Craftsman or Engineer

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Some thoughts resulting from my translations of Sebastian Maillard's 1817 book on canal engineering[1] and Johann Hogrewe's 1780 book on English canals,[2] about the role of the craftsman in the late 18th and early 19th century development of the engineering profession. They are based on a study of contemporary engineering and canal publications from across Europe, not just of the UK. These suggest that the engineering profession was far more advanced on mainland Europe — so why did the late 18th century 'Industrial Revolution' begin in the UK?

Introduction

Although there had been some very useful German and Dutch books published around the first half of the 18th century, French authors had been at the forefront of writing works related to hydraulic engineering, notably Belidor's monumental ***Architecture Hydraulique***, published in 4 volumes between 1737 and 1753. However, by the 1770s Coloumb[3] suggested that developments had overtaken the theories proposed by Belidor, and that he was considering writing something more up-to-date. That never happened, and the number of French books related to hydraulic engineering reduced in the days immediately before and then during the French Revolution. Because of Napoleon's isolationist policies with regard to Britain, it was difficult for French engineers to see and write about developments in England until after the war, when Francois Pierre Charles Dupin[4], and Joseph-Michel Dutens[5] began to assess improvements in British engineering and economics during the wars. The void, if that is what it could be called, was filled with a number of Dutch and German technical books.

Set against the numerous European hydraulic and structural engineering books in the 18th and early-19th century, there was an almost complete dearth of English books on those subjects. The printed word was obviously more important on the European mainland than on the British Isles. One of the possible reasons for this was the effect of the Thirty Years War in European countries, compared to the changes brought about following the Civil War in Britain. On the continent, wars seem to have re-enforced the links between the State and Church, either Catholic or Protestant, and these links helped universities to develop. This, in turn, encouraged academic publications. There was also greater interest in engineering within European armed services, not just for ballistics, but also for fortification. In France, the École de Ponts et Chausées was established in 1747, and as stated on its website: '…has trained top-level engineers, future managers and researchers able to solve the problems of society and change'. However, the links between State, Church and the Military resulted in centralised control by a ruling class with few direct links to the working population.

In contrast to this, the Civil War and its aftermath in England loosened the links between Church and State, allowing the rise of non-conformism, particularly in the North of Britain. There, religious groups such as the Quakers took advantage of freedoms which were uniquely available. For example, they set up their own banks for investing in the local economy, helped by land ownership under the copyhold system, which gave small landowners security of tenure. Equality in opportunity was also one of their beliefs, resulting in highly-skilled craftsmen rising within society and attaining 'professional' status, helped by a decline in influence of the Guilds. Such freedoms – political, religious, economic and societal – could be found in no other country, and they created the foundation upon which the first industrial revolution developed in Britain.

British academic institutions, where they studied pure, rather than applied, sciences, had little effect on how industries adapted to these changes, as can be seen by the lack of published technical works. British craftsmen acquired their knowledge by word of mouth or example, as they learnt 'on the job'. Many had little formal education, but this did not restrict the most intelligent, for whom the theoretical

[1] ***Technology, Economics, and Canal Development – An early technical book and what it reveals***, translation and new text by Mike Clarke, 2021, ISBN 978-0-901461-71-1

[2] ***The First Canal Guide***, J Hogrewe, translation by Mike Clarke, 2025.

[3] ***Coloumb and the Evolution of Physics and Engineering in 18th Century France***, Stewart Gillmor, C., ISBN 0-691-08095-X.

[4] He was the author of two books looking at military and commercial aspects of England after the war: ***Mémoires sur la marine, et les ponts et chaussées de France et de l'Angleterre***, was published in 1818; and ***Force Commerciale de la Grande Bretagne***, 6 vols, 1821-24.

[5] His book ***Mémoires sur les Travaux Publiques de l'Angleterre*** was published in 1819.

mathematics required – mainly simple geometry, and volume and flow measurement – was easy to pick up during their training. The one factor which unites all 18th century British engineers is that they trained under a craftsman at some time. Even Smeaton, regarded as the father of the civil engineering profession, trained as an instrument maker. Such training required little in the way of academic publications, and it is noticeable that it was only as formal education increased in the mid-19th century, improving literacy, that the number of British civil engineering books also increased. The rise of the Mechanics' Institute encouraged many to be written specifically for craftsmen, rather than in a more academic style.

Visitors to England from European countries were usually from the upper echelons of society, and were amazed at how workers here were able to develop their ideas and status, as their culture did not appreciate the knowledge and intelligence required by the most skilled craftsman. Karl Haidinger[1] from Austria described his wonder at the achievements of British craftsmen engineers in a letter dated 9 November, 1795:[2] '…*The longer I am in England, the more I have to admire the happy genius of this nation. Wherever you go you will see inventions that astonish. A few days ago I saw a large brewery, where all the facilities were so well calculated, according to the laws of mechanics and physics, that only a long study of the devices could find improvements. I saw ordinary flour mills, whose design was so simple and chosen for the greatest effect, that one was tempted to believe that every Englishman understood mechanics when they were brought into the world. And this excellent design of all machines can be found all over England, and despite it being well known that French mills were in very poor condition, even though the best mechanics anywhere in the world are in France, yet there Science was only found in the capital, and limited to only a few individuals*….' It is interesting that he calls the academically-trained French men 'mechanics', as an understanding of the word 'engineer' had not yet fully evolved. He states that European technical expertise was centralised, and against this, he suggests that in Britain technical expertise was almost universal, and that craftsmen capable of solving technical problems could be found everywhere.

In his eleventh letter[3] he goes on to say: '*Close to Sheffield is a famous ironworks in Rotherham, which we are also going to see to admire the size of this establishment, then we will probably see nothing of this type until Scotland, as the whole area from Rotherham to the border is restricted to woollen manufacture. It is always very strange that in this richly-blessed land, whole districts are always occupied with a single trade, for which indisputably some special qualities of the land are the cause. For example, sheep farming in Yorkshire is certainly the main cause of woollen manufactures in that county, while coal and coarse clay for crockery are the cause of pottery manufacturing at Newcastle under Lyne etc.; but this contributes not just a little to the perfection of the trade, in that every useful invention is circulated more rapidly and becomes used in general in a much shorter time, and I believe that this distribution of English manufactories is a principal cause of the development of domestic commerce and canals, which certainly would never have become so general, if the factories of one type had been distributed more evenly over the whole country, and I have noticed in some parts of Germany that many an entrepreneur has erected a factory in an area which his imagination suggested to him without considering the nature and possibilities of the area.'* The small distances between industrial centres in Britain made travel comparatively easy in the 18th century, with many of those centres comprising of several small towns close together. This was very different to the continent, or even Ireland, where factories were often built in isolation from those involved in similar work, due to the widely dispersed population, and much greater distances between towns.

The story of the industrial development of the town of Portlaw, in Ireland,[4] is an example of industrial isolation. Situated on the River Clodiagh, a tributary of the Suir in Waterford, it was developed by David and Joseph Malcolmson, a Quaker father and son from Ulster. They opened a cotton mill in 1826, perhaps encouraged by James Cropper,[5] a Liverpool Quaker who was promoting the idea of relieving poverty in Ireland by the provision of work. The Malcolmsons built a large six-storey cotton factory, eventually employing some 1000 workers,[6] and textile operatives were brought from England

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1 He was the Hapsburg Court's Mining and Coinage expert, making the visit to England with Sebastian Maillard, who was looking at canal developments.

2 Published in 1883 in Steiermärkische Geschichtsblätter, the letter was to Count Franz von Saurau, and original was in the Steiermärkishe Provincial Archive. A translation of all 15 letters can be found in ***Technology, Economics, and Canal Development – An early technical book and what it reveals***, translation and new text by Mike Clarke, 2021, ISBN 978-0-901461-71-1.

3 Dated 3 January 1796.

4 Based on 'History of Portlaw'., by the Portlaw I.C.A. Local History Group: http://homepage.tinet.ie/~portlawns/Pages/history_of_portlaw.htm#:~:text=David%20Malcolmson%20was%20the%20founder,Greer%2C%20a%20Quaker%20in%201748, and on https://www.waterfordmuseum.ie/exhibit/web/Display/article/321/1/Portlaw_A_Nineteenth_Century_Industrial_Village_Introduction.html

5 ***The Present State of Ireland: with a Plan for Improving the Condition of the People***, James Cropper, 1825 .

6 He created a factory village, rebuilding it around 1850 with roads in a fan shape from a central square. Roofs were covered

to set the wheels in motion, and to train Irish labour. Housing was built specifically for them, and subsequently, a new town for Irish labour was erected close to the mill. Not unsurprisingly, there appears to have been a few problems in passing English skills to the Irish workers, but the mill remained productive through the cotton shortages of the American Civil War, and then the Potato Famine, but could not survive the subsequent additional duties, levied by the English Parliament to protect English industry, which had to be paid on Irish-produced fabrics.

Some of the flat roofed housing built for factory workers at Portlaw.

The design and layout of many of the various buildings at Portlaw was by John Skipton Mulvany, whose brother William was responsible for much of the mid-19th century Shannon improvement. William Mulvany and Joseph Malcolmson were at the Dublin Industrial Exhibition of 1853, where they must have discussed European investment, resulting in William moving to Germany where Irish ideas and finance founded deep coal mining in the Ruhr.[1] The centralised governance of Ireland does seem to have created a much more European style of society, with London controlling economic development and technological ideas, unlike industry in the more northerly parts of the England, and in Scotland, which were relatively free from such controls.

Looking back at the start of inland navigation in Ireland we come across several European engineers, such as the Hugenot Jean Thomas[2], Richard Castle[3] from Germany or the Low Countries, Thomas Omer[4] from Holland, and Davis Ducart[5] from Piedmont or Sardinia. So engineers from Europe were not uncommon in Ireland, but they seem to have brought the European problem, that of putting their theoretical ideas into practice. In both Ireland and Germany, the Malcomsons had to used highly-skilled English craftsmen to train the local workers, and to bring new ideas.

The Craftsman in Britain

Returning Georgian times, and through until the 1970s in some cases, a 'craftsman' was someone who had undergone a 5 year apprenticeship to achieve a high level of skill in their chosen trade. The best became a 'craftsman engineer', someone who, despite high intelligence, lacks formal academic education. They were highly skilled and took on the design and control of engineering works. University-trained 'academic engineers' only begin to appear around the mid-19th century, following the foundation of the engineering institutions and the introduction of applied sciences to universities.

The craftsman engineer develops his ideas from the skills which have been passed down to him verbally and by example. Mistakes were made, but they did not have the boundaries which should not be crossed which are associated with the academical approach. As a result, they were able to push forward much more swiftly. This was one of the major factors in the Industrial Revolution starting in England, rather than, say, France, where academic technical education was far more advanced.

A review of published works reveals few English civil engineering books in the 18th century, but with increasing numbers published from the 1820s as English academia struggled to catch up with universities on the continent and in Scotland. Improving literacy amongst the 'lower' classes also encouraged publications, and the number of mid-19th century books on stone masonry and associated subjects is particularly noticeable.

The meaning of apprenticeship has become generalised today, but until the late-19th century it was very specific, involving legal indentures binding the apprentice to a term of years working alongside

with calico and tar, with some examples still using the system today.

[1] Schmidt-Rutsch, Olaf, 'The Two Careers of William Thomas Mulvany C.E.', ***International Journal for the History of Engineering***, 80:1, 2010, pp100-118.

[2] BL Add MSS 6027, 1716; 'Captain Thomas, the French engineer, and the teaching of Vauban to the English', A Stuart Mason and Peter Barber, 1991, ***Proc. of Hugenot Soc*** XXV, p279-326.

[3] https://www.dia.ie/architects/view/347/CASTLE-RICHARD. Castle wrote the first English language paper on canal construction, NLI MS 2737 'Essay on Artificial Navigation, 1730, with nothing further being published on general canal technology until 1805 and Rees' ***Cyclopedia*** 'Canals'.

[4] https://www.dia.ie/architects/view/4177/OMER-THOMAS.

[5] https://www.dia.ie/architects/view/1660.

craftsmen to learn their skills. At one time, when guilds were influential, an apprentice would have to produce a master piece which, if of a high enough quality, would allow him — they were almost universally male into the 1980s — to join the relevant guild. However, by the mid-18th century, the guilds had lost all control of most trades in the midlands and north of England, and the necessity for a master piece disappeared in most trades. During my apprenticeship, you would begin undertaking work on your own after two or three years, taking on more complex work during your 5th year. Traditionally, an apprentice then left the firm to become a journey man, travelling around for a couple of years and working for other firms to widen his knowledge. Only then were they considered knowledgable and skilled enough to be a craftsman.

During my apprenticeship at Pilkington Brothers, I had to attend their training school for two months, where all apprentices had to try their hand at all the trades to ensure that they went on into the most suitable one. We had to write up notes on the various trades, and the book we were given for this had the following introduction:

Pride in Craftsmanship

It is our intention in this course of training to encourage you to take that pride in your craft which will enable you to take your place in the firm as a good apprentice and later as a craftsman, and furthermore befit you to take your place confidently in the industrial world where ever you may go.

The title of craftsman is deserved only by the man who has a wide knowledge of his job, and a genuine interest in the tools he is using and the work he is doing.

No man can really do his work well if he does not understand what he is doing. This should be borne in mind throughout your training.

The skill that a competent craftsman must possess takes many years of experience to acquire. You must be able to improvise, remembering that up-to-date workshop facilities are not always available. You should have a good knowledge of technical drawing, and to prepare you for this, instruction will be given in reading and preparing the type of drawings with which you will come into contact.

Much of the workshop technique can only be learned by experience and by being constantly observant when working with other craftsman.

The reading of technical journals will keep this knowledge up-to-date and help him to bring a critical and scientific viewpoint to upon his work.

A competent craftsman should combine the theoretical with the practical side of his job, and must have a keen realisation of his responsibilities both towards his work and his fellow craftsman.

The prospects for apprentices are good, but competition is keen. It is in your interests to fit yourself for this competition by being studious and attentive to your job both in the classroom and in the workshop, and by so doing you will not only become a competent craftsman but also prepare yourself for future responsible positions.

This gives a clear idea of what was expected during an apprenticeship, though there were no technical journals until the mid-19th century. The text does suggest that a craftsman should have a high level of intelligence and, prior to the opening up of secondary education from the late 1960s, the main outlet for those with a high level of intelligence from the working class was an apprenticeship. I certainly remember working with craftsmen who were the equal of many academics I have known subsequently. However, this was a time when education was changing, and the traditional ways of handing down knowledge by word and deed were down-graded as academic qualifications became standard. Managers were becoming less knowledgable of the processes they were managing, and had to rely upon a piece of paper to judge the suitability of a new worker.

The Engineer

Back in the mid 18th century, the term 'Engineer' was the name originally given to a military officer involved in the design of defences and studying the accuracy of artillery; in England, an Office of Ordnance was founded as early as 1370. Training developed over the centuries, with that in European countries more associated with traditional universities than in Britain. The first 'qualified' engineers may have come from the École Nationale des Ponts et Chausées, founded in 1747 to train military engineers in road and bridge building.

In Britain, the use of the term 'engineer' can be traced back to canal construction, with the term being in use by 1769, when the committee for the Leeds & Liverpool Canal wanted to '… *employ and pay Mr. Longbothom, Engineer, for the present survey and for his further trouble in compleating the same and also in concurrence with that of Lancashire to be appointed as above to call in Mr. Smeaton or Mr. Brindley or both of them or* *some other Engineer of reputation to resurvey the same and to pay all of them our full proportion of the expences and wages attending the same*[1].' By then, those either surveying or overseeing building a canal were being called an 'Engineer'. By 1773, the committee set out what those involved with the canal's construction should do, in particular the engineer:

An Engineer

Considered as the first officer in subordination to the committee only and as a chief servant to the company. The ascertainer of the whole line and levels, the designer of all plans, and principal adviser in all contracts and bargains for setting work and purchasing materials, and director in the execution of the works, should exhibit and clearly explained to the committee all such designs etc, and his intended mode of executing and have their advice and concurrence therein. Because, as they alone are accountable for all monies raised and expended in reason and equity, they ought to have the surest grounds for vouching to the same, being in trust for the whole body corporate as well as adventurers themselves.

The great utility of, and advantage to the engineer, from this free and open communication with the committee, is sufficiently evident from the following considerations, viz, it takes an almost inconceivable burden from him, helps him to the judgement of understanding men, and indemnifies every part of his conduct throughout the whole work, by which means his reputation as engineer to such an unparalleled undertaking will be preserved from all blemish at a most easy rate, a security most desirable to an ingenious honest mind.[2]

Canal building was the first time the term Engineer had been used extensively for a non-military occupation. Expertise was variable, with many poorly skilled individuals trying to extract financial benefit from canal building. Even as early as 1772, Smeaton was concerned about the diversity of people vying to become engineers, writing from his home at Austhorpe on 12th December, 1772:

…The greatest difficulty of all therefore, is to get a proper person for the Resident Engineer. Practical Knowledge in Mechanics is not the only thing wanted to equip a man fully for this employment requires so great a number of qualifications that I look upon it as impracticable to find them united in one person. I therefore take it for granted, that he will of course be capitally defective in something, and as such there is the greatest difficulty in the world, to preserve a good understanding between the Resident Engineer, and the Committee that directs him, and yet he is of all others the most difficult to be parted with when this happens. I observe that the Resident Engineer is always the Post of Envy; not only the Clerk, the Store-keeper, the Surveyor, the Digger, are ready to neglect their own departments, and are all ambitious to be practical Engineers; sometimes without knowing or thinking that they are so; but even Members of the Committee have a propensity this way too; and as I have supposed every Engineer to be a mortal man, and to be endowed with some Defects as well as some Excellencies, by the time the work is proceeded with a year or two; all the Errors that arise from his peculiar Defects are noted, and by and by form a Bill of Indictment against him, which being whispered into the ear of such of the Committee, as each Informer happens more particularly to have access to; and some trusting to the credit of such Information, superior to that of the Engineer, while others do not; the Members of the Committee thus taking their side become split into parties, which either renders it disagreeable to The Members to meet to do the necessary Business, or supposing the Engineer dismissed, his Successor being equally defective, though in some other point he will find less quarter than the first, because every one that contributed to oust the first, thinks himself by this time fully master of the whole Undertaking and capable of supplying his place; or if not that length, he thinks himself fully qualified for finding fault; and as there is not an Artificer but what thinks himself better instructed in the Work he has been used to, than his new Master, by this means, all becoming Masters, and the Master without authority, it is easy to figure the confusion that must follow. These Sir, are the great, the very great practical. Difficulties that mull ever attend a Work of this kind; and now give me leave to offer at some things, by which they are most likely to be lessened and palliated, and the ill consequences averted as long as possible. I mention these things now, because fore-warned, fore-armed; they may chance to be of some little use, whereas it is to no purpose to offer advice after the things have happened, and Men's minds become warmed, for or against any particular Man.

It would seem that as soon as canal building began in the 1760s, there was a rush for any job designated as for an 'Engineer', even though there was no recognised method of assessing their skills. Adam Smith was promoting the idea of educating apprentices in 1776, while at the same time scientific groups developed, such as the Lunar Society, which first met in 1768 and was formally set up in 1775. By the late 1760s, the country's top engineers would meet in London, usually in early spring when Parliamentary committees were taking evidence related to Canal Bills and the like. Fortunately, this was the time when work on the ground was restricted by winter weather, and it gave an opportunity for ideas to be exchanged. This led to a more formal meeting, subsequently becoming the Smeatonian Society, set up in 1771.

[1] 1768-1-7, Committee meeting at Bradford, RAIL 846/1

[2] Bradford Record Office, Jowett Papers, JOW/11/a/2/40

An early academic post was created in 1796 when George Birkbeck was appointed Professor of Natural Philosophy in Glasgow. On the other side of Scotland, John Rennie, a millwright who was to become one of Britain's foremost civil engineers, had been studying under Professor John Robison at Edinburgh University in the 1780s. Scottish academics were well ahead of those in England when it came to engineering. South of the border, although there was much interest in chemistry, there was little interest in the other applied sciences. When it came to teaching and researching practical engineering, English universities were decades behind those on the continent. Technical developments undertaken by skilled craftsmen in late-18th century Britain, a major factor in the creation of new and improved industries, were not the result of conventional education, and they even predated the growth of academic interest in Scotland.

By 1818, some Smeatonian Society members realised a more professional arrangement was needed, and The Institution of Civil Engineers (ICE) was founded in London by a group of young engineers. They expected it would give a higher status to craftsmen engineers who had little academic education, and who relied on their extensive practical knowledge.[1] The Institution of Mechanical Engineers was founded in 1847, and both Institutions offered associate membership for those without a degree, providing a way to professional status for those who had followed the craftsman's path.

Education for craftsmen did improve, though initially at a local level, such as the 1796 lectures given by Thomas Garnet in Glasgow, one course attracting 500 students.[2] Eight years later George Birkbeck begins lecturing, also in Glasgow, leading to the first Mechanics Institute being formed in Edinburgh in 1821. The organisers stated, '*It is not intended to teach the trade of the Carpenter, the Mason, the Dyer, or other particular businesses; but there is not trade that does not depend, more or less, upon scientific principles*…' However, there were few academics involved in technical education in Britain prior to the mid-19th century, when the rapid introduction of railways and the limited company would put a tremendous strain on the nascent engineering profession.

The status of apprentices changed with the introduction of the Statute of Artificers in 1813, which allowed people to practise a trade without having to serve a seven year apprenticeship. Despite this, apprenticeships continued and by 1900 there were over 340,000 being served annually.[3] By the 1960s, one third of boys leaving school entered apprenticeships, though numbers were declining and by 1995 there were only half the number there had been in 1979. In 1968, the Royal Commission on Trade Unions and Employers' Associations concluded: …*apprenticeship is a farce and provides less training than a properly constituted course lasting only a few months…The fact that a man has completed an apprenticeship does not therefore of itself guarantee that he has acquired any particular level of skills, or that he has passed any form of test of ability.* They were suggesting that apprentice training should move away from practical skills being handed down by skilled craftsmen, to a more formal system based on the academic approach. From 1973, all Chartered Engineers in the UK were expected to have a degree, removing the possibility of craftsmen receiving professional recognition. As a result, the practical skills once taught through apprenticeships have been adversely affected by the increasing pressure from educationalists to promote academic education, particularly after the wider access to universities possible from the 1970s. This opened up further education for those from poorer families with higher intelligence; unfortunately this is the very cohort who once became our most skilled apprentices.

A major problem resulting from the move to a more academic approach to apprenticeships is a lack of recognition that the best skilled workers need to have high intelligence, and that today such students are encourage to take the purely academic route. Once serving ones time as an apprentice was a way forward to an increased chance of obtaining a better job and a better social status. This no longer seems to be the case. EngineeringUK's report on craft skills training '***Fit for the Future***' lists 13 Acts and inquiries into encouraging apprenticeships which have been published between 2001 and 2024; despite so much time and effort, the academic approach seems to have failed to address the problem, as we still have a major craft skills shortage. Because dexterity and spacial kills are no longer valued by society, our schools no longer provide sufficient early training in such manual skills. Dexterity needs to be acquired at a young age and valued as much as academic qualifications — after all, who wants to be operated on by a clumsy surgeon?

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[1] In 1826, University College, London offered a course in mechanical philosophy and a 'system of academical education' for young men who wanted to become civil engineers. In 1838, King's College, London founded the Class of Civil Engineering and Mining, and in 1840, The University of Glasgow established the UK's first Chair of Engineering.

[2] https://technicaleducationmatters.org/2016/07/20/ashte-chronology/

[3] https://commonslibrary.parliament.uk/a-short-history-of-apprenticeships-in-england-from-medieval-craft-guilds-to-the-twenty-first-century/

The seemingly inevitable rise of academic education, as engineering technology required more theoretical knowledge, has resulted in a decline in society's understanding of the value of those practical skills learnt during traditional apprenticeships. How should craftsmen acquire an understanding of technology? We need to realise that dexterity and spacial skills are the central part of the intelligence needed by craftsmen, and are something that needs to be encouraged just as much as academic intelligence. Unfortunately, examinations and the associated certificates are the main way employers assess job applicants, while dexterity and spacial skills are ignored as they require a much more personal evaluation. A good skills assessment relies on trust in the examiner, who would need to check the understanding of the boundaries of those skills. Unfortunately, trust does not seem to be part of modern management, who rely upon academic qualifications. Managers today generally do not have sufficient training to understand the requirements for skilled work.

The current skill shortage can be seen as a direct response to the way society values manual dexterity and apprenticeships, and the skills and knowledge which must be learnt by those passing through such training. Not only are we not providing the skills needed for economic and societal development, but we are also failing those of the next generation whose intelligence is related to spacial skills rather than academic.

There is no doubt but that it was the craftsman who was crucial to the establishment of the industrial revolution in Britain. Pushing the boundaries of technical knowledge was much easier for craftsman-trained 'engineers', where limits appeared less daunting than for those whose training was academic, as was the case elsewhere in Europe

The Craftsman in Europe

Throughout Europe in the late-18th and early-19th centuries, British craftsmen were in high demand, British engineers less so as educated engineers already existed on the continent. It was the craftsman's ability to put ideas into practice that was needed. It was much easier for craft skills to evolve in Britain, where the journeyman, because of the close proximity of similar industries, had much greater opportunity to acquire additional skills and a better understanding of processes after his apprenticeship. The rapid decline in the power of guilds outside of London was a further encouragement to the widening of the skills base in the 18th century. The rise in non-conformism after the Civil War and the resulting religious upheaval also created a change to perceptions of social position. It was now possible for a skilled and intelligent craftsman to improve his social and economic standing considerably; perhaps not to that of the aristocracy, but certainly to someone of national, and even international, recognition.

Such a rise in social standing was much harder on the continent, where the engineering profession was mainly formed by officers from the armed services, many coming from the aristocracy or wealthy families. Perhaps Prussia was the only country with similarities to the social improvement of craftsmen in Britain.[1] Frederick William I encouraged young men from the lower aristocratic families by setting up a cadet academy in 1717, and an engineering corps in 1729, mostly teaching fortification and military surveying. Regarding publications, there were already several German books on inland waterways, such as Sturm's ***Fang-schläussen*** of 1715,[2] or Leupold's ***Hydraulicarum*** of 1724,[3] and a German translation of Bélidor's ***Architecture Hydraulique***, appeared with a foreword by Christian Wolff in 1740-1742. Wolff proposed the union of theory and practice, and that if you wanted to become an engineer, you had to be thoroughly familiar with both.

Amongst those involved with 18th century Prussian engineering were the Lutheran pastor Johann Silberschlag (1721-1791),[4] hydraulic engineer and mathematician Johann Albert Eytelwein (1764-1848), and the architect and civil engineer David Gilly (1748-1808).[5] Largely self-educated in mathematics, science, and technology, their families were at the lower end of the social scale, much the same as for

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1 'Geopolitics & Prussian Technical Education in the Late-Eighteenth Century', Kathryn M. Olesko, ***Nova època***, vol. 2 (2) : 2009.

2 Sturm, Leonhard Christoph, ***Gründliche und practische Unterweisung, wie man Fang-Schläussen und Roll-Brücken nach der besten Art bauen solle, samt einigen neuen Erfindungen von den gedoppelten Schlag-Brücken ...***, Augsburg, 1715.

3 Leupold, Jacob, ***Theatri Machinarum Hydraulicarum, Tomus 1, oder Schau-Platz der Wasser-Künste…***, Leipzig, 1724.

4 Amongst books written by him were ***Abhandlung vom Wasserbau an Ströme***n in 1756 (2nd Edn. 1766) and ***Ausführlichere Abhandlung der Hydrotecknik oder des Wasserbaues*** in 1786.

5 Gilly and Etelwein worked together on ***Praktische Anweisung zur Wasserbaukunst*** 1802-8 (2nd Edn 1808-20), as well as writing several books individually.

engineers in England. The major difference between British and Prussian engineers was not their family circumstances or engineering knowledge, but that, unlike late-18th century engineers in Britain, those in Prussia wrote books on their understanding of engineering development, conforming to the established European tradition of publishing theories on engineering technology.

It seems to have been perfectly normal for civil engineers on the mainland of Europe to publish details of their ideas and achievements, something which prior to the development of railways, British engineers rarely undertook. This could reflect that the much greater distances, and political division, on the continent made it less likely for German-speaking engineers from Prussia or Austria to meet, so publication was necessary for an exchange of ideas. Regarded as the European leader in science and technology, France was much more centralised, so the need for publication there must have come from the more formal technical education system which was established in the country. German engineers may well have followed the French tradition of publication, this emphasis on the theoretical being one of the factors in the slow growth of industries on the continent, and a major reason why English craftsmen were so highly prized.[1]

As Coulomb suggested back in 1781 with regard to creating an educational link between the theoretical and the practical: '…*that way, one would establish a closer communication between the two bodies, and theory and practice would enlighten each other.*' The French certainly sought English craftsmen to develop some of their industries, rather than the craftsman engineers at the top of England's engineering profession. France already had good academically trained engineers, it was just proving difficult to put that training into practice. The same thing was happening in Germanic areas, with numerous visits by engineers to Britain,[2] with many publishing books on their travels. These can give details of British 18th and 19th century industrial development which have not been recorded in English.[3]

On the continent, engineers were striving to understand the limitations of a design in theory before putting that knowledge into practice. One structure in particular that they were trying to describe mathematically was the arch, and how to understand its structural integrity under load. By the end of the 18th century, they were still struggling with developing equations for the loading on a simple arch, whilst in England craftsmen had already moved on to building skew arches. Several were trying their own methods of construction, and discovering the limitations when there was a collapse. British engineers came from a craft background where this was the method used to develop new designs, with knowledge being handed down verbally 'on the job'. On the continent, in recently created schools for technology, they sought to develop mathematical equations which would allow them to find the limitation of a design before construction took place.

The slow development of theoretical civil engineering in Britain is surprising given the major discoveries British researchers were making in the natural sciences and chemistry. Scientists in Britain were interested in some aspects of the applied sciences, particularly where chemistry was involved, such as glass making, mortars and cements, and gas production, but not in civil engineering, where, unlike on the continent, military engineers also had little interest. It was left to the craftsman to develop the technology which would create the industrial revolution. As their knowledge was passed down by word of mouth, and not by the written word, so historical research has to rely upon the interpretation of surviving structures.

This is getting a little away from Hogrewe, but it is only by comparing his background and achievements in civil engineering, and that of other European engineers, with the craftsman engineers of Britain that we can begin to understand the development of the engineering profession. It also goes a long way to explaining why craft training retains its importance in Europe, but is failing in Britain. To change the latter, societal values need to change, and where better to start than by an understanding that the industrial revolution was created, to a great extent, by the work of highly intelligent craftsmen, with little in the way of academic pretensions. Academic qualifications are certainly needed today, but they are useless without skilled workers to test and develop new ideas, and skilled workers to build the factories and houses which are also required. But most importantly, society has to change to one where it is just as important to be a tool maker, as it is to have one as your father.

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[1] See Harris, J R, ***Industrial Espionage and Technology Transfer: Britain and France in the 18th Century***, ISBN 9780754603672.

[2] See list in the Appendixes in ***Technology, Economics, and Canal Development – An early technical book and what it reveals***, translation and new text by Mike Clarke, 2021, ISBN 978-0-901461-71-1.

[3] Clarke, *ibid*, is a good example, where there are details of canal and narrowboat construction which have not been recorded in English.