THE USE OF ITS SYSTEMS TO IMPROVE COMMERCIAL VEHICLE OPERATOR (CVO) - PORT INTERMODAL FREIGHT OPERATIONS

by

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SUMMARY

The Intermodal Surface Transportation Efficiency Act of 1991 was a landmark piece of legislation in that it specifically called for the consideration of all modes of travel in the planning and programming of transportation projects. Where funding is concerned however, ISTEA primarily pertained to highway and transit programs. Confusing the issue is the stipulation that ISTEA planning encompass maritime agencies, aviation, and freight rail, even though ISTEA’s requirements do not apply to these entities (1).

In an effort to improve operations by increasing the efficiency of existing procedures, the private sector has turned towards a group of advanced technologies that include electronics, computers, and communications. When these advanced technologies are applied in whole or in part to improving transportation facilities they are known as Intelligent Transportation Systems (ITS). ITS America has defined ITS as; “... the use of information technology to improve travel and manage traffic on America’s highways and transit systems.” The goal of this national movement is safer, quicker travel. Indirect benefits are improved productivity, a cleaner environment, and new business opportunities for America (2).

Intelligent Transportation Systems have already been proven to provide substantial improvements in highway operations and in reduction of delays. It is expected that if the same technologies are applied to some of the operational problems currently facing port managers, they will also see significant improvements in efficiency and reductions in delay. European and Asian ports are already using many of the systems outlined in this report. In order for the United States to remain competitive in the Global market, it will have to become very efficient at moving freight across the oceans and across the country.

In summary, significant improvements in port operation can be gained through the use of ITS systems, assuming that institutional barriers such as labor unions can be accommodated. The use of these advanced systems is the future of intermodal freight movement.
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INTRODUCTION

The Intermodal Surface Transportation Efficiency Act of 1991 was a landmark piece of legislation in that it specifically called for the consideration of all modes of travel in the planning and programming of transportation projects. Where funding is concerned however, ISTEA primarily pertains to highway and transit programs. Confusing the issue is the stipulation that ISTEA planning encompass maritime agencies, aviation, and freight rail, even though ISTEA’s requirements do not apply to these entities (1).

One of the most important policy provisions of ISTEA called for the development of a National Intermodal Transportation System, to coordinate all modes of transportation in a unified manner. The goal of this system was to move people and goods in a safe and efficient manner. ISTEA is primarily concerned with intermodalism with emphasis on efficiency and new management systems and techniques (1).

In an effort to improve operations by increasing the efficiency of existing procedures, the private sector has turned towards a group of advanced technologies that include electronics, computers, and communications. When these advanced technologies are applied in whole or in part to improving transportation facilities they are known as Intelligent Transportation Systems (ITS). ITS America has defined ITS as; “... the use of information technology to improve travel and manage traffic on America’s highways and transit systems.” The goal of this national movement is safer, quicker travel. Indirect benefits are improved productivity, a cleaner environment, and new business opportunities for America (2).

Previously, these systems were collectively known as Intelligent Vehicle Highway Systems (IVHS). These technologies can be used at port facilities to improve productivity, reduce congestion, and lessen the impact on the environment due to emissions (3).

Background

The initial concept of intermodal freight movement began in the late 1950s, due in part to the growth of commercial trucking in the United States. The impetus for this movement was the container revolution. The smooth transfer of cargo between land and water had been one of the greatest challenges in, and to, intermodalism. Cargo which is unitized in a container can be carried by several modes such as ship, rail line and truck. The container revolution changed the way in which most freight is currently shipped. Today, over 60 percent of the world’s deep-sea cargo movement is carried in containers (4, 5).
Figure 1. below, shows a forecast of expected container growth from 1978 to 1998.

Figure 1. Containers Handled by World Port Regions 1978-1998, Optimistic Forecast (5).

As shipping lines, rail lines and commercial vehicle operators seek to reduce costs and increase the amount of freight carried, they are turning more and more frequently to new technologies for ways in which to improve the efficiency of their existing operations. One application which offers many possible benefits in many different operational areas is the group of systems that are collectively known as Intelligent Transportation Systems, or ITS.

Intelligent Transportation Systems can improve safety, save energy, enhance mobility, minimize environmental impact and spur economic growth (6). Many effective ITS systems and technologies that pertain to the improvement of freight movement already exist, and only need be applied in a logical and consistent manner.

The utilization of ITS-CVO (Commercial Vehicle Operator) systems is critical to the United States’ ability to compete in global markets. Highlighting the need for implementation of these new technologies is the recent passage of the North American Free Trade Agreement (NAFTA), which is producing staggering levels of congestion at border crossings, especially in Laredo, Texas, at the United States-Mexico border. This situation will most likely continue to deteriorate as trade tariffs between the United States, Canada, and Mexico are gradually eliminated over the next decade and a half (7).
Objectives

The objectives of this paper are to:

1. Identify common problems in Commercial Vehicle Operator (CVO) - port operations that may benefit from the application of one or more ITS systems;

2. Determine and describe any ITS systems that are currently available or that will shortly be available and that may provide operational benefits;

3. Recommend those ITS systems that are most applicable through the use of a case study and an implementation guideline; and

4. Develop implementation guidelines.

Scope

The scope of the project will include all currently available, or soon to be available ITS systems. This report identified and described those ITS systems and techniques that are expected to have some benefit in the improvement of CVO - port operations. Using the Barbours Cut Terminal facility in the Port of Houston as a case study, the author will show how certain ITS systems could be applied through the use of a newly developed implementation guideline. The body of information presented in this paper was obtained from a search of the available current literature, and from discussion and correspondence with various professionals in a variety of engineering and maritime fields.

One area that will not be addressed in this paper is the subject of institutional barriers that exist which may slow or prevent the application of existing ITS technologies. Although the technology may now exist that would have great potential in improving productivity and decreasing congestion, it is likely that it would come at the cost of many jobs, making it an unpopular if efficient.

Organization of Report

Following the introduction, the report consists of four major sections. Using the Barbours Cut Terminal in Houston as a case study, the second section identifies common operational problems that are often found in CVO - port operations. Section three will list and briefly describe those ITS systems and techniques that show potential for improving productivity and reducing congestion in and around ports. Section four outlines an implementation guideline for the use of ITS systems in ports. The last section briefly outlines the use of the guidelines using the Barbours Cut Terminal as an example where applicable.
DESCRIPTION OF COMMON CVO-PORT OPERATIONAL PROBLEMS

"The future of intermodalism depends on the ability of terminal operators to speed the flow of cargo through their facilities." (8)

One of the most important objectives of this paper was the determination of those problems that exist in port operations and that may benefit from the application of Intelligent Transportation System (ITS) technologies. Most of these problems may be common to some extent in all ports, regardless of size or geographical location. In general, improvements will not come in the form of new equipment, but rather in the arena of state-of-the-art information systems (8). The final goal of today’s port operators is to provide a “seamless” freight movement system that smoothly moves cargo between the various transportation modes to its final destination.

Some significant research has already been completed in this area, usually focusing on a single port or terminal complex. This section outlines the basic operations that are common to most ports, using the Barbours Cut Terminal in the Port of Houston as a case study. This section also includes a brief background of how commercial vehicle operators function in and around a port/terminal facility.

Once the background was established, a description of several operational problems that are commonly found in day-to-day port activities was listed. It should be noted that some of these problems have already been addressed, either at the Barbours Cut Facility, or at some other port in the United States or Europe.

Typical Port Activities

The locations of port and rail terminals were generally determined from local geographical and population parameters. Most ports are situated near obvious harbors, such as San Francisco, New Orleans, and New York, whereas rail terminals (vital to intermodal movements) were generally located in close proximity to large population centers such as Los Angeles, New York and Philadelphia. This is important to understand in light of the fact that a large percentage of all freight is moved in containerized units which may be moved from ship to rail to truck (4).

Types of Ports

In the United States there are basically two different types of ports: the operating port and the landlord port. In a landlord port operation the terminals within the port are leased by private concerns. The other type, the operating port system, is owned and operated by a port authority, such as the Port of Houston Authority. The Port Authority is responsible for all operational and management decisions within the port. Many ports are a combination of the two systems. In other words, the port authority will operate some of the terminals within the port while the balance are leased and operated by private concerns. A good example of this type of operation is the Port of Baltimore, which is managed by the Maryland Port Administration and the Maryland Department of Transportation (3).
Types of Terminals

There are two basic types of cargo terminals in the United States: grounded and wheeled. The grounded type of terminal derives its name from the fact that containers are placed directly onto the ground. In the wheeled variety, each container is mounted on its own wheeled chassis. As can be expected there are advantages and disadvantages to each system. The grounded system has the advantage that the terminal operator does not have to provide a chassis for each container, thus saving on hardware costs. Grounded operations also lend themselves more easily to computerization due to the widespread use of straddle cranes which can help to inventory containers as they move them. Additionally, grounded operations allow for higher storage densities by stacking the containers, often resulting in 4 to 5 times more containers for a given storage area.

However, there are also distinct disadvantages to the grounded system. In this type of operation, container movements are often very slow due to the frequent need to move multiple containers to reach the desired container. Each container also requires the use of a straddler crane to load the container on or off of the chassis for each movement. This type of operation also prevents a truck driver from moving directly from processing at the gate to picking up the desired chassis and departing. The need to wait for an available straddle crane results in delays that the CVO operators have no control over. This situation will be discussed in greater detail in the Operational Problems section (3).

As was the case with the grounded system, the wheeled mode of operation also has its pros and cons. The pluses of this system include much quicker turn-around times for CVO operators, less container damage due to less frequent handling of the container, and the ability of the wheeled chassis to be off-loaded from a ship and placed directly onto an over the road (OTR) chassis that can be driven directly from dockside out of the port facility. There are also drawbacks to this system, the most significant being the extensive land requirements for storage of the chassis. Additionally, this necessitates a large number of chassis to be ready for each container off-loaded from the ship (3).
One of the most critical junctions in the intermodal process is the container port. It provides a critical interface between the shipping lines, railroads and over-the-road trucks, as represented by the commercial vehicle operators (CVOs) (9). It must be remembered that all agents involved in the intermodal movement of freight are “for profit” agencies. In other words, their profitability hinges directly on their ability to quickly and efficiently transfer cargo between the various transportation modes, be it ship to rail, or ship to truck. The ship is the most expensive piece of the chain, and it is therefore critical that the ship be serviced as quickly as possible. The ability to effect quick turn-around times in turn depends on how efficiently the operations within the port are coordinated (9). Also of concern are any factors exterior to the port that may effect one of the cogs vital to its operations. An example of this could be a severe refinery accident that prevents trucks from entering or exiting the port.

In general after the ship has docked, off-loading of the containers on the deck will commence (see Figure 2). It should be noted that these above-deck containers only represent a portion of the total load, much of which is carried below decks. However, in order to unload these containers it is often necessary to remove the containers stacked on top of the ship’s hatch covers. These large metal plates are the covers for the cargo holds of the ship. These may sometimes be stacked three or four deep during the unloading process. There are also priority hatches known as “hot hatches”, that are supposed to offer priority service to customers by being the first to be off-loaded (problems with these hatches will be discussed in the Operational Problems section). Finally, the order in which the containers are off-loaded from the ship can have serious consequences on the stability of the ship (9).

Figure 2. Wharf Crane Off-Loading Container from CVO Truck Directly onto Container Ship.
Once the containers are off-loaded they have to be stored in some manner. As previously discussed there are two primary methods of accomplishing this: grounded and wheeled storage. Ground stacking of the containers is the more common of the two methods (9). This method allows similar cargo or container types to be stacked together in designated sections of the storage yard. Stacking of containers necessitates good bookkeeping of the container locations be kept in order to minimize lost or misplaced containers.

The other method, known as wheeled operation, stores the containers on the chassis that the container entered the port on. This method is used at the Barbours Cut facility in the Port of Houston. As previously mentioned there are advantages and disadvantages to each system.

*Example of a CVO Operator Picking up a Container*

When a truck driver wishes to pick up a container from the Barbours Cut Terminal the following basic steps must be taken:

1. The driver must present information at terminal entry gate and fill out a transaction request, also at this time the truck will be weighed and the lane clerk with provide the driver with a equipment interchange receipt (EIR) (see Figure 3);

2. Once initial approval is confirmed, the driver enters the terminal and proceeds to park his truck and enter the customer service building where his documentation and EIR will be checked and entered into the ports computer system;

3. If all paperwork is found to be in order, the driver proceeds to a checker who checks all incoming containers for any damage or vandalism;

4. At this point the driver proceeds either to a container berth to wait for a gantry crane to off-load the container, or to another container berth to wait for a gantry crane to load the correct container, also at this time the container number is to be verified against the EIR;

5. Once the driver has been loaded with the correct container(s), he/she proceeds to the terminal exit lane at which point he/she has to have the outgoing container checked for any signs of damage or vandalism and at the same time the truck and chassis are checked for road-worthiness. Once the driver has been cleared by the checker he must give his EIR and his/her gate pass to the exit lane clerk, after which the driver may then exit the terminal.
This is only one possible permutation of events that may transpire when the driver attempts to enter the Barbours Cut Terminal. However, even this basic example shows that there are many areas where there are possibilities for delay in the different links in the loading/unloading process.

It also points out the number of times that information must be entered or passed between people and agencies. Each one of these information transactions presents an opportunity for an error in data entry further delaying and confusing the issue. It has been estimated that under current operating conditions at the Barbours Cut Terminal Facility, approximately 20% of all entering drivers are “rejected”, meaning that they must wait in a customer service area until the terminal receives additional or new information from either the trucking agent or the shipping line.

Figure 3. Main Truck Entrance for Terminal 1, Barbours Cut Terminal, Port of Houston.
COMMON OPERATIONAL PROBLEMS IN CVO-PORT OPERATIONS

From a review of the existing literature and from discussions with port managers, some operational problems that are common to many ports were identified. Some of these problems relate to operations within the port itself, while others are concerned with external factors that may impact directly or indirectly on port operations. It should be noted that although no discussions were conducted with CVO operators due to time constraints, one of the references (by Easley and Walton), did conduct lengthy interviews with truck drivers which yielded some of the problems listed below (3). These problems are listed, and then described in detail below.

- Delays due to paperwork and inspections upon entering the terminal gate;
- There is no communication between the Port and the state DOT, or the local or regional traffic control center regarding construction projects or incidents/accidents;
- No “First in First Out” (FIFO) Truck Service Policy Currently Exists;
- No land-side priority cargo service plan currently exists;
- No real-time container inventory system currently exists; and
- Absence of a real-time communication link between the rail lines and the terminal.

Delays Due to Paperwork and Inspections Upon Entering the Terminal Gate

In general, when a truck operator attempts to enter a terminal he must have in his possession at a minimum, the following pieces of information/paperwork: a placard on the truck identifying the trucking line he is currently working for, a booking number (provided by the shipping line that contracted the trucking agent), a bill of lading, the container number (if one is to be picked up), a valid drivers license, documents identifying the driver as a registered driver of the shipping line in question, and if necessary, the proper credentials stating that the driver is qualified to transport hazardous materials (10). If any of this information does not match when it is entered into the ports’ computer system, the driver is rejected and must wait while the information is either provided or corrected by the trucking or shipping line(s).

Another complication that exacerbates this situation is the fact that in many areas of the U.S., most of the drivers are independent owner-operators. Approximately 70% of all truck drivers servicing the Barbours Cut facility are independent owner-operators. This results in situation where one driver can drive for two or more trucking lines, and may even make trips for different trucking lines in one day. This is a real consideration when one considers that well over 130 major trucking lines service the Barbours Cut facility (11).

This problem is not unique to the Barbours Cut facility. Since the trucking industry was deregulated, owner-operators have become the norm and not the exception.
There is no Communication Between the Port and the State DOT Regarding Construction Projects or Incidents/Accidents

Often there is no communication between the local or regional advanced traffic management center (ATMC), and the port, regarding any incidents that may effect the arrival or departure of trucks into or out of the port terminals. This could be critical if there are not enough trucks to service a ship that is in the process of being unloaded. The shipping lines are the most important clients that the port serves, and it strives to minimize the amount of time that each ship is in port. Anything that could delay this will cost the shipping line money, and is therefore to be avoided at all costs.

Additionally, there is usually no coordination between the DOT and the Port regarding any current or planned construction projects that may have an impact on the ability of CVO operators to get into, or out of the port.

No “First in First Out” (FIFO) Truck Service Policy Currently Exists

Once the truck drivers have cleared the paperwork at the gate they will then to proceed to the container berth section where their container is being stored and wait for the next available gantry crane to service them. However, the cranes that service the trucks (which are separate from those that service the ships) do not process the trucks in the order in which they arrived but rather in order of convenience to the gantry operator. In other words the operator will move down a given container berth line (see Figure 4) servicing trucks as he goes.

Figure 4. Typical Container Off-Loading Procedure using a Rubber Tired Gantry (RTG) Crane.
He will not in other words move up and down the line, or back and forth between lines (which is a very involved procedure requiring the gantry operator to rotate the gantry wheels) to service trucks in the order in which they cleared the entry gate. This forces truck drivers to queue for the next available gantry crane and is economically wasteful and potentially very unfair, submitting some drivers to lengthy additional delays (3).

**No Land-Side Priority Cargo Service Plan Currently Exists**

Like most other ports in the United States, Barbours Cut offers a priority cargo service to the shipping lines. This is generally referred to as “hot-hatch” cargo and is loaded in a special hatch in such a way that it can be among the first container(s) to be off-loaded from the ship very after docking. The problem begins once the cargo is off-loaded. There currently exists no established procedure for the driver of the priority truck to be served first. As previously noted under the FIFO problem, truck drivers are not served in the order in which they were processed, but rather in the order in which the gantry cranes can get to them.

**No Real-Time Container Inventory System Currently Exists**

Under usual operating conditions, the location of containers is radioed by the gantry operator as he/she places the container in a space in the container berth areas. The terminal headquarters then has an inventory clerk who will then manually enter the radioed location of the container with the container number into the ports’ computer system. This system allows multiple chances for human error either in the reading of the container number or location by the gantry operator, and in data entry by the inventory clerk. Further complicating matters is the re-stacking of containers by terminal employees whenever they wish to move a container that is currently buried under one or more other containers.

A real-time inventory system would also eliminate several other problems such as the time wasted searching for a container that had already been picked up, and the problem of a trucker arriving to pick up a container that has not been cleared by the United States Custom Service (3). Both of these problems can force a driver to leave the terminal without a container, thus necessitating a second trip, wasting time and money.

**Absence of a Real-Time Communication Link Between the Rail Lines and the Terminal**

Most ports in the US are serviced by several rail lines. Barbours Cut Terminal Facility for example is serviced by nine rail lines. At present, none of these rail lines communicate their schedules with the terminal. The only restriction that the terminal places on the rail lines is that all loading and unloading must be completed between 11:30 pm and 6:00 am. Occasionally the rail lines are unable to comply with this, causing some minor problems with trucking operations in the terminal.
In other ports around the country such as Southern Pacific’s ICTF in southern California, truck operators must cross rail lines to enter or exit the terminal (4). In these situations significant delays to CVO operators can occur when they arrive during a train entry or exit from the terminal. Additionally, potentially long queues of trucks may develop which will produce large quantities of pollutants, waste energy, and congest the local traffic system.

Even a cursory examination of these problems will point out the critical need for up to date, factual information. One of the strengths of ITS systems is their ability to rapidly and accurately transfer information from one point to another. Whether it is a changeable message sign that allows for the dissemination of real-time traffic conditions to motorists, or automatic vehicle identification (AVI) systems that generate the traffic information in the first place, ITS systems are vital tools in the effort to move people and goods in a safe and efficient manner.

The next section will show how some of the current systems may be applied to the aforementioned problems facing CVO and port operators.
CURRENT INTELLIGENT TRANSPORTATION SYSTEMS (ITS) THAT MAY PROVIDE EFFICIENCY BENEFITS TO CVO AND PORT OPERATORS

There are many ITS systems that are currently available. The task is to figure out which of these are going to provide the best operational benefit for the cost involved. It must be remembered that both the CVO and port operators are for-profit agencies that will look at the purchase of ITS systems from a cost/benefit ratio. Another factor that must be considered is that any system that is to be used in port operations must be feasible from installation, maintenance, and operational standpoints.

Candidate ITS systems that may have the potential to provide operational benefits to CVO - port operations are listed below and will be described in detail.

- Automatic Vehicle Identification (AVI)
- Automatic Equipment Identification (AEI)
- Automatic Vehicle Location (AVL)
- Real-Time Interface with Regional Advanced Traffic Management Center (ATMC) and with the local department of transportation
- Electronic Data Exchange (EDI)
- Changeable Message Signs (CMS)
- Closed-Circuit Television (CCTV)
- Truck Operator “Smart Cards”
- Weigh-In-Motion (WIM)

**Automatic Vehicle Identification (AVI)**

An AVI system is an electronic system that enables the identification of vehicles through the use of a reader system and a transponder tag mounted on the vehicle. Automatic vehicle identification is becoming a popular system for both commercial vehicle operators and for electronic toll collection. To date its primary use has been for electronic toll collection (12). One added benefit of having a large number of vehicles equipped with AVI transponders in the traffic stream is that they may act as probes, allowing traffic engineers to determine how well traffic is flowing along a given section of roadway.

A typical AVI system consists of the following components:

1. AVI Read/Write Technology;
2. Roadside Equipment;
3. Communication Equipment (from readers to control center);
4. Control Center; and
5. Closed-Circuit Television (CCTV).
AVI Read/Write Technology

The most critical part of the system is the AVI read/write technology. In general these systems have two main components: a tag on the vehicle that can be either read only or read/write, and a reader that can read the information recorded on the tag. Each vehicle tag has a unique identification number that identifies the vehicle. The tag may also have a host of other information, such as the organization of the issuer, the owner’s address/phone number, etc. Basically, the tag can have any information that the owner wishes it to have. It is this flexibility which makes this technology so attractive. There are four main varieties of tags:

1. Radio-Frequency/Microwave;
2. Optical;
3. Infrared; and
4. Inductive Loops.

Radio-Frequency

The radio-frequency (RF) variety is by far the most popular based upon current installations. This type of system would be a good choice for port operations due to its operational characteristics and its relative low cost. An excellent example of this type of system may be found in Houston, Texas, which has an extensive system that encompasses all of the major freeways in the area and which will eventually include over 483 kilometers (300 miles) of highway and over 161 kilometers (100 miles) of HOV lanes (13).

The RF system uses a transponder on the vehicle that can be either active or passive. Active tags are self powered usually by a battery, and generate their own signal while passive tags use some of the readers’ radio energy to reflect a signal back to the reader. The tags for either system are fairly inexpensive, costing on the order of $40-$50 apiece. The readers themselves range in price but cost approximately $10,000 per reader. It should be noted that relatively few readers would be needed in a terminal environment (12).

Roadside Equipment

A roadside computer is paired with the reader to process the tag identification number of each vehicle as well as any other information that the tag may have. It will also encode any information that is to be sent to the tag, and decode any information that is to be sent to the control center.

Communications Equipment

Most current AVI systems in the United States use leased telephone lines to communicate between the reader, roadside equipment, and control center. Planned AVI facilities usually specify buried fiber-optical cable for any new installations. In a port setting the amount of communication cable required would be very small when compared to that of a highway system due to the greatly reduced distances involved, making such a system more cost-effective.
**Control Center**

The control center collects all data that has been processed by the roadside equipment, and stores it in a large database. The control center can also control the flow of information to the AVI reader which will then broadcast it to the tag on the vehicle updating or changing the information stored on the tag. In addition to data management, the control center also monitors all of the equipment and may supplement its operations with closed-circuit television (CCTV).

**Closed-Circuit Television (CCTV)**

Most AVI systems augment their abilities with closed-circuit television, usually for enforcement purposes and for use in case of incidents. In a port setting, a CCTV system would most likely be used to verify the condition and identification number of incoming containers. If videotaped, this would provide a permanent record of the containers’ entry and exit condition. This would be very useful for settling the very common damage claims that are filed against ports. Another use would be to monitor the overall performance of the terminal gates. When queues in either direction became too large the terminal manager could open additional gates (3).

**Automatic Equipment Identification (AEI)**

Automatic equipment identification is very similar in technology and operations to automatic vehicle identification (AVI). As with vehicle identification, this system utilizes an on-board transponder that communicates with a roadside or station receiver. Where an AVI system may be used for toll-collection or for expediting the processing of paperwork, an AEI system will probably be used primarily for a check of the containers contents and for the establishment of a real-time inventory system.

An AEI system used in conjunction with a geographic information system (GIS) of the terminal would allow for real-time acquisition of a container’s location. An inventory clerk in a mobile inventory vehicle would be able to send out a radio query that would enable the container to be located on the facility. When used in conjunction with a GIS system it would allow for more efficient inventory control. It would also serve to eliminate the common problem of a misplaced container when a crane operator moves a stacked containers to get to another one.

Finally, AEI would serve as a means of giving the terminal operators an instant picture of the contents of the container. This would be especially useful for containers that held either hazardous materials (HAZMAT), or that required refrigeration.

**Automatic Vehicle Location (AVL)**

An automatic vehicle location system is an electronic system that delivers real-time vehicle positioning and monitoring of individual vehicles. Having the ability to track and monitor all vehicles in a given fleet allows for exceptional command and control. AVL systems function similarly to AVI systems and have the same basic system components (14).
However, instead of a reader, AVL systems make use of either radio towers or satellite communications. In a tower system, the vehicle’s position is determined by using multilateration of the radio signals. The satellite system is similar in operation but has a much greater range (i.e. the world) and is more expensive. In some systems the vehicle transmits its location back to a control center by using inertial or dead-reckoning systems.

This type of a system could be used to keep track of trucks within the terminal and provide and instantaneous inventory system for containers. The major drawback of that application is the fact that all containers must have a transponder, or the terminal operator must attach and then remove the transponders from each container. This is an extremely labor-intensive operation. For that reason the use of AVL type systems are limited to closed systems such as Matson’s Hawaii facility (11).

If all container owners decided to equip all of their containers with transponders a revolution in container inventory and movement tracking would occur. However, at this time it is economically unfeasible for such a system to be implemented.

**Advanced Traffic Management Center (ATMC)**

An advanced traffic center will integrate the management of various roadway functions, such as, ramp metering, arterial signal control, and changeable message signs. An ATMC will collect, utilize and disseminate real-time traffic data for a network of significant arterial streets and freeways within the local highway system. An ATMC will also coordinate multi-modal information between local public transit authorities, the state department of transportation, and the city traffic department (6).

Data will be collected from a variety of sources including police, local traffic reports, the state department of transportation, any motorist assistance programs that may be in existence and from motorists, many of whom have cellular-phones which often give the most up to date information available. Some areas will also be able to make use of automatic vehicle identification (AVI) systems that have be installed as part of a traffic monitoring system or an electronic toll-collection system (ETC).

Vehicles equipped with AVI tags will act as probes in the traffic stream and allow the traffic center to track their progress through the roadway network, thus yielding a real-time picture of any possible incident sites or locations of congestion. This information will allow for the dynamic routing of drivers around bottlenecks where possible, and will be particularly effective when used in conjunction with changeable message signs (CMS) to mitigate the effect of incidents, roadway construction and congestion, thus reducing delay and emissions.
Electronic Data Interchange (EDI)

In the freight business, documents and data concerning cargo, its destination and its means of transport, must be transferred between shippers, consignees, carriers (rail and truck), terminal operators, government agencies, and transportation facilitators such as drayage companies. Expediting the movement of the information between the various agencies is of vital importance, and can even be more important than the movement of the cargo itself (6).

Electronic data interchange (EDI) is a means of facilitating the flow of information between the interested parties. EDI allows the users to electronically transfer the bill of lading, shipper ID, consignee ID, buyer ID, cargo description, cargo weight, invoice number, any HAZMAT information, and any government required documentation (17). EDI is considered a value-added-data-service (VADS), that helps to reduce shipping costs and improve efficiency.

There are many advantages to EDI. It is much faster than mail, usually taking only a few seconds to send data. It reduces errors in the flow of information between the interested parties. By sending information electronically, the need for entry and re-entry of data is eliminated, thus removing one of the common points of error. EDI also offers real-time control of cargo and inventory. When used efficiently, it can help reduce dwell times at transportation/mode hubs, and improve the efficiency of equipment utilization. EDI is therefore a very important part of intermodal movement of freight.

Weigh-in-Motion Systems (WIM)

A weigh-in-motion system is used to dynamically measure truck axle weights while the truck is in motion, with accuracies of ± 5-15%, when compared to the statically measured weight (18).

Piezoelectric cable systems are the most common systems currently in use, with fiber-optic cable WIM systems likely to become the system of choice in the future. WIM systems operate by measuring axle weights as the tires of the vehicle pass over the sensors. In general, WIM systems can measure single and tandem axle weights, and when coupled with an automatic vehicle detection, system can be used to aggregate gross vehicle weight (18).

Current technology allows for low-speed, off-highway measuring of truck weights. This is due to the fact that the forces exerted on the pavement by the vehicle as it bounces up and down on its’ springs can vary drastically from the forces exerted by the vehicle on the pavement when the vehicle is stationary or moving at low-speeds (18). It is expected that truck weights will be measured on the highway and at normal operating speeds within 10 years at most. At present, 20-50% of all interstate highways are equipped with WIM systems, with almost all of the national highway network being equipped within 20 years (6).
WIM systems can increase terminal operational efficiency by eliminating or reducing queues of trucks as they enter or exit the terminal facility. It can also allow for a permanent computer database record of truck weights which could be used for enforcement purposes, the settling of disputes or further analysis. An accurate WIM system is of particular importance in Mexico-border states such as California, Arizona and Texas that may have to contend with Mexican tractor-trailers with much higher maximum loading capacities.

**Changeable Message Signs (CMS)**

Real-time traffic information plays an increasingly important function in efforts to improve operations, utilize existing facilities and improve highway safety. When used in a highway setting, changeable message signs (CMSs) are used as traffic control devices for the regulation, routing, and management of the traffic stream. They are used to effect the real-time behavior of motorists in order to improve traffic flow (19).

In a port or terminal setting, a CMS may be used to direct trucks upon entering the facility, to the correct lane for processing, as is the case with the Seagirt Marine Terminal in Baltimore, Maryland (3). It may also be used in its traditional format to deliver real-time traffic information to the CVO operators so that they may select the best route to the terminal, and for drivers leaving the facility so that they may avoid any incidents or congested areas. This could be a critical benefit especially when it comes to any delays that may be incurred in unloading the container-ship due to a lack of available trucks.

**Truck Operator “Smart Cards”**

These cards are similar to those that are designed for transit use, and can contain the truck drivers’ license, a photo ID, social security number, any HAZMAT qualifications that the driver may have, and the trucking company currently being represented. These cards would be of a read/write variety and would allow for updates by the trucking lines currently under contract.

They would be of one of two types either, bar-coding or magnetic strip. The technology chosen would depend on the terminal’s preferred use of the cards, and whether or not one of the systems already existed on the facility for some other purpose.
IMPLEMENTATION GUIDELINES AND BARBOURS CUT TERMINAL CASE STUDY

In this section the author will first develop implementation guidelines for the use of Intelligent Transportation Systems (ITS) in CVO-port operations. The author will then apply the guidelines to the case study of the Barbours Cut Terminal in the Port of Houston. Only ten ITS systems are listed in the implementation guidelines. It should be realized that this is by no means a comprehensive list of all possible technologies that are currently available or that will become available in the near future.

Table 1. ITS Systems Application Guidelines.

<table>
<thead>
<tr>
<th>ITS System</th>
<th>Relative Cost</th>
<th>Availability</th>
<th>Benefits/Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automatic Vehicle Identification (AVI)</td>
<td>Medium</td>
<td>Currently Available</td>
<td>Will greatly Reduce Operational Delays</td>
</tr>
<tr>
<td>Automatic Equipment Identification (AEI)</td>
<td>(Very) High</td>
<td>Currently Available</td>
<td>Costly to Implement</td>
</tr>
<tr>
<td>Automatic Veh./Equip. Location (AVL)</td>
<td>High</td>
<td>Currently Available</td>
<td>Costly to Implement</td>
</tr>
<tr>
<td>Real-Time Interface with Advanced Traffic Management Center and the DOT</td>
<td>Very Low</td>
<td>Tech. Available, not yet Implemented</td>
<td>Easily Implementable, will Provide Good Benefits for Cost</td>
</tr>
<tr>
<td>Electronic Data Exchange (EDI)</td>
<td>Low</td>
<td>In Use</td>
<td>Proven Technology, reduces delays and paper work</td>
</tr>
<tr>
<td>Changeable Message Signs (CMS)</td>
<td>Medium</td>
<td>Currently Available</td>
<td>New Application of Existing Technology.</td>
</tr>
<tr>
<td>Closed-Circuit Television (CCTV)</td>
<td>Low</td>
<td>In Use</td>
<td>Proven Technology, provides monitoring capabilities</td>
</tr>
<tr>
<td>Truck Operator “Smart Cards”</td>
<td>Very Low</td>
<td>Currently Available</td>
<td>Will Greatly Reduce Paperwork, Delays</td>
</tr>
<tr>
<td>Weigh-In-Motion (WIM)</td>
<td>Low-Medium</td>
<td>In Use</td>
<td>Proven Technology, reduces delays</td>
</tr>
<tr>
<td>Electronic Placarding/Bill of Lading/Container Number/HAZMAT Information</td>
<td>Low-Medium</td>
<td>Soon to be Available</td>
<td>The next step; base for “paperless” transactions</td>
</tr>
</tbody>
</table>
IMPLEMENTATION GUIDELINES

1. Determine what are the most pressing operational problems facing the port, which may benefit from the use of Intelligent Transportation System (ITS) technologies. These problems will mainly be those that involve the flow, storage and retrieval of information. Involve all interested parties. Survey CVO operators, rail line managers and shipping line managers.

2. Assess what ITS systems are available that may offer efficiency benefits to port operations (see Table 1.). Determine how much of the capital and maintenance costs of such a system may be passed onto the users (shipping lines, trucking lines, railroads, stevedore firms) of the system. If this is not possible, will gains in efficiency be sufficient to offset these costs? Determine if any ISTEA funds are available to fund the project. If the project reduces emissions from the trucks or reduces congestion, this may be a viable option. Precedents have been set for the funding of intermodal port projects (15).

Find out how the users of such a system would like it to work. Accommodate them if possible. An advanced system is worthless if it is not being utilized.

3. Determine what, if any, institutional barriers exist to ITS systems implementation. Are there any labor unions that will oppose a system that may reduce the port workforce? Will any of the agents involved (shipping lines, trucking lines, railroads, labor unions) resist providing information that may be vital to implementing the system(s)? If so, how will these barriers be overcome?

4. Once the first three steps have been passed, consult with transportation engineers and examine existing installations of any proposed system(s) so as to minimize potential problems in the installation and use of the system(s). Make use of any existing database of information on what does and does not work.

5. Perform a “before” analysis of any operations that are to receive an ITS system. Determine how long a given procedure such as checking a truck through the terminal entry gate takes. Note average times for critical operations, person-hours required for a given task, and the cost to perform a given task. This is a very important step as this will help to provide justification for both rate increases to users of the system, and for additional expenditures for other ITS systems.

6. Establish an ITS Systems Committee comprised of all of the users of the system as well as the port management, that will hold periodic meetings to assess the ITS system(s) performance. As with the ITS systems themselves, the port will operate efficiently only if the lines of communication are kept open. Use the committee members as a conduit to the rest of the employees for the purpose of implementing the system(s).
7. Prior to installation of any proposed ITS systems start a media campaign with the users of the system. Conduct training classes on how the system will function and effect the various users of the system. Show the users how the system will directly benefit them. Distribute any information or equipment that users will need to operate system before the system is operational. It is critical that the initial impression of the system be a good one. Elect an ITS contact person for each of the agencies involved.

8. Install the ITS system. Continue to conduct training classes if necessary. Have hardware consultants on call to provide technical support for their systems.

9. After waiting for operations to stabilize, perform an “after” analysis. This is also a critical step because it will show how much the new ITS system has improved operational efficiency. Perform a cost-benefit analysis to determine if the gains in efficiency offset the costs to install and maintain the system. If not, can any of the costs be incrementally passed on to the users of the system as a “value-added” service?

10. Hold monthly meetings of the ITS Systems Committee. The committee will determine if the ITS system(s) are performing efficiently. The committee will also be the group to assess the possibility of adding new systems, or discontinuing old ones.

   It should be noted that the biggest gains in operational efficiency will be made in those areas that deal in information transfer. In these areas, ITS systems offer great potential in improving port operations, reducing delays in and around the port and in reducing pollution and congestion on the surrounding roadway network.
A CASE STUDY: THE BARBOURS CUT CONTAINER TERMINAL
IN THE PORT OF HOUSTON

The Barbours Cut Container Terminal located at Morgan’s Point, on the Northwest shore of
Galveston Bay is a full service intermodal terminal that is served by over 130 trucking lines, 23
shipping lines, and nine railroads. It has five 1,000 foot long container ship berths with one more
currently under construction. Additionally it has a Roll-On/Roll-Off (RO/RO) platform with a 250
acre auto marshaling yard and a 282 foot-long LASH dock. It has a minimum 42 foot-deep mean
low-tide ship channel (16) (see Figure 5).

It has four entry points that can accommodate a total of 26 truck lanes and 16 60-ton scales.
It has direct access to all major freeways in the area. The terminal has 10 wharf cranes with a
minimum capacity of 40 tons, and a total of 18 different rubber tire gantries (RTG) for loading/off-
loading containers from trucks (16).

The terminal can handle up to five ships simultaneously but averages approximately fourteen
ships per week. On average, it requires approximately 12 hours to unload/load a ship, with a range
of 4-36 hours per ship. The terminal currently handles on the order of 60,000 containers per year
with container volume growth of approximately 21 percent (11).

Application of Implementation Guidelines

In this section, the implementation guidelines will be applied to the Barbours Cut Terminal
Facility case study. It should be noted that not all ten of the steps will be addressed in this
application due to the realities of the situation.

1. Determination of operational problems

Paperwork Delays:

From on-site interviews conducted with truck drivers by Easley (3), as well as informal
phone interviews by the author with trucking line fleet managers, the largest problem facing the
average truck driver at the Barbours Cut Terminal was the delay times that were experienced upon
entering and exiting the terminal. These problems were due primarily to the paperwork
presentation/verification process, known as “credentialling”. As previously outlined in the Common
Problems Section, the need to present and verify a number of different pieces of data can be an
extensive process, especially if any of the driver’s information is incorrect. There were also delays
upon entering due to the need for weigh-in and inspection of any containers entering the terminal for
liability purposes. Upon exiting there were similar delays as the driver must once again present
paperwork for verification.
No Real-Time Communication Link between the terminal and the Texas Department of Transportation (TxDOT):

Currently there exists no system for the real-time transfer of traffic/incident data from TxDOT’s Houston regional advanced traffic management center (ATMC) to the Barbours Cut Terminal. It should be noted that this is not a fault of either party, rather it stands as an opportunity to make use of an already existing system at little additional cost to either party while at the same time offering significant potential benefits to the terminal, all CVO operators serving the terminal and TxDOT. It is of benefit to the port by allowing the terminal operator to ensure an adequate supply of trucks arriving on-time to off-load the containers from awaiting ships. It benefits the CVO operators by allowing them to avoid delays due to congestion and incidents in traveling to or from the terminal. It benefits TxDOT by helping to minimize the number of trucks in and around congestion areas. It may also help TxDOT by reducing HAZMAT accident potential from the large number of the trucks in the area carrying petrochemical related materials by allowing them to divert around incident sites.

There are no changeable message signs (CMS) in the immediate vicinity of the port even though the port is a tremendous generator of truck traffic. The Barbours Cut facility by itself attracts 1,200 - 1,500 trucks per day. An additional constraint which could make this a more serious issue is that currently there is only one way to travel north-east out of the port and that is by using the Baytown Tunnel. However, the tunnel will not accommodate oversize loads and prohibits HAZMAT cargo, which is very prevalent due to the nearby concentration of petrochemical plants. A bridge is planned at the same location for the future, but the exact completion date is unknown.

No “First in First Out” (FIFO) Service Policy/Land-Side Priority Cargo Service Plan:

Once drivers have cleared the gauntlet of paperwork waiting for them at the terminal entrance, he or she must then proceed to get in a queue to be serviced by the next available rubber-tired gantry crane (RTG). These cranes do not process the trucks in the order in which they cleared the gate but rather in the order in which the loading/unloading process presents them to the crane. This often results in long waits for drivers that end up in the wrong area of the yard.

This problem is especially critical where there has been no provision made for the special handling of a truck that is to receive a “hot-hatch”, or priority service cargo. This situation could result in a serious degradation in service for the buyer of a priority freight service.

No Real-Time Container Inventory System:

Under current operating conditions, the gantry operator radios in the location of the container as he/she places in a designated berth space. An inventory clerk at the terminal headquarters then manually enters the containers location in the terminals’ computer system. As previously stated, this system allows multiple chances for human error in reading and entry of container locations. Additionally, as containers are moved around to access other containers that are at the bottom of a stack, containers may become misplaced. Under current operating conditions this system is currently updated every fifteen minutes.
Absence of a Real-Time Communication Link between the terminal and the rail lines:

Currently nine rail lines service the Barbour's Cut Terminal, with expanded intermodal freight service with two new spur lines planned for the near future. As can be seen in Figure 5, the rail lines cross all points of ingress and egress to or from the terminal. At present there is no coordination of schedules between the various rail lines and the terminal. The only restriction placed on the rail lines by the terminal is that all loading and unloading of rail cars is to occur between 11:30 pm and 6:30 am. Although the rail lines are usually able to abide by this rule, occasional problems do occur. When this happens, CVO operators may experience potentially significant delays. These delays could result in a long line of trucks queued waiting for entry to, or exit from, the terminal. This in turn would result in the production of large quantities of emissions, and may possibly affect the local traffic system.

2. Assess what ITS Systems are available that may offer benefits to port operations.

Examination of Table 1 (previously shown), displays several ITS systems that are both available, and may offer significant benefits to the operational efficiency of CVO-port operations.

These systems include:

- Automatic Vehicle Identification (AVI);
- Automatic Equipment Identification (AEI);
- Real-Time Interface with Regional Advanced Traffic Management Center (ATMC) and with the local department of transportation;
- Electronic Data Exchange (EDI);
- Changeable Message Signs (CMS);
- Closed-Circuit Television (CCTV);
- Truck Operator “Smart Cards”; and
- Weigh-In-Motion (WIM).

All of these systems with the possible exception of EDI, are currently in use in highway applications, and are for the most part easily implementable.

3. Determine if any institutional barriers exist that would hinder the implementation of ITS systems.

This step will not be addressed in detail in this paper except to say that it is expected that the local chapter of the International Longshoreman's Association (ILA) will probably take issue with any system that management attempts to install without their approval. Their cooperation is vital in this matter, see steps 6 and 7.
4. Consult with transportation engineers, and examine existing ITS system installations.

For the Barbours Cut Terminal installation, the following sites/installation locations should be examined for information on the installation, operation and maintenance of ITS systems:

**Automatic Vehicle Identification (AVI) System:**

Houston Toll Road System

**Real-Time Communication Link with Advanced Traffic Management Center:**

- TransGuide, San Antonio, TX
- GHTEMC, Houston, TX
- Translink, Texas Transportation Institute, College Station, TX

**Changeable Message Signs:**

- TxDOT’s Houston Operations Office

**Truck Operator “Smart Cards”**

- Houston’s “Smart Commuter” program
- Port Authority of New York and New Jersey

**Weigh-in-Motion Systems**

- TxDOT Operations Division
- Federal Highway Administration

**Automatic Equipment Identification (AEI) System**

- Union Pacific Railroad
- Santa Fe Railroad
- Southern Pacific Railroad
- Houston Toll Road System
- Matson Freight Co., Hawaii

**Real-Time Communication Link with Advanced Traffic Management Center:**

- TransGuide, San Antonio, TX
- GHTEMC, Houston, TX
- Translink, Texas Transportation Institute, College Station, TX

The ITS systems installed at these locations should be examined for similarities in operation or installation to the proposed systems. Wherever possible, examples of what has worked successfully in the past should be used as a guideline to any new installations.
5. Perform a “before” analysis of current terminal operations that are to receive/make use of an ITS system.

Once an ITS system (or systems) has been decided upon, determine the time, cost and/or person-hours required to perform critical terminal operations, such as clearing the paperwork upon entering or exiting the terminal.

This guideline will not be addressed in this paper due to scope of the process.

6. Establish an ITS systems committee.

It is recommended that the committee be comprised of representatives of each of the local chapters of the unions, a single representative of all the shipping lines, a single representative of all the trucking lines, a single representative of all the rail lines, and a terminal operations representative. Having all interested parties included in the decision making process will help to ensure that any system that is adopted, will be utilized to its fullest potential.

A single representative for the shipping, trucking, and rail lines is specified due to the large number that would be involved if every organization were represented. The representative for each of the respective modes (rail ship, etc.) would be elected annually by members of the lines in question.

The committee members would then act as liaison/contact person for the media campaign and training sessions outlined in the seventh step, Initiate media campaign with the users of the system and start training classes on the use of the ITS system(s) to be installed.

7. Initiate media campaign with the users of the system and start training classes on the use of the ITS system(s) to be installed.

This guideline will not be addressed in detail in this paper except to say that the early acceptance of these systems by those who have to use them is critical to the systems being utilized in an efficient manner. Whenever possible, any required information or equipment should be distributed before the systems are installed so that there are no delays in the ITS systems’ implementation.

8. Install the ITS system(s), continue to conduct training classes

Self-explanatory.
9. Perform an “after” analysis of terminal operations that have received an ITS system.

This step is critical as part of the validation process for the ITS systems. This analysis will determine the impact of the new system(s) on CVO-port operations. At this point a cost-benefit analysis must also be performed in order to determine if gains in efficiency offset the cost to install and maintain the new systems. If not, can any of the costs be passed on to the users of the system as a “value-added” service.


The committee will determine if the ITS system(s) are performing efficiently, and whether or not to add new systems or discontinue old ones. It should be noted that the port terminal representative should have veto power since the port will be the agency bearing the majority of any financial expenditures.

While each of the individual ITS systems may provide some operational benefit, the full effect will only be gained when a host of systems are employed. Once the ten steps of the implementation guideline have been followed the result will hopefully be a robust set of ITS systems that working together will produce an increase in overall efficiency much greater than the sum of the individual ITS parts.

The following section will outline specific applications of ITS systems to the Barbours Cut Terminal Facility per the implementation guidelines.
Application 1: Use of An Automatic Vehicle Identification (AVI) System, Coupled with a driver “Smart-Card” and a Closed-Circuit Television (CCTV) System

As previously mentioned, one of the most significant problems facing the terminal are the delays incurred by the CVO operators whenever they enter or exit the terminal. This is caused by the need to exchange and check paperwork with the gate clerks. If a read/write AVI tag were attached to each tractor that used the terminal the following advantages could be gained:

1. The truck driver would drive his/her truck under a AVI reader at the trucking lines home base. At this point the reader would write the following information onto the card:

   • An electronic placard stating the name of the trucking line, i.e. Central Freight Lines Inc.;
   • Name of the contracted shipping line, i.e., Lykes Bros. Steamship Co., Inc;
   • The booking number - provided by the shipping line;
   • The container number;
   • A bill of lading;
   • Information regarding the cargo, i.e., is it hazardous?

   Once the information was written to the card it would be verified by having the card send the information back to the control center.

2. After the information had been verified by the trucking line’s computer the driver would be ready to leave for the Barbours Cut Terminal. Upon arrival at the terminal the driver would slowly drive the truck through a toll-collection type facility that would read the information on the tractor’s tag (see Figure 6).

Figure 6. Terminal Gate System showing AVI and WIM Systems Deployment (19)
At this point the driver would proceed in the terminal in one of two directions:

- If the truck was a bobtail (no trailer) it would either proceed to a designated area that is displayed on a TV monitor at a truck driver’s height and on a changeable message sign just inside the gate area to pick up a container; or

- If the truck was carrying a container it would proceed to a checker area to have the incoming container checked for damage. As a further safety check and monitoring system, the checker area would be monitored by closed-circuit television (CCTV) which would also provide a permanent record of the container’s condition.

In either case much of the delay that the CVO operators previously had to contend with at the gate would be eliminated. It would also remove the trucks from Barbour's Cut Blvd. much faster, thus reducing congestion and emissions. Due to the fact that the majority of drivers are private owner-operators, it is suggested that all drivers entering the terminal be required to carry a “smart card”, that would also be read/write in nature. This card would contain the following information:

- The driver’s name and license number;
- The trucking line that the driver was working for on that particular delivery, this could change during the day so this is an important piece of information;
- The driver’s certification information relating to HAZMAT cargo;
- The booking number - provided by the shipping line;
- The container number;
- A bill of lading.

This card could be “swiped” like a bank card at both the entry gate where the driver reads his/her container berth assignment, and at the customer service center if necessary. While it is realized that this system may seem redundant, it will provide a quick and easy means of verifying the necessary information for the port operators for those cases were something does go wrong.

Figure 7 shows an overview of some possible intermodal ITS systems applications as they might look in a port/terminal installation.
Application 2: Terminal Control Center with Real-Time Interface with the Regional Advanced Traffic Management Center and the State Department of Transportation (DOT), with Electronic Data Interchange (EDI) capabilities, coupled with a Changeable Message Sign (CMS) System

Currently the Barbours Cut Terminal has no real-time communications with either the Greater Houston Transportation and Emergency Center or the Texas Department of Transportation (TxDOT). As previously noted this is not a fault of either party, but rather as an opportunity to make use of an existing system. There remains the potential for significant delays in port operations due to surrounding traffic conditions. Trucks could be delayed or even prevented from entering or exiting due to a traffic incident or an explosion in one of the numerous nearby petrochemical plants.

This would seem to be an easy system to set up and would involve the addition of a dedicated computer and monitor, plus a person who would act as traffic coordinator in addition to his/her other duties. A real-time computer link would have to be established with the ATMC in a read only mode. The person responsible for the traffic information would be able to read any incoming incident or congestion warnings and decide what message(s) to display on the CMS sign(s) in the terminal. It is advised that a library of stock messages be composed for common place occurrences such as congestion on the ship channel bridge, etc. This library would allow employees who did not have the proper clearance or who were not knowledgeable about the system to use it in emergency situations.

This system could be further augmented by an additional changeable message sign (CMS) installed on the northern side of Barbours Cut Blvd. (see Figure 8) so as to provide CVO operators the ability to make informed decisions regarding their route choices when leaving the terminal. Although these signs are expensive, it is possible that the sign could be at least partially funded by ISTEA funds.

This would allow the port to keep track of developing traffic problems and, suggest alternate routes via the CMS to drivers leaving the terminal. As a further value-added information service, trucking lines could log into the terminal’s system to get a picture of the local or regional traffic conditions that may effect their delivery times, and their route selection(s) to the terminal.

Although the terminal is already using some EDI technologies, these systems would be supplemented with a new fax machine, and a dedicated computer that would be accessible via phone modem, Internet and internal (within the port) e-mail. This computer would be equipped with a dedicated printer to print out incoming information/forms from shipping lines, trucking lines, customs agents, etc. There would also be a printer at each gate which would allow for remote printing of the necessary information or forms as they came into the terminal.
Application 3: Use of a Weigh-in-Motion (WIM) System with a Presence Detector.

WIM systems can help to increase terminal efficiency by allowing truck drivers to proceed at low speeds through the terminal gates, thus reducing queues and delays. When a WIM system is combined with a presence detector, the total weight of the vehicle can be derived by aggregating axle loads for the vehicle (see Figure 6). These systems are accurate enough (within 5% -15%) at low speeds to enable their use in a port setting.

When a WIM system is combined with an AVI system, it allows for several procedures to occur “on the fly” that normally require the driver to stop the vehicle. By combining these technologies a much greater time savings is possible than for either one of them separately.

In operation the driver would slowly drive over the WIM system before entering the gate area where the truck’s AVI tag would be read by the terminal’s reader system. This would allow a computer to start an account for the truck that would already have the trucks incoming weight and all of the information included on the AVI tag (see Application 1, above) before the truck had actually entered the terminal. This information would be combined with data from AVI/AEI systems, smart-cards, and CCTV systems to form a complete picture of each truck that enters the terminal. This wealth of information would allow for quicker turn-around times for the drivers, and by maintaining a database of information from the various systems, it would allow the port analyze its operations with an eye towards identifying and improving problem spots within the operational chain of events.

As can be seen from the above example, the key to ITS systems is information. The collection, transfer, processing and distribution of information in forms ranging from a printed bill of lading to directions on the CMS sign to avoid an incident on the I-610 Freeway loop, all highlight the importance of accurate information. The advent of cheap, powerful, and user-friendly computers will revolutionize the way in which port operations are conducted. Computers will allow terminal managers to combine disparate pieces of information into a coherent picture that will enable them to more intelligently make decisions about how the port is, or should be operating. These combined systems will allow for gains in operational efficiency that would be impossible with individual systems.

A map of the Barbours Cut Terminal with locations of the proposed ITS systems is shown in Figure 8.
CONCLUSIONS

Intelligent Transportation Systems have already been proven to provide substantial improvements in highway operations and in reduction of delays. It is expected that if the same technologies are applied to some of the operational problems currently being experienced by port managers, they will also see significant improvements in efficiency and reductions in delay. European and Asian ports are already using many of the systems outlined in this report. In order for the United States to remain competitive in the Global market, it will have to become very efficient at moving freight across the oceans and across the country.

It is expected that most of the significant utilizations of ITS Systems will be undertaken by the private sector in an effort to improve their profitability. This will eventually reap benefits not only for the intermodal freight companies, but also for the average consumer who will see prices drop as gains from competition and improved efficiency take effect.

In summary, significant improvements in port operation can be had through the use of ITS systems, assuming that institutional barriers such as labor unions can be accommodated. The use of these systems is the future of intermodal freight movement.
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REFERENCES


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