Dredging: A Basic of Port Development

The most protracted and tedious activity going on in the harbor at the turn of the century was dredging. Between 1896 and 1906 hundreds of thousands of tons of sand and bottom soil were dredged to create more than 17 miles of navigable channels in the harbor, all of it at 20 feet of depth. The dredged material was used to reclaim marshy lands bordering the harbor and to fill in low spots inland. The project changed the face of the harbor by creating large tracts of new land on the waterfront, right where it was most useful for industry.[1] Unlike the relatively new technology used to build the cement breakwaters, dredging technology at the time was largely unchanged from 30 years before, and it would improve little during the 75 years that followed as well. Some of the simplest dredging techniques dated to at least the 14th century. Government spending for turn of the century harbor improvements resulted in the widespread purchase of new dredging equipment by private-sector contracting firms.[2]

A massive port improvement project between 1896 and 1906 created 17 miles of 20-foot deep navigation channels. In this 1906 photo, dredges work around a lineup of lake vessels stalled by a seamen's strike. (Lake Superior Marine Museum Association Archives, Lake Superior Maritime Collection at University of Wisconsin-Superior, Army Corps of Engineers photo)

There were basically four methods for dredging used in Great Lakes harbors. Dipper dredges employed techniques that were several hundred years old, draglines and clamshells were somewhat more recent, and hydraulic or "suction" dredges were relatively new. While all four methods were efficient, their effectiveness depended on conditions of the job site, such as depth of water and nature of the harbor bottom.[3]

Dipper dredges used large steel buckets fixed on the end of a movable arm. They dipped large scoops full of bottom material and lifted it into barges or scows for disposal. Leonardo da Vinci designed a dipper dredge in 1550 and others were employed in Holland before1700, driven by men or horses on treadmills; their design was based on primitive "spoon and bag" dredgers that appear to date to the Roman era. Steam was applied to their machinery after about 1830. They were capable of working in silt, sand, clay, gravel or even with large boulders. Dipper dredges are powerful and versatile, but they are also complex and expensive to build and to operate.[4]

Dragline dredges used large steel buckets suspended from ropes or cables. The bucket was dropped into the water from the end of a boom, and then dragged across the bottom by a second cable and brought up to a point where the dredged material could be dropped into a scow. Dragline dredging could be used only where there were no large rocks. They are inexpensive to build and operate, requiring only a very small crew.

Clamshells were steel buckets that were hinged in the middle. In their open position they were dropped into the water by a heavy cable or chain and then drawn shut by a smaller cable, enclosing a quantity of the bottom material. The first cable was then used to lift out the bucket, and it could be swung over a scow to be emptied of its load. These dredges, like the similar dragline apparatus, worked well in most materials except large rocks. They were also cheap to operate.

Powerful steam-driven centrifugal pumps were used in hydraulic dredges to bring bottom sediments, sand and gravel up in pipelines. Rotating "cutter heads" loosened the material and fed it into the suction pipes, from where it was pumped to disposal sites. Sectional disposal pipes could be linked together to stretch as far as a mile from the dredging job. Suction dredges were effective in loose sediment, clay, sand and gravel, but not where larger stones or boulders occurred. In the right places, these vessels are highly efficient, but they are also costly to equip and to operate. The first hydraulic dredges were introduced in 1855.[5]

In some areas, limited dredging was accomplished by simply dragging timbers, chains or scoops behind tugs and "ploughing" a furrow, or by working the propellers of steamships that were held in a fixed position by anchors. In certain settings it was necessary to blast bedrock in order to dredge out channels. Large rock drills were employed to make holes for dynamite charges, and then the rock was blasted into smaller pieces for removal. Dynamite was also used to break up and remove obstructions like shipwrecks. One of the first steps in the turn of the century harbor improvements at Duluth was removal of a wreck alongside the old South Pier, on a line where the new concrete pier was to be constructed. A diver and deckhand were killed when one of the dynamite charges exploded prematurely on board a work scow during 1898.

Much of the dredging at the turn of the 20th century was done with dipper dredges. "In the case of a steam-operated dipper dredge, you would have a boiler hooked to a steam engine," explained the late L. Keith Yetter, longtime executive with Duluth's Zenith Dredge Co. "The dipper is like the steam shovel that you see in the old mines. You dig under water with it, and it dumps on the bottom just like a regular digger in the mines. You dump into what we call a dump scow or a deck barge, and we swing to the side, dump and dig again. You move ahead with that."[6]

The dredge was leveled with spuds, which held it stationary above the lake bottom. There were two spuds at the bow, and one at the stern. The spuds were raised and lowered by the bucket as the dredge moved forward. A dipper dredge early in the century was capable of digging a channel 25 feet wide.[7]

Contractors at the time also used clamshell dredges, where the dipper shovel was replaced by a hinged bucket suspended by chains. "Clamshell dredges operate very much like a dipper dredge," Yetter said. "They do not level up the barge in most cases. In the old days those scows were bottom-dump scows that you could dump in the lake or deep holes in the harbor -- a very efficient operation."[8]

Hydraulic dredges are used in most other Great Lakes harbors to keep them free of the silt and sand that are deposited continuously by natural currents. Dipper dredges were used in the Duluth-Superior harbor up to the 1970s, and clamshells are still in use, both examples of old technology that was admirably suited to local harbor projects throughout the 20th century

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[1] C. Patrick Labadie, Duluth's Ship Canal," *The Duluthian*, September-October, 1985, p.40.

[2] "A Powerful Dredge Equipped with a Cable Storage Drum*," Engineering News,* V.LVII, No.5, February 7, 1907, p. 145.

[3] John Huston, Hydraulic Dredging, Theoretical and Applied, (Cambridge MD: Cornell Maritime Press, 1970) pp. 3ff. "Mud mills" were also used in many other countries. They used an endless chain of small buckets that scooped up bottom material. They were especially suitable for light riverine silt. Their technology dated to 17th century Holland.

[4] 75 Years of Dredging Progress, 1885-1960. (Baltimore, MD: Ellicott Machine Corporation, 1960)

[5] Huston, Hydraulic Dredging, p.11

[6] Tape Recorded Oral History Interview with L. Keith Yetter, Duluth, Minnesota, May 24, 2001, p.3. Yetter died in Duluth on September 3, 2002.

[7] Ibid., p.3. Modern hydraulic dredging equipment is capable of digging a channel 150 feet wide.

[8] Ibid., pp.3-4