The B.D.1:
'The Most Perfect [Dredger] by Far in the World

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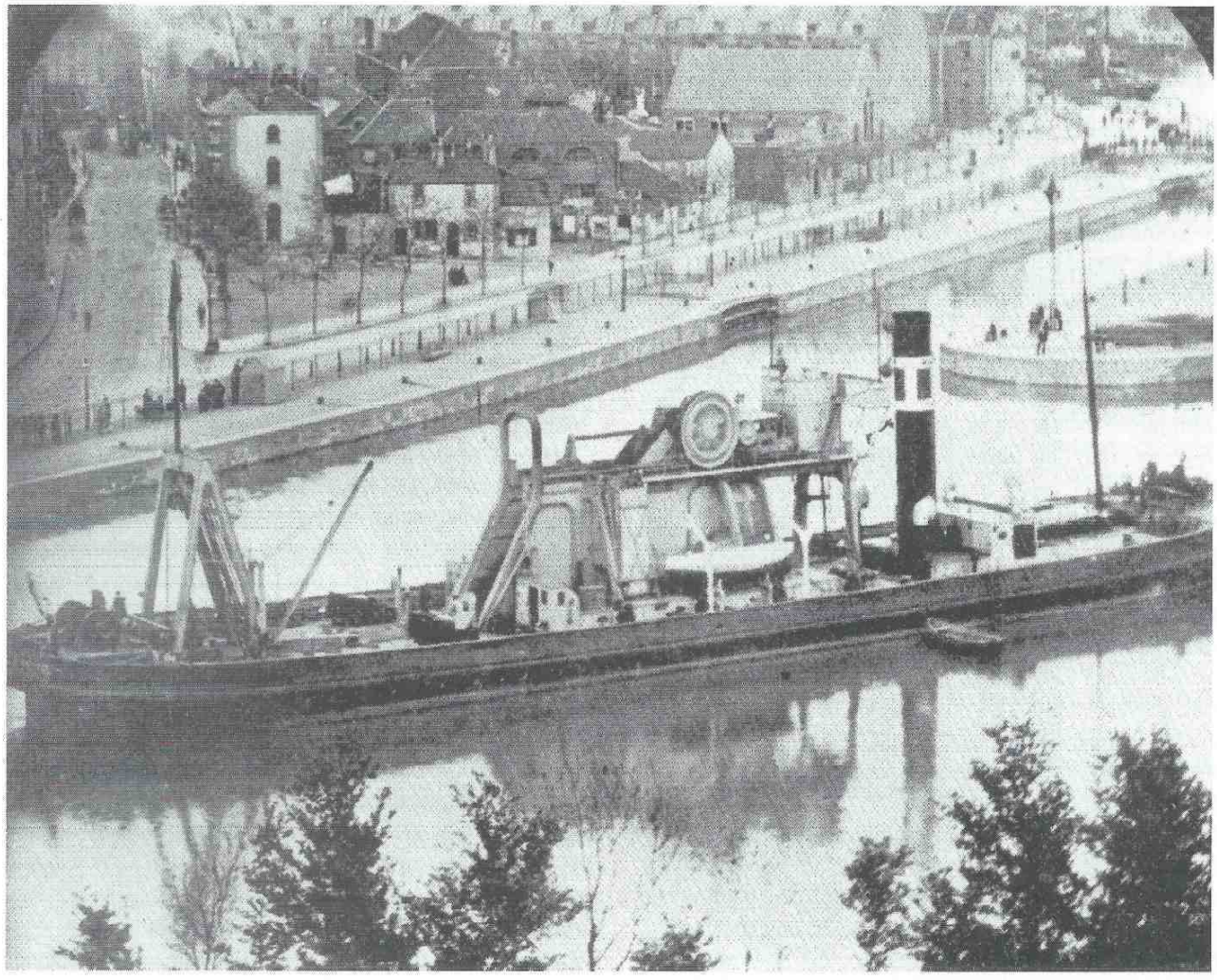
Introduction

This article can to some extent be seen as continuing on a theme touched on by two articles in BIAS Journals of the 1970s.[1] The first was a report on a 1977 BIAS survey of the Underfall Yard workshops in the Floating Harbour, *'an extremely well-preserved example of a steam-powered, shaft-driven workshop of the nineteenth century'*.[2] The second, published in 1979, examined the operation of a hydraulically-powered system in the City Docks, *'one of a dying breed'*, which had first been introduced in 1870 and was considerably extended in the 1880s.[3] The common link is the man who pushed actively for the modernisation of plant and infrastructure at the Port of Bristol during that decade of the previous century: John Ward Girdlestone, M. Inst. C.E., M. Inst. M.E., Engineer-in-Chief to the Docks Corporation.[4]

Girdlestone had been appointed assistant engineer in 1877 and was promoted to docks engineer in November 1882, following the retirement of his predecessor, Thomas Howard, who had ably served his political masters over the previous quarter century.[5] In the same month, the Chair of the City Council's Docks Committee, the body of councillors delegated to supervise the running of the port, passed from Alderman William Proctor Baker to Councillor Charles Low. This resulted in a more expansive investment policy at the Port of Bristol and a temporary easing of the 'Home Improvement' policy of minimal, *ad hoc* expenditure which had been championed by Proctor Baker.[6] The new outlook had been forced upon the corporation as a result of the opening of two private docks at Portishead and Avonmouth in the late 1870s. A price war on dock rates led the city council to negotiate the purchase of its new competitors and from 1 September 1884 the corporation was responsible for the management of three separate docks.

Chairman Low, acknowledged by contemporaries as a shrewd businessman, was keen to push through measures for upgrading the combined docks estate, in order to keep up with the developments taking place at other ports. It was with this in mind that Girdlestone felt he had the necessary financial backing to introduce the latest technology to the Port of



The bucket dredger *B.D.1.* off the entrance locks to Cumberland Basin, Bristol (Courtesy of Port of Bristol Authority)

Bristol.[7] The story that follows of the commissioning and first years of operation of the *B.D.1* shows that he misjudged the complexities of operating within a politically-sensitive framework.

The 'conception' and 'birth' of the B.D.1

The genesis of *B.D.1* can be traced back to an eight-page report by Girdlestone to the Docks Committee dated 5 May 1885, informing its members of the inadequate state of dredging plant in the Port of Bristol.[8] This had become particularly evident since the amalgamation of the City Docks with Avonmouth and Portishead Docks: the existing machinery which included three ladder dredgers, two grab buckets and eight hoppers was proving unable to cope with the demands of both removing deposited sediment and carrying out necessary improvement work.[9] Moreover, the methods of disposal were 'objectionable' according to the docks engineer, as in all cases they involved dumping spoil within the working area of the port. He therefore proposed three solutions, the last and best of which was the acquisition of a self-propelled hopper-dredger. Such a vessel would solve the problem of interference with port traffic caused by stationary dredgers, particularly in the narrow confines of the River Avon, but could also be argued for on the grounds of economy, as it would not only raise spoil but load it and deposit it directly in the Severn estuary. The potential stumbling block in terms of Docks Committee and eventual Council approval was the cost of such a dredger which Girdlestone reckoned at between £25,000 and £30,000. To give added weight to his preferred solution he stressed the savings that would arise once such a vessel was in operation at the port:

In other words the present cost of dredging which is at the rate of about 4.62 pence per ton and which only covers discharge in Bristol will under the arrangement proposed be replaced by a rate of about 2.61 pence per ton which would cover discharge at sea beyond the Holmes.

Fresh from their recent success with the steam tug *Bull Dog*, the Docks Committee members were disposed to support an even larger investment in plant as proposed by their docks engineer. They duly resolved that Girdlestone draw up specifications for the vessel, as well as seek out initial tenders. At the Council Meeting of 14 July 1885, a port development package totalling £300,000 was presented to the full Council by Chairman Low of the Docks Committee, including the recommended purchase of a *'new Hopper Dredger, capable of raising say, 400 tons per hour, and of steaming with 1,000 tons of spoil to the Holmes and back again in eight hours'*. The Council voted through the proposal en bloc, the proviso on the dredger being that the expense was not to exceed £30,000. Two months later Girdlestone reported back to the Docks Committee on a tender from Messrs Simons & Co. of Renfrew, on the Clyde, *'the Patentees and sole builders of the twenty-three Ladder-Hopper Dredgers now at work in various parts of the world'*. He argued, with some justification, that opening up the contract to general tender to include local companies, as had been suggested by some councillors, would delay progress at a time when there was an urgent need for *'so novel and complex a machine'* at the port. Despite their engineer's plea, the members of the Docks Committee resolved that he should give general specifications for the vessel to allow local firms to compete.

Girdlestone was determined to win through on this issue and in December 1885 he produced an extensive and detailed report informing the Docks Committee that he had complied with its wishes, sending specifications to six national and two Bristol contractors (the latter, G.K. Stothert & Co and Charles Hill & Sons, failed to supply tenders). After careful consideration of five key factors (experience, tonnage, strength, design and value), Simons & Co seemed in his opinion to have made the best tender. The 'value' factor was probably the deciding one in winning the approval of the Docks Committee, for as Girdlestone pointedly concluded:

> *I have very carefully considered from almost every possible point of view the question as to which of the dredgers under consideration would prove to be the most durable, that is to say, the least liable to get out of order, and consequently the least costly to maintain, and which would be the one likely to prove most generally useful and of service.*

These words would come back to haunt him later.

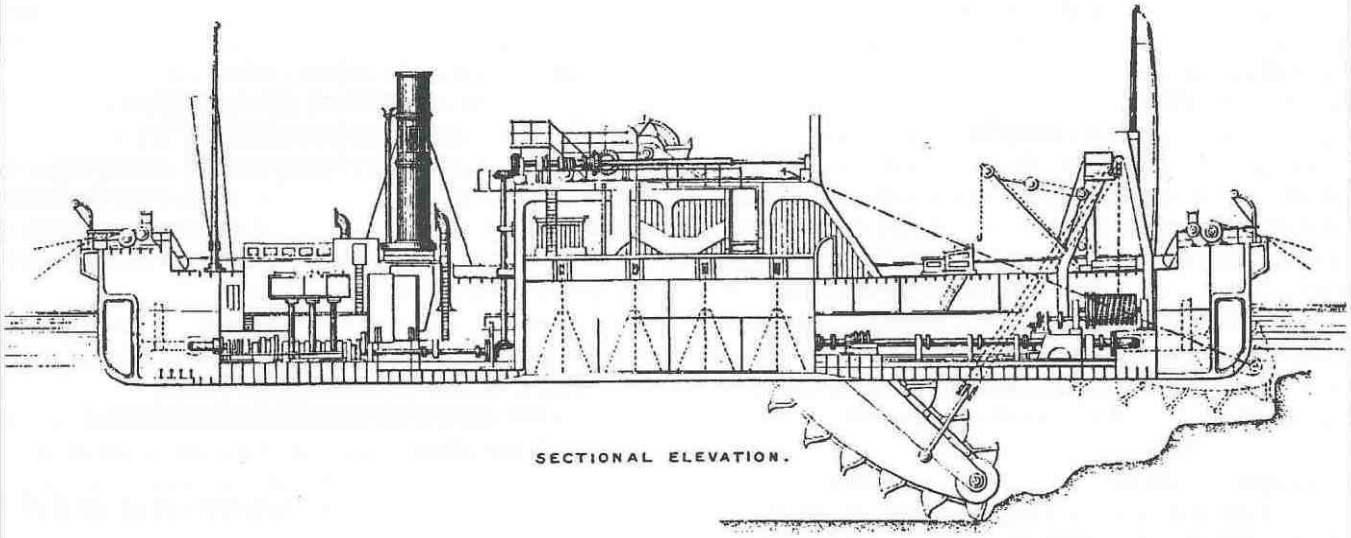
The construction of the hopper dredger therefore took place on the Clyde and eventually in November 1886, the docks engineer could inform his superiors that it had been launched and was due to arrive at Bristol by the end of the month. He did so in another of his extensive reports to the Docks Committee, summarising all the events which had taken place between initial conception and final completion, as well as providing detailed specifications of the finished vessel. It was indeed an impressive machine, with a steel hull measuring 218 ft from end-to-end at deck level and a 43 ft beam, which was propelled by two pairs of 8 ft diameter screws, one set aft and one set fore, allowing the dredger to move in both directions without turning - this was a unique design feature requiring a special hull-length propeller shaft. The power for this, and for the dredging mechanism, came from two sets of triple expansion engines developing together 1,300 ihp, which allowed a maximum speed of over nine knots laden. The huge 135 ton dredging ladder could be lowered and raised according to whether the vessel was at work or on the move but also through a gearing system could operate ahead of the dredger or to one side, allowing work on a dry bank. The three on-board hoppers could hold a maximum of 1,100 tons of spoil. In the final section of his report Girdlestone was keen to justify the commissioning of such a large and expensive piece of machinery. He stressed the speed and economy resulting from the use of triple expansion engines as opposed to the usual compound engines which, together with the extra propellers and three rudders made the vessel *'as handy practically as, say, a fair-sized tug'*.

Both dredger and Engineer on Trial

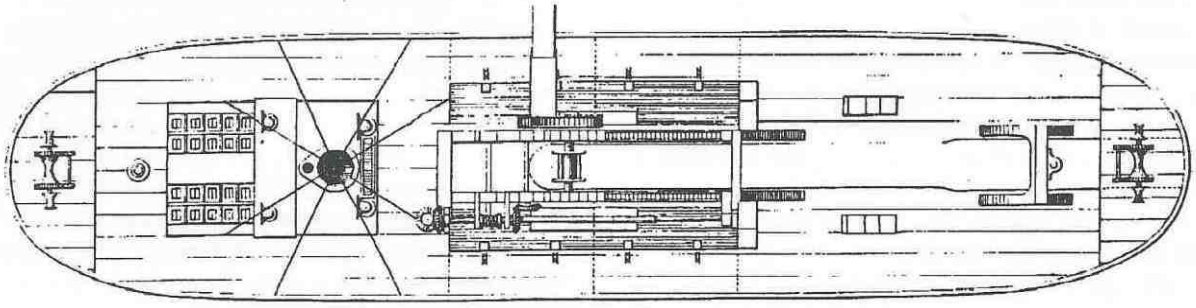
The new dredger, *B.D.1*, began test runs at the Port of Bristol in December 1886 - it was not an auspicious start, for by the end

FOUR-SCREW HOPPER-DREDGER

BELONGING TO THE BRISTOL CORPORATION.



SECTIONAL ELEVATION.



DECK PLAN.

Hull:	Steel plated. 218 ft length; 43 ft beam; 12 ft 4 in draft (15 ft 5 in laden).
Screws:	Two sets of twin screws, fore and aft; 8 ft 4 in mean diameter.
Engines:	Two sets of triple expansion engines (1,300 nhp). Cylinders: High Press. 17 in; Interm. Press. 27 in; Low Press. 43 in. 30 in piston stroke; main drive shaft 8.5 in diameter.
Boilers:	Three circular, steel; 12 in diameter by 9 ft 6 in length. Each with 1,000 sq. ft heating surface.
Dredging:	35 buckets each of 17.5 cu. ft capacity. Speed: 14 to 18 buckets per minute (600 to 800 tons per hour). Depth: maximum 36 ft to 39 ft 6 in below water level. Hoppers: 25,000 cu. ft capacity (1,100 tons equivalent).

Sources: Minutes of the Proceedings of the Inst. of Civil Engineers, 107, 316-22.

Engineering Specifications & Reports, BRO, POBAA, Stack O Shelf 27.

of the month she had already come aground twice in the Avon, the later incident causing damage to some of her steel plating.[10] This resulted in criticisms being raised at the Council Meeting of the 8 February 1887 about the alleged defective construction of the vessel.[11] Councillor Moss Levy proposed an amendment to a motion enabling the registration of the dredger at the port; since he had received information from a private source (which he refused to reveal) that the *B.D.1* was *'not what she was specified for '*, and that an independent surveyor ought to be brought in first to see whether the dredger had been built according to contract. He was seconded by Councillor Terrett who referred to *'the recent accident to the dredger'* which *'proved that she was not suitable for the river.'*[12] The amendment was narrowly voted through, its supporters including four members of the Docks Committee. After some debate about selecting possible surveyors, it was decided to refer this to the Docks Committee. At the latter's meeting of 14 February, a letter from Girdlestone was read out, in which he defended his integrity against the implied criticisms that had been made, going on to *'state emphatically for the information of the Committee that in my opinion the New Dredger is without question the most perfect by far in the world .. '*.[13] After heated discussion, it was resolved to appoint an independent surveyor once the docks engineer had conducted his own tests of the vessel. [14]

In mid-May 1887 Girdlestone could inform the Docks Committee that he would soon complete his report on the trials he had undertaken: at that point the members resolved to employ the pre-eminent harbour engineer, Sir John Coode, to inspect the dredger within the next few weeks.[15] This he did over four days, summarising his findings in a 24 page report dated 3 June 1887.16 Coode began his report by outlining the four criteria under which he had been asked to assess the vessel:

> *..whether the Dredger has been built in accordance with the specifications and Contract .. the carrying capacity of the vessel .. her draught, light and laden and flotation on an even keel .. her speed.*

Apart from two exceptions, the inclusion of triple expansion engines and the omission of propeller guards, both of which increased the speed of the dredger, he found that the *B.D.1* complied with the originally approved specifications. Her carrying capacity was equal to stated requirements, while the fact that her draught when laden was 5 in more than specified, should be balanced by the fact that it was *'practically impossible to calculate beforehand with certainty, and within 2 or 3 inches, the draught of such a vessel as this Dredger.'* Speed tests had shown that the dredger could travel at more than the required nine knots when laden. Coode, perhaps unsurprisingly, came out in favour of the design of the *B.D.1*, praising her superior dredging speed as well as the propulsion system which made her *'remarkably steady and free from vibration when under steam '*. As a final seal of approval on the involvement of his fellow member of the Institution of Civil Engineers, he commended John Ward Girdlestone for *'the efficient arrangements he made to enable me to carry out the tests in a convenient and systematic manner'*.[17] The docks engineer anticipated that Coode would come to his defence, for in his own report to the Docks Committee of the same date, he pressed home his expected moral victory:

> *To have wrong motives imputed to one, to have ones work unfairly criticised and more or less condemned untried; and to have the same submitted, whether one would or not, to inspection by an outsider is hardly pleasant experience .. should my present remarks - supported as I trust that, in due course, they will be by the results of the independent enquiry .. similarly convince those of the Committee .. who yet have doubts on the subject, I for my own part shall think no more of the annoyance to which, as] consider, I have, without just cause, long been subjected.*[18]

In many ways Girdlestone's standpoint was similar to that of a famous predecessor in the autumn of 1848, when the Bristol Corporation first took over the ownership and management of the City Docks: I.K. Brunel wrote to the docks secretary about his evident irritation that:

> *at the last Dock meeting instead of replying to my inquiries some question arose as to them consulting me <u>at all</u> on the subject of the steam boat landing places.* [19]

It was the beginning of the end of Brunel's active involvement with the Bristol docks.

The demise of Girdlestone: the survival of the *B.D.1*

Unfortunately for Girdlestone the *B.D.1*, in her first years of operation was to prove more expensive to run than he had anticipated. This was due in some part to factors outside his control: between June 1888 and October 1891 she was involved in five collisions and three groundings on the River Avon, most due to insufficiently cautious seamanship, either on the part of her master or first mate, or in some cases on the part of oncoming shipmasters.[20] After a collision in March 1890 with the steamliner the *S.S. Brooklyn City*, in which the *B.D.1* was considered wholly to blame, the General Manager of the Docks, Francis Girdlestone, was asked by the Docks Committee to submit a report on all accidents to date.[21] This gave further ammunition to the opponents of the dredger on the Docks Committee, who had, despite the Coode Report, insisted on monitoring its operations.

The engineering department had already been singled out by the Docks Finance Sub-Committee in December 1889, for overspending on its allocated budget for the fiscal year ending April 1890 - among the areas highlighted were the interest and insurance charges on the *B.D.1* of £2,400 *per annum*,as well as dredging costs estimated at £7,000 *per annum* over the previous four years.[22] In February 1890, a memorandum having been submitted by the docks manager to the Docks Committee, detailing both the cost of dredging by the *B.D.1* to date and a comparison with other leading ports, Girdlestone was questioned *'as to the reasons for the apparent high cost of dredging in the river .. '*.[23] He replied that *'the cost under the difficulties attending such work would compare favourably with the cost of similar operations at other ports. '*[24] In July of that year, knowing that the Docks Committee was under growing political pressure to cut dramatically the running costs of his department in the light of falling port income, Girdlestone recommended leasing out the dredger for the winter months. He continued to defend the performance of the *B.D.1* , which had been involved since April in the excavation of a deep-water wharf at Canons Marsh, asserting that in:

one case a portion of wall 10 feet by 18 feet deep and 5 feet wide was brought down in one piece. There are very few dredgers in the Kingdom that would have done this.[25]

By then, however, the Docks Committee members had begun to close ranks against him, united by what they judged to be his blatant disregard for proper financial accountability. In August, 1890, they presented Girdlestone with an ultimatum: either resign or face the humiliation of a report of no confidence in his abilities being presented to the Council.[26] He wisely chose the first option, though would later, unsuccessfully, try to push for an independent inquiry into the circumstances of his resignation.[27] At the Council Meeting of the 26 August, during which Girdlestone's letter of resignation was read out and approved, Councillor Moss Levy declared, to much amusement, that he *'did not know whether the dredger, which was the offspring of Mr Girdlestone, would leave the city finally with that gentleman.'*[28] Moss Levy was to be ultimately disappointed, for after a winter spell at the Admiralty Docks at Chatham, the *B.D.1* would return to Bristol permanently, and would remain in active service at the port for a further 63 years, during which time she reached a 'legendary' status with the staff of the Port of Bristol Authority.[29]

A Technical Evaluation of the *B.D.1*

The *B.D.1* was an example of state-of-the-art engineering technology in her time. In a paper presented by William George Walker to the Institution of Civil Engineers during its 1891-92 session, describing in detail the specifications of the machine, the author referred to it as an example of a 'most modern feature in dredging appliances .. the combination of the dredger and the steam hopper-barge'.[30] Commenting on the triple expansion engines Walker noted that they were *'of the latest design in marine practice, and give very good results, the coal consumed being 1.6 lb. per HP. per hour'*[31] As for the working performance of the *B.D.1*, he maintained that the dredger *'in five years removed and deposited in the Bristol Channel about 1,500,000 tons of spoil from Bristol, Avonmouth and Portishead docks.'*[32] Some caution has to be taken in assessing the objectivity of Walker's analysis, as he acknowledged his indebtedness to John Ward Girdlestone for information and assistance in preparing the paper.

During the 1890s the *B.D.1* was put to good use by the Girdlestone's successor, John M. McCurrich. He described much of the dredging work she had undertaken and was continuing to do so, in part of a paper for the British Association meeting in Bristol, in 1898.[33] Over the previous six years the *B.D.1* had been the principal agent in removing almost 3,000,000 tons of spoil from the Port, most of it due to a combination of mud deposited in the docks by the 'heavily charged' Avon, the deepening of the City and Portishead Docks and the extending of Avonmouth Dock, and the widening of the Swash Channel at the mouth of the river.[34] With the opening of the Royal Edward Dock in 1908, she was employed in four separate docks, helping to remove an impressive 1,400,000 tons of mud and silt *per annum*, in order to maintain the required depth of draft and keep the respective approaches easily accessible to traffic.[35]

An authoritative textbook on river and canal engineering published in 1896, included a chapter on dredging operations, in which the author specifically referred to the *B.D.1* as one of *'the largest dredgers hitherto constructed'*.[36] He went on to inform the reader that the unique propeller system fore and aft had been adopted for dredging the entrance of the Manchester Ship Canal. After noting the fact that the *'Bristol dredger was made wholly of steel'*, he also made financial comparisons between ports, from which it is clear that the *B.D.1* was an expensive piece of dredging equipment, both in terms of initial capital outlay (£30,000 was at the top end of the range for dredgers) and running costs: for example, at Port Glasgow on the Clyde, the total cost of dredging and carrying spoil seven-and-a-half miles was at 3.66 pence per ton, compared to the Bristol dredger's performance of 5 pence per ton (admittedly, travelling an extra two-and-a-half miles), with no allowance made for depreciation.[37] This last figure was almost twice as much as Girdlestone's original estimate of 2.61 pence per ton, which in retrospect seems incredibly optimistic. One wonders whether with hindsight he would have agreed with the following advice given by a fellow Member of the 'Civils' in 1915, on the economics of ladder dredgers:

Clearly the true cost of dredging cannot be arrived at by dividing the working-costs for a month or two by the output, as general overhauls, interest on capital, sinking-fund charges, and idle time must all receive consideration ..As regards capital costs, a cheap-built dredger with a life of 10 years may work just as economically as one of twice the durability, and it may pay to buy such plant and write off its low cost during the job it was bought for... the author confesses some doubt whether any real economy is generally secured by fitting triple-expansion engines, having regard to the enhanced initial cost and the increased weight to be transported, to say nothing of the maintenance of additional moving parts and the wear and tear due to the higher temperatures and pressures.[38]

References

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Stack N

Bristol Docks Engineer Reports 1857-1909, shelf 34. (ER)
Minutes of the Docks Committee Apr 1881- Jul 1894, shelf 29. (DCM)
Minutes of the Docks Finance Sub-Committee 1876-91, shelf 32. (FSCM)

1 Fisher, T., Jones, D., and Day, R., 'The Port of Bristol Underfall Yard Workshops', *BIAS Journal* 10 (1977) 4-11.
Fisher T., and Powell, J., 'The Hydraulic System in Bristol City Docks', *BIAS Journal* 12 (1979) 6-10.

2 Fisher, Jones & Day, note 1, ll. The Underfall Yard was, at the time of writing, being restored by a trust funded largely by English Heritage. The workshops still possessed the original machinery, some of which was in use, plus a steam engine in need of renovation.

3 Fisher & Powell, note 1, 8.

4 For details of other capital projects Girdlestone was involved with, see Lord J. & Southam D., *The Floating Harbour - A Landscape History of the Bristol Docks*, (Bristol, 1983) 55, and Buchanan R. A., *Nineteenth Century Engineers at the Port of*

Bristol, (Bristol, 1971) 15-6.

5 Howard would remain as a paid consultant to the Docks Committee until at least 1886.

6 Neale W.G., *At the Part of Bristol: Members and Problems 1848-1899*, (Bristol, 1968) 19, 45;
Large D., *The Port of Bristol I848-I884*, (Bristol, 1984) xi.

7 Low had the following to say about the docks engineer in a testimonial written in 1889:
I have been much impressed by the untiring energy you have at all times exhibited in the many and various duties of your office, by the originality of your designs, by the accuracy of your estimates, and by the thoroughly substantial and enduring quality of the numerous and important works carried out under your directions.
ER 1890-1, Appendix to letter to the Docks Committee, 7 August 1890.

8 ER 1885-6, 5 May 1885.

9 Bucket-ladder dredgers were stationary, steam-powered dredging platforms, operated by lowering a girder (hence 'ladder') around which a chain of buckets rotated, so that the lowest bucket came into contact with the material to be removed. 'Hoppers', used in this sense, were steam barges into which the dredged material was deposited and eventually disposed of. Hopper dredgers combined dredging with discharge of spoil into hopper wells usually located in the centre of the vessel By this period they were often self-propelled.

10 ER 1887-90, 3 January 1887.

11 *Bristol Times & Mirror* (BT&M), 9 Feb 1887.

12 ibid. See also note 18.

13 ER 1887-90, 14 February 1887.

14 DCM 1886-8, 14 February 1887.

15 ibid, 16 May 1887. Sir John Coode was, according to the *Dictionary of National Biography (DNB), 'probably the most distinguished harbour engineer of the nineteenth century'*. He had received his knighthood in 1872 for his services as engineer-in-chief of the Portland harbour works, which had provided 'the l*argest area of deep water of any artificial harbour in Great Britain'*. In 1889 he was elected President of the Institution of Civil Engineers.
DNB Supplement, 22, (Oxford, 1964-65) 477-8.
ER 1887-90, Report of Sir John Coode, 3 June. 1887.

16 ibid

18 ER 1887-90, 3 June 1887.

19 Buchanan R.A & Williams M., *Brunel's Bristol,* (Bristol, 1982) 30.

20 Such incidents could arguably have been expected given the novelty of the vessel, the difficulties of the River Avon and the intense dredging activity of the period.

21 DCM 1888-90, 26 March 1890.

22 FSCM 1876-91, 13 & 20 December 1889.

23 DCM 1888-90, 10 February 1890.

24 ibid

25 ER 1890-1, 21 July 1890.

26 DCM 1890-2, 11 August 1890.

27 Buchanan, note 4, 16.

28 BT&M, 27 August 1890.

29 She was outlasted by one of her smaller relatives, the *B.D.6*, designed by I.K. Brunel in 1844 for scouring the Floating Harbour, and still doing so into the 1960s. A life-size reproduction of the hull of the *B.D.6*, together with the working original engine, is exhibited at the Bristol Maritime Heritage Centre.

30 Walker W.G., 'Description of a Four-Screw Hopper-Dredger, With Results of its Working.' *Minutes of the Proceedings of th*e *Institute of Civil Engineers* 107 (1891-92) 316-22.

31 ibid

32 ibid. See note 45.

33 McCurrich, J.M., 'Docks, Rivers and Tides', *Handbook to Bristol and the Neighbourhood*, (Bristol, 1898).

34 ibid 93-7. Putting this impressive figure in perspective, in 1880 about 1.2 million tons of spoil per annum were being shified at Hull, while a double-ladder dredger owned by the Tyne Commissioners moved 14.6 million tons between 1863 and 1879.

35 Neale, W.G., *At the Port of Bristol: 1900-14*, (Bristol, 1968) 110

36 Vernon-Harcourt, L.F., *The Flow, Control, and Improvement of Rivers and the Design, Construction and Development of Canals both for Navigation and Irrigation*, (Oxford, 1896) 76

37 ibid 76, 77 & 79 '

38 Berridge, H., 'The Economics of Ladder Dredgers and Steam Hoppers', *Minutes of the Proceedings of the Institute of Civil Engineers,* 200 (1915) 421-35

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