The organisation of civil engineering construction in Britain 1760–1835

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The evolution of the organisation of civil engineering construction in Britain to the system which became standard in the later 19th and much of the 20th century was by no means a linear progress. Nevertheless, comparing what existed in 1760, at the start of the Canal Age, with the situation three quarters of a century later when railway construction was starting in earnest, it is possible to see a general shift towards a more professional approach. This paper will look at the way in which the various participants operated in the period 1760–1835.

THE CLIENT

The first decisions in any construction project, whether and who to appoint as a professional adviser, lie with the client. Before 1760, clients could be categorised broadly as government departments (such as the Office of Works, the Board of Ordnance or Navy Board), local government (magistrates in Quarter Sessions, Commissioners of Sewers, Commissioners of Supply), quasi public bodies (turnpike commissioners, harbour trustees or fen drainage commissioners), joint stock companies (canals), and a few individuals.

Government departments usually employed a large permanent force of craftsmen, who by tradition were employed in new works as well as the repair and maintenance which was their primary role. This privileges, which could carry significant perquisites, was jealously guarded, although on occasion for major works it was necessary to employ outsiders (Colvin et al 1976, 28; Coad 1989, 24).

Much of the work which local government commissioned was traditional in its scope and methods, and well within the capability of the local craftsmen to design and construct. Thus in 1749, the East Kent Commissioners of Sewers decided to «cause a new strong bridge of brick and stone with two arches to be built by John Bundock, bricklayer, of such dimensions and in such sort and manner as are mentioned in his proposals and plan thereof now delivered into compt . . . » (Melling 1959, 50). In 1802 it was left to the Clerk of the Peace in Northamptonshire to obtain an estimate «from an intelligent workman» for repairs to St Peter’s Bridge (Northamptonshire RO: QS Minute Book 1797–1802). Numerous other examples could be cited for, although by 1800 half of the counties of England employed a county surveyor, in 1835 at least eleven of the remainder had yet to make an appointment (Smith 1985, 113–114).

Canal companies usually employed consulting engineers, though as late as 1810 the Stratford on Avon used William Whitmore, a shareholder whose
previous experience was only on the periphery of civil engineering (Skempton et al 2002, 777–778). Most of these consultants held only part-time appointments, so that many decisions were left to be taken on the spot. This enabled the company’s committee of management, a small group of active shareholders with delegated powers who quite frequently, to participate directly in engineering matters. The Staffordshire & Worcestershire, one of the first two joint stock canal companies (Harris 2000), did so in 1766 by appointing a member of the committee as Clerk of the Works, with an experienced surveyor as Under Clerk to support him. Decisions on the Leeds & Liverpool in its early years were taken by committee members with the advice of their Engineer, John Longbothom, but in 1775 the Committee met several times and were «unable to give proper directions for the works for want of necessary information from him» (RAIL 846/2/2). (1) Longbothom resigned in July and individual committee members managed the works for two years before promoting one of their inspectors to the post of Engineer (Clarke 1990, 85).

That committee members might have had an inflated view of their capabilities is shown by the saga of the Dudley Tunnel. Working to the design of Thomas Dadford, the initial contractor was the well known John Pinkerton. He was dismissed in 1787 after the Company became dissatisfied with the quality of work and rate of progress. A proprietor, Isaac Pratt, was «requested to take upon himself the management and direction of finishing the tunnel and that our Clerk do enter into such contract as Mr Pratt shall direct for the compleating thereof with any person or persons he shall approve of . . . provided that every such contract shall not exceed the space of two years in the performance thereof . . . » (RAIL 824/2/2). He struggled on for almost three years; the tunnel became out of line and it required a further year and a half under the experienced and competent engineer Josiah Clowes to bring the work to completion.

Similar problems arose in the development of Grimsby as a port. The lay members of the Haven Company resented paying the usual percentage fees to their engineer, and having arbitrarily reduced them, dismissed him. They then proceeded to execute the work under the direction of a local alderman until a series of accidents and changes of plan forced them to call in John Rennie, one of the leading engineers of the day. Work had progressed so far that he was obliged to propose a scheme that was less than ideal. In this case the Company did proceed with the Engineer’s plans but it was costly and it was only the arrival of the railway fifty years later that transformed the commercial prospects of the port (Jackson 1971, 14–22).

Inertia could also be a problem. In 1791 «Lord Lonsdale has seen many plans as propositions for the alterations of the harbour of Whitehaven. Not one of them has been approved of by the Trustees or the town. It was his wish that an Engineer should be consulted. With a great deal of trouble and difficulty, he obtained the presence of Mr Smeaton (the first Engineer in the Kingdom) to view and inspect the harbour . . . and the Trustees, totally disapproving of what Mr Smeaton had plann’d and the Trustees not agreeing upon a plan of their own, the harbour remains as it was» (quoted in Scott-Hindson 1994, 30). Poor attendance too could cause a hiatus. The Ashby Canal committee was not quorate several times in 1795/96 (RAIL 803/2) and the Stratford Canal in 1809 (RAIL 875/1).

Sometimes the Engineer had only the appearance of freedom of action. In September 1795 the Salisbury & Southampton Canal ordered contracts to be let «for cutting such parts of the canal as Mr Hill has set out, and in such lengths as Mr Hill shall think most adviseable. It appears to this Committee as if pounds betwixt lock and lock are the lengths most adviseable,» (Southampton RO; D/PM6/2, 52). No doubt he took the hint, only to run into trouble when the Company suffered financial problems and outside consultants were called in to report.

An author writing about turnpike roads in the Edinburgh Review in 1819, eight years after McAdam published his Observations of the Highways of the Kingdom, put one side of the argument.

The causes of this universal mismanagement may perhaps receive some explanation . . . the fundamental principle is always to vest the management in the hands of the country gentlemen; and as they act gratuitously, it has been the policy or the law to appoint in each Act a prodigious number of commissioners — frequently from one hundred to two hundred, for the care of ten or fifteen miles of road; and thus a business of art and science is committed to the discretion of a promiscuous mob of
peers, squires, farmers and shopkeepers, who are chosen not for their fitness to discharge the duty of commissioners, but from the sole qualification of residence within a short distance from the road to be made or repaired. They leave the art and science of the business to their surveyor—who is commonly just as much in the clouds as themselves as to his own proper calling. (cited in Hughes 1964, 205)

It should not be thought though that every amateur was incompetent. The Rev. Dr. Henry Beeke was Dean of Bristol and Regius Professor of Modern History in Oxford University and a friend of the owner of Torquay Harbour. It had been built to John Rennie’s plan but without his supervision, and suffered damage by storms. Beeke then undertook the direction of the work, made alterations to the plan and brought it to a successful conclusion in 1815 (Russell 1960, 75–76). Malet (1977) has argued for the contributions of the Duke of Bridgewater and his land agent John Gilbert to the construction of the Bridgewater Canal. Nor were the local surveyors always lacking. William Field was a shopkeeper of Cartmel, who became High Constable, Stamp Distributor, Vestry Clerk and Will Maker, and held the office of Bridgemaster to North Lonsdale Hundred of Lancashire from 1816 until his death 44 years later at the age of 91 (Williams 1975, 53).

Nevertheless, the pace of change was increasing. The period from 1690 onwards had been one of increasing trade and prosperity, which provided both the technical challenges to require the services of professional engineers and the continuing employment which enabled a number of men to specialise in this work. Skempton et al (2002) list thirteen such people, not a huge number. From 1760, the number and more particularly the complexity and size of civil engineering projects increased significantly. The average annual value of projects associated with professional engineers in the 1750s was £20,000, in the 1760s £98,000, the 1790s £703,000 and at or near that level thereafter. The number of these major projects started each decade rose from 8 in 1690–1759 to 28 in 1760–1789 and 39 in 1790–1830 (Skempton et al 2002, xviii). Much of the increase in the years 1760–1799 was due to the boom in canal construction. When that gradually tapered off, it was replaced by work in commercial ports and naval dockyards.

Before 1795 new works in the dockyards were initiated by the yard officers, or less usually by the Navy Board. A small department was created for Sir Samuel Bentham as Inspector General of Naval Works, which introduced several important improvements, but the appointment cut across existing lines of responsibility. The Navy Board may have been reactionary but Bentham seems to have been a difficult man to work with, and the former managed to ease him out of office by 1812. (Coad 1989, 23–40) Despite this, his reforms took root, with the employment of full-time surveyors and outside consultants.

Canal companies too could be forced to confront reality. In 1798, five years after having tried unsuccessfully to recruit an Engineer, the Ashton under Lyne Canal minuted «It being the decided opinion of this Committee that the works of the said Canal have been in many instances improperly managed for want of the assistance of a proper engineer and that thereby the interests of the said Company of Proprietors have suffered materially, Resolved that Mr Outram be . . . requested by this Committee to accept the appointment to the office of Engineer . . . » (RAIL 804/1).

By 1835 it was more usual than not to employ a professional consulting engineer to justify the economic benefits, obtain Parliamentary approval, design the works and procure a contractor to execute the design.

**The Professionals**

It should be borne in mind that engineers were not the only professionals involved in the organisation of civil engineering projects. At Westminster Bridge, the largest project in the years leading up to 1760, the Commissioners were appointed under an Act of Parliament. They appointed Charles Labelye Engineer, Richard Graham Surveyor and Comptroller of the Works and Thomas Lediard Surveyor and Agent. The latter two were responsible for measuring the works, keeping accounts and negotiating the purchase of the lands required (Walker 1979, 88).

This division of responsibility by profession is repeated in most of the canal companies whose minutes still exist. At the first meeting of the proprietors, it was usual first to elect a Treasurer, who would collect the capital from the proprietors as calls were made, and provide funds to the labour force or
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contractors as work progressed. Next would be the election of a Clerk to the Company, who would keep the legal records and be responsible for reaching agreement with sometimes reluctant landowners for the necessary lands. Only after that came the appointment of the Engineer, usually a part-time appointment.

The Treasurer

Treasurers usually had only an indirect effect on civil engineering contracts. The most common was the consequence of lack of money. In the public service, delayed payment for months or even years by the Office of Works, caused often by unworkable Treasury rules, could cause severe cash flow problems for the contractors. There was an instruction that interest should be paid at 5% on outstanding balances, but this was not always much help (Colvin et al, 93–95).

In local government, justices met at Quarter Sessions four times a year, and it was rare for payments to be made until sanction had been given then. It was not infrequent that amounts were challenged, in which case the total amount might be withheld for a further three or six months. Kirkcudbrightshire even had a standing order that payments would be agreed only at the Easter meeting (Dumfries and Galloway RO: Commissioners of Supply minutes K1/1/3, 19Jun1787).

Canal companies, particularly from 1790 on, were plagued by subscribers who could or would not pay their calls as they fell due. Though often due to unrealistically low initial estimates of cost, this problem could be self-feeding. The Ashby Canal was not atypical when, in 1796 with only 60% of the capital called, it restricted its rate of expenditure and borrowed money at interest (RAIL 803/2). The Worcester & Birmingham was £12,680 in arrears when it was forced to consider suspending work on West Hill Tunnel (RAIL 886/4, 10Nov1796). It was customary to allow interest at 5% on calls paid up, and as the construction period lasted for some years before substantial income could be generated, the outflow of capital could be significant. One shareholder in the Somersetshire Coal Canal in 1802, seven years into the construction phase, paid only £15.93 of the £50 due, the £34.07 being a rebate for interest on earlier payments (Somerset RO: DD/MY/30). In these circumstances, it would have been unwise to enter into large contracts for construction, which the company might have been unable to honour. Several companies, throughout the Canal Age, responded by letting a succession of contracts for short lengths to the same people—the Staffordshire & Worcestershire in the 1760s, the Salisbury & Southampton and the Brecknock & Abergavenny in the 1790s and the Leeds & Liverpool in the 1800s are examples.

On some canals, such as the Grand Junction, the Grand Union and the Pocklington, the Treasurer made over the cash to the Engineer, who then paid the contractors on site. This caused disruption to the supervision and exposed the staff to extra risk, and both the Ashby and the Kennet & Avon had to remind their Treasurer that it was part of their duty (RAIL 803/2, 31Oct1794; RAIL 842/2, 17Oct1796). When the payments did arrive, it was sometimes in an unacceptable form. The Leeds & Liverpool paid their contractors with bills, which could only be cashed at a discount (RAIL 846/4, 12Jul1791). The scale can be gauged from John Upton's claim for £65–10–0 loss on bills for Llanellen and Pant y goytre bridges, contracts worth £3720 in all (Gwent RO: QS minute book 8, 19Feb1827). Even the workmen were not immune. The Monmouthshire Canal paid them two thirds in cash, one third in notes, and on the Basingstoke, the contractor had shilling pieces minted in copper, probably to cover a lack of smaller cash (Holland 1992, 14).

The Clerk

Although the office of Clerk of the Peace was of long standing, and could be considered to be analogous to that of Clerk to the Company, not all canals found experienced people available to serve. The Chester Canal ordered their Clerk to buy a book in which to record their minutes, instead of entering them upon a loose sheet of paper, as there was some question whether the record was being subsequently altered (RAIL 816/2, 25Jun1793). As late as 1795, the Neath had to send their Clerk to the Birmingham Canal to learn about his duties (West Glamorgan RO: D/D Nca84).

On the earlier canals it was part of the Clerk's role to arrange the purchase of lands. The Act usually
forbade a start to be made on the works until the land had been bought, or at least a tender made for its purchase. In 1769 the surveyor of the Staffordshire & Worcestershire was diverted from other duties in order to set out the line of the canal through Kidderminster. The Clerk, a part-time appointee, had unexpectedly come over and «his time was precious». The surveyor did his best to comply, though there obstructions, as failure to do so would have meant the loss of a whole season. (Staffordshire RO: John Green's day book 8). Later, much of this aspect of the work was undertaken by specialist land valuers, such as Samuel Wyatt of Burton on Trent, who acted for the Leicester, Grantham and Nottingham Canals.

The Principal Engineer

The period 1760–1835 saw the establishment of two professional institutions for engineers, the Society of Engineers in 1771 for a few leading practitioners, and the more widely based Institution of Civil Engineers in 1818. The new approach was typified by John Smeaton (Smith 1976, 181) and later his former pupil William Jessop who «considered himself as responsible in point of honour and character for the due execution of the [Cromford] canal» (RAIL 819, 4Nov1789). They tended to be paid at an agreed daily rate or annual salary rather than a percentage of the cost of the works, as architects had been (Coad 1898, 30) and engineers would again be in the future.

These men brought a new awareness of their position to the organisation of their works. Brindley’s relations with the academics who formed the committee of the Oxford Canal is well known (Hadfield 1966, 19; RAIL 855/2, 8Aug1769), and Smeaton’s views are recorded in his reports (Skempton 1981, 217–219). Rennie wrote of the Directors of the Royal Canal of Ireland «I do not mean to say they should not settle the works of any dimensions most agreeable to themselves, but when that is done, they ought to leave the execution to me, or appoint some person more capable» and insisted on acceptance of his terms before any further work was done (ICE Rennie reports 4, 106). (3) On other occasions he was willing to be guided by clients with specialist knowledge, such as Trinity House, when they criticised his design for a lighthouse on Plymouth Breakwater (ICE Rennie reports 12, 220).

But the Engineer was not yet prepared to act independently in commercial matters. When the design for the lazarette at Chetney Hill was altered to suit the landowners and ground conditions changed, Rennie recommended the Board of Customs to pay enhanced rates for the work but left it to them to decide whether to do so (ICE Rennie reports 6, 225 & 9, 73). Some clients needed advice. When a contractor on the Montgomeryshire Canal claimed extras for cutting feeders to the canal, of which there was no mention in the contract, the Company had to write to the Hereford, Leominster and Ellesmere Canals to ask what their practice was (RAIL 852/11). By 1832 a more modern view was emerging. Sir John Rennie wrote to a resident engineer «I have seen the certificate you have sent for Mr Dyson, but it is by no means sufficiently explanatory . . . send it to me for my approval before granting another certificate, for the greatest precaution will be necessary on your part in order that justice may be done to the Commission and that the Contractor may not be used with undue severity».

The new profession found that demand for competent personnel outstripped supply. The Leeds & Liverpool appointed James Brindley as their Principal Engineer without checking with him first, and when he declined, had to promote the Chief Clerk of the Works to the post (RAIL 846/2/1, 31Aug1770). Later they named Smeaton, Whitworth, Yeoman, Henshall, Tofield, Morris or Jessop as possible consultants, in the hope that one would be available (RAIL 846/2/2, 19Jul1775). The Nottingham Canal appointed Jessop as Engineer to the Company, but then had to ask him on what terms he would be prepared to act (RAIL 854/2, 26Jun1792). The Herefordshire & Gloucestershire, having failed to secure Robert Whitworth’s services, instructed Josiah Clowes to apply to Hugh Henshall in Staffordshire, or Thomas Dadford senior if he too was not available (RAIL 836/3, 3Sep1792). On the other hand, the Shrewsbury were turned down by Jessop and Dadford and were fortunate to secure part of Clowes’ time (RAIL 868/1, 14Aug1793).

The problem was exacerbated by the difficulties of communication with these peripatetic men. Smeaton explained to the Forth & Clyde Canal that he did not respond to correspondence while he was away from his office near Leeds, as he considered that his proper place for engineering (Scottish RO: FCN/1/2,
29 Nov 1769). Rennie’s travels can be followed by
the addresses on the letters he wrote, on one occasion
spending two-and-a-half months away, but letters to
him often chased one stage behind him, and he too
could often not respond adequately until he reached
home and could consult his records there. It took six
months for him to receive the necessary information
and find time from his other commitments to make
preliminary designs for Kelso Bridge (ICE Rennie
reports 2, 8 May 1799).

The new professionalism required new procedures
to make it effective. For bridgeworks, specifications
became longer and more detailed. Tenderers could
view these specifications at stated times at the lodgings
of the Engineer or the Clerk. Subsequently they were
still often written on parchment as part of a single
document which formed the contract. At least by 1798,
the policy of letting several small contracts on the
Kennet & Avon Canal had led to the preparation and
printing of a specification which the successful
contractor signed. On the Edinburgh & Glasgow Union
Canal in 1818, the practice had increased to the extent
that each of the contracts had its own printed
specification (ICE Telford manuscripts).

Bills of quantities, in all but name, were in use on
the Staffordshire & Worcestershire Canal in 1766.
There James Brindley drew up a table of rates for
evacuation which took account of four different types
of soil and four depths of cutting. Tenders for canal
work usually included different prices for cutting,
with extras for depth of excavation or long wheeling,
and were measured in linear, square or cubic yards as
appropriate. The contract in 1795 for the aqueducts
on the south end of the Lancaster Canal had an item
for provision of temporary works as well as the more
conventional rates for foundations and stonework. By
1811 the Bridgemaster of the West Riding of
Yorkshire had printed Bills of Quantities for
tenderers to use, from which comparisons could be
made (West Yorkshire RO: QD3/367). Similarly,
Rennie urged the client at Pembroke Dockyard in
1815 to accept the second lowest tender, basing his
argument on a comparison of bill rates.

The use of standard bills also helped to resolve
disputes about payment. When Usborne, Benson &
Co delivered beech to Chatham Dockyard for bearing
piles, it was measured by girth for payment, which
Rennie noted was standard practice and well
understood (ICE Rennie reports 8, 367).

The site staff

The new breed of principal engineers had clear views
on the staff necessary for satisfactory supervision of
construction. Smeaton’s model is set out in full in
Skempton (1981). Rennie took matters further in his
report to the Kennet & Avon Canal (RAIL 842/2,
22 Jun 1795) and Telford on the Caledonian Canal
(Penfold 1980, 129–150). Such advice was necessary
because the resident engineering staff were almost
invariably employed by the client for the works,
rather than the Engineer. The appointment was
usually full-time, though James Barnes on the Oxford
and Grand Junction maintained his business as a
brewer and Samuel Hartley on the Bamsley as a
millstayer.

In the 1760s it was hard to find anyone with the
right blend of experience and skill. The Birmingham
Canal had two candidates for election as Clerk of the
Works, but chose a third. For Under Clerk there were
six applicants, and the man appointed was the only
one who appears to have made a career in civil
engineering (RAIL 810/1, 18 Mar 1768). The Clerk on
the Coventry had to go to the Trent & Mersey for
instruction, and his counterpart on the Droitwich for
Yorkshire for the same reason (RAIL 818/1,
19 Feb 1768; RAIL 822/1, 4 Mar 1768). The Clerk of
Works on the Oxford confessed to doubts about
the accuracy of his own plans «because of his
inexperience in canal matters» (RAIL 855/2,
15 Aug 1769). Again in the 1790s, the canal mania
created a shortage of people and the Gloucester &
Berkeley had to choose between two with experience,
two with none and a local surveyor. The references
for one of the experienced men were unsatisfactory,
leaving the committee with little real choice (RAIL
829/3, 15 Oct 1793).

Later, posts could be filled by personal
acquaintance on previous works. Benjamin Davis on
the Kennet & Avon Canal was commissioned to
approach colleagues on the Basingstoke Canal, his
previous employment. Where there was no
connection, references could be sought. The
Rochdale Canal gave William Crosley junior a
satisfactory report when he was appointed to the
Brecknock & Abergavenny. The Leeds & Liverpool
did likewise for Charles Pickmore, despite having
cautioned him for drunkenness shortly before; he did
not last long in his new employment at Lancaster.
To find a suitable resident engineer, the Ellesmere Canal placed advertisements in newspapers as far afield as Chester, Shrewsbury, Leicester, Northampton, Coventry, Birmingham and London (twice), only to find the ideal candidate, Thomas Telford nearby in Shrewsbury (RAIL 827/1, 1793). Where the postholder was responsible for handling money, substantial security was required: £5000 in this case.

The Clerk of Works was often required to find his own immediate subordinates, and occasionally his salary was specifically stated for himself and his deputy. Telford, mentioned above, was allowed £300 p.a. for three clerks or superintendents, whom he was to employ. John Longbotham’s proposals to the Leeds & Liverpool included for his occasional employment of three or four persons, to be reimbursed by the Company (RAIL 846/2/1, 16Oct1772). When Nicholas Brown was appointed Surveyor, Book Keeper and Superintendent of the Huddersfield Canal, his salary of £315 p.a. was to pay for himself and an assistant, both full-time (RAIL 838). By 1809 the rate for Thomas Cartwright and an assistant on the Worcester & Birmingham Canal was 400 guineas p.a. (RAIL 886/5, 1Mar1809), and by 1830 on the St Helens & Runcorn Gap Railway, Charles Vignoles was paid £650 p.a. for complete design and supervision (RAIL 593/1, 15Jun1830).

The job was not without its financial risks. The Chester Canal, not the easiest of employers, at first required that the contractors’ accounts should be certified by the Clerk to the Committee, but then put this responsibility onto the Engineer and ordered that the cost of any work not done properly but certified, should be deducted from his salary (RAIL 816/2, 21Jan1774). The Warwick & Birmingham tried to do the same when it dismissed its Engineer (RAIL 881/7, 14Nov1797).

A more unusual hazard of the job was that which John Thomas encountered at Sheerness Dockyard. He had been resident engineer on this large and difficult job for five years when it was found that public materials had been used for private gain, and the mother of one of the workmen had been placed on the payroll as a millwright. In his report outlining the site organisation required, Rennie had suggested that the resident engineer should not be responsible for payment of wages and that certification of work should done jointly with a dockyard official. Dismissal was contemplated, but his value to the works and lack of personal involvement saved the day (ICE Rennie reports: 9.418). Thomas had worked for Rennie before going to Sheerness, but was employed directly by the client. This was the case with Phillip Richards at Chatham Dockyard also, who found himself in trouble for giving orders varying the contract, contrary to the rules of the naval service, after consulting Rennie but not his employer. He too was a competent and valuable engineer and survived to be promoted to supervise the Royal William Victualling Yard at Plymouth. Engineer’ (ICE Rennie reports 14, 25Jan1823).

THE CONTRACTOR

By 1835, most work was undertaken by contractors working to the designs of a consulting engineer, the work having been won by competitive tender. The contractor would require managerial ability to organise the labour, equipment and materials in order to complete the works within the programmed time, to the specified quality and to make a profit. He would also have the financial strength to fund the work in progress, receiving payment up to two months in arrears. The technical knowledge to design the temporary works and uphold the works in an incomplete state was not always required, as their design was still provided on occasion by the consulting engineer.

Contractors with some but not all of these attributes can be recognised well before the period under review. Sir Thomas Fitch was active from 1663 to 1685, and built the Fleet Canal for the City of London in a contract which might be worth £15million today. The emergence of the modern contractor was influenced also by the attitude of the Engineer. Even in 1834, when major new railways were being planned, Francis Giles and Robert Stephenson could take very different views about the size of contract which should be awarded (Parliamentary evidence on London & Southampton Railway). Stated simply, large contracts would attract men of capital, who could manage the interface between the different works; they would also preclude many potential tenderers and therefore lead to higher prices. Events on the London & Birmingham Railway [1833–38] might suggest that the day of the large contract had not finally arrived (Lee 1964, 112).
It has been suggested that the early canal contractors were little more than superior gangmasters (Burton [1972] 1993, 173), and in some cases that was so. In order to reduce the contractor’s capital, it was a common practice for the company to supply wheelbarrows and planks for the runways along which the excavated soil was wheeled. Sometimes even the tools were provided. Eventually most companies grew weary of employing a person to keep track of these items when they went mysteriously missing, but even as late as 1834 the experienced William Tredwell was being offered £30,000 of temporary works for a contract which would be worth about £600,000. But the independent contractor was making an appearance. In 1766, John Beswick undertook the whole of the cutting of Kymner’s Canal, bringing workforce and equipment to South Wales from the north of England (Bowen 2001, 21) and shortly afterwards undertaking sizeable parts of the Staffordshire & Worcestershire in parallel. His foreman on the latter works, John Clegg, left two years later to become the first contractor on the Forth & Clyde Canal, and made quite a sophisticated arrangement with them about temporary works and commercial matters (Scottish RO: BR/FCN/1/2, 4Feb1769). Other companies preferred small contractors. The Birmingham Canal advertised for tenders from contractors, who were required to be quite free from prior engagements (RAIL 810/1, 30Mar1768).

Although competitive tendering was quite usual, it was also the practice to offer work at the rates which the Engineer had used in his estimate (RAIL 810/1, 8Apr1768). The Forth & Clyde also set its rates, and preferred small contractors, «in order to create emulation and give facility in the execution». Alternatively, a company could let its first contract when competition was fierce, and then offer the subsequent works to other gangs at the same rates (RAIL 816/2, 14May1773). In this case, the contractors were not to employ more than 40 men and their names do not appear in the records of other companies, suggesting that they were local men in a small way of business. Later, during the Canal Mania when clients were more in competition with each other, the Worcester & Birmingham offered a contract at a price which the contractor could not accept, and had to agree to their Engineer settling the difference (RAIL 886/4, 15Apr1793). The Ashby Canal was still offering work at fixed rates in 1797 (RAIL 803/2, 4Jan1797).

A third, less common method of agreeing a contract was for the tenderer to agree to accept prices to be fixed by the Engineer. This implied a degree of trust, which the contractor for the Shrewsbury Canal was willing to give to William Jessop or Thomas Dadford (RAIL 868/1, 6Jul1793), but proved very expensive to John Pinkerton on the Barnsley Canal (RAIL 806/3, 5Aug1793). This latter contract led to a protracted lawsuit when the Company failed to accept Jessop’s recommendations for extra payments. In his judgement the Master of the Rolls recognised the changing nature of the role of the Engineer:

Mr Jessop because he was the Engineer employed by this canal company supposed he was their servant also in fixing the prices at which this work was to be done & that he was to act in their behalf against . . . Mr Pinkerton . . . but he unfortunately has fallen into a mistake with respect to the nature of the situation in which he was placed. (quoted in Hadfield & Skempton 1979, 137)

Financial strength

The changing financial strength of contractors can be seen in the terms of their contracts and the account books of the clients. On the Bridgewater Canal in 1759, John Beswick, mentioned above, was able to work without interim payment for six weeks, but the sum involved was only £38 (Northamptonshire RO: EB 1459). On the Staffordshire & Worcestershire in 1766 he was receiving sums of around £60 weekly (Staffordshire RO: Mr Baker’s accounts).

These payments were in the nature of subsistence money, paid to the contractor at a daily wage for the number of men at work. The company would employ one or more Counters who would walk along the site in order to make a record. Interim measurements of work done, the proper contractual basis for payment, were often irregular and infrequent. The system frequently gave rise to substantial overpayments if the contractor had tendered too low. The impression given is that interim measurements were a low priority for the companies and their few, overstretched site staff, responsible also for progress and quality. But the companies could be quite harsh in these circumstances. The Kennet & Avon Canal ordered a prosecution of James Hollinsworth,
afterwards resident engineer on Waterloo and London Bridges, for £729 overpaid, and had him arrested. The matter must have been dropped at the time for they noted five years later that he was now in receipt of a considerable salary and might be worth pursuing (RAIL 842/3, 23Feb1805).

Between the 1760s and the 1790s a few contractors emerged who had saved enough from the profits of a succession of works to be able to undertake much more valuable contracts than anything which had been seen since the seventeenth entrepreneurs in the fen drainage. The Pinkerton family started in 1767, in partnership with an established engineer/contractor, with a contract worth about £5000 and soon were undertaking works of two or three times that sum. By 1775 they were able to undertake the whole of the cutting of the Selby Canal and in 1783 they tendered for the whole of the summit level of the Thames & Severn. (Gloucestershire RO: TS193/1). In 1788 they started on the Basingstoke Canal, for which their final payment amounted to more than £150,000. Their problems on the Dudley and Barnsley Canals have been noted above, though they earned a good reputation subsequently in the fens.

Two more consistently successful contractors were Hugh McIntosh and Sir Edward Banks (Chrimes 1995; Dickson 1931). McIntosh’s career was the more conventional of the two. Starting with subcontracts, then moderate sized contracts for canals, he progressed to virtually the whole range of civil engineering work. Managing several contracts concurrently, and financing them to the amount of thousands of pounds between interim payments (ICE Rennie reports, 22.220), he amassed a fortune of some £300,000. Banks was two years younger than McIntosh but started independent work seven years later. He may have started work for the Pinkertons on drainage work in East Yorkshire, but his career flourished after he moved south and formed a partnership with the Rev. William Jolliffe. With other commercial interests outside civil engineering contracting, they too were able to finance large scale government contracts.

The Engineer on many of the contracts on which these men worked was John Rennie. When asked to give a reference for a proposed water supply, he described McIntosh as «one of the fittest persons I know for the execution of your works . . . He is besides a man of considerable property». Two years later he wrote to the West India Dock Company «I do not know any persons who will do the work better or more expeditiously than Messrs Jolliffe & Banks». But by 1820 he noted in a report to the Commissioners of the Navy that Banks was no longer giving close personal attention to the works at Sheerness [a contract eventually worth about £1.5 million in the money of the day] and the work was suffering as a result (ICE Rennie reports 11, 91).

McIntosh in particular seems to have developed the idea of the main contractor, describing himself in 1833 at Royal William Victualling Yard as the «contractor in possession of the main work». Whereas on earlier projects it had been usual to employ separate contractors for digging, masonry and carpentry, with the concomitant problems of coordinating their work, he objected to another contractor being employed to install the boilers for steam engines. On the Carlisle Canal in 1820 there is a clear reference to the need to have the Company’s permission to sublet part of the works, and the main contractor’s continuing responsibility for the due performance of the contract (Scottish RO: BR/C/CC1/1).

One problem for contractors is still with us today. It had been common practice on design-and-build contracts for bridges to require the provision of a financial bond from an independent guarantor against any defects arising during the maintenance period, which was often seven years. The sums could be unreasonably large, though common sense could prevail. John Cheshire, a well-known church steeple and bridge builder, was required to provide a bond of £1000 on a contract worth £2950 (Derbyshire RO: D533 A/TT17). He was unable to do so, but the bridge commissioners contracted with him nevertheless.

With the development of the designer/contractor split and supervision by full-time resident engineering staff, it became more usual to retain a percentage of the money due to the contractor, though the period was usually only one year. Again, the amount could be high. The Monmouthshire justices required £2000 retention on the £9500 contract for Caerleon Bridge (Gwent RO: D179.0001 and QS minute book 4, 246). Matters could be ameliorated by paying interest on the outstanding money, enabling the contractor to borrow the sum required, as was done at the Custom House Dock in Dublin. Some
engineers dispensed with the requirement. Francis Giles was one, and the contractor John Tredwell who worked for him thought 10% retention «a very serious difficulty against getting the work done cheap» (Parliamentary evidence, London & Southampton Railway 1834).

Most contracts contained a time or period for completion, but there were several examples of contractors being released from their contracts when it became apparent that they would be unable to complete on time. Sometimes this was done without penalty, as with Thomas and Benjamin Baylis on the Gloucester & Berkeley Canal, but John Pinkerton had to pay £2000 to leave the Dudley Tunnel, mentioned above. Clauses setting damages for lateness in completion were unusual but not rare. £5 per week was the rate for Blackfriars Bridge, Norwich in 1783, a contract worth £1250 (Norfolk RO: NCR 22a[4]).

The workforce

A suitable workforce was not always readily available. In 1768 the Birmingham Canal advertised in the Gloucester, York and Manchester papers for stonemasons (RAIL 810/1, 16Sep1768) and in 1776 the Stroudwater Canal in Gloucestershire recruited from Birmingham and Ripon, North Yorkshire (Gloucester RO: D1180/1). The Monmouthshire Canal advertised in Carmarthenshire and Cardiganshire (RAIL 500/5, 4Sep1792) and for miners the Grand Union in Leicestershire looked to Devon and Cornwall (RAIL 831/1, 11Jul1811).

Parliamentary evidence in 1834 suggested that many engineers preferred to employ local agricultural workers, Robert Stephenson being an exception, but this could give rise to problems at harvest time, when there was not enough labour either to take advantage of the summer to press on with the works or to gather in the harvest.

Much of the period to 1815 was one of wage inflation, and workmen could be enticed away. The Herefordshire and Gloucestershire and the Gloucester & Berkeley tried to suppress mutual poaching, though as the men were employed by the contractors it is not clear that they were successful. The Neath Canal passed a resolution that they would not employ anyone without a discharge from their previous employer, in the hope that other employers would reciprocate (West Glamorgan RO: D/D Nca85). The Grand Union Canal was more realistic, and paid loyalty bonuses to those of its workforce who did not go to the Fens, where work was seasonal but more highly paid (RAIL 831/1).

Accidents to the workforce were not infrequent, and employers gave grudging assistance to those who had been injured. In 1769 the Forth & Clyde Canal gave «such poor people who have been hurt at the works some small thing for their support during their recovery». By 1795 a more regular approach had become usual and the Peak Forest Canal introduced a sickness benefit fund, with rules and regulations, to which the workmen and the Company contributed. The following year Worcester & Birmingham gave the moderate sum of five guineas to the General Hospital «because of numerous accidents to the workmen». The Kennet & Avon Canal, having allowed £13 to one contractor, gave notice that in future they «would not allow any relief to the sick or lame . . . unless a fund by an allowance from the respective men's pay is established for that purpose as is usual on all other canals».

CONCLUSION

Much of the evidence in this paper has been drawn from the first part of the period from 1760, when work on canals formed the bulk of civil engineering construction. The major bridges, dockyards and ports constructed from 1800 were, with few exceptions, constructed under the supervision of engineers who had been involved in canal work. Developments in organisation continued, partly to satisfy the requirements of legislation, partly to deal with the increased size and complexity of the works but also as a result of experience. It can be seen that even by 1835 there was no unanimity about the ideal form of organisation, but there was enough knowledge of good practice to allow the extraordinary growth of the railway system in the years following.

NOTES

1. References in the form «RAIL 8xx» here and subsequently are to manuscript items in the Public Record Office, Kew, London, UK. Page numbers in
minute books are sometimes missing or duplicated, so
dates are given in references.
2. References in the form «county RO» here and
subsequently are to documents in the Record Office of
that county in the UK.
3. References in the form «ICE Rennie reports» are to
manuscript volumes in the archives of the Institution of
Civil Engineers, London, UK. There are twelve
numbered volumes and one general volume by John
Rennie senior. The numbers of the volumes by his son,
Sir John Rennie, have had 13 added to them here in
order to distinguish them from those of his father.

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