mobile area in such a way as to not cause traffic congestion that eventually impedes economic growth.

The Port of Mobile also contains one of the largest coal terminals in the country and is a strategic partner in the power generation industry that supports a significant portion of Alabama and surrounding states. Southern Company, one of the port's largest import customers, expressed a desire to double the amount of import coal coming through the McDuffie Island Coal Terminal operation at the Port of Mobile. The current throughput of coal is about 12 million tons. As part of this effort, UAH worked with the Alabama State Port Authority to develop a plan for productivity improvement to reach the desired import goal.

The Port of Mobile will need to develop a culture of continuous improvement within an environment where this kind of thinking has not been supported in the past. The Alabama State Port Authority has taken steps in that direction. The McDuffie Island Coal Terminal is well on its way to becoming the preeminent coal handling facility in

North America. These efforts should be fully funded and supported by the state and the management of the Alabama State Port Authority.

Airways

Air freight data for the period 1993-2002 was obtained from the U.S Department of Transportation, Bureau of Transportation Statistics. Huntsville, Birmingham, Montgomery and Mobile all have freight air facilities with Huntsville being an international port of entry. Of these, only Huntsville has shown significant growth in the volume of freight with a percentage annual growth rate of 30.2% from 1993 to 2002.[7]

Air freight is often considered the transportation mode of last resort due to the perceived cost of shipment. Air cargo tends to be utilized for high cost, low weight products and components. Several actions are happening that may bring the cost of airfreight down to the level where more manufacturers will consider it as a viable alternative. Pemco Aviation in Dothan, Alabama has been working with a customer on converting Boeing 737's into 737 QC's which consists of installing a large door in the place of the personnel door and rails on the floors. Freight can be moved into and out of the plane on those rails but pallets of seats can also be installed quickly into the plane. Air transportation companies in the Far East are using the planes to fly passengers during the day, and then change the plane over in 30 minutes to fly cargo at night. By managing their airplane resources in this manner, the companies are able to get better utilization out of the equipment and lower the cost of freight shipments.

The increased security since 9/11/01 has caused some delay in importing shipments through customs. Even with this increased security, the Port of Huntsville has a daily flight nonstop from Europe and has recently initiated weekly flights to Asia.

Intermodal

Intermodal freight activity is the act of exchanging freight between two or more modes of freight transportation. The majority of this happens between railroad and truck, typically at an inland site, or between ocean going vessel and either train or truck at a seaport. The four primary Class-1 railroads in the United States each operate their own defined intermodal systems. These systems consist of intermodal terminals at or near major container seaports and inland intermodal terminals, which are typically at or near major population centers. The railroads serve these terminals using dedicated intermodal trains, traveling along lanes designated for intermodal traffic. These lanes are generally established based on density of container volume and the ability to accommodate the double-stacking of containers.

International containers, arriving at U.S. seaports, are transported inland via both truck and rail. Trucks generally deliver containers within a 200-mile radius of the seaport. Rail is generally used to move containers to inland points beyond 200 miles of the seaports. Once the containers arrive at a designated inland terminal, trucks will then deliver the containers, generally within a 200-mile radius of the inland terminal. The process is reversed for containers moving to the seaports for export. The radius distance is not a set number. Exceptions to this distance frequently occur due to many variables.

Domestic containers and rail trailers move from point to point within the U.S. Domestic intermodal freight is typically used for long-haul situations, in excess of 500 miles. Once the containers arrive at a destination terminal, trucks will then deliver the containers, generally within a 100-mile radius of the terminal. The domestic service radius of an intermodal terminal is generally less than the international radius, due to competition with over-the-road truck rates.

Presently there are three primary intermodal rail terminals located in Alabama, each served by a different Class-1 railroad. Huntsville is served by Norfolk-Southern; Birmingham is served by BNSF; and Mobile is served by CSX. Additionally, Norfolk-Southern operates a small intermodal terminal in Birmingham to exclusively serve the Mercedes-Benz plant in Vance, AL. Both Huntsville and Mobile are served by eastbound and westbound intermodal train service. Birmingham is the eastern-most terminus for the BNSF railroad. Therefore, there is no eastbound intermodal train service from the BNSF terminal in Birmingham.

Due to the fact that Mobile, at present, is not a major container port, the railroads hold that there is not sufficient container volume to justify a north-south intermodal rail connection between Mobile and Birmingham and/or Mobile and Huntsville. Both CSX and Norfolk-Southern have rail lines extending from Mobile into central and north Alabama. However, the viability of those rail lines being usable for intermodal rail traffic would have to be determined by the individual railroads. CSX does not have an intermodal terminal in either Birmingham or Huntsville and Norfolk-Southern will usually utilize their intermodal hub terminal, in Austell, GA, to link Mobile to Huntsville.

Even though the Port of Huntsville has access to rail, air and highway modes of transportation, the intermodal nature of the freight dictates the modes of delivery. Freight will typically transfer between truck to rail and truck to air. Very seldom does a product transfer from air to rail or rail to air due to the weight and delivery time requirements. Air freight will carry high value, low weight, time definite delivery items and rail will carry high weight, lower cost, non-time sensitive materials.

Research by the Federal Highway Administration makes it clear that if the freight system within the U.S. continues to rely on trucks and highways, the demand for freight transportation over the next two decades will far outpace the available infrastructure capacity.[8] Intermodal freight movement offers an efficient and socially beneficial alternative, but there are many obstacles to overcome before manufacturers in the U.S. will be persuaded to change their current behavior.

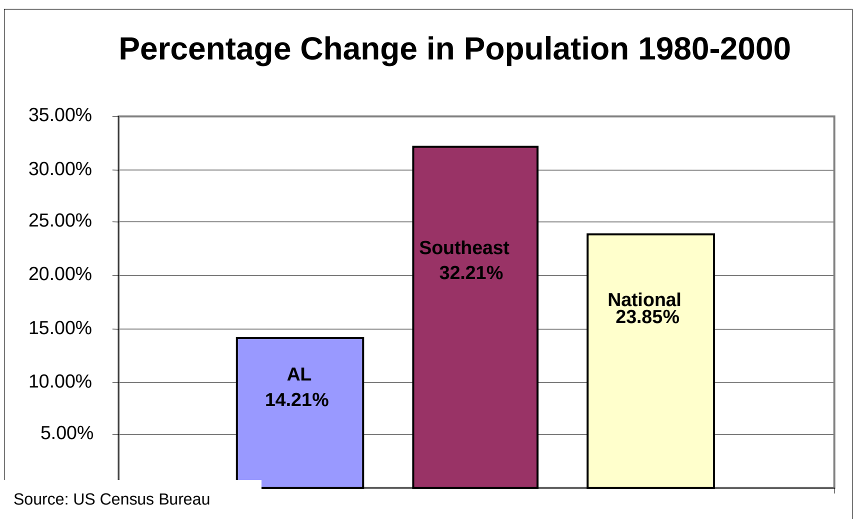
Population

Understanding the infrastructure in Alabama was the first step to the development of an integrated systemic approach to infrastructure planning for dynamic economies in transition. The second important factor to understand is the population of the state and how historical and current dynamics are establishing the future requirements for economic growth.

Population trends do have an effect on the economy and infrastructure of a region. Economic activity needs population to grow. A growing economy attracts population, thus creating a cycle of growth and prosperity. The opposite is also true. An economy in decline will lose population as people leave the region to look for opportunity elsewhere, thus creating a downward spiral from which it is very difficult to pull out. The transportation infrastructure in a region is either an enabler or restrictor of growth. The presence of infrastructure is not necessarily a stimulus for growth, but the lack of infrastructure can extinguish growth.

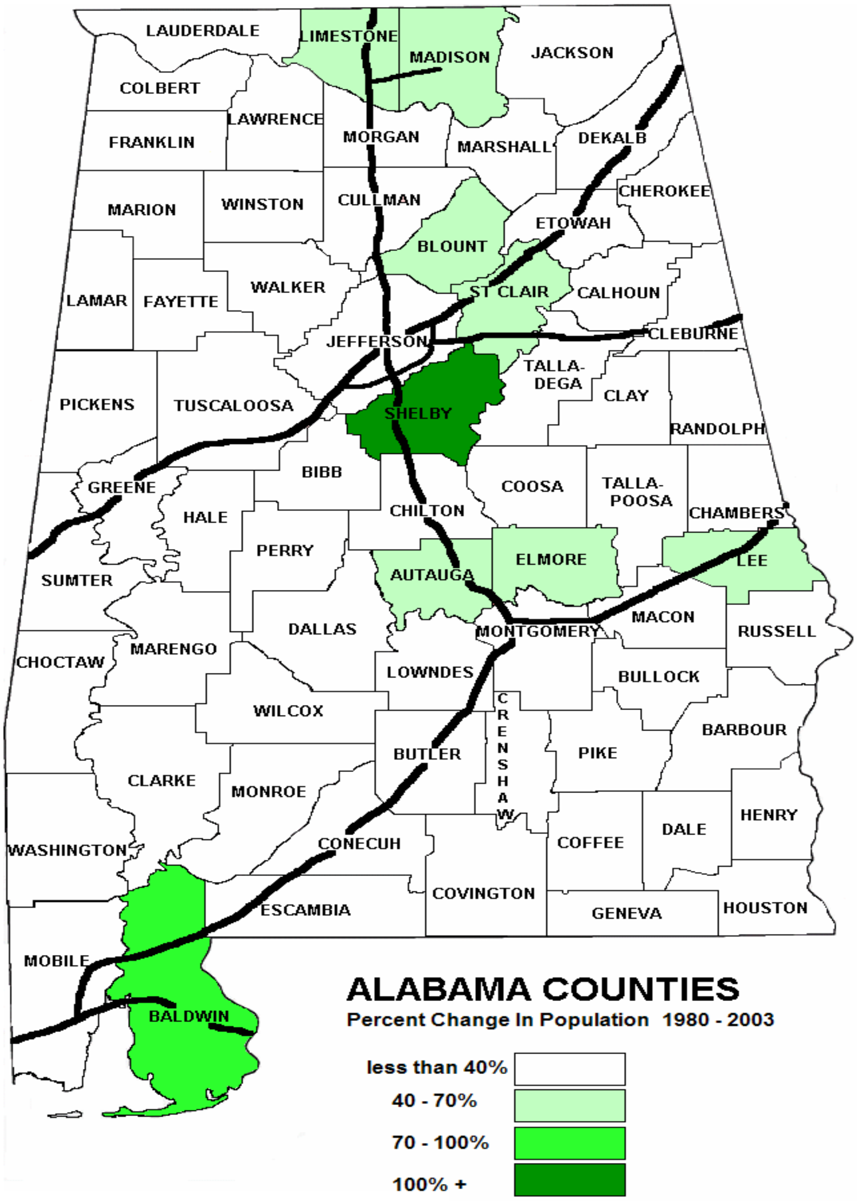
Population growth in Alabama, although positive, has lagged behind the southeast and the nation for the past two decades, as can be seen in Figure ES-4.

Figure ES-4
Relative Population Growth: Alabama, Southeast, and U.S. (1980 to 2000)



Research into population growth and trends yields evidence that there is a movement within the state toward the counties in and around which the major transportation arteries traverse. This, in turn increases congestion on those major transportation arteries. Population tends to increase economic activity, which tends to increase freight requirements. The growing economy, then, increases the attraction for additional population.

Figure ES-5
Population Growth in Alabama, 1980 to 2003



Source: Alabama Department of Industrial Relations

According to the 2000 census, there are 55 counties (out of 67) with less than 100,000 people in residence.[9] Alabama is predominately a rural state. In rural areas, infrastructure needs are not necessarily related to transportation. In the broader definition of infrastructure (which would include education, employment opportunities, commerce, financial resources, in addition to transportation) it may be that there is a greater need for factors other than transportation facilities. To this end, urban transportation planning methods are inadequate for use due to the significant weights given to population and economic activity. Sustainable economic momentum is a basic premise in urban transportation planning but rural transportation planning must be capable of predicting sudden changes in economic activity. Trend analysis will not suffice. Rural Alabama is not lacking in the amount of attention being paid to the unique set of problems in that region. In 2004 there were not less than 16 different Black Belt Initiatives underway to address workforce and economic development issues in this rural and economically depressed area of the state. Coordination and policy directives seem necessary to ensure that the rural regions initiatives provide value added assistance for the investment made.

Economic Activity

The third of the interrelated factors in Figure ES-1 is that of the economic activity in the state and region. This includes identification of what areas of the economy are growing, areas that are in decline and the reasons for each. To achieve this level of understanding, the research team employed the concept of industry clusters developed by Dr. Michael Porter at the Harvard Business School.

Identifying Industry Clusters in Alabama

The primary business clusters and sub-clusters were identified for eleven regions in Alabama. For each cluster, total employment and the change in employment over a ten year period were detailed. For examples, see Figures ES-6 and ES-7.[10] This research also focused in part on overlapping clusters and opportunities for future growth. An understanding of industry clusters is necessary to better evaluate how enterprises, connected by a common purpose, create value and economic activity. By developing this understanding, the characteristics of a cluster can be used to determine how that cluster generates freight needs and the appropriate infrastructure required to satisfy those needs. Combinations of industry clusters in a region will generate a unique set of infrastructure requirements that must be supported for the region to grow and thrive. Each individual industry cluster is composed of a unique set of infrastructure requirements that must be understood if the economic activity is to appropriately model the outcome of resource decisions.

Two particular industry clusters in Alabama, the automotive and aerospace industries, were of significant interest to this research due to the size of the clusters and/or the rate of growth each industry has experienced in recent history.

The Automotive Manufacturing Survey

A survey of the automotive manufacturing cluster in Alabama was conducted to document the growth in the industry from prior years and on future transportation and distribution needs, both in the near and long term. Figures ES-8 and ES-9 present an overview of the results of this task.

Figure ES-6
Top 5 Clusters by Metropolitan Area 2001

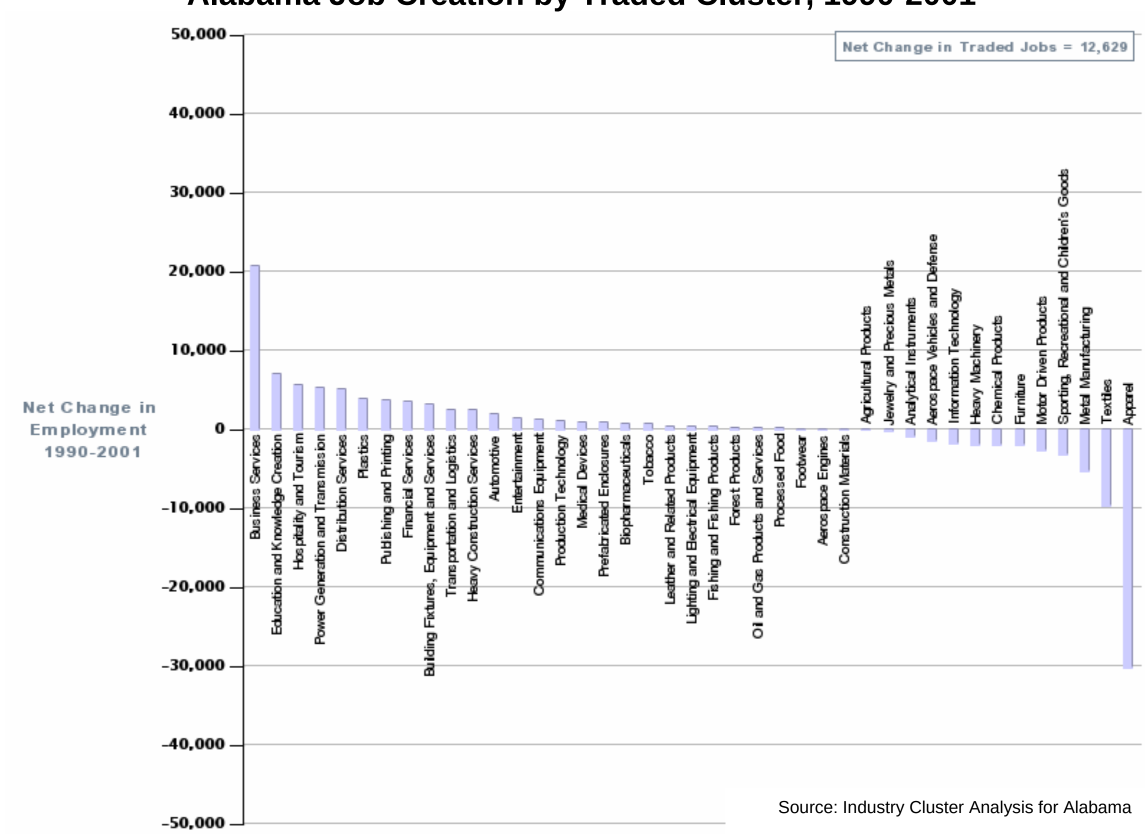
	Decatur	Florence	Huntsville
1	Prefabricated Enclosures	Apparel	Business Services
2	Forest Products	Prefabricated Enclosures	Automotive
3	Motor Driven Products	Metal Manufacturing	Information Technology
4	Textiles	Automotive	Education and Knowledge Creation
5	Metal Manufacturing	Business Services	Analytical Instruments

	Anniston	Gadsden	Tuscaloosa	Birmingham
1	Metal Manufacturing	Motor Driven Products	Heavy Construction Services	Business Services
2	Heavy Construction	Business Services	Motor Driven Products	Financial Services
3	Textiles	Metal Manufacturing	Automotive	Metal Manufacturing
4	Prefabricated Enclosures	Heavy Construction Services	Plastics	Heavy Construction Services
5	Furniture	Publishing and Printing	Business Services	Hospitality and Tourism

	Auburn-Opelika	Dothan	Mobile	Montgomery
1	Motor Driven Products	Transportation and Logsitics	Business Services	Business Services
2	Automotive	Hospitality and Tourism	Transportation and Logistics	Finanical Services
3	Business Services	Business Services	Heavy Construction Services	Heavy Construction Services
4	Heavy Construction Services	Motor Driven Products	Chemical Products	Motor Driven Products
5	Textiles	Heavy Construction Services	Hospitality and Tourism	Plastics

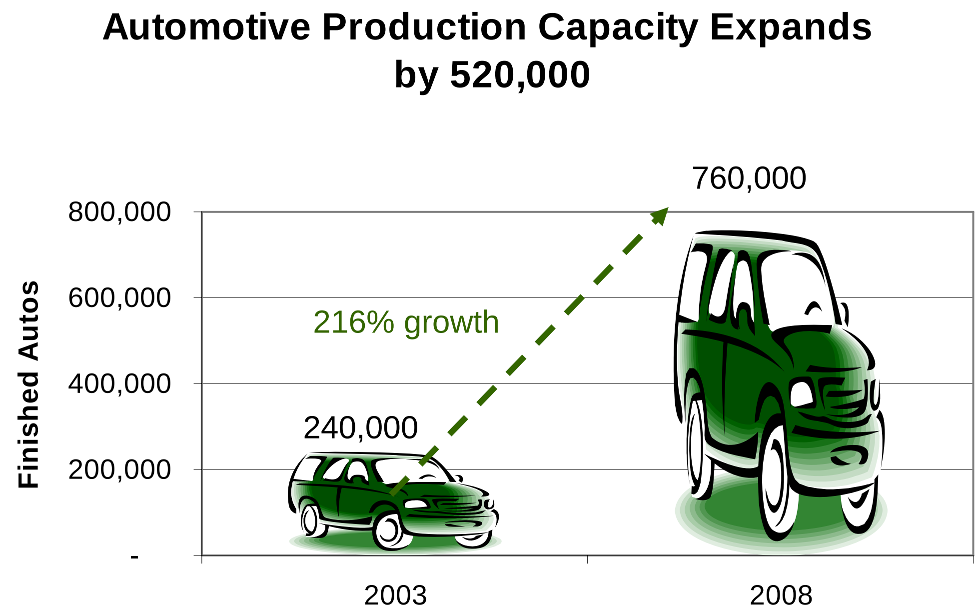
Source: Industry Cluster Analysis for Alabama

Figure ES-7
Alabama Job Creation by Traded Cluster, 1990-2001



Source: Industry Cluster Analysis for Alabama

Figure ES-8



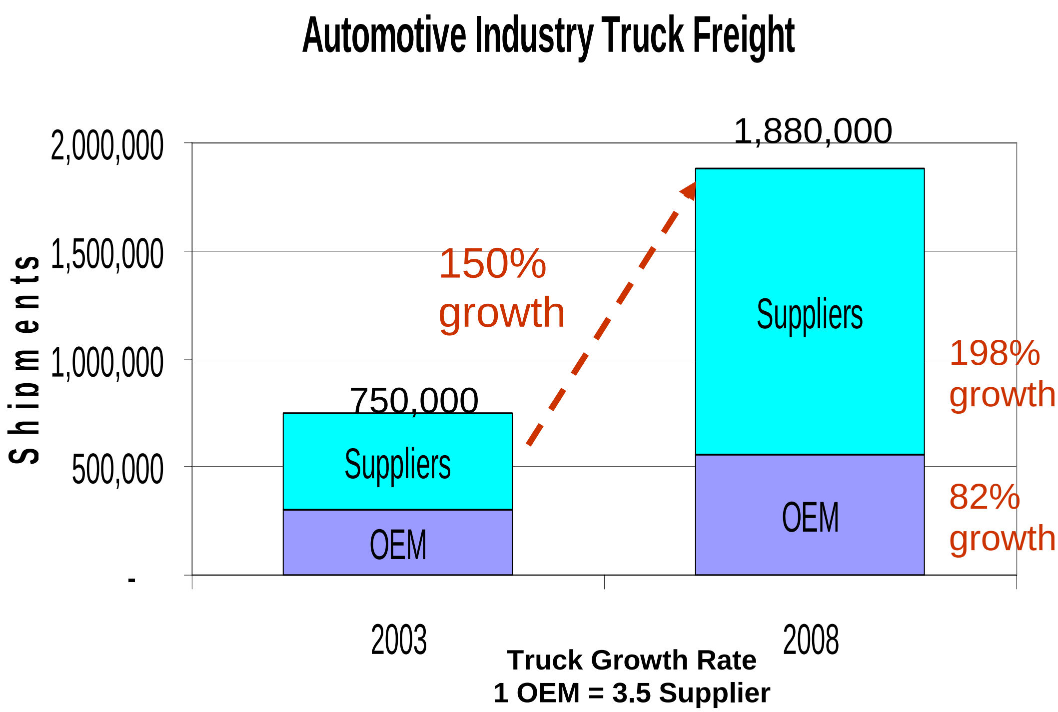
Source: Presentation of Preliminary Projection of Transportation Needs Created by the Growing Alabama Automotive Industry

With the cooperation of the Alabama Automotive Manufacturers Association the survey was conducted and, based upon the distribution of companies and the supplier network, implications for infrastructure were identified and described.

The automotive industry in Alabama is continuing to grow and thrive. The automotive industry has provided high wage jobs and employment growth to the state during a time in which several traditional industries have been in decline. This welcome growth brings with it transportation infrastructure issues such as traffic congestion, that will have to be addressed. This industry will continue to put a strain on the transportation infrastructure as production increases and shipping volume due to Just-In-Time manufacturing requirements escalate. The impact on road infrastructure in Alabama will certainly be noticed as annual automotive truck shipments grow by 150% from 750,000 in 2003 to 1,880,000 by 2008 (see Figure ES-9).

In any given hour of the business day, there are 156 trucks carrying automotive freight on Alabama roads. This average will grow to 392 per hour by 2008.[11] Unfortunately, most of this growth will occur in the region of the state where road capacities are reached or exceeded regularly during normal business hours. Coupled with other truck freight flowing within and through Alabama, significant congestion may result in the locations where business activity can least afford the delays.

Figure ES-9

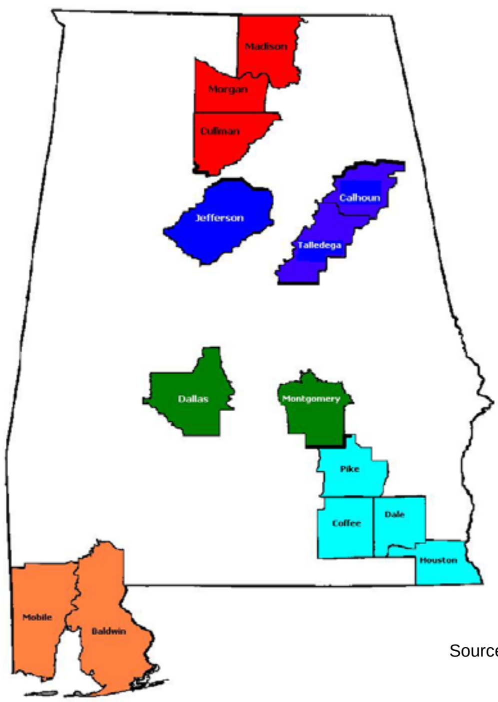


The Aerospace Industry Survey

A survey of the aerospace industry cluster in Alabama was conducted and, in addition to employment and geographical distribution in the state, the survey focused on the transportation and distribution needs of the aerospace cluster, both in the near and long term. Figure ES-10 presents the regions in which participants in the aerospace industry cluster can be found in the state. The survey was conducted with the cooperation of the Alabama Aerospace Industry Association (AAIA).

The Aerospace industry in Alabama is composed of two sectors, those companies involved in commercial products and those involved in military/space products. These two components are distinct and different in terms of the workforce needs, facilities and freight requirements. In its current configuration, the aerospace industry does not put strain upon the transportation infrastructure in the state. Most of the freight moved by the aerospace companies surveyed has a domestic origin and destination, with the volume of freight being low relative to other industry clusters. For comparison, 94% of the tonnage and 97% of the truck (LTL & bulk) shipments is domestic freight versus 6% or less freight originating or terminating outside of the United States.[12] Based on the responses to the survey, international outsourcing by Alabama's aerospace industries has not significantly impacted aerospace manufacturing in the state. The aerospace industry growth in Alabama takes place in the counties that already contain aerospace companies and is not expanding throughout the rest of the state.

Figure ES-10
Five Major Aerospace Regions Counties with 100+ Aerospace Jobs Private Sector



Region #1
(Madison, Morgan, Cullman Counties)
66.7% of total aerospace jobs in the state
Region #2
(Calhoun, Jefferson, Talladega Counties)
5.7% of total aerospace jobs in the state
Region #3
(Montgomery, Dallas Counties)
8.0% of total aerospace jobs in the state
Region #4
(Dale, Pike, Coffee, Houston Counties)
12.3% of total aerospace jobs in the state
Region #5
(Mobile, Baldwin Counties)
6.7% of total aerospace jobs in the state
Rest of State
<1% of total aerospace jobs in the state

Source: Alabama Aerospace Industry 2002: Industry Survey Report

Survey of Transportation Requirements

A survey of the distribution and transportation modes and requirements of Alabama manufacturers was conducted. The focus of this survey was on existing and future modes and requirements for transportation and distribution including air, rail, truck and water. The report identified the current highway, sea, air and rail requirements and any current shortcomings.

Information on Alabama's industrial base was gathered through face-to-face interviews with 240 companies across Alabama. The benefits of this time-consuming task became apparent as inputs were organized by clusters of industry. It was the combination of inputs from companies within an industry cluster that yielded the best insight into the transportation issues and requirements.

Researchers observed conflicting signals from manufacturers. For example, a common complaint from manufacturers was that they could not get trucks to pick up their products in a timely manner, especially in a peak demand situation. This would imply a shortage of trucks in the system. On the other hand, trucking companies indicated that they did not want to send trucks to Alabama for deliveries because they would often have a return trip with an empty trailer. This indicates that the capacity of trucks exceeds the volume of product to be shipped. The fact that these two situations simultaneously exist would indicate that there is a communication gap between the freight service providers and the freight customers they serve.

Regardless of whether an industry sector was growing (automotive), stable (aerospace), or declining (apparel, textiles), the advantages of organizing information by industry cluster were evident. Alabama manufacturing companies in general are primarily focused on their current (short-term) business needs. Future business forecasts are either not being shared or not being incorporated into the transportation department information of the company. Only by connecting the inputs from executive-levels with transportation department data, can reasonable forecasts for industry clusters be made. The disconnect between the board-room and loading dock suggests that transportation information gathered through traditional channels may not be sufficient in planning for the transportation infrastructure of tomorrow. Enhancing the systems for transportation planning should include information beyond the transportation data channels. Planning must incorporate methods of associating data within and across industry clusters.

Freight Transportation Modeling

Modeling freight transportation and the ability to predict future growth in freight transportation has been performed with limited success in this country. The primary reason the forecasting of freight movements has been ineffective is that the current state-of-the-practice is focused on examining historical growth, then forecasting the historical growth trends into the future, essentially utilizing the notion that previous growth is a good predictor of future growth. Unfortunately, this model of freight prediction is limited with respect to the facts that freight growth trends do not follow historical trends and growth in freight transportation is generated by large, independent events that require a multitude of factors to come together in a symbiotic fashion.

Growth in freight transportation occurs when a new facility is opened, not as a gradual process. A roadway or rail-line that has been experiencing limited freight movement will see an abrupt increase in transportation after the construction of a manufacturing plant or timber processing facility. Second, the development of facilities that will be instrumental in affecting the amount of freight transportation on roadways and rail-lines occur when a specific set of external factors are in place to foster the development of such facilities. These factors include the economy, level of productivity, industry clusters in the area, and economies of scale associated with production. It is the combination of discrete freight generating events and external factors that limit the effectiveness of trends line analysis for freight forecasting.

To improve freight forecasting methodologies, this research effort attempted to utilize urban transportation planning models as a tool to model statewide freight transportation. These models, used in almost every metropolitan area in the country, take input levels of transportation demand (in the form of trips produced from one area and trips attracted to another area) and transportation supply (in the form of roadways available to accommodate the trips) and predict future traffic volumes on city streets. The output of these models are used to identify current deficiencies in the transportation system, and with forecasted population and employment data, to identify future transportation system deficiencies that will arise at a specified horizon year. The advantage these models have over trend line forecasting is that the model inputs can be adjusted for discrete events, or sudden changes in employment and/or changes in the transportation network.

The specific items addressed in this research were the application of the urban transportation planning methodology to freight transportation. Relationships between common economic and population factors were developed from the freight transportation survey conducted as part of the research effort and discussed earlier. After defining the relationships, a projected demand for transportation services was generated with knowledge of the industry employment for a county and overall county population.

The model approach undertaken in this research effort follows the traditional four-step urban transportation planning process. The first step required preparation of a highway infrastructure network model. The Alabama specific network used counties as traffic zones. The roadways were attributed with distance, capacity (using Alabama Department of Transportation guidelines), and speed.

Statistical analysis was performed on the survey data to determine the relationship between industry size and type to the resulting freight flow. Statistical relationships were developed to convert socio-economic data to trips and/or freight flow. As freight flow was a primary focal point for this work, a statistical analysis was performed on the relationship between freight flow and the industries located in Alabama to determine the overall county freight movement. The specific tasks performed were: data collection, definition of a relationship between industry and freight flow, network development, and assignment of traffic. Traffic was assigned to the Alabama specific network using the socio-economic data for the counties in Alabama and an equilibrium assignment algorithm. The trips were determined using the relationships developed for freight flow from the survey information and personal travel characteristics.

The input data required by the model are summarized by the following:

- Survey of freight users
- Commodity Flow Data/Railway Bill data
- Modes of freight movement
- Highway/Rail/Waterway networks
- Employment data
- County freight flow relationships
- Origin and destination of freight

The model outputs are:

- Volume of incoming and outgoing freight
- Volume to capacity ratios for interstate and secondary highways
- Visual depiction of demand

The major advantage this methodology provided was the ability to develop future scenarios that were reflective of discrete events where the demand for transportation services would change. For example, the development of a new manufacturing plant in a specific county could be input to the model as a change in employment, which would be reflected as a change in demand for transportation services on that county. The model would then be able to predict the future transportation requirements and allow the user to identify deficiencies in the infrastructure that might need to be addressed to ensure the growth scenario identified is brought to fruition. An example of this is a demonstration utilizing the highway network and the specific growth anticipated in the automotive and aerospace industries in Figures ES-13 through ES-15.

The application of the urban transportation planning model provided a tool to improve the ability to forecast freight transportation needs in the state. The model proved superior to the trend line analysis because of the ability to account for plant openings and discrete changes in the industrial landscape of the state. However, the model was limited in its ability to incorporate the entire universe of economic and social changes that influence freight transportation. The future improvements to the model need to focus obtaining a better understanding the relationships between productivity and freight transportation needs, and ultimately, understanding the universe of external factors that cause industry growth and development.

The Figures ES-11 through ES-15 are output charts from the model. A congested facility, in the context of this model output, is defined by ALDOT to be a volume of greater than 75% in a rural area or 90% in an urban area of the maximum capacity of the highway (Volume to Capacity Ratio). Examples of the Volume to Capacity Ratio are shown from the model in Figures ES-11 and ES-12 for Interstates I-20 and I-65. Note that, in both charts, there are areas where current volumes exceed the available facility capacity guideline. Using the model forecasted volume created by including specific cluster growth knowledge, the area at or over capacity greatly expands by 2008.

Figure ES-11

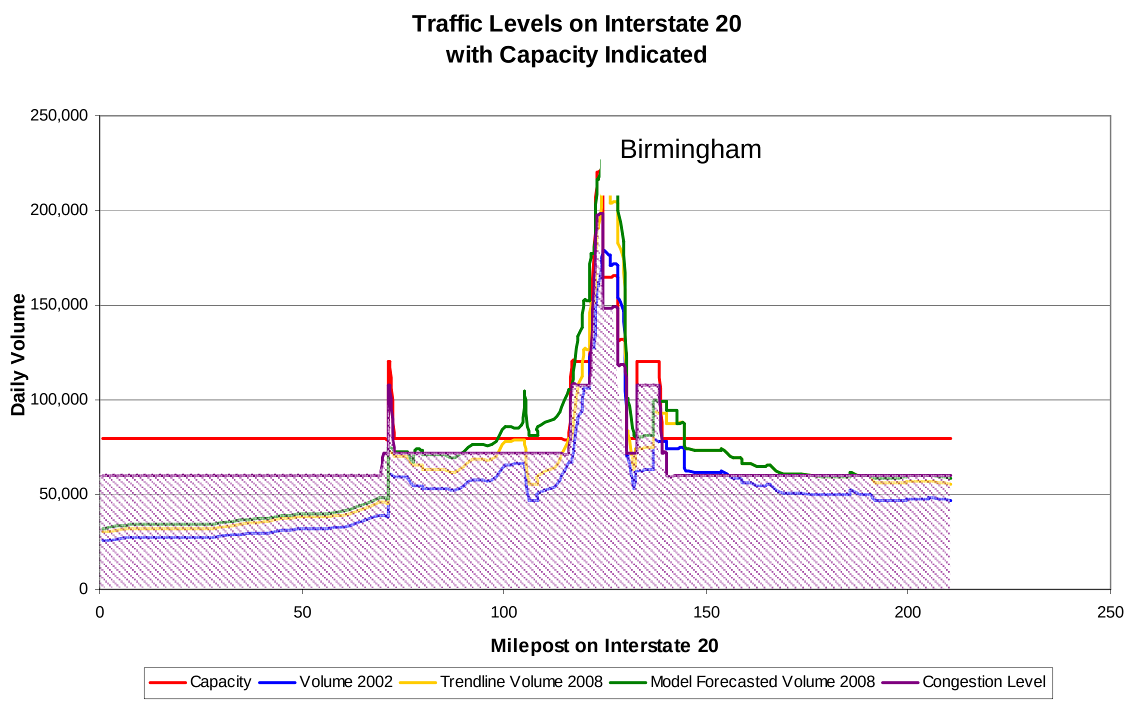
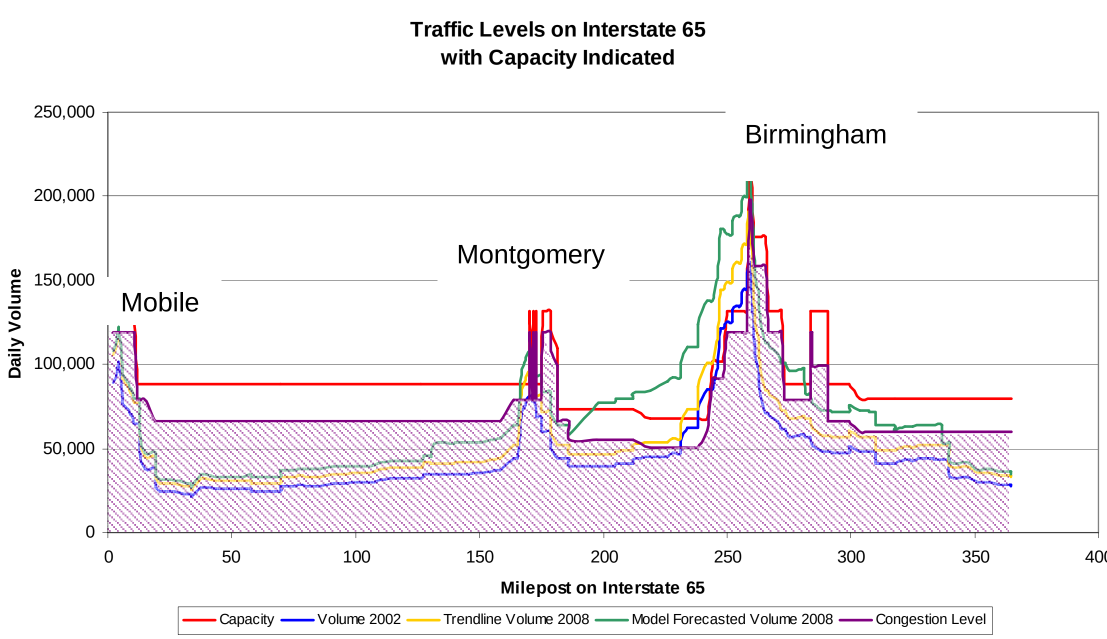


Figure ES-12



The Figures ES-13, ES-14 and ES-15 are output maps from the model. Figure ES-13 shows the current levels of congestion on the highway network. A congested facility, in the context of this model output, means that the volume of vehicles attempting to pass through the area exceeds the ALDOT guidelines for congestion of that segment of road. In Figure ES-13, the total miles of road considered as congested are 455.

Figure ES-13
Congested Locations 2002
Alabama DOT Volumes

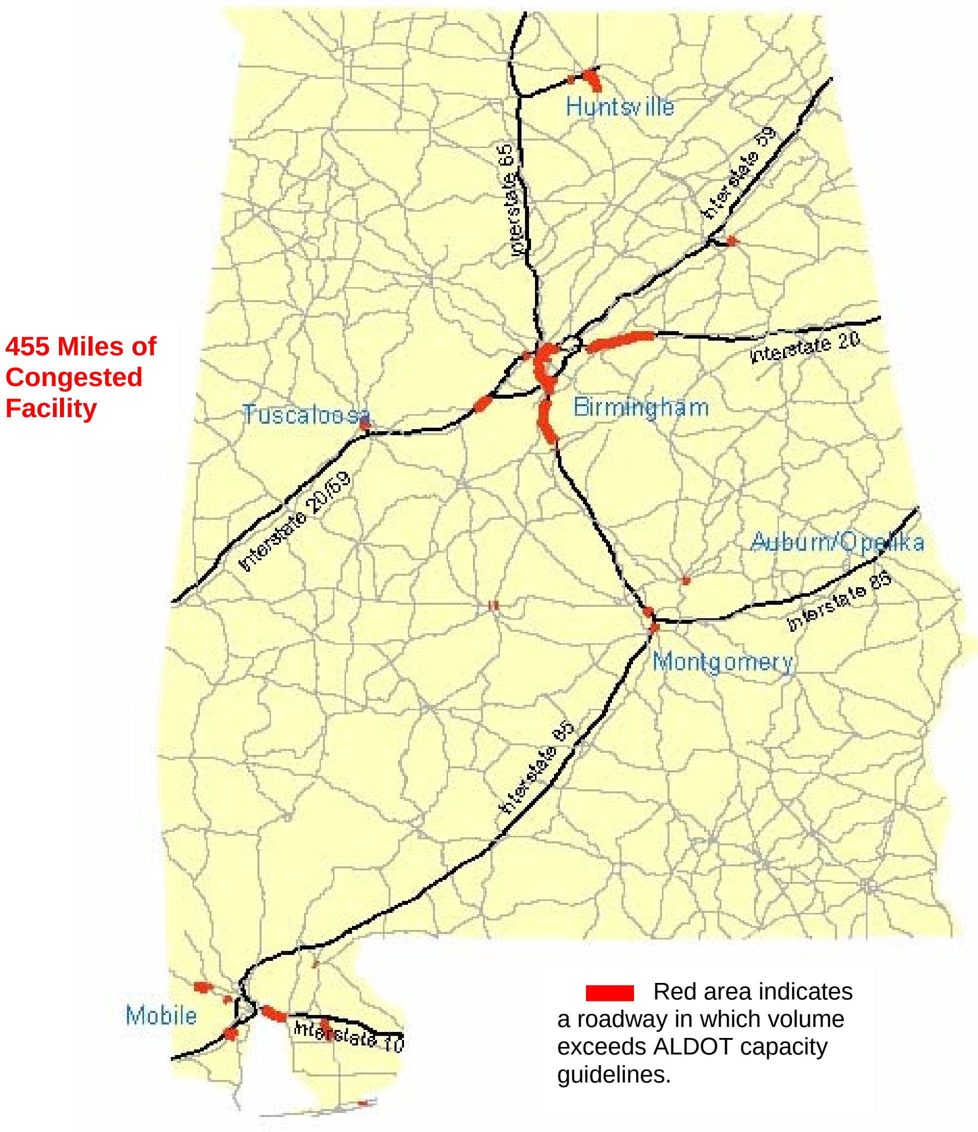
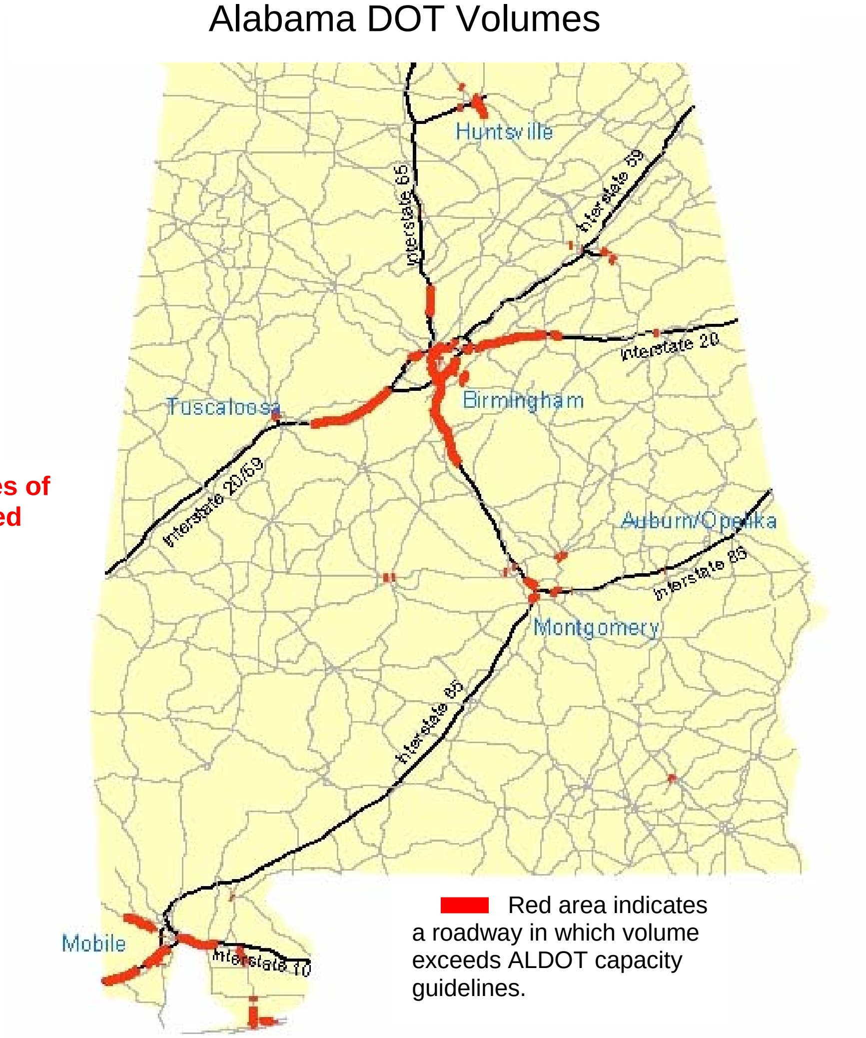


Figure ES-14 shows anticipated congestion in 2008 assuming historical economic growth rates, and Figure ES-15 presents the much greater congestion in 2008 arising from the automobile and aerospace industry clusters over the next several years. In Figure ES-14 the total miles of congested roadway is projected to be 1035, a 128% increase over 2002.

Figure ES-14
Forecast Using Historical Trend Analysis
Congested Locations 2008
Alabama DOT Volumes

1035 Miles of Congested Facility

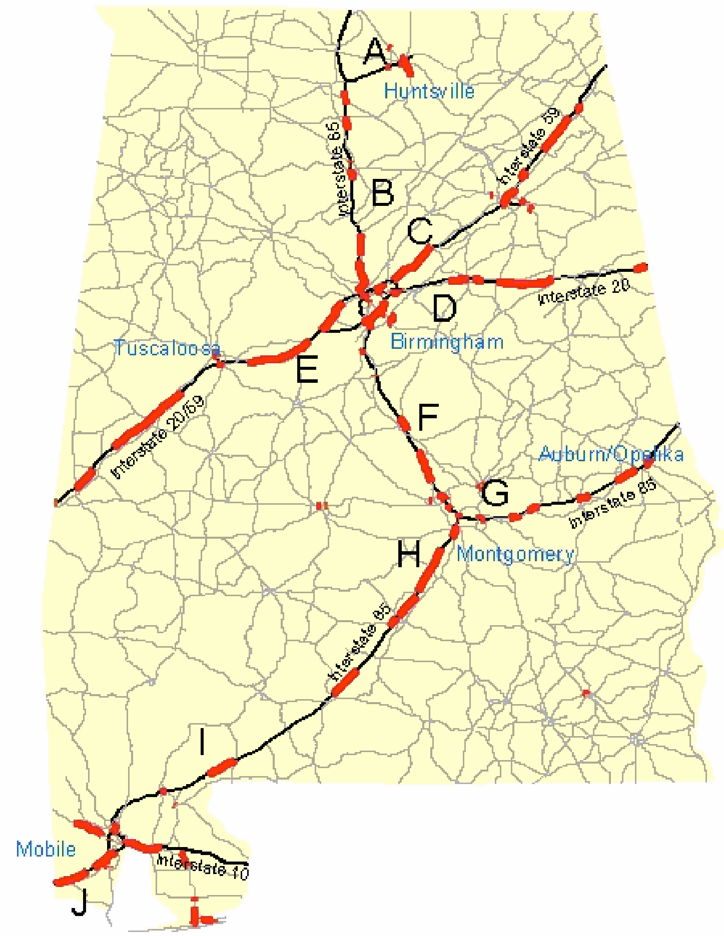


In Figure ES-15, the total miles of congested roadway is projected to be 1760. This forecast predicts a growth in congested roadways of 287% over 2002. Additionally, the inclusion of industry cluster knowledge in traffic forecasting identified 70% more congested roadway than the historical trend forecasting method (Table ES-1).

Table ES-1
Model Output of Congested Highway Miles

Year	Model Methodology	Miles of Congested Highway
2002	Actual Volume of Traffic	455
2008	Historical Trend Analysis Forecast	1035
2008	Industry Cluster Knowledge of Growth Projections	1760

Figure ES-15
2008 Volume to Capacity Ratios with Automotive and Aerospace Cluster Information Included



Map Location	2002 AADT	2008 AADT Historical Trend Forecast	% Increase from 2002 Using Trend Line Forecast	2008 AADT Forecast with Specific Cluster Growth	% Increase from 2002 Using Industry Cluster Analysis
A	57,121	67,842	18.8%	78,577	37.6%
B	48,901	58,080	18.8%	73,494	50.3%
C	29,680	35,251	18.8%	52,885	78.2%
D	61,773	73,367	18.8%	79,853	29.3%
E	53,117	63,087	18.8%	71,112	33.9%
F	43,591	51,773	18.8%	82,589	89.5%
G	84,332	100,148	18.8%	137,207	62.7%
H	34,427	40,942	18.9%	52,735	53.2%
I	26,082	30,978	18.8%	33,165	27.2%
J	53,729	63,814	18.8%	65,314	21.6%

The construction of the traffic demand model brought forth several observations. First, forecasting traffic based on historical rates and growth is going to leave the state unprepared to deal with infrastructure demands shown in Figures ES-14 and ES-15. In these two depictions of model output, historical growth was applied to ES-14 and knowledge based on specific industry characteristics and growth was applied to ES-15. If traditional methods were used to plan, as shown in ES-14, a severe lack of capacity would develop with little or no warning from the forecasting tools. It is quite apparent that a traffic plan established for a 128% increase in congested roadway would be inadequate for an actual increase of 287%.

An additional issue with forecasting tools comes from the source of data used to prepare the forecast. Traditional freight forecasting models utilize employment and SIC or NACIS codes to calculate freight generated. This method of forecasting does not take into consideration the productivity improvements implemented by a company to improve the competitiveness of the organization. Productivity improvement can result in an increase in production with the same number of employees or the same production with fewer employees. In either instance the traditional forecasting methods will understate the freight requirements. This leads to the realization that employment and industry codes are not adequate predictors of freight need generation in a region, a finding of this research during the modeling phase.

Another finding from the modeling effort was that the lead time to add capacity to Alabama's transportation infrastructure is often longer than the time period by which the infrastructure will be at, and over, capacity. There needs to be substantial effort made to investigate alternatives to building capacity.

Conclusions and Recommendations

Alabama infrastructure requires substantial financial resources for improvement and maintenance. It is imperative that funding for the Alabama Department of Transportation be increased to meet the needs of future economic growth. With the problems and opportunities facing Alabama, it is especially important that funding be preserved and not diverted from ALDOT for non-transportation related projects, as frequently happens.

The research described above produced two major findings: first, anticipated growth in major industry clusters will strain the existing infrastructure and potentially limit future growth; and second, because of its current industrial base, geographical location, and natural resources, Alabama has the potential to assume a major role in transportation, logistics, and distribution as the Freight Gateway to Mid-America. This potential new role in the global supply chain will only enhance the current outlook for the state's economy. Alabama is in a unique position to benefit from an increase in the globalization of trade. But to take full advantage of this opportunity, it is important that a systems approach be taken in the evaluation and understanding of the transportation infrastructure. By evaluating and acting on the transportation network as a functioning, interacting system, Alabama can become the Freight Gateway to Mid-America.

Industry Cluster Research

It is important that the understanding of the industry clusters developed during the course of this research be continued and enhanced. The automotive and aerospace industries are vital parts of the Alabama economy and periodic surveys will be necessary to stay abreast of the growth and impact. This process should be expanded to include additional industry clusters in the state. Not only is an understanding of the growth of the industry important but additional information specific to industry clusters can be acquired and used to enable growth.

Establish Freight Demand Functions Based Upon Industry Clusters

The forecasting of freight traffic is commonly performed by estimating truck traffic as a percentage of a forecast for overall traffic flow. The percentage of truck traffic used in the forecast is calculated by randomly sampling a segment of overall highway traffic. This is a very indirect method for forecasting freight and essentially separates the forecast from the specifics of the underlying industry and any specific changes or growth in the industry mix. A direct freight forecast based upon industry economic activity offers an improvement to the forecast based upon a percentage of overall traffic flow. A project to establish a more direct relationship between the major traded industry clusters in a region and the freight traffic generated as a result of that cluster activity should be undertaken. Both gross cluster product and the number of cluster employees should be investigated as indicators of cluster economic activity in the relationships for forecasted freight traffic. The task result would be a methodology to build a forecast based upon the traded cluster makeup of the region and the ability to more accurately forecast demand on the infrastructure created by economic growth and industry recruitment.

Impact of Modern Supply Chain Strategies on Freight Traffic

Many industries in the U.S. are heavily focused on reducing waste, improving efficiencies and increasing return on assets. Supply chain strategies are increasingly being used to achieve these goals. For example, excess inventory is a waste and an unnecessary financial asset. Companies are increasingly turning to Just-In-Time delivery in order to reduce inventories. The frequent deliveries, however, often multiple times a day for large assembly plants, increases truck traffic on a daily basis. Similarly, demand for precise deliveries often results in less than truck load deliveries, again increasing truck traffic. On the other hand, vendor managed inventory facilities located in close proximity to manufacturing facilities, reduces inventory owned by the manufacturer as well as reducing traffic flow. A project to develop a multi-stage (customer, distributor, manufacturer, first, second and third tier suppliers) system dynamics model of the supply chain should be developed. The model would be used to develop estimates for truck traffic based upon alternative supply chain and inventory management policies including JIT (just-in-time) and VMI (vendor managed inventory). The results of this project would be used in the development of an Alabama Transportation Infrastructure Model and a long-term system dynamics model.

Develop an Intermodal Traffic Simulation Model for Alabama

The highway traffic model developed in 2004 calculated a deterministic “snapshot” of average traffic flow during a day. Peak traffic flows were estimated based upon ratios to average flow. The model incorporated no interrelationships between modes of shipping, i.e., truck, rail, air or water. The Alabama Transportation Infrastructure Model (ATIM) would overcome many of the limitations of the earlier model. The proposed model would be a discrete simulation that will create traffic flows over a twenty-four hour day. Automobile traffic and truck traffic would be independently calculated and used to simulate overall traffic flows. The model will also incorporate dynamics between modes of shipping. The ATIM should be stochastic in that it will incorporate the random variation inherent in transportation systems as well as the complex interactions of how freight moves over the transportation network and through intermodal connector points.

The ATIM could then be used to estimate how changes in the network or changes in utilization of network components will impact the performance of the overall transportation system and effectively communicate the expected performance of system investment alternatives through powerful visualization and animation presentations. ATIM outputs would include the transportation mode freight movement by system segment and time of day, the ability to perform “What-If” scenarios that can be compared to determine cost/benefit analysis and the ability to highlight problem areas by time of day providing an understanding peak demand system needs.

Determine the Infrastructure Requirements of Targeted Industry Clusters

This project would determine the infrastructure requirements of targeted industry clusters, develop economic payback models of improvement scenarios, identify interrelationships among specific cluster growth rates and input factors (tax and incentive policy, shipping requirements, workforce needs, etc.). This would provide information to the system dynamics model of Alabama infrastructure.

Analyze the Dynamics of Changing Freight Mode

It is necessary to understand and examine the factors that cause a company to review and change their existing mode of shipping freight. The key variables that influence a company to switch freight modes would be incorporated into model equations. Delays, constraints, and limitations to intermodal shifts will be identified. This task will provide input components to the system dynamics model of Alabama infrastructure.

Development of Preliminary System Dynamics Model of the Alabama Transportation Infrastructure

The highway traffic model developed in 2004 provided a calculated average snapshot of highway traffic for a day for the interstate and secondary highways of Alabama. Alternative assumptions for economic growth could be used to generate snapshots of future congestion. This model, however, did not show variation during the day nor did it include other forms of transportation and shipping. The ATIM model described above will simulate all forms of shipping and transportation during a twenty four hour day. This will allow investigation of peak congestion and impacts of network and infrastructure improvements. Neither of these models however has the ability to examine the long-term interaction between a state’s economy and the transportation infrastructure. These dynamics are influenced by several long-term feedback loops that interact, influence, and in many ways determine the evolution of a state’s well being. One positive feedback loop is the dominant loop identified for cluster growth: as a cluster grows, support resources such as workforce, knowledge base, etc. also increase, thereby supporting continued growth of that cluster. Silicon Valley, Boston and Austin are often cited as examples of cluster growth. On the other hand, traffic congestion is often cited as a constraint to cluster growth. This negative loop arises from cluster growth leading to traffic and congestion and thus inhibiting future industry growth. Another set of dynamic interrelationships involve growth, tax revenues, and future infrastructure improvements to ease congestion. Policies affecting transfer of freight from truck to rail or water can also have multiple impacts through the various relationships, both on highway traffic and the economy. In this project a preliminary system dynamics model that will quantify these interrelationships and develop long-term outlooks for the Alabama economy based on alternative investments in infrastructure would be developed.

In conclusion, the need for a systems approach to freight and traffic analysis and planning was noted in the current USDOT strategic plan: “Americans have built a vast and highly productive network of transportation assets based on the strengths of individual modes – air, marine, highway, transit and rail. Now, our challenge is to become the architects of the future blending these separate constituencies into a single, fully coordinated system – one that connects and integrates the individual modes in a manner that is at once safe, economically efficient, equitable, and environmentally sound.”[13]

The truth of the above statement was evident during the research performed by the Office for Infrastructure, Logistics and Transportation at UAH during this project. To handle the effect of increased global trade we must begin to look at the movement of freight as a system of interconnected and interrelated resources that can be flexible and efficient enough to move freight when it needs to be moved, to where it needs to be taken and at a cost that can sustain the network and keep U.S. companies competitive in a global marketplace.