REVIEW OF TECHNOLOGIES USED IN FREIGHT TRANSPORTATION IN THE NEW YORK METROPOLITAN REGION

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1. INTRODUCTION

The objective of this report is to survey and identify the most significant existing and emerging technologies, which affect or could affect the future of freight transportation in the New York Metropolitan Transportation Council (NYMTC) region. This brief orientation does not present detailed technical information which is available from the listed sources of information. Some areas, such as development of new materials or construction systems, are not mentioned and the reader is advised to contact the Transportation Research Board or other sources for such information. This report is expected to be used by transportation stakeholders, government agencies, professional freight transportation organizations and other recipients who want to find condensed information on the development of technology in the areas of communication, design and scientific instrumentation for the freight transportation industry.

NYMTC is an association of governments and transportation providers which serves as the official Metropolitan Planning Organization (MPO) for the New York metropolitan region. The region comprises the five boroughs of New York City, counties of Nassau, Putnam, Rockland, Suffolk and Westchester, and includes pertinent areas in the states of New Jersey and Connecticut. The region is undergoing major changes in a restructured economy, focusing on national growth industries such as finance, business, security and medical services. Communications and computing industries are developing advanced technologies and improving their business strategies. To keep up with the current trend, transportation providers and planners are promoting multimodal, seamless systems of moving people and goods, and refocusing their approach to transportation planning to mobility-oriented, market-guided systems. The region's transportation is shaped by a constant increase in the users' demands, and especially by demands for customized services that meet Just-In-Time traveling needs. Transportation agencies are promoting modern technology to provide solutions to continuous problems such as congested highways, delays in delivery, aging infrastructure, rising freight costs and air pollution. Recent terrorist attacks in the U.S. have shifted priorities to technologies which will assure the safety and security of mass transportation of both people and freight.

Positioning and communication technological applications, tied to computer databases, are being used increasingly in all modes to improve transportation operations. In some cases, these applications come under the guidance of Intelligent Transportation Systems (ITS).[1] The U.S. Department of Transportation's (DOT) Intelligent Transportation Systems and other initiatives have developed and deployed tag, sensor and reader technology.[2] Extensive use of new technology and better planning approaches to investment priorities may improve economic competitiveness, security and the quality of life in the region.

The technology and information revolution has greatly improved the accuracy of freight shipping data and the speed with which information can be shared. Just-In-Time service may occur only when pertinent real-data shipping information has been developed and shared.[3] This report describes the development and use of technology in the freight transportation industry, particularly in the NYMTC region. Some significant experiences from other parts of the world are also mentioned, since they may have had some impact on the New York region.

2. Development of Communication and Wireless Technology

2.1 General Description

Communication and monitoring technology is increasingly used in the freight movement industry all over the world. Knowledge of these systems is important for NYMTC as well as other government agencies promoting the region's economic development. The agencies analyze and evaluate recently developed technologies in order to introduce their application to studies and to projects designed to develop a modern regional transportation industry.

Internet technology is widely used in the transportation industry to share information and track cargoes. Use of the Internet, including the Web, by the transportation industry has grown rapidly. The number of users worldwide has grown from 56 million in 1997 to 200 million in 2000. Tracking cargo is an important way to maintain control over distribution. Internet information is normally timely, up-to-date and easy to obtain. Several transportation companies make Internet-based tracking mandatory, and some shippers provide tracking information on their own Web sites.[4] The Internet permits direct arrangement of cargo and reports shipment status in real time. For logistics management, the Internet provides information which allows shippers to plan, implement and monitor a more efficient and cost-effective transportation system.[5] Based on Internet technology, the National Transportation Exchange (NTE) system connects electronically received bids and offers from member carriers and shippers, and matches them in real time.[6]

One of the most important tracking technologies, now used in transportation worldwide, is the global positioning system (GPS), which integrates satellite, communication and computer technologies. The system is used largely in air traffic control, in tracking vehicles and cargo, and navigating ships.[7]

Electronic Data Interchange (EDI) is inter-company, computer-to-computer communication of data, which can automate and organize documentation associated with the transportation industry. This program was created in the 1970s, but developed and popularized during the 1990s. It permits transferring the documents such as bills of lading, shipment status, invoices, delivery notifications and credit notes in standardized electronic format. EDI allows carriers to improve their performance, enabling them to offer seamless service, accurate and timely billing and to analyze their performance regarding mileage, terminal activity, costs and pricing processes.

Trucks are equipped with computerized information system
Source: Traffic World, February 25, 2002

Among intelligent transportation systems, Automated Vehicle Identification/Automated Vehicle Location (AVI/AVL) is a powerful tool for electronic toll and traffic management, commercial vehicle operations, access control, law enforcement, origin-destination survey, and vehicle inventory. Technologies that recognize and distinguish vehicles include radio frequency tags, smart cards with radio frequency transponders and laser bar-coded adhesive labels. Automatic License Plate Identification/Recognition (LPI/R) is an emerging technology, which can read license plates without human intervention and hand off the data to an overall integrated system.[8]

VIDEO DETECTION CAMERA
Source: ITS-October 2001
www.itsinternational.com

Automated Equipment Identification (AEI) is a short-range communication system transferring data through radio frequency technology, often used by ports or warehouses, where data is transferred by mobile personnel. This technology is widely used for tracking mobile vehicles and containers. Main components are tags attached to the vehicle or piece of equipment, from which data messages are transferred to the data management system. Other elements include antennas to broadcast and retrieve signals, transmitters which generate and reprocess signals and readers to process and decode signals communicating with the control station. In 1995, to avoid manual counts, AEI tags were installed on the entire U.S. railroad fleet, containing 1.5 million railcars and 20,000 locomotives. Information is transmitted from the tags through wayside readers to the railroad's computers, enabling shippers to access information on their cargo movement through EDI technology. In the trucking industry, AEI technology is used in commercial vehicle programs, such as Heavy-Vehicle Electronic License Plate (HELP) project, Automatic Vehicle Identification (AVI), Vehicle Weigh-in-Motion (VIM) and Automatic Vehicle Classification (AVC) projects.

Another radio frequency based program, *Transmit* manages incidents and traffic. The stationary radio frequency readers are spaced at roughly one-mile intervals along designated roads. Roadside readers detect the passage of tagged vehicles and pass information to Transcom computers which generate a composite picture of traffic flow. Traffic speed is determined by plotting the tagged vehicle passage from one reader to the next, and traffic volume estimates are based on the number of tagged vehicles detected at a given time. Transcom's CCTV/HAR (closed circuit television and highway advisory radio) projects allow local authorities to issue highway advisories to area motorists, based on remote observation of selected roadways and intersections. Advisories are issued in the form of radio broadcast on designated AM radio stations. HAR road signs alert motorists to the AM frequency being used in the area. VMS (variable message signs) are displayed on high-volume routes and critical intersections.[9]

- ***Communication Systems***

The use of communication technology covers a broad range of diverse technologies, known collectively as Intelligent Transportation System or ITS. According to ITS-America, an organization whose members manufacture or use ITS technology, about $209 billion will be invested in the program by the year 2011. A large part of this program is used by the transportation industry, especially in tracking cargo routes and in accident prevention. The ITS technology goal is to:

- ***Improve productivity of commercial and public transportation by sing an automated tracking, dispatch and weight-in-motion system***
- ***Assist drivers to reach destinations with navigation systems enhanced with pathfinding and route guidance***
- ***Gather and transmit information on traffic conditions to enable drivers to reach decisions about the fastest and most adequate route of travel***
- ***Decrease congestion by reducing the number of traffic incidents, clearing them more efficiently, rerouting traffic,***

Vehicle Detection Sensor
Source: TME-October 2001
www.tmemag.com

and providing automatically collected toll payment.

Wireless video and data transmission
Source: www.itsinternational.com. October 2001

Development of information/communication system infrastructure is based on the National ITS Architecture, developed for U.S. DOT by Lockheed Martin and Rockwell. It gives guidance on the broad range of transportation functions and information flow to transit agencies, and is useful in planning or implementing systems. The Transportation Equity Act for the 21st Century (TEA-21) requires federally-funded projects to be consistent with the National ITS Architecture and applicable standards and protocols.[10]

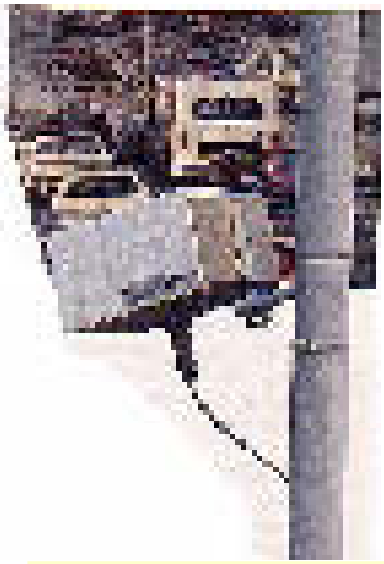
One of the methods of travel information distribution is the electronic display of information. Such information could include warnings posted on electronic displays at gas filling stations regarding topics including traffic ahead, expected weather, possible cut off due to construction or traffic incidents. CUE Corporation, which operates the world's largest radio data network throughout North America, has recently introduced a mechanism for providing travel information on gas pumps at service stations. It has entered into exclusive agreements with major pump manufacturers to install display screens on pumps.[11] Thus far, this system has not been used in the New York metropolitan region.

2.2 Wireless Technology

Wireless technology allows detailed reporting without loop detectors or cameras, and is applicable to all transportation modes. ITS uses the huge existing user-base of wireless communication devices for traffic monitoring. In U.S. alone, there are approximately 85 million cell phones in use. With market penetration of new vehicles factory-equipped with wireless communication devices expected to exceed 50% within the next few years, the potential for these devices as traffic probes is substantial. It is augmented by pending E911 regulations requiring wireless phones to incorporate GPS technology which will allow the accurate location of wireless 911 calls. Advanced Traffic Management System (ATMS) and Advanced Travel Information System (ATIS) that currently rely on fixed monitoring pins, generally located at wide intervals, could be augmented by the addition of data provided by a wireless system. That would allow highway managers to pinpoint trouble spots more accurately in areas where video camera coverage is not available.[12]

Wireless communication networks offer many advantages over hard-wired systems including flexibility, efficiency and lower cost. Trucking operations are investing in wireless technology because it is possible to share more information with a moving communication unit. Ready technologies enable companies to dispatch and route trucks and exchange e-mails and two-way messages with drivers using cellular telephones and electronic devices such as hand-held computers, at lower costs than satellite technologies or onboard computers. While wireless technologies hold great promise, limitations to areas covered by a land-based communications network mean that certain applications are not right for certain trucking operations. If a driver is not in a coverage area, the message doesn't get through. Cellular communication is often used by UPS whose drivers scan bar-codes on packages, write messages on keyboards and capture recipients' signatures on electronic pads. UPS uses the dual-mode system, which can switch automatically to GPS when the truck leaves a cellular coverage area.[13] Cellular communication is used widely in the U.S. transportation system, including NYMTC's area.
Other forms of this system are used in the U.S. A new line of advanced direction-sensing speed displays have

been released by Stalker Radar Inc. of Plano, Texas. One item, named SpeedGuard, is a speed trailer (stationary or in moving modes) which uses numerals and an optional siren to warn those near the unit of an excessively speeding vehicle approaching the area. The other product is a pole- or stand-mounted with suction cups to the tailgate or to the roof of a vehicle. They feature 14-inch-high LED numerals that are AC or DC powered.[14]



Video detection camera is a crucial element for managing traffic
Source: TME, October 2001
www.tmemag.com

2.3 Video Detection System

The Video-Detection System includes a number of cameras added to the Closed Circuit Television Systems (CCTV) deployed for traffic and incident management in congested urban areas. This system is widely used for speed reinforcement. Major events, traffic incidents and ongoing construction projects frequently require monitoring several portions of the road network simultaneously, as well as being able to take a close-up look at specific areas to determine appropriate response or action. Modular video is almost a standard feature in traffic control centers worldwide. In the U.S., the most notable application is Georgia DOT's Traffic Management system, launched during the 1996 Summer Olympics in Atlanta. During operation, a state patrol helicopter mounted with a monitoring camera, transmits images to the management center from as far away as 50 miles. One of most popular examples of video wall is Overview LCD rear-projection product, a screen enclosed in modular housing, allowing an unlimited number of modules to be ganged together, thus producing an unbroken coherent picture.[15]

Another example of a video detection system is PATH (Portable Archival Traffic History) video system which successfully reduces staffing in parking lots, and can be used for highway flow analysis. PATH uses a lightweight, portable, battery-powered, time-lapse video system, consisting of a recording package and a camera enclosure for video surveillance. It is used in various grade crossing intersections in California as well as in studies on expenditures and safety analysis.[15]

Continued development of video imaging systems may include:

- ***Processing of electronic delivery orders via the Internet***
- ***Ability to provide automatic alert to forwarders/brokers/truckers when a container becomes available***
- ***Ability for trucker to enter "proof of delivery" information which would allow an overseas consignor the ability to confirm delivery to the dock***
- ***Enhancements to the tracking of cargo and cargo carrying equipment***
- ***Link to electronic credential information (permits, oversize, registration, tax filing, insurance).***
- ***Linking information technology and management systems to increase efficiencies in commercial curbside parking zone usage in the last segment of the supply chain to the end customers.***[17]

Until recently, most video surveillance systems for the transportation market were based on analog technology, using tape-based VCR recording system. Today, many fleet operators use digital technology in mobile video surveillance, which allows the ability to store more images in much smaller space and for a long period of time[(16)].

2.4 ITS - Fiber Optics Technology

With the development of integrated highway ITS solutions, the demands for VMS *(Variable Message Sign)* are increasing. Fiber optic technology can provide innovative solutions in this field. One example is a fiber optic display system, which consists of a single halogen lamp with up to 350 high-quality glass fiber arms. A semi-transparent mirror is located in front of the glass fibers so that one lamp simultaneously illuminates two arms. The quality of VMS is determined by light intensity, angular characteristics, contrast, color and uniformity. Fiber optic traffic signs can be quickly and clearly identified because of impressive white display. With fiber optic VMSs, white, red, yellow, green and blue can be produced using filters to give motorists the optimum information in all road situations. Fiber optic technology also offers benefits in terms of energy requirements and degree of servicing. With a new generation of long-lasting, glass fiber light guides, lamp replacements on fiber optic devices in the future will be carried out at the side of the road. This will eliminate the need for access bridges and contraflows during servicing and will cut out the associated accident risk.

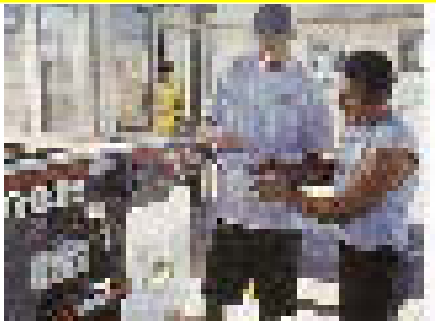
2.5 Barcoding and Labeling Technology

Barcoding was introduced to provide transportation carriers with more accuracy and speed in identification and delivery of cargo. Usually, a barcode holds 40 to 80 characters of information such as a customer's invoice number, company code, service class, date of delivery and destination of package, country and zip code. The new two-dimensional system (as opposing to linear coding) increases the scanning process and eliminates errors. Example of such barcoding is 2-D tag, which allows faster enhanced data scanning, and earned widespread acceptance. Two-dimensional bar codes such as UPS's MaxiCode or Symbol Technologies' PDF 417 can store up to two pages of information compared with the 18-character of the standard one-dimensional barcode. Two-dimensional bar codes can contain an entire bill of lading and can be used for shipment and manufacturing.[19]

The other example of cargo identification is a smart-label "Bistatix" technology from Motorola, part of its "Surface 2000" pilot project. USPS began testing "Bistatix" technology to facilitate automatic data capture, while loading and unloading mail containers on postal vehicles. This technology allows radio-frequency identification (RFID) antennas to be printed on paper with conductive non-metallic ink. The resulting labels are termed "smart" because they contain information that can be read and modified via radio signals. The new RFID tags can be integrated into existing printing process. RFID tags can eventually provide portable database that travel with the freight or package. Unlike barcodes, RFID tags can not be affected by moisture, dust or dirt, are readable without clear line of sight, and can be easily modified.[20]

2.6 Border Crossing Technologies

ACE system allows Custom officers to follow the flow of cargo electronically as it enters the country
Source: JOC Review & Outlook, January 2002



While the New York metropolitan region is not located at the U.S. border, a large part of cargo which moves to, from, or through the region goes through U.S.Customs. This part of the report describes some of the newest systems used by Customs to improve trade statistics, fight crime and speed the cargo handling procedure. These systems are used in all modes of transportation.

The Automated Export Reporting Program (AERP), in use from 1995, was replaced in 2000 by the Automated Export System (AES). This new system calls for automated filing of trade documentation as a way to improve

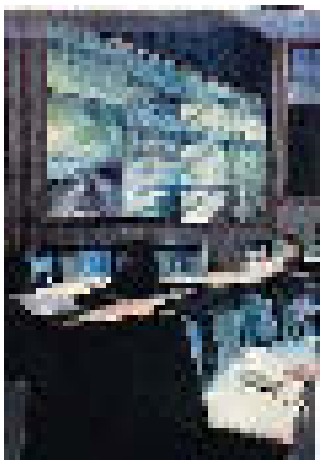
efficiency of its operation in the commercial sector. Today, 95% off all import entries are filed electronically.[21] There are four export filing options under the rules, depending on the type of shipment and the exporter's choice. Option 1 is to file export data on paper, Option 2 involves filing all data electronically prior to the departure of the exporting carrier. Option 3 allows exporters to provide specified information prior to the departure within 5 working days.[22] Part of the system known as Option 4 allows pre-approved exporters on AES to file required data up to ten working days after their goods have departed. AES is paperless; it reduces errors and communication costs, and the information is disseminated worldwide to pre-alerted consignees.[23]

The other Customs' import processing system, Automated Commercial Environment (ACE), has recently replaced the earlier Automated Commercial System. ACE uses a "fast-track" process that gives government and private industry greater flexibility to negotiate contracts quickly. The first module of ACE, the National Customs Automation Prototype, is already in operation at the Canadian and Mexican borders.[24],[25],[26]

One document which definitely requires automation is bill of lading (B/L), the basic transportation contract between cargo owner and carrier, which must accompany every ocean shipment. A signed stamped copy must also be delivered by courier to the consignee or its agent in time for goods to clear customs. Breakdowns occur frequently. In 1999, a combined venture of the Through Transport Club of London, Swift Interbank, La Hulpe of Belgium and others, prepared new prototype software for a paperless bill of lading named Bolero, which will allow fast and secure electronic transmission of several kinds of trade information, including negotiable bills of lading, among the various players in the transportation chain.[27]

At the ports of entry, Customs' agents are using X-ray equipment to detect illegal drugs, guns, and chemicals that can be used to create drugs or explosives, as well as high-priced merchandise hidden to avoid duty payment and large amounts of cash that can be used to finance illegal operations. The X-ray equipment also greatly speeds inspections. A trailer can be examined in six to eight minutes, rather than the several hours needed for ordinary inspection, which may involve unloading a trailer and even drilling into walls and floors in search of hidden compartments. Currently, Mexico uses X-ray equipment to examine cargo trucks at the interior checkpoint north of its main international truck crossing at Nuevo Laredo.[28] The New York Metropolitan region police is considering the use of the X-ray equipment to reinforce police action in fighting illegal activities on the metropolitan highways.

The Custom Trade Partnership against Terrorism (C-TPAT) has been in operation since January 2002. More than 20 large importers have agreed to join the program. It prevents terrorists from taking over transportation or concealing weapons in containers of legal cargo(153).



Traffic Management Center
Source: TME-October 2001
www.tmemag.com

2.7 Management Technologies

Management technology is developing around the world, to help decision-making and to optimize organization of the freight transportation industry. An important system is Incident Management Technology, which allows emergency responses to reach destinations more quickly and safely. One recently proposed program is *Opticom System 3M Technology*. This infrared-based 3M Opticom priority control system involves dedicated short-range communications beacons to provide priority for emergency vehicles. Integrated with Japan's infrared system, the new FAST (Fast Emergency Vehicle Preemption System) system combines infrared (IR) dedicated short-range communication beacons with the Opticom priority control system.

This system works with components such as an infrared emitter which sends a coded signal to a detector mounted above the traffic signal. The detector converts the infrared signal to an electronic impulse and sends it to the phase selector in the intersection controller cabinet. The selector tells the controller to hold the green light until emergency vehicle passes or requests an early green.[29]

Rand McNally develops integrated digital and printed map solutions
Source: ITS-October 2001
www.itsinternational.com

Supply-chain management software will be exchangeable shortly. The new breed of logistic companies- application service providers (ASP) allow their software to be used without being installed in the customer's local area network. Because buying a license for a particular software package is expensive and is often superseded by a new better version, ASPs offer a deal that amount to a rental option. The ASP "hosts" the software applications on its own server, and makes them accessible to the customer through the Internet for a monthly fee.[30]

Important support for management decisions is provided by technical information software, such as products developed by ALK Associates, as PC*Miler packets. The most popular software products providing technical support for the transportation industry include PC*Miler for Window; PC*Fuel Tax; and PC*Miler Connectivity Products. These programs calculate point-to-point truck routes and mileage, provide instruction and map graphics, with attention to stops, road preference and speed; calculate all aspects of fuel and mileage tracking; and help calculate tax and credits, pricing and waybills. The programs cover 655,000 miles and 276,000 location in North America, and include county names, Zip codes, and military installations. There is also a rail version of the program (PC*Rail for Windows).[31]

Other countries are also working on the development of management systems. In 1999, Germany developed a traffic management system which incorporates all tasks related to traffic safety and homogenizing the traffic flow. It includes speed control, tailback warning, dynamic exit signage to landmarks/fairs/events, fog and ice warning, and traffic control in the event of accidents or roadwork. All zone data are relayed to a subsidiary control center, which computes the following traffic information: number of passenger and freight vehicles, average vehicle speed and classification, and measured environmental data. The subsidiary control center processes the data, computes switching requirements for the traffic management system, and issues switching commands, synchronized with the zone stations. The combination of the parking guidance and traffic management systems results in highly advantageous symbiosis by which increased traffic volume can be handled.[32]

2.8 ITS Response to Terrorism

The September 11, 2001 terrorist attack in New York and Washington spotlighted the need for more widespread use of ITS technologies, both for prevention of incidents from occurring and for effective and quick response to incidents. ITS technologies are important for more security of key toll facilities, so more instrumentation is being placed in tunnels, bridges, and toll roads. Increased use of video surveillance, electronic toll collection, automated vehicle location, and cellphones is anticipated. Most agencies have developed disaster scenarios, and a mechanism for sharing information among police, fire departments, engineers and other agencies involved. The FHWA is looking for a complete ground surveillance system on the national highway system, which carries most transport in U.S. The new information system called *infostructure*, would provide the cheap real-time data for performance measuring and protection strategies[152].

Managing Intelligent Transportation System
Source: TME- October 2001
www.tmemag.com

Transportation agencies are looking to new technology, including mobile video surveillance systems. These systems can monitor and record onboard events, collect footage from inside and outside the vehicle, store operational data and generally improve the quality and safety of the trip. The capability of a new video surveillance equipment (provided by Corvallis, Oregon) was tested in May 2001, when an armed suspect hijacked a Los Angeles bus that was equipped with the MobileView digital video recording system. The system alerted police and recorded ensuing police chase, serving as a helpful tool in the case against the lawbreaker[16].

- ***Impact of Communication and Wireless Technology on NYMTC Activities***

All of the described communication and security technologies are widely used in U.S., and many of them, particularly the Internet, cellular communication and ITS, have been introduced in the metropolitan region. Transcom (Transportation Operating Coordination Committee) is an organization which promotes expansion of communication and monitoring technology in freight movements in the metropolitan region. It is a consortium of transportation and public safety agencies in New York, New Jersey and Connecticut. Its mission is to improve responses to incidents and to coordinate ITS construction activities.

The Port Authority of New York and New Jersey (PANY&NJ) is conducting studies on deployment of ITS system technologies to facilitate the movement of intermodal freight. The PA proposal calls for consolidation of various existing sources of critical cargo transfer and carrier information into an Internet-based real-time network called FIRST (Freight Information Real-Time System for Transport) that would be maintained and updated continuously. The Web page will integrate available information on ship, railroad or plane arrivals, provide up-to-date cargo status and real-time road conditions, and provide real-time video, which monitors congestion at seaport entry gates or airport access points. Such a system would facilitate coordination of information on the region's freight service and advance efficient movement of freight through the region. A pilot project is being developed for the Southern Corridor in New Jersey. This integrated data has potential as the preferred method of data storage in the future.[33]

The very innovative project named Integrated Incident Management System (IIMS) is currently (2002) being tested operationally in NYC. IIMS provides inter-agency data communications across NYC/NYS agencies throughout managing incident and emergency responses. This real-time incident management system uses GIS map and GPS-determined coordinates, text and digital images to assess emergency response by public safety centers and mobile teams. The IIMS demonstration project will reduce severity and duration of incidents and help to manage traffic flows effectively [155].

One interesting example of the new technology, which was recently introduced to the region, is a video imaging detection system (VIDS). This system has cameras installed at critical points along the travel route, that provide information from which travel time and traffic volume can be calculated. Roadside readers then transmit this information in "voice" format to transponders installed in the vehicles, advising drivers on possible alternate routes.

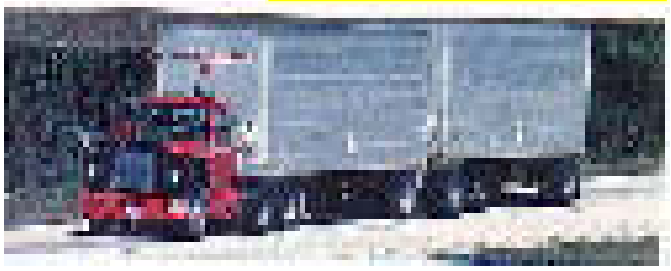
Recently, such cameras were installed in Jersey City. VIDS technology can be used under certain conditions to replace loop detectors, to provide traffic flow and volume information to the Operations Center.[34]

Most of the ITS programs described are or will be used by the commercial carriers within the region, and the impact of these technologies is being evaluated and incorporated in the planning process conducted by MPOs (Metropolitan Planning Organizations), including NYMTC.

3. Review of Technology Use in the Trucking Industry

3.1 General Description

Six-Axle Truck
Source: Traffic World, February 4, 2002



Congestion and air pollution are important problems in the metropolitan region. Transportation contributes 33% of U.S. CO^2 emissions and is increasing annually. In the New York metropolitan region, vehicle travel increased 23% from 1987 to 1997 and is expected to jump another 35% by the year 2015, while population growth in the same period increased only by 2%.[35] With more and more trucks on the road, the number of crashes has gone up by 10% since 1995. Thirteen percent of all traffic deaths are caused by trucks, but trucks comprise only 3% of vehicles on the road.[36] The solution to future transportation problems is complex. Part of the solution is the development of computer-based information technologies. Other improvement methods, such as better design of vehicles and their elements, logistics-based traffic management, and infrastructure improvements, are also important.[37]

- ***Standardization Trend***

Standardization of trucks and equipment can eliminate many technical integration troubles and benefit the industry. For a long time, truckers who want to infuse high-tech elements into truck manufacturers' design have been pointing out that the electronic platform of the future must be compatible and operate on a standardized protocol.[38] In 1998, over a dozen companies formed Trailer Tracking Interface Standard Committee to devise a universal standard. The Committee adopted the proposed Trailer-Trucking Interface Standard (TTIS), based on XML (Extensible Markup Language), the programming language of computer communications which integrates a carrier's dispatch operation with the trailer-tracking system. TTIS is using a data format similar to the Internet's XML. It defines required request and response messages and makes provision for vendor-specific data elements within the context of the standard.[39]

Standardization also applies to methods of load distribution. Road vehicles constantly change the distribution of weight over their wheels when in motion. In terms of static axle weighing, there are variable factors such as malfunctions in a vehicle's axle load compensation mechanism, moving loads, road gradient, degree of tire concentricity, wind loads, and difference in height. The individual effect of these factors is tested by the International Organization of Legal Metrology (OIML) which covers 93 nations, and whose scope is to harmonize and coordinate technical regulations on measurements and accuracy of measuring instruments.[40]

- ***Alternative Fuel Usage***

Electric charged UK trucks use digital map solutions
Source: ITS-Jan/Feb 2002
www.itsinternational.com

Alternative fuel technology, being currently tested or in limited use, includes liquefied natural gas (LNG), compressed natural gas (CNG), and electrically powered vehicles. Because of the need to lower gas emission, this technology, an alternative to gasoline and internal combustion engine- powered vehicles, is gaining interest. Substantial tax incentives are provided for purchasing alternative fuel vehicles such as buses and heavy-duty trucks. Some states such as California, and recently New York are using CNG-powered public buses. The U.S. Department of Energy has developed an interactive mapping system, Alternative Fuel Refueling Station Locator, based on ESRI's ArcView, which helps find refueling and recharging stations available across the U.S.[41]

Electric cars are already in use, however not yet in the trucking industry. The barriers to widespread use of this technology include high costs, lack of fueling stations and limited traveling range, specifically for electric cars. Hybrid type has become the most popular, however its use in trucking industry is still limited. Hybrid car's electric motor assists the gas motor when needed. It draws its power from the vehicle's batteries, but the energy flow is two-way. The motor doubles as a generator when the electric motor is not needed to power the car. Hybrid vehicles use nickel metal hydride (NiMH) technology, which provides higher energy density and longer service than typical car batteries. New York transportation agencies are promoting use of this technology, which provides partial solution to regional air quality concern. [42]

Another concept which has support of the U.S. Energy Department and environmentalists is the use of fuel cells which use stored hydrogen and oxygen from the air to create electricity. The only emission from such an engine is water vapor. But experts predict that commercial production of cars with fuel-cell engines is 10 to 20 years away [(156)].

3.2 Truck Modernization

The current trend in the trucking industry is toward automated transmissions. Large scale conversion to shiftless transmissions began in late 1990s. Previously, fleets used a lesser form of automation that automatically shifted only the top two gears. The new Automated Mechanical Transmission (AMT) (such as offered by Eaton-Meritor Wabco Transmission), offers transmission with varying parts run by electronic controls. The electronic stream of advanced link runs at 250 kilobaud-250,000 bits of data per second. This capacity makes room for antilock braking, with its automatic traction control, to send messages to the engine between data spurts from the transmission. [43]

The Advanced Vehicle Technologies Program (AVP) authorized in 1998 under TEA-21 and managed by DOT, promotes an innovative program with the goal of improving energy efficiency. [44] Examples of the projects include such elements as:

- **Hybrid electric transmission**
- **Auxiliary power units (APU) and motors**
- **Advanced battery and charger systems and controllers**
- **Flywheels to augment or replace batteries**
- **Advanced materials to reduce vehicle weight**

Managing LCVs- double or triple-trailer combinations
Source: Traffic World, December 24, 2001

The program developed a fuel cell APU for over-the-road trucks, which generates electricity for various accessories and truck cabin compartments' climate control, and thus eliminates the current practice of idling truck diesel engines during non-driving operations. This APU will result in significant reductions in emissions, fuel consumption and noise. Potential saving can reach 590 million gallons of fuel, 4.3 million tons of carbon dioxide, 80 thousand tons of carbon monoxide, and 46 thousand tons of nitrogen oxides annually, if all of the nation's truck fleets adopt this technology. Another example is the AV-900 Cycler, a combined battery cycler/ charger test system capable of operating 600-900 Volts for use with heavy-duty hybrids. The market trend is a movement toward higher voltage drive trains for increased performance and packaging options while reducing the size and weight of components and reducing the cooling requirements. The cycler provides a test system capable of handling higher voltage drive trains.[45]

Size and weight limit is another important issue in the trucking industry. Many major U.S. highway carriers and private fleet operators are already using longer, higher and wider trailers. By 1992, the over-48-foot trailers accounted for 36% of all units manufactured, up from 1% in 1985. Although trailers over 53 feet in length represent the most popular size unit, several southern and western states allow 57-foot trailers on Interstate and designated highways. The 57-foot trailers offer about 8% more cubic capacity than 53-footers. For trailer width, the 102-inch model remains the most popular size, replacing the former standard 96-inch wide trailers. Major productivity issues involve heavier trucks and longer combination vehicles. The Alliance for Safe and Efficient Transportation (ASET) is an industry coalition seeking an increase in truck gross vehicle weight limit to 97,000 pounds from the current 80,000 pounds with addition of a third axle. In addition, some truckers hope to win the rights to operate longer combination vehicles-trucks with multiple trailers- which are currently allowed in some states. A new type of combination chassis permits location of different load types in various combinations.

Proposed House legislation, HR 1667, may override the current 80,000-pound limit and authorize states to allow 97,000-pound trucks. It would reduce the number of trucks needed to carry the same amount of freight and make U.S. companies more competitive. An FHWA study found that vehicle-miles would be reduced by 11%, and the increased weight limit would produce an overall saving of $15 billion.[46] Related safety and infrastructure problems are still under discussion.

- ***Safety Devices***

With large-truck crashes killing 14 persons a day in the United States, government officials and the trucking industry need to make fast improvement in truck safety. Along with proposed DOT measures requiring drivers to take longer breaks, the efforts concentrate on technological improvements.[47]

Smart devices, designed to improve safety and insure that loads arrive on time, have increased drivers' comfort. They also place the long-distance trucker under increased scrutiny. In fact, some long-haul drivers view such devices as an invasion of privacy. On-board computers that connect drivers to dispatchers via satellite are the most common technology on trucks these days. Many on-board computers are equipped with GPS technology that allows the

company to know where a truck is at all times. Collision-avoidance technology helps reduce the frequency of accidents. Such technology includes flashing lights and electronic buzzers that warn when cars are getting too close. This technology is based on two sensors; one looks for obstructions in the lanes ahead, another monitors the blind spot near the cab's passenger door. This system also acts as a sort of backseat driver by recording performance of the person behind the wheel and tracking the use of brakes as well as the distance from the vehicle ahead. This information is later inserted on memory card into the truck's computer and analyzed by company management. Equipping a truck with the latest technology is expensive. Computers and sensors can add $15,000, or about 12% to the total cost of the truck.[48]

To increase safety of cargo in transit, the Federal Motor Carrier Safety Administration (FMCSA) has proposed legislation to regulate the way cargo is secured to truck trailers throughout the U.S., Canada and Mexico. This standard is backed by a series of recommendations that the FMCSA expects will go into effect despite lack of unanimity on some points, including who should be responsible for labeling the capacity of tie-down materials such as webbing and chains. The new standard recommends proper tie-down for all possible cargo transported on trailers, requires drivers inspect the load within the first 50 miles of travel to spot loosening due to road vibrations, and provides minimum requirements to prevent shifting.[49]

In March 1999, the FHWA issued a new regulation requiring trucking companies to install red-and-white reflective tape or reflectors on trailers to improve their visibility, thereby increasing safety on the road. The rule requires motor carriers to complete retrofitting older trailers within two years of the effective date. According to the FHWA, this new rule will save lives and injuries associated with passenger cars colliding with trailers.[50]

Some highway projects use pressure-sensitive pavement lane marking tape which reflects better at night and makes it possible to reopen traffic lanes immediately after application, eliminating the waiting time required with painted lines.[51]

A specialized device, SAM-S, offers an optimum performance safety detection device for over-height vehicles approaching tunnels or bridges. This device can detect even small protrusions (down to 2 inches) at speeds of up to 62 mph. A major advantage over conventional light barriers is immunity against vibrations and wind.[52]

A very useful safety-increasing device is the automatic self-dimming rearview mirror, which reduces the blinding glare from headlight at night. Such a device is based on electrochromics technology, has not been commercially viable for large trucks since it is too expensive, does not work well on trucks' large mirrors or in the commercial truck environment. However, new technology based on suspended particle devices technology, may make this convenience possible for the trucks. Mirrors made with suspended particle devices (SPD) have an advantage over electrochromics because they cost less, respond faster to glare, and are more durable, able to withstand the pounding of a big rig. The SPD technology reduces glare by using microscopic particles of light-absorbing material suspended in a liquid medium between two pieces of glass.[53]

Theft is another big problem for truck operations. In 1999, Qualcomm company from San Diego developed a new security-related device to slow or stop a stolen truck. This type of device could be useful also in the New York metropolitan area.

3.3 Containerization and packaging

Containers (receptacles for transporting cargo) have for decades been widely used in trucking and other modes of freight transportation. Standardization of containers and other ULD (Unit Load Devices) has increased their usefulness. Standardized containers are interchangeable, permit calculation of capacity and weight restriction, and can be moved by handling equipment. Main types of containers include these which can replace truck or railcar by adding wheels, and containers acting solely as package boxes for transport of merchandise.

Several new concepts in the box/container construction were recently proposed, including the DryTainer model introduced by Heil Trailer International. The DryTainer is a dry bulk intermodal container of 40-foot long x 8-foot wide x 9.5-foot hight, volume of 1,575 square foot, and a tare weight of 7,500 pounds, which can be safely loaded with up to 60,000 pounds of product. The container can be doublestacked on railcars, used by ships or trucks, and is effective in dedicated and general cargo service.[54]

Weight is a problem common to many types of containers. In 1999, BAG Corp. offered the lightweight Pellet-Pack Container made from moisture-resistant coated polypropylene, designed to replace the corrugated box. It requires less storage space and may be stacked three high. Also, Spin-Cast Plastics Inc. has introduced a dry bulk container Dri-BC with a removable seamless polyethylene liner, which offers a choice of three different material-release valves. Each model is designed with 60-degree sloped bottom and standard lids.[55]

The popular device used by trucks for cargo transport is a pallet constructed as a platform of wood, metal, fiberglass, or other material, on which cargo can be stacked and secured. It can be moved by forklift or crane. The standard pallet in the U.S. is usually 40x48 inches. Pallets can be designed for special packaging jobs in a choice of reusable or expendable material. Loading equipment is developed according to the cargo type and package system.

Specialized containers are used for intermodal carriage of specific products such as machinery, animals, and certain hazardous material, because they provide point-to-point delivery, without intermediate transfer and handling. Refrigerated containers (also called “reefers”) are used to transport products that need to be kept cool or frozen throughout the journey. There are many categories of reefer containers to satisfy the wide range of product requirements.

Tank containers carrying bulk liquids are replacing the metal drums. They avoid problems of bulk transfer, such as leakage and contamination. Tank containers are currently the most purchased style, along with reefers. New construction of boxes was recently offered by Bulk-Pack Inc. “CUBEPACK” Baffle Flexible Container does not take on a cylindrical shape when filled but remains square during filling, transportation and storage, saving 25% in volume and space utilization. These containers are available in 20- to 50-cubic feet capacities.[56]

3.4 Traffic Management

Traffic management systems includes traffic monitoring, incident detection and management, motorist information, traffic diversion, and logistics-based organization of traffic, such as truck-only lanes on designated highways, where cars are segregated from trucks, and widespread use of ITS to provide information and fast help in case of incident.[57]

- ***Parking and Truck Stops***

Street parking during delivery, along with the penalties imposed for illegal or underpaid parking, are important issues for truck drivers. New technology will allow truck drives to buy an exact amount of on-street parking time via mobile phone in order to avoid penalties or overpaying at parking meters. This mobile phone-based technology is currently in use in two major Swedish cities. Instead of inserting coins in a meter, a driver can use a mobile phone to connect with a *call center* to record when he occupies and leaves a parking space. Once logged, this data is automatically available to patrolling wardens carrying handheld units with connection to the center. Other parking authorities are already expressing interest in a remote cashless parking payment.[58] In New York, authorities have started to experiment with similar approaches.

The long-distance truck driver's requirement for electricity requires installation of the electrical outlets for trucks at travel plazas and truck stops. Long-haul drivers parking there could run microwave ovens, refrigerators, TV and laptop computers. A recently developed industrial-grade inverter can help trucks use electricity at stops. In 2000, Idele-Aire Technologies (Ohio) prepared a model for an electrified truck stop, designed to supply air conditioning and heating to truck cabs at stops without having to idle engines. The company plans to expand the system, and to also provide telephone, Internet, and cable television service. The benefits of this system include reducing air pollution and fuel consumption, eliminating engine icing and improving service for drivers.[59]

- ***Inspection Devices***

Various improved inspection devices are now being used to increase safety by detecting faulty brakes, exhaust leaks, over-inflated tires, hot-wheel-bearings, and other mechanical problems. Faulty brakes are the most frequently cited inspection violation for motor carriers. Kentucky DOT is working on a long-term pilot project funded by U.S. DOT, using infrared technology. Screening will take place at highway speeds; trucks won't have to slow down unless a problem is detected.[60]

Another safety system test is under way. The Intelligent Vehicle Initiative (IVI) program conducts field tests of the advanced safety system. The aim of the tests is to determine the effectiveness of the sensor used in automated highway programs.[61]

- ***Security and Safety Technologies***

The terrorist attack on the World Trade Center and Pentagon in September 11, 2001 and the arrest of men who allegedly tried to fraudulently obtain commercial driver's licences for hauling hazardous materials has shocked the trucking industry with the rest of America, and fanned fear that commercial trucks could be used as weapons of mass destruction. To prevent access to the truck of an unauthorized person, a driver identification technology (such as Engine's RoadRelay system) requires an identification code to be entered before the vehicle will start. Kenworth Truck Co. is developing a fingerprint recognition system, linked to ignition, which allows only authorized drivers to start the engine. Volvo's

Trucks are scanned at Customs point at entrance to the US
Source:JOC Week, April 8-14, 2002
www.joc.com

Intelligent Vehicle Division developed a range of high-tech systems for Class 8 trucks, using existing E-ZPass devices modified to provide trucking fleets with more information for security purposes. Recently introduced in all provinces of India, smart-based standardized driver licences can validate the identification of the individual, based on biometric features, such as fingerprint or an iris scan during the enrolment process. This licence card can prevent individual to obtain a driver's licence in different state under a different name. This same system could work in the U.S. as well[152].

After 9-11 there is increased truck and container security
Source: Traffic World, December 24, 2001

Satellite tracking systems (GPS) are valuable tools for solving cargo crimes. Not only can drivers alert dispatchers to emergencies instantly, these and other types of tracking systems can also be used to pinpoint a hijacked truck's location. The "geo-fencing" system, developed by Maptuit Corp, sounds an alarm if truck deviates from a designed route, and developed a method for using GPS to build invisible fences around hijacked commercial vehicles.[62] Organizations that combat car theft, such as the Technology Asset Protection Association, provide high-tech products, education, information sharing and support services.[63]

While technology speeds the flow of cargo information by developing paperless trade, it also increases the risk of cargo loss through theft. London-based International Maritime Bureau, part of the International Chamber of Commerce, has taken several steps to increase security. Among these risk-reduction efforts is the assignment of random six-digit numbers to clearing import shipments for pickup or an additional security layer, such as a time element that puts a deadline on the cargo pickup. Unfortunately, these efforts to reduce risk often increase responsibility for the ports. In 1999, IMB has developed a database of cargo thefts that may be used to analyze cargo crime patterns in more detail, and to develop additional anti-theft strategies.[64]

New technology has a great impact on safety improvement. While large trucks are involved in only nine percent of fatal crashes, they are involved in 40 percent of fatal rear-end crashes, according to federal statistics. Radar devices that are now available could sharply reduce the number of rear-end fatalities. These devices are not intended to relieve the vehicle operator of responsibility for safe driving; they are meant as an aid to the driver.

The National Transportation Safety Board has recommended that all new trucks have radar installed. One likely use of radar is in a collision-warning system, which gives a visual or audible warning when it detects that a truck is closing fast on another vehicle. Another device is adaptive cruise control, which maintain the truck's speed on the open road but automatically applies the brakes if it senses something stopped or moving slowly ahead. Trucks need 20 percent more distance than cars to stop, and crashes involving trucks are most often fatal because the vehicle is so heavy. A collision-warning system is already available on Peterbilt tractors, and adaptive cruise-control is offered on Mercedes S-Class cars and on the Lexus LS430. U.S. DOT is currently conducting studies involving General Motors and Volvo trucks.[65]

3.5 Elements of ITS Technologies

• *Toll Collection*

The road pricing system continues to evolve, with more toll operators exploring demand the management options and making future public policy decisions about incentive pricing. There is also the trend in U.S. and Europe public policy toward making transport, particularly road transport, pay for its full operational costs, such as infrastructure maintenance and damage to the environment. Lately, Switzerland has estimated these costs in the region of $925 million annually, and therefore has introduced a fee, calculated on the basis of weight threshold, vehicle emission class, and distance driven per month. The fee applies to all heavy goods vehicles (HGVs) with maximum laden weights over 3.5 tons which use Swiss public roads, with the exception of agricultural, emergency, and military vehicles[66].

Providing modern electronic toll express (ETX) lanes is currently of major interest to U.S. toll agencies. All new toll roads are being built with these lanes, so that transponder equipped cars can drive straight through in a multiple-lane open road environment at a normal highway speed. Toll accounts are debited on the basis of reads from the equipment installed on overhead gantries that also house cameras to record violators' licence plate. A "smart loops" technology developed in UK, is being widely used for automatic vehicle classification and vehicle separation in these new high-speed ETX applications. In the NY metropolitan region, ETX lanes are now being designed for the heavily trafficked Newark toll plaza on I-95[152].

• *Weigh-In-Motion*

Throughout the country, trucks are required to pass through roadside weight stations for weight, safety, credentials and sometimes tax collection purposes. Weigh-in-motion (WIM) sensors are used to catch illegal operators, but also help plan road infrastructure. The WIM system helps lower the cost of weight stations in terms of staffing and disruption to traffic flows. In the past, static weighing of trucks has been a norm. However, the stations are expensive to build and operate, and often can be open only for limited hours. Implementing a WIM pre-screening and sorting system in conjunction with conventional static weight stations is a cost-effective solution and minimizes delays to legally loaded vehicles. As a truck approaches the weight station and passes over the sensor, the weight of the vehicle is determined. If the weight of the vehicle and axle loading is within prescribed legal limits, the vehicle is allowed to pass without stopping. Variable Message Signs (VMS) transmit this information to driver. If the vehicle is overweight or improperly loaded, it is pulled over to a static scale for determination of the legally enforceable weight. The saving to the trucking industry and the enforcement agencies are significant. WIM data is also useful for identifying routes trucks use when they go off the main Interstate to avoid weight stations. WIM sensors placed strategically in the road help to establish patterns, and portable static scales can be brought in for weight enforcement purpose. The WIM system is also used for the evaluation of pavement performance.[67]

PrePass is a popular electronic weigh-in-motion system used to speed trucks through state weigh stations. Trucks equipped with PrePass transponders can be electronically identified and weighed while driving at a normal rate of speed on the road. PrePass was developed by HELP (Heavy Vehicle Electronic Licence Plate) in June 1995, and currently has more than 100 sites nationwide. Other weigh-in-motion systems are emerging. Two different business models of WIM have been developed for private-sector: NORPASS (North American Pre-clearance Automated Safety System), which is used in six states (Kentucky, Georgia, Florida, Oregon, Washington and Idaho) and serves 257 permanent weight stations, and HELP Inc. (Heavy Vehicle Electronic Licence Plate) PrePass program, which serves 372 weight stations in 16 states. These systems may be integrated in the future.[68,69]

- ***Automated Highway***

Automated vehicle guidance for freight movement is tested in several countries. At the Demo-98 event, the Dutch Centre for Transport Technology presented the Combi-Road project, which used driverless vehicles traveling on a specially constructed track. Vehicles were mechanically guided by two wheels, which run along the walls of the track. This system is planned for use in transporting containers from Rotterdam, one of the world's biggest container ports, to a number of container exchange locations up to 70km inland, thereby avoiding traffic congestion around the port. In the Combi-Road system, electric vehicles are automatically loaded with 50-ton containers before traveling at cruising speeds of about 50 km/hr, with a headway of approximately 12 seconds between vehicles. The vehicles are autonomous, capable of transporting containers with no interaction from a central system. Their movements are constantly monitored by a central computer, which responds to any system failures and optimizes the operation of a network. A sensor in the track monitors each vehicle's position and warns of any obstacles. A similar system using a different lateral vehicle guidance technique - magnet markers in the track - has been developed and tested by the University of California at Berkeley. In this system, trucks communicate with each other over a so-called "electronic towbar." The lead vehicle is driven conventionally by a driver, while the vehicles that follow are controlled automatically.

Another system for moving containers between the dock and the container-stacking yard, called Automated Guided Vehicle Navigation Control System, was developed in 1999 in Israel and is now successfully used in large European ports. This system uses an electro-optical tracking system to find orientation around the port. A wireless data communication system enables the port operations center to monitor each vehicle's position and status and allocate jobs. Guided vehicles were also used during construction of the Channel Tunnel between Britain and France. Thus far, the automated vehicle guidance systems were segregated from normal traffic. However, Japan is currently testing a light-weight dual-mode truck (DMT) capable of being driven manually on the street for local delivery, and which can also operate automatically on dedicated guideways for longer journeys. DMTs are electrically powered from a battery, which recharges while the vehicle is on the guideway.[70]

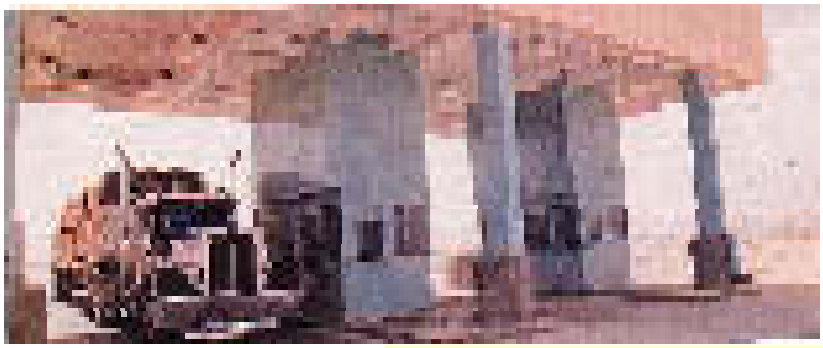
Tests are being done on DMTs fitted with laser-radar, inter-vehicle sensing devices, which prevent collisions between vehicles and allow vehicles to run together in line. These devices reduce wind resistance and energy consumption. In the New York metropolitan area, the automated highway system was judged to be a potential environmental and community hazard; however, it can be used in the future for moving traffic in the ports or other highly congested areas.[71]

- ***Intelligent Vehicle-Highway System***

The Intelligent Transportation System has created significant benefits in areas where vehicles and highway meet. These include electronic toll collection, traffic information gathered via traffic probes, priority signal control for emergency vehicles and magnetic lane markings offering guidance in low visibility situations. However, although these automatic systems can perform a single function, they cannot react to changes in the environment or make decisions.

The Intelligent Vehicle-Highway System (IVHS) promises dynamic information flow directly between processing systems within vehicle and road to optimize safety, vehicle operation and traffic flow. Over the next few years, we can expect the development of electronic license plates (ELP) which look like today's plates, but have embedded electronics and antenna within. These tags provide vehicle ID and tag information directly to roadside readers for toll collection or traffic probing. Interoperable vehicle communication becomes possible. The Vehicle Braking

System will receive notice of braking from the vehicle ahead-and perhaps several vehicles ahead-including the degree of braking. This in turn enables closer headway for longitudinal control systems such as adaptive cruise control. Closer headways are expected to result in greater per-lane capacity on the highway.



A truck passes through the custom inspection station
Source: www.joc, November 26, 2001

Merging and lane changes can be assisted by cooperative negotiation between vehicles. In inclement weather, the real-time road-tire friction, as measured by other vehicles or roadway sensors, can be transmitted to your car before it hits the slippery spot, so that speed and handling characteristics can be adjusted. At a busy intersection, the car will inform a driver that another car on the cross street is not stopping at red signal, and driver is warned to slow to avoid collision. [72]

- ***Expansion of Wireless and Monitoring Technologies***

Many examples of these technologies are used by the trucking industry. One of the more interesting example is the new "lane departure" warning technology developed by Commercial Vehicle Operations (CVO) which can reduce unintended lane departures, such as those caused by inattention, distraction or falling asleep. These systems alert the driver when the truck is not tracking straight in the traffic lane. Another example is VORAD technology and its SmartCruise speed control system. By connecting the Collision Avoidance Radar to the throttle control, engine brake and cruise control, SmartCruise is able to reduce the vehicle's speed as traffic slows ahead, maintaining a safe headway, and then automatically return to the set cruise as traffic resumes normal speed.

Many regions are experimenting with ITS technology. For example, Trimble Navigation Ltd. from California recently introduced the CrossCheck XR/GSM, an intelligent positioning unit that uses the GSM cellular communications protocol for voice and data messaging information. It is the first device that combines GPS, cellular and computing technologies into a single circuit board, providing fleet operators with a cost-effective solution to improve operation by increasing efficiency, driver compliance and management information. The Transview Corp. from Minneapolis promotes creation of a web-driven trading centers that could link on-line networks offering transportation and logistics. Transview offers such value-added services as a combined transportation program, market-driven distribution, and insurance in a single customized package as a delivered product. Transview operates with TimeForward Adaptive Technology software, and also sells e-Logisticx software that helps companies manage their logistics activities from order through delivery to payment. [73]

3.6 Detection and Reinforcement

These technological solutions have been developed to control speed and to assure the safety of freight movement. Sensors are important tools for the gathering of information from the roads. They are typically divided into two groups: intrusive and non-intrusive. The intrusive sensors are these that are put into the road, and are typically used to gather information on each specific vehicle. Non-intrusive sensors are typically overhead and are used for the gathering of general information on the flow of traffic. New devices can also provide advanced tools against theft. Some examples of security technology used in the trucking industry are discussed below.

SPEC, a new type of speed enforcement system, is used widely in England. This system consists of a pair of cameras placed a distance apart to create a speed-controlled zone. As vehicles pass between the entry and exit cameras, their number plates are digitally recorded and the time taken to travel between the two points is used to calculate the average speed. If it exceeds the threshold set by the local police force, the speeding violation record is automatically generated with a color camera at the exit point, producing a complete picture of vehicle and driver. Another program, developed in Holland, uses video-control technology to discourage tailgating, which is a major source of traffic accidents. The Dutch installed devices, based on digital imaging technology, at locations of frequent road accidents. The system makes it possible to analyze precisely-timed, live video-recording of suspected tailgating, using clearly defined road sector measurements. The control computer calculates the distance between individual vehicles at the speeds at which they are traveling and enables a police officer to determine whether an offense has been committed.[74]

Another security-related program was developed in response to the increase in fraud linked to vehicle license plates and other parts of the registration process. The use of reflective sheeting on plates represents a first level of protection: security features such as as embedded graphics, watermarks and reflective values make it difficult to copy or modify a plate convincingly. A new method of protection against falsification uses holographic images, which cannot be copied or reproduced by any means. That system's basic components are: a self-adhesive holographic label, attached to inside of the windshield that repeats the vehicle registration details and can be compared with its license plate; a similar label attached to the license plate; and a holographically-protected registration document validating ownership and vehicle details. Additional security elements can be added and integrated, including hidden information stored in machine-read, two-dimensional barcodes. The Holographic Car Identification System (HoloCIS) developed in France provides maximum security for vehicles, license plates and documents, using high-security holographic elements. This system has an immediate effect on reducing illegal registrations and forgeries.[75]

Another system named New Tracker Communicator has been developed by the Tracker Network for tracking stolen vehicles. It uses GPS and GSM cellular phone technologies to obtain live reports on vehicle status at any time from any touch-tone phone in the world. A 24-hour monitoring facility ensures up-to-date information. The driver can alert a control center by pressing a panic button if the vehicle is hijacked or stolen.[76]

Distribution Center Equipment
Source: JOC Review & Outlook
January 2002

3.7 Warehouses and Distribution Centers

Warehousing is an important part of the distribution process. During the past decade, a number of technologies and management systems have reduced the need for inventory and storage time, and therefore for traditional warehouses. Logistics analysis seeks to eliminate unnecessary inventory from the manufacturing/production process by putting supplies and finished goods in the distribution pipeline for a minimum amount of time.

Tomorrow's retail distribution centers will require sophisticated warehouse-management system (WMS) software to keep pace with changing replenishment techniques. They will also incorporate modern equipment that will support the faster and easier movement of cargo.

The 1999 study by Penske Logistics of Reading, PA, a major third-party provider, shows that 21% of the top 250 U.S. companies surveyed acknowledge that use of technology, including EDI and online usage, will simplify the supply chain, increase efficiency and reduce costs. Some 10% of those surveyed indicated the need to standardize

products and equipment, and 8% mentioned use of Just-In-Time (JIT) system. In addition, the 1999 meeting of the National Small Shipment Traffic Conference in Ohio pointed out the need to identify, monitor and respond to rapidly changing customer value requirements.

Modern Warehouses use logistics technology
Source: JOC Review & Outlook
January 2002

In an effort to reduce inventory, Hewlett-Packard developed a product-tracking system called "Voyager." This inbound material-tracking system provides status updates and visibility at any predefined point in the procurement and transportation network. Under this system, HP's procurement operation produces a purchase order, which is transmitted to the manufacturer, and informs Voyager of the status of the transaction. The manufacturer, after receiving an order, sends transaction notices about the order, quantity and shipment date over the Internet-based system. If notice on the expected shipment date is not received, Voyager sends an alarm to HP, who will contact the manufacturer or freight forwarders. Use of Voyager provides benefits in inventory reduction and improves HP's reaction time across the entire North American supply chain from raw material to customer.[77]

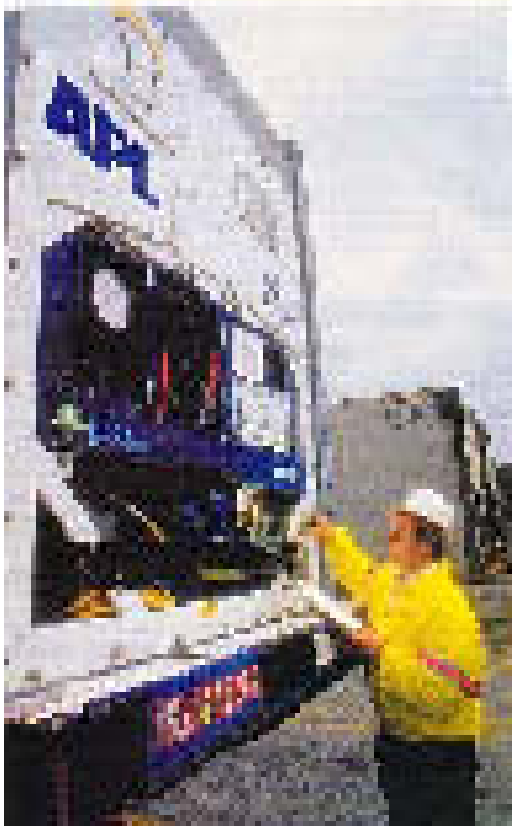
Another management system applies to the delivery of shipments with multiple components. Use of a merge-in-traffic distribution system, designed to unite components from multiple suppliers at a specific point located close to the end customer, can yield a number of benefits. Among these advantages is delivery of a single consolidated shipment to the customer within a prescribed time period, reduced cycle times from order receipt to delivery, reduced inventory and transportation costs, and improved customer service. Under a merge-in-transit system, "merge points" will replace the traditional warehouse in which orders are assembled from inventory in stock for shipment. "Merge points" are locations where no structural inventory is stored, but freight from multiple suppliers is consolidated, with such provided services as sub-assembly or addition of materials such as instruction manuals. The study *("Merge in Transit from Theory to Practice"*, by GeoLogistics, 1999) says that by optimizing locations, time of operation and redundant transportation costs can be largely reduced.[78]

The use of advanced predictive software makes possible the cross-docking of virtually all products. Cross-docking warehouse management entails shipping products immediately without storing them. It reduces the time and labor needed to handle materials, but requires software to track and record products and their movement. The industry is working on a new generation of radio frequency products that will identify products automatically with chips that carry more information than the traditional barcode, such as the manufacturer's ID, product serial numbers, country of origin, lot control number, and destination information.

Controlled-climate technology extends the shelf life of perishables. The new, highly specialized integrated units, could in addition to controlling temperature and humidity levels, control levels of oxygen and carbon dioxide to a margin of error of 1% in a container. The main producers of container' refrigeration units are Carrier Transicold Inc. of

Syracuse, NY, which serves Sea-Land Service Inc. Another producer is the Thermo King Corp., which has created a system that pumps nitrogen, and in some cases, carbon dioxide through a porthole in boxes, to create the optimal atmosphere for the particular cargo. These companies also evaluate technologies that could control ethylene and bacteria and fungal growth. Another technique is treating fruits and vegetables with a chemical blocking agent that prevents the ethylene gas from jump-starting the ripening process. The results vary depending on the cargo and loading conditions, but the shelf-life of produce can be extended by weeks with the use of a blocking agent. Food irradiation, which has recently made a comeback, can also extend the shelf life of a product. The food processing industry wants to integrate this system (based on exposing food products to a measured amount of electrons, gamma-rays or x-rays) into the supply chain, fighting strong public opposition to this system[79].

Refrigerated shipping industry is growing
Source: www.joc, October 8, 2001



- ***Impact of Truck Technologies on NYMTC Activity***

NYMTC supports the development and modernization of truck-related facilities and infrastructure over the region, and promotes the use of new technologies with the goal of improving freight transport safety and efficiency. There are many successful examples of the use of ITS in trucking in the Metropolitan Region. The region's motor carriers use Citizen Band Radios, pagers, cellular phones, computerized routing and dispatch systems, and automated telephone response systems from terminals to obtain information. TRANSCOM operates Operation Information Centers, which collect and disseminate construction, incidents and special event information through alphanumeric pager network, workstations, fax and phone, to over 100 recipients. The ITS program on the George Washington Bridge (GWB) provides automatic detection of traffic tie-ups along the corridor connecting New York and New Jersey and relays information on traffic conditions in coordination with other transportation agencies.[80] Also, PANY&NJ's "FIRST" system (see page# 9) provides cargo and equipment information.

Another example of the use of ITS technology in the metropolitan region is electronic toll collection introduced on all applicable crossings. It is the most popular means to collect money for transportation maintenance and improvement. The electronic pre-paid toll collection system on highways, tunnels, and bridges, known in the region as EZ-Pass, has been in use in the New York area since 1999. In this system, ETC tags are activated to transmit a unique identifier code, which is read by a reader using radio frequency identification technology. A computer deducts a toll from the tag-bearer's account. In an effort to curb road congestion, PANY&NJ introduced in 2001 variable payment, depending on the time of day. Authorities are expecting that the system of rewarding off-rush-hour travelers will help to reduce congestion. The EZ-Pass system has also made it possible to collect traffic data without stopping and interviewing the vehicle occupants. Sensor evaluation of over 3 million vehicles passing through toll booths of New York in 1999, under usual weather conditions, has shown a classification accuracy of 98.5%.[81]

Alternative fuel technology is already in use by the NYMTC area's transit buses and utility fleet. The region's agencies, including NYMTC, are promoting the use of electric cars and hybrid cars, and some businesses (ConEd, LIPA) are already use this type. During the process of planning and helping to finance new facilities and programs,

NYMTC recommends the use of technology to decrease costs and assure safe vehicle travel.

Just in Time (JIT) distribution saves substantial money on transport
Source: Traffic World, March 3, 02

While the expected increase in truck size and weight limits is a big issue in the U.S. transportation industry, in the New York metropolitan area problems of the insufficiently wide roads and a narrow curvature of roads in several parts of the region preclude so far approval of an increase of vehicle parameters.

Parking for commercial vehicles (trucks, vans) in the metropolitan region is a major challenge. In addition to congestion, limited curb space and time restrictions for truck parking and loading or unloading of cargo become a significant logistic issue. Incorporating adequate and efficiently managed facilities in strategically located areas along with improvement in payment methods for street parking would help truck drivers to avoid tensions, violations and related penalties while providing for the timely delivery of freight. In 2000, NYC DOT has created in mid-Manhattan a metered parking area, specially designed for commercial vehicles. The pilot program introduces a congestion pricing concept with variable hourly parking rates.

Other problems are truck stops. While industry representatives in other regions of the U.S. and abroad discuss truck stop modernization, the NYMTC region has no truck stops at all. With the steady increase in freight traffic, building truck stops along the main corridors has become an important issue. Weigh-in-motion stations (WIM), which provide many important functions, are also absent in the NYMTC region. When built, these facilities may help to develop an efficient, seamless freight transportation system, vital to the region's economic stability and competitiveness.

Promoting development of modern, automated, multifunctional warehouses-distribution centers in the metropolitan area is an important part of the planning process. The role of warehouses in the supply chain is changing rapidly. Logistics centers seek to eliminate unnecessary inventory. The traditional warehouse is rapidly being replaced by service and distribution centers, answering the growing demand for value-added and custom services. These services often provide such tasks as reconditioning and repacking, consolidation, weighing and sorting, stockpiling, product mixing, distribution and discharge, export and foreign trade zone (FTZ) and logistics. These functions, as well as the "just-in-time" (JIT) distribution system, have changed the physical layout and operation of facilities. The new distribution centers, while responding to requirements to decrease cost and meet customers' demands, will have to adapt their layout and operations to the new functions. This will not be easy in the congested metropolitan area.

A good example of warehouse logistics is the management center opened in 1999, the Circle International Logistics Center in Lawrence, Long Island, NY. This center handles the company's international transportation, warehousing inventory management and supply chain outsourcing services. With a 27,000-square foot of office and 100,000 square foot of warehouse space accessed from 24 loading bays, this multi-story, state-of-the-art logistics center includes a recessed material-handling system to accommodate pallets and cargo containers, refrigeration capabilities, racking systems for inventory management, order-fulfillment services and a dedicated trucking fleet.

An important type of warehouse is for storage of perishable goods. Refrigerated Warehouse has opened a new refrigerated fruit terminal at Howland Hook and in Newark, New Jersey. East Coast Warehouses has expanded its facility in Port Elizabeth. There is also growing demand for ethnic food in the NY metropolitan area, which will need increased capacity of refrigerated terminals.[82]

4. Marine Technologies

4.1 General Description

Technology plays an important role in water commerce and waterborne transportation. With cargo volume expected to double over the next 20 years and waterfront property at a premium, the nation's ports can't keep building larger terminals indefinitely. And since many container terminals are used at only part of their potential capacity, the trend is to improve utilization of those facilities before investing hundreds of millions of dollars to build new ones. The table below shows that the 2000 East Coast region ports' productivity was far from satisfactory.[83]

U.S. ports (average)	**2,144 TEUs per acre per year**
U.S. West Coast ports	**3,567 TEUs per acre per year**
U.S. East Coast ports	**1,281 TEUs per acre per year**
Asian ports	**8,834 TEUs per acre per year**
European ports	**2,974 TEUs per acre per year**

(Note: TEU=20-foot equivalent unit)

To improve the flow of information, all stakeholders of the ports-terminal operators, shippers and carriers, government agencies and logistics service providers - started to adopt a new information technology, such as computerized gate processing, automated document processing, and other computer applications. The components of the systems are high-resolution digital cameras, electronic strobes, sensors, input/output devices, and image-capturing interface software.[84] Sonar, Global Positioning Satellites and other technologies used for navigation purposes are helping with the efficient routing and processing of freight. For international freight, especially higher value containerized cargo, the communications system developed by the U.S. Customs Service is used. Also, voluntary public/private organizations, such as Terminal Operators Port Authorities Subcommittee (TOPAS) which developed EDI implementation guidelines, help standardize waterside electronic communications.[85]

Interesting concepts of how to deal with the rapid increase in marine world trade were presented at the "Summer 2000" conference by the National Ports and Waterways Institute in Louisiana. The vision presents a way to operate a round-the-world shipping service using six ships that would circle the globe roughly at the equator in 42 days, compared with more than 70 days now. The service would skip U.S. and Northern European ports and any other areas off the equator. Those regions would be served by feeder ships the size of today's largest containerships. About half of the world's container trade could move via such services. While considerable operational reordering would be required, today's ports would escape heavy investments in infrastructure. That concept would require the expansion of Panama Canal to handle ships that can carry some 15,000 TEUs, almost double the capacity of today's largest vessels, and over three times the capacity of the containerships the Canal can now accommodate. The new system would effectively freeze the growing size of ships now used to serve ports and reduce dredging work, because the equatorial service would become the world's primary traffic lane. The beltway system could also impact current North American landbridge services, replacing them by swift and less expensive feeder hauling through the Panama

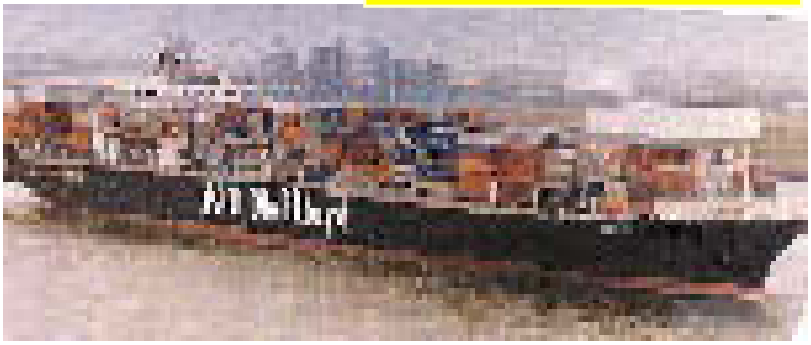
Canal.[86]

4.2 Future Types of Vessels

• *Mega Ships*

The new containerships are able to carry huge amounts of cargo. The Mega-Ships or Post-Panamax vessels, so named because their size precludes using the Panama Canal, are built for a capacity of 6,000 or more TEUs (20-foot container units). The Panama Canal has a vessel beam limitation of 105 feet. The Post-Panamax vessels have a speed of about 25 knots and because of their capacity offer about 20% cost savings per container in term of fuel, crew, port dues, maintenance and repairs. Their size as well as draft have significant impact on future ports' location, layout and equipment type. Except for special instances, containerships can use only those ports that have adequate depth (50 feet and possibly more in the future) and marine container handling facilities, including container cranes that stretch as far as 158 feet to reach container slots across 17 or 18 rows. The landside infrastructure, including the transportation system to and from the port, should be able to accommodate a huge amount of cargo moved within a short time. In U.S., only a few ports such as Los Angeles-Long Beach, Tacoma and Norfolk, can accommodate these vessels. To stay competitive, the Port of New York has entered an agreement with the Army Corps of Engineers to deep dredge its access channels and dispose sediments.

Ocean transportation-inspection station
Source: JOC-December 2001



An example of a mega-ship is the Regina Maersk, which visited New York in 1998.[87] This containership is part of the new Asian-European Maersk Line service that covers the globe, making round-trips through the Suez Canal, competing with the U.S. West Coast for Asian cargo. The Regina Maersk is 1,043 ft long and can carry over 6,000 tractor-trailer-sized containers. When fully loaded, it requires 51 ft of water. The ship's arrival highlighted the need for deepening channels and the infrastructure investment in the New York region. There are 100 post-Panamax ships currently on order, and according to some reports, some of these ships are able to carry 9,000 TEUs.[88]

• *Fast Ships*

Another new type of vessel is the fast ship. It was formerly used only to carry passengers over short distances, but now is designed to carry cargo over the Atlantic. The terminal for that type of ship will require specialized features. The Philadelphia-based FastShip Company, formed in 1994, has patented technology for the freighter that was approved by Det Norske Veritas, the Norwegian ship classification society. FastShip is powered by 5 gas turbines, each driving a water jet that resembles the smaller jets that propel high-speed yachts. The jets deliver a total of 250 megawatts or 335,000 horsepower, roughly equivalent to the takeoff power of two B747 jet airplanes. The engine, which works on principles similar to airplane jet engines, can propel ships up to 38 knots or 40 mph, compared to 25 mph for a conventional containership. The 860-foot-long vessels, with 1,432 TEUs capacity, will use a patented hull and propulsion technology enabling them to sit high in the water and avoid water friction that slows regular vessels, and to operate safely even during North Atlantic winter storms.

The service is expected to begin in 2003 with ships sailing from Philadelphia and Cherbourg (France) every three days, spending only six hours in port for loading and unloading cargo.[89] The planned 3.5-day ocean link between Europe and North America - about half the time required by conventional ships and cheaper than airlines - could create a new market for time-sensitive shipments and attract new multimodal business.[90] Shipments will include perishables, automobile parts and fashions, electronics, consumer goods, and certain chemicals. FastShip is aiming for 5% of the total Trans-Atlantic market and 27% of the market of high-value, time-sensitive goods. About one-third of its business would be siphoned off from air cargo, and two-thirds from ocean carriers. The Delaware River Port Authority and the Port of Cherbourg have committed to building multimillion-dollar port facilities that will incorporate Fast Ship's unique trolley-to-ship loading system. The first four ships are intended to be built in the National Steel and Shipbuilding Co. in San Diego, the largest shipyard on the West Coast.[91]

Another company, FastShip Atlantic of Reston, Virginia, proposed a service that would operate between Philadelphia and Zeebrugge, Belgium using ships that can operate at a top speed of 45 knots, about twice the speed of other containerships. Loading and unloading time will be minimized through the use of unique air-cushioned trains. Although smaller than other containerships, this type of vessel can serve a niche market in transporting time-sensitive, high-value products.[92]

Some other companies are also involved in the fast ship concept. Norasia Lines contracted the British firm Nigel Gee & Assoc. Ltd. to design a ship model capable of cruising more than 30 knots, using only about 30 megawatts of power, and capable of carrying 13,000 tons of containerized cargo. Norasia's ship, "Pentamaran", is a relatively long, thin vessel uses four outriggers called "outer sponsons" designed to stabilize it on the high sea. The ship could travel at a speed of 37.5 knots (43 mph) as compared with 25 mph for the typical oceangoing containership. Norasia has not planned a specific route for the vessel, but is considering East Coast-Caribbean trade, Singapore-to-Australia, and intra-Asian. Ideally, that vessel would be used over distances from 2,500 to 3,000 miles. For distances over 3,000 miles, the size of vessel becomes more important than speed to achieve greater economies of scale. In comparison with FastShip, for example, Pentamaran's fuel cost will be 4.5 less.[93]

High-speed container vessels, such as those designed by Norasia and FastShip, conceivably would reduce door-to-door delivery times between the U.S. and Europe to about a week from the current 3 to 4 weeks for conventional containerships. This offers an important advantage for high-value, time-sensitive cargo that must be delivered faster than typical ocean carriage, but is too heavy or bulky for costly air freight.

- ***Roll-on, Roll-off Ships***

Other vessels that are undergoing structural changes are Roll-on, Roll-off (ro/ro) ships. Ro/ro vessels handle containerized cargo on wheeled chassis, all sorts of wheeled vehicles, and outsized cargo on wheels. During the sea voyage, the cargo remains on its wheeled chassis and is secured to the vessel by a tiedown or locking mechanism. Movable or "hoistable" decks, either hydraulically or manually lifted, have been around for some years, and make ships much more versatile than otherwise. The new construction of these ships redefined the capabilities of ro/ro ships for nearly every major carrier. The movable decks on the ship are comprised of panels that are lifted hydraulically or manually with a scissor lift secured below each deck panel.

An example of such are ACL's ro/ro ships, that carry containers on the top deck and a host of other cargoes, including trucks, buses, trailers and construction equipment which can be driven on and off the ship and stored on its lower decks. The ACL ship has a sophisticated "cell guide" or rack system for securing containers that are stored above

Roll-on, roll-off transportation
JOC, February 11, 2002
www.joc.com

deck. ACL also may carry a break-bulk cargo in the form of lumber and other forest products, as well as steel. The ship has a speed of 18 knots, but with addition of modern technology speed could increase to a more effective 30 knots. ACL, one of most profitable companies in shipping business, has five such vessels in its fleet. Another company, Wilhelmsen Lines, offers shippers flexibility with three different styles of ro/ro vessels: those with container capacity; pure car and truck carriers (PCTC) equipped with movable decks; and pure car carriers (PCC), which carry passenger cars and light duty vehicles. Breakbulk is an important part of the cargo mix on nearly every route.

Modernization has also come to inland and coastal vessels. The U.S. Coast Guard is writing industry standards for securing on-board cargo of container shipping on barges. Coastal barging is expanding, according to American Waterways Operators, the national trade association for barge and tugboat operators. Barges are often preferred to small ships for coastal trade.[94]

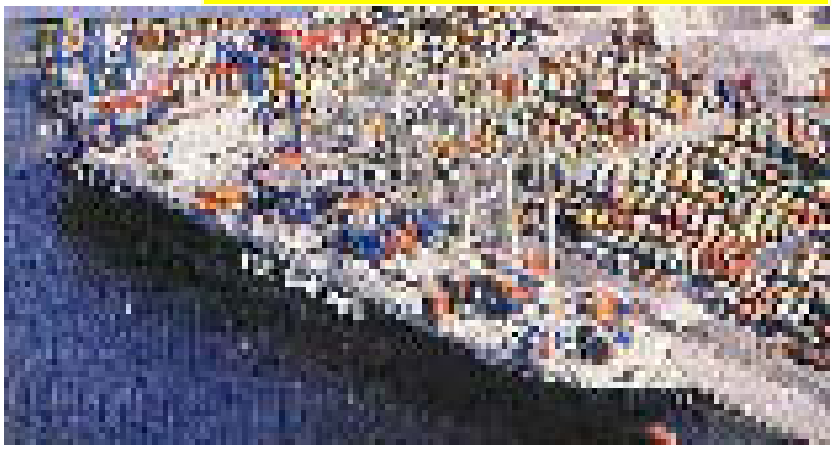
4.3 Modernization of Port Terminals

A port terminal serves as an intermodal storage and transfer facility with the objective of optimizing the efficient flow of cargo. Facing changes in the shipping industry and an increase in cargo volume, the efficiency of ports has become a central issue, critical to the region's economic competitiveness.

Future development of port technology may include:

- ***processing electronic delivery orders via the Internet, providing an automatic alert to forwarders/ brokers/truckers when a container becomes available & providing information which would allow a cosignor in foreign country to confirm delivery to the dock***
- ***creating enhancements to the tracking of cargo and cargo carrying equipment***
- ***linking information technology and management systems in commercial parking zone usage.***

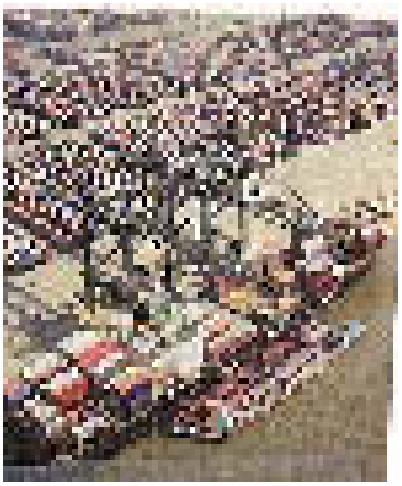
TACA (Trans-Atlantic Conference Agreement)
controls half of the trans-Atlantic trade
Source: JOC Week, February 18-24, 2002
www.joc.com



Ports are developing communication technology by incorporating it into sophisticated systems that automate activities ranging from gate operation to cargo handling. The new Port of Hamburg's Container Terminal Altenwerder, which will handle 1.9 million TEUs by 2003, will use 60 unmanned, remote-controlled vehicles to transport containers between the cargo storage area

and the quay. Within the storage area, portal cranes will automatically move up and down the stacks of boxes. Loading and unloading of trucks is automated until the cranes are positioned just above the truck chassis. The final stage will be completed remotely by the operator with the aid of cameras.[95]

Carriers form alliances to boost market share and cut costs
Source: JOC-December 10, 2001
www.joc.com



To shorten loading dock operations and waiting times, CompuNet from Arizona has developed an Internet "report card." This dock report can be used to show shippers how to improve their operations, to demonstrate what is being done wrong and to check on competitors' performance. The information also can be used in rate negotiation with the shippers.[96]

Mega-ports collect huge amounts of data. Hub port is expected to be a facilitator, linking shippers, carriers, terminal operator, truckers and customs brokers into a single transportation chain. To reach this goal, ports are creating web-based information technology systems. In one example, the Port of Seattle operates an information system for the harbor, using Portnet.com, which will allow port customers to trace their containers from a factory in South Korea to the destination warehouse anywhere. Another system is the California-based eModal.com, which provides service linking truckers and other port users with terminal operators. Also, PANY&NJ contracted in 2001 with the outside firm to develop a $2-million, web-based information exchange on cargo movements through its marine terminals.[97]

- ***Port Security***

As a result of the terrorist threats, the inspection of foreign vessels and its crew is very thoroughly performed by the coast guard and covers most of new arrivals. The use of new technological solutions is much needed. Protecting cargo in transition is one of the fastest growing security markets. Companies turning to advanced technology are providing sophisticated new cargo security solutions. The humble container seal is still commonly used to protect a container against theft, but other applications are also in use. Sea-Land Services use an "identification card" for the truck driver that includes the driver's license number and personal history. In the future Sea-Land is planning to use an automated fingerprint verification system, known as Identix, which has already been installed in some large ports by Sunnydale, a California-based company, which develops and manufactures a fingerprint ID system. Improving product security by a standardized system of tagging, and installing bolt or bottle seals which require a heavy-duty bolt cutter to break their shaft, helps companies reduce theft and counterfeiting. Further up the spectrum are reusable electronic seals that provide a barrier to thieves and store relevant data such as the container number. Transport Security Inc, a Minnesota-based company, makes an adjustable kingpin lock for containers and trailers called "the Enforcer". However, the new security devices need to be economically justified, low-cost and flexible enough to keep pace with changing technology.

While technology speeds the flow of cargo information, it also stores it in systems that can be accessed by criminals inside and out of freight facilities. The very efficiencies of EDI systems can increase the risk of cargo losses through theft. IBM tries to reduce these risks by using a random number while important shipping is cleared for pickup. The number is then transmitted to the cargo agent who relays it to the trucker as the password to be used to collect cargo. IBM is also developing a database of cargo thefts that will be used to analyze cargo crime patterns and develop more effective anti-theft strategies. They also prepare listings of parking areas rated according to how vulnerable they are to cargo crime in order to help carriers avoid high-risk areas.[98]

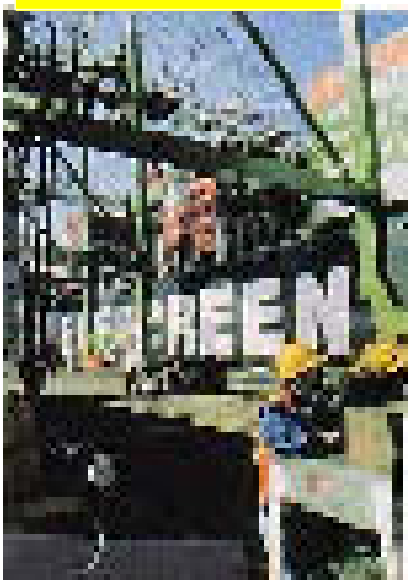
- ***Inland Ports***

The modern mega-port's landside operation will require large space. The most congested U.S. ports such as Los Angeles-Long Beach and Port of New York & New Jersey are considering moving all non-essential cargo and equipment to off-dock container yards, extending gate hours, adding modern technology and establishing a centralized dispatch hall. The off-port container yards are located at three to seven miles from the harbor, and used for storage and staging of containers, chassis and other equipment. In LA, the port identified hundreds of acres within seven miles of the harbor, that could be turned into extended terminals. Leases on these properties are $15,000 to $25,000 per acre, compared to $125,000 per acre for marine terminals at the ports. Transport between facilities could be provided by short-line rail or trucks.[99] Some types of inland ports are located at adistance of hundreds of miles from the coast. Example of such is Fort Royal, the inland port for Port of Norfolk, Virginia, which is located closer to the major market area of Washington/Baltimore than to the port.

- ***Terminal Velocity***

Operators are trying to get the ships in and out of the port as quickly as possible. Also, while ships have gotten bigger and faster, there's a need to move cargo faster to final destinations. Until now, marine terminals typically handled the ships by gantry cranes working the ship from one side. To cut down the time needed to get a 6,000-TEU containership in and out of port, the Port of Amsterdam decided to build a terminal with slips where ships can be worked with dockside gantry cranes from both sides, simultaneously. Their 135-acre new terminal has three berths with a total capacity of 950,000 TEUs a year. This means capacity of about 7,000 TEUs per acre, making it one of the most productive ports in the world. The berth size is 1,150 foot. by 180 foot, and has 9 to 12 cranes working the ship from both sides. If 10 cranes are used and each moves 30 boxes an hour, throughput would total 300 boxes an hour. At that rate, a large ship could be worked in 10 hours, compared to 21 hours at a one-sided berth. Cantilever steel deck at the edge of the dock can be removed to accommodate wider ships, even those with 22 rows across.[100]

Containers arrive at port
Source: JOC Review & Outlook
January 2002



Other major time-saving step on the inland side is a patented system designed to cut loading and unloading times to less than four hours. One such system recently proposed in the U.S. consists of trolleys that run by remote control on tracks, lifting and carrying 20- and 40-foot containers onto and off the ship.

Another system consists of dedicated trains running back and forth to forward distribution points (system used widely in Europe). Unlike normal cargo trains, dedicated trains wouldn't be shunted aside by passenger trains due to computerized management system. The train could cross national boundaries without switching locomotives, because systems have been developed to adjust to the different power sources used by various countries' rail systems.

4.4 Infrastructure and Equipment

- ***Gate System***

The gate complex serves as an interface between the port and surface transportation, with the objective of moving containers in and out of the terminal smoothly, efficiently and safely. The configuration of gate complexes differs for each terminal. The productivity of the gate has a direct impact on the overall terminal capacity as well as on truckers' profitability. The paperless method

of handling cargo has increased gate productivity. To link information technology with intermodal gate operation, cameras have been installed at marine terminal gates so that truck queues can be observed and the trucks routed to other gates as needed. A web site designed to provide status and locations of container information is available through Transcom. A PANY&NJ demonstration project was completed in 1999.[101] In 2001, PANY&NJ started to use the *FIRST* program (Freight Information Real-Time for Transportation System). The FIRST covers all Port Authority's terminal operations, provides containers data, booking and vessel activities, rail activity, truck movements, application and regulatory information and contact list. For details see www.firstnynj.com.

- ***Cranes***

Gantry cranes, which load or discharge containers between the ship and pier, average 30 containers per hour. The new vessel size forces the port operator to use new types of cranes, with outreaches of 165 to 184 feet and high operating speeds. Lift height above the quay needs to be at least 115 feet, preferably 131 feet or more. As crane lift heights increase, faster trolley and hoisting speeds are achieved. The power supply should be electric, which makes the investment less expensive. An important addition for the future crane is electronic capability including EDI-Electronic Data Interchange, GPS-Global Positioning System, AEI-Automated Equipment Identification, ELS-Equipment Location System, and communication technologies. While cranes are getting bigger, some ports have added dual-hoist cranes that allow two boxes to be moved at the same time.

Source: JOC-December 10, 2001
www.joc.com

New concepts of handling cargo are under study. The proposed innovations include a robotic container handling machine (RCHM), Reggiane's "Octopus System", Mannesmann's automated transport system AGV (Driveless Automatic Guided Vehicle), and others.[102]

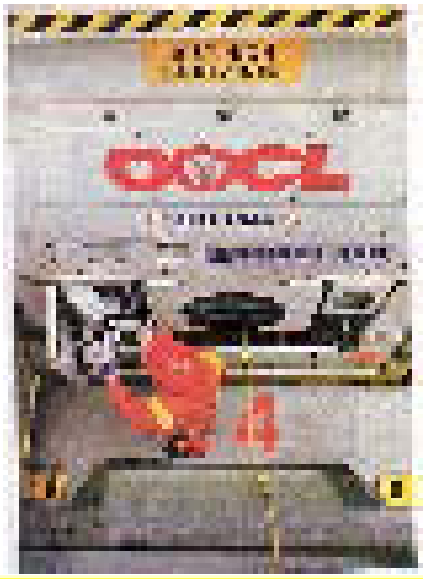
4.5 Containerization of Cargo Transport

Most cargo on ships, with the exception of bulk cargo and ro/ro, is transported in standardized 20- and 40-foot containers. Ocean carriers are following the trend of using larger boxes that don't cost much more to handle and are better suited to higher-valued cargo. That trend has gained momentum as the center of international trade shifts from the Trans-Atlantic route to the Pacific Rim, where trade is dominated by light-weight cargoes that can fill 40 ft. or larger containers. Some carriers are reducing both the percentage and number of 20-footers in their fleet. According to the Institute of International Container Lessors, between 1990 and 1999, the number of 20-footers, has fallen from 44.8% of the major lessors' fleet capacity to 34.9%.

Shippers prefer larger boxes because their rates per cubic foot or ton are less than the 20-footer. Yangming Marine Transport has introduced its first 45-foot containers in 2000. Sea-Land Service Inc. cuts its inventory of company-owned 20-footers from 25.8% in 1996 to 18.6% in 1999, and plans a further annual reduction of 15%. Twenty-footers, which became the industry standard as 20-foot equivalent unit, or TEU, emerged as the box of choice in 1960s, primarily because they met European road and rail requirements. Now, container shipping's top volume region is Asia, which produces apparel, shoes, toys and other consumer goods, that can be packed in a 40-footer without overloading it. Some heavy cargo (such as tile and marble from the Mediterranean, coffee from Africa or

South America) still require 20-footers. Ships are now designed with specific number of TEUs, FEUs (20-foot, 40-foot or 48-foot containers), enabling the consignor to use the ideal mix of boxes to reach the design capability of the vessel.[103]

Refrigerated cargo transportation in the marine industry is growing rapidly. Nearly three decades ago, Columbus Line and its parent company, Hamburg Sud, developed cellular containerships with Conair refrigeration technology. These ships pioneered modern containerized service to Australia and New Zealand, and helped establish today's vibrant trade in meat and seafood. The Conair system has used shipboard refrigeration to maintain proper temperatures in individual boxes. Today, Conair systems are being replaced by integrated containers with a computer controlled and monitored refrigeration system built into the box. This system permits greater flexibility in the movement of high value cargoes aboard ship and during inland moves. Lately, Hamburg Sud has developed a new design with greater interior capacity and computerized monitoring and data collection capacity.



Reefers gain market share. Several hundred reefer slots are installed in large containerships.
Source:JOC Review & Outlook, January 2002
www.joc.com

Other companies are also working on reefer shipping equipment. Car Rental Power, the Illinois-based company, has developed Cat, 20-foot ISO container, able to provide generating power for refrigerated containers or to augment a ship's own electrical system. The container has the capacity to produce 30-kilowatts. Engines inside are connected to 40 external plugs to provide power for onboard reefer containers. Each Cat unit is compartmentalized into two "rooms," one housing an engine and the other a radiator and cooling system. Underneath is a 1,200-gallon diesel fuel tank. The unit also carries onboard Carbon Dioxide systems for fire-sensing and discharge during a fire. Ports are a growing market, given the rise in intermodal shipment, and reefers often will require temporary electrical power, offered by the caterpillar system.

The new technology, called "controlled atmosphere" can replace air in reefer containers by an inert gas such as nitrogen, which keeps vegetables and other perishable products fresh longer and can eliminate pests such as fruit flies. Gensets (generator sets) are used to power the reefer containers, thereby maintaining the set temperature during the transport (www.norasia.com).

Fresh fruit transport industry provides electronic seals on its containers which prevent tampering once the box is closed.
JOC Week, April 8-14, 2002
www.joc.com

Insta-Bulk company (Texas) has developed a new type of liner and polypropylene woven bag for ocean shipping, which can replace bags, boxes, drums and pallets, can hold up to 46,000 pounds (21 metric tons), and allows for virtually all loading and unloading possibilities (www.insta-bulk.com).

Oversized cargo that cannot fit inside standard containers, such as yachts, big machinery or military equipment, can be transported in flatrack containers. Flatracks are basically standard containers without the two long sides or

a roof. Shaped like a "U" with a long bottom, they have two upright ends for lifting the containers onto or off the ship. The containers can be folded and stacked on top of each other to minimize their space when not holding cargo. The flatracks have been around for 25 years, but only lately, after the redesign made the upright walls collapsible, have they increased in appeal and usage to become cost effective. On a return voyage as many as four or five 40-foot units can be stacked in a single slot. The new generation of flatracks is competing with breakbulk carriers for project cargo and oversized cargo business. The main flatrack manufacturers are California-based APL Ltd., TransAmerica Leasing and GE Seaco Services. The flatracks' unique design permits the transport and storage of large machinery on deck-the kind of cargo that typically rides on ro/ro or breakbulk vessels.[104]

Those advocating chassis pools say equipment would be used more efficiently
Source: JOC, September 17, 2001
www.joc.com

Since containerization began, the ocean carriers that own containers have been expected to provide chassis to move boxes over the road. Today, in time of deregulation, there is a trend to form "chassis pools", and shift chassis ownership to truckers. Equipment sharing trims duplication and reduces costs. IANA (Intermodal Association of North America) proposes maintaining a national pool of 700,000 chassis, which would generate a saving of a $250 million annually. Currently, Maher Terminals in Jersey City manages a cooperative chassis pool for carriers at Port Newark/Port Elizabeth in New Jersey. Maher's chassis are owned by steamship lines, but in other terminals lessors often contribute to the chassis pool. Sea-Land is testing a similar program in Florida, and wants to sell or lease up to 900 chassis to drayage carriers. There are several reasons chassis pools are becoming attractive to carriers, such as global erosion of shipping rates which has restrained capital for investment in chassis; insurance liability; vessel-sharing agreements, etc. Allowing truckers to supply chassis would give truckers more operational responsibility. However, some of the opposition says that could reduce the ocean or rail carriers control of the assets.[105]

- ***Impact of Marine Trade Modernization on NYMTC Activity***

NYMTC has a profound interest in the development and modernization of the region's ports. NYMTC Council members cooperate with PANY&NJ, NYCEDC, and other agencies, by helping finance several marine projects and promoting preparation of facilities for the expected increase in volume and the arrival of new generation of large ships. The arrival of mega-ships as well as the need to provide space to handle the extra 6.5 million cargo containers expected to arrive at the Port of New York & New Jersey by 2040, has created a new concept of the future marine terminals. PANY&NJ's $5.6 billion development plan includes a 520-acre hub for megaships on the Hudson County waterfront, and 350-acre new mega terminal for SeaLand-Maersk in Port Elizabeth.

NYMTC initiated the Regional Freight Plan project, which includes analysis of ports and their impact on the regional economy, and suggested technological solutions to problems facing the marine industry. The NYMTC staff works closely with PANY&NJ and NYCEDC on port development and related issues on both sides of Hudson River. The NYEDC plan calls for a new automobile export/import hub in South Brooklyn. However, the big question is how a megaport in Brooklyn could be served in face of road congestion. Plans call for building a freight tunnel beneath Upper NY Bay to link Brooklyn with SI or the rail yard in the Greenville section of NJ. There is also a plan to move

Containers transported to ship
Source: JOC-February 18, 2002
www.joc.com

cargo to an inland yard.[106]

The New York metropolitan region ports are considering building an inland port in nearby Connecticut, to ease port traffic congestion. The latest studies in other parts of the country (by the International Longshore and Warehouse Union) estimated that at least half of the containers and equipment at terminals are superfluous and are just in the way.

The arrival of the containership Regina Maersk to New York/New Jersey ports in 1998 underscored the port's importance to shippers around the world. The arrival of a new generation of large ships requires extensive dredging in the metropolitan region's ports. To keep the port's position as a deep-water hub will require extensive deepening of its two primary navigation channels, along with a multibillion-dollar modernization strategy. The PANY&NJ anticipates a shift of 2.5 million TEUs from the West to the East Coast by 2020, and the arrival of 7,000 TEU or even larger mega-vessels. The Army Corps of Engineers, in cooperation with PANY&NJ, is deepening the Kill Van Kull and Newark Bay Channel, and plans to dredge the region's other channels to 50 feet, to accommodate large vessels. Approximately 260,000 cubic yards of dredged material will be deposited at the Historic Area Remediation Site, six miles off the coast in Sandy Hook, New Jersey, to cover previously dredged material, and 232,000 cu. yd. of the non-toxic sediment will be placed in the ocean to expand artificial reef sites.[107]

Methods of disposal depend on the dredged material's characteristics, and include decontamination technologies (such as a new technique known as water injection dredging or WID), submerged discharge, sanitary landfill cover, containment islands, pit filling, and others. Along with land development, PANY & NJ is developing communication systems that encompass both land and water-based operations. A port Information Network System links navigational systems such as chart information to an Oceanographic Real-Time System that measures the rise and fall of tides and vessel clearances in navigation channels. There is also a project to link the ports' vessel management system to computers aboard ships, so pilots have updated information on traffic patterns in the harbor. On land, the Freight Information Real Time System is a web-based information system that makes freight traffic information available to terminal operators, shipping lines and truckers. The port is planning to extend this communication system to internal facilities such as warehouses.[108]

There are many successful examples of information technology and ITS in trucking movements in ports of the metropolitan region. Maersk Data USA has released in Spring 2002 DrayWatch, a real-time, Web-based program for tracking containers after they leave a terminal by truck (JOC, 5/10/2002). SeaLink's truck driver identification system provides a single database of authorized drivers, each with an unique code. The data is also linked to specific information about terminals, steamship lines, and the U.S. Customs Manifest. Data covers freight invoices, cargo status, intermodal ramp activity, and carrier interchange agreements. Another example is PA's Automated Cargo Expediting System (ACES), which offers an EDI network for exchange of information. A value-added network, such as General Electric Information Services (GEIS), collects and distributes EDI files. Systems, such as National Oceanic and Atmospheric Administration's PORT (Physical Oceanographic Real-Time System, see Ref. 153), provide real-time data on water depth and flow, and the U.S. Coast Guard's Vessel Traffic Information System (VTIS) registers vessel navigation data and time of ship arrival.

The warehouses and freight centers serving the ports are undergoing major changes. In 1999, PANY&NJ released a study on a port inland distribution network for the New York/New Jersey area, which identified the network of freight centers that would be supplied by the intermodal shipments from the ports, a prerequisite to the expected huge growth (a five-to-six-fold increase) of capacity by 2040. This freight centers network will play a fundamental role in cutting costs and increasing productivity of the ports.[109]

5 Rail Technology

5.1 General Description

As highway congestion increases, more and more shippers are looking at rail and intermodal services as a competitively priced, efficient alternative. To help draw new customers and better serve existing ones, rail and intermodal companies are adding new services, modernizing the equipment, and offering new software to improve the management systems. Also, freight car builders are promoting equipment with better productivity and a higher rate of utilization. The new technology includes heat-treated and alloy steel components, continuously welded rail, ultrasonic, radial trucks and A.C. traction technology. There are several issues in rail freight transportation that will still need improvements and modernization, such as lower costs, increased velocity and improved safety. Railroads have invested heavily in information technology in recent years. One benefit is that they know where their freight is, and their customers can use the Internet to enter rail computer systems and track their shipments.[110]

5.2 Rail Transportation Management Systems

Rail companies are using various logistics-based management systems to improve their performance and lower costs. In 1998, Norfolk Southern expanded its Intermodal Equipment Management Program (EMP) which offers integrated equipment supply and transport management for long-haul domestic freight. Its cornerstone is a shared responsibility between railroads and customers, including intermodal marketing companies, logistics and motor carriers, to improve equipment utilization. It involves more than 11,000 48-foot containers that move over the NS, UP and Conrail railroads, under EMP customer control.[111]

Cameras relay information to monitors in the yard managers office.
Source: JOC Review & Outlook, January 2002

In 2002, CSX Lines has introduced an automated account management tool that allows customers to pay their freight bill once. The new Sea-Pay service is managed by CSX Horizon Services Group (see Ref. 154).

Formerly used management system software such as NOL or Pacer are now being replaced by the new concept of non-branded “stacktrain service” also known as “gray boxes” loaded onto a “gray train.” Gray boxes are equipment that is pooled and not tied to a specific carrier, allowing customers to ship in various schedules and train services any time they require it. This system promotes more scheduled services instead of on-demand in an effort to improve throughput and avoid choke points. The most visible bottleneck is terminal congestion. Use of the Internet, e-commerce and e-engineering can greatly improve efficiency of operations.[112]

- ***Car Scheduling***

In 1998, Canadian National adopted the Illinois Central's Car Scheduling methods with very promising results. Prior to the adoption of the Car Scheduling system, less than half of CN's shipment were arriving on time. After the system was in place, 81% of CN's shipment were arriving on time. This lead to other productivity gains as well. Terminal dwell time decreased by 18%, the active locomotive fleet was reduced by 33%, and operating ratio dropped below 70% from 72%. These dramatic results have been noticed by other Class I freight railroads, and according to "Railway Age" (December and February 2000) many of these major carriers have been implementing their own version of car scheduling.

- ***Modern Terminal***

Efficient intermodal service will require modern terminals. Modernization of rail yards is an ongoing trend. In the New York region, modern terminals are being built in the Harlem River Yard, in New Jersey (ExpressRail, E-Rail, E-Port, Portside, Oak Island, Croxton, North Bergen, Resources, Little Ferry), and are planned in Maspeth, New York, and Long Island (Pilgrim State). An example of a fully automated intermodal terminal is the proposed rail Super-Terminal in Memphis *(Automated Intermodal)*, unprecedented in scope. This project would consolidate railyards for five Class I railroads (BN/SF, CN, CSX, NS and Illinois Central) in a new state-of-the-art facility, on land owned by the city and Shelby County. Over its 20-year life span, the Super Terminal is projected to generate $2.75 trillion in the new economic activity. Memphis, which is an important FedEx hub, is undergoing airport and highway improvements and is expected to become a major distribution center. An automated center will work with the average transaction time of two minutes, which covers:[113]

1-Trucks entering the terminal;
2- Sensors electronically scanning the vehicle;
3-Detection Devices give operators an instant computerized check of equipment's condition and a permanent record of damage;
4-Driver pulls up to a console. Card is swiped through the machine and provides load information while transmitting an electronic image of the driver to clerk.

- ***Tracking Systems***

In September 1999, CSX Transportation introduced to its fleet a new global positioning satellite system called Pinpoint, which consists of an onboard computer, satellite transceiver, interfaces to the locomotive and a power system. The system not only tracks where the locomotive is, but also provides CSX with fuel data, the direction in which the locomotive is heading, whether it is running, idling or under power, and the rudimentary health of the locomotive (too hot, has enough water). Some companies prefer container tracking instead of locomotive tracking, because sometimes a locomotive can become disconnected from the cars containing goods. CSX will also be offering container-tracking to its customers in the future. CSX is the Class I rail company operating in the East Coast including the New York metropolitan region.[114]

5.3 Types of Rail Service

Rail and rail intermodal service use a broad range of services, such as trailer-on-flatcar (TOFC), also known as a "piggyback", which includes a container mounted on a chassis moving on a flatcar, or highway trailers on rail flatcars. Container on flatcar (COFC) refers to a container moved on a flatcar without chassis. Carless technology refers to

CSX Train on the way
Source: Railpace News Magazine
www.railpace.com March 2002

specialized highway semi-trailer with attached rail wheels or a separate modified rail truck which can be placed under the trailer allowing it to move on railroad tracks. RoadRailer is the best known example of this technology. Traditional boxcars are also undergoing modernization, depending on freight types. Double and triple-deck auto cars are used for the transport of vehicles. Reefers are the isolated refrigerated cars, transporting perishable food products, flowers and other temperature-sensitive cargo. Generators are used to power the reefers maintaining the temperature during the rail or road transportation.

- ***Double Stack***

To better compete with truck transportation, railroads found a method to reduce overall costs by using the double stacking (DS) concept, involving stacking two containers on a railway flat car. This method rose in the late 1990s, in tandem with the growth of domestic containerization. Doublestack equipment doubled the number of containers per train, cutting train crew labor in half, reducing train length, increasing rail quality and reducing costs per carload. Another advantage of this system is the reduction of theft, because the container's door cannot be opened while in transit. The principal disadvantages of this system are the large volumes of freight required to make it viable, and the need for high vertical clearance in tunnels and overpasses on the way. The New York metropolitan region provides doublestack service in northern New Jersey and in the upper part of the Hudson Line. .

Double stack train loaded with containers
Source: JOC Review & Outlook
January 2002

- ***Fast Rail***

One example of emerging technology is fast rail service. The fast train is already in use in France, the U.S. (Acela), and in Japan; however, it is used only for passenger service. With current technology, freight cannot be transported in trains traveling more than 70 mph. However, it is expected that in the future fast trains will be used to transport some freight.

Magnetic Levitation System (Maglev) 300-mph trains are in use in Japan, and are in the testing stage in several locations. American Maglev Technologies (Edgewater, Florida) uses permanent magnets to execute levitation and propulsion. Its guideway track requires no electrification or artificial intelligence. The bottom of the car straddles the track and two opposing magnets face each other to create a magnetic bearing.[115] Magnets lift the train slightly off the ground, eliminating friction with the tracks that reduce speed. This technology, now used only for passenger cars, may be in the future extended to cargo.[116]

- ***Expressway (Iron Highway)***

Amtrak fast train
Source: Railpace News Magazine
www.railpace.com

The Expressway (formerly named Iron Highway) provides an innovative rail intermodal concept. It is a short train with a single, 1,200-foot long, cargo-carrying platform with a built-in ramp. The ramp can provide loading and unloading of highway trailers from both sides of platform simultaneously. Several Expressway elements can be coupled to form a train, making this technology attractive to the 300 to 700-mile distance. This concept can be used without a specialized yard or terminal.[117] In 1997, Canadian Pacific Railway (CP) bought the technology and is providing the shorthaul intermodal service. Using its St. Lawrence & Hudson Railway subsidiary, CP doubled capacity on its existing Montreal-Toronto route and expanded service up to Detroit. In 1999, to attract more motor carriers, CP bought 240 new freight-carrying platforms to replace the original Iron Highway equipment. This expansion marks a favorable turn for the Expressway technology that was developed and abandoned by CSX Intermodal in the mid-80s. CP renamed a revamped version of its Iron Highway operation *Expressway*, and used new equipment and new terminal in Montreal, Toronto and Detroit. Expressway offers two 60-trailer trains each day in each direction. In the New York region this system has not yet been used; however, in the future it can be tried over short distances, wherever fully equipped yards are unavailable.[118]

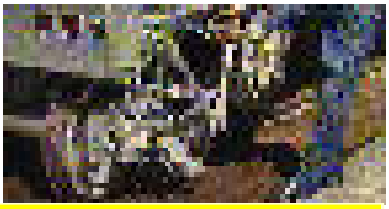
- ***RoadRailers***

The concept of highway trailers mounted on detachable railcar trucks was first tested in the United Kingdom, and is widely used in the U.S. and elsewhere. RoadRailer is a proven, cost-effective bimodal technology enabling railroads to compete with over-the-road transport in corridors of 400 to 1000 km (250-600-mile), and could capture short-haul freight from road carriers. The main advantage of this technology is tare weight reduction and low terminal expenses, due to the elimination of the need for heavy-lift loading equipment. Also, because it operates between dedicated terminals without intermediate handling, loss or damage is reduced. In the New York metropolitan region, Triple Crown Service Company (TCSC) offers a door-to-door truckload service featuring the innovative, intermodal RoadRailer trailer, which can go anywhere a conventional trailer can go and has the self-contained capability of riding directly on railway rails. The RoadRailer is equipped with independent air-ride running gear for both highway and rail travel.[119] Amtrak has used Express Roadrailer service since 1998. By combining the speed of Amtrak passenger trains with the convenience of dock-to-dock shipping in the same trailer, Amtrak railroad units provide short transit time at costs below typical highway carrier rates. Amtrak operates 291 such units and recently deployed its first temperature-controlled, 48-foot Reefer-Railer units to provide service on the Philadelphia to Chicago and Florida, marking the first time ReeferRailers have been put into service on passenger-train schedules. In Canada, CN and CP are using new RoadRailer Mark V trailers (produced by Wabash National Corp of Lafayette, Indiana) for freight traffic between Montreal and Toronto.[120]

Source: Trains-May 2002
www.trainsmag.com

The other model, designed for use at regular speeds on mixed trains, is RailRunner, currently being tested on Georgia Railroad's short line in

Americus. RailRunner will attach steel wheels to cargo containers, temporarily converting them to railroad cars. Truck drivers can complete the process in minutes, according to the producer, Barnesville-based RailRunner NA company. This model could be used over short lines, allowing companies to use smaller, cheaper intermodal facilities.[121]



Roadrailer, Source: Trains-May 2002
www.trainsmag.com

5.4 Equipment Modernization

• *New Locomotives*

In 1999, the Federal Railroad Administration provided special funds for the design and construction of a prototype 5,000-hp non-electric high-speed, 100-ton gas-turbine-powered locomotive, with speeds capable up to 150 mph. The prototype, built by the Bombardier Transportation company, has been in use since 2000. Also, ZTR-Control System, based in Minneapolis, has developed NEXSYS, a complete electrical control system designed to improve performance and reliability of older locomotives. AC traction motor locomotives of 6,000 hp are used widely in the New York region to carry freight cars. It is a new way of generating power inside the engine, and one locomotive can replace more than two of the previous system.

Onboard locomotive management systems such as EMD's FIRE (Functionally Integrated Railroad Electronics) and GE Harris' IHUB (Integration Hub) continue to evolve toward standardized, off-the-shelf control systems that will support such multiple sub-systems as self-diagnostics, PTC, wired or wireless ECP braking. A big challenge facing locomotive builders is compliance with EPA new emissions regulations.[122]

AAR's locomotive fuel interface standard (LFIS) is designed to help railroads reduce fuel spills and costly environmental clean-ups. Fuel is the railroads' third largest annual expense (after labor and depreciation), and new regulations have heightened fuel spill awareness, dictating the need for a spill-proof fueling system. The locomotive fueling LFIS-based system has a mechanical/fluid interface and a signal interface to prevent spillage. The signal interface monitors fuel level and controls flow. When fuel level is below the set "full" mark, a sensor will generate a permissible signal; otherwise, fueling is interrupted and the controller is notified. This standard has been adopted by several railroads, and will probably be used by others. Implementation will take time and will require the retrofit of existing locomotives and wayside systems.

The new U.S. EPA emission law, which will go into effect in 2002, sets up standards applying to new and existing locomotives to reduce emission of nitrogen oxides (NOx), hydrocarbons (HC), carbon monoxide(CO) and particulate matter. GE and Argonne National Laboratory are testing prototypes of cleaner, more efficient diesel engines[123].

• *Rail Car Technology*

The new generation of freight cars includes several innovative designs. Advanced rail car designs include specialized cars, such as Johnstown Articulated Bulk Container, with 354,000 pounds capacity, designed to carry special ISO 20-foot solid waste containers, weighing up to 59,000 pounds each. Trinity's insulated composite-body boxcar with 7,900 cubic-foot capacity, offers reliable internal temperature control. Cryogenic reefer cars are used to transport perishable goods and food products. The modern system is equipped with a monitoring device, which alarms shippers when the inside temperature falls out of the prescribed range. The cooling agent is currently cryogen, but the industry is experimenting constantly with other products.

Another example of efficient, multi-purpose rail cars is Gunderson's AutoMax or Thrall Car's Q-2, an 89-foot tri-level motor vehicle carrier. Q-2 is not a superstructure on a flat car, but incorporates a new underframe, an all-steel welded car body, a cleanbore interior and is designed to carry all sizes of vehicles.[124]

Yet other specialized cars are redesigned boxcars for the newsprint industry, recently unveiled by CSX. The 60-foot cube boxcars provide additional loading capacity and better ride quality. The smooth-wall interior is designed to prevent damage to paper products, and a new premium suspension system called "swing-motion truck" was added to facilitate a smoother ride. In 2000, the Canadian National Railroad built 73-foot centerbeam flat cars to be used in all CN-controlled boxcars, flatcars and gondola cars, through a guarantee system. The program applies to their fleet of 4,200 centerbeam flat cars, used mostly for lumber shipping.[125]

In1999, the FRA signed a cooperative agreement with Transport Canada for a joint research program on the effect of low temperatures on rail tank cars. The goal is to improve safety in transportation of hazardous materials or dangerous goods in railroad tank cars. Over the last several years, in the U.S. and Canada many incidents have occurred involving brittle fracture failure of tank cars subjected to cold temperatures (-20 F or below) which have lead to an investigation and repair program. The research conclusions will help the FRA develop new requirement to reduce this type of tank failure.[126]

Also in 1999, Chassis King Corp. introduced four types of new chassis. The first is for overweight 40-foot containers; a second type is lightweight, spread-axle, drop-frame ISO tank chassis featuring 130 psi minimum yield and a front-lift mechanism for complete draining of the tank. The third type is new fixed-length 20/40, 12-pin gooseneck combination chassis which can carry 40-foot or 20-foot containers, or an overweight 20-foot container in the center position. The fourth type is a lightweight tri-axle slider chassis for overweight 20-foot containers.

- ***Containers and Cargo Handling***

Heil Trailer International has introduced the corrosion-resistant, 100% aluminum, Heil DryTainer, a dry-bulk intermodal container, which is airtight, providing protection for humidity-sensitive products. According to the manufacturer, it is the optimal solution for bulk shipments in less-than-railcar quantities and can be shipped in doublestack containers as dry-bulk commodities.

Container handling equipment is also undergoing modernization. That includes stacking cranes, also known as the rubber-tired gantry (RTG) crane, forklift trucks, and straddle carriers, which lift and carry containers with the help of spreader bars, locking container corners for the time needed to deposit it at the destination within the terminal.

In July 1999, Gunderson Inc. delivered to Burlington Northern/Santa Fe Railway the first equipment specially designed to handle pickup trucks, minivans and sport utility vehicles (SUV), on three levels within a railcar. Total height of the Auto-Max car matches conventional doublestack vertical clearance of 20-foot 2 inches above the rail, and additional vertical clearance was achieved by adapting double-stack container technology, which puts freight in a well that rides barely a foot above the rail. Other manufacturers (Thrall Car Co., Chicago, Wabash National Corp.of Lafayette, Ind.) have also developed technology for handling vehicles. Because of their height, SUV and other tall vehicles have been allowed only on two levels of racks built inside conventional railcars. Railcar manufacturers are working to create more efficient, less damaging ways to move SUVs and similar vehicles, which represent approximately half of all new North American vehicle sales.[127]

5.5 Safety Technologies

• *Train Control*

One of the newest train control systems is the Incremental Train Control System (ITCS), used by Amtrak on the Detroit-Chicago Corridor. This system was supplied by the Harmon Industries (Missouri), and is used at grade crossings and signal locations to enforce speed restrictions and stop signals. ITCS gives the engineer time to bring the train under the required speed cap before enforcing a speed restriction. The on-board equipment consists of a host processor, location processor, two GPS antennas, GPS receiver interface modules, compact display unit and a mobile communication package (MCP) radio. The wayside equipment comprises wayside interface units (WIU) and spread spectrum radios.[128] The North American railway industry is developing an advanced freight train braking system. Transportation Technology Center, Inc. (TTCI) have developed standard for a new generation of ECP (electronically controlled pneumatic brakes) that can achieve stopping distance reduction of more than 60% on heavy grades. Because signal spacing and therefore track capacity is determined by braking distance, the reduction in stopping distance can be utilized for higher speeds or increased track capacity.

The remote control for yard locomotives has been used for years in Canada (BeltPack technology has been used for remote control in over 1.5 million hours of operation), and has reduced accidents by half. U.S. Railroads are also beginning to use this technology. Efficiency improvement in yard switching will lead to increased business, and several American companies have created new improvement prototypes, such as Vectran's VR10 product that incorporated and improved BeltPack technology, or Cattron's multi-processor series of PRRCs (portable radio remote controls) which provides communication between the remote controller and locomotive.[129] CSX Transportation was first to place a major remote control order. In January 2002, the United Transportation Union & Brotherhood of Locomotive Engineers (UTU) has joined Class I railroads in pilot projects utilizing remote control technology in switching operations. According to Morgan Stanley Dean Witter analysis, remote control technology could save Class I railroads as much as $250 million a year in operating costs.

Another item, a new electro-pneumatic braking system (ECP) has passed successfully pilot applications and is expected to be installed on the major rail lines. BNSF are already running the ECP-equipped trains (Railway Age, January & February 2002).

• *Grade Crossing*

Grade crossing is the biggest rail safety problem issue. There are over 259,000 existing highway-rail grade crossings in the U.S. In 1995, U.S. DOT started a multi-faced initiative to improve them, which resulted in closing more than 33,000 crossings, and decreased collisions and fatalities by over 30%. In 1999, the U.S. DOT spent $155 million exclusively for highway-rail grade crossing improvement or elimination.[130] Some railroads have used remote monitoring equipment, installed at highway/rail grade crossings, such as ScadaNet (used by Union Pacific) which provides notification of power and battery-related grade crossing equipment failures. That system has replaced phone-line communication with a wireless cellular phone network control channel transmission.[131]

Other grade crossing improvement technology is a four-quadrant gate system. Amtrak has installed this system at a grade crossing in Stonington, CT, where 300 vehicles per day cross the tracks on Palmer Street. Also, this type was installed with success in 1998 at the School Street Crossing in Groton, CT. The Stonington installation features a gate for each of four lanes of traffic, thereby deterring motorists who do not have clearance from entering via the

opposite lane. The system employs three inductive loops buried in the pavement: one placed in front of the crossing, one located after the crossing, and one situated between the tracks. In the event that a vehicle gets trapped between the lowered gates, the system is programmed to immediately lift the gate. The system is tied to the Amtrak in-cab signal system and can provide the engineer with advance warning to reduce his speed to 15 mph in case of emergency. The engineer's failure to comply leads to an automatic emergency stop. That system will not be tied to the currently used advanced civil speed reinforcement system (ACSES), a transponder-based type of train control that enforces speed restrictions.[132] ACSES-equipped Amtrak locomotives will be able to operate up to 95 mph over crossings that feature four gates and a detention technology. ACSES is tentatively set to be in place in the Northeast Corridor and is expected to be installed in all New York crossings, especially on Long Island.

- ***Impact of Rail Technology on the New York Metropolitan Area***

Advanced technologies in the rail system can be very important in the New York metropolitan area. Only about 3% of freight is moved by rail, for various geographic and economic reasons. In promoting increased use of diversified means of freight transportation, NYMTC initiated the Regional Freight Plan project. One way to increase the use of rail transportation to move freight over short or longer distances is to modernize its infrastructure and equipment, as well as its logistic-based management system. An example of modernization of freight transport includes Expressway (former Iron Highway) service, which is expected to enter the Harlem River Yard in 2003. In 2001, New Jersey Transit upgraded railroad protections by introducing a computer-controlled system that prevents a train from going through a red signal by automatically shutting it down. This mechanism is known as "positive train stop" [157].

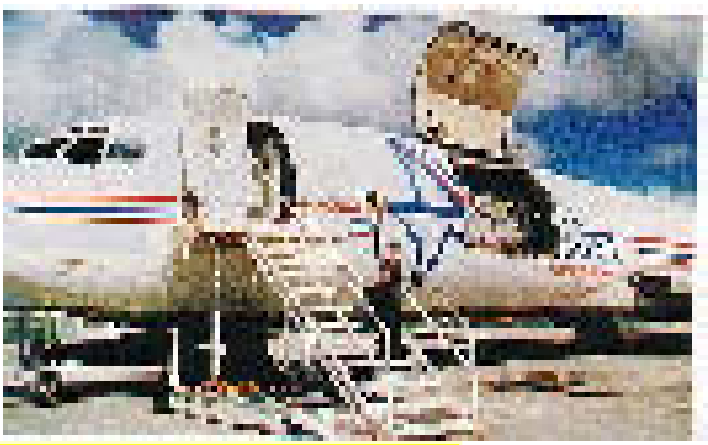
NYMTC has participated in the process of acquisition of Conrail by the two Class 1 intercontinental railroads, CSX and Norfolk Southern. NYMTC also participated in the entrance into the region of other freight-moving railroads, such as Canadian Pacific (CP), Delaware and Hudson (D&H), and Providence and Worcester Railroad (P&W). This system created healthy competition and helped development of the infrastructure and services. NYMTC participated in the privatization of freight rail service on Long Island, which succeeded by increasing the amount of cargo and number of customers. The New York and Atlantic Railway (NYA) now operates freight service on the MTA-Long Island Rail Road (LIRR) tracks.

A hindrance to the increase and modernization of rail service in the New York metropolitan region is a lack of adequate yards that can provide intermodal service and handle double stack railcars. The 76-acre Harlem River Yard in the Bronx is the City's only current site for an intermodal terminal. New York State reserved a portion of the site formerly occupied by Pilgrim State Hospital on Long Island for a prospective rail intermodal facility. It is still in the planning process. Currently, transportation agencies including NYMTC are in the process of evaluating several available sites along rail tracks located within the region, which can be used to build new modern rail yards.

Another problem preventing rail transport modernization is railway weight and height restriction. Some lines (such as the Hudson Line north of Yonkers) have already improved their clearance envelope by heightening the cross-bridges and rebuilding the infrastructure, but the clearance problem has not been fully resolved, preventing the intercontinental connection of double stack service. It is expected that the Hudson Line will be TOFC (Trailer On Flat Car) cleared to the Bronx by the end of 2002. The LIRR is conducting a vertical clearance study, and working to increase weight limits above its current 263,000 pound maximum limit.

6.0 Air Freight Technologies

6.1 General Description



Loading 727-200 freighter
Source: JOC, September 17, 2001
www.joc.com

Air freight is predicted to triple within the next 20 years. The Federal Aviation Administration (FAA) predicts that by 2010 domestic revenue for U.S. air cargo sector will double, from 11.7 billion ton miles in 1999 to 22.6 billion. International air cargo is growing even faster, rising 117.1% from 14 billion revenue ton miles to an estimated 30.3 billion in 2010. Cargo is presently transported in the holds of passenger airplanes or in the dedicated freight-only planes. The integrated all-cargo carriers are growing faster than air cargo operations of U.S. passenger carriers (10% vs 6%), a trend that is expected to continue. Introduction of some new aircraft such as the Boeing 777, which currently offers the greatest cargo capacity on a passenger plane, focused attention on managing cargo at large carriers. In the 777, there are seven pallets of space available, compared to three or four on a DC-10 or L-1011. Also, anticipating strong growth in cargo, several airlines have converted passenger jets (such as the DC-10) to freighters. For example, in 1999 United Airlines converted four jets to freighters.[133]

Significant trends include the proliferation of widebody passenger airplanes (such as the 777 or A340) that have large lower holds and the ability to fly long routes with full payloads. Other developments include expansion of the widebody freighter fleet with new or converted models and launching passenger-to-freighter conversion operations (e.g. Boeing Airplane Services, British Aerospace Systems and DaimlerChrysler Aerospace) as well as the new and innovative production of freighter models meeting specific market requirements (e.g. 737-700 cargo variant, A3XXX and 747X Stretch freighters).

To improve transit times and services for customers through a mixture of technology and integration, several leading carriers in the air cargo industry and Air Transport Association introduced a plan named Cargo2000. This organization is helping the air cargo industry to serve high-value customers and time-definite products and to promote new technology. Shippers are willing to pay for upgrades in service. Carriers are experimenting with radio-frequency tags to replace one-dimensional barcodes. They are also examining two-dimensional barcodes which hold more information at minimal additional cost. *Sato America*, the barcode printing company, has introduced a new labeling/packaging model, which includes technology to improve throughput and response time.[134]

Airfreight market is growing rapidly
Source: JOC Week, April 8-14, 2002
www.joc.com

6.2 Role of Technology in Air Transportation

Airlines introduced new security measures
Source:JOC, October 8, 2001
www.joc.com

Technology and information systems play a critical role in the air freight industry. The air cargo industry has been a pioneer in using EDI (Electronic Data Interchange) and other technologies to track and quickly move shipments. Air cargo carriers, their customers and third parties have developed information sharing data bases which improve their ability to move goods quickly through the supply chain. The U.S. airport systems require a huge investment effort to implement technological innovations. FAA research and development (R&D) promotes projects grouped in areas such as air traffic services; airport technology; aircraft safety and environment and energy issues. Recent developments include a system that uses infrared energy to melt ice/snow from aircraft as well as a soft ground arrestor system that uses lightweight cellular concrete to safely stop aircraft from going beyond the runway. Testing is underway on an electrically conducted asphalt pavement that can be heated to melt snow and ice on runways. In addition, partnerships have been established with American Pacific Corp. to develop replacement for Halon 1211 for fire fighting services and with Boeing Corp. to establish the National Airport Pavement Test Machine. Another step to improve traffic is the development of Traffic Alert and Collision Avoidance System (TCAS), and a uniform 1999 ACAS standard, imposing mandatory equipment.[135]

The exchange of information and communication between forwarders and carriers today is relatively complicated and, to a large degree, is manual. A new Internet booking service, Global Freight Exchange (GFX), revolutionize the business by allowing capacity to be bought or sold by carriers or third parties, and enables the solicitation of rate quotations. In this system, the airline lists contract rates, spot rates and space availability on the GFX Web site. The forwarder is then able to select an airline and enter handling codes, which describe the goods, listing any special handling requirements. Lastly, the carrier accepts booking via the Web site and sends electronic confirmation. Over 15 forwarders already use this GFX innovative service.

Several airlines have installed barcode technology and upgraded their labeling system, but still need a long-term master plan. The dialogue between airlines is leading in some instances to "partnership programs" between two sides. Cargo2001 initiative helps major airlines and forwarders to compete with integrated express carriers like FedEx, which have virtually taken over domestic market and are gaining market share in the international area.[136]

- ***Airmail Technology***

Mail comprises one of the main commodities transported by aircraft. To improve its handling, Lockheed Martin Postal System in Bethesda has developed for USPS a new Automatic Airline Assignment system to automatically process trays and flat containers for air mail. The $15.5 million contract for delivery of 220 AAA systems was completed in 2000. The system scans the barcode on each container of mail, weighs each container, processes an aircraft reservation and applies a routing barcode. The throughput may increase by five times over the current system during peak workload periods, optimizing aircraft scheduling and mail container processing.

6.3 Type of Airplanes

• *New Large Freight Carrying Airplanes (NLA)*

In the last few years, several manufacturers have started to design huge aircraft, known as New Large Airplanes (NLA). Shippers and forwarders are now more willing to use the oversized and expensive aircraft to fill special needs. These aircraft are double-decked, capable of carrying 600 to 800 passengers and significant amounts of cargo. These large planes would allow airlines to carry more passengers and cargo in tightly controlled markets. However, large planes require more time and ground support for loading and handling. The planes are longer, wider and higher than any existing commercial aircraft and will require significant modification in infrastructure, such as runway and taxiway alternation, terminal expansion, increased pavement strength, and larger maintenance facilities. To date, nine major airlines and 25 major airports have expressed an interest in this type of plane.

The world's largest manufacturers of commercial jets (Boeing, Airbus) are already using this technology to move oversize air cargo, and to deliver huge aircraft sections, too big to move on the ground. Boeing doesn't operate its own cargo fleet but relies on commercial airlines to move cargo. The new Boeing 747-300 presents a plane with takeoff weight of 378 tons, which can carry 624 passengers and cargo. European Airbus Industrie plans to build a mega-jumbo jet (A3XX-200), designed to carry about 1,000 passengers along with 515 tons of cargo. The A3XX has a range of 7,500 nautical miles, and its catalog price is $198 million.

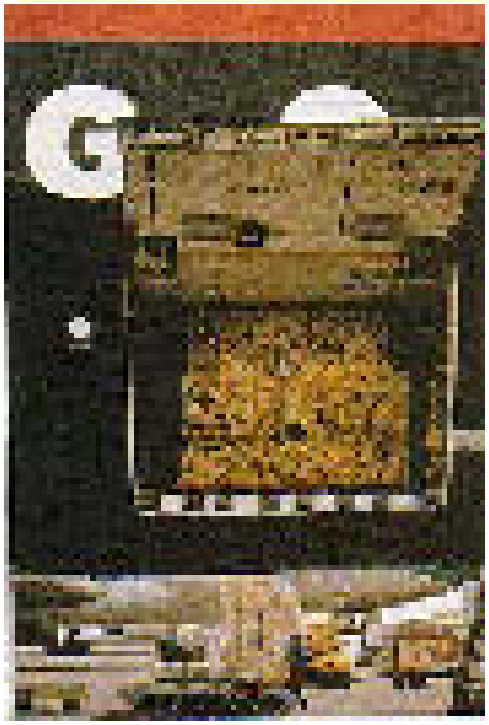
The first six Airbus A300B4 aircraft were delivered in August, 1999, to DHL Airway Inc. and began service between two of DHL's U.S. hubs in Cincinnati and Miami and other major business centers. The A300B4 has a lift capacity of 95,000 pounds and 20 main deck container load positions. The six aircraft powered by GE engines are all Stage III compliant, meeting the government's strictest aircraft noise requirement.[137]

Currently the world's largest transportation plane is the Airbus Super Transporter A300-600 ST, called Beluga (because of its whale-like appearance). It utilizes the fuselage of the Airbus 330, and ferries aircraft sections to final assembly in Hamburg and Touluse. The plane has a cruising speed of 400 knots and can lift 100,300 pounds over ranges of 900 nautical miles. The main cargo compartment has volume of 50,000 cubic feet. Airbus Industrie won order an from British Airways for 100 planes, and has plans to build a super 600-seat jumbo jet (A3XX). Three Belugas are in operation, a fourth in construction, and a fifth will be built to complete the Airbus transport fleet. Airbus also plans to launch a freighter, entering the traditional Boeing field. The new cargo plane, scheduled for delivery in 2004, will carry 150 tons of cargo, compared with the maximum 120-ton capacity of the Boeing 747 freighter. Boeing forecasts that 650 new freighters will be ordered in next 20 years, including 160 large planes. New type introduced in 2002, Antonov 225, could carry even more cargo.

Mega-freighter
Source: Air Cargo World, Dec. 2001
www.aircargoworld.com

Another type of usable craft for cargo transportation is the large airship, the Cargolifter AG, built in Wiesbaden, Germany. Cargolifter dimensions are 200 ft wide, 264 ft high, has an on-board crane that can lift cargo from one point to another on board without landing, and will be fueled

Shippers are willing to pay more for service to get boarding priority
Source:JOC-Review & Outlook, January 2002



by helium (safer than combustive hydrogen such as used in the 1930s ill-fated airship, the Hindenburg). The reception has been good from potential shippers and freight forwarders.

In 1993 in the U.S., the Illinois Institute of Technology designed an experimental 1 1/2 mile long airship which will be able to carry three containers along with 2,000 passengers. The project won a prize in the 1993 Sixth International Design Competition in Osaka. Most commercial interest came from Europe.

In 1989, Russia introduced the An-124, which can carry an odd loads that can't fit in a C5A or 747 freighter. That craft has, however, restricted market growth. It is slow, burns fuel at almost twice the rate of a 747-400, and must also deal with much tighter environmental regulations than were a consideration when the Soviets built the plane. However, the An-124 is in such demand, that companies that plan to use one would schedule flights from 1 to 5 years in advance. The American equivalent of the An-124 is Boeing's MD-17, currently in development. Although that plane's capacity is only half the payload of An-124, is estimated to cost $170 million, 10 times more than the An-124 and $30 million more than a 747 freighter, it has ability to operate to and from a short runways, thereby allowing delivery of cargo close to a development project. It also has a proper palletized floor. Both planes can be good partners for specific requirements. Below are data for both aircraft:

	Boeing MD-17	**An-124**
Wingspan:	240 ft.	169 ft.
Overall length/height:	226 ft./68 ft.	174 ft./55 ft.
Maximum Payload:	330,693 lbs. (150 metric tons)	172,098 lbs. (70 metric tons)
Maximum Fuel:	507,063 lbs.	181,054 lbs.
Maximum take-off weight:	892,872 lbs.	585,000 lbs.
Range with Max. Payload:	2,795 miles	2,500 miles
Runway Required:	10,000' takeoff/7,500' landing	7,740' takeoff/3,000' landing
Max. Altitude/Crew	40,000 ft/19	45,000 ft/3

The An-124 is managed by Volga-Dnepr of Russia, and its operation, still a small niche in the international air cargo business, has grown from $72 million in 1995 to $126 million in 2000. The company opened new offices in Europe and the U.S. and plans operations that would link Europe and China, through the Czech Republic. The main commodities carried on An-124s are aerospace equipment (65%), heavy machinery (15%), oil and gas equipment, automobiles and tracking vehicles (5% each) and others.[138]

According to the latest Boeing prediction, the future of wide-body aircraft in mid-size planes such as the 777, which carries fewer passengers and less cargo but at a longer distance, will more than triple in the next 20 years, while large jumbo jets will increase only modestly. Boeing expects relatively few sales of the 747 aircraft and the even larger A-3XX planned by competitor Airbus Industries. Currently, Boeing is designing a longer-range version of the 777 that will be available by 2003. The new 777 has an extra-wide cargo door in the rear for cargo movement. The implication is, that as longer-range 777s start to replace older wide-bodies, overall

cargo space on passenger flights will diminish. That means more freight will have to move on freighters, and with less competition from passenger planes, freighter rates will inevitably rise.[139]

- ***Freighters***

The worldwide fleet of jet freighters has doubled in the past 10 years to nearly 1,600 aircraft, and is forecast to increase even more, based on an increasing demand for global air services. Air freight traffic, measured in revenue ton-miles, is expected to increase about 6% per year, more than tripling the business that moves in the bellies and on the main decks of aircraft over the next 20 years. All-cargo aircraft still represent a relatively small portion of the world's commercial air fleet. More than half of the world's air freight moves in the lower deck on passenger flights, and airlines can afford to sell belly spaces at low prices, but the quality of such freight service is mixed. Freight is bumped if passenger loads are high or if weather conditions mandate higher fuel loads. Thus shippers and freight forwarders prefer to move goods on freighters when they are available. The current trend is for widebody units, the large capacity aircraft with payloads in excess of 140,000 pounds. By 2020, the widebody models will command more than 50% share of freight markets. Attention has turned recently to the use of twin-engine widebody freighters such as the A300, A310 and 767, along with the narrowbody 757-200. The fastest growing segment of the freighter fleet in recent years has been the medium-widebody type.[140]

Loading container to the freighter
Source: JOC Review & Outlook
www.joc.com, January 2002

- ***Airplane Conversion***

Freighter aircraft are in demand. According to Boeing's study, over the next 20 years the number of these aircraft is expected to double, from 1,600 all-cargo aircraft in 1999 to 3,336 by 2018, with medium to large sizes accounting for most of the increase. The rate of growth exceeds the increase in passenger traffic, and the current trend is to convert former passenger aircraft to all-cargo configurations. Boeing predicts that about 70% of future cargo fleet additions will be modified planes, such as the 747-200, 737, 757, 767, and MD-80.

Conversion is financially a more attractive option to most operators. A brand new 747-400 freighter comes with a $160 million price tag, whereas an older 200 can be bought for about $40 million. Conversion costs vary, depending on a number of factors, such as aircraft age and special requirements set by the buyer.[133] Several large companies are engaged in converting. In 1999, Boeing converted 19 MD-11 passenger planes into freighters for FedEx, the world largest express transportation company.

Boeing Co. is also planning conversions of its 757 and 767 aircraft from passenger to freight configuration, creating low-cost options for air cargo and express carriers and boosting capacity for their customers. Boeing is also considering conversions of the 747-400, which could have a second life as a freighter. The FAA approved the process. UPS, who has a significant number of converted freighters in its fleet of 225 planes, including its 727s, recently discussed buying converted 767-200s, after FAA approval.[141]

Recently, BAE Systems and DASA/EADS have launched separate freighter conversion programs for the earlier A300-B4, and Airborne Express has developed a unique conversion program for the 767-200. Also, FedEx acquired for freighter conversion the DC-10 passenger fleets of United and American. The U.S. Federal Aviation Administration demands more rigorous engineering analysis to support certification of major aircraft modification such as freighter conversion. There is pressure to mandate the retirement of older types of aircraft that do not meet the new regulations. But still, a large percentage of older models can be converted at a much lower cost than a new plane.

6.4 Navigation and Safety Technologies

Numerous Air Traffic Control (ATC) electronic equipment projects have been developed and are already in use in U.S. airports and in various regions around the globe. New global Air Traffic Management (ATM) software system is replacing the current ATC. GPS signals for navigation are the cornerstone of ATM architecture. New software (such as TRACON, and airport sensor) is improving the ability to monitor airport surface traffic and detect potential conflicts on the ground and in the air. DGPS (Differential GPS) leads to deployment of Wide Area Augmentation System (WAAS) array, in operation from 1998. Other emerging technologies with big potential are Automatic Dependent Surveillance Broadcast and Communication-Navigation-Surveillance/ATM. Local Area Augmentation System (LAAS), developed in 1998, creates a low-cost alternative to the standard Instrument Landing System (ILS). Currently in use is Precision Runway Monitor, which furnishes safe simultaneous parallel runway use, and is experiencing strong market growth. Numerous other electronic equipment projects are available or in planning.

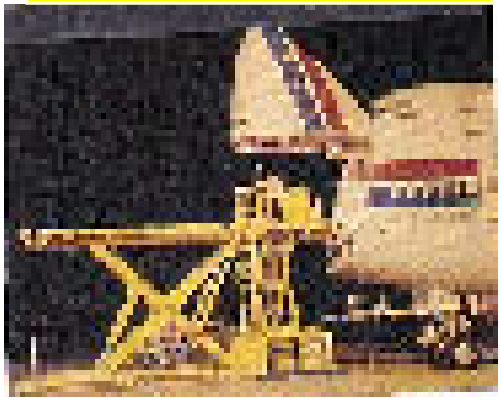
To reduce the margin of error, the U.S. Federal Aviation Administration is replacing its aging nationwide network of radio beacons and other navigation aids to guide planes with a satellite-based GPS system that is simpler, more accurate and less expensive to maintain.[142] The standard signal from GPS satellites is tested for error by ground station that send a correction factor via a central ground station and a geosynchronous satellite. This system is accurate to about 20 feet and is called *Wide Area Augmentation System*. WAAS lets planes fly closer together and land safely in low-visibility weather because of greater certainty about where they are. This system is already fully operational. However, some air traffic experts say that the current decentralized system, with its network of more than 1,000 radio beacons used as lighthouses in long-distance navigation, its radio-aids and about 100 long-distance radars used by ground controllers, has an advantage. It can withstand the loss of several radio beacons or radar, while GPS, although accurate and cheap, could easily be jammed by terrorist or a hostile power, and could even be subject to inadvertent interference, partly because of the use of a low-power signal.

Loading containers in a freighter
Source: Aircargo World, December 2001
www.aircargoworld.com

With more plane travel every year, concern grows over aviation safety. The most critical is surveillance technology that helps avoid collisions on the ground and in the air. The currently used Traffic Alert & Collision Avoidance system (TCAS) is radar-based and will be replaced by the new

technology-based Automatic Dependent Surveillance Broadcast (ADS-B). ADS-B uses global positioning system satellites to help determine a plane's precise location. It allows better coverage where it is too difficult to install radar. Cargo Airline Association (Capstone), which is working with the FAA on Safe Flight 21 test project, has already installed ADB-S technology on 82 planes and expects to equip 150 planes within the 2001. The FAA is running a test program and by 2004, ADS-B may be certified and eventually replace radar-based TCAS. Here's how it works: ADS-B determines location of an ADS-B-equipped aircraft, converts its position in space into a digital code and broadcasts the code along with other data (airspeed, altitude and whether the aircraft is turning, climbing or descending) to other aircraft and ground stations within 150 miles. That means pilots as well as traffic controllers can see the same real-time data. Based on this technology, the accident rate is expected to decrease 40%. For more information see *http://www.faa.gov.safeflight21*.

Cars loaded into freighter
Source: JOC, September 17, 2001
www.joc.com



Trying to pinpoint flying dangers that radar can miss, a laser-based system for detecting air turbulence and other invisible hazards has been tested at JFK Airport. This technique uses lasers to listen for the sound of rapidly moving air, such as detecting the wake behind large jets, which can toss a smaller plane, much as the wake of larger ship can swamp a rowboat. This technique could also be adapted to hear the micro-bursts that cause wind shear, a deadly hazard to planes at low altitude, and to detect clear-air turbulence, another danger to aircraft.

To increase cargo security, new devices are being developed. One example is the X-Ray Machine scan cargo unit developed by Rapiscan Security Products, Inc. that scans a 12,000-pound pallet in less than 30 seconds. This machine is currently used by Miami-based Aerofloral, which imports a variety of types of cargo, including flowers from Colombia. Aerofloral currently X-rays the contents of two 747s per day for about an hour each. This system is also used to detect under-invoicing and false documentation. This unit differs from other X-ray machines in that it uses a frequency at the higher end of the color spectrum that can penetrate dense product and produce a clearer image. U.S. Customs started pre-testing the unit, hoping to use it in anti-smuggling program. Rapiscan competes against American Science & Engineering Application International, whose X-ray and gamma-ray machines are currently used at the U.S.-Mexico border and at seaports.[143] In the future, the Rapiscan unit can be used in New York metropolitan area airports to help fight the criminal activity in the aviation industry.

6.5 Equipment

• *Containers*

Freight is moved mostly in specialized air-surface containers loaded on freighters or in the bellies of passenger planes. The 8x8x20-foot container, with average density of about 8 pounds per cubic foot, has International Standard Organization (ISO) corner fittings and a reinforced floor. It is the only true intermodal container because it is compatible with both air and surface vehicles (airplane, truck, rail). Like vehicles, every container has a registration number, which makes it possible to identify its owner and other important information about the container and its contents. The identification number is based on codes established by the ISO. These containers are convenient for transport of special products, such as machinery, animals, and certain hazardous materials, because they can provide point-to-point delivery without intermediate transfer and handling of the contents.

However, many airlines stopped using the traditional 20-foot containers, because their weight (2,200 pounds) can add 20% to the weight of aircraft. The other factors are the container's price, its susceptibility to damage because of light-weight construction, and limitation of effective use to the specific aircraft types, such as 747 freighter. Tests are being performed on a new lightweight container to be used in aircargo terminals. One model, which passed the test, will be used by SAS in its new Copenhagen air cargo terminal. The new containers are made of a high-strength fiber called "Twaron". They weigh about 40 lbs - much less than standard aluminum and polycarbon containers, and have the same gross weight capacity (5,388 lbs.) as an aluminum container. The unit's light weight will help load more cargo in the same space, saving aircraft fuel and number of trips. The cost of the unit is also lower.[144]

DHL Airway Inc. is offering shippers of perishable cargo a new temperature-controlled air-express service. The product, called ThermoExpress, is a convenient alternative to dry ice, which is treated as hazardous material and has unstable temperature extremes. The insulated boxes are available in three sizes, and refrigerant packets surrounding the shipment can be closely matched to specific temperature requirements of fresh or frozen items such as food or medical products. The refrigerant maintains a consistent temperature ranging from 8 degrees Celsius (46°F) to -20°C (-4°F) for up to four days in transit. It also does not require additional paperwork or the labeling required for such hazardous material as dry ice.[145]

- ***Pallets and Cargo Moving Equipment***

Some shippers are using pallets instead of containers, which save tare weight while using the full contour of the airplane upper and lower deck. Air pallets are wood or aluminum platforms. The wood standard pallet is 40x48 inches, constructed of oak, with 2-way or 4-way entry. Cargo is secured to pallets in many ways, including plastic or metal strapping or wrapping. For commodities like fruits and vegetables, or cargo subject to damage from condensation, a plastic netting is used. Air pallets themselves are held by "stops" in a track on the airplane's deck, enabling the entire load to withstand deceleration of the plane. To bridge the gap between the intermodal 20-foot air container and the small-shipment characteristics of airfreight, Boeing Air Freight System has developed the intermodal module concept — a family of sturdy, light-weight, inexpensive and standardized shipping cartons, which are readily transferable among air, truck, ship and rail modes.[14134]

Cargo moving equipment is used to load or unload the plane's cargo, as well as move it to the waiting surface modes: trucks, ships, or rail. A scissorlift platform, usually equipped with powered rollers, is used to load and unload the main deck of air freighters. Some large planes, such as the Boeing 747, have both nose and side-door entrances to the main deck, often equipped with the capability of direct nosing into a mechanical loading dock. The nose door permits easy straight-in loading of 20-foot intermodal air-surface containers and other long freight. Both nose and side doors can be used simultaneously for faster loading. The smaller planes have mostly one loading door. In large airports, the transfer facility and equipment is similar to that used in land-sea transfers.

6.6 Infrastructure and Airport Access

The top U.S. airports hold important positions in world air cargo movements. In view of the consistent increase in cargo tonnage, airlines are increasingly building new, fully automated cargo facilities at airports. Several modern freight-handling facilities have recently been built in JFK and other airports in the metropolitan region. In Europe, the latest example is a giant cargo terminal opened in1998 in Copenhagen Airport. It has specially designed sections for temperature-controlled, radioactive, and high-value cargo, over two dozen loading/receiving docks equipped with trucks, tractors and forklifts, automated storage/retrieval and freight transfer systems. A "Europallet" storage area with 1,560 pallet-storage positions can handle 204 operations per hour. All shipments are

labeled with bar codes upon arrival and are immediately expedited to a unit load device (ULD), to a vertical storage position, or to one of 40 workstations where freight is reloaded for trans-shipment.

Airfreight expansion continues
Source: JOC, September 17, 2001
www.joc.com

Other airports are also investing in cargo facilities. In 1998, Air France opened its million-square-foot G1XL cargo showcase at Paris's Charles De Gaulle Airport, and Luxair opened a 600,000-square-foot facility in Luxemburg, which will handle 500,000 tons of cargo annually. British Airways has completed construction on a high-tech facility at London's Heathrow, that will handle 800,000 tons of cargo per year (70% of its transshipment). Also, in 1999, Lufthansa expanded its freight operation in Frankfurt's cargo hub.[144]

6.7 Environmental Considerations

Aiming for clean air, the EPA and the FAA try to find a way to reduce aircraft emission, and thereby reduce air pollution and improve public health. One of the goals signed in the March 1998 agreement on emission reduction is to urge the aviation industry to participate in a retrofit program for the Pratt & Whitney JT8D engine that powers the Boeing 727 and DC-9, among others. Retrofitting engines was chosen because of EPA expertise in retrofit programs for buses and diesel trucks. A study sponsored by the Air Transport Association found that if changed, aviation emission could be reduced by approximately 12% worldwide without making any technical changes to the aircraft. FAA is expected to come out with national emission reduction programs that comply with the Clean Air Act.[147]

To decrease the land-side emission, British Airway and Nippon Airline are currently switching their on-airport ground support vehicles over to compressed natural gas (CNG).

Aircraft noise and emission may have a dramatic impact on environment. Many all-cargo carriers cannot comply with Stage3/Chapter 3 noise standards and so will shut down. U.S. and European air freight authorities are revisiting their previous approval of several freighter aircraft conversion programs because of this concern. The studies are performed to reduce environmental effects. The National Aviation and Transportation Simulation System Laboratory (ITSS) has developed a 3-D intermodal modeling system which performs sophisticated modeling of airports down to an accuracy level of under one inch, and can be used to detect environmental problems in their performance through virtual reality simulation.[148]

6.8 Logistics and Management of Cargo

One of the goals of the Cargo2000 group is to move freight on a global basis within 72 hours with a reliability rate of 95%. The group states that airlines and forwarders can build in-house, value-added modules to standardize the non-competitive elements of business along the chain. Besides embracing bar-coding on a piece level and "smart scanning" (which controls the box and manages it as opposed to a passive scan that just tells what happens to it afterward), they promote changes in the relationship between airline and forwarder.

Just-In-Time (JIT) demand service is offered in the global market by integrated carriers such as FedEx and UPS

which carry next-day service between Asia and the U.S. For these services, the fastest growing air trade markets are Europe-South America, US-SE Asia, Intra-Far East, and US-Eastern Europe. An example of JIT service is provided by Skyway Freight Systems Inc., a provider of integrated logistic and supply chain management services, which has launched two-day cargo service from the East to the West Coast. The company uses a combination of surface and air transportation, with goods trucked to the Cincinnati hub and later flown to the West Coast by DHL Worldwide Express.

Another example of changes in the management system is cargo handling by the U.S. Customs Service. The new automated export filing system significantly cut paperwork and changes the way companies do business. In 2000, the Automated Export System, the U.S. Customs Service platform for electronic filing of export documentation, fully replaced the 30-year-old AERP system used by exporters, ocean and air carriers, and forwarders.[148]

- ***Warehouse Technology***

An important aspect of the landside part of air freight operations is warehousing or distribution centers where the cargo is sheltered, sorted, and distributed to the interested party. Warehouse activities have become highly modernized. AT JFK, for instance, Japan Airlines Management Corp. has a modern computer operated cargo center in Bldg. 14. Activity at the center consists of building up unit load devices (ULD) for dispatch and breakdown as well as shipment acceptance and discharging of shipments to truckers. Rack storage structures are 50 to 125 ft high to economize the space and are designed to accommodate the automated Material Handling System (MHS). A dedicated temperature controlled special handling area allows the handling of livestock (including horses), and specialized refrigerated shipments. In addition to the highly sophisticated material handling system, it is the first cargo facility to offer hydrant fueling and ground power support for aircraft, including a helicopter landing pad.

Innovative features include buffer floors for temporary storage and retrieval, and high-speed loading/unloading by direct transfer of ULDs from aircraft to a truck or work station within the terminal. The roller-decks ordinarily used to store ULDs were eliminated and replaced by an Elevated Transfer Vehicle (ETV) with telescopic blades, deposited directly on 4,600 shelf beams that are part of the rack structure frame. A network of distribution conveyors, transfer vehicles, ETVs, and vertical lifts move ULDs to various locations through the building. Cargo for immediate breakdown is routed directly to a work station. Cargo to be picked up for immediate delivery is routed to an automated Pre-Pack delivery dock. Shipments awaiting pick-up or break-down are directed to high bay ULD storage racks. The system is designed to turn around a fully loaded 747-F in 1 hour and 45 minutes. Additionally, the facility offers a break-bulk service, customs and other related services, and provides container station functions for a number of freight consolidators.

New technology, such as automated wheeled transfer vehicles to store and retrieve freight are used also by the Northwest Airlines and Delta Air Lines cargo facilities at JFK, as well as in the planned Continental cargo facilities in Newark.[149]

- ***Impact of Technology in the Air Freight Industry in the New York Metropolitan Area***

The New York region's international airports are promoting advanced technologies in navigation, land access solutions and preparation for the new types of aircraft entering the market. The New York/New Jersey region is the world's largest air cargo market. The air cargo industry is growing fast and has an important impact on the economic development of the region. Nearly 25 percent of air cargo imported to the United States comes through Kennedy and Newark airports. In 2000, JFK and Newark International airports set new records in cargo volume

and were the 4th (JFK) and 8th (EWR) busiest cargo airports in the nation. Since 1993, over 2.4 million square feet of new cargo-handling facilities were created in the region's airports. This includes Japan Airlines' new, and most advanced, cargo facility completed in 1994 at the North Cargo Area; a facility opened in 2000 by Korean Air Cargo in Building 9; Northwest Airlines' cargo building, completed in 1999; and the Air Express International Building, completed in 1999. Airis' $161 million project, scheduled for completion in 2003, is the largest cargo development in JFK history. Continental Airlines is building an 80,000-square-foot facility scheduled for completion in 2002. Several new facilities were also built at Newark Airport. The primary commercial service airports in the New York metropolitan area are JFK and Newark, and to a lesser extent, LaGuardia Airport and Stewart International Airport.[150]

Continental's Global Gateway Project at Newark International Airport
Source: Continental Airline Brochure, 2001

In the metropolitan area, JFK and Newark airports are already analyzing which investments in infrastructure will be required to accommodate the new large airplane (NLA) service. It will require major infrastructure modification, including longer runways and taxiways, as well as terminal expansion. PANY&NJ has conducted a study to determine if these investments will be justified.

Another problem facing the region's airports is the landside access. Land access to airports requires an extensive highway network along with rail access. From New York's three major airports (JFK, LGA and Newark), only Newark International airport (EWR) meets the requirements. Newark has a good rail freight connection located in close proximity to the airport. It is located close to major marine terminals in the Port of New York & New Jersey, and is also connected to a relatively uncongested interstate highway system. Responsible government agencies, including NYMTC, are working on modernization and several improvements in access to the other New York region airports, such as the ITS program, better signing, and improved curvature and clearance on access roads. Trucks currently transport most cargo going to airports, which increases congestion and air pollution problems in the region. A planned modern fast ferry connection could help to fight congestion and pollution.[151]

To improve access, JFK put $4.4 billion in its terminal improvement program, and is building the $1.5 billion JFK Light Rail System (LRS), scheduled for completion in 2003. This rail is for passenger access only; however, in the future it may be widened for local transport of lighter freight.

In promoting air freight transportation, NYMTC has included air cargo related projects in its Transportation Improvement Program and supports technological solutions to the problems facing the industry.

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Glossary of Terms

Bogie A set of highway wheels built specifically to be used as rear wheels under a container. An overseas term for a railroad car "trucor wheel assembly.

Boxcar An enclosed railcar, typically 40-50 feet long, used for packaged freight and some bulk commodities.

Breakbulk To reduce a large shipment of a single commodity into many small shipments which are then dispersed to various buyers.

Chassis A special trailer or undercarriage on which a container is moved over-the-road by truck.

Container A box for transporting cargo constructed in varying dimensions to withstand safeguard goods in transport.

Customs Federal government authority regulating imports.

Custom tariff Import duty schedule, usually commodity specific.

COFC Container-on-flatcar. COFC service transports marine containers without chassis loaded on a flatcar.

Double-Stack Marine containers stacked two high on a low profile wellcar, commonly articulated in five-unit multiples. Similar to TOFC/COFC, packers or cranes are used to load containers onto the wellcars (railcars with the floor of the car located below the top of the rail wheels to provide lower vertical clearance). Typical train lengths are 10-20 units, carrying 100 to 200 containers per train. A vertical clearance of over 20 feet is required for these railcars.

Drayage Transporting freight by truck, usually within short distances.

Export Sale and shipment of goods from one country to another.

FAA Federal Aviation Administration, the department which regulates the airways, air safety, airport planning and development.

FHWA Federal Highway Administration, the agency responsible for approval of transportation projects that affect the federal highwaysystem.

Hub Port Term used to describe a major port used as a center to distribute freight to a region.

Intermodal The transfer of freight between all modes involved in general cargo transportation (e.g. ship, rail, and truck). This term is also used to indicate the movement of passengers between transportation modes.

ITS Intelligent Transportation System, a generic term for advanced technology applications that provide real-time monitoring and information to enable the more efficient and safer use of the transportation system.

Multimodal Use of more than one transportation mode to move a load of goods.

Pallet A platform on which cargo is loaded, which can be stacked and handled by a forklift or sling, usually constructed of wood.

Reefer Refrigerated container. A specialized container that holds perishable goods at controlled temperatures.

RoadRailers Trailers with detachable railroad wheels. A trailer can be driven over the road or on rails without the need for other equipment.[190]

Roll-on/Roll-off Ro/ro. A specially constructed ship that allows cargo to be rolled in and out doors on wheeled loading devices or under the cargo's own propulsion, such as a motor vehicle.

TEU Abbreviation for 20-foot equivalent unit, a term used to describe a freight container's volume. One standard 40-foot container equal two TEU's.

TOFC Trailer-on-flatcar. TOFC service moves over-the-road rubber-wheeled truck trailers on railroad flatcars. All types of freight are carried in these trailers.