Exam No: Y3835665

Centre for Lifelong Learning

Assessment Cover Sheet for Anonymous Marking

Essay: **The railways would not have been built when they were had it not been for the economic and political changes that occurred during the industrial revolution, 1750 to 1830. Discuss**

Module title:	**15/16 RS T1 - The Coming of the Railways to Britain, 1825-1900**
Module code:	**CED00007M**
Module level:	**M**
Tutor:	**David Turner**

Tutor's comments:
General Comments

A very good first effort. A good introduction here, however, please state more clearly how you are going to answer the question. You have demonstrated a very good understanding of the literature and the issues at hand, and the points throughout are relevant and interesting. Indeed, the extent of the reading list is to be commended. You sometimes need to state more clearly at the start of paragraphs how the points you are making tie into the main argument. The question asks about economic and political factors; and the latter's role particularly should have been given more attention. Indeed, addressing these things should have been your first job as the question asks about this. Your exploration of technical pre-conditions is welcome, however what about the demand in the economy for new transport services? Referencing is generally good, although some of the choices of source in the piece could be considered of dubious quality and in places references should have been given and were not.

Actions to improve

- Perhaps look at what sources could be used.
- Make sure that you answer a bit more directly.
- Check the referencing format.

2nd Marker's comments:

This is a very strong first essay, rich in historical detail, which considers the case very carefully indeed. I particularly like the way that you tackle wider discussions around industrialisation. The main area for improvement is to work on your referencing. Well done.

Signature: D A Turner (1st marker)	**Mark/Grade: 70**	**Date: 10/12/2015**
Signature: K D Tennent (2nd marker)	**Mark/Grade: 72**	**Date: 03/01/2016**

Exam No: Y3835665

The railways would not have been built when they were had it not been for the economic and political changes that occurred during the industrial revolution, 1750 to 1830. Discuss

This question avoids the pitfall of asking whether railway development was 'inevitable,' a highly problematic concept, but does ask whether the changes from 1750-1830 were a *sine qua non* for the eventual construction of the railways. This essay largely answers the question in the affirmative, though with some caveats and qualifications in order to prevent the case from being made in excessively teleological terms.

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For example, it is important to lift our eyes momentarily from these shores and this period in order to note that there are examples of major transport infrastructure projects that have been built in pre-industrial societies. Rome built its excellent roads across much of western Europe in its heyday, Louis XIV commissioned the successful building of the 150-mile Canal du Midi (as it became) in the late seventeenth century[1], and Tsar Nicholas I paid close attention to the construction of his desired St Petersburg to Moscow railway from 1842-51[2]. All three examples are of pre-industrial autocracies where a command decision was made, and subordinates organised things to carry it out. Military considerations were important, but were not the sole reason for these projects, and the availability of forced (or forcible) labour was a factor in the first and third. But in pre-industrial societies these are notable exceptions, though 'colonial' railways such as in India in the nineteenth century offer a variation on that point.

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The vital points about these exceptions, however, are that roads and canals have relatively few technical challenges, and that railway technology is not that difficult to import or copy once it has already been invented somewhere else, so the key task for these projects was the effective mobilisation of all the necessary resources to design and construct them. This therefore draws attention to the point that, in contrast, the invention of the railways for the first time in the world required a qualitative leap forward for humanity – a technological step-change –

[1] https://en.wikipedia.org/wiki/Canal_du_Midi Accessed 3/11/15

[2] Christian Wolmar, *To the Edge of the World*, (London: Atlantic Books, 2013 Kindle ed), Location 405-490

in addition to the task of mobilising the necessary resources. This essay therefore considers the contribution made by the various changes in the eighty years up to 1830 in bringing together the necessary technological innovations and resource mobilisation that enabled the first railways to be built. Since Britain made the breakthrough of building the first steam-driven railway linking two cities this country will receive the most attention.

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Focusing first on resource mobilisation, the main resources to be covered are (alliteratively, rather than 100% accurately) 'men', materials and money. Starting with 'men', the general population of the United Kingdom increased markedly during the 1750-1830 period (and continued to increase thereafter), so that after briefly threatening to bring about the disaster feared by Malthus – poverty caused by more people sharing finite resources – the surplus available labour moved into creating more value in, for example, factories and building canals. Wrigley showed how Britain's (especially England's) proportion of the population of Europe rose during the period 1680-1820, as did the Gross Domestic Product (GDP) per head.[3] It was the transition from an 'organic' – agrarian – economy into the early stages of industrialisation that in Britain the Malthusian trap experienced in the Low Countries at the time was prevented, as new opportunities for wage labour started to grow. It was therefore productivity, rather than simply population growth as a whole, that led to increased GDP per head[4], although both played a part – and meant that there was a reserve of both money and men awaiting deployment in the 1750-1830 period and onward.

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The canals are particularly relevant, since they became the model for how to mobilise a workforce to build a transport infrastructure route across the countryside. Although rolling groups of local agricultural labourers did provide supplementary labour, the main workforce consisted of the new phenomenon of

[3] E.A. Wrigley, "British population during the 'long' eighteenth century, 1680–1840," in *The Cambridge Economic History of Modern Britain Volume 1: Industrialisation, 1700–1860*, eds. Roderick Floud and Paul Johnson (Cambridge: Cambridge University Press, 2004), 57-95

[4] Michael Bar and Oksana Leukhina "Demographic Transition and Industrial Revolution: A Macroeconomic Investigation" (July 2007), 5 Accessed 17/11/15 at: http://faculty.washington.edu/oml/Paper1.pdf

'navvies' (navigators) who specialised in this project work[5]. They were hired by contractors who gained skills in managing these mixed groups of workers into delivering the required project. Building canals through tunnels, over aqueducts and up flights of locks was certainly a skilled job, but none of it really required a radical technological breakthrough to achieve. However, given that, broadly speaking, the same system of construction and project management continued with the building of the early railways, it was helpful that canal-building embedded in a generation of 'engineers', surveyors, contract managers and 'navigators' a body of skilled experience awaiting further deployment. In a country where mass use of forced labour was not an option, this ability to mobilise 'men' for infrastructure projects before 1830 was a very useful precondition for the building of railways in Britain after that date.

In terms of materials, both coal and iron were particularly important for the building of track and the driving of locomotives. Coal (and coke) gradually replaced charcoal as the main medium for smelting iron, and thus also became essential for the static steam engines of the eighteenth and early nineteenth centuries. Britain's mines and quarries, across many parts of the country, were both a source of industrial development and also a stimulus to transport development, since canals and early tramroads (waggonways) were often built to ease the distribution of their produce.

But iron merits particular attention at this point. Railway-building required both a substantial increase in quantity or iron production compared with the past, and some major improvements to its finished quality. Iron production had been stimulated during the 1750-1830 period by the need to produce static steam engines and various early forms of rails or rail coverings, even though these were not the only uses of iron at the time. But it is easy to take British iron production for granted as a precondition for Britain's post-1830 railway

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[5] Terry Coleman, *The Railway Navvies, A History of the Men who made the Railways* (1965, new ed London: Head of Zeus 2015), Kindle Location 281, reports that the original canal navvies were fenmen from Lincolnshire, but such groups quickly came to include men from Lancashire, Yorkshire, Scotland and Ireland.

construction: it transpires that Britain's prodigious iron production was also a precondition for railways in other countries such as the USA until about 1850.[6]

In addition, it was necessary for wrought iron to be invented and produced[7], using Henry Cort's puddling process from about 1784 onwards[8], and developed by John Birkinshaw in 1820 with an efficient rolling process[9], for iron to become strong and durable enough to make commercially viable rails for early steam locomotives and their trains. This improvement, arising from the 1750-1830 period, was another necessary precondition for railway-building, although it was in turn superseded by the efficient production of steel over time using the Bessemer process that was developed during the period 1856-64[10].

The final key resource that needed to be mobilised was money. This was another area where Britain was well placed during this period, despite the economic depression that struck soon after 1815. Most of continental Europe had experienced the recurring destruction and disruption of warfare for some twenty-five years, while the Five Coalitions against Napoleon had been largely financed by Britain, whose powerful financial standing had grown from a low base during the course of the 'long' eighteenth century.

Not only was wealth available to be deployed, but it was capable of being deployed, including for infrastructure purposes, as was demonstrated with the financing of the canals from 1770 onwards[11]. By 1830 people from a range of backgrounds were experienced in, and wishing to develop further, investing more widely than simply government debt (gilts). This included successful industrialists in the north of England, leading to the development of stock

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[6] Christian Wolmar, *The Great Railway Revolution*, Location 792 onward
[7] Michael Freeman, "Introduction", in Michael J Freeman and Derek H Aldcroft, eds, *Transport in Victorian Britain* (Manchester: Manchester University Press 1988), 16
[8] https://en.wikipedia.org/wiki/Wrought_iron, accessed 13/11/15, references R. A. Mott (ed. P. Singer), *Henry Cort, The Great Finer* (The Metals Society, London 1983)
[9] Henry Parris, *Government and the Railways in Nineteenth Century Britain*, (London: Routledge & Kegan Paul 1965), 3
[10] https://en.wikipedia.org/wiki/History_of_the_steel_industry_(1850–1970) Accessed 13/11/15
[11] By 1824, some £12m had been raised by canal companies, according to Henry English, in his 1827 *A complete view of the Joint Stock Companies formed during 1824 and 1825*, quoted by M.C.Reed, "Railways and the Growth of the Capital Market," in M.C.Reed, ed, *Railways in the Victorian Economy* (Newton Abbot: David & Charles), 162

exchanges marketing early railway shares in Liverpool and Manchester[12], although when the railways reached London the metropolitan exchange started to come into the railway market too, with increasing success at pulling the money market back to the capital during the 1840s[13]. This growth in the capital market was, it can be acknowledged, a step-change at least in terms of quantity[14] after 1830, though the principle of buying shares in companies building transport infrastructure had already been established well before that date. (Dyos and Aldcroft cite an 1882 estimate suggesting that the total capital invested in canals had been £19 million[15] - not too far away from the 1824 estimate of £12 million to that date. In comparison, although only about a quarter of a million pounds had been invested in railways prior to 1830[16], the amount increased massively after that.) In this sense it is a case of another element of the precondition of resource mobilisation being in place.

In many ways the building of the canals in Britain served as a pilot for the building of the railways, in that the way that men, materials and money had been mobilised to build the canals (and some turnpikes) would be used again with the first railways – in the main it was a case of continuation. But alongside this – in contrast - a major technological advance was also needed, indeed a series of linked advances, and here the analysis is about how the 1750-1830 period paved the way for this step-change through a process of a series of improvements.

The invention of wrought iron has already been mentioned – steam locomotives were too heavy for cast-iron rails, so this advance from this period was an essential precondition. Related to that, the invention of the flanged wheel[17] was

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[12] Michael Freeman, "Introduction" to *Transport in Victorian Britain*, 17-18
[13] M.C.Reed, "Railways and the Growth of the Capital Market", 169
[14] T.R.Gourvish, "Railways 1830-70: The Formative Years" in *Transport in Victorian Britain*, 61-2, discusses the uncertainty of how much the investment ratio of national income increased prior to 1830, but increase it certainly did, and then leapt further with the coming of the railways.
[15] H.J Dyos & D.H.Aldcroft, *British Transport: An Economic Survey from the Seventeenth Century to the Twentieth*. (Leicester: Leicester University Press, 1971), 112
[16] T.R. Gourvish, *Railways and the British Economy, 1830-1914*, (London: Macmillan, 1980), 12 (Table 1)
[17] Christian Wolmar cites William Jessop in Loughborough in 1789 as the probable inventor of both the flanged wheel and transverse sleepers in Christian Wolmar, *The Great Railway Revolution: the epic story of the American Railroad,* (London: Atlantic Books 2012), Kindle location 306

also necessary, because the alternative style of plateway with ordinary wheels could never have developed into a flexible and efficient permanent way. Various designs of iron rail still had to be experimented with in the early days before the T-design later broadly proved itself to be the best option.

On a further relevant connected detail, it was by no means obvious that smooth metal wheels would work effectively on smooth metal rails. It would seem that Stephenson's observation of Blenkinsop's *Salamanca* in 1812[18], his own *Blucher* at Killingworth in 1814[19], and Hedley and Hackworth's two locomotives at Wylam Colliery also in 1814[20], for the consensus to emerge that a cogged rail was not needed (except for some future mountain railways).

The option of not having a dedicated permanent way at all had to be discarded, after the experiences of Trevithick's early locomotives in Cornwall, and in London's Tottenham Court Road[21], demonstrated that the lack of ability to steer or brake properly, or indeed haul trains, on existing roadways when rubber tyres had not yet been invented, made this option a non-starter. Therefore the invention of a dedicated permanent way that could be used by steam locomotives was itself a step-change, a departure from the idea of simply adapting or extending existing roadways or waterways. A further departure from precedent was when the experience of the Stockton & Darlington railway made it clear that the use of the track could not be as a public highway open to any users, but would have to be managed as a closed system.

In addition to all these advances that made a dedicated effective permanent way possible was the major advance of devising a steam engine that would at the same time be powerful enough to haul both itself and a reasonable payload, and also light (and small) enough to be moved without breaking its track. Although others had previously made a key breakthrough from 1800 by using high pressure boilers, Stephenson's introduction of the multi-tubular boiler in his

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[18] Christian Wolmar, *The Great Railway Revolution*, Location 499
[19] Harold Pollins, *Britain's Railways: An Industrial History* (Newton Abbot: David & Charles 1971), 20
[20] Stuart Hylton, *The Grand Experiment: the birth of the railway age 1820-1845* (Hersham: Ian Allan 2007), 22-3
[21] Philip Bagwell and Peter Lyth, *Transport in Britain 1750-2000: from canal lock to gridlock*, (London : Hambledon and London, 2002), 51

Rocket at the 1829 Rainhill trials was the final key improvement that proved that steam locomotion was a viable commercial proposition on new railways.

If we look back from the vantage point of knowing how matters developed in reality from 1830 onward it is easy to take for granted the collection of interdependent technological advances that were made in order to bring about the first successful railways. Once invented they were (relatively) easy to copy, imitate and/or export, and they could spread across the world with a relatively small amount of local variations during the nineteenth century. But until they were invented it was still a huge leap waiting to happen for these ideas to be both recognised and then implemented in one coherent package - it was at least possible that that coherent implementation might not have happened until later in the century, perhaps after the invention of the rubber tyre[22]. This could, if improbably, have led to a different sequence of subsequent developments.

As for the steam engine itself and its role in the British economy over time there is not the straightforward connection that is sometimes portrayed. In 1769 James Watt patented his version that was so much better than Newcomen's, but its use of low pressure meant high fuel costs and his patent prevented alternative models – especially smaller higher-pressure versions for potential locomotives – from being developed until after 1800. Indeed Crafts has argued that steam made a relatively small contribution to overall economic growth prior to 1850.[23] He is right to point out that water power was still extensively used prior to that date, and it is also the case that carriage by canals in total remained strong until 1850 (some, like the Kennet and Avon, were exceptions), but it remains the case that by then the technological breakthrough in building the first railways had been achieved. The refinements that enabled steam engines in all their settings to grow and impact on the economy as a whole could come later in the century – the radical innovation of locomotion had been made by 1830.

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Commented [DT28]: Crafts is talking about the period before 1830.

[22] Goodyear invented vulcanisation of rubber in 1845, and the Scot R.W.Thomson not only patented the pneumatic tyre in the USA in 1846, but also ran steam vehicles on (solid) rubber tyres in Edinburgh long before Dunlop's 1880s patent. https://en.wikipedia.org/wiki/Robert_William_Thomson Accessed 15/11/15

[23] Nicholas Crafts, "Steam as a General Purpose Technology: a Growth Accounting Perspective", *The Economic Journal*, (2004) vol. 114, issue 495, pp. 338-351

What made this advance happen? Was there something else in the preconditions that grew from 1760-1830 that sparked the breakthrough? The idea of the 'March of Intellect' has some merit, despite the danger of a tautological argument being made here. (It adds little to one's understanding of the achievements of an individual such as da Vinci to be told that he was an imaginative genius, for example – that is already evident from his achievements.) But if there is wider evidence of a mindset held by one or more groups of people in a society, as there is in this case, and it is mentioned contemporaneously, then it is worth considering.

Mokyr, in his 2014 chapter[24], makes a strong case for finding that in Europe as a whole a very slow long-term buildup of economic growth fed into, and was in turn fed by, a growing belief by a range of thinkers in the idea of progress, and developing ways of making that progress happen – in England, Bacon's promotion of empirical scientific method and the establishment of the Royal Society in 1660 are two illustrations, but it was a cross-European phenomenon that had in turn grown from the earlier idea of the 'Republic of Letters'. From 1760 onwards the pace of this interactive process increased markedly, and Mokyr uses the analogy of a pelaton to explain how for a key period Britain broke ahead of the pelaton in becoming the first to industrialise. During a key period of various technological developments, Britain was free of the repeated disruption of warfare on its own land, and the pace of the work of intellectuals, wealthy investors and practical investors continued to increase. In an earlier work Mokyr called this 'Industrial Enlightenment'[25], citing how practical inventors had continued to refine and improve the devices and methods that had

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[24] Joel Mokyr, "An Age of Progress", in *The Cambridge Economic History of Modern Britain, New Edition Volume 1: 1700–1870*, eds. Roderick Floud, Jane Humphries and Paul Johnson. (Cambridge: Cambridge University Press, 2014), 315-353

[25] Joel Mokyr, "Accounting for the Industrial Revolution", in *The Cambridge Economic History of Modern Britain Volume 1: Industrialisation, 1700–1860*, eds. Roderick Floud and Paul Johnson (Cambridge: Cambridge University Press, 2004), 17-27

only recently been introduced. More modestly, Bruland calls it 'a general social propensity to innovate' that had grown during this period.[26]

Britain's geography helped in another way; the mining of iron and especially coal (they stimulated each other), interacting with the human drive to improve coalmining production, led to both the first steam engines and the main early uses of rails. But Britain's stable government and its other institutions – scientific and financial – all enabled a range of practical engineers and entrepreneurs to work on finding ways of continuously improving the developing technology.

However, the specifically political institutions give a mixed picture, as Harris has outlined[27], and were a mixed benefit at the start of the railway age. Though benefiting from no warfare on British mainland, the post-Napoleonic governments – and parliament itself - were repressive of radical politics, and protective of private property to the extent that establishing both a company and a route by Private Act of Parliament was difficult and expensive for any prospective railway, even though there was economic deregulation in other respects such as the abolition of the Bubble Act. In the very different setting of the United States the possibility of state loans, and the granting of eminent domain, it was far easier[28] and cheaper to get a railway started. But the political repression in Britain did not extend to commerce, and at least the accepted orthodoxy of laissez-faire allowed the entrepreneurial improvers to flourish – if expensively for railways. It was only in the late 1830s that the fear of monopolies led to the prospect of ongoing government regulation of railways, though without strangling wider technological improvement. In Mokyr's succinct words:

> …political power's main purpose was to defend the interests of those already wealthy: a government by, of and for private property. Britain's great achievement was to reconcile this attitude with economic and technological progress.[29]

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[26] Kristine Bruland, "Industrialisation and technological change", in *The Cambridge Economic History of Modern Britain Volume 1: Industrialisation, 1700–1860*, eds. Roderick Floud and Paul Johnson (Cambridge: Cambridge University Press, 2004), 146

[27] Ron Harris, 'Government and the Economy, 1688-1850', in *The Cambridge Economic History of Modern Britain Volume 1: Industrialisation, 1700–1860*, eds. Roderick Floud and Paul Johnson (Cambridge: Cambridge University Press, 2004), 235-7

[28] Christian Wolmar, *The Great Railway Revolution*, Location 711

[29] Joel Mokyr, "An Age of Progress", 343

In this climate the wrought iron rails, rolled efficiently by Birkinshaw, and the triumphant *Rocket* of Stephenson, were improved versions of previous inventions, so that the qualitative breakthrough that all the elements of the Liverpool and Manchester Railway together achieved was that the whole enterprise crossed the tipping point into suddenly becoming a package that was a commercial proposition that could be applied almost anywhere in the world. Ironically, although the business case planning had been principally about moving freight economically, it was its instant success in capturing a passenger market that was particularly eye-catching.

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This company, and its successor railways, pulled from the previous eighty years the already-developed ability to mobilise men, materials and money, and combined it with the needed technological inventions that had recently appeared for the first time, and improved them into a package that became an unprecedented breakthrough for humanity.

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2,957 words, plus c90 words of text in footnotes

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Plus some Wikipedia details, referenced in some footnotes.