Conneaut: An Economical Superport

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Summary

The Pittsburgh and Conneaut Dock Co.'s ore and coal bulk handling facility at Conneaut, Ohio on Lake Erie, is one of the largest bulk terminals in the world. The author describes the design philosophy and the various construction stages of this superport and shows why and how economical terminal charges could be achieved. The main reason for this, in addition to highly competent port management, is the combination of high production, great reliability and low operating costs, with minimum investment.

1. Introduction

Conneaut is one of the world's largest and most economical bulk terminals.

It is a public facility owned by private enterprise. It received no subsidies, and no part of it was built by public funds. Nevertheless, Conneaut is one of the lowest cost bulk terminal operations. Terminal charges are $1.19 per ton of coal for railroad unloading, stockpiling and shiploading [1]. It charges $1.40 per ton of iron ore from vessel to stockpile to railroad [2].

Obviously, this requires highly competent management. Indeed, the computerized preventive maintenance systems developed at Conneaut received extensive treatment in the technical literature [3]. However, from an economic viewpoint the fact that Conneaut succeeded in keeping capital costs to a minimum was crucial and is the subject of this paper.

2. Capital Cost Savings Through Innovation

The reduction of capital costs required innovative concepts, as well as advances in the existing state of the art. Conneaut was built in many phases and incorporates an unusual number of engineering firsts:

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- The first ground storage type coal terminal in the U.S.
- The world record effective coal loading rate (7,650 t/h)
- The highest capacity ship unloading system (20,000 t/h)
- The highest capacity bottom dump coal unloading (3,600 t/h)
- The highest capacity single rotary dumper for coal (6,000 t/h)
- The first slave stacking system (Soros patent)
- The first automated clean-out system
- The first high speed coal conveyor system in the U.S.
- First installation where a unit train unloads one material and is loaded with another material at the same time.

3. Original Coal Terminal — 1965

Railroad unloading at 3,600 t/h, 3 million ton stockpile in multiple grades, shiploading at 7,000 t/h [4] (Fig. 1).

3.1 Basic Handling Concept

Much of the stockpile is for winter storage. One customer accounts for 60—70 % of the tonnage. Thus, most of the turnover could be accomplished in a small part of the system. High operating efficiency and high investment is limited to this small portion; the balance of the system handles coal at lower rates, with minimum capital cost.

3.2 Realization

Bottom dump railroad unloading was used because of lower capital cost. The 3-car station with 6 shakeouts is the largest of this type. The central control is strategically located at a distance where the operator's field of vision covers 3 railroad cars. The shakeout building is designed to silhouette the coal flowing from the railroad car gates, and the shakeouts on top of the railroad cars (Fig. 2). Moving the train, raising, lowering and operating the shakeouts and coal stockpile is controlled by a single operator.

Realizing that Great Lakes vessels have special winches which makes it just as efficient to shift the vessel as to travel

Fig. 1: Coal terminal, initial phase. Existing high rise dumper is converted to 7,000 t/h shiploader. Surge bin in front of loader can be fed at 6,000 t/h, with 3,000 t/h available from railroad, gravity pit or bucket wheel

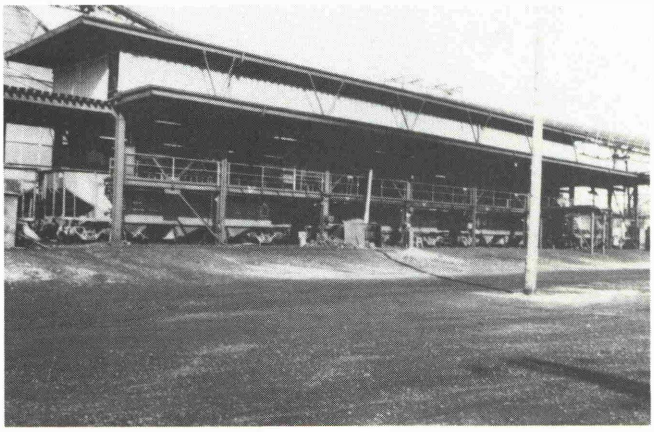

Fig. 2: Highest capacity bottom dumping installation. Silhouettes shakeouts and gates, so that a single operator, located at a distance, operates the 6 shakeouts, the train locomotive and the coal stockpiling

the shiploader, an existing high-rise dumper, dating back to the early part of the century, was converted into a fixed shiploader at nominal cost.

The shiploader is fed from a 900 ton surge bin by a short conveyor specially designed for stop-start service to cope with 19 to 27 hatches customary on Great Lakes vessels. The bin is fed by a 6,000 t/h conveyor. The rest of the system, representing most of the investment, has only a 3,000 t/h capacity, to minimize capital costs.

The 7,000 t/h nominal loading rate was achieved by building only a 3,000 t/h conveying and reclaiming system at less capital cost, and combining two material flows from the railroad unloading or from a 3,000 t/h bucket wheel serving the coal yard, or from a 7,000 ton live pile over a reclaim pit for the main customer (see Fig. 1).

The conveyor system was the first high speed (1,000 ft/min) installation in the U.S.

To eliminate slow-down toward the end of shiploading the installation incorporated the first automated clean-out system.

4. Coal Expansion — 1967

To increase annual tonnage and accommodate new wider beam vessels, shiploading rate is boosted to 11,000 t/h and stockpile capacity increased to 4 million tons [5].

4.1 Basic Concept

Single berth with unprecedented 11,000 t/h loading rate would cost less to build and operate than building a second loading berth. Capital costs would be kept to a minimum by achieving the 11,000 t/h loading rates with the existing 3,000 t/h yard system.

4.2 Realization

The 11,000 t/h loading rate was based on the concept of preprogramming the loading sequence. This was feasible, because the Great Lakes is a closed system with only a certain

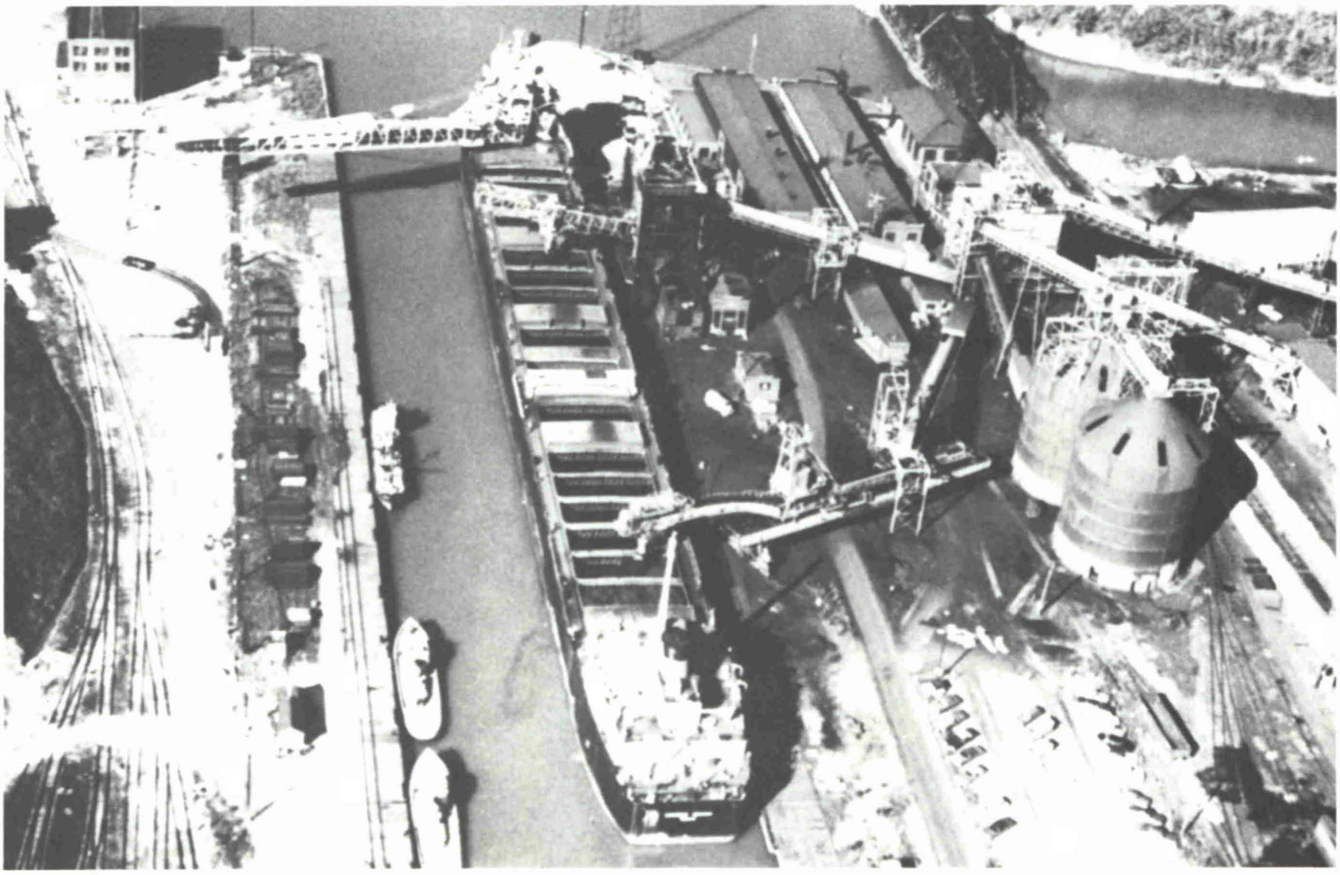

Fig. 3: 7,000 t/h shuttle boom extends reach of high rise dumper. 4,000 t/h quadrant loader reduces wharf length necessary to shift larger vessels. Two 7,000 ton bins are pre-loaded between vessels, to provide 11,000 t/h loading rate

number of vessels in the trade. The old high line dumper was reinforced and equipped with a luffing and shuttling conveyor boom to extend its reach. A 4,000 t/h slewing-bridge type shiploader was added, to limit vessel shifting. This cost less than a second fixed loader, which would have required lengthening the wharf to accommodate shifting of the new, longer vessels.

The stockpile system was lengthened to 2,500 ft. This required only intermediate conveyor sections, as the original design made provisions for the expansion.

The cost of adding a 4,000 t/h reclaim system was avoided by taking advantage of the fact that most vessels take up to 35,000 ton cargoes. Thus, the new 11,000 t/h shiploading rate could be sustained by having up to 14,000 tons pre-loaded in silos feeding the new slewing loader, combined with the 6,000 t/h material flow to the fixed loader from the existing installations (see Fig. 3). Two 7,000 ton silos were constructed. The pre-loading utilizes essentially the time that is lost between the departure of the loaded vessel and the arrival and berthing of the next vessel to be loaded.

After loading a vessel, the coal remaining in one of the silos (the other has been emptied completely) is recirculated to the stockpile. At the same time the other silo can be filled at 6,000 t/h from the original installation, followed by filling the second silo, certain to be empty by that time.

Thus, an 11,000 t/h loading rate is achieved with mostly a 3,000 t/h conveyor system, obviously at very low capital cost. At least 75 % of the material flow is by gravity, from the silos, the pit or direct from the train, providing good reliability, high performance and low operating costs. The system holds the world record effective loading rate, 7,650 t/h, despite the fact that the vessels to be loaded are small and have many hatches.

5. Ore Unloading Terminal — 1973

10,000 t/h unloading system for bulk carriers and self-unloaders. 3.2 million ton stockpile in multiple grades. Train loading into random cars [6] (see Fig. 4).

5.1 Basic Concept

Trains to be loaded with exact blast furnace charges and delivered to the Pittsburgh steel mills the next day, bypassing the ore yard operations at the mills. Ore yard to provide maximum live storage, as bulldozing is not economical.

5.2 Realization

Five existing Hulett unloaders were modified to feed a 10,000 t/h dock conveyor, rather than into railroad cars. The stockpile system incorporated the first slave-stacking system (Soros patent) (Fig. 5). This saved capital cost of an additional runway, 10,000 t/h yard conveyor and stacker. The 5,000 t/h rail loadout station loads random order cars, with different car sizes and capacities with a weight accuracy of 0.01, with the weight evenly distributed over the axles with an accuracy of 0.02 (see Fig. 6).

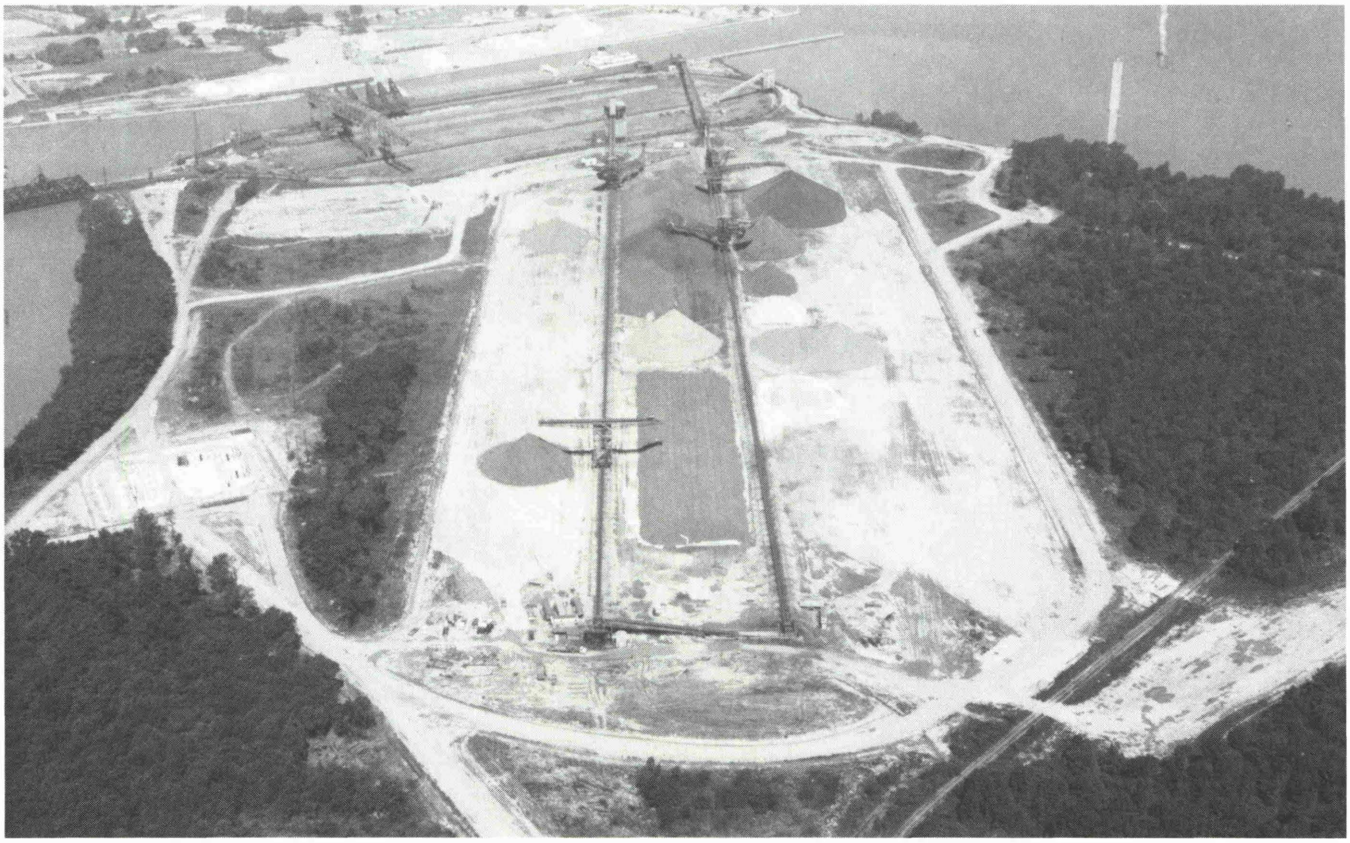

Fig. 4: Initial ore unloading terminal consists of 5 converted Hulett unloaders, 10,000 t/h stockpiling system, two bucket wheels and railroad loadout for random cars

Fig. 5: Patented Soros slave stacking system builds third row of stockpiles, saving the capital cost of an additional 10,000 t/h yard conveyor, stacker and runway

6. 35 Million Tons Per Year Master Plan

The main conclusions, based on extensive computer simulations were:

- The existing coal loading berth could attain over 15 million tons during the available loading season.
- It is feasible and more economical to maximize capacity of the single loading berth than to build a second one.
- A second coal dumper and additional stockpile capacity will be required to achieve this tonnage.
- Expansion of the unloading terminal to 20 million tons per year is feasible within the existing infrastructure. It will require:
  - — lengthening the main ore yard to increase stockpile capacity to second 10,000 t/h unloading berth, limited to self-unloaders.

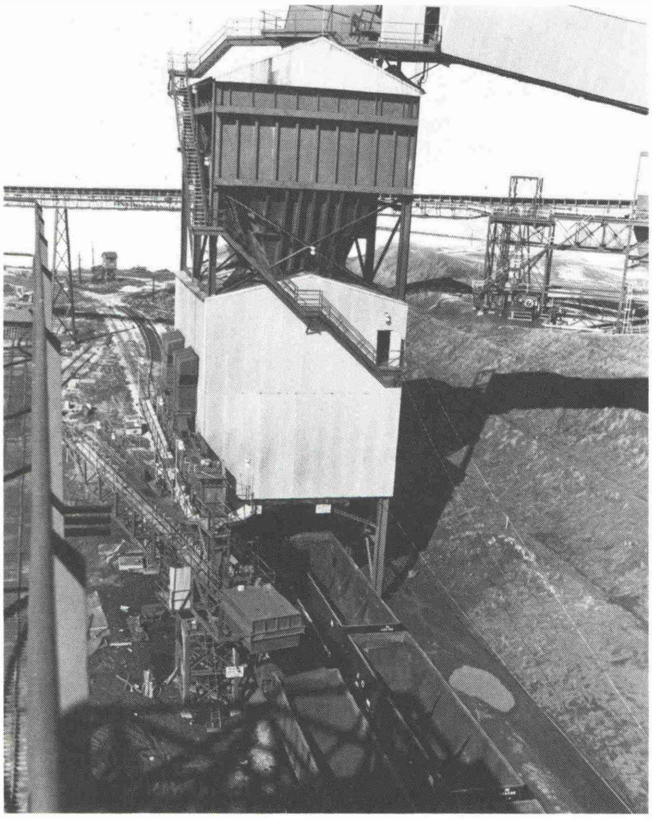

Fig. 6: 5,400 t/h railroad loadout loads random cars with 0.01 accuracy, with weight evenly distributed over the axles with an accuracy of 0.02

Fig. 7: New upper coal yard with 6,000 t/h single rotary dumper. Single yard belt has bucket wheel in front of stacker. One gravity pit is within reach of stacker, the other is fed by fixed stacker. The system is flexible, with above average reliability and low capital cost

— second small ore yard with 10,000 t/h stacking capability.
— second 3,000 t/h railroad loading station.

- A maintenance building dedicated to and adjoining the 5 unloaders.
- Channel congestion will not restrict vessel traffic.

7. Ore Terminal Expansion — 1975

All of the steps of the Master Plan were carried out without interruption of existing operations.

8. New Coal Yard — 1979

New rail yard, 6,000 t/h rail unloading, 3 million ton stockpile, 6,000 t/h conveyor connection to existing shiploading system (see Fig. 7).

The new upper coal yard has a single rotary dumper with a capacity of 6,000 t/h. This is comparable to or higher than any of the tandem dumper installations currently in operation. The break-through in capacity has been achieved by reducing the cycle time to feed the cars to the dumper. The indexing system does not start from standstill, but is synchronized with cars moving at 4 miles/h, thus reducing the time required for acceleration, as well as the shock to be absorbed by the car couplings and the indexing mechanism (Fig. 8). Of course, a single car rotary dumper, hoppers, feeders etc. has substantially lower capital cost than a tandem installation for the same capacity.

A single 6,000 t/h yard conveyor has stacker with bypass (Fig. 9) and a 3,500 t/h railmounted bucket wheel reclaimer in front of the stacker (Fig. 10). At the head end of the yard conveyor there are two 3,000 t/h gravity reclaim pits, with one trainload of live capacity. One of the pits can be fed by the travelling stacker, the other by a fixed stacker (Fig. 11). The system has reasonable flexibility, above average reliability

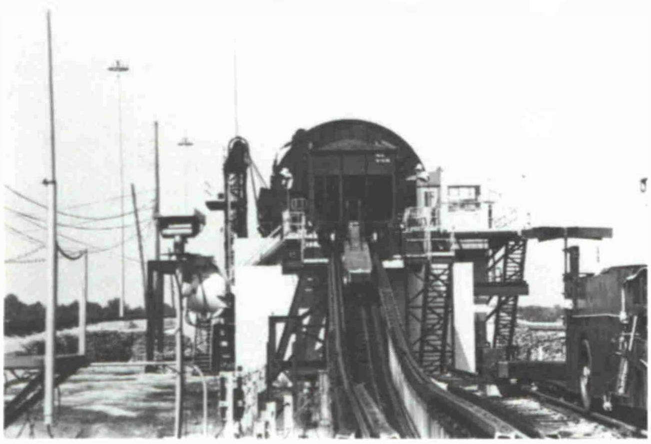

Fig. 8: 6,000 t/h single rotary dumping cycle is achieved by accelerating with the barney a railroad car already moving at 4 miles/h

and low capital cost. One grade of coal can be stacked, and another reclaimed from one or both pits, or alternately reclaimed by the bucket wheel and augmented by the surge pit. Further, if for whatever reason, the shiploading dock can not accept coal, coal can be diverted to the surge pit via the fixed stacker, allowing the bucket wheel or train unloading to continue without interruption [7].

The overall facilities are shown in Fig. 12 [8].

Fig. 9: Yard conveyor stacker with bypass

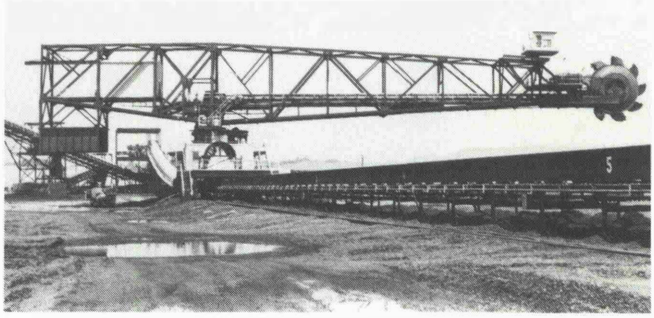

Fig. 10: 3,500 t/h bucket wheel serves same yard belt, in front of stacker

9. Conclusion

The Pittsburgh and Conneaut Dock Co. facilities were designed for continued growth, as justified by the development of the business. Economical per ton costs are achieved by a competent management operating a minimum capital cost facility. The combination of high production, great reliability and low operating costs, with minimum investment required innovative engineering and pioneering advances in the state of the art.

Fig. 11: One of 2 reclaim pits with one trainload live capacity is fed by a fixed stacker at the head end of the yard conveyor

References

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Fig. 12: The overall facilities, with the master plan nearly completed. It includes the second coal yard and dumper. The ore yard expansion and the second 10,000 t/h ore yard with its own railroad loadout station