



# Barbados Screwdock – oldest surviving shiplift in the world

In December 2009 Keith Mackie was in engineers' heaven – sitting by the sea in Barbados on a pile of rusty iron, measuring it up as part of his involvement in the possible restoration of the Barbados Screwdock. Here he shares some fascinating facts with us

## HISTORY

Because of its position commanding the windward approaches to the Caribbean, in the 17th century Barbados was the largest port in the Western hemisphere. By the end of the 19th century there were still some 1 500 vessels a year calling at Bridgetown. The estuarine mouth of the Constitution River, which enters the sea at Bridgetown, became a centre of ship repair and is still known as the "Careenage" – the place where ships were careened, i.e.

beached and laid over for scraping, painting and repair. In 1880 a Scottish engineer, John Blackwood, went out to Barbados as a young man to work in this industry and was soon in business on his own account.

In November 1887 the Barbados Parliament passed an act to authorise the lease of government land for harbour improvements and the construction of a dry dock. A lease for the site of the screwdock was signed in favour of John Blackwood. The government reserved the right to take over the dock on expiry of the lease at prime cost less a reasonable allowance for deterioration. Work began in 1889 and the lift was formally opened on 10 March 1893 by Miss Hay, daughter of Sir James Hay, then Governor of Barbados.

Actual construction took far longer than the two years allowed. One of the reasons given was the flooding of the works by exceptionally high tides. Because the retaining walls had not yet been completed, portions of the embankments collapsed into the works.



1 The Barbados Screwdock with maximum vessel in the early 20th century

While this can only be part of the explanation for the extended delays, it does serve to suggest that the works, at least initially, were coffered and built in the dry.

Blackwood died in 1904, lost at sea, and his business was taken over by his brother-in-law, William McLaren, who ran it until the formation of the Central Foundry which took over the running of the dock.

By the 1970s, the dock was still lifting over 10 000 tons of shipping per year. By the start of the fourth quarter of the 20th century, however, the operations of the Central Foundry

*The design of the screwdock is a superb example of Victorian engineering, representing dry dock design at its best – good even by modern standards. The two primary elements that formed the basis of the design are unique: the use of power screws for lifting and trussed timber beams for the transverse girders*

- 2 The screwdock as it is today
- 3 Piers, copes and screws



and the screwdock were coming to an end. Peter Simpson, who worked for the Central Foundry as a mechanical engineer, was quoted as saying that the dock was “antiquated and not easy to work”. Although ship construction was changing from wood to steel, labour rates were increasing, and Barbados had lost its pre-eminence as a shipping centre, institutional and financial matters seem to have been at the heart of the problem. In the late 1970s there were also problems with the lease of the site. The Central Foundry was not able to reach agreement with the government on this matter. The Foundry had also suffered a number of fires, the first in 1938 and then another in 1948. They were able to recover from these, but it was the third fire in 1981 that ravaged the works and destroyed all the records. The firm never really recovered after that. In 1984 it went into liquidation and the screwdock ceased operations. It has been derelict ever since.

## CONTEXT OF THE SCREWDOCK

Threlfall (1995) makes the comment that “after carefully studying some ideas embodying hydraulics, Blackwood chose a system based upon screwjacks”. Although this quote is not explicit, it does sound rather like the hydraulic lift dock of Edwin Clark built in London in 1857 – the first shiplift ever built. Blackwood’s screwdock some 30 years later is the second shiplift ever built and, although it is currently derelict, it can be restored. Abandonment of the dock, tragic as this may sound, was something of a godsend – the dock avoided being modified into something modern and quite different. What survives today is substantially original and the dock could be restored to its original condition.

## DESIGN

The design of the screwdock is a superb example of Victorian engineering, representing dry dock design at its best – good even by modern standards (Figures 2 & 3). The two primary elements that formed the basis of the design are unique: the use of power screws for lifting and trussed timber beams for the transverse girders.

Another key feature of the design was the spacing of the screwjacks. Thirty-one pairs were used spaced at 7’0” (213,36 cm) centres (the lift was originally built in feet and inches and this is still the standard system of measurement on the island). This keeps down the loading on individual screws and beams and is close enough to obviate the need for intermediate grillages. Planking laid athwart each beam abuts that on adjacent beams and creates a continuous working platform.

The retaining walls to the docking pit were built of hard coral blocks – the only stone available on the island – with piers at the same 7’0” centres. The copes to the docking pit are formed of a pair of 12” (365 cm) square greenheart timber baulks laid side by side spanning across the piers. The screwjacks are supported by these cope baulks at mid-span between the piers.

Each transverse girder is formed from a pair of 20” by 20” (50,8 by 50,8 cm) baulks of greenheart timber (given, in some references as “whalebone” greenheart) laid side by side. Each end of each baulk rests on one side of a cast iron plate at each end hanging off the screw rods.



A cotter and washer system underneath these plates transfers the load to the screw rods. A cast-iron bracket at each end of each baulk (a pair at each end of each beam) anchors the 2" (5.0 cm) steel truss rods. These pass each side of the baulks and under cross-timbers under the baulks (Figures 4, 5 & 6).

The main drive was routed through a pair of lay shafts interconnected by two sets of gears and pinions with a dog clutch connector so that what appeared to be either a 1:1 or a 2:1 ratio could be selected. Thereafter the drive was routed through a pair of bevel gear sets on each side to drive the lay shafts running down each side of the dock.

At each screw a sliding dog clutch keyed to the drive shaft engages a worm wheel that floats on the shaft (Figure 9). The worm in turn engages a gear wheel that has a bronze nut/thrust washer embedded in it (Figure 10). The screw rod passes through the nut and is raised or lowered depending on the direction the wheel turns.

This arrangement allowed any combination of beams to be lowered or raised without moving the rest. Hence the dock could be used to dock two vessels separately – the aft vessel coming in after the forward vessel and leaving before it. Otherwise, individual beams could be lowered to work on the keel of a vessel.

The worm and wheel sets are diagnostic of the quality of management and maintenance of the dock in its last days. Both worms and wheels come in a full spectrum of conditions from almost new to the teeth worn to sharp edges and virtually unworkable. (Figure 11).

Peter Simpson, the mechanical engineer, and Joe Weeks, at one time assistant dockmaster, concurred that when a large vessel was being lifted, the worm and wheel sets to the heavily loaded screws emitted a steady stream of sparks.

Surprisingly, all the wheels are spur gears, which is completely inappropriate for this use and explains why both worms and wheels had to be replaced at regular intervals. In the 1890s, when the facility was built, the technology of worm and wheel gearing was well established. It seems highly unlikely that these were original equipment. However, when and why the wheels were changed to spur gears is completely unknown.



## RESTORATION

The people of Barbados seem to be surprisingly well informed about the screwdock and generally feel keenly that it should be preserved. Although some antiquarians feel strongly that preservation should be static, merely preserving what is there at present, as it stands, they generally seem to lack any understanding of the technology involved. Other antiquarians, however, believe that it can only be properly preserved if it is "active", i.e. if it is restored to full working condition and operated as a dry dock. When these views are put to the common Barbadians, they generally support the full, active, restoration.

Voices opposed to full restoration reflect a pragmatic recognition of the difficulty in raising the funds needed, which is estimated to cost somewhere between US\$4 and 7 million. Quite rightly, they warn against embarking on any restoration without a guarantee of the full amount needed.

A notable feature of the dock is the almost complete lack of any dock

furniture – bollards, capstans, fairleads, leading mules, etc. This, together with the degraded condition of the equipment at the time it was abandoned, goes a long way to explaining the comment by Peter Simpson that the dock was difficult to work. In fact, for its day, the dock was an impressively modern and efficient system and only a full restoration to a working system can preserve the most important component – the actual trade practice of operating the dock.

On the matter of authenticity, most of the dock consists of wearing parts that needed to be and were regularly replaced. To do so properly in the future will not compromise the authenticity. Greenheart timber for the main beams and the copes could, however, be a problem. Greenheart comes from neighbouring Guyana and is well known to the Barbadians. Opinion is that there are not a lot of suitable trees left and it will need something like two years to find enough suitable trees in the forest. Given that these beams are a consumable item with a lifespan of 20 to 30 years, some conservation

- 4 The last cross-beam
- 5 Truss tie rods and brackets
- 6 Beam support plate at end of screw rod
- 7 Main drive
- 8 Gear change (note the two-way bronze dog clutch and handle)





plan will be needed to guarantee an indefinite supply of greenheart if full restoration is to be done.

The economics of dry docking is another matter that must be considered. The Caribbean is an archipelagic region so there is no shortage of shipping and demand for dry docking. The economics of dry docks, however, are such that they cannot make money. A rule of thumb is that shipowners will not tolerate a docking charge of much more than 10% of their spend on repair costs. Generally, this is only enough to cover operation and maintenance. The money is made in ship repair. Hence ship repairers can afford to own dry docks. Any profit they forgo to amortise the dock remains an asset on their books. However, since they are in business, they cannot be relied on to maintain authenticity. The State is the only other player that can afford to own dry docks and run them on a common user basis, amortising them from the tax flows from the increased industrial activity of the ship repair that takes place.

In the case of the screwdock, the best vehicle would probably be some sort of trust set up to run the dock on a common user basis but unburdened by the capital cost of the dock.

### RELEVANCE

Finally, one must ask whether the restoration is justified. First, it is not only a marvellous piece of Victorian engineering worthy of preservation in its own right, but it also occupies a key place in the evolution of dry dock engineering.

But there is another side. The whole system is fundamentally robust and survived in operation for almost 100 years in a relatively out-of-the-way place like Barbados. The more modern wire rope shiplift is liable to rope failure and is too complex for small fishing harbours or much of the Third World. The screwdock may be just the technology needed. A full restoration will be an excellent opportunity to study the screwdock in detail and really assess its practicality.

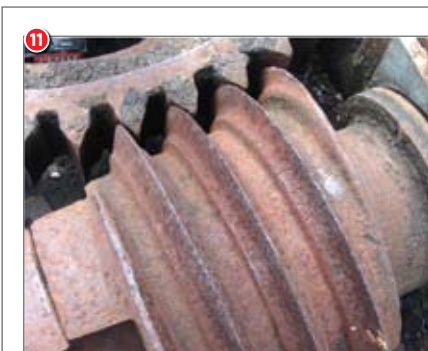
### REFERENCES

The list of references is available from the editor. □

9 Worm, wheel, screw and dog clutch set (note crack in base plate)

10 Bronze thrust washer (note cracked oil bath)

11 Various conditions of worm and wheel



▶ Worn worm and wheel



▶ New worm and worn wheel



▶ Worn worm and new wheel



▶ New worm and wheel

Source:

[http://www.saice.org.za/downloads/monthly\\_publications/2010/2010-Civil-Engineering-May/#/0](http://www.saice.org.za/downloads/monthly_publications/2010/2010-Civil-Engineering-May/#/0)