The problems of the Asia-North America Container Routes - Los Angeles and Panama -

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ABSTRACT

There are two principal routes for the Asia-North America containerized cargo, that of Asia-West Coast and Asia-East Coast. On the West Coast, the Asia-Los Angeles, dominate the commerce, whereas on the Asia-East Coast it's the Panama Canal. Each of these routes has different characteristics. All are similar in that each is the door to the commerce of containerized cargo originating in Asia; each combines maritime and overland transportation; each has important intermodal connections and is able to distribute cargo throughout the West and East Coasts of the United States. Each route also has its port of preference that has the necessary infrastructure, equipment and intermodal connections. For example, in the case of the Port of Los Angeles, in spite of some of its advantages, it has several serious problems due to the interminable containerized cargo traffic that must be solved rapidly and satisfactorily in order to progress. In this paper, we would like to show the problems of two main routes.

1. INTRODUCTION

Within the Asia-North America commercial route, the Asia-Los Angeles route has captured the greatest volume of containerized cargo. The Port of Los Angeles is strategically located to receive and distribute Asian cargo to the industrial heart of the East Coast of the United States. It also has modern infrastructure specialized equipment to receive and unload large ships and huge volumes of cargo, a fact that makes it one of the most attractive ports along the Pacific basin. Given these characteristics, it is not difficult to understand why the Port of Los Angeles is the North American leader.

The advantages offered by the Port of Los Angeles continue to attract a greater number of shipping lines but at the same time this becomes a negative factor due to the overwhelming volumes of cargo that must in turn be managed. This has lead that expansion and modernization efforts make insufficient for the magnitude of cargo that grows annually. One of the alternatives to this problem has been to divert commerce to relatively under-utilized ports such as those of Seattle, Tacoma and Vancouver. The growing volume of cargo at the Port of Los Angeles also creates occasionally serious environmental problems due to contamination. Some of the terminal operators have not adhered strictly to the environmental regulations.

At the same time, the maritime industry dependent on this port has sought alternate routes due to the 2002 longshoremen's strike along the Pacific that paralyzed the industry and lead to millions of dollars in losses.

The Panama Canal route also serves the East Coast of North America through the use of the Ports of Balboa and Cristobal, as well as the Port of Manzanillo, Mexico and is able to manage considerable volumes of cargo.

However, according to statistics regarding containerized cargo, the volumes originating in Asia and destined for the East Coast have diminished considerably in comparison with the cargo being shipped to the West Coast.
The distance and the transport time have been essential factors impacting on the traffic through the Panama Canal. Panamanian authorities have invested vital resources in the modernization of the ports' facilities in order to be able to accommodate containerized cargo. Due to the increase in containerized cargo that arrives on the West Coast destined for the East Coast of the United States, authorities signed collaborative agreements in 2003 with ports on the East Coast of the United States to transport some of the West Coast commerce through the Panama Canal.
These ports may enjoy many competitive advantages, however, if they don't develop long range, strategic plans that provide efficient solutions in line with the increases in cargo, environmental and labor problems could lead to an eventual decrease in the volumes of cargo managed.
The objective of this paper is to analyze the growth of containerized cargo in Asia and the problems that exist on the Asia-Los Angeles and Asia-Panama Canal routes. The methodology to be used is a comparative analysis of the containerized cargo statistics along the principal routes from Asia to the West and East Coasts. The problems faced by the Port of Los Angeles, such as labor and environmental will be analyzed along with those faced by the Panama Canal, such as the decline in containerized cargo and the challenge to reverse the trend.

2. CONTAINERIZED CARGO TRENDS FROM THE WEST AND EAST COASTS ON THE ASIA-NORTH AMERICA ROUTE

This section will study the cargo from Asia to North America delivered to the West Coast and to the East Coast.

Table1. Cargo from Key Asian Countries to North America (thousand TEUS)

year	Main China	Hong Kong China	China Taiwan	Japan	South Korea	Southeast Asia	Sum total
1986	99	222	827	771	311	234	2,464
1987	143	246	887	719	368	259	2,622
1988	200	271	795	742	392	322	2,722
1989	196	365	778	800	358	374	2,871
1990	225	425	690	783	343	433	2,899
1991	258	547	700	713	300	477	2,995
1992	373	656	695	729	298	576	3,327
1993	497	717	667	750	293	631	3,555
1994	806	677	671	781	309	708	3,952
1995	1,025	625	599	728	300	729	4,006
1996	1,198	570	578	670	284	746	4,046
1997	1,511	578	593	705	317	794	4,498
1998	1,819	730	658	751	428	954	5,340
1999	2,180	1066	658	791	427	1043	6,165
2000	2,924	1011	650	804	462	1148	6,999

Table 2. Cargo from North America to Key Countries and Areas in Asia (thousand TEUS)

year	Japan	Southeast Asia	Hong Kong China	South Korea	China Taiwan	Main China	Sum total
1986	653	190	133	229	288	*60*	1,553
1987	772	218	156	266	342	*81*	1,835
1988	852	240	198	330	383	*106*	2,109
1989	901	298	189	352	431	*106*	2,277
1990	910	354	209	380	421	*105*	2,379
1991	945	382	272	397	464	*137*	2,597
1992	856	409	305	388	435	*139*	2,532
1993	924	401	312	382	420	*125*	2,564
1994	1,054	516	379	405	484	*218*	3,056
1995	1,118	591	473	448	452	*277*	3,359
1996	1,113	620	481	425	415	*341*	3,395
1997	1,102	629	503	431	397	*381*	3,443
1998	1,021	440	427	329	352	*388*	2,957
1999	960	459	363	394	322	456	2954
2000	987	568	362	438	311	653	3319

The total flow of cargo from Asian countries to North America increased from 2,464 (thousand TEUS) in 1986 to 6,999 (thousand TEUS) in 2000. The flow of cargo from North America to Asia increased from 1,553 (thousand TEUS) in 1986 to 3,319 (thousand TEUS) in 2000. It is readily clear that the volume of cargo transported by Asia is greater than that by North America. The number of containers that North America receives from Asian countries increases annually leading to an overflow of traffic along the West Coast.

Table 3. Cargo Movements on the West Coast, East Coast and the Gulf of North America (thousand TEUS)

	West Coast			East Coast and Gulf		
	For North America	From North America	West Bank	For North America	From North America	East Coast and Gulf
1989	2285	1692	**3977**	586	586	**1172**
1990	2322	1761	**4083**	578	617	**1195**
1991	2458	1978	**4436**	537	620	**1157**
1992	2713	1968	**4681**	613	572	**1185**
1993	2898	2011	**4909**	657	553	**1210**
1994	3282	2449	**5731**	668	602	**1270**
1995	3305	2709	**6014**	694	644	**1338**
1996	3371	2705	**6076**	676	689	**1365**
1997	3768	2731	**6499**	731	712	**1443**
1998	4466	2335	**6801**	876	623	**1499**
1999	5238	2293	**7531**	936	653	**1589**
2000	5994	2590	**8584**	1027	725	**1752**

On Table 3 and Figure 1, along the Asia-North America route, the total cargo received on the West Coast increased from 3,977 (thousand TEUS) in 1989 to 8,584 (thousand TEUS) in 2000. The cargo delivered to the East Coast increased from 1,172 (thousand TEUS) in 1989 to 1,752 (thousand TEUS) in 2000. The cargo delivered to the West Coast is clearly greater than that delivered to the East Coast.

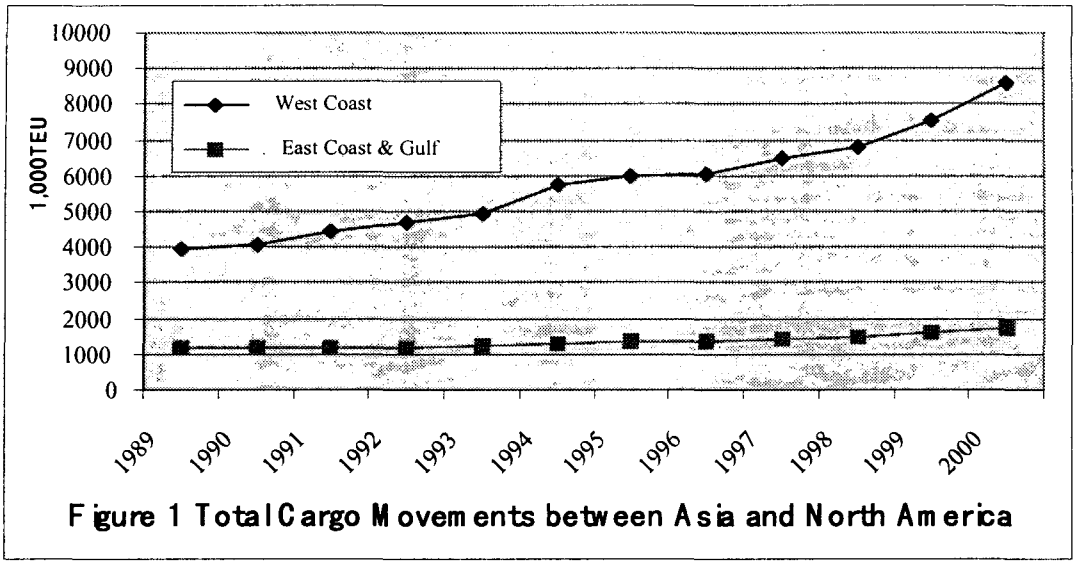


Figure 1 Total Cargo Movements between Asia and North America

Figures 2 and 3 demonstrate the movements of containerized cargo. As one may observe along the Asia-North America route (Figure 2), the volume increased from 519 (thousand TEUS) in 1990 to 1027 (thousand TEUS) in 2000 on the East Coast, whereas the volume for the West Coast increased from 2491 (thousand TEUS) in 1990 to 5994 (thousand TEUS) in 2000. In the case of containerized cargo from North America to Asia (Figure 3), the volume from the East Coast increased from 514 (thousand TEUS) in 1990 to 725 (thousand TEUS) in 2000. By the same token, containerized cargo from the West Coast during the same period increased from 1671 (thousand TEUS) to 2590 (thousand TEUS). Yet again, one may observe greater traffic along the West Coast of the Asia-North America route.

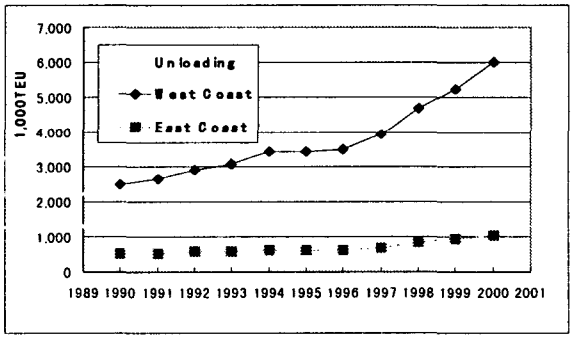


Figure 2. Container Movements from Asia to North America: East and West Coast

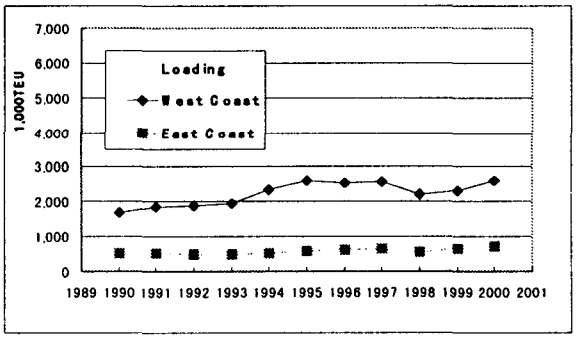


Figure 3. Container Movements from North America to Asia: East and West Coast

3. THE CAUSES FOR THE CONGESTION AT THE PORT OF LOS ANGELES

One of the effects of the increase in cargo from Asia is the congestion on the West Coast, the Port of Los Angeles in particular. This cargo originates principally in China, Hong Kong, Japan and Taiwan, the countries that provide the bulk of the imports to the United States. The congestion at the Port of Los Angeles is important to consider because it demonstrates the decrease in the port's capacity to receive large volumes of cargo, and a fact that forces the port to find quick solutions.

There are 7.9 million containers of 20 feet (TEUS) transported from Asia to the United States annually. Approximately 20% of the containers, 1.5 million TEUS, are destined for the East Coast.

Of the many ports located along the West Coast, the Port of Los Angeles has the highest traffic of containerized cargo. Its portion of the total commerce along the West Coast was 25.21% in 1999, 28.34 in 2000, 30.22% in 2001, while in 2002, it rose to 32.27%, as is indicated in Table 4.

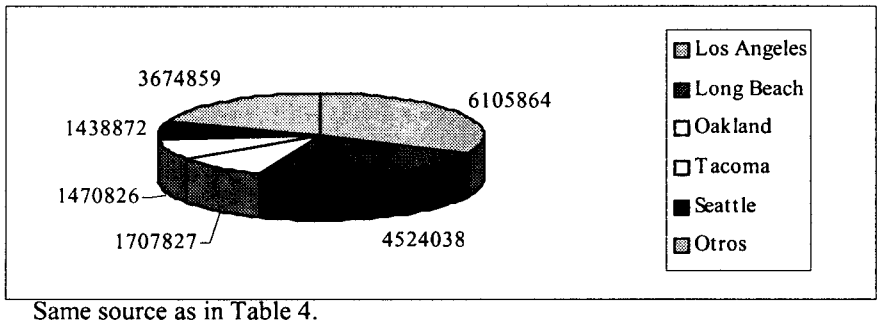
Table 4. Increase of Containerized Cargo at the Port of Los Angeles (TEUS)

	1999	2000	2001	2002
Port of Los Angeles	3,828,851	4,789,429	5,183,511	6,105,864
Total of West Coast	15,187,111	16,895,364	17,149,057	18,922,286
Total of USA	28,037,785	30,391,720	30,677,963	32,427,656

Source: AAPA Port Industry Statistics: Industry Information. Port Industry Statistics obtained from the Internet 2/23/2004: http://www.aapa-ports.org/pdf//americ_rank-02pdf.

An annual basis, the Port of Los Angeles receives more than 11 shipping lines from Asia such as APL, Hyundai, MOL, China Shipping, CMA-CGM, Maersk Sealand, Evergreen, Wan Hai China among others. In 2002, the Port of Los Angeles had the highest volume of containerized cargo along the West Coast, as is indicated in Figure 4.

Figure 4.Container Traffic along the West Coast of North America in 2002 (TEUS)



Same source as in Table 4.

The following reasons explain why the Port of Los Angeles receives such a large volume of cargo from Asia: the port's infrastructure accommodates large ships, the capacity of the port's terminal to handle such a huge volume of cargo, its equipment and level of productivity along with its intermodal connections. Thanks to these characteristics, the volume of cargo from Asia increases annually as indicated on Table 4, but they also lead to the port's congestion and overload. After 2000, there was an approximately 30% increase in cargo.

In 2000, 9% of the GNP of the United States depended on the imports from the West Coast (James Espinosa, 2001). The congestion at the Port of Los Angeles is not beneficial for the economy for different reasons. From the perspective of the container companies shipping to the Unites States, the congestion slows down the process in dispatching the ships and their cargo. Interruptions in productivity are possible, as was the case for example with the automobile company NUMMI that was forced to close for a few days due to the strike of October 2002 (Anderson Economic Group, 2002). Another result could be the companies' depletion of inventories, especially those that depend on imports transported by sea. All of these factors would increase the cost of imports as well any products already on the market before a predicted scarcity.

From the point of view of the shipping companies traveling from the United States to Asia, the congestion would effect them similarly in slowing down the process in dispatching the ships and their cargo, producing delays in delivering the merchandise and damaging some such as agricultural products and other perishable goods.

3.1 Infrastructure

In maritime transportation, the actual ships transport 6,000 to 7,000 TEUS that is not a problem for any of the ports located along the West Coast of the United States because they have the adequate infrastructure for processing these large cargo ships. Despite this, at the beginning of 2003, the first two ships with a capacity of more than 8,000 TEUS sailed almost exclusively among the Asian and European markets (Fair Play Register, 2003) See Table 5.

The ships that dock at the Port of Los Angeles have a capacity of 7,200 TEUS while the port has yet been able to service the ships with 8,000 TEUS because its present infrastructure doesn't enable it. However, it will have this capacity once the deep ship dredging is performed in the channel during the summer of 2004. For the moment, these ships only travel along the Asian and European routes (David Greenberg, 2003).

Table 5 depicts the dizzying speed with which the size of ships grew from 1992 to 2002, in short time surpassing fifth generation ships of 4,900 TEUS with sixth generation ships with 8,000 TEUS. The growth of the ships conducive to the growth in container cargo, leading to an annual growth rate of 8.4%, while the worldwide

maritime commerce achieved a 2.4% annual rate according to the data from the UNCDC (United Nations Conference on Development and Commerce). (Fairplay Ship Register, November,2003).

Table 5. Growth of Container Ships

Item	First Generation	Second Generation	Third Generation	Fourth Generation	Fifth Generation	Sixth Generation	Seventh Generation
Length (M)	190	210	210-290	270-300	290-320	305-310	355-360
Breadth (M)	27	27	32	37-41	39.6-47.2	38-40	38-40
Depth (M)	9	10	11.5	13-14	13-14	13.5-14	15
Speed (knot)	16	23	23	24-24.8	25	25	
TEUS	1,000	2,000	3,000	4,000	4,900	6,000	8000
on deck	1-2 tier	2 tier/8 rows	3 tier/12 rows	3 tier/14 rows	6 tier/16 rows	6 tier/16 rows	
		2 tier/10 rows	3 tier/13 rows	4 tier/16 rows		10 tier/13 rows	-
hold	5-6 tier	6 tier/7 rows	7 tier/9 rows	9 tier/10 rows			
		6 tier/8 rows	9 tier/10 rows	9 tier/12 rows	-	-	-
Period of time	the 1960s	the 1970s	the 1980s	1984 or later	1992 or later	1996 or later	2002 or later

Note: 1984 or later means 1984 and so on, also 1984 and after means years after 1984.
Source: International Container Transportation of Present Condition Rule Relief of Fixed Marine Business and a Mega-competition Time 1997-1998. Research Cooperation Office of Mitsui O.S.K. Lines, October 1998 and Shipping Port Industrial-Policy Design, South Korea Maritime Institute, 1996 edition

The new sixth generation Panamax ships require a channel with a minimal depth of 50 feet (15.24 meters). The accessible channel at the Port of Los Angeles has a depth of 45 feet (13.71 meters) at the moment but is expected to increase to 53 feet (16.51 meters) later in 2004 (David Greenberg, 2003). When the depth of the channel is finalized, the Port of Los Angeles will have resolved the problem only temporarily given that ships' dimensions and cargo capacities keep growing, forcing ports to continue with the upgrading necessary to keep pace with the growing volumes of container ships. Construction is planned for ships with 10,000 TEUS during 2004 (Fairplay Ship Register, November, 2003), now that China, South Korea, and Taiwan have ordered the construction of ships with capacities of 12,000 and 15,000 TEUS (David Greenberg, 2003).

3.1.1 Port Terminals

The seven terminals that service containers at the Port of Los Angeles have been insufficiently able to attend to the large volumes of cargo received annually. One of them, PIER 400, embarked in 2002 on an expansion with a cost of $473 million in order to dispose of 484 acres in 2004, an annual increase of 2.4 million TEUS (Port of Los Angeles, 2003). This terminal, operated by Maersk Sealand-APM, is the only one among the other five terminals able to receive large ships due to the fact that it's located at the outskirts of the port.

The other terminals are pressured to expand given that the cargo originating from Asia increases annually. The problem with expansion is finding the appropriate location in the interior of the port wide and deep enough for the ships to maneuver from one terminal to another. The expansion of one terminal has to be planned carefully to that the ships' movements are not impeded .

The most ships moor at the Port of Los Angeles for two or three days. This means that with each moored ship there are increased numbers of containers to load and unload at the terminals. According to data from ILWU (International Longshore and Warehouse Union), the level of productivity at the ports along the West Coast is of 28 to 30 containers per hour (Bill Mongelluzzo, 1999 Journal of Commerce). In order to maximize the space available for these and other work (comings and goings of trucks and trains), the containers are piled up in three or four tiers and are processed as quickly as possible in order to receive the next ship of containers.

Slightly over 50% of the available space is utilized for activities not related to containerized cargo (James Espinoza, 2001). This indicates that the containerized space available at the port is not specific to that function

The expansion of one terminal doesn't necessarily signify new business (Brian Milligan, 2000), it can also indicate attending to the current demand that keeps increasing annually. This refers to the constant flow of containers coming primarily from China, Hong Kong and Taiwan that continue to increase at a rapid pace. It is difficult to attract new business clients when the port terminals at the Port of Los Angeles are beyond the saturation point and ships are being diverted to the Ports of Tacoma or Vancouver in Canada in order to relieve some of the congestion.

To attract new business would mean to bring greater volumes of containers to the port terminals that cannot actually be processed. On the other hand, this would indicate a sacrifice of quality service by the port. In order to

solve this problem, the expansion of the terminals has been planned that will streamline the loading and unloading procedures. This plan is difficult to initiate at the moment because the port must face the overwhelming congestion every day. This congestion reveals yet another problem: bad planning regarding the utilization of port space. Space that should be designated exclusively for loading and unloading is occupied as storage space for empty chassis, containers and unnecessary equipment. (James Spinoza, 2001). The expansion work could further reduce the limited space designated for loading and unloading leaving insufficient space to process the cargo of any possible new clients.

3.1.2 Port Equipment

In order to handle the 8,000 TEUS, new generation ships, modern equipment of large capacity is required. The Port of Los Angeles can only handle 7,200 TEUS ships. A port crane can handle Post Panamax container ships with 18 to 25 containers in rows. A crane for 18 containers in rows can serve eight to nine thousand TEUS ships, while a crane for 22 containers in rows can serve 12,000 TEUS ships. Pier 400 is the only terminal with equipment capable of handling large cargo volumes. It is equipped with 100-feet (30.48 meters) electric cranes whose arms span over the width of 22 containers. Trapac, Yusen, Evergreen, and APL terminals are equipped with Post Panamax cranes capable of moving important volumes of cargo. Besides these terminals and the Pier 400, no other terminal is equipped to handle large cargo volumes.

3.2 Intermodal connections

Ironically, slow railroad service contributes to the port's saturation, even though they work 24/7 (24 hours 7 days per week). Railroad companies claim that the number of containers arriving at the Port of Los Angeles is excessive (Brian Milligan, 2000) because shipping lines spend too much time at ports such as Hong Kong, Taiwan, China, or Japan. It is at these ports that ships are loaded with a large number of containers that will be sent to the U.S. Most U.S. imports originate at these ports; this is why shipping lines consider them as strategic ports.

In order to foster scale economies, large ships must operate at high level of utilization with respect to their capacity. The need to build larger ships is the result of market demands (Fairplay Ship Register, November, 2003).

Once these ships arrive at The Port of Los Angeles, containers are unloaded at the terminal, transported by truck to railroad terminals, from where they will be transported to the various parts of the country. Problems arise when a large number of containers must be transported by truck to the railroad terminals because there is a shortage of trucks. There are few trucks; therefore, transportation ends up being very slow (Brian Milligan, 2000). The other problem is related to the timetable of intermodal operations at ports which operate 8 hours a day, thus hindering transportation and slowing down railroad operations, which operate 24/7 (Brian Milligan, 2000).

3.3 Environmental problems

The Port of Los Angeles is located 20 miles from downtown Los Angeles. It extends over 3,036 hectares (7,500 acres) and 35 miles on the waterfront. The port's dimensions allow for frequent arrival of 7,200 TEUS ships, which are a pollution source because of waste thrown into the water and smoke emissions that pollute the air. An unloading ship may remain at the port for three days discharging waste into the environment. Three tons of smog are emitted every day (Jim Johnson, 2002). Ships and trucks transporting containers inside the port use diesel and emit particles and nitrogen oxide that damage the ozone layer (California Environment Report, 2003).

3.4 Labor Problems

In October 2002, a strike broke out along West Coast ports lasting 10 days. This happened when the Pacific Maritime Association (PMA), which represents shipping lines, terminal companies, and stevedores, decided to close down the ports because of the frequent strikes of port workers affiliated to the International Longshore & Warehouse Union (ILWU). The strike ended when President Bush invoked the Taft-Hartley Act in order to reopen the ports and prevent further damage to U.S. economy (Barbara Morris, 2002). The closing of the ports caused losses at the rate of $1 billion U.S. dollars per day (Barbara Morris, 2002). In September 2002, before the strike, the productivity of West Coast ports, including the Port of Los Angeles, was reduced by 90% (Pacific Maritime Association, 2004).

The event affected various companies located somewhere along the distribution and production chain, beginning with shipping lines whose ships remained docked for several days with full or empty containers that could not be unloaded or loaded. Railroad companies were not able to run normally because there were no containers to transport. Companies relying on the delivery of imported goods were affected in different ways; some of them closed down for a few hours because of lack of parts; inventories for self-service chains such as Wal-Mart and

K-Mart were depleted, while exporters were late in the delivery of their orders. Of this group, the ones suffering the greater losses were those exporting perishable goods. Many losses were not fully covered by insurance companies because they do not cover events such as strikes.
There are other labor related problems such as the reduced salaries paid to truck operators who are paid by the trip and not by the hour; they are rarely paid for the time they spend waiting in line to enter the port's incoming station. Drivers remain in the waiting line from one to six hours before they enter the port. Once inside the port, they have to wait even more while the container is loaded or unloaded. Low salaries discourage drivers and that is why many of them have resigned. The low number of drivers causes a shortage of trucks to transport the cargo (George Cashman, 2001).
Another factor contributing to the congestion is the port's access timetable from 8:00 AM to 5:00 PM. Port authorities and terminal operators refuse to work outside this timetable claiming that overtime implies heavy expenses (George Cashman, 2001).
Unresolved labor problems are a source of instability for maritime-port activities since they end up in short and long strikes affecting the port, companies and economic activities within the port's area of influence. One of the present challenges faced by the ILWU is about how to deal with the integration of technology to port terminals, since it replaces large numbers of workers. Technology integration at port terminals in recent years has undermined ILWU's prestige as well as the number of members in their union (Patrick L. Anderson, 2002).

4. THE PANAMA CANAL PROBLEMS IN THE EAST COAST

Among the Asia-North America routes, there is the Asia-Panama Canal route. Even though it operates at lower cargo level, the Canal receives cargo coming from various Asian countries. This route is an alternative to the use of the Port of Los Angeles to send cargo to the U.S. East Coast.
The Port of Los Angeles strike boosted the use of the Panama Canal. Panamanian authorities are facing a decrease in container cargo through the Canal; so, in the last three years they signed agreements with U.S. East Coast ports in order to promote and recover the dynamics of previous years. However, this brought to light a series of problems that could become an obstacle for its performance as will be explained later in this paper.

4.1 BEHAVIOR OF CONTAINER CARGO THROUGH THE PANAMA CANAL

During 2003 trade, using containers, from Asia to the Panama Canal was approximately 1,883,090 TEUS. More than 60% of the cargo passing through the Panama Canal has U.S. ports as its origin or destination.
In order to attract larger cargo volumes, the Panama Canal Authority signed agreements with the ports of New York and New Jersey for a maritime route only through the Panama Canal. Another goal is to sign similar agreements with Norfolk, Virginia; Savannah, Georgia; Charleston, South Carolina, New Orleans, Louisiana; Houston, Texas; and Miami, Florida (Panama Canal, 2003).

4.1.1 Infrastructure

The following ports are located at the Panama Canal: Balboa on the Pacific, and Manzanillo and Cristobal on the Atlantic. The Balboa and Cristobal ports have only one container dock. As a consequence of the agreements signed with ports on the U.S. East Coast, port authorities saw the need to build a second container dock at Balboa port in order to meet future demands.
Ships crossing the Panama Canal travel a distance of 54 miles (86.886 km) in 24 hours. The Canal consists of a flight of locks 33.5 meters wide, 305 meters long and 26 meters deep. These measurements have been exceeded by the new generation of Post Panamax ships. The Panama Canal can only be crossed by ships with the following measurements: girder, 294.13 meters; breadth, 32.31 meters; and draft, 12.04 meters. Therefore, it cannot handle ships bigger than 5,000 TEUS. Panamax ships can cross if they are not full and with 200 containers less than the maximum allowed.
In order for a ship to go across the Canal, it must wait between 14 and 24 hours (there are companies that must make a reservation one year in advance and pay three times the normal rate). If smaller container-ships are used, the crossing takes two or three additional days (Anthony Coia, 2001).
The attraction of more businesses to the Canal motivated the authorities to implement a Modernization and Maintenance Program by the end of 2003. Up till now, new seals have been installed on the bottom of the Miraflores locks to reduce water consumption. In January 2004, Canal operations were interrupted for 12 hours in order to replace railroad tracks. This work is 75% complete and is expected to be concluded in 2005. These tasks have caused 6-day delays to ships, thus, reducing traffic from 38 to 30 daily crossings.
Due to ship traffic, a Modernization and Maintenance Program was implemented, which proposed the expansion of some Canal areas in order to receive ships of more than 7,400 TEUS, and even the construction of a third flight of locks whose size has not been determined with precision yet. In addition to this, tugboats will be introduced to pull ships into the locks (its estimated cost is 10 million U.S. dollars).

Making Lake Gatun deeper is also being considered in order to increase stored water capacity to 300 million gallons of water per year. Authorities estimate the volume of water will be enough to meet population needs in the Canal's neighborhood. The estimated cost is 13.9 million U.S. dollars (ACP Studies, 2001).
Additionally, in order to give access to Post Panamax ships, the Canal's narrowest part, Cut Gillard, will be enlarged, from 500 feet (152.40 meters) to 630 feet (192.02 meters), in order to allow for two ways ship traffic.
Investments for the modernization and enlargement of the Canal, acquiring new equipment to replace heavy machinery, and securing water and energy supply are very expensive. These endeavors are neither in harmony with sustainable development nor with protection of the environment.

4.1.2. Port Equipment

Panama Canal ports are equipped with Panamax cranes in order to handle large cargo volumes. The Manzanillo International Terminal has 2 Panamax cranes, 6 Post-Panamax, and 2 Super Panamax; Cristobal port has 2 Panamax cranes and Balboa port has 3 Super Post Panamax. A modernization program aims to have 12 of this type of crane. This equipment is capable of handling the present level of cargo. However, as a result of the agreements signed with U.S. ports to take the cargo from Asia to the East Coast through the Panama Canal, cargo volume will increase and a larger number of cranes will be needed, which are not there at the present time. Furthermore, this requires large investments of up to several million U.S. dollars.

4.2 CIRCUMSTANCE OF THE PANAMA CANAL

4.2.1 Environmental Problems.

Previous studies have shown that the Panama Canal totally relies on the area's ecosystem. The woods are essential in order to maintain water supply to the Canal; they cause abundant rain and make it possible to maintain certain water levels during the dry months of December to April. With the Canal activities, green areas have decreased as a result of population growth and urbanization. If basin reforestation does not occur, the Canal will not have enough water.
A larger volume of water would be required as a consequence of the proposed third flight of locks for ships that cannot cross the Canal at the present time. This man-made Canal receives water from both Oceans; however, since the flow is not permanent, water would be brought from the West Basin or a dike would be built on the Chagres River or Lake Madden. Water used for the locks would affect urban areas, especially during the dry months. In the 1990's the Canal used 94% of the basins' water, of which 60% was used to operate the locks and 34% to generate electricity (Guillermo Castro, 2002). According to these figures, only the remaining 6% was used for human consumption. In the presence of shortages of the vital liquid, this could cause social demonstrations against the works of the new flight of locks, whose construction would generate a serious social problem.
Worth mentioning is the fact that the Panama Canal is located in a seismic zone experiencing strong earthquakes that have even reached 7.5 degrees of magnitude (Hugh Cowan, 1998). Seismic activity could affect the Canal expansion works or even the construction of the new flight of locks.

4.2.2 Intermodal connections

The Canal's narrow width leads to the use of a trans-isthmus railroad, Panama Canal Railway Company, which covers a distance of 54 miles (86.886 km) in approximately one to three hours at a slightly higher cost than the maritime route. The railroad links the Balboa port on the Pacific side with Colon, and Manzanillo on the Atlantic side. The railroad offers an alternative for container transportation from Asia to the U.S. East Coast.
In the late 1990's it was agreed that the railroad would run 20 times per day, 320 days per year, which would result in 307,200 containers being transported each year. If double stacker train is used, then 399,360 to 491,520 containers could be transported each year. This idea can be written in the following Equation.
Single stacker train: $48\times20\times320=307{,}200$.
Double stacker train: $48\times\alpha\times20\times320=N,\alpha=1.3:N=399{,}360,\alpha=1.6:N=491{,}520$.
However, if 8.6 million containers are transported to the U.S. each year, of which 20% (1.7 million TEUS) have the East Coast as their final destination, it can be seen that the capacity of the railroad would be insufficient to send that amount of container cargo between Asia and the U.S. East Coast.

4.2.3 Canal's Safety

The Panama Canal is an important container transfer center offering 24/7 service during the entire year. It serves more than 50 countries located in 3 continents, Europe, America, and Asia. It handles between 13,000 and 14,000 ships per year. 60% of the cargo that goes through has U.S. ports as their origin or destination. This explains the importance of the Canal for U.S. commerce, but also for transoceanic and transatlantic commerce. When the U.S. transferred control of the Canal to the Panama Canal Authority in December 1999, the U.S. and

other commercial powers were afraid that the Canal would be the object of hostilities without the protection of the U.S. Army (Halley Stieber 2001). This is why the Panama Canal Authority was established as a separate entity from the Panamanian government, with its own financial sovereignty in order to avoid this problem. Free from political interference, the Panama Canal Authority would operate exclusively as a business serving numerous clients (Halley Stieber, 2001).
However, there is an always-present threat to the Canal's safety. This is the crossing point for some members of a Colombian revolutionary group crossing towards Panama, which, at any moment, could engage in terrorist acts against the Canal just to attract attention for political purposes (Central America: Panama Canal, 2002).
An act of such magnitude would have a strong negative effect on this transfer center because it would affect ship traffic and containers would have to be transported using the railroad, which would experience saturation and congestion, resulting in the inability to meet transportation demands. This would affect international commerce, particularly that with origin or destination in the U.S. It would even be necessary to send ships crossing the Canal to other ports or nearby routes.

4.2.4 Social Problems

The expansion of the Canal and the plan to build a new flight of locks are the source of much controversy since the work would affect the environment, depleting green areas and water sources for human consumption. Groups in opposition to these works (Caritas, the Catholic ministry; environmentalists and leftist groups), even though they represent a small segment of the population, they are an important pressure group that would discredit actions launched by Canal authorities. Presently, there is awareness that new engineering projects must be friendly to the environment and to society. If new Canal works take into consideration community concerns, the project could receive support from the Panamanian people.
On the other hand, the Canal's expansion and the construction of the new flight of locks would require large investments worth millions of dollars in the next 5 or 10 years, in addition to investments already in progress for maintenance of the existing infrastructure.

5. CONCLUSIONS

The results obtained above are summarized in the following table 6.

Table 6. Evaluation of the Port of Los Angeles and the Panama Canal for the Asia-North America routes

Concept	Los Angeles	Panama Canal
Infra-structure	Limited terminal capacity for container reception. Bad space planning.	Limited lock capacity to receive Post-Panamax containers. The modernization plan causes interruptions for ship trips and the reduction from 38 to 30 crossings/day.
Ground and maritime connections	Ship mooring time is of 2 to 3 days causing great congestion. Shortage of trucks, 8 hrs terminal operation timetable, and lack of workers all contribute to the congestion and together cause delays.	Ships wait 24 hours to enter the Canal. Since only small ships can go across, loading and unloading causes delays. The Panama Canal Railway makes the coast to coast trip in one to three hours, but it can only transport a small number of containers, even using double stowage.
The environment	Large ships arriving at the port emit large amounts of pollutants endangering animal species of the region and the population of nearby cities.	The expansion of the Canal implies larger amounts of water that will be brought from the closest rivers and lakes. This will cause shortage of water for human consumption, especially during the dry months. Canal related activities caused rapid urbanization which reduced green areas. If reforestation does not occur, there will be less rain, and consequently, less water supply for the Canal.
Social Issues	East Coast workers affiliated to the International Longshore and Warehouse Union (one of the strongest associations) called for a 10-day strike in 2002 with serious consequences for the U.S. economy and financial losses for industries and shipping lines.	Environmental opposition groups, leftist groups and Catholic missions are important pressure groups against Canal modernization actions. They claim that this project threatens the environment in irreversible ways.
Safety	It is the most important port on the West Coast, feeding the U.S. northwest, southwest, central and east zones. Given the amount of trade that depends on maritime operations, this port is highly susceptible to threats and terrorist attacks which, if they materialize, would produce huge and irreversible economic losses.	Since the Canal handles approximately 60% of the U.S. container cargo, it is also a target for possible attacks caused by the Colombian guerrilla, which would cause economic losses to industries located on the U.S. East Coast (the region with the heaviest commercial activity).

Source: Our own sources.

As shown above, the main two routes have various problems. So we are considering the alternative new route connecting Manzanillo and Brownsville to solve the problems as the next study.

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