INTERMODAL TRANSSHIPMENT TECHNOLOGIES – AN OVERVIEW

JOHAN WOXENIUS

DETACHED APPENDIX TO THE DISSERTATION:
DEVELOPMENT OF SMALL-SCALE INTERMODAL FREIGHT TRANSPORTATION IN A SYSTEMS CONTEXT
PREFACE

This detached appendix to my dissertation Development of small-scale intermodal freight transportation in a systems context is mainly a worked up extract from an inventory study commissioned by the International Road Transport Union (IRU) and published in 1998. The inventory was basically intended to survey and describe small-scale intermodal transfer technologies relevant to the future European intermodal transport system. The appendix can be read independently, but for a proper understanding of the environment of the different technologies, it ought to be read together with the dissertation.

The appendix is a rather straightforward description of a large number of past and present development efforts in the field of intermodal transport. Technologies for road-rail transshipment are prioritised, but also some technologies for the combinations road-sea and road-air are described, however only briefly. The scope of this appendix is slightly wider than that of the IRU inventory that focused strictly on the small-scale systems. For instance, bimodal systems, RoRo-loading techniques and bulk container systems are described more in detail here. Finally, some minor updates distinguish this appendix from the IRU-report. Geographically, Europe is covered in most detail but examples from Australia, New Zealand, Japan, South Africa and the USA are included in the survey.

I would like to express my deepest thanks to the IRU – especially to Mr. Pieter G. Wildschut – and the company representatives contributing valuable information as well as their time to the study. My gratitude also extends to Per Olof Arnäs for scanning and editing the numerous pictures as well as for general editing. Finally, I want to thank Darren Yates who has corrected the text for linguistic errors. Those errors remaining are caused by late changes from my keyboard.

Göteborg March 1998

Johan Woxenius
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<td>Abroll Container Transport System</td>
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<tr>
<td>AGV</td>
<td>Automated Guided Vehicle</td>
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<td>BR</td>
<td>British Rail</td>
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<tr>
<td>CCT</td>
<td>CarConTrain</td>
</tr>
<tr>
<td>DB AG</td>
<td>Deutsche Bahn AG – German State Railways</td>
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<tr>
<td>DSB</td>
<td>Danske Statsbaner – Danish State Railways</td>
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<td>DUSS</td>
<td>Deutsche Umschlaggesellschaft Schiene-Strasse mbH – German terminal operator</td>
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<tr>
<td>EU</td>
<td>The European Union (as a political or geographical unit)</td>
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<td>IRU</td>
<td>International Road Transport Union</td>
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<td>ISO</td>
<td>International Standardization Organisation</td>
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<td>ITU</td>
<td>Intermodal Transport Unit (ISO and domestic containers, swap bodies and semi-trailers)</td>
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<td>JNR</td>
<td>Japan National Railways</td>
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<td>JR Freight</td>
<td>Japan Freight Railway Company</td>
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<td>NS</td>
<td>N.V. Nederlandse Spoorwegen – National Railways of the Netherlands</td>
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<td>NSB</td>
<td>Norges Statsbaner – Norwegian State Railways</td>
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<td>ÖBB</td>
<td>Österreichische Bundesbahnen – Austrian State Railways</td>
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<tr>
<td>PACT</td>
<td>Pilot Actions for Combined Transport (EU Commission programme)</td>
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<td>RSS</td>
<td>Roland System Schiene-Strasse</td>
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<tr>
<td>RTD</td>
<td>Research, Technological development and Demonstration</td>
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<tr>
<td>SBB</td>
<td>Schweizerische Bundesbahnen – Swiss State Railways</td>
</tr>
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<td>SJ</td>
<td>Statens Järnvägar – Swedish State Railways</td>
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<td>SNCF</td>
<td>Société Nationale des Chemins de fer Français – French State Railways</td>
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<td>TEU</td>
<td>Twenty foot Equivalent Unit (measurement for container transport)</td>
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<td>UIC</td>
<td>The International Union of Railways</td>
</tr>
<tr>
<td>UIRR</td>
<td>Union Internationale des sociétés de transport combiné Rail-Route – international union of intermodal operators</td>
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<td>VR</td>
<td>Valtion Rautatiet – Finnish State Railways</td>
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1 INTRODUCTION

This inventory is especially aimed at describing simple transshipment technologies that:

- do not interfere with the overhead contact line of electrically powered trains
- are able to cope with various standards of freight containers and swap bodies

However, the scope of the survey is wide, describing technologies that are not specifically aimed at satisfying the points above, e.g. large-scale transshipment technologies and technologies for transshipping semi-trailers. This is intended to give an overview of current and future technologies in the overall intermodal system. Technologies for road-rail transshipment are mainly searched for, but also some technologies for the combinations road-sea and road-air are briefly investigated.

The scope of this appendix is slightly wider than that of the IRU inventory. For instance, bimodal systems, RoRo-loading and other technologies for semi-trailers as well as bulk container systems are described more in detail here.

The main criterion for choosing technologies to be presented is that they comprise the transshipment function. Many of the described technologies also cover other functions needed in the intermodal transport chain while others, however, are not particularly aimed for solving the transshipment problems. The reason for presenting the latter technologies, that obviously are not applicable as general intermodal systems, is that they comprise interesting technical solutions directly affecting the use of transshipment technology. Hence, in order to give inspiration for the design and implementation of future intermodal systems, the search has not been narrowly focused onto transshipment technologies.

Geographically, Europe is covered in most detail but examples from Australia, New Zealand, Japan, South Africa and the USA are included in the survey.

1.1 METHODOLOGY

This is basically a desk study compilation of information collected during six years of research in the field. Nevertheless, new technologies have been searched for in reports from conferences and exhibitions, in trade journals, in academic and practical reports as well as through personal contacts. The Internet was also used as a source of the most current information.

Beside the secondary data sources mentioned above, telephone and personal interviews were carried out and more than 110 fax inquiries were sent to the main suppliers and manufacturers for updating purposes. In total, some 120 published references, 100 brochures and similar pieces of marketing materials, 15 interviews, 6 marketing video tapes, 5 world wide web sites and 25 letter, faxes and E-mail messages were compiled in the writing process. Finally, some 30 faxes and E-mail messages were sent to manufacturers for fact proofing.

A major goal during the work was to make the report clear and easy to read. For instance, length measures are given as metres and centimetres rather than in millimetres as used in classical engineering. Following the practice in the dissertation, and contrary to the IRU-report, family names are written in CAPITAL LETTERS. Internationally, this habit is becoming common in order to help people to distinguish between given and family names when different nationalities meet. A more pragmatic rea-
son for applying the fashion is that many readers will inevitably search for their own names to see that they are correctly cited or at least mentioned.

1.2 TERMINOLOGY

There is a slight confusion about terminology when systems combining different transport modes are concerned. In this appendix, a transport satisfying the demands below is defined as an intermodal transport:

- The goods shall be transported in unbroken ITUs from sending point to receiving point
- ISO-containers, swap bodies, semi-trailers and specially designed freight containers of corresponding size are regarded as ITUs
- The ITUs must change between transportation modes at least once between sending point and receiving point

Intermodal transport is here used for any combination of modes, but if nothing else is stated it is meant the road-rail combination that contains a pick up service with a short road haulage at the place of dispatch, transshipment to a rail wagon, long distance rail haulage, another transshipment and a delivery road haulage. Combined transport is used somewhat interchangeably but only for the road-rail combination.

The term multimodal transport is used here to denote a transportation system for unit loads taking into account the special requirements of sea, road and rail transport, i.e. more than two modes. Bimodal systems here denotes various technical systems where semi-trailers are main components in road as well as rail operations, best illustrated by the hybrid RoadRailer equipment – a semi-trailer with both rubber and steel wheels. Thus it should not be used for any combination of two modes of transport.

Unit loads and Intermodal Transport Units (ITUs), are used interchangeably, and are here defined as all load units designed to cover the goods and facilitate easy transshipment between transportation modes. From the transport operators’ point of view there is no great difference between the transport of a loaded box and the repositioning of an empty one, and it is thus not crucial to the definition if the term denotes the device or the device with its content. In this appendix it should be possible for the reader to judge what is meant in each single case. The most common ITUs are ISO-containers, swap bodies and semi-trailers but also smaller specially designed freight containers like German State Railways’ (DB AG) Logistikbox are included in the definition. However, the load unit must conform to size and construction strength standards and be equipped with devices allowing transfer between transportation modes with standardised transshipment equipment. In this report, Euro-pallets¹ are not regarded as ITUs.

Overhead contact line denotes the catenary or electric wires used for supplying electricity to the rail engines.

Transshipment and transfer are here regarded as synonymous terms describing the activity of shifting goods between vehicles or transportation modes. The term gateway denotes a terminal used for rail-

¹ The Euro-pallet is a standardised, normally wooden, pallet with the dimensions 800 x 1200 mm.
rail transshipment in order to connect two network modules without mixing the rail wagons used in each of the two modules. *Horizontal transfer* means that only a very small vertical lift is needed, e.g. to lift a container above the container lock pivots or a swap body in order to make the support-legs possible to fold. The possibility to transship ITUs under the overhead contact line could obviously be the base for an alternative definition, but the degree of vertical lift is used for classifying technologies in the dissertation as well as in this detached appendix.

**1.3 COSTS, CURRENCIES AND DIMENSIONS**

Costs of technologies and investment schemes are very dependent on manufacturing series and thus often hard to calculate. Consequently, costs are only given if directly stated by manufacturers or other reliable sources. Throughout the report, costs in different currencies are also given in ECU$s$ – calculated with an exchange rate from 4 April 1997 – with appropriate rounding off.

For weights, kg and tons are used, the latter meaning a metric ton = 1000 kg. For lengths m and cm are used rather than the mm usually used in engineering.

**1.4 PRINCIPLES OF CLASSIFICATION AND EVALUATION**

In order to make the presentation clear, the technologies must be classified. The first classification base is the transport modes covered. The focus is on road-rail transshipment technologies but examples of road-sea and road-air technologies are also given.

Road-rail technologies are classified according to the smallest scale the technologies can be implemented in. Large-scale technologies are normally dedicated terminal equipment for large flows while small-scale technologies are not necessarily dedicated to the transshipment function. Their target market – small-scale flows – might not be able to carry the costs of dedicated terminal equipment on many small terminals which often calls for transshipment equipment being an integral part of employed vehicles, vessels or even unit loads. Nevertheless, too much attention should not be placed upon the classifications; it should merely be seen as a way of structuring the text.

Following the purpose of the dissertation, the focus is on the small-scale technologies. Some groups of small-scale technologies have earned their own headers; i.e. lorry-to-ground and turntable systems, self-loading trailers and rail wagons, rail wagons for lifting swap bodies or cassettes, small and special container systems, bimodal systems and, finally, rail wagons for RoRo-transshipment of semi-trailers and lorries. These sections are started with an extensive description of the original or most well-known technology, followed by specific features for each of the other brand names. The classification follows the scheme shown in the figure below.
The technologies are briefly evaluated in terms of advantages and disadvantages according to in which system environment they are supposed to function. It is mainly divergences, positive as well as negative, from the following list of requirements:

- is open for rail, road and preferably also sea transportation, within the whole of Western Europe
- is compatible with conventional large-scale intermodal transport
- at least accommodates 20-foot and 40-foot ISO-containers as well as swap bodies up to 7.82 m long
- avoids the loading of entire vehicles of different transportation modes upon each other
- is compatible with the currently dominating types of vehicles and vessels
- facilitates low cost terminals – both in terms of investments and operations – for sufficiently dense terminal networks in small-flow areas
- utilises a simple transshipment technology that facilitates quick, flexible, reliable and safe ITU transshipment under the overhead contact line
- avoids the need for co-ordination of vehicles at terminals
- is possible to implement gradually – both technically and commercially

Groups of similar technologies are evaluated as a group, but special features of the different brand names are commented upon. However, only intermodal road-rail technologies are evaluated, the neighbouring technologies are described as orientation.

The reference materials used for compiling the facts in this appendix are generally specified as footnotes. The descriptions are generally written in the present tense although some technologies are no longer marketed. However, the aim of the study is to highlight the different principles for transshipment technologies and even if a technology or brand name is not marketed anymore, the technical content can be revived or used by other manufacturers.
2 SMALL-SCALE ROAD-RAIL TECHNOLOGIES

Due to the fact that national and regional conditions differ widely within and between continents, a general and global intermodal transport system will most probably never be implemented. The ISO-containers are globally spread, but the ways of transporting them differ between regions. When it comes to Europe, the central regions are believed to favour highly automated terminals, which costs are divided between a very large number of transshipments while the remote regions must seek for efficient systems that do not require large investments at each terminal. The small-scale technologies may also enable new actors to enter the intermodal industry without excessive initial investments.

2.1 VERTICAL TRANSSHIPMENT

Vertical transshipment technologies resemble the principles of conventional transshipment technologies; i.e. gantry cranes and counter-balanced trucks, as they grip the ITUs from above and the transshipment equipment carries the full weight. In this section, technologies that do this in a new or a promising manner are described. Most of these development projects are not run by the supply side; i.e. the inventors and manufacturers of intermodal technologies, but rather by the demand side; i.e. the intermodal rail operators. Hence, the whole system is focused upon rather than technologies aimed for defined parts of the transport chain.

2.1.1 JR Freight: Multi-functional freight track system

In Japan, Japan National Railways (JNR) introduced a domestic intermodal transport system based on forklift trucks some 25 years ago. JNR was reformed in 1987 and now Japan Freight Railway Company (JR Freight) operates the system. In all, JR Freight’s intermodal system includes 160 terminals and about 2/3 of the trains are direct full trains. The transport volumes increased by 8 million tons between 1986 and 1991, but have not increased since then. In 1995, 20.5 million tons were transported by intermodal transport in Japan. The container trains follow three basic production types:

- Direct inter-city high speed trains
- Inter-city express trains between terminals at major cities and 2-3 strategic hubs
- Short-line feeder services connecting smaller cities with the main lines

In addition, a new operating principle with the purpose to avoid all shunting operations was recently introduced at 16 stations. The new operation is based upon short stops at terminals on side-tracks along corridors connecting most Japanese cities. Fortuitous arriving and departing container can be transshipped – at most terminals under the overhead contact line – in an average time of 40 seconds. The total time for a stop at a terminal is 20-30 minutes. A transshipment using a forklift truck is shown in the figure below.

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2 BABA, E-mail dated 3 February 1996.
3 WEDE, fax dated 19 February 1997.
4 MASUDA, fax dated 14 February 1996.
5 WEDE, fax dated 19 February 1997.
The purpose-built containers are fastened to rail wagons through a central locking device. Some containers are equipped with ISO corner fittings but only in the bottom corners for fastening purposes. Reportedly\(^6\), these containers were adapted for use even in Korea. Besides the clearly dominating 10-foot and 12-foot containers, occasional 20-foot ISO-containers are transported. The dedicated containers are of slightly varying sizes and shapes, but most 12-foot containers have the measures (length x width x height) 3.72 x 2.44 x 2.50 m giving an inner volume of approximately 20 m\(^3\) with a maximum gross weight of 5 tons\(^7\). The 4-axle rail wagons carry four to five containers and pick-up and distribution lorries carry one or two containers and an additional one on a trailer as seen in Figure 2-2.

Most containers are owned and operated door-to-door by JR Freight, but also large forwarders such as Nippon Express own containers and buy transshipment and rail line-haul from JR Freight. Nippon Express is connected directly via an EDI link to JR Freight’s FRENS information system controlling the operations.

The resources currently used in Japanese intermodal transport include\(^8\):

- 8 300 container rail wagons
- 17 reach-stackers
- 466 fork lift trucks
- 82 000 containers owned by JR Freight, 10-12 foot

\(^6\) JR Freight, interview at study visit, 21 October 1996.
\(^7\) JR Freight, 1996.
\(^8\) WEDE, fax dated 19 February 1997.
• 13 500 privately owned containers, 10-12 foot

Further developments are planned and discussions are held with SJ that develops a similar system as is described below.

![Figure 2-2](image)

**Figure 2-2** Distribution lorry in the Multi-functional freight track system at the Umekoij terminal in Kyoto. *(Source: own photography taken at a study visit 21 October 1996).*

**Table 2.1** Short summary evaluation: JR Freight’s Multi-functional freight track system.

<table>
<thead>
<tr>
<th>Aimed for fast transshipment along a transport corridor.</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Direct as well as indirect road-rail transfer possible</td>
<td></td>
</tr>
<tr>
<td>- Facilitates flexible use of terminal equipment</td>
<td></td>
</tr>
<tr>
<td>- Fast transshipment when the train arrives</td>
<td></td>
</tr>
<tr>
<td>- Low demands on the terminal surface</td>
<td></td>
</tr>
<tr>
<td>- Potential for good utilisation of rail wagons</td>
<td></td>
</tr>
<tr>
<td>- Simple and cheap terminals</td>
<td></td>
</tr>
<tr>
<td>- Suitable for corridor terminals</td>
<td></td>
</tr>
<tr>
<td>- Transshipment under the overhead contact line</td>
<td></td>
</tr>
<tr>
<td>- Use of conventional and well proven technology</td>
<td></td>
</tr>
<tr>
<td>- Does not accommodate standard rail wagons</td>
<td></td>
</tr>
<tr>
<td>- Does not accommodate standard ITUs</td>
<td></td>
</tr>
<tr>
<td>- Not compatible with large-scale intermodal transport</td>
<td></td>
</tr>
</tbody>
</table>

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### 2.1.2 NS Cargo: Rail Distributie Nederland

The National Railways of the Netherlands (NS) plans to introduce an intermodal door-to-door service named Rail Distributie Nederland (Rail Distribution in the Netherlands)\(^9\). The aim is to compete with pure road transport in the market for high value and time sensitive cargo\(^10\). Forklift trucks or dedicated horizontal transshipment technology will be used for loading three 10-foot “all steel” containers on each wagon. Unloading and loading a train will take some 15-30 minutes\(^11\).

Three kinds of terminals are planned. *Source terminals* are central transshipment locations for suppliers in regional areas. It concerns large volumes from groups of consignors, which are sent to a limited

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\(^9\) TER POORTEN, letter dated 28 February 1996.

\(^10\) O’MAHONY, 1995/b, p. 33.

\(^11\) NS Cargo, brochure 1996.
number of addresses, e.g. goods flows between freight villages. Rail/Rail terminals are designed for transshipment between trains, i.e. a railway hub function. These terminals will employ an advanced transshipment technology. The City terminals, finally, are specially designed for fine-meshed distribution in urban areas and lie a little farther ahead in the future. The vision is that the current passenger railway stations can be used for transshipment and that electric vehicles can be used in the cities\textsuperscript{12}.

NS Cargo want to realise 10 to 30 brand new terminals in a partnership with the company Groenewout, which is experienced in developing and managing distribution centres and warehouses. An advanced tracking and tracing system is intended to support the transport system.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure2-3}
\caption{Simulation plot of a terminal for trains with six wagons. (Source: NS Cargo, brochure 1996).}
\end{figure}

The network will be operated at high frequencies and with high priority on the lines. NS has stated that the network will facilitate national coverage within 4 hours, which, however, seems a little optimistic. Initially, the plans are to run a pilot service connecting Amsterdam and Amsfort, Zwolle and Groeningen and another connecting Utrecht and Eindhoven. In a later stage, NS plans to connect Schiphol (air transport connection), Amsterdam, Utrecht (groupage and rail connection eastwards), Rotterdam and The Hague with an urban ring network.

\textsuperscript{12} NS Cargo, brochure 1996.
Table 2.2  Short summary evaluation: NS Cargo’s Rail Distributie Nederland.

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aimed for fast transshipment of small containers along a transport corridor.</td>
<td></td>
</tr>
<tr>
<td>- Facilitates flexible use of terminal equipment</td>
<td>- Does not accommodate standard rail wagons</td>
</tr>
<tr>
<td>- Facilitates integration with passenger trains</td>
<td>- Does not accommodate standard ITUs</td>
</tr>
<tr>
<td>- Fast transshipment when the train arrives</td>
<td>- Not compatible with large-scale intermodal transport</td>
</tr>
<tr>
<td>- Low demands on the terminal surface</td>
<td></td>
</tr>
<tr>
<td>- Low noise emissions (if covered)</td>
<td></td>
</tr>
<tr>
<td>- Potential for good utilisation of rail wagons</td>
<td></td>
</tr>
<tr>
<td>- Simple and cheap terminals</td>
<td></td>
</tr>
<tr>
<td>- Suitable for corridor terminals</td>
<td></td>
</tr>
<tr>
<td>- Transshipment under the overhead contact line</td>
<td></td>
</tr>
<tr>
<td>- Use of conventional and well proven technology</td>
<td></td>
</tr>
</tbody>
</table>

2.1.3 SJ: Light-combi

Sweden with its small and dispersed goods flows is a natural breeding place for small-scale intermodal concepts. Swedish State Railways’ (SJ) has taken various initiatives for establishing a viable intermodal system in competition with the large lorries allowed in Sweden. Only the most recent one, the Light-combi project, is described in depth and evaluated, but also two of its predecessors are briefly described. A common feature of the three projects is that a comprehensive systems approach was used for analysing the whole transport system rather than only the transshipment function.

Plans for how intermodal transport can be better adapted to Swedish needs for small-scale flows were released in 1994. The vision covers development steps until the year 2010. A fine-meshed network of simple and flexible terminals served by forklift trucks is suggested as a complement to the few larger conventional terminals employing gantry cranes and reach-stackers. Fixed integral trains of up to 40 short-coupled units with 41 pairs of axles are parts of the concept\(^{13}\). The figure below shows a small-scale corridor terminal and a part of an integral train.

\(^{13}\) NELLDAL, 1994, p. 28.
Semi-trailers are not intended to be transshipped at the small-scale terminals and 40-foot containers and the longer series of swap bodies cannot be transferred with the forklift trucks due to instability.

Another development project within SJ, Quality Cargo, suggests a Swedish domestic distribution module of 10.2 m with a swap body design. Two such units are suitable for one Swedish 24 m lorry and roll-on frames and lift-dumpers are suggested as complements\textsuperscript{14}. Nevertheless, the permissible lorry dimensions will be increased to 25.25 m in Sweden, meaning that the new distribution module will be less viable.

The visionary plans where converted into a formal project in 1995 under the working name Light-combi. The plans include a division between a network for large flows using direct trains between a limited number of medium-scale terminals, with working name “heavy-combi”, and a complementing network of small-scale terminals, called “light-combi”. Heavy combi is the conventional network using gantry cranes and reach stackers for transshipment of all ISO-containers, swap bodies and semi-trailers while light-combi is not open for semi-trailers and may be limited to 20-foot ISO-containers and swap bodies of up to 8 meters in length.

\textsuperscript{14} LEANDER, unpublished working document, 1992, p. 6.
The Light-combi project investigates different technical solutions for direct or indirect transfer between lorries and rail wagons. Leading principles are:\(^\text{15}\):

- fixed train sets
- no shunting
- short stops (15-30 minutes) at small, simple and unmanned terminals
- loading and unloading with horizontal transshipment under the overhead contact line
- close co-operation with road hauliers

Nevertheless, the advocated solution with forklift trucks might be classified as a vertical technology, but the lift height is technically limited in order not to reach the contact line. The handling equipment can be transported by the train or positioned at the unmanned terminals. An important part of the strategy is to keep to standardised resources including ITUs, lorries as well as rail wagons\(^\text{16}\). However, smaller and cheaper rail engines are considered.

The trains are intended to travel at 120 km/h although wagon designs capable of up to 160 km/h are being examined. With the faster trains, average speeds in the region of 85-90 km/h are foreseen by SJ\(^\text{17}\).

SJ intends to apply semi-flexible timetables. The reason is that the system should be used for establishing the larger flows needed for economically viable direct trains. SJ realises that such flows cannot be forced into a fine-meshed network – potential competitors will find them and compete with cheaper full trains. If Light-combi is to be realised, a network of 30-40 small-scale terminals will be linked to the heavy combi network and international lines through gateway terminals\(^\text{18}\). The terminals will be connected by about ten rail corridor lines with an average length of 600 km, each connecting between five and ten small terminals\(^\text{19}\). Consequently, this will be a restoration of the Swedish intermodal transport network that has decreased from 45 to 16 terminals over the last 15 years. An artist’s impression of a future Light-combi terminal is shown in the figure below.


\(^{16}\) DAHLLÖF, 1996, p. 29.

\(^{17}\) YOUNG, 1997, p. 111.

\(^{18}\) LARSSON, 1996, p. 3.

\(^{19}\) YOUNG, 1997, p. 111.
A commercial pilot test involving transport of foodstuffs for the wholesale/retail chain DAGAB/Hemköp commence in 1998\textsuperscript{20}. The goal is to start full scale commercial traffic in 2003\textsuperscript{21}. Nevertheless, the project is still run by SJ’s Staff Strategic Development and not by the Freight Division which means that SJ still has not decided to go operational. A fully implemented system with trains and 20 to 25 terminals is expected to cost some SEK 500 million (ECU 57 million)\textsuperscript{22}. The picture below shows how the forklift truck is manoeuvred onto the train.

\textsuperscript{20} SJ, brochure, 1997, p. 17 and 21
\textsuperscript{21} DAHLLÖF, 1996, p. 29.
\textsuperscript{22} YOUNG, 1997, p. 111.
SJ personnel have discussed with JR Freight concerning knowledge dissemination between the companies in the field of intermodal transport\textsuperscript{23}. Also the Italian intermodal company CEMAT and the IRU are involved in a dialogue regarding the project\textsuperscript{24}.

Table 2.3  \textit{Short summary evaluation: SJ's Light-combi.}

<table>
<thead>
<tr>
<th>Aimed for fast transshipment of containers and swap bodies along a transport corridor.</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Advantages</strong></td>
<td><strong>Disadvantages</strong></td>
</tr>
<tr>
<td>- Easy use at private rail sidings or at forwarders’ general cargo terminals</td>
<td>- Does not (yet) accommodate 40-foot ISO-containers</td>
</tr>
<tr>
<td>- Facilitates integration with passenger trains</td>
<td>- Demands ITUs with forklift tunnels</td>
</tr>
<tr>
<td>- Facilitates relatively flexible use of terminal equipment</td>
<td></td>
</tr>
<tr>
<td>- Fast transshipment when the train arrives</td>
<td></td>
</tr>
<tr>
<td>- Low demands on the terminal surface</td>
<td></td>
</tr>
<tr>
<td>- No need for external transshipment equipment or terminal personnel – the engine driver transships the units alone</td>
<td></td>
</tr>
<tr>
<td>- Potential for good utilisation of rail wagons</td>
<td></td>
</tr>
<tr>
<td>- Simple and cheap terminals</td>
<td></td>
</tr>
<tr>
<td>- Suitable for corridor terminals</td>
<td></td>
</tr>
<tr>
<td>- The transshipment equipment can follow the train</td>
<td></td>
</tr>
<tr>
<td>- Transshipment under the overhead contact line</td>
<td></td>
</tr>
<tr>
<td>- Use of conventional and well proven technology</td>
<td></td>
</tr>
</tbody>
</table>

### 2.2 HORIZONTAL TRANSSHIPMENT

Horizontal transshipment means that only a very small vertical lift is needed, e.g. to lift a container above the container locks or a swap body in order to make the support legs possible to fold. For many of the systems, the transshipment equipment is not dimensioned to carry the full weight of the ITUs since only a small force is needed to transship them horizontally over rollers on the vehicles. Besides

\textsuperscript{23} LARSSON, conference presentation, 1996.

\textsuperscript{24} YOUNG, 1997, p. 111.
the possibility of slimmer dimensioning, the big advantage of horizontal transshipment is to transship under the existing overhead contact line. This possibility could obviously be the base for an alternative definition. Nevertheless, the degree of vertical lift is used for classifying technologies in this report.

The ideas of horizontal transshipment are not new – milk containers were transshipped between flat wagons and lorries in the UK already in the 1930’s. 25

2.2.1 Proveho: CarConTrain

The first generation of CarConTrain (CCT), is a small-scale transshipment concept only requiring a driving lane for lorries parallel to the railway track. Standard containers and swap bodies are transferred horizontally, below the existing overhead contact line, after connecting the lorry and the rail wagon with sliding beams. The container is lifted by use of bellows and the sliding surface of the beam is made of Teflon for low friction.

There is no firm restriction on the length of boxes to be transshipped. Both railway wagons and lorries are specially designed and the direct transfer means that they have to be co-ordinated at the terminal area. In a final version for series production, the transshipment equipment will add some 1500 kg to the weight of the lorry.

CCT was developed by the Swedish company Proveho together with Volvo who developed individually controlled air suspensions for the lorries. They have a piston stroke of 27 cm and the air cushioning of the transshipment equipment adds 20 cm to the height of the lorry bed. The actual transshipment is carried out by use of a screw jack. The frame on the wagons makes it 20 cm higher, which in certain European countries might impede the use of high ITUs when the frame is mounted on standard flat wagons.

A second version, the CCT PLUS, was presented in 1995. In the new concept, the handling equipment is mounted on a dedicated transfer vehicle that operates on a track between the rail wagons and a set of storage racks that provide storage space for ITUs. The transfer vehicle could also be rubber tyre mounted. With CCT PLUS, lorries able to exchange containers and swap bodies with the storage racks can be used without need for co-ordinating them with the train. Alternatively, the CCT PLUS transfer vehicle can be used for transshipping containers and swap bodies between lorries and the storage racks.

The wagons, lorries and storage racks used in the CCT PLUS version are equipped with hydraulically elevating twistlocks for lifting and securing the container or swap body. The elevation function allows for much simpler design of the transfer vehicle. Alternatively, it could be used together with counter-balanced trucks mounted with wide forks for distributing the weight of the ITU. The elevating twistlocks on lorries adds value as they can be used for transshipping ISO-containers to simple racks at premises lacking transshipment equipment. Also swap bodies can be transshipped to the ground without demanding lorries with scissors tables or air suspension.

25 Railway Age, 1938 and 1939.
The transshipment cycle starts when the transfer vehicle extends telescopic beams to the middle of the rail wagon, the lorry or the storage rack. The vehicles do not need to be connected directly. A sled with bellows for lifting ITUs runs on the beams that can be extended on either side of the transfer vehicle. The principles of CCT and CCT PLUS are shown in the figure below.

![CarConTrain and CarConTrain PLUS](image)

**Figure 2-8** Proveho’s CarConTrain and CarConTrain PLUS.

All ISO-containers and swap bodies except some tank containers can be lifted, but two transfer vehicles are needed for lifting 40-foot and longer containers. A prototype has proven to be capable of lifting up to 34 tons using two beams\(^{27}\).

Transfer times are short – 3-5 minutes for CCT\(^{28}\) and one minute (+ positioning of the transfer vehicle) for CCT PLUS\(^{29}\). For small flows, this technology is very promising due to the small initial investment and the modular design allowing for gradual increase of the capacity through purchase of more transshipment units. A fully developed terminal with one transfer unit per ITU position of the train is claimed to be able to unload and load a full train in just 5 minutes\(^{30}\). With simple computer support, a CCT PLUS terminal can be easily automated. An example of the design of a medium-scale terminal is shown below.

![Mid-size and large size layouts of CCT terminals](image)

**Figure 2-9** Mid-size and large size layouts of CCT terminals. (Source: Lövgren, file transmission, 1997).

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\(^{27}\) SUNDSTRÖM, fax dated 26 June 1997.

\(^{28}\) DENELL, 1979.

\(^{29}\) SUNDSTRÖM, fax dated 26 June 1997.

\(^{30}\) CarConTrain AB, product brochure, 1997, p. 6.
For flexibility, elevating twistlocks are needed for each ITU position or the twistlocks have to be movable along the wagon. A power supply unit may be mounted on the wagon, or power can be supplied from the rail engine, from the transfer vehicle or externally at the terminal spot. The technology is believed to be suitable for trains like DB Cargo’s CargoSprinter\textsuperscript{31}. An artist’s impression of a future terminal site is seen below.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{future_terminal.png}
\caption{Image of a future terminal employing CCT AB’s CCT PLUS. (Source: SJ).}
\end{figure}

The inventor of CCT, Mr. S. Lövgren, first got the idea in 1979\textsuperscript{32}. The idea of the CCT was developed to a working prototype, which has been tested by NSB and BR. The CCT PLUS was developed into a prototype in 1996. The work on the CCT PLUS proceeds within a product specific development company under the name CarConTrain AB. The later steps in the development of the concept is carried out in co-operation with SJ\textsuperscript{33}.

\begin{flushright}
\textsuperscript{32} BRANKE, 1985, p. 60.
\textsuperscript{33} SUNDSTRÖM, fax dated 26 June 1997.
\end{flushright}
Table 2.4 Short summary evaluation: Proveho’s CarConTrain PLUS.

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Facilitates fast transshipment along a corridor</td>
<td>- Does not accommodate standard rail wagons</td>
</tr>
<tr>
<td>- Facilitates integration with passenger trains</td>
<td>- Requires dedicated and relatively expensive equipment on rail wagons, storage racks and lorries</td>
</tr>
<tr>
<td>- Facilitates relatively flexible use of terminal equipment (moving transfer vehicles between terminals and modular extension possible)</td>
<td>- Several units needed for fast transshipment</td>
</tr>
<tr>
<td>- Fast transshipment when the train arrives</td>
<td></td>
</tr>
<tr>
<td>- Full automatisation of terminal possible</td>
<td></td>
</tr>
<tr>
<td>- Low demands on the terminal surface</td>
<td></td>
</tr>
<tr>
<td>- Modular increase of capacity possible</td>
<td></td>
</tr>
<tr>
<td>- Simple and cheap terminals</td>
<td></td>
</tr>
<tr>
<td>- The elevating twistlocks on lorries adds value</td>
<td></td>
</tr>
<tr>
<td>- Transshipment under the overhead contact line</td>
<td></td>
</tr>
</tbody>
</table>

2.2.2 Steadman Industries: Railtainer/Steadman System

The Railtainer works in a manner similar to the CCT Basic, but the equipment is mounted on a semi-trailer chassis making it available as pure terminal equipment as well as road vehicle. Another difference is that the height is controlled by support legs rather than the air suspension of the lorry. As with CCT, only a limited flat surface along the tracks is needed as terminal.

A transshipment operation is started when the lorry pulls alongside the wagon and adjusts its height to the same as the wagon by use of the individually controlled support legs. Arms extend from the lorry and position themselves underneath the container’s adjacent corner castings. Hooks located at intervals inside the arm are elevated and then lifted into position inside the corner castings. The assembly is then retracted back across to the lorry dragging the container with it. The driving system is hydraulic. The hooks then disengage and the arm extends beneath the container again until another hook is positioned under the corner casting and the previous sequence is repeated. When the container is moved fully across onto the lorry, it is locked into position. The transfer time is said to be 5-6 minutes.

The system uses standard skeleton rail wagons (i.e. two beams sitting on bogies) or flat wagons with a frame lifting the container allowing access under the corner fittings. With this configuration, 8 foot 6 inch high containers cannot be transshipped under the overhead contact line in some European countries, e.g. in the UK. However, in a submerged position they can be moved along the track network. The semi-trailers are dedicated, as is the case with CCT Basic. An equipped semi-trailer is said to weigh six tons\(^\text{34}\). Up to 40-foot long ISO-containers can be handled by the system.

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\(^{34}\) JÖNSSON AND KROON, 1990, in Appendix.
The Railtainer saw some acceptance in Canada by the railway company Canadian National and in the United States by Railway Express Agency. The small-scale operations at the terminals implied that the units were to be loaded by the driver of the shipper. As this was in the pre-deregulation days, the authorities and the unions together stopped the procedure.

Table 2.5 Short summary evaluation: The Steadman Industries’ Railtainer/Steadman System.

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easy use at private rail sidings or at forwarders’ general cargo terminals</td>
<td>Does not accommodate standard rail wagons</td>
</tr>
<tr>
<td>Facilitates relatively flexible use of terminal equipment</td>
<td>Limited loading height on flat wagons with frames</td>
</tr>
<tr>
<td>Fast transshipment when the train arrives</td>
<td>Need for synchronisation of road and rail vehicles at terminals</td>
</tr>
<tr>
<td>Low demands on the terminal surface</td>
<td>Relatively low net to tare weight relationship on road</td>
</tr>
<tr>
<td>No need for external transshipment equipment or terminal personnel – the lorry driver transships the units alone</td>
<td>Requires dedicated and relatively expensive equipment on lorries/semi-trailers</td>
</tr>
<tr>
<td>Potential for good utilisation of rail wagons</td>
<td>Several units needed for fast transshipment</td>
</tr>
<tr>
<td>Simple and cheap terminals</td>
<td></td>
</tr>
<tr>
<td>Transshipment under the overhead contact line</td>
<td></td>
</tr>
</tbody>
</table>

2.2.3 Southern Car & Manufacturing Company: Railiner

Even the Americans came up with a horizontal transshipment technology in the 1950’s. The Railiner marketed by Southern Car & Manufacturing Company is very similar to the Railtainer/Steadman System, but the side-loading trailer chassis was dedicated to terminal use.

35 DEBOER, 1992, p. 60.
The transshipment procedure is similar to the CCT Basic or PLUS. Transfer arms would be connected between the road chassis and the transfer chassis and the box was then pulled to the transfer chassis. At this point hydraulics on the transfer chassis could be used to raise or lower the container to align with the height of the flat wagon where it would be secured. Another innovative feature was that the semi-trailer was designed to handle any container from 20 to 40 foot lengths through a telescoping chassis.\(^\text{36}\)

![Transshipment using the Railiner](Source: DEBOER, 1992, p. 60).

The containers were not of ISO-type but rather like European swap bodies with extendable support legs as well as tunnels for the transshipment arms.

**Table 2.6**  
*Short summary evaluation: Southern Car & Manufacturing Company’s Railiner.*

<table>
<thead>
<tr>
<th>Aimed for small-scale transshipment.</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Easy use at private rail sidings or at forwarders’ general cargo terminals</td>
<td>- Does not accommodate standard ITUs (but might be adapted for it with slight changes)</td>
</tr>
<tr>
<td>- Facilitates relatively flexible use of terminal equipment</td>
<td>- Need for synchronisation of road and rail vehicles at terminals</td>
</tr>
<tr>
<td>- Low demands on the terminal surface</td>
<td>- Relatively low net to tare relationship on road</td>
</tr>
<tr>
<td>- Simple and cheap terminals</td>
<td>- Requires dedicated and relatively expensive equipment on lorries/semi-trailers</td>
</tr>
<tr>
<td>- Transshipment under the overhead contact line</td>
<td>- Several units needed for fast transshipment</td>
</tr>
<tr>
<td>- Limited loading height on flat wagons with frames</td>
<td></td>
</tr>
</tbody>
</table>

\(^{36}\) DEBOER, 1992, p. 60.
BR Research: Self-Loading Vehicle

Also British Rail (BR) Research has developed systems for horizontal transfer of containers and swap bodies. One such technology is the Self-Loading Vehicle. It is a variant of the CCT and the Railtainer. Instead of letting the wagon elevate the container, this operation is performed by the vehicle.

For transshipment of a container, the Self-Loading Vehicle positions itself parallel to the wagon and lowers a stabilising beam to the ground. A lifting arm is extended across from the lorry connecting to the near side corner casting of the container. The arm then lifts, tilting the container sideways. A pivoting beam is then extended from the lorry and located under the container. The lifting arm is then lowered from the lorry and lowered so that the pivoting beam on which the container sits rotates into the horizontal position. The beam is then drawn back across into the truck and fixed into position. A transshipment cycle is said to take 7 minutes.

The technology works on any flat surfaces, even unpaved ones. No modifications are needed for the wagons, but the lorry needs to be fitted with stabilising arms along with the lifting arm, the pivoting beam and a hydraulic power system. Only 20-foot ISO-containers can be transshipped.

BR Research developed the system to a working prototype, but it has not attracted any customers.

Table 2.7 Short summary evaluation: BR Research's Self-Loading Vehicle.

<table>
<thead>
<tr>
<th><strong>Aimed for small-scale transshipment under the overhead contact line.</strong></th>
<th><strong>Disadvantages</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Advantages</td>
<td>Disadvantages</td>
</tr>
<tr>
<td>- Easy use at private rail sidings or at forwarders’</td>
<td>- Accommodates only 20-foot ISO-containers</td>
</tr>
<tr>
<td>general cargo terminals</td>
<td>- Does not accommodate standard rail wagons</td>
</tr>
<tr>
<td>- Facilitates relatively flexible use of terminal equipment</td>
<td>- Limited loading height on flat wagons with frames</td>
</tr>
<tr>
<td>- Fast transshipment when the train arrives</td>
<td>- Relatively low net to tare relationship on road</td>
</tr>
<tr>
<td>- Low demands on the terminal surface</td>
<td>- Requires dedicated and relatively expensive</td>
</tr>
<tr>
<td>- No need for external transshipment equipment or</td>
<td>equipment on lorries/semi-trailers</td>
</tr>
<tr>
<td>terminal personnel – the lorry driver transships the</td>
<td>- Several units needed for fast transshipment</td>
</tr>
<tr>
<td>units alone</td>
<td></td>
</tr>
<tr>
<td>- Simple and cheap terminals</td>
<td></td>
</tr>
<tr>
<td>- Suitable for corridor terminals</td>
<td></td>
</tr>
<tr>
<td>- Transshipment under the overhead contact line</td>
<td></td>
</tr>
</tbody>
</table>

37 JÖNSSON and KROON, 1990, in Appendix.
2.2.5  BR Research: Rail wagon with elevating twistlocks and lorry with a roller trolley

Another horizontal transshipment technology developed by BR Research consists of dedicated wagons with elevating twistlocks and lorries equipped with a roller trolley. The transfer procedure is similar to the CCT, especially CCT PLUS, as well as the Railtainer, but the equipment mounted on the lorry can be made simpler. BR might have been influenced by the CCT after testing the technology.

The transshipment sequence starts with the lorry parking parallel to the rail wagon. Hydraulically actuated twistlocks on the rail wagon then lift the container sufficiently high for the roller trolley of the lorry to be moved under it. The container is then lowered onto the trolley and pulled across to the lorry by a winch and fixed onto the lorry. The elevating twistlocks may be used either to give space under a container for fork lift access or it may be used in conjunction with support legs to demount a container or swap body from a rail wagon (compare with the rail wagons for lifting swap bodies or cassettes in section 2.5 below.

![Figure 2-14  British Rail Research's Rail wagon with elevating twistlocks.](Source: JÖNSSON and KROON, 1990, in Appendix).

Four elevating twistlocks are needed per container position. The power supply may be mounted on the wagon, or power can be supplied from the rail engine or externally at the terminal spot. The lorry must be fitted with a winch and a trolley but the containers do not need any changes.

The technology was developed by British Rail Research as a working prototype, but it has not been taken any further. Reportedly, the wagon works well, but the trolley needs more development effort.

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38 JÖNSSON and KROON, 1990, in Appendix.
39 RYDING et al., 1993.
Table 2.8 Short summary evaluation: BR Research’s Rail wagon with elevating twistlocks and lorry with a roller trolley.

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Facilitates integration with passenger trains</td>
<td>- Accommodates only 20-foot ISO-containers</td>
</tr>
<tr>
<td>- Facilitates relatively flexible use of terminal equipment</td>
<td>- Relatively complicated and thus expensive rail wagon</td>
</tr>
<tr>
<td>- Fast transshipment when the train arrives</td>
<td>- Relatively low net to tare relationship on road</td>
</tr>
<tr>
<td>- Low demands on the terminal surface</td>
<td>- Requires dedicated and relatively expensive</td>
</tr>
<tr>
<td>- No need for external transshipment equipment or terminal personnel</td>
<td>equipment on lorries/semi-trailers</td>
</tr>
<tr>
<td>- Simple and cheap terminals</td>
<td></td>
</tr>
<tr>
<td>- Suitable for corridor terminals</td>
<td></td>
</tr>
<tr>
<td>- The equipment can follow the train</td>
<td></td>
</tr>
<tr>
<td>- Transshipment under the overhead contact line</td>
<td></td>
</tr>
</tbody>
</table>

2.2.6 The Ringer System

In 1978, Mr. K. RINGER of Germany proposed a technology also using roller trolleys, or “rolling ramps”. The rolling ramps are mounted on powered transshipment wagons that follow the train. At the terminal, the transshipment wagons are switched to parallel tracks from where they can tranship swap bodies and containers between the other rail wagons and storage wagons at the terminal. Transshipment is carried out under the overhead contact line40.

The principle of horizontal transshipment using rollers is theoretically very attractive, but a severe shortcoming is that neither swap bodies nor containers are flat on the underneath side. In the System Ringer, loading ITUs upon flat pallets solves this problem41.

For certain reasons, probably to keep the pallets inside the railway system, transshipment to and from lorries is carried out with a small gantry crane. It seems a little odd to mix this innovative horizontal transshipment system with the traditional and vertical gantry cranes because the main benefit from this proposed system is that the railway side of a terminal can work under the overhead contact line. Hence, system improvements should be possible and needed for small-scale applications.

![Figure 2-15 The Ringer System. (Source: Bundesminister für Verkehr, 1981, p. 46).](image)

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Three terminal layouts have been presented, designed for 500, 3,000 and 10,000 transshipments per month respectively. The smallest version involves 4 rolling ramps, 2 small gantry cranes, 20 storage wagons and a positioning system. The medium version involves 10 rolling ramps, 2 small gantry cranes, one larger gantry crane and one forklift truck. The latter equipment is used for operating a storage facility and for extra capacity on the roadside of the terminal. The largest version, finally, is definitely no longer a small-scale terminal and it is also designed for transshipment of semi-trailers. It involves 2 rolling ramps for cross movements, 3 rolling ramps for movements alongside the tracks, 6 larger gantry cranes, 2 forklifts and 70 storage wagons42.

Any connection between the Ringer System and the BR’s technologies, described above, is not known.

Table 2.9  Short summary evaluation: The Ringer System.

<table>
<thead>
<tr>
<th>Aimed for small-scale transshipment under the overhead contact line.</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advantages</td>
<td>Disadvantages</td>
</tr>
<tr>
<td>- Facilitates relatively flexible use of terminal equipment</td>
<td>- Does not accommodate standard rail wagons</td>
</tr>
<tr>
<td>- The equipment can follow the train</td>
<td>- Relatively complicated and thus expensive trans-</td>
</tr>
<tr>
<td>- Transshipment under the overhead contact line</td>
<td>- shipment rail wagon</td>
</tr>
<tr>
<td></td>
<td>- Requires extra track parallel to the train</td>
</tr>
<tr>
<td></td>
<td>- Requires interface pallets on ITUs</td>
</tr>
<tr>
<td></td>
<td>- Switching needed prior to transshipment</td>
</tr>
<tr>
<td></td>
<td>- Works together with large-scale, conventional</td>
</tr>
<tr>
<td></td>
<td>technologies</td>
</tr>
</tbody>
</table>

2.2.7 LogMan: Container FTS

For maximum flexibility at the terminal, the German company Logistics Management AG (LogMan) has presented plans for an Automatic Guided Vehicle (AGV) with internal container handling equipment. The Container FTS43 system can tranship ITUs on either side using shuttle beams with rollers that are pushed underneath the ITU.

With the dimensions (length x width) 12.2 m x 2.60 m, the AGV can carry one 40 foot or two 20 foot ISO-containers or a swap body 7.15-12.60 m. The AGV hovers and moves like a hovercraft powered by a diesel, petrol or gas engine of 100 to 200 horse powers.

A transshipment cycle starts with connecting the AGV and the rail wagon and pushing the shuttle beams underneath the container. The beams then lift the container and pull it to the AGV where it is lowered. After disconnection, the AGV is free to move on the terminal space. Two transshipments to and from a rail wagon are stated to take 15-20 minutes44. The transshipment cycle is shown in the figure below.

43 Information about what the letters FTS originally stands for has not been obtainable.
44 JÖNSSON and KROON, 1990, in Appendix.
Nothing is said about the requirements for the terminal surface, but a flat surface should be sufficient since the hovercraft principle provides very well distributed forces. The AGV operates between rail wagons and storage racks in railway wagon height, but also this system is intended to work together with a traditional gantry crane that make the system less feasible for pure small-scale operations. However, also the FTS technology shows potential for improvements.

---

45 JÖNSSON and KROON, 1990, in Appendix.
Table 2.10  Short summary evaluation: LogMan’s Container FTS.

<table>
<thead>
<tr>
<th>Aimed for small-scale transshipment under the overhead contact line.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Advantages</strong></td>
</tr>
<tr>
<td>- Facilitates relatively flexible use of terminal equipment</td>
</tr>
<tr>
<td>- Transshipment under the overhead contact line</td>
</tr>
<tr>
<td>- Simple and cheap terminals (for the core technology)</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

2.2.8  The Hochstein System

Yet another system for horizontal transshipment is the German Hochstein System. Like some of the above technologies, it utilises lifting beams that are pushed underneath the container. The lifting device, however, is rather innovative since it uses a scissors principle and small wheels for smoother push and pull operation as is shown in the figure below. The equipment is mounted on a railway vehicle that can follow the train.

Figure 2-17  The Hochstein System. (Source: Bundesminister für Verkehr, 1981, p. 47).

In comparison with the Container FTS and the Ringer System, the Hochstein System has the advantage of also being designed for transshipment to and from road vehicles46.

Table 2.11  Short summary evaluation: The Hochstein System.

<table>
<thead>
<tr>
<th>Aimed for small-scale transshipment under the overhead contact line.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Advantages</strong></td>
</tr>
<tr>
<td>- Facilitates relatively flexible use of terminal equipment</td>
</tr>
<tr>
<td>- The equipment can follow the train</td>
</tr>
<tr>
<td>- Transshipment under the overhead contact line</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

2.2.9 Blatchford: Stag

The British company Blatchford Transport Equipment markets a wide range of lorry and train mounted container cranes including sideloading trailers (SLTs) and the T-lift, both technologies described later in this report.

Blatchford’s semi-trailer mounted Stag technology is innovative in the sense that it stretches out an outrigger beam across the rail wagon on which the crane equipment can slide upon. Besides road-rail transshipment, the technology offers possibilities for lorry-to-lorry transshipment, for lorry-to-ground transshipment and for stacking containers two high. It is restricted to ISO-container transshipment as it lifts the ITUs in the upper corner pockets. Blatchford offers units for 20, 30 or 40 feet with capacities of 14, 20 or 32 metric tons respectively and the technology can easily be adapted to handle 45-foot containers up to 36 tons. The semi-trailer can be used for container delivery or as pure small-scale terminal equipment.

![The Blatchford Stag. (Source: Blatchford Cranes/Herbert Pool Ltd, product brochure, 1985).](image)

The transshipment operation starts with the lorry folding out support beams resting with support legs on the other side of the rail wagon. The container is then lifted in its upper corner castings by a spreader hoisted by use of chains mounted on a pillar that runs as a trolley on the support beam. With a lower pillar, the transshipment should be possible under electric overhead contact line. The Stag can also be used for passing through low doors for indoor delivery of containers.

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47 JÖNSSON and KROON, 1990, in Appendix.
49 POOL, fax dated 16 May 1997.
Figure 2.19  Principle for transshipment to a railway wagon using the Blatchford Stag.  
(Source: Blatchford Cranes/Herbert Pool Ltd, product brochure, 1985).

On the positive side, the technology combines the stability of a gantry crane with the small-scale and mobility of SLTs. The distribution of forces between four rather than two support points facilitates very low demands for the terminal surface. A shortcoming, however, is that the containers have to be loaded with a distance allowing the beams to stretch across the rail wagon. The Stag is currently not in production although it can be readily revived for special applications\(^{50}\).

Table 2.12  Short summary evaluation: Blatchford’s Stag.

<table>
<thead>
<tr>
<th>Aimed for small-scale transshipment under the overhead contact line.</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Advantages</strong></td>
<td><strong>Disadvantages</strong></td>
</tr>
<tr>
<td>- Facilitates flexible use of terminal equipment</td>
<td>- Does not accommodate swap bodies</td>
</tr>
<tr>
<td>- No need for external transshipment equipment or terminal personnel – the lorry driver transships the units alone</td>
<td>- Need for synchronisation of road and rail vehicles at terminals</td>
</tr>
<tr>
<td>- Simple and cheap terminals</td>
<td>- Relatively low net to tare relationship on road</td>
</tr>
<tr>
<td>- Transshipment under the overhead contact line possible</td>
<td>- Requires dedicated and relatively expensive equipment on lorries/semi-trailers</td>
</tr>
<tr>
<td>- Very low demands on the terminal surface</td>
<td>- Several units needed for fast transshipment</td>
</tr>
<tr>
<td></td>
<td>- The transfer equipment “steals” length on rail wagons</td>
</tr>
</tbody>
</table>

2.2.10  **Stenhagen: Stenhagen System**

The Swedish inventor Mr. K. Ohlson of the company Stenhagen, a specialist on systems and components for lorry superstructures, has presented an intermodal system strongly influenced by the air cargo industry\(^{51}\). The system is primarily intended for lightweight air cargo pallets and containers, but instead of today’s custom of stuffing and stripping these at the airport, the Stenhagen System integrates them with the road and rail transport modes. Nevertheless, a prototype allowing road-rail transshipment of 20-foot containers has been presented which is the reason for describing the technology in this section of the report. The road/air application is further described in section 5.1 (road-air technologies).

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\(^{50}\) POOL, letter dated 22 April 1997.

\(^{51}\) Hägglunds, brochure, 1993.
In short, the general system is based upon a semi-trailer with a vertically adjustable floor; aluminium frames with integral rollers and dedicated flat pallets\(^{52}\). The principle is to position the roller frames on the ground and then adjust the height of the semi-trailer floor for manual pushing of the pallets horizontally over to the roller frames. Due to low friction, quite high loads can actually be pushed manually. A clear advantage of handling over the side rather than over the rear is that any pallet can be transshipped\(^{53}\).

![The Stenhagen Trailer with vertically adjustable floor.](image)

For the horizontal transshipment, the small containers and pallets need a flat bottom. They can only be moved horizontally – they are not designed for vertical lift. In principle, the pallets are rather large sheets of aluminium with tightening points. The Stenhagen pallet measures 2.46 and 3.30 m and carries eight Europallets. Like the C-sam system (see section 2.6.5) they combine the maximum width on Swedish roads in one axis and the maximum width on Swedish rail tracks in the other. Thus they efficiently use the measures of both modes.

By use of the roller frames and rollers in the loading floor of the vehicles, one Stenhagen pallet carrying eight Europallets can be exchanged with another in one manual operation. The manual transshipment operations for the road and rail modes are presented below.

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\(^{53}\) Hägglund Vehicles, product leaflet, 1993.
Figure 2-21  Manual transshipment of Stenhagen pallets to a lorry and a to railway wagon. Both vehicles are equipped with rollers in the floor. Note the orientation of the pallets and the loading patterns of Europallets. (Source: Hägglunds, brochure, 1993).

For transshipment of ISO-containers, a special side-loading device is mounted on the semi-trailer. Together with the hydraulic system for lowering the floor, this obviously makes the solution heavy and bulky. Some achievements, however, are notable. The ability of transshipping a 20-foot ISO-container under electric overhead contact line was proven at a press conference. Moreover, the semi-trailer floor can be lowered close to the ground level, thus letting the loaded vehicle combination passing through rather low doors at consignors and consignees premises. The transshipment of an ISO-container, but more probably, smaller pallets or lightweight containers can be carried out indoors, which is really floor-to-floor transportation. As a complement to some of the small container systems, e.g. the Logistikbox, the Stenhaen Trailer could find further applications.

With a lowered floor, the Stenhagen semi-trailer as such can be moved on top of a flat wagon. This procedure, however, brings both weight and capital costs to the intermodal system and the semi-trailer should be regarded more as a road vehicle or transshipment equipment.

The project is still in a prototype stage, but another Swedish company, Hägglunds, has an option on commercialising the technology. Currently, they work on setting up pilot services in co-operation with shippers.
### Table 2.13 Short summary evaluation: Stenhagen System.

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Easy use at private rail sidings or at forwarders’ general cargo terminals</td>
<td>- Best suited for smaller ITUs with flat bottom</td>
</tr>
<tr>
<td>- Facilitates flexible use of terminal equipment</td>
<td>- Need for synchronisation of road and rail vehicles at terminals</td>
</tr>
<tr>
<td>- No need for external transshipment equipment or terminal personnel – the lorry driver transships the units alone</td>
<td>- Relatively low net to tare relationship on road</td>
</tr>
<tr>
<td>- Simple and cheap terminals</td>
<td>- Requires dedicated and expensive equipment on lorries/semi-trailers</td>
</tr>
<tr>
<td>- Transshipment under the overhead contact line possible</td>
<td>- Several units needed for fast transshipment</td>
</tr>
<tr>
<td>- Truly horizontal transfer, also to ground</td>
<td></td>
</tr>
<tr>
<td>- Very low demands on the terminal surface</td>
<td></td>
</tr>
</tbody>
</table>

### 2.2.11 Albatec: Kombiflex

Another Swedish inventor, Mr. G. Rodin of Albatec AB, has presented blue prints of a truly horizontal transshipment technology. The Kombiflex system is primarily designed for horizontal transfer of the shorter series of containers and swap bodies but the system principles allows for an extension to include 40-foot containers. It consists of train-based equipment permitting the ITU to be lifted and rotated perpendicular to the rail wagon, and from there unloaded into a rack at the side of the track, while the loading sequence is the reverse of the above.

![Figure 2-22 Albatec’s Kombiflex.](image)

The transshipment time is, dependent upon the rack facilities, taking only a couple of minutes, but transferring many boxes in a train can be time consuming. Transshipment is performed under existing overhead contact line.
The system permits the use of standard road vehicles, while the train set has to be fitted with a purpose-built, and rather costly, Kombiflex sledge. However, the sledge is moveable between the wagons meaning that only one such sledge is needed per train set keeping the total system costs low. For higher capacity, further sledges can be added to the train set.

There is no need for trains and lorries to meet at the terminal. The system is thus well suited for a corridor, a fixed routes or an flexible routes design where transshipment is carried out during short stops at the terminal. As the ITUs are swung out perpendicular to the wagon, it blocks any closely adjacent track, thus requiring a side track terminal or restriction to railway lines where the goods flow is moderate with a corresponding limitation of capacity. Kombiflex shows similarities to turntable systems and C-sam (see section 2.6.5) but its train-based transfer equipment makes it more innovative.

The system is patented although its development has been halted, since funds for building a prototype have not been made available yet.

<table>
<thead>
<tr>
<th>Aimed for small-scale transshipment under the overhead contact line</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Advantages</strong>&lt;br&gt;- Easy use at private rail sidings or at forwarders’ general cargo terminals&lt;br&gt;- Facilitates flexible use of terminal equipment&lt;br&gt;- No need for external transshipment equipment or terminal personnel – the engine driver transships the units alone&lt;br&gt;- Simple and cheap terminals&lt;br&gt;- Suitable for corridor terminals&lt;br&gt;- The transshipment equipment follows the train&lt;br&gt;- Transshipment under the overhead contact line</td>
<td><strong>Disadvantages</strong>&lt;br&gt;- Requires dedicated and expensive equipment on the train&lt;br&gt;- Several pieces of transshipment equipment needed for fast transshipment</td>
</tr>
</tbody>
</table>

### 2.2.12 N.C.H. Hydraulic Systems: Mondiso Rail Terminal

As a complement to their container-to-ground equipment ISO 2000 and ISO 4000 (see section 2.3.1), the Dutch family business N.C.H.\(^{54}\) Hydraulics System has presented the Mondiso Rail Terminal in co-operation with Emons Transport, Terberg Container Handling B.V., Interrijn B.V. and Firma Keuken Transport\(^{55}\). Together with N.C.H.’s barges equipped with onboard gantry cranes (see section 4.1.2) they are marketed as the Mondiso Intermodal Transportation System.

Two variants of transfer equipment have been presented, both for being mounted in platforms at wagon height at side-tracks. Depending on the location and the required capacity, hydraulic rolling systems or electric/hydraulic ISO trolleys will be used. With one such equipment at each ITU position of the train, entire trains can be converted within 10 minutes. The transshipment is fully horizontal allowing also high volume containers to be transferred under the existing electric contact wire used in European rail networks\(^{56}\).

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54 N.C.H. is an abbreviation of Nijenhuis Container Hoogeveen.  
55 Mondiso, leaflet, 1996.  
The system is mainly designed for ISO-containers, but pallet wide containers and swap bodies with corner fittings on their far ends can be handled\(^\text{57}\). However, the main shortcoming of the system is its incapability of taking standardised swap bodies with corner castings subtracted underneath the bottom frame in order to correspond to the distance of 20-foot containers. Nevertheless, for Dutch needs with a huge number of ISO-containers moving in and out via the Port of Rotterdam\(^\text{58}\), the system can make up the capillary parts of a trans-ocean network.

Intermodal road-rail use depends on the development of a new low-bed railway wagon with air suspension\(^\text{59}\). Discussions in the matter have been held with wagon manufacturers Siemens and Rautaruikki. Air suspension will probably be implemented anyway as it follows general trends in the railway industry. The air suspension facilitates smoother running, less noise, less maintenance as well as higher loads. Air suspension is needed in the Mondiso system for stabilising the wagon through deflating the suspension and letting the wagon rest directly on the axles. Nevertheless, it is a shortcoming that might delay commercial operations since the benefits from the Mondiso Intermodal Transportation System are not sufficient to pay for developing the new rail wagons.

\(^{57}\) NIJENHUIS, interview 5 December 1996.  
\(^{58}\) In 1995 4.8 million TEUs where transshipped in Rotterdam and 5 million where estimated for 1996 (Cargo Systems, 1997/b).  
The Mondiso Rail Terminal is designed for a corridor network operation philosophy, by N.C.H. compared to rail passenger services. The many specialised items limit it to be a closed integrated transport chain, with, according to N.C.H., simplicity as the main feature.

The system has attracted attention from SJ and is being evaluated within their Light-combi project (as described in section 2.1.3)\textsuperscript{60}. A prototype was presented in February 1997.

\begin{table}
\centering
\caption{Short summary evaluation: Mondiso’s Rail Terminal.}
\begin{tabular}{|l|l|}
\hline
\textbf{Aimed for small-scale transshipment under the overhead contact line.} & \\
\hline
\textbf{Advantages} & \textbf{Disadvantages} \\
- Suitable for corridor terminals & - Does not (yet) accommodate swap bodies \\
- Transshipment under the overhead contact line & - Requires dedicated and expensive equipment on the train \\
\hline
\end{tabular}
\begin{itemize}
\item Requires dedicated terminal platforms with transshipment equipment
\item Requires the ITUs to be placed on the ground
\end{itemize}
\end{table}

2.3 LORRY-TO-GROUND AND TURNTABLE SYSTEMS

The lorry-to-ground group of technologies, known under brand names such as ISO 4000 and Multilift, has a primary purpose to allow transshipment of freight containers between a lorry and the ground. Some systems aim for the big market of pick-up and distribution of ISO-containers around ports while others use purpose built containers to serve niche markets such as transport of scrap iron and building site refuse. Since the containers are hoisted along a tilting frame or levered over the end of the lorry, the lorry-to-ground systems have not proven to be practical for pure inland transport of general cargo since that type of load is generally not very well secured. General cargo in ISO-containers for trans-ocean transport, on the other hand, is secured in order to cope with the tilting of ships, which often are at greater angles than the transshipment to ground.

As a bonus, however, the lorry-to-ground systems generally allow for horizontal transshipment between lorries and rail wagons fitted with turntables such as those used in the ACTS and RSS systems (see under separate heading below). In such systems, also for various types of swap bodies, there is no steep transshipment angle, thus facilitating in-land general cargo transport. The systems show similarities with many systems limited to smaller load units, notably the C-sam group of technologies and the Logistikbox.

A big problem with this set of technologies is that there is a general lack of standardisation\textsuperscript{61}. The systems are not compatible but tests carried out in 1992 showed that rather small changes would allow better compatibility between two of the road/rail systems; ACTS and Multi-berces (see below)\textsuperscript{62}. Also DB has tested and evaluated various road/rail systems based upon turntables\textsuperscript{63}.

\textsuperscript{60} NIJENHUIS, interview 5 December 1996 and WEDE, telephone interview 19 February 1997.
\textsuperscript{61} SUTELA, letter dated 17 March 1997.
\textsuperscript{62} BORHART, 1993.
\textsuperscript{63} Deutsche Bundesbahn, 1990, p. 2.
The basic lorry-to-ground technologies are only briefly described, mainly as an introduction and to show their role in road-rail transportation. They are not evaluated with pros and cons. Thereafter, some intermodal systems based upon the lorry-to-ground technologies are described more in detail.

### Table 2.16  Short summary evaluation: Turntable systems.

<table>
<thead>
<tr>
<th>Aimed for small-scale transshipment of dedicated containers.</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Advantages</strong></td>
<td><strong>Disadvantages</strong></td>
</tr>
<tr>
<td>- Easy use at private rail sidings or at forwarders’ general cargo terminals</td>
<td>- Need for synchronisation of road and rail vehicles at terminals</td>
</tr>
<tr>
<td>- No need for external transshipment equipment or terminal personnel – the lorry driver transships the units alone</td>
<td>- Non-standard and relatively expensive containers (or use of interface frames), lorries and rail wagons</td>
</tr>
<tr>
<td>- Simple and cheap terminal</td>
<td>- Relatively high tare weight on lorries and wagons</td>
</tr>
<tr>
<td>- Transshipment under the overhead contact line</td>
<td>- Several units needed for fast transshipment</td>
</tr>
<tr>
<td></td>
<td>- The transfer equipment “steals” height both on rail wagons and on lorries</td>
</tr>
</tbody>
</table>

### 2.3.1 Chain-lifts: ISO 2000/4000; Translift and Trailer Mounted Roll-Off Hoist

In view of the growing use of ISO-containers, N.C.H. Hydraulic Systems has developed the ISO 2000 and ISO 4000 systems, which are, as indicated by their names, suitable for transport of 20-foot and 40-foot ISO-containers respectively. In the long run it is intended to be an integral part of the Mondiso Intermodal Transportation System (see the previous section), but so far it is mostly used for pure pick-up and distribution of ISO-containers around ports.

The system comprises of a winch unit with free run or slip mechanism, a tilting frame and a locking device. A transshipment of a container from ground to a lorry is carried out using the following procedure:

1. The vehicle is reversed in line towards the container and stops 1.5 m away from the container.
2. The tilt-frame is moved with the twist locks to the corner pocket of the container. This can easily be done by operation of the switch at the rear of the lorry or semi-trailer.
3. The driver closes the twist locks and continues the operation in the driver’s compartment.
4. The vehicle lifts the container and the tilting frame rolls under it.
5. The winch is used for sliding the container along the tilting frame.
6. The tilting frame is lowered and the transfer operation is complete

With this procedure, the driver can transfer a container to the ground in less than 10 minutes. A transshipment cycle is shown in the figure below.

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The device is also useful for transshipment between a lorry and its trailer meaning that only one device is needed for the joint vehicle combination\textsuperscript{66}. The elevating transshipment device also facilitates vertical positioning of specially built bulk silo-containers\textsuperscript{67}.

Finnish Multilift Oy, a subsidiary to Partek, marketed a range of chain-lifts under the brand name Multilift. The forces required for transshipment is stated to be smaller than those encountered in normal acceleration and braking in traffic. The angle of inclination when the container is pulled onto the vehicle is 24 degrees and it can be raised to a tipping angle of 50 degrees\textsuperscript{68}.

Dutch Multilift BV used to be a licensee for the Multilift technology, but after buying the patent from the Finnish Partek Group, they have further developed the technology and renamed it Translift. Also

\textsuperscript{67} N.C.H. Hydraulics Systems BV, brochure, 1994/b.
\textsuperscript{68} Partek Multilift Factory, product brochure 1990.
Swiss Tuchschmid Engineering manufactures the equipment under the brand name Hercules. The technology can lift standard ISO-containers by pulling them in the corner pockets. However, also roll-on frames can be lifted if they have standardised corner pockets. Ideally, the frames should be equipped with rollers, but they do not need to be equipped with a clamp such as those needed for hook-lift transshipment (see below).

The tipping movement necessary to pick up a grounded container is based upon a common “scissors” principle featuring two frames. It can be used on three different types of lorry units. The smallest, the ML 17.60 type is designed for two-axled vehicles and has a lifting capacity of 14 tons. The larger ML 26.65 and the ML 33.75 types can handle 23 and 30 tons respectively.

One customer is the Swiss fruit and vegetable grower/canner Hero, which in 1989 owned 50 stackable containers for intermediate storage on growing fields. Translifters belonging to a haulier pick up the containers for transport to the factory or by rail using the ACTS system. Also maize is transported across Switzerland.

Moreover, terminal tractors can be equipped with a translift superstructure for transshipment and positioning of containers within terminals. A terminal tractor equipped with a Translift device is shown in the figure below.

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71 VON STEMPEL, 1989, p. 97.
72 VON STEMPEL, 1989, p. 97.
73 ACTS Nederland BV, marketing folder, 1994.
In the US intermodal transport industry, life seems much easier than in Europe. It is common practice to move semi-trailer on flat wagons or containers on flat wagons or stacked on double-stack wagons. At terminals containers are transshipped directly to semi-trailer chassis, thus the road transport system treats all units as semi-trailers. Once the container/chassis combination is back on the rail terminal it is transshipped to a rail wagon, thus being treated as a container again.

Nevertheless, lorry-to-ground equipment is marketed also in the USA. Accurate Industries, Inc. of New Jersey markets its Roll-Off Hoist mounted on a semi-trailer chassis. By use of a tilting frame similar to that of Multilift and Translift, dedicated roll-on frame style containers can be transferred to and from the ground. The main differences are that the Roll-Off hoist is mounted on a semi-trailer and that the equipment uses a wire rather than a chain for sliding the container along the tilting frame. The primary market targeted is that of transport of waste materials. One variant of the semi-trailer, the Double Container Trailer DC80, can take two containers handled with the same device as shown in the figure below.

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74 Accurate Industries, brochure, 1995/a.
2.3.2 Hook-lifts: Ampiriroll, Multilift Hooklift; HIAB Hooklift and LIVAB Load Exchanger

Since the 1950’s containers with integrated roll-on frames have been transshipped between lorry and ground. The idea of ground level demountables was born in Finland in the late 1940’s where two brothers made the invention and started the company called Autolava Oy, later renamed Multilift Oy\textsuperscript{75}. The main application is the transport of bulk materials that normally are unloaded by tilting the container. Today they are frequently seen at building sites where they are used as waste bins that are exchanged for empty ones when they are full. Containers are built on special frames with small rear wheels; also interface frames for ISO-containers are available. The lorries are equipped with a hydraulically movable hook that grips a clamp at the roll-on frame and pulls it up from the ground.

The hook-lift transshipment implies even higher angles than those technologies using a tilting frame, which make them even less suitable for general cargo. Depending on the make and the container to be transshipped, the angle of attack is 20 to 30 degrees\textsuperscript{76}. The high angle does not occur when transshipping directly between a lorry and a rail wagon, but such equipment can be designed to be lighter and simpler. For flexibility reasons, however, with occasional road-rail transshipments, the technology can be useful.

A transshipment cycle is started when the lorry reverses towards the container. The hook-lift is folded backwards until it grips the connecting mounting of the roll-on frame. The hook-lift device is then lifted and the container is levered over the end of the lorry. The hook-lift then pulls the container forwards until it is positioned fully on the lorry bed. A transshipment is shown in the figure below.

\textsuperscript{75} SUTELA, E-mail dated 9 May 1997.
\textsuperscript{76} WOXENIUS \textit{et al.}, 1995, p. 77.
In NATO-terms, these containers are called DROPS (British Forces) or PLS (US Forces). The UK Ministry of Defence established the first full-scale hooklift system in the mid 1980’s and they had their breakthrough in the Gulf War where immense amounts of ammunition and supplies had to be moved without support of advanced infrastructure. The good experiences has caused NATO to deploy the technology further and it is now a frequent view in Bosnia. Examples of applications related to peace-keeping operations are shown in the picture below.

Hook-lifts are manufactured by many suppliers under many brand names. One brand, the Ampliroll, is marketed by the French company Bennes Marrel and in 1992 there where some 15 000 Amplirolls in France. In Germany, Meiller markets hook-lifts and Roland Tankbau is a large supplier of roll-on frame containers which Abrollkippers are also available with lift pockets for vertical transshipment. After selling their chain-lift concept to Translift, Finnish Cargotec Oy, a Partek subsidiary, now markets a wide range of hook-lifts under the brand name Multilift Hooklift. The smallest versions is re-

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77 CHAMPION, 1992.
78 SUTELA, E-mail dated 9 May 1997.
79 Cargotec, product brochure and various product leaflets, 1997.
stricted to carry small loads such as a lawn mower tractor or passenger cars. The larger versions are widely sold to the European construction industry as well as to military forces.80

In Sweden, long combinations with one roll-on-frame container on the lorry and two on the trailer are common. The hook system of the lorry is used for all transshipments. Swedish brand names include Zetterberg’s LIVAB load exchanger81 and HIAB’s Hooklift82. Together with Multilift, HIAB is a part of Finnish Partek’s Cargotec group which means that they co-operate in design and manufacturing. The Swedish systems are developed for domestic use and has had interoperability problems when Swedish armed forces have co-operated with NATO forces in Bosnia.83 Consequently, harmonisation measures have to be taken in order to smooth future peace-keeping co-operation.

2.3.3 Translift: Abroll Container Transport System (ACTS)

Abroll Container Transport System (ACTS) is designed to permit horizontal transfer of different types of containers between road and rail. It is presently aimed mainly at special bulk containers, but ISO-containers and swap bodies can also be handled if they are mounted on special interface frames, however violating some of Europe’s rail loading profiles.84 Standard wagons are fitted with turntable frames and lorries are fitted with transshipment equipment based upon chains or hooks. No external handling equipment or surface hardening is needed at the terminals, thus keeping the sunk costs invested in terminals at a very low level.

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84 ERNI, fax dated 11 May 1997.
The total transfer time is very short, it is claimed to be no more than two minutes\textsuperscript{85}, which indicates that the system is suitable for a corridor or a hub and spoke design. Unfortunately, simultaneous presence of lorries and rail wagons is needed for the transshipment. Consequently, the use is directed towards small-scale, customer specific solutions with transshipment at private sidings at the customer’s pace throughout the day rather than public solutions with open access terminals\textsuperscript{86}. The use of dedicated equipment and the high cost of the lorries strengthens the limitation to customer specific transport solutions as one lorry can be used for many pick up and delivery operations during the day.

In order to transfer a container from a lorry to a rail wagon, the driver pulls out manually the turntable frame at a 45 degree angle and adjusts the height of the lorry bed by means of a hydraulic cylinder to the level of the rail wagon. The equipment mounted on the lorry carries out the horizontal transshipment. Once the container is at rest on the turntable, the driver attaches a cable on the lever arm of the turntable and swings it into a locked position. Empty containers can be swung in manually. Transshipment from a rail wagon to a lorry is done in the reverse order, which is shown in the figure below.

The equipment mounted on the lorries can be chain based – such as the ISO 2000, Multilift, Translift and Tuchschmid Hercules systems (described above) – or hook based working together with roll-on-frames (also described above). However, lorries have to be slightly adjusted for the ACTS system. The equipment adds significantly to the total weight of the lorry that is about 29 tons\textsuperscript{87}. An additional container can be loaded onto a trailer towed by the lorry but it makes transshipment more complicated – either by fitting the trailer with transshipment equipment or using the equipment of the lorry. Nevertheless, the typical weight of a lorry and trailer combination violates the 44 ton road regulation applicable in most European countries.

\textbf{Figure 2-31}  Transferring a container from a rail wagon to a lorry with the ACTS system.

\textsuperscript{85} ACTS Nederland BV, marketing folder, 1996.
\textsuperscript{87} EURET, 1994, p. 17.
The most common rail wagons are of standard 4-axle flat wagon design, normally used Res, Rs or Ks types, equipped with turntable frames. The Res and Rs types can carry three containers of maximum 16.5 tons. The smaller Ks type can carry two containers of 13.5 tons or four double-stacked containers of 5.7 tons, the latter combination however not permitted by the UIC. Purpose built ACTS wagons are lighter and allow for heavier containers. The turntable frames add some 2 tons each which allows the wagon to load three containers of total weight from 18 to 22 tons each within a total wagon load of 90 tons 88.

The only requirement at the terminal is a minimum of ten metres along the track for the lorry to manoeuvre at89. Compared to systems using forklift trucks, a great advantage is that the terminal surface does not have to be hardened. A shortcoming is that the transshipment operation blocks any parallel track at normal double track distance.

Tuchschmid Engineering AG in Switzerland is a supplier of the following elements for ACTS systems90:

- interchangeable modular truck units
- turntable frame rail wagons
- containers, tanks, loading platforms

Other manufacturers include Haller and Netherlands-based Deckeris who have built non-cranable swap bodies specially designed for the ACTS system. During the last 10 years, Tuchschmid has installed more than 1000 ACTS turntable frames for DB AG, Swiss State Railways (SBB) and Austrian State Railways (ÖBB)91. In November 1996 approximately 950 ACTS rail wagons were in operation, mainly for bulk materials92.

In Switzerland, ACTS was tested in 1984 and commercially introduced in 1987 by Abroll-Container-Transport-Service AG, a 50-50 joint venture between five railway companies and road transport forwarders. At their disposal are 350 containers and Slps-x wagons from SBB equipped with turntable frames. The 4600 consignments of 1989 doubled to 199193.

ACTS is used for moving household waste from Geneva to Bern where there is spare landfill capacity and for moving toxic waste between a plant in Sihlbrugg and a hazardous material incineration plant in Winthertur. SBB uses old wagons that otherwise would be obsolete. Since the minimum economic transport distance is as low as 80 km inside Switzerland, partly because of strong limitations on vehicle sizes, the system has also been used for recycling paper94, palletised drink crates, reprocessed glass and clay, aluminium95, palletised building material, milk and refrigerated products. Consequently, new

89 VON STEMPEL, 1989, p. 97.
90 TUCHSCHMID, brochure, 1996.
91 ERNI, 1995.
92 RENKEMA, letter dated 13 November 1996.
93 SBB Cargo, newsletter, 1993.
94 SBB Cargo, newsletter, 1995/b.
95 SBB Cargo, newsletter, 1995/a.
container designs have been employed. The hook technology is much more common than the chain technology (80/20 in market share) but all lorries are not adapted for use in the ACTS system. As a matter of fact, 90-95% of the lorries operated in the ACTS system uses chain transshipment. The reason is that the hook technology is not totally horizontal and wears a lot on the turntable frames.

Commercial companies for developing national ACTS-services based on the Swiss model have been established also in the Netherlands, Belgium, Germany and Austria. A similar company called Gateba has tested ACTS in France. In the Netherlands, ACTS Nederland BV defines the market for ACTS as being in the range between 150 to 500 kilometres which means mainly international transport as shown in the figure below. Shorter distances are covered by single-mode road transport and longer distances by conventional intermodal shuttle trains.

![Figure 2-32](image)

*Figure 2-32  The market area (between the two circles) of ACTS services to and from Rotterdam. (Source: ACTS Nederland BV, brochure, 1996).*

Reference transport assignment for the Dutch company includes:

- Transport of refuse from Haarlem to an incineration plant in Amsterdam on behalf of Gewest Zuid-Kennemerland. The contract covers 80 000 tons per year in 15 years from 1993 onwards using 39 containers and 13 rail wagons.
- Transport of highly polluted earth from Hengelo to a recycling plant in Utrecht and transport of cleaned earth back to Hengelo. The contract for H.W.Z – Apeldoorn runs for 10 months and covers some 100 000 tons. 45 containers and 15 wagons are used.

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96 VON STEMPEL, 1990.
98 ACTS Nederland BV, brochure, 1996.
99 ACTS Nederland BV, marketing folder, 1996.
• Transport of refuse from Amersfoort to an incineration plant in Rozenburg. Started in 1990, the contract runs for 10 years with annual movement of 40 000 tons using 33 containers and 11 wagons.

• Transport of 450 000 tons of household and industrial waste from Brabant/Zeeland to Moerdijk using 61 wagons and 200 containers in round-the-clock traffic\textsuperscript{100}.

ACTS has found users also in Austria. In a dedicated solution for Österreichische Brau AG, ÖBB uses dedicated isolated containers with a loading capacity of 14 Europallets carrying 16 000 bottles of beer loaded in crates. Full side doors enables cargo handling even when the container is loaded onto a rail wagon. Over night leaps are used for transporting beer from the brewery in Schwechat to Kaltenhausen and Innsbruck and then empty bottles back to Schwechat\textsuperscript{101}. The figure below shows a transshipment of an ACTS container with beer.

![Figure 2-33 Transshipping beer using ACTS. (Source: ACTS Nederland BV, brochure 1996).](image)

For the German market, DB tested ACTS for twelve months in 1990-91\textsuperscript{102}. In Luxembourg, finally, ACTS has been used for moving 60 000 tons of polluted earth after the closing of a tar factory. OeKolux/ACTS and the national railway company of Luxembourg jointly offered the service\textsuperscript{103}.

### 2.3.4 Roland Tankbau: Roland-System Schiene-Strasse (RSS)

The German company RSS I – Transport GmbH & Co. KG, a subsidiary to Roland Tankbau GmbH & Co KG, markets its Roland-System Schiene-Strasse (RSS) as a competitor to the ACTS system. In principle, the two systems work in the same way, but the RSS adds another range of containers\textsuperscript{104}.

\textsuperscript{100} ACTS Nederland BV, brochure 1997.
\textsuperscript{101} ÖBB, brochure, 1994.
\textsuperscript{102} Deutsche Bundesbahn, 1990, p. 2.
\textsuperscript{103} RAG Umwelt Netzwerk, newsletter, 1995.
\textsuperscript{104} SCHREYER, 1996, p. 71 and Roland Tankbau, brochure, 1993/b.
however compatible with the ACTS containers\textsuperscript{105}. The RSS wagons can also be loaded with conventional vertical transshipment equipment, but most ACTS and RSS containers lack the necessary lift pockets for vertical lift. A special RSS container, however, is equipped for vertical lift as well as with standard ISO corner pockets for fastening to conventional container wagons. As the company name indicates, the primary business of Roland Tankbau is to manufacture the containers\textsuperscript{106}.

![Figure 2-34 Transshipment using the RSS in a small-scale terminal. (Source: Roland Tankbau, brochure, 1996).](image)

DB (then Deutsche Bundesbahn) started commercial tests in 1989\textsuperscript{107} but facts about the outcome have not been obtainable. The summary evaluation is the same as for ACTS with the only difference that the hydraulic turntables make the rail wagon more complicated and expensive without adding significantly to the system’s performance.

### 2.3.5 SNCF Fret: Multi-berces

In conjunction with Bennes Marrel and AFR, French State Railways (SNCF) launched an ACTS-like technology under the name “Multi-berces – the multi-loader system” in 1992. One distinction is that the Multi-berces system only works together with hook-lifts thus limiting the range of containers to those mounted on roll-on frames.

Three types of dedicated containers are marketed. For bulk freight, two steel plate containers with a capacity of 20 m\textsuperscript{3} and 30 m\textsuperscript{3} respectively are offered. The loaded containers are covered with a tarpaulin. For general cargo, a 7.5 m curtain sided, cut resistant, swap body-like box with a load capacity of

\textsuperscript{105} Roland Tankbau, brochure, 1996.
\textsuperscript{106} SUTELA, E-mail dated 9 May 1997.
\textsuperscript{107} Deutsche Bundesbahn, 1990, p. 2.
18 Europallets/16.5 tons is marketed. All boxes are adapted for vertical lift at conventional terminals through integrated lift pockets\textsuperscript{108}.

The wagons, developed by the company AFR, are named S82 and S83 and can carry three 5.7 m bulk boxes and two swap body-style boxes of up to 7.5 m length respectively.

\begin{figure}[h]
\centering
\includegraphics[width=0.8\textwidth]{figure2-35.png}
\caption{A transshipment using the Multi-berces system. Note the integrated lift pockets.}
\textit{(Source: SNCF Fret, brochure, 1993)}
\end{figure}

The transshipment in the Multi-berces system is carried out by use of lorries equipped with Bennes Marrel’s Ampliroll hydraulic hook-lift device (see above). The 15 000 Amplirolls operational in France make the system a rather open system with no fear of equipment shortages. The turntable frames and locking devices, as well as the height of the adjusting ring on the hook comply with DIN and AFNOR norms. Thus, the system is internationally compatible\textsuperscript{109}. The evaluation is similar to that of ACTS with the distinction that the limitation to hook-lifts make it more restricted in its use and add the problems of the vertical angle at which the boxes are transferred.

2.3.6 Partek Multilift Factory: TTT-System

Together with Partek Multilift Factory, Finnish State Railways (VR) presented a technology very similar to the ACTS already in 1982\textsuperscript{110}, actually before the ACTS was introduced. It is possible that the know-how was transferred together with the Multilift as it was first licensed and then sold to Translift in the Netherlands.

For natural reasons, the TTT (Truck-Train-Truck) System is based upon Partek’s Multilift equipment. The transshipment principle is very similar to that of ACTS but the system is more directed towards swap bodies than dedicated bulk containers. Transshipment to and from the ground is carried out using

\begin{itemize}
\item \textsuperscript{108} SNCF Fret, brochure, 1993.
\item \textsuperscript{109} CHAMPION, 1992.
\item \textsuperscript{110} Transport-nytt, 1982, p. 22.
\end{itemize}
a hydraulic lift on the lorry and the support legs of the swap body, that is the standard way for swap bodies. A transshipment operation using the TTT-system is shown in the figure below.

Figure 2-36 Transshipment using the TTT-System. (Source: Partek Multilift Factory, product brochure 1982).

The TTT-System was developed to accommodate swap bodies complying with the Finnish standard but the principles could rather easily be adapted for any swap body standard. A special interface was developed for taking 20-foot ISO-containers, but it was never commercialised. The wagons were normal open flatbed wagons equipped with a turntable. Such a turntable wagon used by SJ, is shown in the figure below.

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112 SUTELA, E-mail dated 9 May 1997.
In 1983, six wagons ran in commercial traffic with fertilisers from the port of Kotka to Kitee in Karelia in northern Finland. Grain is balancing the flow southwards. Five of the wagons could take two turntables for 7.7 m swap bodies and one could take three turntables for 6.05 m. Further 10 two-frame wagons and 20 three-frame wagons were on order in 1983. The turntable had a tare weight of 1.65 tons and was sold to VR at a cost of some ECU 8000 in 1983. An anecdote says that the inventor Matti Nevalainen first came up with the idea while playing with Lego\textsuperscript{114}. The superstructure added some 600-800 kg. It could lift a swap body of maximum 18 tons, 32 centimeters in 15 seconds\textsuperscript{115}.

The TTT-System was also marketed in Sweden, then with focus on 20-foot ISO-containers\textsuperscript{116} but it never saw any big success. In recent years, Partek has not been very active in marketing the TTT-System, but it was used by VR for many years\textsuperscript{117}.

The evaluation of the TTT-System is similar to that of its follower ACTS, but the aim for standard swap bodies is a clear advantage for the TTT-System.

### 2.4 SELF-LOADING TRAILERS AND RAIL WAGONS

As indicated above, a big problem with containerisation is how to lift a container onto a lorry at the premises of consignors and unload them to the ground at consignees. The major problems occur when the flows are small since occasional container handling cannot justify the purchase of large counterbalanced trucks. Fully utilising the benefits of containerisation also means that the lorry should not be standing still while the container is stuffed or stripped.

\textsuperscript{114} BRANKE, 1983, p. 12.
\textsuperscript{115} Transport-nytt, 1982, p. 22.
\textsuperscript{116} HIAB-FOCO, product brochure, 1985, p. 35.
\textsuperscript{117} SUTELA, letter dated 17 March 1997.
One way of solving the problem is, as described above, to hoist the container over the end of the lorry, e.g. with the N.C.H. 4000. An alternative way is to fold out hydraulic jibs from the side of the lorry or semi-trailer and lift the container after fastening it with a spreader or a set of chains. Such an equipment; usually referred to as a self-loading trailer (SLT), sideloader or sidelifter; is basically designed for picking up containers from the ground, transporting them to their destination and placing them down again. However, they can also be used for loading a container onto another container, another lorry or, as is interesting to this study, to a rail wagon. The ISO-container is the dominant ITU but at least two brands are marketed with the possibility of lifting swap bodies. The figure below shows some transshipment alternatives for one of the most common brands, the Hammarlift.

![Figure 2-38 Loading alternatives using a self-loading trailer with chains. (Source: Hammar Maskin AB, technical specifications leaflet, 1993/b).](image)

SLTs can operate in areas that otherwise might be fairly inaccessible as far as container operations are concerned since the need for container cranes and reach stackers can be avoided and there are only moderate requirements for the terminal surface. The flexibility is indicated by the success in military deployments, e.g. in the recent UN mission in Somalia[^118]. SLTs are sometimes criticised for being a heavy, bulky and expensive way of transporting containers over the road. Nevertheless, their advantage lies in the easy transshipments to and from the ground, and they are generally not used for longer transport assignments due to the high costs compared to simple semi-trailer chassis. Nevertheless, an option for longer distances is to operate one SLT as a part of a convoy with other standard lorries and semi-trailers to maximise the use of the equipment[^119].

Today, SLTs are used in a wide range of low to medium throughput applications, including small intermodal rail yards, shippers’ premises and small ports. SLTs have been particularly successful in Scandinavia, Australia and parts of Asia where container operations are of a relatively small-scale. Eastern Europe is stated as a big potential market[^120] as infrastructure for container handling is lacking in many places and SLTs offer an easy start in container use. One of the market leaders, Swedish Hammar Maskin AB has tried to market their SLTs in the US, but that market has proven to be hard to penetrate, albeit huge amounts of ISO-containers are moved locally each year[^121]. Besides technology conservatism, the reason is most probably the wide spread use of semi-trailer chassis, the Americans

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[^121]: HALLBERG, interview, 1995.
use simpler and cheaper design than those used in Europe, which allows them to be resting while the containers are stuffed and stripped. Nonetheless, significant improvements in design, for example in terms of maximum weight capacities and overall reliability, have been made by the manufacturers and they report much more widespread acceptance of the SLT concept in the recent past.

A transshipment of a container from a railway wagon to the lorry starts with positioning the lorry along the rail wagon and the integrated support legs/jibs are adjusted lengthways to match the position of the container, and the support legs/jibs are folded out sideways. Then, depending on the design, the spreader is fastened to the container or chains are fastened by use of hooks in the lower corner pockets. The actual transshipment is carried out using the hydraulic jibs and the operation is generally controlled by the lorry driver using a remote control. A transshipment of a container from the ground takes about 4-5 minutes and from a railway wagon a little bit more due to the needs for more exact positioning and unlocking the container from the wagon.

For intermodal use, SLTs are suitable in a direct connection design or any other terminal where transfer can take place throughout the day. It can also be used for pure local road haulage serving a traditional port or intermodal terminal where container are unloaded to the ground for further handling with gantry cranes and reach stackers.

The first SLTs appeared on the market about 20 years ago and today there are many competing manufacturers. Below, some brands, including some mounted on rail vehicles, are described with their specific features and markets.

Table 2.17  Short summary evaluation: Side loading trailers and rail wagons.

<table>
<thead>
<tr>
<th>Aimed for small-scale transshipment of ISO-containers (some brands also accommodate swap bodies).</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Advantages</strong></td>
<td><strong>Disadvantages</strong></td>
</tr>
<tr>
<td>- Easy use at private rail sidings or at forwarders’ general cargo terminals</td>
<td>- Does not (yet) accommodate swap bodies (most brands)</td>
</tr>
<tr>
<td>- No need for external transshipment equipment or terminal personnel – the lorry driver transships the units alone</td>
<td>- Need for synchronisation of road and rail vehicles at terminals</td>
</tr>
<tr>
<td>- Very simple and cheap terminal</td>
<td>- Non-standard and relatively expensive equipment on lorries or transshipment rail wagon</td>
</tr>
<tr>
<td>- Flexible use of terminals</td>
<td>- Relatively high tare weight on lorries (or rail wagon)</td>
</tr>
<tr>
<td>- Transshipment under the overhead contact line (some brands)</td>
<td>- The transfer equipment “steals” length both on rail wagons and on lorries</td>
</tr>
<tr>
<td></td>
<td>- Several units needed for fast transshipment</td>
</tr>
<tr>
<td></td>
<td>- Shunting needed prior to transshipment (rail mounted side loaders)</td>
</tr>
</tbody>
</table>

### 2.4.1 Steel Bros.: Sidelifter

Steel Bros. manufactures a wide range of SLTs under the brand name Steelbro Sidelifter. Acceptance of the SLT concept in New Zealand, Australia and more recently in Asia, has helped Steel Bros. to develop a very robust SLT for these markets. Besides its home market, Steel Bros. penetrates the

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122 Cargo Systems, 1994/a, p. 31.
European market through its UK based agent Containerlift\textsuperscript{125} and Steel Bros. claims to be market leader with 52\% of the world market\textsuperscript{126}. In all, Steel Bros. reckons to have built 1000 of a total world population of 2000-3000 SLTs\textsuperscript{127}. A particular area of growth has, reportedly, been intermodal transfer at small railway sidings and small container depots\textsuperscript{128}.

In Australia, sidelifters are frequently used in convoys with standard lorries or semi-trailers\textsuperscript{129}, although the very generous (even to Swedish standards) lorry permits in Western Australia means that one such vehicle combination, as shown in the figure below, would be referred to as a convoy in other countries.

![Steelbro MK6 Sidelifter combination in Western Australia. (Source: Steelbro, newsletter, 1995, p.1)](image)

Recent developments include low profile chassis for high cube containers, units for 45 foot containers, new steering systems, increased container stacking capabilities and a new power supply system. Steel Bros. has also developed a new model, which is suitable for truck mounting. This has an extremely low tare weight, but still retains significant lifting capacity\textsuperscript{130}. A further, and notable, application of the Steelbro SLT is to transport mobile petrol stations such as the one shown below.

![Mobile petrol station for distribution by an SLT. (Source: Steelbro, newsletter, 1996/b, p. 3)](image)

\textsuperscript{125} Cargo Systems, 1996/c, p. 41.
\textsuperscript{126} HART, letter dated 7 October 1996.
\textsuperscript{127} O’MAHONY, 1997, p. 61.
\textsuperscript{128} HART, letter dated 7 October 1996.
\textsuperscript{129} HART, letter dated 7 October 1996.
\textsuperscript{130} Cargo Systems, 1996/c, p. 38.
In order to reach the market, Containerlift operates own units and leases to prospective customers for trial use. A unit has also been delivered to the Dutch owner-operator Gevezet Container Transport\textsuperscript{131}.

\subsection{Hammar Maskin: Hammarlift}

Hammar Maskin AB based close to Gothenburg, Sweden, produces its Hammarlift for lorries and semi-trailers. The various models are capable of handling a wide range of containers from 20 to 48 feet, with a 20 to 36-ton lifting capacity and the ability to stack two containers on top of each other\textsuperscript{132}. Containers can also be transferred to other lorries or to rail wagons. Moreover, a separate twin-lock device allows for simultaneous lift of two 20-foot containers\textsuperscript{133}. The trailers are fitted with stabilisers and operated directly using manual hydraulic valves or via a remote control system. Further options for faster operations are automatic twist-locks for the lorry, a toplift spreader for containers\textsuperscript{134} and spreaders for swap bodies\textsuperscript{135}.

The Hammarlift is designed for lifting in one direction only, but empty containers can be unloaded on the reverse side of the lorry\textsuperscript{136}. With its patented folding support legs, Hammar claims that its SLTs are the only ones able to load or offload any of the new low platform container rail wagons currently entering service in Europe\textsuperscript{137}.

A new model, shown in the figure below, is mounted on a telescopic semi-trailer\textsuperscript{138}, which means that it is 11-12 m when carrying a single 20-foot container and 15,1 m (allowed in Sweden) when carrying a 45-foot container\textsuperscript{139}. Both the hydraulic jibs and the telescopic trailer are manoeuvred with a remote control.

Asia, Middle East, Africa and South America are all familiar markets for Hammar\textsuperscript{140} and recently, they have also set up a sales office in Australia\textsuperscript{141}. The increase in sales can be linked to the fact that the big chemical companies increase their use of dry and tank containers for rail transportation of their products. German and Swiss companies such as Bayer, Ciba Geigy, Hoechst and Hercules all use Hammarlifts\textsuperscript{142}.

\begin{flushleft}
\textsuperscript{132} European Intermodal Yearbook, 1996, p. 216.
\textsuperscript{133} Hammar Maskin AB, product brochure, 1995.
\textsuperscript{134} Hammar Maskin AB, product brochure, 1997.
\textsuperscript{135} Hammar Maskin AB, technical specifications leaflets, 1993/b and 1996.
\textsuperscript{136} Hammar Maskin AB, technical specifications leaflet, 1993/a.
\textsuperscript{137} Cargo Systems, 1994/a, p. 33.
\textsuperscript{138} Cargo Systems, 1995/b, p. 21.
\textsuperscript{139} Cargo Systems, 1996/c, p. 38.
\textsuperscript{140} Cargo Systems, 1996/c, p. 37.
\textsuperscript{141} Cargo Systems, 1995/b, p. 22.
\textsuperscript{142} Cargo Systems, 1994/a, p. 33.
\end{flushleft}
Hammar has recently expanded its production facilities allowing deliveries of some 150 units annually. In its marketing, Hammar especially focus on low tare weights, high lifting capacity and fast transshipment. Furthermore, reliability is proved by the fact that the first ever produced Hammarlift is still in operation after 20 years\textsuperscript{143}.

Hammar claims that 50-60\% of the customers are SMEs in the road haulage industry, distributing to a fairly small area or between specific locations such as a port or to a local industry. The cost of a basic model of the Hammarlift is about USD 60 000\textsuperscript{144} (ECU 52 000).

2.4.3 Arbau-Klaus Transportsysteme Vertriebs: Kranmobil

The Klaus-Kranmobils can be classified in two groups; 1) equipment with one-sided loading capability used as road worthy loading and transporting equipment; and, 2) equipment with top lift spreader attachment facilitating bilateral loading capability used as mobile transfer equipment. An option for the hauliers is to use a clamp spreader allowing lifts of swap bodies in their lift pockets\textsuperscript{145}. With the different types of equipment, lifts of up to 36 tons are possible\textsuperscript{146}. Klaus has recently been able to de-

\begin{itemize}
\item \textsuperscript{143} Cargo Systems, 1994/a, p. 32.
\item \textsuperscript{144} COULTER, 1995, p. 53.
\item \textsuperscript{145} Klaus Transportsysteme Vertriebs GmBH, 1996/a, p. 10.
\item \textsuperscript{146} European Intermodal Yearbook, 1996, p. 216 and Klaus Transportsysteme Vertriebs GmBH, 1996/b, p. 1.
\end{itemize}
crease the weight of the Kranmobil device with one ton\textsuperscript{147} which is needed since the top-lift spreader design is much heavier than that using chains and hooks.

After financial problems in 1993, Arbau-Klaus temporarily suspended trading in 1993, but during the last years they have sold some 20-25 machines annually. In October 1996, it was taken over by a former employee, Franz Prestel\textsuperscript{148}. The home market Germany is the most important one, but Kranmobil have also found their way to the Caribbean and Eastern Europe\textsuperscript{149}.

Kranmobil were also used in the UN mission in Somalia, and as the units were produced to meet EC and German standards, the German Federal Forces could license and operate them in Europe after the Somali mission. Also the UK Ministry of Defence, to whom Arbau-Klaus delivered a significant amount of SLTs in 1989-90, has discovered the benefits of SLTs in military operations\textsuperscript{150}.

2.4.4 Steelmec: SIMAN-lift

Another Gothenburg-based company, Steelmec Verkstäder i Ale AB, manufactures SIMAN self-loading trailers\textsuperscript{151}. One man operates the equipment via a remote control and the cycle time for loading or unloading is said to be 4-5 minutes. Besides 20, 30, 40 and 45 foot ISO-containers, the SIMAN-lift handles swap bodies, modular assemblies, construction materials and machinery\textsuperscript{152}. Support legs extend in line with the short crane arms in order to give a fast lift cycle and a stable lift platform.

The SIMAN-lift is developed to be a hard-wearing sideloader easy to drive, fast and of low weight\textsuperscript{153}. As the only manufacturer, Steelmec offers their SLT in kit form to be mounted on any lorry or trailer\textsuperscript{154}.

2.4.5 Blatchford Transport Equipment: Blatchford-SIMAN sideloader system

In the UK, the SIMAN-lift is licensed to Blatchford Transport Equipment\textsuperscript{155} where it is marketed under the name Blatchford-SIMAN sideloader system. The actual sideloader equipment is manufactured by Swedish Steelmec, but Blatchford mounts SIMAN-lift kits onto semi-trailer units of own manufacturing. Blatchford has further developed the SIMAN technology in three specific aspects\textsuperscript{156}:

- Specially designed trailer chassis to fit the road regulations in the UK and other European countries.

\textsuperscript{147} Cargo Systems, 1996/c, p. 37.
\textsuperscript{148} Cargo Systems, 1997/c, p. 35.
\textsuperscript{149} COULTER, 1995, p. 53.
\textsuperscript{150} Cargo Systems, 1995/b, p. 20.
\textsuperscript{151} Steelmec Verkstäder i Ale AB, 1996.
\textsuperscript{153} Steelmec Verkstäder i Ale AB, 1997.
\textsuperscript{154} Cargo Systems, 1994/a, p. 33 and Trafikmagasinet, 1997/b, p. 40.
\textsuperscript{155} European Intermodal Yearbook, 1996, p. 216.
\textsuperscript{156} POOL, letter dated 22 April 1997.
- A Total Moment Indicator system which has the capacity to be upgraded to act as a weighing system.

- A heavy duty, slow speed, diesel hydraulic power pack which makes extensive use of stainless steel components and is detachable from the trailer in less than ten minutes.

Blatchford also sells a handling kit for 7.15 to 13.6 m swap bodies. The Blatchford SLT with 30.5 tons capacity is shown in the figure below.

![Blatchford-SIMAN semi-trailer mounted sideloader system.](image)

(Source: Blatchford Transport Equipment, product brochure, 1997).

Blatchford believes that most potential for their equipment exists in the intermodal road/rail market.

### 2.4.6 Mitra: Mitralift and the Rural Road-Rail Container Handling and Transport System

A South African company, Mitra, has designed an intermodal container handling and transport concept primarily for the servicing of intermediate destinations between main intermodal terminals. It is called the Rural Road-Rail Container Handling and Transport System and the complete system is patented by Mitra. The concept incorporates the sideloader Mitralift and is especially designed for the harsh conditions prevalent in South Africa, although its application is universal. ISO-containers of up

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to 20 foot length can be accommodated by the system\textsuperscript{158}. The sideloader is equipped with its own hy-
draulic power source.

What make the concept special is that it is mounted on a semi-trailer of a bimodal design (see section 2.7) and that the semi-trailer tractor is carried on a special tractor wagon at the end of the train. At the intermediate terminal, the tractor drives off its wagon on a ramp. Then the Mitralift lowers its outrig-
gers using its own hydraulic power and lifts the whole unit clear of the rail bogie and tractor wagon connections. The train moves forward and the tractor pulls the tractor wagon backwards thus releasing the Mitralift that now can be lowered and coupled to the tractor. Then it is used as a normal sideloader transhipping any container on the train.

The whole operation is carried out by one person. It can obviously be the engine driver but he then has to walk along the train several times since the train has to be moved in the midst of the operation.

2.4.7 Biglo Oy: Biglo Bigloader

The Finnish company Biglo Oy, a part of the Rautaruukki group is restructuring\textsuperscript{159} and it is seeking partners for the marketing and further development of its Bigloader SLTs. Rautaruukki believes that the Bigloader does not fit into their core activity of producing steel, although Rautaruukki is a signifi-
cant producer of rail wagons and various intermodal systems. Negotiations concerning manufacturing and marketing Bigloaders have, reportedly, taken place between Rautaruukki and two Finnish paper manufacturers\textsuperscript{160}. In terms of markets, Biglo naturally sees potential in its home market in Finland, but also in Singapore and Korea as well as in Russia\textsuperscript{161}.

2.4.8 Voest-Alpine MCE: S4036

Austrian steel producer Voest-Alpine launches a range of SLTs developed together with Entwick-
ungsbüro Udo Winter. The new container handling and transport system is effectively a trailer-
mounted sidelifter which can carry containers up to 40 foot and 36 tons and its tare weight is 9.5 tons. Voest-Alpine markets four basic models and all operations can be handled by the lorry driver using a remote control. Transshipment time is said to be 5-7 minutes. Voest-Alpine specifically aims for the intermodal road/rail market, but the company also intends to promote the device for use at warehouses and for military purposes\textsuperscript{162}.

2.4.9 Karl Maier: Container Loading and Transport System

Another Austrian firm, Karl Maier, has developed an SLT together with Entwicklungsbüro Winter. Also the Maier SLT can handle 20-foot to 40-foot containers with a maximum weight of 36 tons, but, moreover, it can accommodate swap bodies with a length of up to 12.3 m. The design allows for transfer from a rail wagon onto its own loading platform, onto another lorry or directly to the ground on

\textsuperscript{159} COULTER, 1995, p. 53.
\textsuperscript{160} Cargo Systems, 1995/b, p. 22; 1996/d, p. 41 and 1997/c, p. 36.
\textsuperscript{161} Cargo Systems, 1994/a, p. 33.
\textsuperscript{162} Cargo Systems, 1996/c, p. 41.
either side of the lorry. The vehicle does not have to be positioned very precisely beside the container
since the loading arms can be individually moved lengthways. The height is only 4.1 m allowing it to
transship containers on and off rail wagons without interfering with overhead contact lines\(^{163}\). After
introducing its SLT in 1993, Karl Maier went out of business already in 1995\(^{164}\).

### 2.4.10 CHR. Olsson: Triolift

As a third Gothenburg-based manufacturer of side-loaders, Chr. Olsson AB markets its Triolift. The
basic features are similar to other side-loaders\(^{165}\). The design is similar to the SIMAN-lift since it was
developed by Glenn Forslund who later went to Steelmec.

### 2.4.11 KMA System: Sideloader

A fourth Swedish manufacturer, KMA System, based in Lövånger in the far north of Sweden, sells
around 12 machines annually. SLTs have been sold to Volvo for the distribution of spare parts and to
the mining company LKAB\(^{166}\).

### 2.4.12 Umschlagfahrzeug Lässig Schwanhäusser – ULS

Besides the pure investment help described in the dissertation (section 6.2.6), the German Government
has sponsored several technical development projects in the field of combined transport. The result of
one such project is the Umschlagfahrzeug Lässig Schwanhäusser\(^{167}\) (ULS) that follows the principles
used by SLTs, however mounted on a railway vehicle. The basic idea is to transfer boxes in a railway
station similar to how passengers change trains. The following features were requested\(^{168}\):

- Autonomous driving on track
- Integration into DB’s intermodal production system
- Transshipment of up to 40-foot maritime containers, German domestic (pallet-wide) containers as
  well as swap bodies
- Transshipment between container flat wagons, directly or indirectly between flat wagon and lorry
- Transshipment under the overhead contact line
- Service at side tracks
- Ability to be transported as an ordinary goods wagon on German railway lines
- Ability to pull two container flat wagons

\(^{163}\) Cargo Systems, 1994/a, p. 33.
\(^{164}\) Cargo Systems, 1997/c, p. 35.
\(^{165}\) Chr. Olsson, product brochure, 1992.
\(^{166}\) COULTER, 1995, p. 53.
\(^{167}\) Lässig and Schwanhäusser are the names of the inventors and “Umschlagfahrzeug” is transshipment vehicle
  in English.
\(^{168}\) EURET, 1994, p. 29.
The resulting solution is a specialised diesel powered railway vehicle with a gantry crane mounted between two driver cabins. The gantry crane is designed with foldable arms on which the spreader runs hanging in wires. The balance is maintained by folding support legs. One shortcoming is that the weight of the unit implies the use of 3-axle bogies, a cost revision suggests the use of standard 2-axle bogies, but that prevents the vehicle being transported on normal trains. The transshipment principles are shown in the figure below.

Figure 2-43  Umschlagfahrzeug Lässig Schwanhäusser. (Source: Bundesminister für Verkehr, 1981, p. 43).

The positioning system is either manual or automatic. For manual transshipment, the driver is helped by one video camera for each of the four lifting points, and the automatic positioning system uses ID tags on the flat wagon. Simulations have proved the rather odd key figure 4 minutes per transshipment if four ULS units are used concurrently

Four different vehicles were built for service with German State Railways (then DB, now DB AG), some of which were in use by Austrian State Railways (ÖBB) as late as in 1994. The reception was not entirely warm by DB and no orders were placed after the test phase. The main reasons were:

- Long cycle times due to complexity of the positioning as well as the crane system
- High costs (ECU 0.7 million for each of the four prototypes in the early 1980’s), mainly related to the abilities to be transported in normal trains and to pull two flat wagons.
- Strategic decision not to serve intermediate stops at low equipped terminals and siding tracks.

One of the prototypes is shown in the figure below.

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169 Bundesministers für Forschung und Technologie, 1986, p. 32.
Much has changed during the last ten years, and DB AG might not be the only possible customer, even if only the German market is aimed for. Even DB AG’s production system has changed dramatically and, as the strategic decision on stops at intermediate terminals no longer is in force, the ULS can possibly find a utilisation as a complement to DB AG’s Cargo Sprinter.

2.4.13 The Blatchford T-lift system

Blatchford’s T-lift system could be described as a foldable gantry crane able to transship ISO-containers and, as an option for some versions, swap bodies. Versions for mounting on a semi-trailer or a railway vehicle have been presented. In its basic version it can carry a container like a standard SLT, but the train mounted version is more of a pure transshipment equipment. Hence, the technology is something between the Arbau-Klaus’ Kranmobil with a top-spreader and the ULS.
All T-lifts come with an integrated diesel engine and a hydraulic pump. The top-lift spreader can be manoeuvred through a remote control and if the unit is supposed to be used for stacking purposes, taller masts are optional.

The train-mounted version has been tested by Freightliner in the UK and the principle is very similar to the ULS as can be seen in the figure above. Note the overhead beam that carries the spreader. In the transport mode, the size of the folded crane prohibits the vehicle carrying a container during rail transport. The unit can be towed in the train in up to 120 km/hour but for flexible shunting operations it is