‘The Chance Begins to Assume a Fair Prospect’: Marc Brunel and the Invention of the Steamboat

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The Brunel name is inextricably linked with the great nineteenth-century steamships and the dawn of steam-powered inter-continental travel. Isambard Kingdom Brunel designed and launched three world-changing steamships. First, the Great Western whose maiden voyage in 1838 from Bristol to New York took just 15 days, half the time of sailing ships. It was the earliest regular transatlantic steamer and used a combination of steam-paddles and sails. Five years later, the SS Great Britain sailed, this time from Liverpool. It was the first Atlantic liner built of iron and with screw propulsion, supplemented with sails on six (later five) masts. Finally, in 1858, the Great Eastern, accurately known during its construction as the Leviathan. It was the largest ship in the world for decades. Powered by two paddle engines, a single screw propeller and sails on six masts, it was the prototype of the modern ocean liner.

Twenty-five years before the SS Great Britain, in 1813, Isambard’s father, Marc Brunel had built his own, more modest steam-powered vessel. The Regent, designed by Marc Brunel and built by Henry Maudslay operated successfully as a mail-boat on the Thames between London and Margate.[1] Isambard, aged 8, and his two older sisters Sophia and Emma are said to have excitedly watched from a pier near London Bridge as their father piloted the ship on its maiden voyage.

Few people realise that Marc Brunel had been involved with steamboats much earlier than this. And not in England, but in the United States of America, where he lived from 1793 to 1799. To understand how this came about, we have to delve into the dramatic story of the steamboat pioneers – a tale of big ambitions and even bigger rivalries, of invention and obsession, of patents, monopolies and legal battles, of fallings-out within families. It is an epic story with walk-on parts for Thomas Jefferson and Napoleon Bonaparte.

[1] Clements, P. (1970) *Marc Isambard Brunel* pp. 62-63; Brindle, S. (2005) *Brunel: The Man Who Built the World* p. 33.

Experiments with steamboats had already begun by the last quarter of the 18th Century. In France, Claude de Jouffroy had piloted a steamboat upstream on the River Saône for a short distance. In the 18th Century, Britain was the home of the industrial revolution and the world leader in the application of steam technology. Despite this in Britain there was little interest in developing steamboats. The reasons relate to both geography and to infrastructure. Britain is a relatively small island. Nowhere in England is more than about 70-80 miles from the sea, and so the transport of goods by coastal vessels was common. Moreover, in the second half of the century, an extensive network of canals was developed during the 'Canal Mania' as well as major improvements to highways financed through the use of turnpike trusts.

Hence, inventing and deploying a steam-powered boat to move goods or people at a few miles an hour did not present much of an improvement on transport by stagecoach or sailboat. Britain had the technical means to develop a steamboat, but lacked an economic motive to do so.[2]

But in America, after the end of the Revolutionary War and the establishment of an independent United States of America, the situation was very different. The USA at the end of that war comprised thirteen states along the Atlantic seaboard. To the west lay a continent waiting to be explored, colonised and settled. Much time and effort were spent in investigating and mapping the river routes along which people and goods could travel to exploit the advantages of the continent and settle the wilderness. Indeed, Marc Brunel's first activity in the USA was participating in the surveying of an area in what is now Upper New York State, bordering the Great Lakes, for a company formed in Paris whose aim was to parcel up the land for sale to settlers, mainly French. The area was to be known as 'Castorland' after the French word for beavers. Beaver pelts were an extremely valuable commodity at this time. Once in America, Brunel also worked for American entrepreneurs looking to improve inland navigation.

People and goods were beginning to travel west, over the Appalachian Mountains and onto the Ohio River and into the basin of the mighty Mississippi river. Goods from the interior could travel by river to the port of New Orleans from where they could be exported to the Caribbean or to Europe. But there was a catch: sailing ships could go down the Mississippi to New Orleans, the main port, but could not return against the current from New Orleans to the interior. On river stretches not suitable for sailboats, goods travelled by flatboats and keelboats. Flatboats were so primitive that they made one-way trips; at the destination the boats were broken up for timber. Keelboats were a little more sophisticated, at least having a curved bow and stern and a covered cargo area. These were not broken up at the destination, but returned by a combination of oars, poles, bushwacking (cutting through vegetation) and cordelling (towing). The keelboat workers were a tough and hard-drinking lot: Mike Fink, a celebrated keelboatman described himself as 'half-horse, half-alligator' [3].

[2] McDonald, C. (2022?) "Steamboat Inventors: The First Generation" https://technicshistory.com/2022/03/18/the-steamboat-inventors-the-first-generation/
[3]McDonald, C. (2022?) "Steamboat Inventors: The First Generation" https://technicshistory.com/2022/03/18/the-steamboat-inventors-the-first-generation/

Hence, the commercial motive to develop steamboats was very present in the America of the 1780s and 1790s. But the industry and skills needed to develop and implement this technology were practically non-existent. America at this time was a country of rural and small-town dwellers, with very little industry and only small cities. Statesmen like Thomas Jefferson, principal author of the Declaration of Independence and America's third president, wanted it mostly to remain that way. Jefferson viewed this social and settlement structure as an essential bulwark against European-style centralisation which he saw as leading inevitably to Kings, Courts and Emperors – precisely what the Revolution had fought against.

Early American steamboats would therefore have to be built mostly by back-country mechanics, in contrast with high-technology England, with its established engineers like James Watt, and its established and growing industrial base:

> [W]hen it came to casting and boring cylinders, making valves, casting gears, and soldering copper sheets into pipes, all of the early steam boat experimenters were obliged to engage others more skilled in these occupations…[a] handicap…common to everyone attempting to apply the steam engine to navigation or to any other purpose [was] the unbelievably primitive nature of American industry. A foundry might cast pots and skillets, but a cylinder for a large steam engine was a different matter…Boiler makers were unknown…fashioning and repairing pipes subjected to the heat and pressure of steam was often beyond [coppersmiths'] skill.[4]

Stevens' biographer Archibald Turnbull writes similarly:

> However, more serious than the lack of ready cash was the other obstacle confronting every early engineer — the absolute dearth of competent mechanics. Opportunities on this side of the Atlantic had been so rare that Englishmen trained to a trade preferred to hunt out and fill the openings at home. When American mechanical enterprise was first born, few Englishmen heard its faint cries and fewer still cared to cross the ocean to answer them.[5]

The first great steamboat rivalry in America was between James Rumsey and John Fitch. It was a battle with no winner but plenty of acrimony. James Rumsey developed a steamboat using jet propulsion of water from the rear and demonstrated it publicly in December 1787 on the Potomac River, achieving four knots against the current. He moved to England in 1788 and died there four years later, aged 48 or 49. Rumsey met Thomas Jefferson in Paris (Jefferson was the USA's ambassador to France between 1784-1789) and patented a 'tube boiler' in both London and Paris.

Rumsey's rival, John Fitch, developed a steamboat with an endless chain and oars which in July 1786 moved against the current of the Delaware, and the following year a full-scale version travelled at about 3 mph. But at these speeds, it could not compete with the packet ships on the Delaware or the stagecoaches on the roads along the

[4] Dubois, R. L. (1973) 'John Stevens: Transportation Pioneer' PhD thesis, New York University.
[5] Turnbull, A. (1928) *John Stevens: An American Record*, pp. 116-117.

banks.[6] Three years later, another boat, using paddles in the stern was completed and was operating from 1790 providing a regular packet service between Philadelphia and Trenton at 7-8mph. According to Dubois, this was 'the most successful of Fitch's steam boats' but, although a success mechanically, it was a commercial failure.[7] It was faster than sailing and cheaper than the stagecoaches, but there was too much competition and not enough backers to subsidise the experiment. Fitch died in 1798, aged 55.

We have no evidence that Marc Brunel knew of or corresponded with either Rumsey or Fitch – and of course Rumsey died before Brunel had even left France. But Brunel certainly did know the next two big figures in the steamboat story – Robert R. Livingston, known as 'Chancellor' Livingston, and Livingston's brother-in-law Colonel John Stevens. Among Colonel John Stevens' papers in the Stevens Institute of Technology in New Jersey, there is correspondence between Marc Brunel and Colonel Stevens as well as receipts for payments and loans made by Stevens to Brunel, and in other archives there are letters between Marc Brunel and Chancellor Livingston.

Livingston and Stevens were brothers-in-law but they were more like the Odd Couple than Brothers-in-Arms. Neither the Colonel nor the Chancellor were engineers or even mechanics, and their responses to the challenges presented by their general ignorance of engineering principles and practical skills took radically different forms.

John Stevens Jr. was born in 1749 in New York City and became a captain, later a colonel, in the American Revolutionary Army. Colonel Stevens was aware of his own lack of knowledge and technical shortcomings and he tried to remedy this both by assiduous reading and by employing whatever skilled mechanics and engineers he could find. His biographer writes that Stevens 'pored over every book dealing with fundamental principles as thus far understood. Descriptions of every effort in steam, from Savery to Newcomen, were constantly before him; on almost any night, the account of James Watt's experiments could crowd the Bible from the table under his bed-candle. If he could not build anything, he must at least know how it should be built.'[8]

Stevens scoured the bookshops of New York for the latest science and technology treatises and if he could not find them would write to the London bookshops in the Strand and High Holborn for them. Stevens realised that reading alone was not sufficient, and he was always on the look-out for men with the technical ability to build the machines he devised. It is therefore no surprise that he later brought Marc Brunel into the steamboat enterprise – but how and when did they meet?

Colonel Stevens was rich in land, and even richer in ideas, but he was frequently short of actual cash. Fortunately, his sister Mary had married Robert R Livingston in 1770. The Chancellor was soon, in Turnbull's words, to 'catch steamboat fever,' and became a significant investor in the emerging technology, much later switching horses away from

[6] Dubois (1973), pp. 99-100.
[7] Dubois (1973).
[8] Turnbull (1928), pp. 117-118.

his brother-in-law Stevens and backing Robert Fulton, who generally gets the credit (perhaps unfairly) as the 'inventor of the steamboat'.

Robert R. Livingston, born in 1746, was a member of the sprawling and powerful Livingston family, of Scottish and Dutch origin. He was one of the 'Founding Fathers,' a member of the committee that drafted the Declaration of Independence. He was the first Chancellor of New York state, and often therefore referred to as 'Chancellor Livingston' or simply 'the Chancellor'.

Chancellor Livingston was a gentleman-farmer, an epicure and strictly an amateur inventor. Although he had a strong interest in natural philosophy, he had little sense of mechanical principles or practical construction techniques. But he was 'the first wealthy and politically influential person to become passionate about steam navigation.'[9]

He applied considerable energy to the project of steam navigation rather in the manner of the 21st-century Silicon Valley to come – move fast and break things. His suggestions and demands were often unhelpful to his more practically minded collaborators. The Chancellor 'was often led astray in his ideas of steam-engines, and always sure that his path was the best' and even 'attempted technical interventions that were entirely unhelpful.'[10] However, the Chancellor possessed both money and political influence, which in the innovation world were - and are - key resources.

Stevens had devised his own boiler in the late 1780s, and had opposed Rumsey's claim for a patent for the Rumsey steamboat. After Congress passed the USA's first patent law in 1790, John Stevens, John Fitch, James Rumsay and multiple others applied for protection under the Act.[11] A commission was set up to rule on patent applications comprising the Secretary of State (Thomas Jefferson), the Secretary for War (Henry Knox) and the Attorney-General (Edmund Randolph). These were all men busy with their day jobs, and, with the exception of Jefferson, they had limited knowledge of and interest in, science and technology. They did not want the burden of reading through detailed drafts and specifications from rival inventors and adjudicating between them.

The Commissioners therefore decided to grant patents to all the applicants, on the basis of the specifications submitted, and to leave it to the courts to settle the matter.[12] The can had been kicked down the road.

The first dozen patents were therefore issued on 26 August 1791, including one to Stevens. In Turnbull's words, writing in 1928, 'Reading these patents, it is hard to believe that engineering [in America] ever could have been so primitive; but, once that basic fact has been accepted, they loom up like signboards on the engineering highway.'[13]

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[9] McDonald (2022b) "Steamboat Inventors: The Second Generation" https://technicshistory.com/2022/04/19/the-steamboat-inventors-the-second-generation/
[10] Turnbull (1928), p. 131; McDonald (2022b).
[11] Turnbull (1928); Dubois (1973).
[12] Dubois (1973), p. 112.
[13] Turnbull (1928), pp. 111-112.

In 1798, the Chancellor had the Fitch monopoly on the Hudson River (then known as the North River) set aside, and obtained from the New York State legislature his own 20-year monopoly provided he could demonstrate within 12 months that he had a boat of more than 20 tons capable of going against the current at 4 miles per hour or faster, and that he would provide a regular service between New York and Albany.[14]

The Colonel and the Chancellor now had the monopoly, the ideas and the enthusiasm. What they lacked however was an actual working steam engine. Here they had two options. They could import a suitable steam engine from England, preferably from the world-leading workshop of Matthew Boulton and James Watt in Soho, Birmingham. Or they could build their own steam engine in the primitive engineering landscape of 1790s America, with a dearth of both suitable machinery and skilled engineers.

At times Stevens and Livingston certainly at times considered the first option. But they had earlier also entered into a partnership with Nicholas J. Roosevelt, born in 1767, and a distant relative of the two later American presidents. Roosevelt had bought land in New Jersey and established there a foundry, a machine shop and a smelting works. He named it the 'Soho Works' after the Boulton and Watt establishment in England, and hired skilled engineers from that establishment, including the Englishmen James Smallman and John Hewitt and the German Charles Stoudinger. Global technological know-how, human resources and experience was on its way to the New World.

The Chancellor was providing the money and the political influence, the Colonel was generating the ideas, and Roosevelt had the workshop and the skilled workers to make a suitable steam engine. What could go possibly wrong? In fact, many things could and many things did. There were frequent squabbles between Livingston, the anxious investor, and Stevens and Roosevelt the more practical men. Livingston became impatient with the delays that were inevitable with developing a new technology with limited resources, telling Roosevelt that if he had known earlier, he would have imported a Boulton and Watt engine from England.

The Chancellor vehemently rejected Roosevelt's idea of providing motion via a vertical wheel or wheels at the side of the boat. Roosevelt would later of course be proved right on this. Livingston however insisted on a horizontal wheel at the stern: 'the chancellor had no faith in the side-wheeler, and thus it was years before Roosevelt's idea was generally adopted in America. Livingston was always confident that his own scheme — whatever it might chance to be — was the best.'[15]

On the 21 October 1798, the three were able to trial their steamboat, the *Polacca* on the Passaic River. Stevens' biographer says that 'all the notables' were invited, including the Marquess d'Yrujo, Spanish minister to the United States. This dignitary estimated the speed at 'upwards of five miles an hour, but the colonel and Roosevelt were not inclined

[14] New York State Library, 'Steamboats on the Hudson: An American Saga' https://nyslibrary.libguides.com/steamboats/legislature
[15] Turnbull (1928), p. 137.

to claim more than three and a half.'[16] This result by the *Polacca* was largely considered a failure.[17] From Turnbull's account, it seems the *Polacca* was still using a horizontal wheel in the stern, despite Roosevelt and Stevens already trying out an alternative propulsion means using elliptical paddles and a Boulton-Watt style steam engine built at Soho, New Jersey, by Roosevelt with Stoudenger and Smallman. In addition, there was excessive vibration caused by the engine.

Earlier in 1798, or perhaps towards the end of 1797, Marc Brunel enters the picture. Brunel had become an American citizen in 1796. He had possibly designed a grand house in the Hudson Valley, called 'Massena' for the Chancellor's brother, John Livingston. We know that Brunel was living in New York in 1797 and 1798. Commercial directories for New York list him having a 'manufactory' at 17 Murray Street in 1797, and at 58 George Street (now Spruce Street) in Lower Manhattan in 1798.[18]

New York City grew rapidly through the 1790s: from around 33,000 in 1790 to almost double that, 60,000 people in the Census of 1800 – still relatively small compared with its explosive growth over the next two centuries. At some time in 1797 or possibly earlier, Colonel John Stevens made contact with Marc Brunel.

Stevens' approach to Brunel suggested that Brunel had already developed some reputation in America as an engineer – a profession in short supply on that side of the Atlantic. Brunel had already registered one patent – a machine for ruling books and paper – in 1796, and would register two further patents before he left for England. In addition, and unlike either Stevens or Livingston, he had considerable experience of the practicalities of navigation on both ocean-going ships and smaller boats on American rivers. He had been a sailor in the French Navy in the Caribbean for six years, and then later directly experienced the difficulties of navigating American rivers – just about the only way to the interior - in his work in the Hudson Valley for the Castorland company and others.

Frustratingly, we do not know exactly when he met John Stevens and I have come across no record of how Stevens and Brunel first met. Turnbull tells the story as follows:

> At this stage in steamboating, Marc Isambard Brunel presented himself…Naturally planning to earn his living as a mechanic, he applied to the colonel, who was not long in discovering that a place must be made for a young man who knew so much more than the average. Brunel found the colonel in the midst of an effort to get higher steam temperatures and consequent greater boiler efficiency. Experimenting with primitive "flash-boilers," the colonel was led to something new in engines. [19]

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[16] Turnbull (1928), p. 138

[17] New Jersey Historical Society, 'Manuscript Group 1508 Stoudinger-Aloufsen-Fulton drawings https://jerseyhistory.org/manuscript-group-1508-stoudinger-alofsen-fulton-drawings/

[18] Kleeberg J.M. (1995) 'The Theatre at New York' in Doty R.G. (ed) *The Token: America's Other Money,* American Numismatic Society.

[19] Turnbull (1928), p. 139.

That ‘something new’ was internal combustion, a possible way of making the engine lighter and more efficient. Dubois’s account, written fifty years after Turnbull’s is similar: Stevens’ goal,

> was to develop an engine that was simple, within the limits of American manufacturing skills, and economical enough both to construct and maintain…Stevens [therefore] entered into a series of collaborations with men who possessed the technological skills he lacked. Marc Isambard Brunel was one… Stevens became acquainted with Brunel in New York and employed him to make the machinery for his new experiments.[20]

This idea - to apply an internal combustion engine to the problem of the steamboat - was not as outlandish as might appear at first sight. As Turnbull says:

> The internal combustion engine originated with Papin and the Abbé Hautefeuille, Frenchmen of about 1680, who used powder explosions for motive power. A century later, in England, John Barber mixed coal-gas with air in a retort, lighted this mixture, and discharged it against a paddle-wheel. In 1794 the explosion of gases ignited outside a cylinder was first used by Robert Street, another Englishman, to operate an actual piston. It is entirely possible that the colonel had studied Street's engine, but his own is the earliest that has been found in any American record.[21]

And so Spring 1798 finds Marc Brunel 'busy making a working model according to Stevens’ plans.'[22] It involves a cylinder and a piston, like a steam engine. Inflammable gas is mixed with air, is introduced into the cylinder and ignited. The explosion pushes the piston to the top of the cylinder, creating a vacuum, and the piston is drawn down again. Connect this to a crank, and you can impart elliptical movement to paddles.

Brunel writes to Stevens on 30 January 1798 setting out his commission from Stevens, and, presumably at Stevens’ insistence, makes clear that the idea originates with Stevens and not with Brunel:

> I do hereby certify that the machinery for propelling a boat, a draft of which Mr Stevens has put into my hands for the purpose of constructing a working model, is not in any part my invention but, as far as I know, altogether an invention of his own. The essence of which invention consists principally in the following particulars, viz: A piston working in a cylinder and put in motion by the explosion of an inflammable gas; and is re-acted upon by the pressure or elasticity of the air in the cylinder above the piston. This air, as the piston rises, becomes more and more compressed and, in proportion to this compression, its resistance increases. By this means, the motion of the piston is gradually retarded, and must finally be arrested, without violence or injury; let the force of the explosion be what it may. The explosion is instantly succeeded by a vacuum under the piston and the condensed air, acting above the

[20] Dubois (1973), pp. 130-131.
[21] Turnbull (1928), p. 140.
[22] Dubois (1973), p. 131.

> piston, presses it down again. Thus, an alternating or reciprocating motion is established which, with proper machinery, may be applied to any mechanical purpose. The present application towards propelling a boat is, by means of cranks, to give an elliptical motion to a number of paddles in a mode not hitherto practiced.[23]

Another letter from Brunel to Stevens gives more detail on the experiments he has undertaken. Unfortunately, there is no date on this letter. Marc Brunel is clearly encouraged by progress so far:

> Soon after your going off, I began some experiments on the machine. The heat of the brass cup was sufficient to create the gas. Having injected some Spirit with the Seringe [*sic*] and kept the candle by the hole in the front (I mean the hole which was shut with a little bit of wood) an explosion took place; such a one as to blow water out from the horizontal or square pipe with a great vilence. The fire ruched through all the apertures, though there was but little spirit injected. I tried immediately a second explosion, which impressed like the first one. I could not get a third explosion, the cylinder being quite full with Smoke. I blowed out all the smock [*sic*] and then tried again. I met with the former success. I proceeded further but, the more I tried, the longer was the time necessary to create another explosion. I found that the bellows ought to have a very large aperture or pipe leading to the Cylinder in order to blow the Smock out. I suppose that is the cause which causes so much delay in the intervals between the explosions. The explosions don't make much noise, about as much as yesterday, when the gaz-box was open. I will make no alteration until you see the same effect.
> The Chance begins to assume a fair prospect.[24]

Reading this correspondence, one inescapably forms a dramatic picture in one's imagination. Here is Marc Brunel, a man in his late 20s, full of ideas and energy, in the winter of 1797/98, in a dingy downtown workshop in the primitive industrial milieu of post-Revolutionary New York City, experimenting to create a working model of an internal combustion engine, a machine powerful enough to pull a laden boat along a river. It sounds like a science fiction or alternative history fantasy – but nevertheless it happened. Marc Brunel was finding his metier.

The high drama of the quest was offset by a leavening of (unintentional) comedy – Brunel adds a postscript to the letter as follows:

> My men got terrified when, at the first explosion, Smith who set the candle to the aperture was watered by the blowing out of the water.

We know nothing about Brunel's New York manufactories beyond their addresses. The previous year (1796) Brunel had become an American citizen, suggesting he was

[23] Marc Brunel to John Stevens, 30 January 1798, Stevens Institute of Technology, Samuel C. Williams Library, Stevens Family Papers Reel 12, ref 651; also in Turnbull (1928), pp. 139-140.
[24] Marc Brunel to John Stevens, undated, Stevens Institute of Technology, Samuel C. Williams Library, Stevens Family Papers Reel 12, ref 544-545; also in Turnbull (1928), pp. 140-141.

thinking in terms of more than temporary residence in the USA. Clearly, he employed men to work in his manufactory – but how many men, who were they and what skills did they possess? What other inventions was he working on at this time, and how was he making his living?

In Stevens' papers we can see records of payments and loans to Brunel.[25] In the first quarter of 1798, Stevens paid Brunel $150 and also loaned him a total of $500. Adjusting for inflation, that is equivalent to just under $4000 in payments and almost $13,000 in loans. At that time, an unskilled worker was paid perhaps $1 per day and a skilled worker twice that. Stevens hence made an important contribution to the running costs of Brunel's manufactory and to his own income. Did Brunel repay the loans from Stevens later? We simply do not know.

We do know that the Chancellor wrote to William Constable on the 4th November 1798, asking him to meet James Watt in London in order to purchase a steam engine. Chancellor Livingston wrote as follows:

> Dear Sir Having just learned that you propose to make another trip across the Atlantic, I avail myself of this opportunity to offer you my best wishes for a prosperous voyage & a safe & happy return. [*illegible*] also to trouble you with a piece of business which will be best explained by your reading, at your leisure the enclosed letter to Dr Watt, who you will probably meet with in London tho' he usually resides in Birmingham. I believe that inventions I communicate to him to be very valuable & as I wish to have a number of his engines, I think you may make terms with him for an [*illegible*] of the invention, that may be [useful] to the [better] in this I submit to your discretion. It would be wise to keep a copy of my letter as it will put it in your power to negotiate with any other project or, if Dr Watt [*illegible*] not come up to what you may deem reasonable. Will you be so obliging as to let me know by the by the earliest opportunity the expense of a steam engine [*illegible*] & by what time one could be delivered here on credit being given for 12 months. You find you can not escape the common fate of travelers, that of having the trouble of their friends' business, as well as their own. I am Dear Sir with much esteem & regard Your most [*obedient servant?*] Robert R. Livingston[26]

Three months later, Marc Brunel had himself left for England, never to return to the USA. Was Brunel's journey partly related to Livingston's desire for a Boulton and Watt steam engine? At least one author thinks so – Roger G. Kennedy writes that 'Chancellor Livingston told William Constable that he sent the young man to England to promote a steamboat scheme.'[27] Kennedy gives no reference for this however.

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[25] Letters from Marc Brunel to John Stevens 1798, Stevens Institute of Technology, Samuel C. Williams Library, Stevens Family Papers Reel 12, refs 648, 649, 654, 655, 662, 663.

[26] Robert R. Livingston to William Constable giving instructions for purchasing a steam engine, 4 November 1798, Gilder Lehman Institute of American History. https://www.americanhistory.amdigital.co.uk/Documents/Details/Robert-R--Livingston-to-William-Constable-giving-instructions-for-purchasing-a-steam-engine/GLC04330

[27] Roger G. Kennedy (1989) *Orders from France*, p. 82.

The plot thickens further. Brunel writes to Livingston on 14 January 1799, just before his departure to England as follows:

> Expecting to sail for London by the 25th, at latest, of this month, I offer you the services it might be in my power to render you on the subject of your late improvements on hydroliques and steam machine. Your late improvements particularly upon the steam engine without friction is in my opinion of very great importance and reflect much honor upon the inventor. I flatter myself that undertaking perfectly your principle, I am able to bring your invention to an early practice by making a model of about 150th power upon which I will be able to make all the experiments requisite to ascertain the practicability of this valuable discovery.[28]

Brunel goes on to pitch to Chancellor Livingston both for an advance and for a share in profits as follows:

> As it is not in my power to make advances for the expenses, I hope you will join to your orders a credit of 800 dollars upon some friends of yours or Mr Constable's to whom I shall be accountable for by communicating to him my operations. I hope at the same time you will allow me a share of one third in the profits arising from that discovery which ought never be made public previous to its execution. If your orders to Mr. Constable cannot be conciliated with my proposals or some thing like them, nothing is said on that subject and you many rely upon my discretion.
>
> The offer you made me of some letters of recommendation to some persons in England induced me to recall it to your remembrance. Conceived on the consideration you have honoured me with I flatter myself that it is not an [indecent?] request.

This is a remarkable letter. On the eve of his departure for England, and with Constable presumably already in London and negotiating with James Watt, Brunel is delicately but clearly suggesting to Livingston an alternative course of action via Livingston authorising Brunel to make a model of a Livingston-designed steam engine. We do not know, at least from this letter, what the Livingston 'improvements' on the Watt steam engine might have been, but the experience of Stevens and Roosevelt with Livingston's earlier suggestions of engineering improvements does not generate confidence in their utility. Was Brunel unaware of this? Or – more likely in my view – Brunel was flattering the Chancellor into releasing the money and agreeing to a profit-share before perhaps planning to design his own engine. At this point, we do not have sight of any reply from Livingston.

We have no further record of Brunel working with Stevens, nor of any further development of the internal combustion idea as the method of propulsion for a

[28] See Lot #209, 'Marc Isambard Brunel Autograph Letter Signed' RR Auctions, 2021 https://www.rrauction.com/auctions/lot-detail/345137406220209-marc-isambard-brunel-autograph-letter-signed/

steamboat. But the 'Odd Couple' of the Chancellor and the Colonel had evolved into the Dream Team of Livingston, Stevens, Roosevelt and Brunel. The four men probably never met together, but they were nonetheless engaged in a common enterprise even if only for a very limited time. This 1790s 'Dream Team' might have continued and deepened their relationship and thereby played a significant role in the industrialisation and economic development of the USA – but circumstances meant that it was not to be.

Much later, in England, Marc Brunel and his son Isambard Kingdom Brunel unsuccessfully pursued the idea of a 'gaz engine' for about ten years. This was not an internal combustion engine, but rather an engine that made use of the then-recent discoveries by Humphrey Davy and Michael Faraday that a number of gases could be liquefied by the use of low temperature and very high pressure. By alternately condensing and re-liquefying the gases, the Brunels were convinced that a new and more efficient engine could be produced.[29] As Brindle puts it 'So for the rest of the 1820s, Isambard spent much of his time working with pressurised carbonic gas and achieving hair-raisingly high pressures…There were occasional mishaps and it is a marvel, or perhaps it is a tribute to Marc's and Isambard's skill, that no one was injured.'[30]

Marc Brunel made clear, in a letter to his friend and supporter Earl Spencer in 1825, that his then-current gaz experiments were based on an entirely different principle to his American work on an internal combustion engine.[31] From Brunel's letter, it seems that Spencer had written to him regarding a 'proposed new Power by means of an inflammable gas.' Brunel replies that the particulars

> …are the old invention on which I was engaged in 1798 at New York, where Mr R. Livingston, the Chancellor of that State had an idea of applying it to the propelling of Vessels. It failed with me, and has had no better result with others who have tried it since in this Country. The difference between the two powers…is such as to bear no analogy whatever with each other.

It is noteworthy, to say the least, that in this letter Brunel refers to Chancellor Livingston, the funder of the project, but neither to Colonel Stevens, who was the author of the idea to try internal combustion to improve the steamboat's engine, and whose authorship Brunel acknowledged in his 1798 letter to Stevens, nor to Nicholas Roosevelt. Brunel – either by calculation or by habit – in writing to Spencer, an important and influential figure in England, refers solely to the Chancellor, who was of course the most important and influential member of the American Dream Team.

At this stage, Brunel is dismissive of the future of internal combustion but has high hopes for his and Isambard's condensing 'gaz engine':

> Convinced as I am that something useful will result from my present pursuits, I have thought it prudent to take out a Patent for it, and by that means shall, with the

[29] Brindle (2005), p. 37.
[30] Brindle (2005), p. 38.
[31] Marc Brunel to Earl Spencer, 15 March 1825, National Archives Althorp Papers, G357 ADD 76133.

> cooperation of Isambard, secure to myself the practical application of the invention. I have every reason to be satisfied with what is already done and trust, that with the precautions I have taken, we shall attain our great object without any accident…We are going to fix up a commodious laboratory at Rotherhithe where we can very properly say, that we shall there kill two Birds at one stroke.

The 'two Birds' analogy presumably refers to the Brunels being able to work on the gaz engine and on the Thames Tunnel at the same time and place.

Ironically, while the Brunels' gaz engine idea ultimately went nowhere, boats powered by internal combustion were only a few decades away. Daimler and Maybach successfully trialled a motor boat in 1886, and from the early 20th century, larger diesel-powered vessels appeared. Internal combustion gradually replaced steam power in the 20th Century, although steam remained king for the fastest liners and the larger battleships.

What happened to the rest of the Dream Team?

Stevens continued his steamboat work after Brunel left for England. In 1804, assisted by his sons, he successfully trialled the *Little Juliana*, with a multi-tubular boiler and a high-pressure engine driving twin screws. This was an important historical milestone: the 'first practical screw-driven steam boat.'[32] The technology and engineering of the time did not at this stage permit the further development of steamboats driven by screw propellers. These would develop in the nineteenth century, and Isambard Kingdom Brunel, Marc's son, would build the first Atlantic liner with both an iron hull and screw propulsion, the *SS Great Britain* of 1843. In this regard, Stevens was ahead of his time: 'with the re-introduction of the screw propeller in 1839, all of the elements Stevens had combined in the Little Juliana became essential factors in steam navigation of the ocean.'[33]

A later sidewheel boat from Stevens, the *Phoenix*, made the first ever voyage by a steam-driven vessel on the open sea in 1807. The ocean voyage was from necessity. Livingston and his new partner Fulton held the monopoly regarding steamboats on the Hudson, and so Stevens was obliged to take the *Phoenix* onto the ocean in order to get it to Philadelphia for use on the Delaware River. Later, Stevens operated a steam ferry-boat across the Hudson.

Stevens' steam fever never left him, and later it found a new and exciting form in the shape of the railroad. In 1815, the Colonel applied for and received from New Jersey the first American railway charter. At 76 years old, in 1825, around the time that in England, the first regular steam locomotive service in the world was starting between Stockton and Darlington, Stevens built the first locomotive in the Americas and ran it on a circular track around his New Jersey estate. Stevens' son, Edwin Augustus Stevens, also an engineer and inventor, left a bequest in 1868 to establish the Stevens Institute of Technology in New Jersey.

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[32] Colonel John Stevens (1749-1838) Obituary, 'Science News a Century Ago,' *Nature,* 5 March 1938.
[33] Dubois (1973), p. 428.

In 1799 Nicholas Roosevelt was contracted by the US government to provide copper-sheathing for six new 74-gun ships for the fledgling US navy. But when Jefferson replaced Adams as President in 1801, the contract was cancelled, causing severe financial loss to Roosevelt. [34] Also in 1799, Benjamin Henry Latrobe, architect and future supervisor of the building of the US Capitol, commissioned Roosevelt to provide steam-driven pumps for the Philadelphia Waterworks. In 1808 Roosevelt married Latrobe's daughter Lydia, some 24 years his junior, in a gala wedding on Capitol Hill with the President's wife, among other social luminaries attending[35] Latrobe initially opposed the marriage but eventually consented.

Roosevelt and Latrobe later became partners with Fulton in building steamboats for the American West. Their steamboat the *New Orleans* successfully completed an epic voyage from Philadelphia down the Ohio and Mississippi rivers to New Orleans in 1811-12. The pregnant Lydia Roosevelt insisted in accompanying her husband, together with her young daughter. The Roosevelts' second child was born on the trip during a stop in Louisville in October 1811. While waiting for the river to deepen so that the steamboat could negotiate the Falls on the Ohio River, Roosevelt ran excursion trips up-river, against the current to demonstrate the efficacy of steam technology. After several adventures, the *New Orleans* reached its namesake city on 10 January 1812. This steamboat, according to one author, had 'proved to be the prototype for the western river steamboats that revolutionised transportation and commerce along the inland rivers.'[36]

Meanwhile, Chancellor Livingston's career continued its upward trajectory. In 1801, Thomas Jefferson appointed him to be Minister (that is US ambassador) to France. In this role, Livingston successfully negotiated the Louisiana Purchase, a milestone in the development of the United States and a spectacular gain for the new nation. The Louisiana Purchase, comprising some 530 million acres, effectively doubled the size of the United States, for a price of just $15 million.

France had acquired the Louisiana Territory from Spain in 1800. The United States had been reasonably content with relatively lax Spanish ownership, access to New Orleans via the Mississippi – essential for exploiting the resources of the American interior - having been agreed. But France and Napoleon Bonaparte were potentially a threat. Napoleon, short of cash and seeing nominal ownership of the territory as more of a threat than a resource agreed to sell. The US negotiators in France had initially targeted only the more limited objective of securing ownership of the port of New Orleans at the mouth of the Mississippi river but they achieved far in excess of this goal.[37]

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[34] Maurer, M. (1945), 'Coppered Bottoms For The United States Navy, 1794-1803', US Naval Institute Proceedings Vol 71/6/508.
[35] Leland R. Johnson (2011) 'Harbinger of Revolution: The Voyage of the New Orleans' Indiana Historical Society *Traces of Indiana and Midwestern History* Summer, pp. 14-23.
[36] Johnson (2011).
[37] Office of the Historian, Louisiana Purchase 1803 https://history.state.gov/milestones/1801-1829/louisiana-purchase

Livingston's interest in steam engines continued, although his expertise in the technology did not improve. On 4 June 1800 he wrote to Thomas Jefferson, then Vice President of the USA and later that year to be elected President, enclosing a 'sketch of a Steam engine which certainly avoids many of the inconveniences of Dr Watts as it works with less friction & wear & renders the escape of Steam from one to the other side of the cylinder almost impossible…it is evident that this engine has many advantages over any yet known.'[38]

James Watt did not agree with Livingston's claim in the latter's letter to Jefferson. The Chancellor had written to James Watt in England the previous month (May 1800) setting out his suggested improvements to the great inventor and engineer.[39] The firm of Boulton and Watt were not impressed by these suggestions. In what appears to be an internal note drafted by John Southern, one of James Watt's employees and later a partner in Boulton and Watt, Southern writes 'Mr L. has evidently had no experience either in Steam Engines or any other machines wherein the resistance of fluids has been concerned.'[40] Southern goes on to make a number of detailed criticisms of Livingston's ideas.

James Watt replied to the Chancellor on 16 January 1801. Watt apologises for both his delay in replying, and also for 'the freedom with which I have criticised your inventions…candour […] required me to state to you some of the most Material of my objections; otherwise I might have been accused of misleading you.'[41] Watt appends his own critique of Livingston's plans, making many of the same substantial points as in Southern's earlier note, albeit more politely. Watt's note concludes: 'Mr Livingston has been much deceived in the friction of the Piston and loss of Steam in B&W's [Boulton & Watt's] Engines and must have taken his data from some bad imitations of their Engines. The friction of the Piston in a well bored Cylinder is a mere trifle & the loss of Steam none or next to none. The real causes of the loss of power which take place in all Steam Engines are many & of different kinds, most of which admit of no remedy, and which it is not incumbent on me to explain.'

Marc Brunel's engagement with Chancellor Livingston did not end with the failure of the internal combustion steamboat. The Dream Team was over, but Marc Brunel was keen to maintain his relationship with Robert Livingston after they each had separately moved to the other side of the Atlantic. On 18 December 1801, Brunel in London wrote to Livingston in Paris, and referred, as he had in his letter of 1799 on the eve of his departure from America, to Livingston's supposed 'improvements on the steam

[38] Robert R. Livingston to Thomas Jefferson, 4 June 1800, via https://founders.archives.gov/documents/Jefferson/01-32-02-0004
[39] Letter not read by this author.
[40] Note by John Southern entitled 'Observations on Mr Livingston's Engines,' 31 December 1800, included with Livingston's letter (Robert R. Livingston to James Watt, 20 May 1800, Matthew Boulton Papers, Wolfson Archive Centre, Birmingham Library, MS 3219/4/1/5/6/34).
[41] Copy of letter from James Watt to Rt Hon. Robert R. Livingston, 16 Jan 1801, with enclosure of separate document of Watt's 'observations,' Matthew Boulton Papers, Wolfson Archive Centre, Birmingham Library MS 3219/4/1/5/6/37a.

engine.'[42] Given what we know of the views of Stevens, Roosevelt and James Watt about the Chancellor's engineering ideas, this was once again, likely to be calculated flattery on Brunel's part. Brunel had other and more urgent reasons for writing to the Chancellor in the latter's new role as the US Minister in France – reasons relating to Brunel's invention of the block-making machinery. But that is another story which I shall tell at another time

In Paris, Livingston met Robert Fulton and effectively abandoned Stevens and Roosevelt to partner with Fulton. Robert Fulton's peripatetic career moving between the USA, England and France provides an interesting counterpoint to that of Marc Brunel. Fulton was born in Pennsylvania in 1765, and moved to England in 1786 where he was a successful painter as well as an inventor involved in canals and other civil engineering projects. In 1797 he moved to Paris where he tried and failed to interest Napoleon and the French government in his ideas for 'torpedoes' and (human-powered) submarines. He was also interested in developing steam-powered vessels.

In 1804 he moved to Britain, developing 'torpedoes', effectively mines, for Napoleon's arch-enemy, the Royal Navy. In 1806 he returned to the United States, and in 1807 his and Robert Livingston's steamboat, the *North River* – later renamed the *Clermont* after the Chancellor's mansion on the Hudson - plied a commercially successful trade between New York and Albany along the Hudson.

Fulton and Livingston are generally credited with inventing the first successful steamboat. But a case can be made for at least equal billing for Stevens and Roosevelt earlier. Dubois's judgement on Stevens is that he 'deserves to be included with the steam boat pioneers in every sense of the word. He did not invent the steam boat nor did he claim to: but for that matter, no one else did either, despite their claim.'[43] And Turnbull points out that the Stevens/Roosevelt steamboat the *Polacca*, was the first non-condensing and double-acting boiler in use on the American continent, and its trip on the Passaic happened years before Fulton and Livingston's later boat the *Clermont* steamed on the Hudson. Moreover, Stevens was an early proponent of screw propulsion, which eventually replaced paddle-wheels steamships.

Stevens and Roosevelt's achievements in steamboat development do not as far as we know relate directly to Brunel's internal combustion experiments. But as a skilled engineer and former mariner, perhaps Brunel made other suggestions to them, beyond fulfilling his commission to attempt an internal combustion machine? Until and unless we find further letters or other evidence from this time, this must remain speculation.

Nevertheless, Brunel's engagement with some of the American steamboat pioneers in the 1790s helps us to understand better his wider story and his achievements, and also brings out the importance of the crucial years he spent in the United States.

[42] Marc Brunel to Robert R. Livingston, 18 December 1801, Robert R. Livingston Papers 1707-1862, New York Historical Society Manuscripts Collection.
[43] Dubois (1973), p. 101.

First, to what degree was Brunel involved in Livingston's plans to buy a steam-engine from Boulton and Watt in England? Was *this* the reason – or at least one of the reasons – why he decided to come to England in early 1799?

Secondly, by the late 1790s, it is clear that he had built and important reputation in the USA. This reputation was sufficient for Stevens directly and for Roosevelt and Livingston indirectly to seek Brunel's help when their steamboat project ran into difficulties.

Thirdly, Marc Brunel's location, not just in America, but specifically in New York City was important. It was still a very small city at that time: its population was 60,000 in 1800 compared with 600,000 in Paris and 1 million or more in London and Beijing. Marc's location first in Murray Street, then in George Street, placed him close to, among others, Nicholas Roosevelt, Alexander Hamilton and probably Robert Livingston's town address. More generally, he was living and working in New York City just at the point when the somewhat ramshackle former Dutch trading post was beginning its rapid trajectory from global backwater to world city.

Fourthly, by working for Stevens, Roosevelt and Livingston, he was connected, at least indirectly, and possibly directly, with the global centre of innovation and industry – England in general, and Boulton and Watt's Soho works in Birmingham in particular. Was Brunel connected more directly with Boulton and Watt, perhaps via James Smallman and others? We know that Brunel wrote directly to Matthew Boulton in the summer of 1799, not long after he arrived in England (another important story, for another time). How much direct and indirect contact with the Soho Works did Brunel have while still in America?

Finally, this episode in the history of steam navigation shows the range of Marc Brunel's ideas and ingenuity. By the end of his time in the USA, he was clearly brimming with ideas and inventions and enjoying the role of inventor. He fully deserves Alexander Hamilton's description of him as 'an inventor of ingenious machines' as well as justifying his own comment, ascribed to him by his descendant Celia Brunel Noble in her 1938 biography of *the Brunels Father and Son*, that he brought with him from America to England 'some small means and many great ideas.' These great ideas were developed by Marc Brunel from his own genius - but developed in the specific milieu of New York in the last decade of the eighteenth century.