A new Short Sea Shipping System

As Port De-Congester and Throughput Multiplier

The Trans Sea Lifter (TSL) is an innovative barge carrier that loads/unloads barges in a 90 minute float-on/float-off (Flo/Flo) cycle. The TSL System is comprised of the TSL barge carrier and barges of up to 6000 tdw each. It is a transportation chain for short sea routes. The TSL System's barges open up a network of coastal and inland ports otherwise inaccessible to conventional deep-draft feeders. The TSL System also contributes a short sea route network that diminishes port congestion, a growing threat to all links of many trades, especially to the container trade.

The exponential growth of container shipping has shown that cargo in containers as simple to handle units has changed and will continue to change shipping. Not only the handling unit itself, but the thereby enabled logistic developments have attained much higher efficiencies and greatly improved transportation chain speed. At the core of any of these developments is a two-step process, 1) load aggregation: cargo aggregation in container units (low-value asset), and 2) load transfer: fast transfer of the units onto a vessel (high-value asset). These two principles have spiraled development of huge new fleets of ever larger ships, which place great demands on the ship-to-shore interface. Although ports have developed solutions to accommodate bigger ships, the fast growth of the container trade has outpaced infrastructure development. This presents marine transportation, including short sea shipping, with a new challenge: port congestion

Port Congestion

Stated in logistics terms, port congestion is a cargo velocity problem. The slower the cargo moves through port, the less cargo the port can handle, and port congestion builds up. In order to mitigate the congestion problem, any viable solution must address the speed in which cargo can flow through port.
Shippers and ship operators are caught up in the vicious cycle of key system constraints: the greater the load - the higher the economies of scale, but the longer the cargo handling time - the more vulnerable vessels are to infrastructure availability in ports. Rather than accepting this vicious cycle as inevitable, a sustainable solution must remove it.

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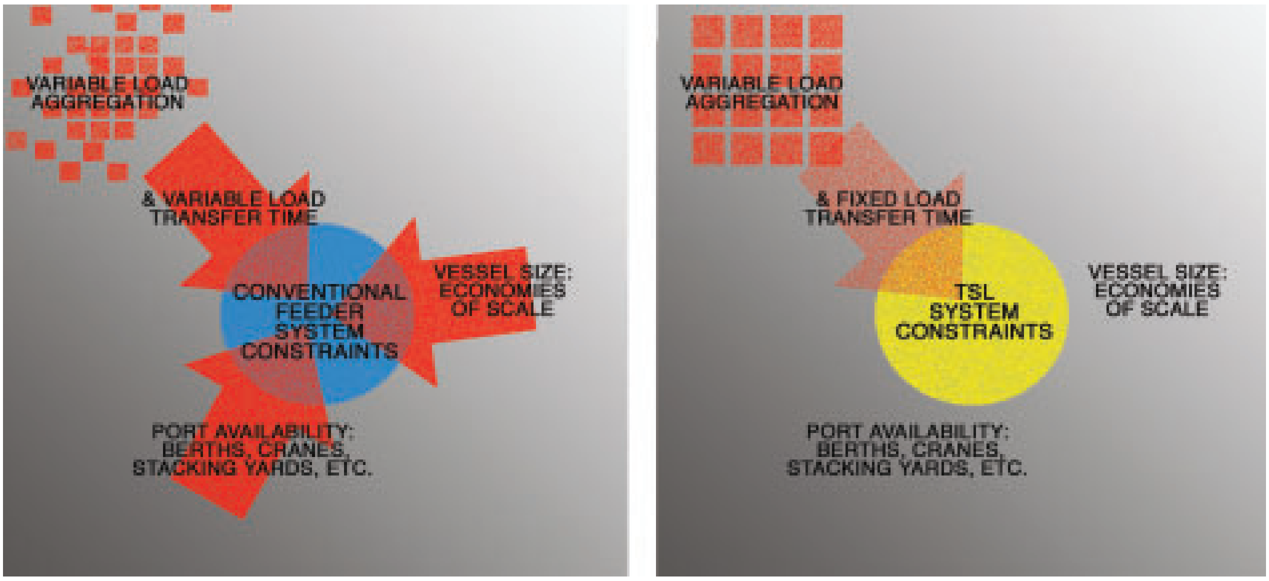

Figure 1: The many constrains to conventional feeder systems' throughput. The TSL System has far fewer constraints to total system throughput.

TSL Vessel Characteristics

Length o.a.:	185,0 m
Breadth:	Suezmax (70,0 m at WL)
Number of Platforms:	3 Movable
Platform Size:	32,6 m x 76,5 m
Voyage Draft:	12,0 m
Displacement:	41.840 m^3
Tonnage:	Gross: 20.800 BRT
	Net: 6.250 NRT
Capacity:	Gross: 19.800 t /
	abt 1,848 TEU barge slots
Main Engines:	4 x 11.250 kW @ 600 rpm
Economic Speed:	20,9 knots @ 72% MCR
Minimum Crew:	14

Figure 2: A TSL with 132-308 TEU Barges

The left diagram in figure 1 illustrates the accepted paradigm that load transfer time, vessel size and port infrastructure constrain the flow of cargo through port. It also shows a secondary constraint that impacts the flow of cargo: load aggregation. Specifically, the smaller the aggregation unit, the higher the number of units to be handled and the longer the load transfer time.

Vicious Cycle of Constraints

The diagram on the right in figure 1 illustrates the paradigm shift induced by the TSL and the TSL System. The TSL aggregates cargo in large units, i.e. in barge loads. Barges are then loaded/offloaded by the TSL in a 90 minute Flo/Flo cycle. This feature considerably reduces load transfer time. Combined with performing the Flo/Flo process outside port, it totally removes the constraints that vessel size and port availability impose on the flow of cargo through port.

So what is the TSL and how does it solve congestion problems?

Trans Sea Lifter (TSL)

The TSL can be characterized by its innovative features as an 1800+ TEU SWATH-type catamaran with three submersible cargo platforms onto which barges of any size and combination can be loaded via a robust ninety minute Flo/Flo process, performed outside port.

An in-depth look reveals many innovative aspects in the TSL's design focused on fast and safe barge handling and transportation.

For comparison, the TSL is half as long as and 25 percent wider than the recently commissioned super-size container ship Emma Maersk. Basic to the TSL's fast Flo/Flo and heavy barge lifting capacities is its configuration as a SWATH, or Small Waterplane Area Twin Hull. SWATHs are inherently steady in waves.

The TSL has three drafts controlled by an innovative ballast system: a voyage draft (twelve meters), a loading draft (twenty meters) and a traversing draft (seven meters) for reaching otherwise unapproachable coastal sea floor depressions [1] near shore for Flo/Flo operations.

Subject to planned tank tests, a TSL will be able to perform its Flo/Flo cycle in sea states resulting from Beaufort 6 winds (for reference: container cranes suspend operations in winds of this force).

The duration of a TSL's Flo/Flo exchange (full tip-out and reload) is a constant ninety minutes, regardless of the number of barges handled. Key is the optimized platform operation which allows for selective and simultaneous discharge of barges. About fourty minutes are required for ballasting the vessel down and up again, leaving fifty minutes for Flo/Flo operations. One, two or all three platforms can be submerged simultaneously or sequentially. This allows for selective barge exchange at each stop on a TSL's route within a fixed time frame.

The TSL's ability to carry all types of barges makes it highly adaptable to routes with a high flow of diversified goods. Conventional feeders are usually one-cargo vessels; increasing their carrying capacity for economies of scale increases the risk of underutilization on a short sea route. The TSL is a universal carrier that transports anything that floats as long as it fits on its cargo platform. Thus selecting a barge for the aggregation volume rather than aggregating enough volume for vessel size, and fast Flo/Flo loading of barges allows for the cargo to flow quickly through the transportation chain.

Furthermore, being a universal sea

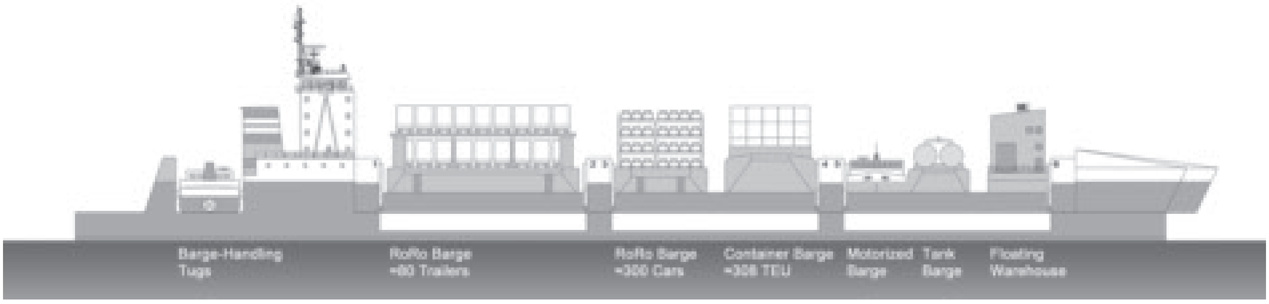

Figure 3: A TSL carrying a mix of short sea barges and canal-going inland barges

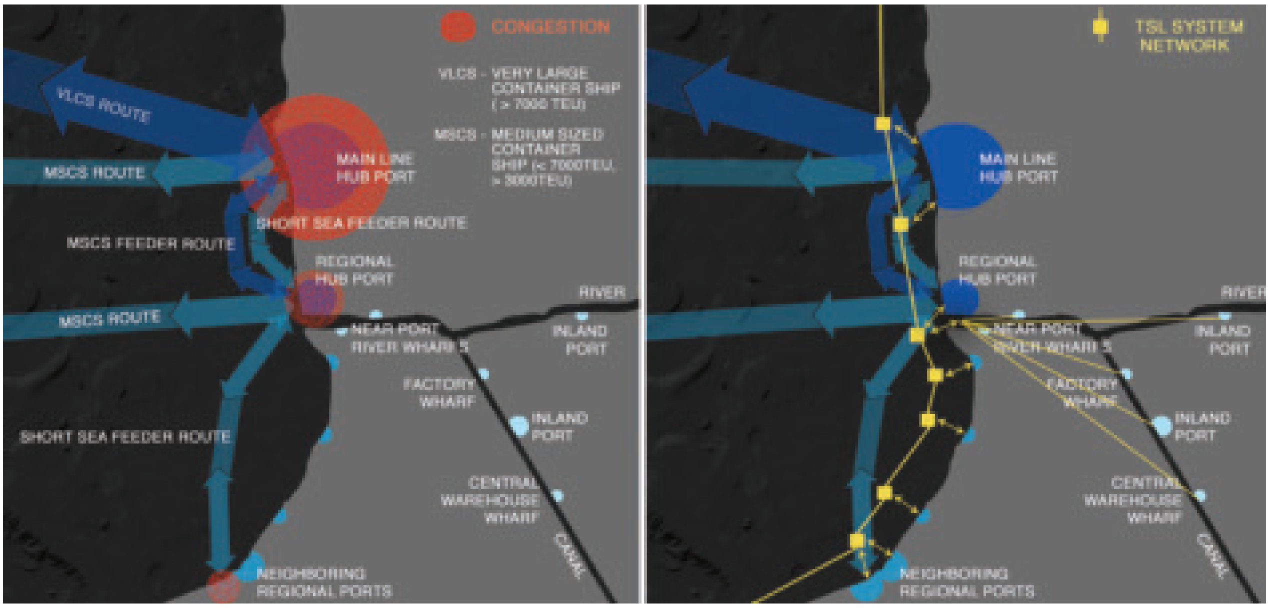

Figure 4: Concentrated cargo aggregation and distribution cause congestion and impede growth. Decentralized cargo aggregation and distribution reduce congestion and support growth

frame for all types of different barges also eliminates the risk of trade obsolescence on routes with a changing flow of cargoes, e.g. from Ro/Ro to containers, and enables the TSL to fill residual capacity with barges carrying non-containerized cargo.
The TSL's design combines many elements of proven technology that enable new processes in the short sea distribution of cargo. This is at the root of the TSL System's capability to challenge current constraints to the speed of cargo transfer that no other vessel can match.

The TSL System

The TSL System consists of the TSL barge carrier and barges of up to 6.000 t carrying capacity each. It is a universal short sea liner service that shifts barges at ferry-like frequency on fixed routes between near-shore drop-off points off port entrances and river mouths.
Viewing the TSL System as a 'barge shifter' best describes its mode of operation:
Barges are loaded in port with outbound cargo, then pre-positioned in the drop-off spot prior to the TSL's scheduled call.
The TSL exchanges inbound for outbound barges just outside port and sails on after ninety minutes.
Inbound barges move to coastal and inland ports for discharging and reloading.
The TSL is fully ocean-going. However, the competitive advantage of accelerated port throughput, schedule reliability and system time is best utilized on routes on which port time has more impact than steam time, i.e. in the short sea trade.
The related competitive advantage of the TSL System is that its schedule consists of two predictable elements: fixed barge exchange time of 1.5 hours and constant operating speed of ≈21 knots. In contrast to conventional shipping networks, the influence of port operations such as unplanned extension of port time and slow steaming due to late berth availability are off the TSL schedule's critical path.
A consequence of port congestion is that it delays all vessels; from main line VLCS (Very Large Container Ship > 7000 TEU) through MSCS (Medium Size Container Ship # 7000 TEU, > 3000 TEU) to feeder. A 2006 survey indicated that only 54% of all container vessels achieve on-schedule performance. As port time is off the TSL's critical path, schedule reliability is an inherent attribute.
Schedule reliability also affects throughput capacity. In order to minimize cascading late calls resulting from port delays, the voyage schedule of conventional vessels must include buffer times. This is to the detriment of system time, i.e. the time span required for transporting cargo on a round voyage. As the TSL's cycle time does not need such buffer times, its system speed - i.e. its throughput capacity - inherently exceeds that of conventional feeders.

Making use of Infrastructure

Because of shipping cargo in barge lots, the TSL System also enables decentralized cargo aggregation by including small ports into the short sea shipping network. In this expanded short sea

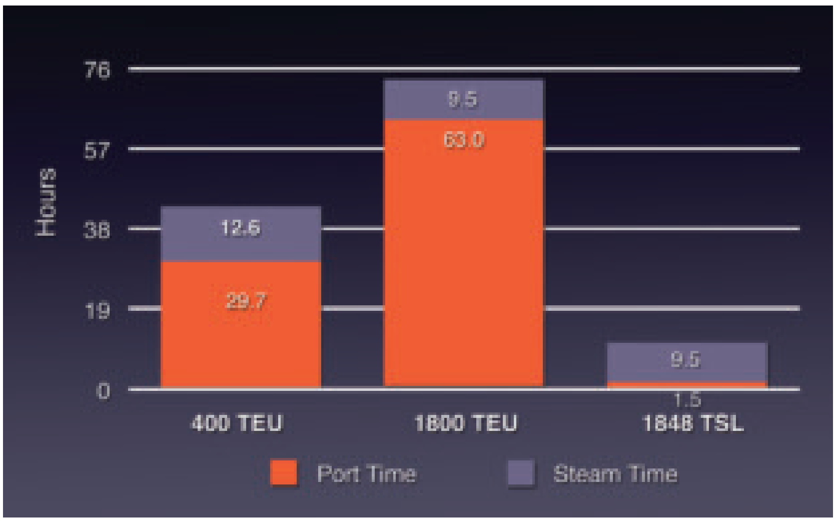

Figure 5: Port time vs. steam time on a 200 nm sea leg

network, the TSL System's barges can process cargo distribution at a consistent 21 knot speed to any size port. This also offers more interface options for distributing and aggregating cargo in the region contiguous to a hub port and for shifting traffic from road to water.
A key advantage of the TSL System is illustrated near the lower margin of the diagram in Figure 4, i.e. the exchange of inbound for outbound barges from several ports in one single stop. Bigger container ships call at only one of two neighboring ports for minimizing port time and costs. Many containers handled in one port are moved to the other by truck. By contrast, the TSL exchanges barges for both ports in one stop. This reduces drayage between ports, congestion and delays on roads through residential areas between ports.
More generally: The TSL System's barges reach ports closer to the containers' destination. This applies above all to the barges' ability to penetrate farther into the hinterland.
Conclusion: the TSL System plays well with the existing infrastructure while dramatically increasing throughput. This enables ports to minimize logistics problems of VLCSs and the ever growing vessels for short sea distribution competing for the same limited berth space and cargo handling schedule.

Reduction of Port Congestion

Particularly as a feeder between a hub port and regional ports, the TSL System offers advantages regarding route capacity and better utilization of existing ports. The reason is its high ratio of steam time to port time, as illustrated in Figure 5.
The TSL System's higher number of round trips per year results in drastically increased route capacity. Improvements to current vessel performance are measured in a limited number of additional annual round trips. Not having to enter port and thereby not being affected by the related problems, the TSL System will multiply the annual number of round trips by two to seven times by doing what it does best: transporting cargo at a steady speed of 21 knots.
Better utilization of the existing traffic infrastructure pertains not only to the expanded short sea network of ports that barges can reach, as shown earlier, it is also the handling of barges inside port and at a terminal:

– The big TSL barge carrier does not enter port.
– Several barges fit into the berth of one feeder, thus containers can be shifted directly from a big containership to barges destined for the onward containers' port of destination instead of being buffer-stored in the stacking yard.
– The TSL System's barges do not choke the terminal as barges are moored off terminal when not loading or unloading cargo.
– The barges flow through port without delay, as barges are shifted by the TSL on a ferry-like schedule at high frequency.

The example below compares throughput capacities of an 1.800 TEU container feeder handling containers in port vs. a TSL exchanging barges outside port.

Sea Leg: 200 nm	1.800 TEU Feeder	1.848 TEU TSL
Loading	30 h	0,75 h
Unberthing	1 h	0 h
Departure	1 h	0 h
Steaming (21 kn)	9,5 h	9,5 h
Approach	1 h	0 h
Berthing	1 h	0 h
Unloading	30 h	0,75 h
Total Voyage Time	73,5 h	11 h
Round Trips in 73,5 h	1	6
Throughput in 73,5 h	1.800 TEU	11.088 TEU

Throughput: TSL System vs. a container feeder of comparable TEU capacity

Assumed is full-tip out and reload at the ports of origin and destination. Further assumptions address the number of cranes, crane efficiency, number of lifts at a typical mix of 20' and 40' containers etcetera. Both vessels have practically equal TEU slot capacity, and operate at the same speed on a short sea leg of 200 nm.
The table shows that the TSL System outperforms the conventional container ship on the 200 nm route by six times the number of round trips, i.e. it improves system throughput six-fold. This acceleration of throughput makes the TSL System attractive to both shippers and ports in resolving the port congestion problem.
The potential of the TSL System for reducing port congestion is best visualized when converting its six-fold throughput advantage to the equivalent in the number of ships: six of the 1.800 TEU vessels are required to achieve the same annual throughput through port as one TSL. Of course, this ratio changes with route length etcetera, but the principle of having more conventional ships in port and the consequences for port congestion become apparent.

Scarce Feeder Capacity

Another problem to throughput is scarce feeder capacity. In addition to container ships up to the size of smaller VLCSs re-deployed on feeder routes, the demand for new feeder vessels is high while shipyards are full for the next several years. Due to its multiple throughput per vessel, fewer TSLs than conventional feeder vessels will be required for the same throughput. Furthermore, the TSL itself is easy to build. Its hulls can be built and launched separately and joined afloat to the top-side structure. Thus, the TSL can be built in smaller shipyards. As big conventional feeders must be built by currently overloaded bigger shipyards, feeder capacity can be increased much sooner by building TSLs.

Development Status

The Preliminary Systems Design of the TSL has been completed and is ready for optimization to client's requirements. A comprehensive tank testing program has been planned with a Dutch model basin. First reviews of the concept were made with two European classification societies. Subject to availability of building berth, the first TSL could be operational in 26 to 29 months after contract.
The TSL System's economic feasibility has been assessed in several general applications. The methodology for assessing the TSL System for applicability to clients' specific requirements has been developed.