MMRCV Loading & Unloading

Review of Load Handling Systems for London's Canal Network

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Final Report

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1 Introduction

This review has been produced by Peter Brett Associates for Transport for London and provides a summary of the types of loading and unloading equipment required for handling the various cargoes which can be carried by craft using the London canal network.

For the transport of goods and materials on the waterways to take pace, suitable and effective methods of handling it at the origin and destination are necessary. Using the most appropriate equipment for this task will ensure that cargoes are transferred between the wharf and craft quickly, safely and economically.

In considering the transfer of cargoes between waterborne craft and the land (and *visa versa*), there are essentially two forms of handling equipment:

- machinery which is permanently positioned on the wharf; or
- machinery which is mobile - i.e. can also be used a away from the wharf.

The cost of installing and operating these two groups of equipment is quite different and careful consideration and assessment is required when selecting a system to suit the cargo handling needs of a wharf.

Other factors, which need to be taken into account, are the volume of material to be handled and any other functions required from the equipment, such as transferring goods to and from road vehicles as well as barges.

In their heyday, canals were used to transport almost any type of commodity. In the case of non-bulk materials (e.g. sacks, chests, barrels), these were carried as loose cargoes, usually being transferred over the gunwale by crane in carrying nets and then manually handled on the barge or wharf. As a result many forms of handling equipment were provided (e.g. building mounted hoists and pulleys), some of which will not be relevant today, since it is unlikely that similar loose cargoes will be transported in any volume by canal. Changes to packaging and handling methods, as well as health and safety and standards regulations, means not all the previously used equipment will be suitable today.

1.1 Canal use in London

All of London's usable canals are situated north of the Thames, with the main access points between the two waterway networks found at Brentwood, Limehouse Basin and Bow Creek. However, very little, if any freight, currently moves from one water system to the other.

The levels of freight carried exclusively on the canals (i.e. Grand Union Main Line, Regents Canal, Paddington Arm, Slough Arm, Hertford Union and Lee Navigation) into and out of, and within London are very small.

The most important waterway route in London (in terms of tonnes lifted) is the River Thames, with 1.81 million tonnes of freight carried by water transport, in 2005. A key factor for this position extends directly from the fact that the Thames has many sources and destinations from and to which freight can be moved. On the lower Thames a range of products are available for barging including aggregates, timber and steel. Waste can also be transported downstream to disposal points in Essex.

With respect to London's canals, their use for freight transport is so negligible that no separate data are included in published national statistics - i.e. Waterborne Freight in the United Kingdom 2005. Furthermore, information is not readily available, because data regarding tonnages lifted and moved does not appear to be systematically collected.

The largest regular flow of freight on London's canals is the aggregates movement from Denham to West Drayton (Harleyford Aggregates to Hanson), which has planned traffic of 60,000 tonnes per annum, but is at present below this target at around 50,000t per annum. Other movements of freight are more *ad hoc*, and include traffic such as the transport of waste paper from Paddington Basin to Rickmansworth and other construction waste and materials.

Although the quantity of freight moving on London's canals during 2005 is estimated by PBA to be no more 75,000t, a range of new traffic has either started or is predicted to move shortly. These include:

- 10,000t of steel is being transported by water to the Kings Place development taking place at Battlebridge Basin

- 100,000t of soil is being moved by barge from a development at Sutton's Wharf to Mile End before being transferred to road vehicles for onward transport
- A possibility that 60,000t of steel could be transported to the Sutton's Wharf development, but this is to be confirmed
- 1,000t of aggregates are to be transported by water from Hanson's West Drayton Depot to Powerday at Willesden in a trial that could eventually convert into a total of 80,000t per annum (30,000t of new aggregate to Powerday; 50,000t of recycled aggregate to Hanson)
- Probable removal of 120,000t of demolition material from Paddington Basin to Powerday in the second half of 2007, with a possibility that steel is delivered for the development during its construction.

If this traffic materialises, freight movements on the London canal network could rise to around 300,000t over the year. However, because a large proportion of the flows are not permanent and chiefly occur for a specific period (i.e. during the course of a new canal side development), the annual volumes of traffic fluctuate.

The list above indicates the types of commodities that are typically transported by the canals. These can be categorised as:

- Aggregates
- Construction and demolition waste
- Ground preparation spoil
- Some building materials
- Recyclates and general waste if containerised

The erratic nature of canal freight generation has implications on the number of operators working the London network. The two most prominent companies are Land and Water, and Wood, Hall and Heward, which between them own and operate the most barges and tugs. There are a few owner/operators of tugs and barges such as Mick Hillier, who typically subcontract to the larger companies as well as transporting opportune loads.

1.2 Planning policy context

Handling equipment is an integral part of waterborne freight operations and its proper deployment is an implicit requirement of the Mayor's freight and intermodal strategy for London, namely as part of:

- The London Plan - Policy 3C.24: *"The Mayor will promote sustainable development of the full range of road, rail and waterborne freight facilities in London and seeks to improve integration between the modes."*
- Transport Strategy - Policy 4K.1: *"Ensure that London's transport networks allow for the efficient and reliable handling and distribution of freight. Forster a progressive shift from road to mode sustainable modes such as rail and water."*
- Municipal Waste Strategy - Policy 40: *"The Mayor will work with all agencies, including TfL and the LDA to develop capacity of sustainable modes for the transport of recyclables in London and will promote new schemes where they are feasible within this overall framework."*
- Sustainable Freight Distribution - A Plan for London: The Delivery Plan *"Securing development of intermodal facilities and promoting modal shift towards more sustainable forms of freight transport"*
- Safeguarded Wharves - Fifty wharves along the Thames lying within Greater London are safeguarded by ministerial direction following the Mayor's recommendations in the London Plan Implementation Report[1]. The Mayor's power to secure river wharves along the Thames does not currently extend to canal wharves or the necessary supporting land.

For the remainder of this report the content is structured such that:

- chapter two considers the types of craft used on the canals,
- chapter three provides a summary of the handling equipment,
- chapter four presents closing remarks.

[1] GLA, Safeguarded Wharves on the River Thames London Plan Implementation Report, 2005

2 Types of vessel

2.1 Introduction

In order to consider the methods for handling freight on and off of barges and craft that use the canals, it is helpful to have an overview of the types of vessels that are used to carry freight by water.

2.2 Background

For craft to move efficiently and safely on the waterways they have to be designed to work within the physical parameters of the infrastructure. Essentially these parameters can be considered as relating to factors affecting:

- their movement; and
- their loading and unloading.

Within London the different sections of the Grand Union Canal's infrastructure conform to the same dimensions. This is an important factor since it permits vessel design and configuration to be optimised such that the craft can be built to maximise their permissible capacity and therefore offer the best commercial option for freight movement within the working environment. The key causes that constrain the dimensions of craft include the size of locks, bridges, tunnels, turning requirements and radii of bends.

The maximum dimensions of a craft such that it can move on the London sections of the Grand Union Canal are provided in Table 2-1.

Table 2-1: Maximum craft dimensions for use on London section of Grand Union Canal

Grand Union Canal Section	Length	Beam	Height	Draught
Regents Canal	21.95m (72ft)	4.2m (14ft)	2.28m (7ft 6in)	1.06m (3ft 6in)
Paddington Arm	21.95m (72ft)	4.2m (14ft)	2.28m (7ft 6in)	1.06m (3ft 6in)
Main Line	21.95m (72ft)	4.2m (14ft)	2.28m (7ft 6in)	1.06m (3ft 6in)
Slough Arm	21.95m (72ft)	4.2m (14ft)	2.28m (7ft 6in)	1.06m (3ft 6in)

However, it is worth noting that craft sizes are more constrained on the London section of the Grand Union Canal when compared with the other parts of London's waterways network. Table 2-2 provides details of the other waterway dimensions and indicates that craft designed for the Grand Union Canal can be easily accommodated on the other waterways.

Table 2-2: Maximum craft dimensions for use on other London canals

Other Canals	Length	Beam	Height	Draught
Hertford Union (Grand Union Canal)	21.95m (72ft)	4.2m (14ft)	2.28m (7ft 6in)	1.06m (3ft 6in)
Lee Navigation - Thames/Old Ford	26.82m (88ft)	5.8m (19ft)	2.05m (6ft 9in)	2.05m (6ft 9in)
Lee Navigation - Old Ford/Ponders End	26.82m (88ft)	5.5m (18ft)	2.05m (6ft 9in)	1.06m (3ft 6in)
Lee Navigation - Ponders End/ Hertford	25.9m (85ft)	4.8m (15ft 9in)	2.05m (6ft 9in)	1.06m (3ft 6in)

The implications of having different canal infrastructure dimensions means that craft designed to navigate the Lee Navigation are unable to enter the Grand Union Canal (GUC), although the smaller craft of the GUC are able to operate on the Lee. In terms of capacity, a Lee Navigation craft can carry up to 120 tonnes of cargo, while GUC vessels are limited to about 80 tonnes. There are also implications if the carriage of containerised freight is being considered.

Although certain infrastructure features limit craft dimensions in terms of their movement along waterways, canalside mooring can also have a bearing on vessel size. On-going canalside development has resulted in the depletion of commercial wharves and in some areas has led to the removal of continuous stretches of wharf at which freight vessels can moor.

Vessel design also needs to take account of the loading and unloading methods at wharves, as these will impact upon factors such as the size of hatch openings, internal vessel construction or whether it should be self-propelled or a 'dumb' unit.

2.3 Vessel design

Vessels designed to carry freight on canals should aim to satisfy the following elements:

- maximise the capacity of the vessel within the limits of canal dimensions,
- facilitate loading and unloading methods,
- ensure protection for the cargoes, and
- maintain the performance / handling of the vessels (BWS, 2006).

It is noted in the Lowland Canals Freight Action Plan Report, that, "The ideal shape of a vessel to maximise the carrying capacity is a rectangle. However the optimum shape for vessel handling is smoothly curved, pointed at the front and rounded at the rear (boat shaped!). Vessel design therefore has to be a trade-off in hull design between maximum capacity and maximum performance." (BWS, 2006)

Various vessel configurations are available for use on inland waterways, which can be considered under the flowing headings:

- Dumb barges and tugs.
- Self-propelled craft.
- Containers with built-in flotation.
- Floating skip rafts.
- Container carriers.

2.3.1 Dumb barges and tugs

This type of barge is a non-motorised barge which needs to be pushed or pulled by a motorised tug. Constructed of steel, ideally the hull should be double skinned or built to a design that dispenses with the need for internal cross-hull bracing (e.g. chains or bulkheads). This type of vessel is commonly used for a wide range of cargoes which are both bulk and general purpose and can be moved more than one at a time since they can be lashed together in tandem.

The tugs are a separate motorised unit capable of pushing and/or pulling dumb barges. This may be carried out in various configurations - e.g. a tug pulling one or two barges, a tug pushing one barge, a tug pushing one barge and pulling one or two, with a helmsman steering the rear barge. Table 2-3 summarises the key features, while Figure 1 shows examples of the vessels.

Table 2-3: Dumb barges & push tugs

Dumb barges	
Advantages	▪ Cheap to construct. ▪ Can have multiple barges and, where relevant for freight type, multiple sets of containers. ▪ Can be stored at suitable lay-byes or wide areas. ▪ Large loads can be cheaply transported along longer pounds using one tug working more than one barge. ▪ Removes reliance on 'winding holes' (turning points) and thereby reduce the journey times.
Disadvantages	▪ Handling – dumb barges need extra handling to pass through locks etc. For practical purposes, it might be necessary to assign a tug to each barge down flights of locks.

	▪ There are practical & safety considerations that might preclude the use of towlines - the use of long towlines has safety implications for other canal users. However, use of a push-tug pushing one barge and towing another one or two is a possibility, particularly if towlines are short. ▪ Lack of available modern designs and new builds.
Push tugs	
Advantages	▪ Relatively cheap to construct compared with motorised barges. ▪ Capable of moving single or multiple barge units, offering larger tonnage movement each trip. ▪ Can be used for shunting operations at wharf if a number of barges moored. ▪ Fully flexible - can be used for moving any type of cargo.
Disadvantages	▪ Require two crew members if used to haul more than one barge. ▪ Unable to enter lock along with barge due over length of tow. ▪ Where a barge fills the lock tugs are unable to

Source: Adapted from BWS, 2005

Figure 1: Tugs and dumb barges used on London's canals


British Waterways Tug


Land and Water Tug


Square ended dumb barge


Oval bow dumb barge

The cost of procuring and operating tugs and barges of this nature depends on the exact specification, but typically they might be in the order of:

Tug:

Purchase cost:	£40,000
Maintenance cost:	£3,000
Fuel costs at 6 lt per hour:	£19,500 a year
2 x Literman at £24,000:	£48,000
Total yearly outlay including purchase:	£110,842
Yearly outlay thereafter:	£70,500

Dumb barge:

Purchase cost:	£10,500
Maintenance cost:	£500
Total yearly outlay including Purchase:	£11,000
Yearly outlay thereafter:	£500

2.3.2 Self-propelled craft

This type of barge is motorised comprising an engine at the rear of the vessel and a large hold area in the remainder. It has a crew of one or two people and can pass through locks in a single cycle. These vessels are able to carry a variety of cargoes and can be designed to include a 'tanked' hold to carry bulk powders (e.g. cement) or liquids. Table 2-4 summarises the key features, while Figure 2 shows examples of the vessels.

Table 2-4: Self-propelled vessels

Self-propelled vessels	
Advantages	▪ Manoeuvred under own power, so no roping needed. ▪ Self contained so no problems involving towing. ▪ Multi-purpose – can be used for different cargoes.
Disadvantages	▪ Expensive to build, so need to be operating as many hours as possible to get return on investment. ▪ Need more than one to handle most potential traffic types, so more capital outlay is required to move large quantities of freight.

Figure 2: Self-propelled barges

Self-propelled aggregates barge on GUC

Self-propelled aggregates barge on River Severn

The cost of procuring and operating this type of barge depends on the exact specification, but typically it might be in the order of:

Self-propelled barge:	
Purchase cost:	£110,000
Maintenance cost:	£5,000
Fuel costs at 7 lt per hour:	£22,750
2 x Literman at £24,000:	£48,000
Total yearly outlay including purchase:	£185,750
Yearly outlay thereafter:	£75,750

2.3.3 Containers with built-in flotation

This type of vessel is an open topped container with built-in buoyancy chambers. While not in use today (they ceased being used in 1979), this concept was extensively used in Yorkshire for the transport of coal from collieries to the port of Goole. They were locally known as 'Tom Puddings' and consisted of long trains of compartments, which could each hold around 40 tons of coal. As part of this transport, the containers would be loaded onto railway bogies to move between the colliery and canal, providing a unique intermodal transfer system. To empty the containers at Goole, each unit was hoisted from the water by special lifting gear and tipped. (Goole, 2007) Table 2-5 summarises the key features.

Table 2-5: Containers with built-in flotation

"Tom Pudding" type vessels / Containers with built-in flotation	
Advantages	▪ Make up loads steadily, with spare empties. ▪ Can store at locations along the canals to await onward passage. ▪ Cheap to construct. ▪ Large loads can be bulked together and quickly and easily transported along longer lock-free stretches of canals. ▪ Containers can be lifted and emptied away from the canal.
Disadvantages	▪ Each individual "pan" is likely to have different loads - trimming each container to form a tow could be time consuming. ▪ Would need extra handling to work them through locks. ▪ For practical purposes, each configuration would need a separate tug to work the flights of locks. ▪ There are practical & safety considerations that might preclude the use of long towlines.

Source: Adapted from BWS, 2005

2.3.4 Floating skip rafts

This type of equipment permits conventional builders' skips to be transported on water by sitting in a buoyant raft framework. The 'Pond Skater', which is now known as Smart Barge (see Table 2-6), is designed to be loaded from a standard skip lorry. Once loaded, a number of skips can be towed in tandem behind a tug. It is assumed that more than one empty skip can be returned in a single trip due to the ability to 'stack' empty skips. (STRAW, 2005) This form of equipment is untested commercially and trial are planned to test its operational and commercial viability (See

Figure 3 and Figure 4).

Table 2-6: Floating skip rafts

"Pond Skater" - Floating skip rafts	
Advantages	▪ Can use standard skip equipment. ▪ Generally, can be loaded straight from standard skip lorry. ▪ Cheap to build and readily available ▪ Can be lifted from water by basic crane or standard skip lorry. ▪ Can be loaded away from water and moved along side canal when full.
Disadvantages	▪ Limited payload - largest skips carry about 9 cubic metres of material ▪ Skips must be in perfect condition and seam welding has to be to a high standard to prevent water ingress. ▪ Require load bearing wharf to water's edge at correct height. ▪ In some locations the skip lorry might require extending lifting arms.

Source: Adapted from BWS, 2005

Figure 3: Smart Barge units moving on the River Lee Navigation

Source: London Remade, 2007

Figure 4: Smart Barge units having skips unloaded

Source: PBA, 2007

The cost of procuring and operating this technology depends on the nature of the materials to be hauled, the volume and the length of time for which the transport is required. This will determine the number of skip carriers (modules) required. The system is supplied as a bought solution on a lease-purchase arrangement with a guaranteed buy-back value included, with the terms of contract being negotiable and includes items such as maintenance.

2.3.5 Container carriers

The standard intermodal container used for domestic and international carriage of goods is known as the ISO[2] Twenty-foot Equivalent Unit (TEU), which refers to the length of the container - 20 foot (6.1m). The variations of container dimensions are:

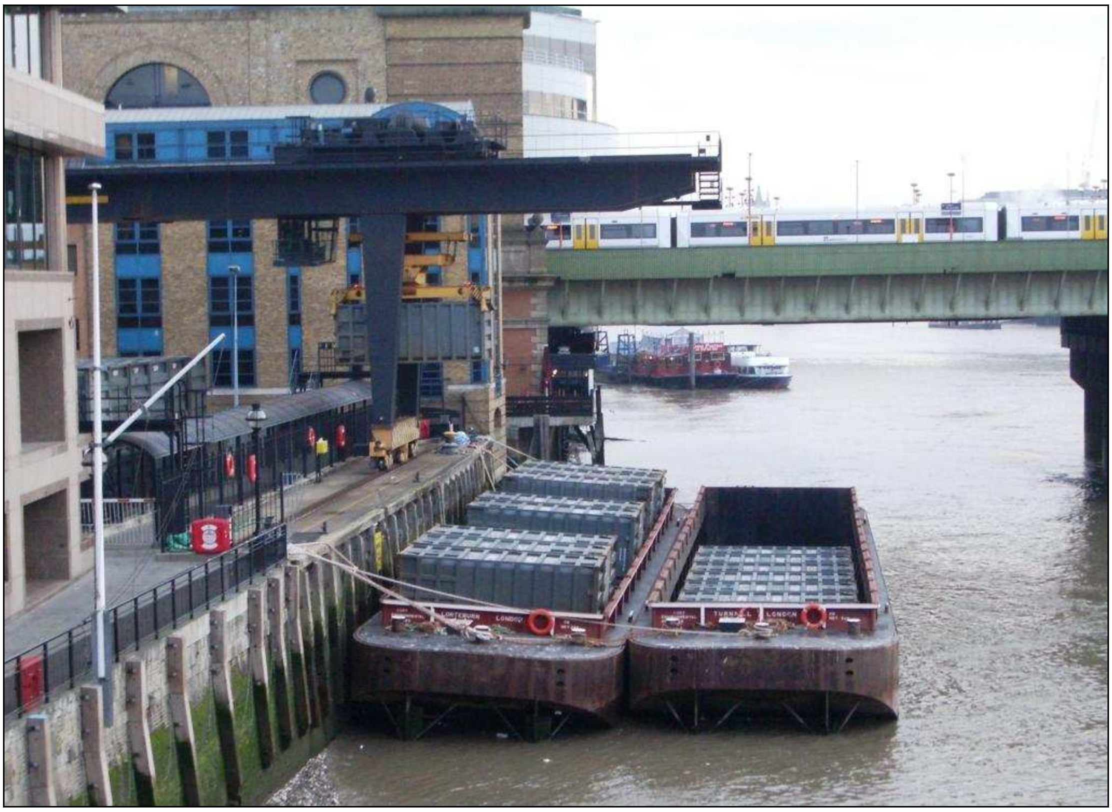
Table 2-7: ISO Container sizes

TEU Container	Standard size	Hi-cube size
Length container	6.1m (20')	6.1m (20')
Width container	2.4m (8')	2.4m (8')
Height container	2.6m (8'6")	2.9m (9'6")

[2] International Standards Organisation

Containers with these dimensions are moved on the Thames daily (see Figure 5) and could be, in theory, be accommodated on a Grand Union Canal size barge as the vessel's total length is 21.95m, beam 4.2m and combined water and air draught 3.34m.

Figure 5: TEU sized containers being loaded onto waste barges on the Thames



Assuming that neither the bow nor stern curvatures exceed a radius of 1.5m, it is theoretically possible to load three TEUs lengthwise into a barge. Since these would be loaded along the centre of the barge, overall height should be accommodated within the canals infrastructure (e.g. bridges and tunnels).

Containers do not have to conform to an ISO standard size and a trial of moving waste on the River Lee Navigation in 2003/04 used containers which had dimensions that were suited to waste vehicles - e.g. 5m DIN/CHEM standard. In this instance a dedicated barge was designed to carry and move the containers (see Figure 6).

Figure 6: Waste containers on specially design barge on River Lee Navigation

Figure 6 usefully demonstrated how a container can be accommodated across the beam of a barge, albeit one which is wider than those used on the Grand Union Canal. The craft in Figure 6 was used for a trial, but should such a system become fully operational it is envisaged that barges capable of carrying seven containers would navigate the waterway.

The craft in Figure 6 is self-propelled, but as illustrated in Figure 5 the carrying barge could be a non-powered and hauled by a tug. This option is likely to prove less costly and also potentially more efficient as barges could be moored for loading and unloading while full and empty containers are being transferred between pickup and drop off points.

Another variant of a multimodal system is ACTS (Advanced Container Transfer System), which is a simple horizontal load transfer system used in a road/rail intermodal environment. The ACTS system comprises a tipper lorry chassis fitted with approved road - rail load transfer equipment using a hook or chain attachment; a rail wagon fitted with specially designed turntables, and container units, typically 5.95 metres long, with payloads varying between 13 and 28 tonnes and up to 30 cu metres according to loading gauge.

Whilst the turntable element cannot be fitted to a barge, the containers could in principle be lifted on and off a craft. However, for some applications such as the MMRCV swap body, the bottom lift component (i.e. heavy duty forklift slots) is not compatible with the ACTS system and would require the container to be modified. Furthermore, ACTS requires are rear loading road vehicle and proposals for MMRCVs in London are side loading. Also it is not clear if road vehicles capable of carrying two ACTS containers can be used as designed. In an MMRCV operation a key advantage is the ability to consolidate two (or maybe three) swap bodies on a large lorry in order to reduce the overall level of waste vehicle kilometres.

3 Handling, loading and discharge of commodities

3.1 Introduction

Different cargoes have different handling, loading and discharge requirements and these factors need to be taken into account when accessing the method of loading/unloading and the equipment to be used. There are a range of potential commodities suited to water transport, including:

- Aggregates.
- Processed scrap.
- Demolition waste.
- Steel products, cables.
- General waste and recyclates.
- Construction materials.

3.2 Handling Specifications

While the primary function of handling equipment may be to transfer freight to and from the waterway, in many situations additional functions are required. For instance, if multimodal refuse collection units are to be handled, the following functions may be required:

- Transfer loaded container from load to the ground when RCV arrives from a round
- Reload the RCV with an empty container
- Remove empty containers from the barge when it arrives and transfer them to the ground
- Load the barge with loaded containers from the ground.
- Other functions such as managing the stock of loaded and empty containers and transferring containers between two road vehicles.

The volume of throughput and barge dwell time will also be a major determinant of the most suitable system to be used. High volume terminals or wharves will require equipment capable of moving freight volumes quickly. This equipment may be more expensive, but the cost will be spread across a larger volume of freight. Slower equipment will tend to be cheaper, but may result in barge loading or unloading taking a long time. The extended loading time may not be an issue, but in some circumstances might lead to additional barges being required, adding to costs.

3.3 Handling methods

In terms of handling, these commodities will be transhipped either as:

- Loose bulk material.
- Large containers.
- Large individual loads.
- Smaller loads.

The methods of handling these commodities and the advantages and disadvantages associated with each is summarised in Table 3-1 to Table 3-4.

3.3.1 Loose bulk materials

Loose bulk materials generally comprise cargoes which are handled in an uncontained form - i.e. the craft will act as the container for the material in transit. A summary of the key characteristics is given in Table 3-1.

Table 3-1: Handling bulk loads

Methods for handling bulk loads		
Type of freight	**Advantages**	**Disadvantages**
Loose load	▪ Can be moved to wharf by conveyor. ▪ Can be poured into hold from land based overhead storage hoppers. ▪ Does not require separate containers. ▪ Grabs for unloading / loading are readily available.	▪ Loading/unloading with a grab can be time consuming. ▪ Hold linings can be damaged by unloading equipment. ▪ Requires person to enter hold to sweep out remains of load.

Source: Adapted from BWS, 2005

Below are two examples of land-based equipment being used to handle bulk materials in a canal environment (see Figure 7).

Figure 7: Methods of handling bulk materials on and off barges

Crawler excavator with clam shell bucket

Conveyor and pouring hopper

The movement of aggregates between Denham and West Drayton on the GUC involves the use of a conveyor system at the gravel pit (designed and supplied by Continental Conveyor Ltd), because only loading barges is performed. At the destination (West Drayton), a conventional excavator is used for unloading the arriving aggregate and loading product going to customers. This is a good example of deploying equipment to meet specific requirements.

3.3.2 Large containers

Large containers in the context of canal transport comprise skips, hook-lifts, ISO containers and bespoke containers. These are suited to different commodities and also handled differently depending on their design.

Table 3-2: Types of large containers

Types of large containers		
Container type	**Advantages**	**Disadvantages**
Standard Skip	▪ Freely available. ▪ Available in a range of sizes, including lidded versions. ▪ Suitable for carrying any form of bulk and semi-bulk material. ▪ Can be lifted by specialist	▪ Proper covering required to prevent contents falling spilling during transit. ▪ If used in raft, skip must be undamaged to prevent water ingress. ▪ Cannot be used for

	lorries or cable cranes. ▪ Can be handled by a single operative. ▪ Can be carried by a barge or used in a 'Pond Skater' raft. ▪ Size permits approximately 8 skips to be carried on a single barge.	municipal household waste or for other decomposable waste.
Hook-lift skip/container	▪ Offers more capacity than standard skip. ▪ Suitable for carrying any form of bulk and semi-bulk material. ▪ Container could carry household waste and be part of a multi modal refuse collection system.	▪ Length may prevent use athwartships. ▪ Requires specialist road vehicle for carriage and handling. ▪ Barges require spud-legs to provide stability during loading and unloading.
ISO/bespoke containers	▪ Readily available ▪ ISO containers comply with international standards. ▪ Are suitable for non bulk freight. ▪ Can take advantage of bag liners (e.g. flexitanks) for heavier density cargoes such as dry bulk powders (e.g. cement). ▪ Can be used as part of a long distance logistics chain. ▪ Bespoke containers can be designed to fit dimension limits of GUC barges. ▪ ISO containers can be stacked where there is limited storage. This may also be true for bespoke containers if built to a suitable standard.	▪ Require top-lift for loading/unloading. ▪ Lifting equipment must be cable crane or flexible armed reach stacker. ▪ ISO containers can only fit lengthwise on GUC barges. ▪ Dangers of cross lifts over towpaths must be addressed.

Source: Adapted from BWS, 2005

3.3.3 Large individual loads

For the purpose of this review, large individual loads are considered to be freight which is not suitable for movement in a container or skip. In this category freight such as structural steel components, rebar, timber products and logs are included.

Table 3-3: Large individual loads

Large individual loads		
Type of freight	**Advantages**	**Disadvantages**
Large individual loads	▪ Does not require container. ▪ Can be loaded along side smaller loads of freight on barge. ▪ Can be stored on barge at destination ▪ Mobile cranes and grabs for unloading / loading are readily available.	▪ Requires more than one person to oversee loading/unloading operation. ▪ Loading/unloading can be time consuming. ▪ Potential to damage cargo if mishandled ▪ Some cargoes require proper weather protection and therefore need a barge capable of being covered.

Source: Adapted from BWS, 2005

Other units in which goods are packed and handled are typically smaller and available in both standard and bespoke sizes. Table 3-4 summarises the types of unit and also indicates their advantages and disadvantages when used in the context of canal transport.

Table 3-4: Types of small unit loads

Types of small unit loads		
Type of freight	**Advantages**	**Disadvantages**
Pallets 800 x 1200 mm (CEN Standard - also called a Euro Pallet) used mainly for retail business 1000 x 1200 mm (ISO Standard) used mainly for industrial use 1200 x 1200 mm is also used mainly for vegetable retail business	▪ Can fit pallets lengthways or crossways in hold to obtain the optimum loading. ▪ Can be made of wood, plastic or metal. ▪ Raise the load above floor level allowing space for pallet truck forks. ▪ Reduces risk of ingress of damp from below. ▪ Vessels can be trimmed easily. ▪ Compatible with existing delivery methods.	▪ Unable to use forklift truck on barge ▪ Required to be loaded/unloaded by lifting gear with suitable 'fork' attachment. ▪ Handling each pallet individually for transhipment is time-consuming.
Stillages	▪ Can be made of metal or plastic.	▪ No standard base size ▪ Can be heavy to man-

	▪ Raise the load above floor level allowing space for pallet truck forks. ▪ High sides prevent damage to contents or holds freight place.	handle ▪ Required to be loaded/unloaded by lifting gear with suitable 'fork' attachment.
Boxes/crates/bins	▪ Very flexible loading configurations possible. ▪ Plastic crates keep damp out from below, can be lidded and stackable. ▪ Compatible with existing delivery methods. ▪ Available in standard or bespoke sizes.	▪ May require bespoke handling methods. ▪ Manhandling on shore and in hold could have time implications.
"Pods": Unit containers such as those designed to be lifted into and out of the new BW vessels.	▪ Design already established and vessels built. ▪ Loads can be preassembled on bank for easy transfer to barge by crane. ▪ Cargoes protected from weather and potential damage.	▪ Dimensions not necessarily compatible with other modes. ▪ Cannot be stacked or folded, which will affect economic use of this type of container.

Source: Adapted from BWS, 2005

The handling of materials on and off a barge can be achieved by using land based equipment or machinery mounted on the craft. These are summarised in the sections below.

3.3.3.1 Skip carrying vehicles

This type of vehicle is commonly used by the waste and construction industry for the transporting of loose waste. The size of the vehicles can vary up to a maximum of 18t GVW when carrying a single skip or 32t GWV if the vehicle is capable of moving two skips.

The skips themselves are made from steel plate with welded seams and are typically available in various sizes ranging from about 1.5 cu metres (mini skip) to 12.2 cu m (maxi skip) capacity. There are also variations which are fully enclosed with a lid, converting them into a form of container, and others which have higher sides providing a large capacity.

Table 3-5: Skips

Methods for handling loads		
Handling method	**Advantages**	**Disadvantages**
Skip carrying vehicles	▪ Enables barge-vehicle transhipment without intermediate lifting equipment. ▪ One-man operation. ▪ Vehicle can also be used for collecting / tipping containers.	▪ Requires load-bearing wharf to water's edge at correct height to assist with loading/unloading operation. ▪ Skip has to be at correct height on vessel to allow loading/unloading. ▪ Skip lorry needs extending lifting arms. ▪ Vessel may need stabilising legs to prevent rolling.

Source: Adapted from BWS, 2005

Figure 8: Transferring a skip to a barge using a skip lorry

Source: Freight Afloat Consultants

Since the loading/unloading mechanism is by way of a conventional skip lorry, any skip firm could provide a loading/unloading service. Although it is necessary for a suitable load-bearing canal bank to be used when transferring skips between barge and land, this technology does offer a very flexible solution since waterside access can be achieved at relatively restricted points - e.g. reverse down road with no turning space adjacent to canal. If a barge operator were to purchase this equipment it would cost in the order of:

Skip loader:
Telescopic Arm Skip Loader for 18 tonne GVW

chassis with a 13 tonne lifting capability supplied and fitted:	£16,000
Suitable 18 tonne vehicle:	£44,000

Steel skip:

Example - 9 cu m steel skip:	£625

British Waterways uses skips on barges in the London area for the transport of waste materials when carrying out canalside maintenance or improvements, and rubbish dumped in the water.

3.3.3.2 Hook lift

Hooklift containers are another form of container that is hauled onto a carrying lorry by a hook mechanism which is fitted to the chassis of the vehicle. On the front of the container is an 'eye' for the hook to attach, while on the base there are steel runners and rollers; the vehicle is also equipped with rollers. The hydraulic hook attaches to the container and pulls it onboard the lorry. The containers are available in various configurations - e.g. open or boxes - and come in sizes up to about 30.5 cu m.

The hooklift loader mechanism can be fitted on to any lorry chassis from 3.5t to 32t GVW.

Table 3-6: Hooklifts

Methods for handling loads		
Handling method	**Advantages**	**Disadvantages**
Hook lift	▪ Enables barge-vehicle transhipment without intermediate lifting equipment. ▪ One-man operation. ▪ Vehicle can also be used for collecting / tipping containers.	▪ Requires load-bearing wharf to water's edge at correct height to assist with procedure. ▪ Requires container to be at correct height on vessel to enable hook lift operation. ▪ Vessel may need stabilising legs to prevent rolling. ▪ Vessel may need onboard mechanism for lowering and raising container.

Source: Adapted from BWS, 2005

Figure 9: 32 tonnes hooklift vehicle

Source: http://www.truckspecialists.co.uk/hooklifts.htm

The Waste on Water trial demonstrated that this type of technology is useable in an intermodal environment. However, it is necessary that the barges used for transporting hooklift containers are fitted with a suitable sub-frame such that they can be loaded/unloaded and carried by the craft. This is necessary because the container is lifted at the front while moved backwards or forwards on roller fitted to the rear of its base. Furthermore, this push/pull movement of the container during transfer requires the barge to be fitted with retractable stabilising legs ('spud legs') that sit on the canal bed to preventing it from rolling. It should be noted that loading is only possible across the beam of the barge, which means containers are limited to 4m in length for GUC movements and 5m on the Lee Navigation. If a barge operator were to purchase this equipment it would cost in the order of:

Hooklift loader:
Hooklift suitable for 8x4 chassis at 32 tonnes GVW

25 tonnes lift capacity supplied and fitted:	£17,500
Suitable 32 tonne GVW vehicle:	£54,500

3.3.3.3 Land cranes - wheeled / crawler

Land based wheeled and crawler cranes are general purpose equipment that can be fitted with a variety of attachments for handling different materials and loads, and are suitable for a wide range of lifting applications. This type of craneage is often used on canal wharves, as it does not require any special installation (apart from an appropriately strengthened wharf surface and edge), can be operated in relatively small spaces and is easy to operate. Furthermore, this type of equipment is available through short-term hire, long-term lease, as well as through a good second hand market.

Table 3-7: Mobile land cranes

Methods for handling loads		
Handling method	**Advantages**	**Disadvantages**
Land cranes - wheeled / crawler	▪ Flexible method for craning as different attachments can be used - e.g. buckets, pallet forks, slings. ▪ Crane can be moved between wharves. ▪ Can be used for other uses on-site when not required at wharf. ▪ Cost attractive option because can be brought in for short term use. ▪ Good second hand market for this equipment.	▪ Needs suitable platform capable of withstanding point load of stabilisers. ▪ Needs sufficient space for manoeuvring and stabilisers. ▪ Requires qualified crane driver and slinger or container-grab.

Source: Adapted from BWS, 2005

Figure 10: Wheeled crane used for lifting canal boats at a GUC boatyard

The equipment in Figure 10 demonstrates that is does no have to be the most modern if it is not going to be used too intensively.

Figure 11: Crawler crane unloading sand at a Thames wharf

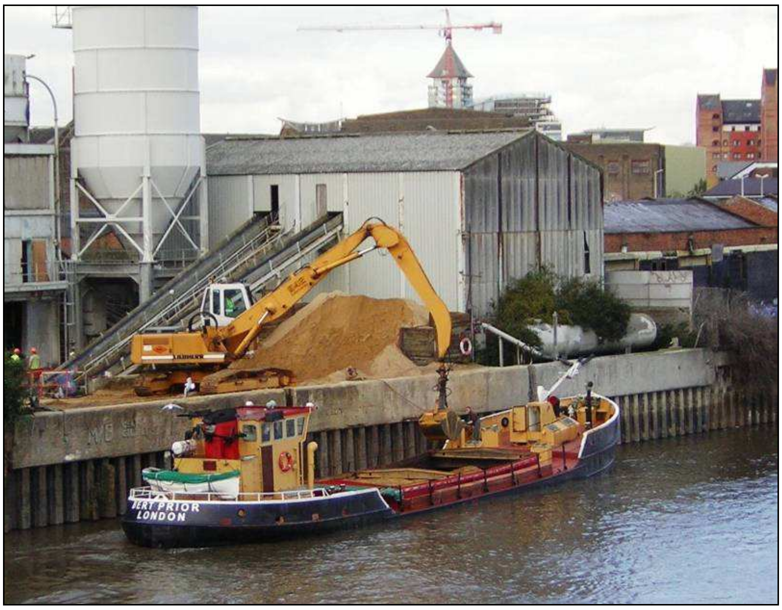


Figure 11 shows a good example of the extent of reach that this type of equipment has, as it unloads sand on at a Thames side wharf.

Figure 12: Large mobile port crane

As the examples in Figure 12 shows, this equipment is available in a variety of formats, depending on the function of the wharf and the cargoes to be handled. If this type of equipment were to be obtained either as second hand or new, the costs will differ accordingly. For example the cost of a crawler excavator is:

Crawler excavator:	
Purchase cost:	£79,000
Maintenance Cost:	£5,000
Fuel Costs at 11lt per hour:	£32,000
Trained operator:	£21,000

For large quayside cranes as show in the bottom example above, the costs could be:

Large mobile port crane:	
Purchase cost second hand for a 350 ton crane:	£623,500
Annual maintenance cost:	£9,000
Fuel costs at 12lt per hour:	£37,000
2 x Drivers at£26,000:	£52,000
Total yearly outlay including purchase:	£721,000
Yearly outlay thereafter:	£98,000

3.3.3.4 Land cranes - fixed / tracked

This type of equipment is typically located on wharves and quays serving larger waterborne traffic (e.g. main river and sea ports, Rhine-Danube canal ports), although disused examples can be found on the Lee Navigation. As the title implies, this machinery is permanently located on the quay and can be permitted travel along the quay using rails or completely static only working from the same point. In a London context their installation will require substantial wharf improvements to take place since no canals have the necessary strengthened bases in place.

Table 3-8: Fixed land cranes

Methods for handling loads		
Handling method	**Advantages**	**Disadvantages**
Land cranes - fixed / tracked	▪ Capable of lifting heavy loads. ▪ If fixed, less space required. ▪ Only requires crane base area to be sufficiently load-bearing	▪ Crane permanently located at wharf. ▪ One crane per wharf required. ▪ Requires qualified crane driver and slinger or ISO container-grab. ▪ Expensive procurement costs. ▪ Requires high utilisation rate to be cost effective. ▪ May be issues of with wharf security if operating 24 hours a day.

Source: Adapted from BWS, 2005

Figure 13: Tracked cranes at Nurnberg inland port

The suitability of this type of crane for London's canals is questionable, unless a fairly small version is available and high volumes of cargo are to be handled. The cost of acquiring and operating such equipment will not be too different from that of large mobile port cranes.

Other forms of fixed cranes have been used in the past on the canals and some disused examples are still in place. On the Lee Navigation there a few examples (see Figure 14) of cranes which are no longer operating, but the structure and/or machinery is still in place. In most instances they were probably used to hoist loose general cargo on and off barges - i.e. with various forms of net and straps being used to secure the load.

Figure 14: Examples of disused fixed cranes on the Lee Navigation

Crane located adjacent to Ponder's End Lock

Crane located on Watermint Quay

Grantry type cranes located on Watermint Quay

3.3.3.5 Vessel mounted cranes

The size of barges used on the London's canals makes them suitable to being fitted with telescopic cranes. This equipment uses hydraulics to operate its mechanism and is commonly fitted to builders merchants lorries, construction lorries and brick delivery vehicles. A variety of attachments can be fitted to the crane and when fitted to a barge, permits it to be self sufficient for loading and unloading. Since these crane use hydraulics to work, they do require the pump to be powered from a motor (i.e. normal the vehicle motor on a lorry). This suggests that the crane needs to be mounted on a self-propelled barge in order for the craft's engine to drive the crane's hydraulics, although the possibility of fitting a crane and motor to a dumb barge needs to be investigated.

Table 3-9: Vessel mounted hoists

Methods for handling loads		
Handling method	**Advantages**	**Disadvantages**
Vessel mounted cranes	▪ Provides self-sufficient and flexible vessel. ▪ Can be used at any suitable canal side location. ▪ Can use hoists designed for mounting on goods vehicles. ▪ Can be used to	▪ Could limit vessel configuration and payload. ▪ Vessel might require stabilising legs to prevent roll. ▪ If used to unload/load alongside vessels, occupies mooring

	unload/load other alongside vessels if fitted with suitable telescoping arm.	capacity.

Source: Adapted from BWS, 2005

Figure 15: Barge fitted with telescopic crane

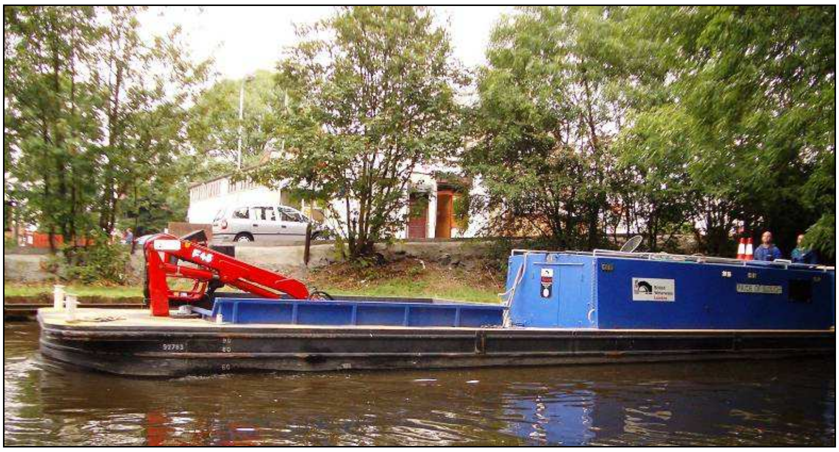


Figure 16: Example of lorry mounted telescopic crane working

Source: Palfinger

As Figure 16 illustrates these cranes offer a versatile solution and are capable of lifting relatively heavy loads. If mounted on a barge they could be located at the bow or stern, or on a platform midway down its length. There are versions of these crane that can extend the jib to about 12 metres, which means if fitted midway along the barge it could access cargo both fore and after, although fully extending the jib may have implications on the weight that can be lifted. Issues regarding barge stability during use also need to be considered.

Other options including fitting the crane portion of an excavator to the hull of a self-propelled barge, which can act as a floating craneage platform transferring loads between barge and embankment at points where no suitable land-based wharf exist (see Figure 17).

Figure 17: Barge mounted excavator crane

The example in Figure 17 is of a British Waterways' barge that is used for dredging and rubbish clearance of the canal and is moored on the Lee Navigation.

3.3.3.6 Container reach-stackers

Reach stackers are designed to do what they say, reach and stack. Equipped with a telescopic jib, they can reach out over the water and lift a container from some distance away. However, in situations where the use of a long jib is required, a more expensive and heavy the reach stacker is needed. Once lifted, they can carry the container around the yard if required, making these machines extremely flexible.

In Continental inland waterway ports, they are commonly used for the barge to shore cargo handling and would be reasonably cost effective solution for most high volume canal side container lifting operations.

One of the main considerations in deploying this type of equipment is the strength of the wharf, which has to be built to a standard which can cope with the weight of these machines. In a railway yard, a reinforced concrete pavement is generally specified, such that the slab is in the order of 300 mm thick for the most part and 400 mm thick at the edge, (i.e. where the railway lines are), because this is where the stacker does its lifting and consequently throws almost all its weight onto its front axle. Due to this requirement and the high capital cost of reach stackers, they are generally preferred where throughput volumes are high and where flexibility is required.

Table 3-10: Container lifting vehicles

Methods for handling loads		
Handling method	**Advantages**	**Disadvantages**
Container reach-stackers	▪ Designed to handle standard containers flexibly & efficiently. ▪ Only requires one man to operate. ▪ Can be moved between wharves. ▪ Can be used to move containers when not required for vessel loading/unloading.	▪ Requires load-bearing wharf to water's edge. ▪ Expensive to buy. ▪ May be issues of with wharf security if operating 24 hours a day. ▪ Requires high utilisation rate to be cost effective.

Source: Adapted from BWS, 2005

Figure 18: Reach stacker loading a barge

This type of machinery is able to handle 1 container about every 3 minutes and is capable of working in relatively small areas due to its good turning circle and ability to swivel a container held in the spreader. This means a single reach stacker could be operated on fairly constrained wharves, which are typical of the type found on the London canal network.

Reach stacker:
Indicative costs for procuring and running a reach

stacker:

Purchase cost:	£300,000
Maintenance cost at £9.50p/h:	£17,337
Fuel costs at 11lt per hour:	£32,000
Trained operator:	£21,000
Reinforcement of Pier:	£500,000
Total yearly outlay including purchase:	£891,337
Yearly outlay thereafter	£70,337

3.3.3.7 Goods Vehicle Based Container Handling Systems

Recently a new category of handling system has been developed which allows the transfer of containers between vehicles using equipment mounted on the road vehicle. The most widespread system in use in the UK is Containerlift, which involves a crane mounted on a road vehicle which can transfer containers to other vehicles or to the ground. When not being used as a crane the vehicle can be used to transport containers in the normal way.

Table 3-11: Vehicle Based Container Handling Systems

Methods for handling loads		
Handling method	**Advantages**	**Disadvantages**
Vehicle based container handling systems	▪ Designed to handle standard containers efficiently. ▪ Requires only one man to operate. ▪ Vehicle and driver can transport containers or move to different locations. ▪ Low investment cost, little or no site preparation required.	▪ Specialist operators and maintenance requirements. ▪ Only suitable for container lifts.
Source: Meeting with Containerlift 7/11/2005		

Figure 19: Container on Containerlift vehicle

Figure 20: Container being unloaded from Containerlift vehicle

When used for transferring container to/from barges the crane arms can be extended, permitting the equipment to reach over the centre of the craft. However, due to its configuration on the vehicle, this equipment can only place/lift containers which are lengthwise in the barge.

Containerlift:
Indicative costs for procuring and running a Containerlift vehicle:

Purchase cost:	£70,000 - £100,000
Maintenance cost (estimate):	£10,000
Trained operator:	£32,000
Reinforcement of Pier:	£0
Total yearly outlay including purchase:	£112,000 - £142,000
Yearly outlay thereafter	£42,000

3.3.3.8 Land based gantry cranes

Gantry crane systems today are generally designed to handle large numbers containers for port or railway intermodal transfers. A good gantry crane is likely to be able to transfer containers faster than any other handling system and they are, therefore, often used where ship or train dwell time needs to be minimised.

They are a heavy construction and have to be purpose designed and built for the wharf on which they are sited.

Table 3-12: Gantry cranes

Methods for handling loads		
Handling method	**Advantages**	**Disadvantages**
Land based gantry cranes	▪ Designed to handle standard containers efficiently. ▪ Requires only one man to operate. ▪ Predominately used at high throughput intermodal terminals.	▪ Considerable infrastructure & investment required, therefore extremely expensive. ▪ Specialist operators and maintenance requirements. ▪ Only suitable for container lifts. ▪ Requires very high utilisation rate to be cost effective.

Source: Adapted from BWS, 2005

Figure 21: Smugglers Way gantry crane

	This is a high cost option and is only suitable for a facilities that will be handling large volumes of containers for a long period. Purchase cost: £2,000,000 Maintenance cost at £12.50p/h: £22,812 Electricity cost at £0.95pKwh: £1,733 Trained operator: £26,000 Reinforcement of Pier: £2,000,000 Total yearly outlay including purchase approximately £4 million Yearly outlay thereafter £76,545

At present there is a proposal that this type of equipment might be appropriate at two locations (Hackney and Edmonton EfW) on the Lee Navigation for the handling of multimodal refuse vehicle (MMRCV) containers, although the scoping study does recommend that full feasibility study is carried out, in order to compare this system with other handling options.

3.3.3.9 Innovative use of existing equipment

It is not inconceivable that any suitably sized piece of handling equipment can be used onboard a craft. For example:

- British Waterways have mounted excavators within barges for dredging and rubbish clearance of the GUC and Lee navigation. In the case of the GUC, the machine sits within the hold permitting it to reach over the side barge to perform its work (see Figure 17 for the Lee Navigation adaptation to this approach).
- Small mobile shovels (e.g. Bobcat) are able to operate on barges since they are of a size which allows them to fit into the hold. They can be either lifted or driven on (using a suitable ramp) and used to load other buckets fitted to land cranes.

Similarly smaller forms of equipment found on construction sites are used for transferring materials between craft and the wharf, for example:

- Forklift trucks, which have an extending arm, are used for unloading barges for canalside building works. As Figure 22 shows, these are able to operate in small areas, but capable of lifting pre-packaged aggregates (e.g. jumbo bag weighing about 1 tonne) and pallets of bricks and other materials.

Figure 22: Forklift hoist used to unload/load barges

3.4 Operating costs compared with road

Lifting freight on/off a vehicle will incur a cost per lift, regardless of the mode. However, this cost will be tempered depending on whether the machinery performing the task is being used as part of the general site activity, or if it has to be "brought in" in order for the lifting to take place, or if it onboard the vehicle.

It is accepted that watercraft require handling equipment to be available to perform loading/unloading. For the loading of loose bulk materials (e.g. aggregates, demolition waste) a crane will be necessary and the cost of using such equipment is about £1 per tonne lifted for water and road transport. If a hopper system were used then the cost would be lower.

For unloading, a similar cost will be incurred by water transport, but for a road vehicle the cost will be negligible, since the type of vehicle used for transporting loose bulk materials normally have a self discharging capability - i.e. can raise its body to discharge material without the need of assistance from a crane.

For other freight such as containers the costs are likely to be similar, as craneage will be necessary; to lift a container in a port costs between £70 and £150 per lift, depending on the port. It is not unreasonable to expect the *pro rata* cost for lifts to/from barges and lorries to be similar for each mode. In the case of ship/shore pallet lifts, ports typically charge £8 per pallet, which is probably higher than the equivalent cost for moving pallets on and off goods vehicles.

4 Canal locations and equipment options

4.1 Introduction

There are many points along London's canals at which the loading and unloading of craft can be achieved. However, the area of the land available will influence the choice of handling equipment that can be sensibly used for the task it needs to perform, regardless of the cargo handled. For example, a gantry crane, which is a large machine compared with other forms of equipment, is only suitable for a wharf that has sufficient space to accommodate a structure that is likely to be 20m wide, excluding other vehicles manoeuvring areas.

As part of the study, a number of sites have been visited in order to consider the handling equipment options that could be sited along side the canal. Since at this time a relatively limited number of wharves are operating any type of craneage, few examples exist. Those which are known comprise:

- Conveyor and hopper for loading gravel/sand at on the GUC at Denham
- Excavator fitted with clamshell bucket for unloading aggregates at Hanson site, West Drayton (GUC)
- Wheeled mobile crane for lifting boats in/out of water at Uxbridge Boat Centre (GUC)
- A straddle boat hoist at Adelaide Dock

4.2 Sites and their options

The West London Canal Network study provided a detailed catalogue of points at which access could be gained to the GUC and the type of activity that could potentially take place; however, it did not suggest types of craneage for these sites.

As mentioned, important factors such as the type of cargo, the volume to be handled and the permanency of the freight flow will influence the choice of crane, since there is a number of alternative types of equipment that can fulfil the same role.

Generally, no decision will be made about the type of craneage required until the site operator is able to define the cargo to move by water. It will also be necessary to carry out some form of feasibility assessment unless the operator is fully aware of and comfortable with using particular types of machinery. For example, if Hanson were to operate another canalside facility, it is possible it would automatically opt for the same set up as used at the West Drayton site. However, if the volumes handled were to be significantly different (e.g. much higher), it is possible they would opt for equipment with a greater transfer capacity.

Along the Lee Navigation there are a number of canalside industrial redevelopments, which as part of their renewal, have new wharf moorings included, although not presently used. From brief observations of these sites it appears that they could serve as transfer point with the canal and should be able to accommodate mobile lifting equipment.

It is unrealistic in this review to comment upon which type of equipment can/should be used at specific canalside sites, as there are too many unknowns. This type of issue can only be resolved as and when a wharf plans to become operational.

5 Closing remarks

In summary, it can be said that there are four main groups of equipment for loading/unloading a barge: reach stackers, vehicle mounted systems, common mobile construction site and road cranes, and harbour and gantry cranes. They all have strengths and weaknesses, but much depends on the state the wharf, the cargo to be handled and accessibility to the site. A summary of the key characteristics of handling systems is provided in Table 5-1 at the end of this chapter.

An important consideration for London canals is the extent to which equipment has to reach out over the barge, which on the Lee Navigation is essentially 5.5m (18ft) and 4.2m (14ft) on the GUC. Since 4.2m wide barge will not accommodate a two twenty foot containers side-by-side (because they are 2.4m (8') wide) it will only be possible to carry one line of up to 3 containers loaded centrally for balance, which means that the edge of a container will be at least a metre away from the edge of the wharf. On the Lee Navigation it is theoretically possible to load eight TEUs (4 in length by 2 in width) into a dumb barge, but it would required to be specifically designed and built to accommodate the containers.

Mobile road cranes can be used as a substitute for a reach stacker, although more cumbersome to use. They are designed to lift from a single hook, which is not ideal for lifting a container, as in practice a rigid spreader needed, which is able to grab a container by its four corner twist lock points and lift it straight up. Mobile cranes can be fitted with a spreader, but the attachment is to a single hook, so it tends to swing about a lot. In practise this means that loading and unloading takes longer. Furthermore, the wharf will require sufficient space in order to accommodate jacks and supporting arms which stabilise the crane itself, so reducing its versatility. However, it can be a cheap option if, for example, only relatively few containers have to load/unload once or twice a week, since the mobile crane can be rented in for the days it is needed.

Given that these cranes have a single hook they are an obvious choice where individual loads need lifting (e.g. girders, skips), since straps and chains can be used.

Construction site cranes imply using either a tracked or wheeled excavator fitted with a suitable bucket for lifting loose bulks (e.g. aggregates, soil, rubble). Cemex uses this equipment for unloading barges at its wharves on the Thames and Severn, and Hanson at West Drayton. They are relatively cheap to operate and can be use in other location around the site.

Vehicle mounted container handling cranes would appear to have some important advantages for low throughput sites and, particularly, for MMRCV operation. These systems would be particularly attractive for trial operation, as Containerlift vehicles can be hired for short term use and the equipment can be moved between sites. For example, a crane could load a train of barges at one location and drive to the destination to unload the same train of barges.

The most elaborate, costly and specialised are harbour and gantry cranes. These are heavy duty machines and generally best suited to high volumes of work in a railway yard or seaport. They have extensive metal frames, usually supported by wheeled bogies running on rails, and it has a control cabin, a hoist and a spreader within the frame. A large financial commitment is required for the wharf to support one of these, in the form of providing strengthened foundations, rails and beams; something in the order of £4million. Such craneage is only installed if high volumes are anticipated.

The remaining special case is skips. These can be transferred by the skip lorry to/from the barge, providing the embankment or wharf is strong enough to cope with the weight and pressure place on the rear of the vehicle as the lift takes place. The skips are standard to the waste industry, but if used in a "Pond skater" type system the bodywork would have to be watertight.

In conclusion, for many situations a vehicle mounted container system may be suitable, but for large throughput locations it is expected that a reach stacker would be the best option when lifting containers. A mobile crane is a good solution for general purpose lifting and an excavator is the preferred solution for loose bulks.

Table 5-1: Summary of key characteristics of handling systems

	Suitable For	Capital Cost	Infrastructure Required	Special barge required	Volume Required	Operating Cost / Unit	Portability	Flexibility	Conclusions
Conveyor	Loose bulk	Medium	May be high	No	High volume	Very low	Low	None	Recommended for high volume bulk loading
Excavator / Grab	Loose bulk	Low	Some reinforcement	No	Low volume	Medium	High	High	Recommended for lower volumes and for bulk unloading
Standard Skip	Loose materials	Low	Minimal	Not necessarily	Low volume	Very low	High	High	Can be used for demolition waste and aggregates. Potential vastly improved if special barge system is developed
Hook and Haul	Loose materials	Low	Minimal	Yes	Low volume	Very low	High	High	As for skip but technology unproven
Land cranes - wheeled / crawler	All materials	Medium	Some reinforcement	No	Medium volume	Medium	High	High	Useful for irregular flows or where it can be used for other functions
Land cranes - fixed / tracked	All materials	High	High	No	High volume	Medium	None	Low	Only useful for dedicated high volume terminals
Vessel mounted cranes	Loose bulk and pallets etc.	Low	None	Yes	Low volume	Very low	High	Low	Useful for irregular flows to unprepared wharves
Container reach-stackers	Containers	High	High	No	High volume	High	High	High	Useful for locations where significant volumes of containers are handled
Goods Vehicle Based Container Handling Systems	Containers	Low	Some reinforcement	No	Low volume	Medium / Low	High	High	Useful for low volumes or irregular flows

	Suitable For	Capital Cost	Infrastructure Required	Special barge required	Volume Required	Operating Cost / Unit	Portability	Flexibility	Conclusions
Land based gantry cranes	Containers	High	High	No	High volume	High	None	None	Only useful for dedicated high volume terminals
Innovative use of existing equipment	Various	Low	Varied	Sometimes	Low volume	Low	Variable	Variable	Preferred solution for some new flows and for one off movements