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MULTIMODALISM AND AUSTRALIAN TRANSPORT INDUSTRY

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Abstract

The authors review the current status of some of the Australian modes of transport with reference to ports, evaluating the means of improving the efficiency of freight transportation systems by upgrading facilities so that they function within space and time limits typical of the sector.

INTRODUCTION

One of the essential aspects of a port's activity is its role as a cardinal link in the multimodal transport chain. It performs cargo transfer (loading and unloading) buffering and storage and physical form changes (for example, from bulk to containerised cargo) in preparation for the next form of multimodal transport. Given the importance of sea trade in the Australian economy due to the country's distance and the nature of the commodities exported and imported, any possible improvement designed to achieve greater efficiency and lower costs must be given serious consideration. In this paper the predominant role of road transport in the transport chain is questioned while rail transport is more actively promoted, particularly considering the recent development of systems like the RoadRailer, Under the Hook and Vessel Cycle Configuration.

TRANSPORT MODES AND AUSTRALIAN ECONOMY

The primary factor affecting Australian transport modes is distance. Different areas of economic activity in Australia are separated by large distances (Figure 1) and the continent itself is remote from most of the world.

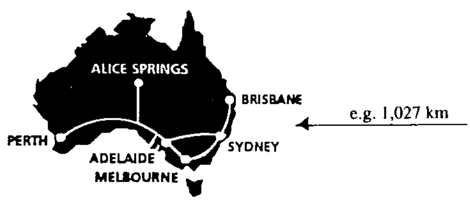

Figure 1 Distances and the Australian States

Australia, with a relatively small domestic market, is obviously dependent on trade, including commodity trade, which in turn is dependent on transport efficiency.

The extent of this dependency is easily demonstrated by a review of current trade statistics: in 1992-3 Australia's exports of goods and services increased by 8.8 percent to A$74,878 million compared to 1991-2 and imports also increased by 13.7 per cent to A$77,074 million (Castleman 1993). The value of seaborne exports in 1988 was estimated at A$12,928 million which was 36 per cent of Australia's exports, whereas seaborne imports in that year were worth A$5,213 million or 16 per cent of Australia's total imports. In 1994 the total cost of seafreight was $6.5 billion. Although this year the Australian wheat crop, following the drought, is expected to be only 15.5 million tonnes which is nearly 15 per cent lower than in 1993-94, an efficient transport chain will be even more necessary than usual.

The most recent available national accounts for Australia calculate the total national stock at around A$1088 billion, which on a pro capita basis is A$63,000. It is interesting to note that A$126 billion of the total is attributed to the transport and communications sectors (Castleman 1993).

MODAL SELECTION

An intermodal movement involves transfer of cargo from one mode to another, as in the truck/rail combinations. A multimodal movement involves transfer of cargo more than once to a third (or more) mode(s), such as ship, truck and rail combinations. Intermodal can also describe a multimodal movement. Figure 2 illustrates intermodal and multimodal systems in the Australian freight industry.

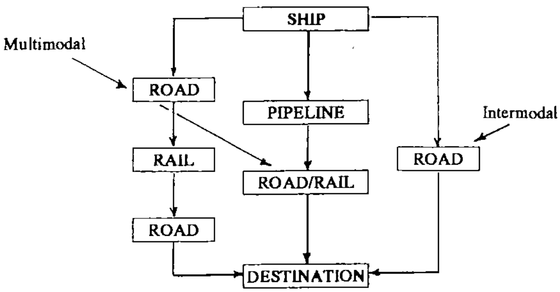

Figure 2 Australia's inter/multimodal system

The following discussion reviews the process of modal selection by freight shippers. Factors which determine the selection of any particular mode include transportation cost, transit time reliability, capability of the mode, accessibility and security. Modal selection is essentially a long term decision because the choice of one mode or another often involves major loading/unloading facility investment by shippers and receivers. This factor will be discussed in detail in the section dealing with direct ship-to-rail loading. In Australia, where distance is a primary consideration in transport, haul length is particularly important in determining the choice of transport mode. Generally, domestic freight transportation in Australia is carried out by four modes: sea, road, rail and pipe-line. In 1991 (the most recent year for which statistics are available), coastal shipping accounted for 32 per cent (tonne-distance basis), road 31, rail 31 per cent and pipelines 6 per cent (Bureau of Industry Economics 1994).

Sea transport tends to be used for longer distance movement of bulk goods due to its low unit-distance cost which other forms of land transport cannot match. It is interesting to note that, although approximately 67 per cent of the coastal shipping transport tasks involve interstate movements, the bulk of this interstate transport is to and from the isle of Tasmania. Most containerised and non-containerised general freight normally travels by land transport and there is relatively little movement between mainland ports.

Road transport tends to be used for short haul movements of non-containerised non-bulk goods due to its greater flexibility and because it avoids much of the double handling associated with other modes. On the other hand, rail predominates in the short haul bulk movements of commodities, such as wheat and other grains, as well as long haul movements of containers.

In comparison with railroad transport, transport by truck is not characterised by a substantial element of fixed costs. A comparatively small amount of capital is necessary to start a small-scale truck business and any equipment used can be easily adjusted to the volume of traffic. Furthermore the road hauliers do not have to provide and maintain their own infrastructures (roads and depots). Their contribution to public roads is limited to registration fees and indirect excises, as for example fuel taxes. These differences based on various structures of fixed and variable costs are not the only elements influencing the shipper's choice between the rail and road services. In view of the advantages and disadvantages of the two transport systems it is obvious that there should be competition and co-operation between road and railroad at the same time.

Finally, air transport is used to move high value goods where speed of delivery is an important consideration, especially where perishable goods are concerned. However, air transport is selected in a proportionately small minority of cases. In some situations, such as remote locations, the choice of this transport mode is often limited. The most recent statistics indicate that the total air freight to/from Australia in 1992-93 was 432,810 tonnes (Herald Sun 1994).

TRANSPORT MODES COMPETITION

In the long term, the effect of competitive pressures in the transport industry will be decided by institutional and regulatory factors. The influence of these factors varies across the freight industry and is beyond the scope of this paper. Currently, however, competition within the Australian freight transport industry has become non-constructive and damaging to the Australian industries. The emphasis on the rate/distance is both misleading and destabilising and will not necessarily lead to lower freight transport costs, especially in the long run, and may result in market instability.

The speed of delivery and safe transportation of cargo by air has lead to significant increases in this sector over the last five years. The overall volume of a transport is between 1-to-1.5 per cent of the total Australian freight handled in 1994 with a significantly high compared to land/sea transport. It appears that this reliable and safe service will probably become an increasingly active sector in freight transport competition. Air transport does not compete effectively for the carriage of bulk goods over any distance due to the high operating costs involved, which are compounded by technical factors such as lifting capacity. Across Bass Strait air freight is the only competitor to coastal shipping.

Interstate rail freight is about to enter the open market with the establishment of the first private venture to challenge the National Rail Corporation (NRC)'s monopoly of its 2.6 billion market. The joint venture will also provide a practical test for the Federal Government's reforms, aimed at making the railways more competitive and regaining a share of the freight business lost to road transport. Public railway costs in Australia are still expensive by world standards and further cuts in overhead together with increased productivity are essential in order to attain best practice for freight. The best source of stimulation in achieving this goal might prove to come from the private sector and open-market competition.

SEA FREIGHT AND AUSTRALIAN COASTAL SHIPPING

Definition of coastal shipping: The coastal shipping industry encompasses operators and managers of ships involved in the transport of freight by sea between Australian ports. The Australian coastal shipping industry provides vital services to a range of industries, notably steel making, the aluminium production chain, and petroleum industries. By international standards, Australian shippers are much more reliant on coastal shipping transport services than shippers in a number of other countries such as the USA and EC countries (Bureau of Industry Economics 1994). Interestingly, Australian bulk coastal shipping services, arrive on-time more than 95 per cent of the time. The survey conducted in 1993 for on-time arrival of the Australian coastal ships indicates that they were 88 per cent better than other international coastal shipping and had a loss and damage rate of only 0.01 per cent. Ranking of importance of external factors that adversely affect the cost/quality of service provision of coastal shipping in 1993 were as follows:

The interface between Australian ports and the road and rail network is a crucial element in overall transport chain efficiency and therefore the ultimate productivity of ports. One of the main cost factors in the multimodal transport system is calling expenses in ports, as well as the time spent there by highly sophisticated container vessels with extremely high daily costs (A$30,000-35,000). The objective of efficient multimodal transport is to move cargo from origin to destination in minimum time and at a minimum cost. To achieve this technology, operations, and management of each modal link must be integrated with the overall system. The Australian transport system is characterised by:

- high port and waterfront costs and inefficient work practices;
- high international liner shipping charges;
- inefficient coastal shipping due to the lack of waterfront productivity; and
- inefficient rail and bulk land transport system.

Despite efforts to the contrary, the high costs of shipping in Australia are leading importers/exporters to use increasingly the road mode. As a consequence multi-billion dollar port facilities have become underutilised and ports around Australia are loosing revenue to road, particularly in transhipment where demand for freight transportation is rapidly increasing. Transport technology usually lags behind shipping and terminal technology by a few years, making it difficult for transport modes to maintain effective services for users. Due to the length of transportation time, the unreliability of waterfront activity and high government and waterfront charges, between 1970/71 to 1988/89 coastal transhipment lost 15 per cent of its share to road and 4 per cent to rail. In 1988, total delay costs to shipping ranged from A$200-A$250 million. Of these costs A$150-A$175 million fell on imports and A$50-75 million on exports. In both cases one would expect such costs to be reflected in increased freight rates. It follows that, if road domination of freight transport is not reviewed by the Federal/State Government, the consequences may damage the future of the coastal shipping. Since the introduction of containers (1968-70), high port costs in Australia have been a burden to the Australian shipping industry's productivity and can be expected to continue for a long time. In 1993, a survey was conducted (Herald Sun 1994) on national and international port costs to establish the differences between Australian ports and overseas. For comprehensive interpretation, the costs of the Melbourne port were assumed to be 100 per cent. It should be noted that the figures given below are extracted from the Australian trade with Japan, East Asia, New Zealand, Europe, and South East Asia. The efficient operation of a port is vital to the health of that country's economy. Not only should the port perform its transport services properly, but these services should be priced to distribute the benefits of port investments between the domestic economy and foreign interests. Figure 3 illustrates the results obtained.

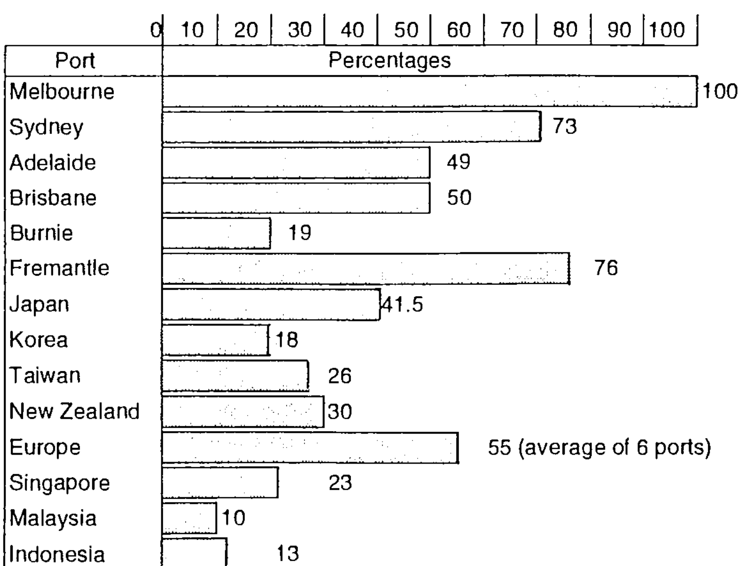

Figure 3 Australian and international port costs

ROAD

The ability of road transport to offer flexible door-to-door delivery services to or from virtually any origin or destination is difficult for rail to match, except where high volumes of cargo are to be carried over relatively long distances. However, increasing road transport links to a central port will entail environmental disadvantages (such as an increase in accidents, air and noise pollution). The latest statistics (ABS 1995) show the number of trucks in Australia to be 389,100 (336,600 rigid and 52,500 articulated).

To obtain an idea of the dimension of costs which road haulage entails, the estimated road damage caused by six-axle articulated trucks to selected ports (ABS 1987) is illustrated in Table 1.

Table 1 Road damage caused by trucks

Port	Silo to export terminal(Km)	No. of trucks per year	Costs (A$ mil.)
Sydney	500	17140	2.6—4.9
Newcastle	500	13317	2.0—3.8
Geelong	330	15306	1.5—2.9
Brisbane	380	13746	1.6—3.0
Fremantle	270	17837	1.4—2.7

It should be noted that the average unit financial cost of main line rail compared to the articulated truck is approximately 230 per cent lower, a factor which is not always taken into consideration. For example, transportation of a 20 foot container from Melbourne's port to Sydney (door-to-door) by rail costs A$720 and by road A$1430.

With the constant increase of tonne/km volumes on the road, Australian authorities are currently faced with the decision to invest more in road construction and servicing in order to avoid an increase in congestion and decay of the system. At present there are around 850,000kms of roads in the country, of which 28 percent are either bitumen or concrete, 25 percent are gravel or crushed stone and the rest are formed or cleared only.

Australian agriculture is a major user of road transport services, directly purchasing almost A$1.5 billion worth of these services annually. Agriculture depends on the efficient supply of road transport services to maintain international competitiveness. On average, for each A$10 agricultural output 73 cents is expended in road haulage. The corresponding figures for mining and manufacturing are 46 cents and 33 cents respectively. For some agricultural activities such as beef cattle, up to 10 percent of total cost of production is comprised of road transport costs.

Due to this dependence on road transport, any increases in road transport costs have a dramatic impact on the viability of primary industry. It is worth noting that in 1990, the Federal Government collected some A$4.7 billion from road users and returned only 25 per cent to roads. It could be agreed that part of the balance is used to subsidise farmers who are directly affected by road costs.

In the multimodal transport chain, it is road transport which has performed the major part of the inland transport tasks in the past decade, accounting for the transport of about 78 per cent of containers which passed through Australian ports. The tendency of transport costs to taper off with increasing distance is, however, more marked for those modes that require heavy investment in terminal facilities. Figure 4 shows the relation of transport costs to distance in Australia (Federal Bureau of Statistics 1987).

The user will choose the carrier with the lowest costs for a particular distance, so that this effective curve of transport costs will be the lower envelope in Figure 4, this being more curved than that of any one mode.

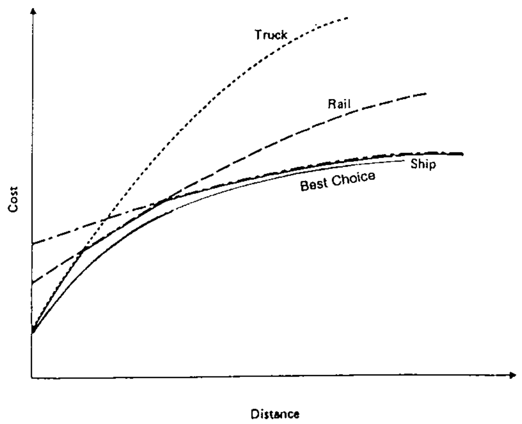

Figure 4 **Transport cost by alternative carriers**

RAIL

Inland multimodal transport is seen as a means to reduce congestion, increase safety, protect the environment and improve distribution by making more effective use of existing rail infrastructure. For rail transport to be efficient, there must be rail connections between the main production and consumption areas in the hinterland of a seaport. Furthermore, hinterland terminals at focal points are essential for multimodal operations, so that containers can be transported by truck to the owners premises or to wherever cargo can be collected or distributed. The lower expenditure per TEU moved for road traffic reflects the use of road as a single mode for shorter itineraries around the port. As distance increases, road transport becomes less attractive in terms of cost and the viability of rail transport increases. For journeys over 200 kms, rail becomes progressively more competitive in terms of price and service. In the following section the role of rail in the Australian freight industry is discussed.

The existing Australian rail system

The Australian rail system uses two different gauges, the standard gauge (1435mm wide) and the broad gauge (1600mm). The standard gauge system currently includes Brisbane, Adelaide, Perth, virtually the whole of New South Wales and different locations in South Australia, Western Australia and the Northern Territory. The Victorian railways track network is currently being converted to standard gauge and only insignificant tracts of broad gauge line remain. The gauge differences between the States have become increasing expensive, as they necessitate stopping, adjusting and moving of wagons. The Federal Government is spending several hundred million dollars on upgrading and standardising the rail to recover these A$300-400mil losses/year. The standardisation of the Melbourne-Adelaide rail link will be completed in 1995. The upgrading costs of this project is A$190 million funded by the Federal Government from the One Nation package (International Cargo Systems 1992).

Completion of the standard gauge will also allow NatRail to run trains from Brisbane to Perth without changing bogies or consolidating loads saving a day in transporting cargo or containers on the above line.

Whereas conventional trains move freight between all six states of Australia, the new system RoadRailer only operates in Tasmania and on the Adelaide-Perth line. Despite widespread use in

Northern American and European countries, RoadRailer in Australia is not yet extensively used for cargo transportation. Rail transport of containers with a conventional train carry the container on 40ft (2x20ft) flat cars (COFC). Only 15-18% of container transportation over short distances is by rail.

At the Port of Melbourne the use of trucks is now essential for the transport of containers between Port and the main state freight terminal depots, for example from Port of Melbourne to South Dynon Rail Freight Terminal (SDRFT). This two kilometre stretch of road, which is merely five minutes transportation time, adds approximately A$60 to the cost of transfering each container between the Port of Melbourne and the rail freight terminal. In 1994 the road between Swanson (Port of Melbourne) and SDRFT was completed at a cost of A$5 million to replace the rail siding between Swanson Dock West and East (the major container terminals in Melbourne with a throughput of approximately 480,000 TEU/year).

Between 1994-2003, the National Rail Corporation (NRC) plans to invest a total of A$1.6b in infrastructure, rolling stock, locos, terminal equipment and control systems. In 1992 alone, Interstate rail freight lost A$324m on revenues of A$468m, of which intermodal accounted around A$300m and industrial products carried the rest (International Cargo Systems 1992): these losses are ultimately funded by the Government and the taxpayer.

Freight rail has taken many measures to improve their services. They had a steady average growth over the last decade.

THE ROADRAILER TECHNOLOGY

RoadRailer (RR) technology has created a worldwide revolution which began in the USA. Today, RR is in use in the U.K., Canada, Mexico, Austria, Denmark, Spain, Germany, France, New Zealand and Australia to provide integration and co-operation of road and rail, with each carrying out the task it is best equipped to handle. RR unleashes some far reaching benefits as follows:

- economy: a single RR can do the work of 70 Prime Movers on road.
- road safety: by reducing heavy road traffic RR improves road safety.
- road system: maintenance by cutting the damage caused by heavy vehicles.
- ride quality: via a smoother ride it reduces vibration, and packing wastes.
- dangerous goods: are reduced on public roads.
- fossil fuels and emission: RR demands less fuel than its road-based equivalent, and releases only a fraction of the exhaust emissions. Freight by road creates 11 grams/CO_2 per net tonne/km compared to 35 grams for rail freight (Australian National 1993).

Australian National Railway Commission (AN) is working in close association with Indiana-based Wabash National, the U.S parent company of the innovative freight haul concept.

The major ranges of RR manufactured in Australia can be categorised as follows:

- Low profile skeleta chassis to suit 1 x 40ft container or 2 x 20ft containers.
- Aluminium fuel tanker with 40,000 litre capacity.
- 34 cubic meters aluminium tipper.
- Dry freight pantechnicon.
- Telescopic platform 19.5m long.
- Dry freight curtain sider.
- Flatbed trailer.

The RR have a speed of 120-140Km/hr, compared to 160Km/hr in USA, which is faster than conventional trains. They also have better wind resistance, yielding 25 percent less fuel consumption (Australian National 1993).

AN's inaugural RoadRailer bi-modal service was launched in September 1992, linking Whyalla and rural Eyre Peninsula with Adelaide via trailer ports at Mile End and Whyalla. An important testing ground for the planned east-west service trails on the Adelaide-Whyalla corridor demonstrated the ease with which RR trailer ports could be established and the relatively low set-up costs involved. Linked to Australian National's broad ranging quality improvement program, service reliability has been at the front of the Adelaide/Whyalla trails, with attention to customer needs ensuring the new technology realises its maximum potential. Other RR connections are:

- A new, dedicated east-west trail RoadRailer service was launched by AN in early September 1992 moving freight between the eastern State and Perth via a high speed rail service between Adelaide and Parkeston, covering nearly 2,000 km. It is the longest trailer port to trailer port RoadRailer journey in the world.
- RoadRailer was officially launched in Tasmania in late June 1993 with an initial focus on log skeletal and wood chip bin operation.
- The TNT car carrying RoadRailer is world first and is by far the most advanced, professional method for distribution of the finished vehicle product.

Barriers to roadrailer implementation

One of the major impediments to use of the RoadRailer on the Melbourne-Sydney corridor is the bridge height clearance which does not accommodate the RoadRailer trailers. To provide 4.30m height clearance, most road levels under the bridges would have to be lowered by between 300-400mm, a difficult task considering the work to be executed on each bridge, with interruption of the present train service.

The rail tracks existing in Australia are based on the British design. The RR in Australia accommodates 70 wagons with a maximum speed of 140km/h. Before the RR can run on Australian rails some civil engineering problems must be taken into account, such as:

- Strengthening of the existing bridges;
- Increase of the height clearance;
- Investigation of the superelevation of railway and transit guideway curves;
- Re-design of the minimum degree of curves to suit the 70 trailer trains;
- Re-design of the equilibrium elevation for various speeds on curves;
- Investigation of the vertical alignment design criteria and
- Re-design of the spiral or transition curves.

The above-mentioned adaptations require significant capital investment. However, it will improve the existing freight transport systems and the costs can be recovered by increasing the traffic volumes in the short term.

PRODUCTIVITY IMPROVEMENT PROPOSALS

Ports have become complex multimodal transfer and processing facilities that must respond quickly and efficiently to change in trade, volume, form and type of commodities traded, modal technology, operating procedures, and more. Changes in international trade over the past few years have necessitated in a highly integrated transportation system, combining the water, rail and track modes of transportation.

As this integrated water and rail container transportation system has grown, the role played by the transfer terminal has become increasingly more important. For the purpose of this paper the terminal refers to that facility or combination of facilities through which the container moves from ship to train. This terminal is the link between the rail and water modes. It is one area in the Australian transport path where significant amounts of time can be saved or wasted.

The recent study carried out by the American National Ports and Waterways concluded that the ports which use rail as a multimodal transport element provide higher operational productivity than the ones that do not (Asaf 1990). Our research on rail facilities in the Australian ports indicates that compared to world standard ports, the rail facilities in Australia are underutilised and the loading/unloading of containers at terminals is outdated.

Under the hook and vessel cycle configuration

The ship to rail configurations, whereby the containers are loaded/unloaded directly from/onto rail-cars by shore gantries, can increase productivity enormously, especially if a continuous looping rail system can be installed. However, there are three major problems that need to be tackled to achieve a desirable configuration:

(1) matching of the stowage plans of vessel and trains;

(2) provision of a looping trackage for RR/conventional trains within the narrow confines of the waterfront area; and

(3) co-handling of rail and non-rail containers in such a terminal.

The only terminal known to practice under hook operation is at Zeebrugee in Belgium.

The combination of most 'rail' scenarios and Vessel Cycle Configuration is of a special interest. If 3/4 of the cargo is railbound and staged directly on railcars located at the container yard, the marine container yard becomes a railyard. The containers are carried by terminal tractors which shuttle between the shore gantry and the railcars for most of the time, and between the gantry and the container yard slots for the rest of the time. Consequently, the ship-to-rail linkage in Vessel Cycle is almost as high as that of the Under the Hook, but it is much simpler and does not require any technological breakthrough. Theoretically, the difference in time between railcar loading in Under the Hook and Vessel Cycle is approximately 3 minutes, which is the cycle time of the terminal tractor. For a more desirable rail trackage, rails should be laid in perpendicular to the apron, to allow convenience switching of large blocks or railcars, whilst they are kept intact, which provides easy access to the railcars for the hostlers. The perpendicular arrangement, which is similar to the one commonly used for rubber tyred gantry or straddle carriers, will also permit handling of both railbound and truckbound containers in the same terminal, yet without interference. In principal, the ship-to-rail transfer can follow two generic intermodal configurations; it can be performed either within the marine terminal, called on-terminal, or outside it, called off-terminal.

Although the ship to rail configurations method is technically simple and the facilities can be used for both conventional and RoadRailer trains, it is not easily accommodated in the every current layout of marine terminals in Australia. However, it is plausible to expect that the fundamental advantages of the system will be recognised in the future. Our analysis indicates that the cost of infrastructure can be justified by a reduction in ships turnaround time and by an increase in terminal capacity and slot utilisation at container terminals. Later, as was the case with RoadRailer technology, they may include changes, first in terminal layout and gradually, in the long term, in the overall planning of the industry.

Most Australian ports agree on the critical importance of an efficient ship-to-rail linkage. In our case, computer simulation would permit an assessment to be made of any alternative designs for the above situations. The layout of ship-to-rail is illustrated in Figure 5.

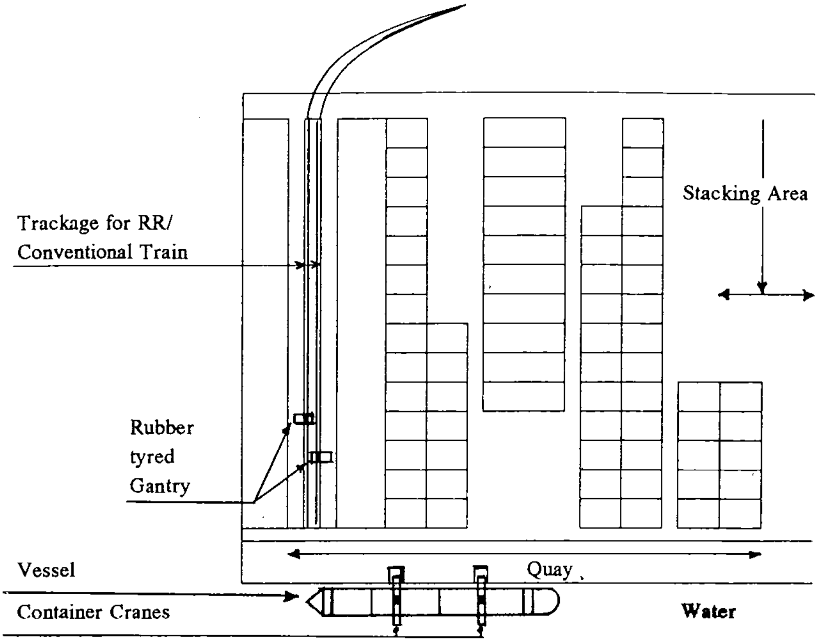

Figure 5 The ship-to-rail layout at container terminal

Ship to rail linkage

In planning/upgrading the multimodal terminal several issues must be dealt with. These include:

- the number of container ships to be served;
- their trade routes;
- the number of railroads providing services to the terminal;
- the combination of rail destinations to be served; and
- type of rail equipment to be used.

Some of the logistic issues which must be taken into account include the actual length and width of the site, its distance and relationship to the shipping lines container yards, the location of the railroads support yard facilities, and the orientation of mainline tracks with respect to the primary service path for the railroad. Another important factor is the mode by which the containers will be transported from the container yard area to the terminal facility.

One of the first considerations in facility layout is the number and length of tracks in the facility. The space available will obviously have a great influence on this item. Where possible, one track should be setup for each primary inland block, to provide flexibility in the variation of the number of containers to each of the destinations. The usable track length should be one half, one third or one fourth of the total train length and should also be equal to the length of tracks in the support yard. Previous planning aimed at making the terminal long enough to place a full train on one track. (Some port authorities/port planners in Australia have not yet adopted these new theories and still hold to the old version of a full train on one track). Most railroads have now significantly increased the maximum length of an intermodal train to the point where a terminal of equal length would have unacceptably long internal operation cycle times.

Process of container transportation by roadrailer

The key to the efficient operation of an intermodal terminal is the timely access to, and processing of, vast amounts of information. Using import movement as an example, the following types of information must be processed by Electronic Data Interchange (EDI) system. Several days prior to the planned date for the train, the shipping line must provide a count of the number of containers to be shipped, their size and their railroad destination. This permits the terminal operator to arrange to have an adequate number of the appropriate types of rail cars available. A day or two prior to the train departure each container to be moved is identified by its number, size, gross weight, and destination. Once its is known that these containers will be released (customs clearance) a train load plan must be developed. Given the known characteristics of each available rail car, the containers are assigned to a specific position on a specific rail car or type of rail car. In the earliest days of double-stack container cars there were only two or three car types, and all the cars in a given train set could be expected to be identical. Today, a wide variety of RR's car types can be found thoroughly intermixed in all areas of the system as described in RR section. Once the load plan has been established and the loading track set up with the proper rail cars, the containers can be transported to destinations by RR-truck combinations.

Efficiency of movement is only possible if each container can be traced according to its collocation upon arrival. Modern computer systems provide the necessary support in this and in many other in many other areas. Finally the total load plan of the train/number of containers together with the estimate of the time availability must relayed to the railroad so that they may assign appropriate amounts of power, arrange for the crew, and plan for passage along railroad property.

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