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Autor: Clarke, Christopher

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The English piano*

Christopher Clarke

> Music, as an insignificant activity in Britain, might well have remained little influenced by the Industrial Revolution; instruments of the fiddle or pipe species, by their relative simplicity and rarity, might never have tempted anyone to build them by factory methods. But the pianoforte, with its manifold, intricate structure – and especially with its abundance of serially repeated parts – seemed particularly suited to the new mechanical processes. Any zealot for factory production would have cast a lecherous eye upon the pianoforte's tens of identical wooden keys, its dozens of identical jacks and hammer-shanks, its greater dozens of identical tuning pins and hitch pins, and its yards of identically drawn wire. The pianoforte was the factory's natural prey; purely on the basis of its structure, it was the instrument of the time.

Thus wrote Arthur Loesser, in his *Men, Women and Pianos*, published in 1954.[1] But how far does history support Loesser's remarks? This paper will examine the extent to which the Industrial Revolution shaped the trade of piano building in London by describing the activities of piano makers who worked there between about 1760 and 1850. The paper explores a number of instruments in some detail with the intention of determining how they might have been built, and from this, how makers' companies might have been organised.

A detailed study of the later industrial history of piano making is to be found in Cyril Ehrlich's *The piano: A history.*[2] I hope to complement his work by putting the British beginnings of the industry into context.

The chief means by which productivity was improved during the Industrial Revolution were the division of labour, the mechanisation of some or all of the operations needed to finish a product, the standardisation of production and a system of sales and distribution divorced from the means of production. While the division of labour permitted semi-skilled or unskilled workers each to perform a rigorously defined and separate task to a high standard, mechanisation extended and regularised human capabilities. Production was probably first

* I would like to thank Christopher Nobbs and my brother Tristram Clarke, of the Scottish National Archive, for providing me with a good deal of source material. Many thanks also to Chris Nobbs for the permission to use his beautiful drawing of the structure of an 1802 Broadwood. I am also indebted to Michael Latcham for having brought together the strands of a very unwieldy first draft and tying them into a more elegant bow than I could ever have hoped.

1 Arthur Loesser, *Men, women and pianos*, New York 1954, 233.

2 Cyril Ehrlich, *The piano: A history*, (London 1976), revised edition: Oxford 1990.

standardised in response to military needs and it was not long before other fields followed suit. Lastly, the system of large-scale, speculative production (coupled with inventive sales techniques) was made possible by the growth of a new consumer class, in turn made wealthy by the increased production of the factories. At the same time, the possibility of investing in production through a system of shareholder capital was one of the means which enabled those factories to be set up on a large scale. As we shall see, some of these facets of the Industrial Revolution quickly came to characterize the piano-making industry in London while others were held at bay by conservatism. On the one hand, a complex form of the division of labour was already used by the piano makers towards the end of the eighteenth century; on the other, mechanisation was largely eschewed by them until the last two decades of the nineteenth century. In London, while the division of labour in the form of specialisation seems to have been one of the main factors which contributed to the production of pianos of the highest quality in the mid-nineteenth century, the resistance to mechanisation was probably one of the main reasons which led to the decay of the industry.[3]

The crafts before the Industrial Revolution

A glimpse into how the crafts were organised before the Industrial Revolution is given by a small book published in 1568, the *Ständebuch*, or 'book of occupations', in which a busy town and its inhabitants are described in verses by Hans Sachs and in woodcuts by Jost Amman.[4] The book includes a cross-section of the various trades to be found in such a town: those of armourer, baker, furrier, goldsmith, joiner, instrument maker, wire drawer, and numerous others. Many craftsmen, those who did not require purpose-built premises, are shown at their trades in rooms or cellars of town houses or in their workshops, the latter open to the street.

In general, crafts of the same type were concentrated in the same street, a tendency that has left its traces in the street names of many old towns. Traditionally, these streets comprised a single area of the town. This obviously made sense; many of the trades were dependent on each other. The nail maker, for instance, made nails for the joiner, the carpenter, the shoemaker and the cooper; the wire drawer made wires for the strings used by the clavichord maker and for the goldsmith. Any one artisan could draw on the specialist skills of those around him for those parts of complex projects for which he was not equipped

3 Ehrlich, *The Piano*, *op. cit.*, 18.

4 Hans Sachs and Jost Amman, *Ständebuch*, Frankfurt am Main 1568, reprint: New York 1973.

or which, by guild rules, he was not allowed to make himself. But although the guild system acted as a protective and exclusive structure for the various trades, it also bred conservatism, tending to stand in the way of innovation.[5] Each craftsman, reliant on the knowledge and skills of others, would continue along well-tried paths, leaving the making of certain elements of his final product to colleagues in other trades; innovation would probably have been better stimulated in a master who had direct command of the complete process of making his product.

Within the trade of keyboard-instrument making a certain loose division of labour appears to have been present already in the early seventeenth century, if not before. This we know, for instance, from the large production rates of the two extensive and busy workshops of the Ruckers family in Antwerp in the seventeenth century, rates which would surely have been impossible without some specialisation.[6] Although other workshops may have produced only a few instruments each year, made in their entirety by just one or two men, the idea that all makers operated in this way (as most makers of harpsichords do today) is clearly disproved by the case of the Ruckers family. In such large workshops as theirs, the task of making a harpsichord could be broken down into several independent tasks, each allotted to a different workman. One man might construct the cases, another make soundboards, another the keyboards; one man might make the jacks while another might position the pins and put on the strings. Not only would there have been such a division of labour but also, in consequence, a considerable degree of standardisation. The coded inscriptions found written inside each instrument to identify its model and the unvarying use of certain basic measurements support this view.[7] In general, items such as jacks and key plates can be shown to have been standardised in size within a workshop, ready to be fitted into each instrument of a particular series. Items like tuning pins, bridge pins, strings, hinges and locks could be (and according to guild rules had to be) acquired outside the workshop from other craftsmen, probably in the neighbourhood. But while all of this conjures up the familiar picture of a purpose-built building or even something approaching our idea of a factory, it is probably true to say that from the Renaissance until the early nineteenth century most keyboard-instrument makers' workshops were still set up in the rooms of part or all of a town house or perhaps, in the case of a successful artisan, in several houses. The master and his family usually lived in the same part of the house in which the finished instruments were kept for sale while the attic rooms were generally occupied by journeymen or apprentices.

5 See: David Landes, *Revolution in Time: clocks and the making of the modern world*, Harvard 2000.

6 See: Grant O'Brien, *Ruckers, A harpsichord and virginal building tradition*, Cambridge 1990, 50–3.

7 See: O'Brien, *Ruckers*, *op. cit.*, 46–54.

The eighteenth century

From the information we have, it seems that most eighteenth-century craftsmen's workshops, including those of instrument makers, were organised in more or less the same way. Although there would obviously have been differences depending on location and country, on the guild rules and on the style of each particular maker, the following sketch gives an idea of the type of organisation involved.[8] Besides the master, there would commonly have been a foreman. He would have overseen a number of journeymen who would usually have been paid on a piecework basis, that is, paid for each item of work produced rather than for their time. In the workshop itself, materials, benches and specialised equipment would have been provided by the master whereas each journeyman would have owned his set of small tools.[9] The apprentices (perhaps just one) would have been bound by a contract with the master for a certain number of years – six in Paris. It was usual for the parents or guardians of the apprentices to pay the master a certain sum on signing the contract. The apprentice lived with his master's family and was not paid for his work. At the end of his term, the apprentice became a journeyman, entitling him to work for any master he chose. A journeyman would travel from one master to another, sometimes staying for a matter of months, sometimes longer. Eventually, a journeyman could himself become a master if he fulfilled the necessary demands of the guild. In most towns and cities the number of masters in particular trades was limited however, making it difficult for incomers. This difficulty was effectively increased by the fact that masters' sons were expected to follow their fathers' trade and take over their businesses; a son neither had to undergo an apprenticeship nor did he have to produce a masterpiece to become the new master of the family business when their father retired or died. A widow could continue her late husband's business until a son came of age. Otherwise, in the absence of a suitable son, a widow could marry a journeyman to ensure the firm's continuity.

In the eighteenth century and in places such as Paris where the guilds continued to exercise power, the work done in the workshop would be strictly demarcated according to trade, making it impossible, for instance, for a keyboard-instrument maker to cut ivory or bone, the province of the *tablettier*. As in the seventeenth century, such guild restrictions inhibited innovation and progress, preventing individual artisans from giving their talents and imagination free

8 Some makers did not work in this way. Johann David Schiedmayer (Erlangen and Nuremberg) worked with just one unqualified helper and produced two or three instruments a year. See: Michael Latcham, 'The pianos of Johann David Schiedmayer', forthcoming in: *The Early Keyboard Journal*, 2005.

9 Frank Hubbard, *Three centuries of harpsichord making*, Cambridge (Massachusetts) and London 1965, 192.

rein and forcing them to rely on the long-established traditions of other craftsmen. It is true that in eighteenth-century Paris, artisans of exceptional talent could obtain a dispensation from the king, as did Sébastien Érard in 1785, allowing him and his workmen to use wood, iron or any other materials necessary to build pianos, but such dispensations do not appear to have been available in the seventeenth century and were rare even in the late-eighteenth century when the powers of the guilds were fast crumbling.

Burkat Shudi and the English harpsichord

Burkat Shudi's workshop in London brings us closer to the focus of this paper. Shudi had come from Switzerland as a young journeyman joiner, working for the harpsichord maker Hermann Tabel for several years before setting up his own workshop at some time shortly before 1729. His annual production rate slowly increased from thirteen harpsichords in the 1740s to twenty-five in the 1780s. Some insight into the workings of Shudi's workshop can be gleaned from an affidavit sworn by two journeymen working for Shudi, Andrew Clark and John Broadwood, with regard to the work done on four harpsichords made for Frederick the Great during the years 1765 and 1766. The affidavit makes clear that most of the work on these particularly elaborate instruments was personally undertaken by Clark and Broadwood in the workshop. The document almost entirely concerns the case structures and soundboards of the instruments. It is clear that the cases of the harpsichords were built in the workshop and not sub-contracted to a cabinet-maker. The fact that the other important steps in the construction of these harpsichords (notably the making of the actions and the setting-up) are not mentioned in the affidavit suggests that these steps were not done by Clark and Broadwood but by others in the workshop. We can also imagine that the final voicing and regulation – the finishing of the instrument – would have been done by Shudi himself. In other words, there appears to have been a division of labour like that in the Ruckers workshop.

The English harpsichord of the period, including those made by Shudi's firm, are clearly derived from those of the Flemish school in their structure.[10] Instead of having poplar for the case sides, however, the English harpsichords have sides, including the curved bentside, of solid oak, thicker than the poplar used for instance by the Ruckers family. Whereas the Flemish instruments are painted on the outside, the English instruments are veneered. Inside the case, the structure, including the internal liners, the bellyrail (which support the soundboard or 'belly' of the instrument) and the braces, is of softwood. Of

10 See: Hubbard, *Three centuries*, *op. cit.* 157–64 and Plate XXI.

the braces, the main ones are let into the case sides, as is the wrestplank. The outer case sides, the wrestplank and the bellyrail thus all had to be assembled simultaneously. Thereafter the liners, the main braces and the soundboard would have been glued in. In Shudi's instruments it seems that only then were the upper braces nailed and glued in place, across the instrument under the soundboard, tensioning it. The bottom, also of soft wood, went on last. It is thinner than the oak case sides and only about three or four times as thick as the spruce soundboard.

The building of the case (including the soundboard and bottom), at each stage requiring complex operations depending on the previous stages, would hardly have been possible except in a single process conducted in the workshop. The nature of the construction thus seems to confirm the information we already inferred from the affidavit of Clark and Broadwood: these instruments were entirely built within the confines of Shudi's workshop.

In the 1770s Shudi's prices for standard instruments ranged from thirty-five guineas for a single-manual harpsichord with two unisons, to eighty guineas for a double-manual instrument with two unisons, an octave and a pedal-operated 'Venetian swell'. The latter consisted of a set of wooden slats, like the shutters of an organ swell, above the strings and covering the whole area of the soundboard. This mechanism was patented for the harpsichord by Shudi in 1769.[11] A slightly later extra also incorporated by Shudi was the so-called 'machine stop'. This stop, operated by another pedal, changed the selection of stops on both the manuals. Instruments with the machine stop usually had a so-called lute stop as well: an extra set of jacks plucking close to the nut (thus giving a nasal sound) could be engaged for the upper manual instead of the usual ones. The machine stop and the Venetian swell involved a large number of metal parts. There is evidence that these and other metal items like the decorative case hinges, were bought ready-made from the locksmith. The tuning pins and the hitchpins for the strings were probably bought from specialist suppliers.

The total output of new instruments from the Shudi workshop came to about twenty instruments a year.[12] As surviving documents show, tuning and maintenance work on existing instruments and the hiring of instruments took up considerable time, probably occupying much of the time of the master and at least one other workman. With some apprentices and a clerk, the total workforce might have come to around fourteen men.

11 The original patent is in The National Archives, Kew, London, signature c210/10.

12 Evidence from continental workshops suggests that to realize more than thirty (probably simpler) instruments a year a workforce of only about eight journeymen was required. See: Michael Latcham, *The stringing, scaling and pitch of Hammerflügel built in the south German and Viennese traditions, 1780–1820*, Munich and Salzburg 2000, 9–10.

If we can generalise from the situation in the Shudi workshop, we can say that harpsichord making in England in the third quarter of the eighteenth century was carried out in quite small workshops situated in town houses under a regime which, though largely emancipated from the guild system, still owed much to it in practice, especially in the hierarchical relationships between the master, the journeymen and the apprentices. A degree of specialisation of tasks and the standardisation of parts within the workshop helped efficiency in a way which anticipated aspects of the Industrial Revolution. Certain parts of the instruments were produced outside the workshop by tradesmen who supplied several harpsichord makers. This both harks back to the old guild system in which such specialisation was obligatory and also heralds the nineteenth century in which there was to be a general tendency towards the standardisation of parts both within and across the trades. Nevertheless, most of the skills which went into the building of a harpsichord remained specific to the trade so that by far the greater part of the work was carried on in the workshop itself. Instruments appear to have been made individually or in small batches, not in the large series typical of nineteenth-century factories. Furthermore, customers ordered their harpsichords directly from the maker, or through a music-master (who would be given a commission), not from dealers or other retail sources.

Piano making

Although both pianos and harpsichords were made throughout the eighteenth century, the piano had largely superseded the harpsichord by about 1795. Not surprisingly, many of the pianos made in England in the 1780s and 1790s came from harpsichord workshops which had gradually adapted to making the newer instrument. It is clear that at first the grand piano, as the successor to the harpsichord and often (but not always) fulfilling the same social and musical role, continued to be built in very much the same way as its predecessor. Its elaboration demanded scant change in workshop structure and practice; its high price and prestigious nature ensured that it was produced in quantities comparable to those of the harpsichord and for the same privileged market. In terms of the scale of production, the change to the grand piano thus made little difference to the maker, at least at first. Change did of course take place, however; a comparison of a grand piano made in London in the 1790s with one made in the 1850s makes this clear. To illustrate the change and the concomitant changes in production, we now turn to a number of specific makers and some of their instruments.

A grand piano by Americus Backers (1772)

The early history of the piano in Great Britain remains unclear. Charles Burney noted that both Roger Plenius and Friedrich Neubauer were involved in making harpsichord-shaped pianos in London in the 1760s.[13] Michael Cole cited an advertisement of 1763 in which Neubauer offered *Piano Fortes* amongst other instruments.[14] No instruments by these makers have survived however, so we can only guess at their appearance and construction. More can be said of the instruments of Americus Backers, a harpsichord maker who had been established in London since 1763. In both February and March of 1771 the following advertisement appeared:

> ... a new invented Instrument, of the Size and Shape of a Harpsichord, which answers all the Purposes that have been hitherto wanted in an Instrument of the Harpsichord Kind. It is played on in the same Manner, but differs in all other Respects, as the Tone and Expressions are far superior to any Musical Instrument yet offered for public Inspection. This Instrument is made by Americus Backers, of Jermyn-street, St. James's, who calls it an Original Forte Piano, and thereby means that it is no Copy, being entirely his own Invention. There are many Things made under the Denomination of Forte Piano, but as this is the real one, Mr. Backers takes this Method of informing the Public, that they may form a Judgement how much this is superior to those which have been offered under that Name [...].[15]

Only one grand piano by Backers, dated 1772 and numbered 21, survives.[16] In appearance and structure it resembles a single-manual English harpsichord and, as in many such harpsichords, there is a metal rose in the soundboard, a feature found later only in the pianos of Jackob Kirkman. A link with Kirkman is also suggested by the notes made during a restoration of 1969 which describe the internal construction as being 'like that of a Kirkman'.[17]

The 1772 piano by Backers is important in that it presents the majority of the distinguishing features consistently found in the English grand pianos made in the subsequent fifty years. The most important of these, the escapement action apparently devised by Backers, was quickly taken up by Robert Stodart and John Broadwood and was still being built into grand pianos by the Broadwood firm in the 1890s.[18] The advantage of this action lay in the direct

13 Charles Burney, 'Harpsichord', in: Abraham Rees (ed.), *The Cyclopædia; or universal directory of arts, sciences, and literature*, London 1819, vol. 18, no pagination.

14 Michael Cole, *The pianoforte in the classical era*, Oxford 1998, 49.

15 Warwick Henry Cole, 'Americus Backers: Original Forte Piano Maker', *Harpsichord & Fortepiano Magazine* 4/4, October 1987, 79.

16 Russell Collection, University of Edinburgh, Cat. No. 24, on loan from the Duke of Wellington. See: Cole, *The pianoforte*, *op. cit.*, Plate 8.

17 Peter Redstone, private communication, 2004.

18 An escapement action is one in which the hammer escapes from the action train independently of the release of the key. In all previous escapement actions, including those inspired

and limitless transmission of force from the keyboard to the string, coupled with a robustness and simplicity which ensured long, trouble-free operation. The hammers of the 1772 instrument consist of thin flat wooden blades tipped with buckskin. The string lengths are shorter than those generally found in the English harpsichords of the time.[19] This was no doubt to ensure an adequate safety margin to cope with the blows dealt by the powerful action and to take account of the strings used for pianos, generally thicker than those used in harpsichords. Due to the increased toughness imparted by working the metal through the drawplate, thinner strings can stand a higher pitch than thicker ones, other things being equal.

The back of the wrestplank is tapered to about half its thickness in order not to get in the way of the hammer shanks. The edge of the wrestplank is prevented from sagging downwards under the pull of the strings by three iron arcs passing from the wrestplank to the upper bellyrail between two choirs of strings. The two pedals work the *una corda* and the *forte*, as in the modern piano. Although these stops were already present in Gottfried Silbermann's pianos, they were engaged by hand in his instruments. Pedals had already been invented in England but for other purposes. In Thomas Mace's book *Musick's monument*, published in 1676, two pedals for changing stops are described, invented by John Haward for a single-manual harpsichord.[20] Furthermore, as noted above, pedals had already been used for the machine stop and for the Venetian swell in eighteenth-century English harpsichords. Backers appears to have been the first in England to incorporate a pedal for disengaging the dampers. The advantage to the musician is obvious to us today – to be able to use the dampers intermittently while playing without taking the hands from the keyboard – but in 1772 this was something new.[21]

by the type invented by Bartolomeo Cristofori not long before 1700 and those of the type invented by Johann Andreas Stein in about 1780, the hammer comes to be released through the intersection of the arcs described by the action parts. In the action by Backers the release is forced by means of a button acting on the escapement hopper, pushing it out of contact with the hammer notch.

19 The c2 strings are 259 mm long while the c2 (long string) of the 1776 Kirkmann harpsichord in the Victoria & Albert Museum, London is 355 mm.

20 These pedals were explicitly intended to provide different dynamic levels. See: Thomas Mace, *Musick's monument*, London 1676 (facsimile: Paris 1977), 235–6. Boalch notes that Haward probably died in 1667. See: Donald H. Boalch, *Makers of the harpsichord and clavichord 1440–1840*, 2nd ed., Oxford 1974, 65.

21 An earlier example of such a device is described in the 1769 announcement of a complex combination instrument by Johann Andreas Stein of Augsburg. See: Anonymous, 'Von Erfindung eines Poly-Toni-Clavichordii oder musikalischen Affecten-Instruments, und von Verbesserung eines neuen Orgelwerks', *Augsburger Intelligenzblatt* XL, 5 October 1769, no pagination. In the Poli-Toni-Clavichord the dampers were engaged using a knee lever. Usually they were disengaged.

When Backers died in 1778 an inventory of his effects was made. The inventory has been preserved and offers a glimpse into his workshop.[22] There were six workbenches, implying the same number of workmen. Five grand pianos were under construction at the time, their keyboards, soundboards and actions ready to be assembled. There were also 'four small frames for little Forte Pianos' as well as 'two small Piano Forte cases'.[23] Both from the serial numbers (60 to 64 inclusive) given in the inventory for the five grand pianos under construction in 1778 and from the serial number of the surviving grand piano of 1772 (21) we can deduce that the Backers workshop produced about seven grand pianos a year between 1772 and 1778. The workshop included 'one Saddle for bending of Sides, one Tin Boiler for ditto', the equipment needed to bend the bentside, proof that cases for grand pianos were made on the premises. Another item of interest is 'one Machine for cutting of Ivory'. Perhaps this was a treadle-operated circular saw, as patented by Samuel Miller in 1777.[24]

The inventory only mentions a very small quantity of wood present in the workshop, perhaps just enough for the instruments in hand. While timber conversion had been a mechanised trade since medieval times in many parts of the Continent, the English sawyers, concentrated in London, resisted mechanisation until far into the nineteenth century. As a result, much of the wood for the furniture trade was bought more cheaply from the continent, ready seasoned and sawn (often by wind or water power) to standard dimensions.[25] Frank Hubbard wrote:

> A sawmill was erected near London in 1663 but was soon abandoned as a result of the hostility of sawyers. No further attempt was made until 1767 when a wind driven mill was set up near Limehouse. This was destroyed in a riot but was rebuilt and continued to operate.[26]

As a piano maker, Backers, like the cabinet-makers, would almost certainly have bought in ready-sawn and seasoned wood as he required it, thus obviating the capital outlay required for the maintenance of a large stock in the workshop.

Backers can be seen as the founder of the English tradition of making grand pianos. His designs were adopted by two important and prolific makers, first Robert Stodart and then, starting in 1785, John Broadwood.

22 The inventory is given in full in Cole, *The pianoforte*, *op. cit.*, 371–6.

23 In those days in England the two types of piano, the one in the shape of a harpsichord and the one in the shape of the clavichord, were distinguished by their size: the larger one was called a grand piano and the smaller one a small or little piano. While the term grand piano has since been retained the smaller version is now known as the square piano.

24 See: Charles Hayward, *Antique or Fake? The Making of Old Furniture*, London 1970, 81. I have observed circular-saw marks on the undersides of the ivory keys of an English piano of about 1800, indicating that piano makers may have used such saws.

25 *Ibid.*, 14 and 80.

26 Hubbard, *Three centuries*, *op. cit.*, 200.

John Broadwood

A letter of 1789 from Broadwood to an Edinburgh client, Lady Forbes, indicates that he produced each grand piano individually and that the standard price for such instruments was £60, the same price as for a simple double-manual harpsichord. Like practically all the English harpsichords made towards the end of the eighteenth century, the first grand pianos made by Broadwood had the range FF to f3. It was not long however before there was an increase in the treble. In 1793 Broadwood wrote:

> We now make most of the Grand Pianofortes in compass to CC in alt [c4]. We have made some so for these three years past, the first to please Dussek, which being much liked Cramer Jr. had one of us so that now they are become quite common and we have just begun to make some of the small Pianofortes up to that compass.[27]

The first six-octave grand piano, from CC to c4, was probably made in 1794. Not every increase in range was adopted for every new instrument, however. The FF to c4 range prevailed from 1794 to 1810 although at least one grand piano by Broadwood of 1796 with the five-octave compass survives. Similarly, the six-octave compass appears to have been standard from 1810 until 1821 but with some exceptions in which the five-and-a-half-octave compass was retained and others with the six octaves standard in Vienna, that is, from FF to f4.

Change came about not only as the result of the exchange of ideas with musicians like Jan Ladislav Dussek. Broadwood also took advice from two scientists, Tiberius Cavallo and Edward Gray, for some aspects of the design of his pianos.[28] One of the improvements which resulted was the so-called divided bridge. Instead of a single continuous bridge, there were now two bridges, one in the bass for the brass strings and another for the iron strings. This enabled about the same stress level to be maintained at the changeover from iron to brass and hence the change in the tone colour otherwise produced there could be minimised.

Not surprisingly, the type of internal structure Broadwood used in his early grand pianos appears as a reinforced version of the type of the structure of English harpsichords, including those of Broadwood's master Shudi. The treble corner is strengthened with an additional, horizontally placed plank in which holes are pierced and the upper bracing system is modified, with wide braces crossing each other across the width of the instrument. The structure is quite flexible and surprisingly light, considering that the total string tension is around 2600 kilos (fig. 1).

27 David Wainwright, *Broadwood by Appointment*, London 1982, 74–5.

28 For a discussion of the divided bridge see: John Koster, 'The divided bridge, due tension, and rational striking point in early English grand pianos', *Journal of the American Musical Instrument Society* XXIII, 1997, 5–55.

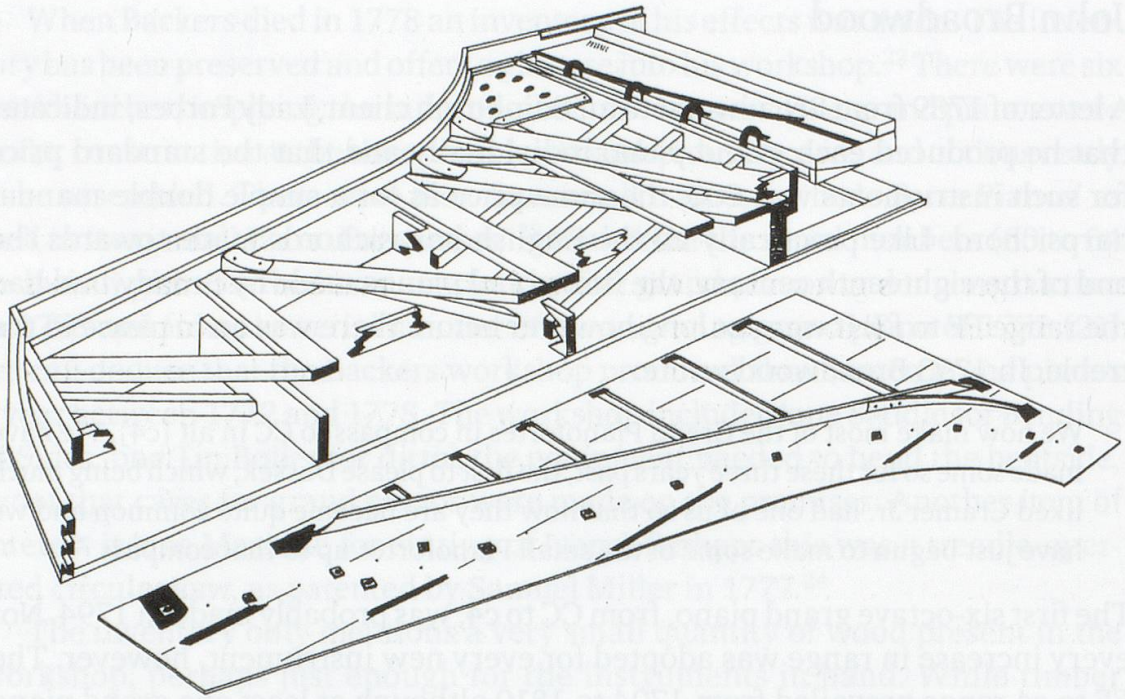

Figure 1: *Diagram of the construction of a grand piano by John Broadwood and Sons, 1801, drawn by Christopher Nobbs*

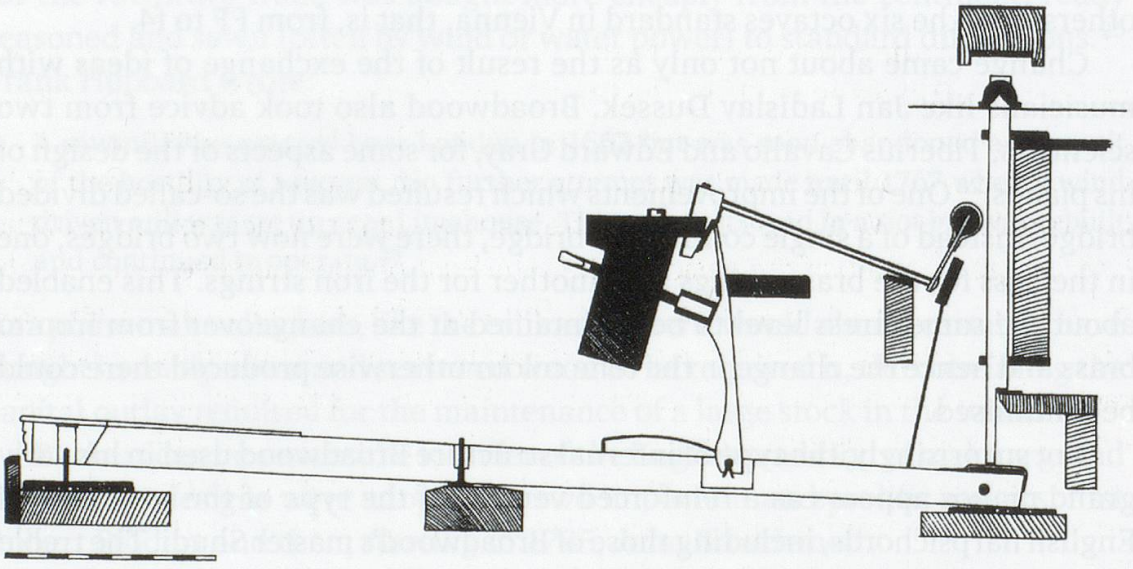

Figure 2: *Diagram of the action of a grand piano by John Broadwood and Sons, 1801, drawn by Christopher Nobbs*

The type of action of the grand pianos made by Broadwood is clearly derived from that found in the 1772 grand piano by Backers (fig. 2). The main development is that in Broadwood's instruments the hammers, although still made of thin flat blades of wood, are covered with many layers of leather, sheep or goatskin for the inner layers and a soft outer layer of oil-tanned deerskin. Hammers of this type are capable of a much wider dynamic range than those used by Backers; their larger mass gives a tone with more fundamental and the many layers of covering ensure that the sound does not become shrill with hard playing. The change towards an instrument capable of a louder sound is also reflected in the stringing. While the 1772 instrument by Backers is entirely double strung, Broadwood used triple stringing throughout and longer scaling from at least 1787, the year of the oldest grand piano by him to have survived.[29]

If we compare the grand piano of 1772 produced by Backers with that of the Broadwood firm of 1800 we can say that there is no great technical advance. This implies that no new technical challenges presented themselves to piano makers in this period.

Stodart (*circa* 1830)

The next instrument presented here to show the development of the English piano is a grand piano made by the Stodart firm in around 1830.[30] This instrument has a six-and-a-half-octave compass (from CC to f4), a Backers-type action with some improvements: the hammers are again heavier and have multiple layers of leather. With the lid closed, the instrument is a typical example of the English grand piano of the period. When the lid is opened however, an entirely new structure becomes visible. Above the soundboard and strings there are nine tubes, running in the same direction as the strings, retained by mahogany racks which run across the strings (fig. 3). The tubes are attached to a strong iron beam fixed to the wrestplank and at the other end to a flat metal hitch-plate which runs the length of the bentside and to which the strings are 'hitched' or attached. In the original design, patented by two of Stodart's workmen, Thom & Allen, in 1820, the tubes over the brass bass strings were made of brass and those over the iron strings were made of iron – an arrangement known as the 'Compensation frame'. It was designed so that the differing rates of expansion with changes of temperature the brass and iron strings would be matched by those of the corresponding tubes, resulting in better tuning stability. In later instruments, such as the one discussed here, all the tubes are of iron. This major step forward in the construction of the English grand piano lies in what

29 No. 69, in private ownership in England.
30 Private ownership, Switzerland.

Figure 3: *View of the tubular metal framing of a grand piano by William Stodart,* circa *1830. (Private collection)*

is effectively the introduction of the iron frame.[31] The tension of the strings, in total some 7300 kilos, is taken up by the metal frame which floats, as it were, in the wooden case. The wooden structure under the soundboard still has to resist the forces tending to twist and distort the case, but its members, relieved of the task of taking up the direct tension of the strings, can be far lighter than in previous instruments. The bottom, no longer necessary, is dispensed with, thus eliminating bothersome box resonances and increasing the volume of sound.

The presence of the metal tubes makes the use of dampers acting from above the strings out of the question, hence the system of under-dampers in this instrument. Another innovation made by Stodart in this type of instrument was the use of soundboard ribs crossing the entire soundboard transversely instead of the old harpsichord-style ribs.[32] In this particular instrument there is also a wooden *capo-tasto* bar in the treble. It appears to replace an earlier, conventional nut. This bar may thus be a later modification or alternatively may represent a change of mind made during the construction of the piano.[33]

Broadwood (1849)

The last grand piano to be mentioned here in this sketch of the development of the English piano was built by the Broadwood firm in 1849.[34] In 1827 the firm had patented a similar structure to that used by Stodart, at least in as much as it incorporated an iron hitch-plate and longitudinal metal bars (rectangular in cross-section rather than round). This combination is found in the 1849 instrument.[35] The design of the 1849 instrument, while not different in kind from the design the firm used in 1827, makes for a piano which is nonetheless larger, heavier and more powerful. This instrument is also the first one mentioned here to have felt-covered hammers. These had been invented by Henri Pape in Paris in 1825 and gradually came to be used universally after that date.[36]

31 The invention of the complete iron frame, cast in one piece, was first patented by Alpheus Babcock of Boston, Massachusetts, on December 25 1718. See: Rosamond Harding, *A history of the pianoforte. Its history traced to the Great Exhibition of 1851*, Cambridge 1933, 204.

32 It should be noted however that certain Viennese firms such as those of Graf and Streicher had been using such barring for some time already.

33 Another slightly later piano by Stodart, in private ownership in France, also has a wooden *capo-tasto* bar.

34 Private ownership, Germany. This piano is similar to the one used by Chopin on his final tour of Great Britain.

35 For the patent diagram, see: Harding, *A history of the pianoforte*, *op. cit.*, 201.

36 Christopher Clarke, 'Fortepiano hammers: A Field Report', in: Thomas Steiner (ed.), *Instruments à claviers – expressivité et flexibilité, Actes des rencontres internationales harmoniques, Lausanne 2002*, Bern, Berlin, etc., 2004, 222–58.

With only small modifications aimed at improving the repetition, the Broadwood firm, like most of the English makers, kept to the Backers action throughout the nineteenth century. In this respect neither the 1827 piano nor the one of 1849 is an exception. But the overall sophistication of the craftsmanship and of the cabinet making are noticeably superior in the 1849 instrument compared with the one of 1827. This suggests that by 1849 the firm was employing the very best tradesmen for these aspects of the construction of their pianos. At the same time, the extensive use of metal framing by both Stodart and Broadwood suggests an acceptance of the functional use of metal in itself for an instrument traditionally built of wood. Such metal framing parts were probably bought in from industrial producers. In these ways the piano-making firms, while remaining conservative, at least acknowledged the utility of the products of the Industrial Revolution.

The square piano

The square piano, unlike the grand piano, owes virtually nothing to the harpsichord, either in its layout or in its construction. Furthermore, in many other respects, the square piano enjoyed a different history from that of the grand piano. In the first place, the square piano was produced for a more or less defined period while the grand piano slowly took over from the harpsichord and has continued to be produced ever since. In the second place, the far larger market for the square piano led to production on a huge scale. This must have entailed a different approach on the part of the piano makers concerned. Their workshops could almost certainly never have coped with the sheer numbers of instruments if they had had to make them entirely in the workshop. There are good reasons for thinking that because of the simplicity of the construction of the square piano the majority of its components could have been made outside the workshop by skilled or semi-skilled men who did not have to be instrument makers. The parts thus obtained could have been assembled in the piano makers' workshops together with others made on the premises. We will now examine the probable processes of construction which lead to this conclusion.

The case of the early English square piano, like that of the clavichord, is an oblong, fairly shallow box, open at the top (but of course closed by the lid) and divided into two compartments. The soundboard is mounted in the right-hand compartment, closed to the front, while the larger, left-hand compartment, open to the front, contains the keyboard and action, a single unit which slides in under the strings like a drawer. The sides of the box, often decorated with inlaid stringing and cross-banding, are made of solid mahogany, assembled at the joins with hidden dovetails. The thick bottom of the box is of spruce or pine, often with a second layer inside the instrument with the grain running

parallel with the diagonal strings of the instrument.[37] The bass strings are stretched obliquely from the back left to the front right of the box, passing over the soundboard and bridge in the right-hand compartment. The rest of the strings, which run parallel to the bass strings, are attached at the rear of the piano to a triangular hitchrail and at the right held by the tuning pins driven into the wrestplank.[38]

Johannes Zumpe

Johannes Zumpe is counted as the maker who, in the 1760s, first introduced the square piano to London. The new instrument caused quite a stir. Burney wrote:

> . .These [Zumpe's instruments], from their low price, and the convenience of their form, as well as power of expression, suddenly grew into such favour, that there was scarcely a house in the kingdom where a keyed instrument had ever had admission, but was supplied with one of Zumpé's pianofortes, for which there was nearly as much call in France as in England. In short, he could not make them fast enough to gratify the craving of the public. Pohlmann, whose instruments were very inferior in tone, fabricated an almost infinite number for such as Zumpé was unable to supply.[39]

Zumpe, who was born near Nuremberg in 1726, came to London around 1750 and worked for several years for Shudi.[40] In 1761 he set up on his own at 7, Princes Street, making citterns, then enjoying a vogue.

The four earliest known pianos by Zumpe date from 1766.[41] They vary somewhat in their design, perhaps indicating an exploratory phase.[42] They are all built in simple, solid mahogany cases about 125 cm long by 45 cm wide and 14½ cm deep, about the dimensions of a reasonably-sized clavichord.[43] One of the four has the compass AA to f3 while the other three have GG to f3 without $GG^{\sharp}$. Two have, or had until recently, a laminated soundboard. One of the three GG–f3 pianos has a partly enharmonic keyboard, with seventeen notes to the octave from $D^{\sharp}$ to $a^{\sharp}2$. All four pianos have one stop, engaged by hand, which raises all the dampers. Overspun strings are used in the bass to compensate for their relatively short lengths in comparison with those in a grand piano.

37 Later instruments are constructed entirely of softwood and the case sides are veneered.
38 For a diagram of the structure, see: Cole, *The pianoforte, op. cit.*, 71.
39 Burney, 'Harpsichord', *op. cit.*, no pagination.
40 For more details on Zumpe see: Cole, *The pianoforte, op. cit.*, 51–68.
41 See: Cole, *The pianoforte, op. cit.*, Plate 1.
42 See: Richard Maunder, 'The Earliest English Square Piano?', *The Galpin Society Journal* XLII, 1989, 77–84, for more details of these instruments.
43 Two have reversed keyboards, that is with white sharps and black naturals, perhaps a reflection of Zumpe's continental background. In both Germany and France such reversed keyboards had been popular.

Already by 1767 Zumpe's design appears to have become more consolidated; from this date onwards he made no important changes.[44] The dampers were divided into two sections, treble and bass, each of which could be raised independently of the other half. This allowed the player a number of possibilities. For example he could leave the treble strings undamped, creating an agreeable 'halo' of sound in the treble while keeping the dampers in the bass lowered for the clearer articulation required there.[45] By 1769 Zumpe appears to have incorporated the buff stop as an optional extra. This stop brings a strip of soft leather into contact with the ends of the strings next to the nut, giving a *pizzicato* effect. The three stop levers, two for the dampers and one for the buff stop, were to be found inside the case walls to the left of the keyboard (fig. 4). These stops became more or less standard in English square pianos for the next fifteen years.

Zumpe's genius showed itself in the simplicity of the action.[46] Probably drawing on earlier German designs, he reduced the piano action to its barest essentials; a hammer, pivoted on a rail, is struck from below, near its pivot, by a small leather-covered knob connected to the rear of the key lever by a stiff threaded wire.[47] The key, and thus the knob, are stopped just before they can press the hammer against the string, allowing the hammer to continue in free flight to the strings. Just before the hammer hits the string, the rear of the key raises a sprung damper lever pivoted at the back of the case, thus disengaging the pad of soft leather attached to it which had been resting on the strings, so allowing them to sound. The repetition of this action, despite (or rather because of) the absence of an escapement mechanism, is irreproachable. The action is as sensitive as an escapement action since the hammer is propelled to within the same distance of the strings; the low inertia of the hammers, the damping due to the forced oscillation they are obliged to adopt and the air-braking due to their paddle-like shape all tend to reduce rebounds in loud playing.[48]

44 Cole, *The pianoforte*, *op. cit.*, Plate 2.

45 This, with the lid closed, appears to have been the configuration for normal playing; the stop lever for the treble dampers is much less accessible than that for the bass in many such pianos.

46 A diagram of the action can be seen in: Cole, *The pianoforte*, *op. cit.*, 74.

47 The knob is known as the old man's head.

48 The hammers, in rebounding between the string and the old man's head, are in a mode of forced oscillation which is 'out of tune' with their natural period; thus their motion is strongly damped. Unfortunately, there are always some hammers whose natural period (or its harmonic) is 'in tune' with the forced vibration, and these will rebound strongly. See: Hermann Helmholtz, *On the Sensations of Tone*, London 1885, (facsimile: New York 1954), 36–41 and John Robison: 'Pianoforte', in: Colin MacFarquhar and George Gleig (eds.) *Encyclopædia Britannica*, 3rd ed., Edinburgh 1797.

Improvements

Zumpe's action was improved in the mid 1780s by his successor Schoene through the introduction of an intermediate lever between the hammer and the key.[49] This had the effect of transforming the action from one in which the acceleration ratio between the hammer and the key increases as the key is depressed, to one in which it decreases. Paul Poletti has shown that this makes for much easier finger control.[50] Moreover, this second lever also increased the damping factor of the action, reducing hammer rebound. This action, even more so than Zumpe's simpler action, was capable of rapid and reliable repetition and of a wide dynamic range; the overall performance of this action was not improved further until the advent of Érard's double-escapement action in the 1820s.

Other refinements to Zumpe's action followed. John Geib patented his version, which included an escapement mechanism like that of Cristofori, in 1786.[51] Geib appears to have constructed complete instruments for the London firm of Longman & Broderip who put their name on the instruments before retailing them to clients. Geib's invention appears to have quickly put them in a leading position amongst London makers. William Southwell of Dublin simplified the damping system by screwing the dampers, held on thin wires, directly into the back of the keys.[52] This lightened the action and removed points of friction but, judging by examples which have survived, made the servicing of such an instrument a nightmare: all the dampers had to be individually unscrewed out of the keys before the action was taken out and screwed back in and regulated after the action was put back. This particular problem was later solved by placing each damper on a lever hinged independently of the key and positioned above it.

Pedals on early English square pianos were rare; up to about 1795 hand-operated levers for the dampers, usually divided, and the buff stop were the rule. Only after about 1795 were pedals generally used. In early examples of instruments with pedals there was often a lid swell. By depressing the appropriate pedal the small section of the lid at the front of the instrument and to the right of the keyboard is lifted, giving a sudden *forte* or a *crescendo*.[53] Some

49 For a diagram, see: Cole, *The pianoforte*, *op. cit.*, 104.

50 Schoene and company, probably headed at the time by Frederick Schoene, had become the successors to Zumpe by at least 1785.

51 Geib's original patent application, together with his drawing, is to be found in The National Archives, Kew, London, signature c54/ 6773. For a diagram, see: Cole, *The pianoforte*, *op. cit.*, 102.

52 For a diagram, see: Cole, *The pianoforte*, *op. cit.*, 105.

53 For instance four instruments by Adam Beyer. 1775: Staatliches Institut für Musikforschung, Preußischer Kulturbesitz, Musikinstrumenten-Museum, Berlin, cat. no. 4591; 1776:

makers incorporated a true *una corda* operated by a pedal which shifted the complete action slightly towards the player such that each hammer only strikes one of its respective pair of strings.[54]

The Broadwood firm made astonishing numbers of square pianos; between 1784 and 1800 about five thousand Broadwood square pianos had been sold. During the same period the same firm had made just under two thousand grand pianos. By 1815 they had made no less than twenty thousand square pianos and nearly seven thousand grand pianos. Broadwood's square pianos of before 1800 are exceptional in that they almost never have a means of disengaging or engaging all the dampers at once and nor do they have any other stops. Nonetheless, the Broadwood firm also introduced their share of improvements; these included the use of under dampers (the so-called peacock dampers), patented in 1783. The firm also interchanged the positions of the wrestplank and the hitchpin rail. As a result, the distance between the tuning pins and the nut was much shorter than the distance there had been between the tuning pins and the bridge, making tuning easier and increasing tuning stability. The change in position of the hitchpin rail in turn paved the way for Broadwood's introduction, in 1820, of an iron hitch plate which projected over the soundboard, reducing the lengths of the strings between the bridge and the hitch pins, now incorporated in the iron plate. The plate also increased the stability of the case.

We have already glimpsed the extraordinary popularity of Zumpe's square piano in the late 1760s and 1770s; in the 1780s and 1790s there was a huge demand at home and abroad for English square pianos and numerous workshops were established in which these instruments were made. Success probably depended on the patenting of technical improvements, good workmanship, a well-organised network of sub-contracting and good marketing. At the beginning, Zumpe's pianos sold for only 16 guineas, half the price of the cheapest harpsichord, and were actively promoted by his influential friends Charles Burney and Johannn Christian Bach. Harpsichords would only have been accessible to affluent customers; Zumpe's square pianos would have been affordable by middle-class buyers who would thus have been able to imitate the fashion for these new instruments among the well-to-do.

By the end of the eighteenth century a flourishing hire trade had built up and there were increasing numbers of customers from the middle class. An early form of hire-purchase also evolved which allowed money already paid for

private ownership, England; 1777: Händel-Haus Halle, inv. no. MS-4; 1778: Reka Sammlung, Museum Viadrina, Frankfurt/Oder, inv. no. Mk. 2. A piano of 1780 signed Fredericus Beck (private ownership, England) embodies a pedal to lift the entire lid, a sprung lever relieving most of the weight. See also: Cole, *The pianoforte*, *op. cit.*, Plate 3.

54 Johannes Pohlman, *circa* 1785, Gemeentemuseum, The Hague, inv. no. 2000–0003. Cole points out that Beyer was probably the first to use such an *una corda*. See: Michael Cole, 'Adam Beyer, piano maker', *The Galpin Society Journal* XLVIII, 1995, 107.

hiring an instrument to be put towards its eventual purchase. The piano also had built-in obsolescence. For perhaps a hundred years, any piano more than fifteen years old would have been out of date, both musically and as a piece of furniture. After all, the designs of the instruments were developed and improved all the time, at least from the perspective of the day, and fashions in furniture were continually on the move. Although the essential features of the English square piano had already been established in the eighteenth century, both the compass and the power of the square piano, like those of the grand piano, grew. Many of the important patents had lapsed by around 1800, leaving makers free to combine ideas which had previously been the sole right of each patentee to exploit. This freedom contributed to a general improvement in quality. New music needed the larger compass, newer drawing rooms required the newer furniture styles. It must have seemed to the piano makers that demand would continue to rise for ever.

Square piano production

We saw above that by the mid-nineteenth century the grand piano had reached a level of complexity and a perfection of execution which could only exist through a wide range of high-level specialist skills. In 1854 Charles Tomlinson listed forty-two different operations in the manufacture of a grand piano, each performed by a different workman and his assistants.[55] It seems too that the complexity of the grand piano entailed that it was produced in its entirety in the workshop. In short, for the production of grand pianos, there existed a division of labour within the workshops. With the square piano it appears to have been a different matter, at least until the late 1820s.

Perhaps to increase production, Zumpe entered into partnership with Gabriel Buntebart in 1769. Of the square pianos made by Zumpe alone (dated 1766 to 1769) and of those by Zumpe and Buntebart (1769 to 1782), a combined total of only some fifty survive. From data about the production of other late eighteenth-century stringed keyboard instrument makers, both in England and on the continent, it seems that typically, only between 2% and 4% of their instruments have survived.[56] We can thus guess that between 1766 and 1782 Zumpe (and Buntebart) produced between 1250 and 2500 square pianos, that is, between about 75 and 150 instruments a year, probably fewer at first but more later. Burney wrote of the difficulty Zumpe encountered in producing sufficient instruments to meet the demand, indicating that he was under pressure

55 Charles Tomlinson, 'Piano-forte' in: *Cyclopædia of the Useful Arts*, London & New York 1854, 306–14.

56 See: Latcham, *The stringing*, *op. cit.*, 9–10.

to produce more. While he almost certainly began by making most if not all of his instruments in his own rather small workshop, the growing demand may have meant resorting to assembly-line production. This is where Zumpe's design could reveal its advantages. Numerous items required for such a production, including the case, the keyboard, the hammers ready hinged to their rail and the dampers and small metal parts such as tuning pins, could all have been made by individuals or small workshops specialised in such parts. The pianos could then have been assembled in the workshop using these items together with those made on the premises, including such specialised parts as the soundboard. The instrument would then have been completed by stringing it, setting-up it up and voicing it in the workshop. It is as if Zumpe had made the prototype of the English square piano with such a production in mind. The simplicity of the action and of the case appears to have opened the door to the use of semi-skilled workers in the production process.

Building a square piano

Unlike the case of a grand piano, with its complicated shape and a wrestplank and braces which must be glued in as the case is constructed, the case of a square piano could have been made by any competent cabinet maker; moreover, the layout of a square piano case only requires certain dimensions to be accurately followed. The cases could thus have been delivered as empty boxes to be filled in the instrument maker's workshop where each one could receive in turn the wrestplank, the belly rail and the long triangular hitchpin rail, pierced through with accurately-placed holes determined by a template to receive the damper-lifters. The soundboard could be made and fitted by a specialised worker and glued in place once the string positions had been marked and the bridge pinned. After putting in the hitch pins and nut pins and drilling for the tuning pins, the instrument would be strung in plain wire of iron, yellow brass and red brass wire, and with overspun strings in the bass. The latter strings consisted of an open spiral of silvered copper wire wound on a core of brass.[57] All the pins and the wire were doubtless supplied from outside, as they were for harpsichord makers.

Next came the keyboard with the action. The keys and hammers were held in a frame which could be taken out of the case as a complete unit. The key levers themselves were made of lime wood and were probably marked out from a template and then sawn out after marking the positions of the action parts with scribed lines. Usually, the naturals had ivory key plates and the sharps were topped with ebony.

57 The core was turned in a simple hand-cranked machine.

Figure 4: *A detail of the action and stop-knobs in a square piano by Frederick Beck of 1773 (Private collection)*

The hammer shanks used by Zumpe (and virtually all 'English' makers after him) are flat tapered slips of wood, wider at the hinge end than at the hammer end and two to three millimetres in thickness (fig. 4). It appears that a single sheet of mahogany the width of all the hammers placed next to each other (as they are in the hammer rail) was made up and planed to the right thickness with the grain of the wood running in the direction of the shanks. Along the underside of one long edge of this sheet a strip of leather was glued in a shallow rebate and gripped by a narrow, slightly thicker strip of wood fixed underneath. Along the other top edge a strip of lime wood was glued on. The individual shanks were then marked and sawn out leaving each one with a piece of the leather strip as a hinge and a section of the strip of lime wood as the hammer head.[58] Only after sawing out would the heads have been given their rounded shape and covered in a number of layers of sheepskin or goat-skin. Even then, the hammer heads would have been left considerably too wide both fore and aft. After assembling the hammers in the hammer rail the action would have been put in the instrument, presumably by an action finisher in the workshop. In a square piano the strings run obliquely across the action so that the position of each hammer in the front-to-back direction is critical. By leaving the hammers oversize in this direction each hammer could be trimmed to give it its correct position. The action finisher could bring each hammer in turn up to its pair of strings and mark the hammer head on either side of the pair. Guided by these marks he could then remove the excess wood and leather of the head fore and aft. The damper levers and their vellum hinges were no doubt made in a similar way, that is, cut out of a made-up strip of mahogany of the right dimensions. The small wooden blocks bearing the soft leather damper pads must have been glued in place above their respective pairs of strings at the same stage at which the hammers were trimmed, that is, after the installation of the action.

While all the preparatory operations could have taken place in the instrument maker's workshop, they could equally well have been performed elsewhere, dimensions being standardised by means of simple templates. Sets of hammers (perhaps in large quantities), made for instance by out-workers, could have been delivered both hinged to their rail and ready covered in leather. Sets of dampers and even keyboards could have been produced in the same way.

We can well imagine that there were numerous piano makers in London who lacked the space to produce a sufficient number of entire instruments to complete the orders they had attracted. The demand on Zumpe and on the numerous makers who followed him may at first have led to a system in which specialists grew up who produced particular items and supplied these to such

58 This use of leather and vellum for hinges, probably inspired by organ-making practice, obviated the usual system of wire axles pivoting in fabric-bushed holes. The latter would have been much more expensive to make, but more accurate and durable.

over-burdened piano makers. Cabinet makers, for instance, may have become specialists in making square piano cases. Other craftsmen could have specialised in making hammers and other action parts as outlined above. The well-known firm of Brooks set up as the world's first specialist action-maker in 1810.[59] The relationship between the piano makers and the specialists would have varied. In some cases the piano makers would have bought parts in from suppliers, in other cases from sub-contractors, while in other cases the 'specialists' would have been out-workers. Out-workers differed from sub-contractors in that they were more or less tied to one entrepreneur and dependent on him. Some makers may have continued to make entire instruments alone. Adam Beyer, for instance, with an average yearly production of around fifty square pianos between 1773 and 1783, might have made all his instruments in a workshop with say, eight workmen. Something similar but on a smaller scale was probably true of Thomas Haxby who, in York, produced an average of 28 square pianos a year between 1783 and 1794. We have no information on Geib's production rates but as a supplier to the the retailing firm Longman & Broderip he may also have produced instruments in their entirety.[60] But for the Broadwood firm, who already produced an average of about five hundred square pianos a year between 1793 and 1797, there must have been some system of sub-contracting or, more likely, a well-organised force of out-workers engaged on a piece-work basis.

A diffuse division of labour

Out-working and sub-contracting had long been practised in various trades in Europe; in England the practice of a diffuse division of labour was epitomised by the Birmingham clock and gun trades. The Birmingham trades, centred on the production of many different small articles in iron, brass and steel, were dominated by small workshops equipped with simple yet effective tools and small machines such as lathes and fly-presses. Sketchley's Birmingham Directory of 1767 lists 55 categories of metal-working trades. For gun makers there are gun and pistol makers, gun-barrel makers and filers, gun-barrel polishers and finishers, gun-lock makers, forgers, finishers and filers, gun-swivel makers and stockers. Eric Hopkins wrote:

> The gun-maker was usually an entrepreneur who marketed guns made up of parts which had first been fashioned by specialist workmen (the 'material men', working

59 Alfred Dolge, *Pianos and their Makers*, Covina 1911 (facsimile: New York 1972), 126.

60 A square piano by Geib (and inscribed with his name) privately owned in Belgium and made in about 1790 has the number 3225 (with a 6 stamped over the second 2) stamped near the hand levers for the stops. The range is FF–c4. Geib worked in the Tottenham Court Road.

> on sub-contract), and then assembled by others (the 'fabricators', or 'setters-up'). By the mid-nineteenth century there were as many as 63 parts to a gun, and the total number of processes on an Enfield musket of 1853 pattern was more than 600. It follows that there was an extraordinary profusion of specialist trades within the gun trade. For the second quarter of the 19th century the 'material men' comprised 17 specialists [all listed] including makers of gun stocks; and the 'setters-up' comprised 14 specialities, including gun-stocker and gun-stock polisher. By 1862 this list had lengthened to 32 types of 'material men' and 16 of 'setters-up'.[61]

Hopkins goes on to show that the trades were concentrated within a small area of a few streets and the advantages of not housing the entire production process under one roof:

> How did this trade organisation remain virtually unchanged 1760–1840? It suited the needs of the time. Since the basic processes required considerable manual skill, it was inevitable that the work would be carried out in workshops of traditional type. Supervision of the various branches of manufacture could have been more efficient if done under one roof, but this would have meant heavy commitments in buildings and labour. It was thus more convenient to call on skills on demand, according to its ebb and flow.

On the one hand the system could be run with low overheads and on the other enabled craftsmen to work at home, probably often with the help of their families. The entrepreneur would provide materials, specifications and sometimes specialist tools to the home worker, making the rounds at regular intervals to replenish supplies and uplift the finished articles. As we have seen, all the action parts of a square piano could be produced in this way. In their homes or in small workshops, out-workers could have made hammer rails complete with ready-mounted and covered hammers, sets of action parts, damper mechanisms and even keyboards, all ready to be incorporated into instruments in the parent workshop. Complete actions may have been sub-contracted to specialists and the cases may have been made on the same conditions by cabinet makers. In Tomlinson's *Cyclopædia of the Useful Arts* we read:

> The manufacture of piano-fortes is an important branch of industry in the metropolis. In the London Directory for 1853, the names of upwards of 200 'piano-forte makers' are entered; although many of these are those of sellers, or retail-dealers as they may be called. The names of a large number of small makers, however, do not appear in the Directory: men who purchase the different parts of the action, the metal work, &c., of large dealers in those articles, and then put them together, much in the same way as a watchmaker combines the different parts of a watch which he does not himself make. Some of the small dealers are, we fear, sufficiently dishonest to put the name of some eminent maker on their key-board, and thus enhance

61 Eric Hopkins, *Birmingham, the first manufacturing town in the world, 1760–1840*, London 1989, 40–1.

> the price of the instrument. At one time, when the name of *Tomkinson* was a sort of passport to an instrument, the small dealers would put *Tomkisson* on their name-boards, and thus escape the notice of the law.
>
> The number of subsidiary trades is also large. Although in the London Directory there are only entered 6 piano-forte *fret cutters,* 2 *hammer* and *damper-cloth* manufacturers, 4 *hammer-rail* makers, 6 pianoforte *key*-makers, 2 piano-forte *pin*-makers, 5 silkers, 1 *stringer,* and 29 tuners, yet there are a large number of persons occupied as small makers of parts of the instrument, and not being housekeepers are not entered. And even if it were possible to make this list complete, it would by no means represent the extensive subdivision of the trade. In the manufacture of a piano there are, in fact, upwards of 40 different classes of operatives employed, each of whom, with his assistants, is exclusively engaged in his own peculiar branch of the manufacture.[62]

Although this description relates to the mid-nineteenth century it is clear that something similar was the case with regard to the production of square pianos already towards the end of the eighteenth century. By then, the piano trade in London had already become a complex network of partnerships made and broken, of makers like Geib selling some or all of their production for resale to music dealers and entrepreneurs such as Longman & Broderip, of out-workers and of small workshops to which the larger ones sub-contracted and, beginning to dwarf all the others firms in scale, Broadwood.

The Broadwood firm

In size, the Broadwood firm produced more square pianos (and grand pianos) than any other. Their production of square pianos rose from an annual rate of about a hundred in 1785 to two hundred in 1790 and four hundred in 1800, at which date there were also a hundred grand pianos being made annually. By 1815 about one thousand square pianos were made by the firm each year. It is obvious that considerable organisational changes must have taken place in the manufactory. For such a production they must have engaged both to sub-contractors and to out-workers in the manner described above. This we can infer purely on the basis of our knowledge of the size of their premises and their rate of production. In 1800, the Broadwood firm occupied only rather more than twice the space they had taken up thirty years earlier, even though the total production was now about twenty times greater than that of the Shudi workshop of the 1770s.[63]

The Broadwood firm is certainly known to have sub-contracted the complete manufacture of certain types of instruments to other makers; between 1805

62 Tomlinson, 'Piano-forte', *op. cit.*, 313.
63 Wainwright, *Broadwood*, *op. cit.*, 326–8

and 1813 all Broadwood's upright grand pianos and some horizontal ones were entirely made and finished by James Black on his own premises. There is also evidence to show that the Broadwood firm sold some pianos with blank nameboards to provincial makers who could then inscribe them their own names, as in the contemporary clock and watch trade.[64] The Broadwood firm also bought in some materials in large quantities from abroad. In 1805 they bought 1568 soundboards as a single lot from Leipzig and in 1804 they ordered 400 pounds of 'steel' wire in four gauges from Lieber of Berlin.[65]

The organisation of the firm must have been considerable and it is no wonder that up-to-date methods of business accounting were introduced by James Shudi Broadwood over the years 1792–1796.[66] By the turn of the century the production of square pianos was probably responsible for the largest part of Broadwood's turnover. Some instruments were sold through music teachers and through introduction by customers who were thereby allowed a 5% commission. Many instruments were ordered directly from the firm. But these old methods were no longer adequate. The instruments, now produced on a speculative basis, needed to be distributed and sold using new outlets. By taking full advantage of the improved system of turnpike roads and marine transport to bring pianos to every part of the United Kingdom, the Broadwood firm built up a network of dealerships throughout the country.[67] 25% reduction was offered to the entrepreneur in return for immediate payment on the one hand and terms of credit were made available to them on the other. As with many prosperous commercial concerns, the firm not only drew returns from its principal business of piano making but also made a considerable amount of money from the interest accrued on loans. Needless to say, the respectable capital the firm thus built up further aided expansion.

Continuing success and no doubt a wish to centralise and control all the means of production made expansion outside Soho inevitable. In 1823, the Broadwood firm leased a large factory in the Horseferry Road, also in London. In the Supplement to the Penny Magazine of April 1842 there is an exhaustive account of a visit to this new factory by the journalist George Dodd. The space was rationally laid out for the production of pianos. The timber was brought in, stacked and seasoned.[68] It was then cut in saw-pits to approximate size

64 See: Michael Spiller, 'The Regency Piano Trade in Aberdeen', *The Galpin Society Journal* XXXII, 1979, 115–23.

65 Wainwright, *Broadwood*, *op. cit.*, 101.

66 Cole, *The pianoforte*, *op. cit.*, 101.

67 Wainwright, *Broadwood*, *op. cit.*, 99.

68 The Broadwood firm also started to buy timber in the log, paying record prices for mahogany and other timbers and materials, often imported from across the world. Dodd notes that the wood was seasoned on the premises for several years before use, and that a stock was kept for five thousand pianos, or two years' production. See: George Dodd, 'A Day at a Pianoforte Factory', (supplement), *The Penny Magazine* XI-Z, April 1842.

and placed in a steam-heated hot room to dry before being sent to the various workshops in one of the four buildings which comprised the factory. Each of these was three hundred feet in length and had three stories. Between three and four hundred men worked in the factory. As Wainwright states:

> The numbers fluctuated with the seasons, for piano-making, like cabinet-making, remained a seasonal trade building up to the main period for purchasing in the autumn. Men were taken on as sales dictated (this irregularity of employment led many of them to start up one-man businesses: in hard times, however, some worked from week to week, pawning their tools on a Friday, selling a piano on a Saturday, and reclaiming the tools to start work again on Monday morning).[69]

Meanwhile, in Soho, the Great Pulteney Street workshops and showrooms had undergone considerable expansion into neighbouring buildings. One-hundred-and-fifty men (besides those in the Horseferry Road) worked there as finishers, tuners and clerks. But the old system of out-working had not been entirely abandoned as a result. Dodd mentioned:

> Besides these, there are many others engaged in the smaller branches of the manufacture, who do not work on the premises.

The out-workers probably included the 'silkers', women who made the pleated silk fronts that adorned upright pianos which, by 1842, were beginning to achieve supremacy over the square pianos as domestic instruments. These upright pianos were different from the imposing upright grand pianos made earlier in the century. They were much simpler to make and more economical of costly materials. The action was only marginally more difficult to produce than Geib's square piano action (of which it was an adaptation). These advantages to the producer were complemented by another, pertinent to the buyer. By the mid-nineteenth century the square had become a large, complex and costly instrument which took up considerable space in the home; for those with smaller homes the upright piano, taking up far less floor-space, would have been attractive. Tomlinson cites an annual London production in 1851 of twenty thousand upright pianos and possibly even more.[70] In its simplified form the upright piano seems to have become the musical instrument of the prosperous working-class in the same way that the square piano had been the musical instrument of the prosperous middle-class some eighty years before.

However, the significance of the move to Horseferry Road lies in the fact that the network of outworkers and sub-contractors, so essential to the mass-production of pianos in cramped premises, was now largely abandoned. The Broadwood firm must have taken on to their payroll a good part of their former outworkers and sub-contractors, though as we have already seen, these craftsmen continued to be paid on a piecework basis. This fundamental change in

69 Wainwright, *Broadwood*, *op. cit.*, 150.
70 Tomlinson, 'Piano-forte', *op. cit.*, 314.

organisation reinstated the old workshop-based system except that many operations hitherto performed by outside specialists could now be done inside the factory. The most obvious example is that of timber conversion, but there are undoubtedly many others.

The increased specialisation of the workmen seems to have gone hand-in-hand with the pursuit of craftsmanly prowess within the factory. The complexity and sophistication of the instruments built after the factory became fully operational increased enormously. This was true not only of grand pianos, as discussed earlier, but also of the more expensive models of square and upright instruments. The technical advances involved were greatly facilitated by grouping all the workers under one roof. For these reasons the larger firms came to dominate the high-quality market. Smaller makers, more reliant on the now depleted pool of independent specialists, were henceforward at a growing technical disadvantage and often found themselves reduced to making low-technology, low-priced pianos. These were the men who pawned their tools on Saturday and redeemed them on Monday. But that some of these garret makers could succeed in breaking through to the upper end of the market is vividly described in Donald Fostle's *The Steinway Saga*.[71]

In any case, by the 1840s and 1850s the piano, considered as a work of craftsmanship, was at a pinnacle which was never to be reached again. Yet this excellence was achieved almost entirely using tools and equipment essentially the same as to those in use a hundred years before. The adherence to tradition had its price, however. Ehrlich, citing a mid-nineteenth-century source, wrote:

> Even Broadwood's elaborate division of labour achieved an annual productivity of only about seven pianos per man, no higher than that of small firms; indeed, one informed observer argued that it was considerably lower![72]

While a very considerable division of labour was thus present in the piano-making factories, machinery remained virtually absent, at least in England.[73] At the time, technology revolutionised the cotton and steel industries but passed over the making of English pianos. Dodd's account of the Broadwood factory describes 'a series of saw-pits, in which the logs are cut', indicating that the logs were still being laboriously sawn into planks by hand. Dodd does mention an 'engine-house', but the only machine in the entire factory is described as:

> ... a beautiful lathe, the action of which is of a highly scientific order. An hexagonal or octagonal pattern is produced in a circular leg, by allowing the leg to remain stationary, and making the cutting-tool revolve rapidly at such a distance from it as to cut away one sixth or one-eighth of the surface. The cutting-tool has at the same time a motion backward and forward in the direction of the length of the leg.[74]

71 See: Donald W. Fostle, *The Steinway Saga*, New York 1995.
72 Ehrlich, *The Piano*, *op. cit.*, 38.
73 *Ibid.*
74 Dodd, 'A Day at a Pianoforte Factory', *op. cit.*, 175.

Although woodworking machinery invented in 1779 had already been used in the British naval workshops to make standardised pulley-sheaves in the 1790s, its use was eschewed by English cabinet makers and piano makers alike until very late in the nineteenth century. Power-driven woodworking machinery was already well-developed in the early part of the century in America. Its application there to the mass-production of keyboard instruments from the 1850s onwards dealt a mortal blow to the craft-based European trade.[75] The failure of the great English piano houses to exploit in timely fashion technologies which had been on their doorsteps for decades reduced them to extinction or second rank. The garret makers at the shallow end of the profession were annihilated in the face of the enormously increased productivity of foreign firms using mechanised technology. But although this mechanisation somewhat lowered the standard of workmanship at the top end of the market, it greatly improved or at least cheapened it at the bottom end, making possible for the first time a piano affordable by a broad spectrum of society. In 1842 however, this cataclysm was still some way off. Dodd wrote:

> The pianoforte manufacture is one in which nothing but highly-skilled manual dexterity can make and adjust the numerous pieces of mechanism involved in it; and those workmen who possess this skill are not likely to be supplanted by any automatic machine. Hence it happens that the same workmen are seen year after year, occupying their old benches, using their old tools, coming to work and leaving at the old hours, and seeming as if the old shop belonged to them and they to the shop.[76]

By dint of considerable specialisation and a formidable tradition of emulation and *esprit de corps*, the mid-nineteenth-century craftsmen turned out work of a virtuosity that has never since been equalled. Specialisation was a means to attaining excellence; it was important for each man to push back the limits of craftsmanship in order to produce, collectively, a complete instrument of the highest possible intrinsic worth. In 1817 Beethoven had written to James Shudi Broadwood to thank him for the gift of a grand piano:

> Mon très cher ami Broadwood! Jamais je n'éprouvais pas un plus grand Plaisir de ce que me causa votre Annonce de l'arrivée de cette Piano, avec qui vous m'honorès de m'en faire présent, je regarderai comme un Autel, ou je deposerai les plus belles offrandes de mon Esprit au divine Apollon.[77]

A mechanically-produced piano would have seemed completely inconsistent with this ideal of the constitution of a musical instrument, not only in the minds

75 Ehrlich, *The Piano*, *op. cit.*, 19, 38. Some progressive firms in Germany and France also adopted machinery in the 1860s.

76 Dodd, 'A Day at a Pianoforte Factory', *op. cit.*, 176.

77 See: A. C. Kalischer (ed.), *Beethovens Sämtliche Briefe. Kritische Ausgabe mit Erläuterungen*, 5 vols., Berlin and Leipzig 1906–8, III, 1907, 267.

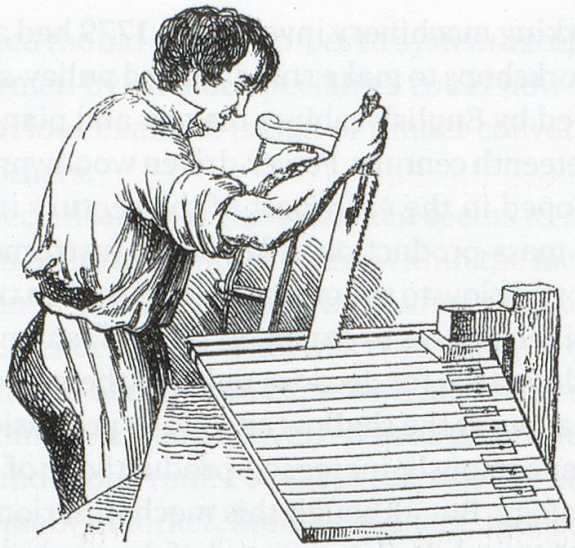
[Key-cutter at work.]

Figure 5: *A key cutter at Broadwood's factory: illustration to George Dodd's article 'A Visit to a Piano-forte Factory',* The Penny Magazine, *April 1842.*

of the public, but also in those of the best makers; a musical instrument after all should possess a soul, a magical quality that could only be instilled in it by the hand of the craftsman. Tomlinson wrote:

> The progress of the various works must not be hurried; a grand piano ought to occupy at least six months in its manufacture.[78]

One can only marvel at the proud obstinacy of both the craftsmen and the master. We see the fret cutter working at a donkey with a fret-saw and the key cutter accurately cutting out keys with a frame-saw, keeping it square to the board by eye key after key, keyboard after keyboard (fig. 5).[79] These, the notch maker, the beam maker, the hammer leatherer, the brass stud maker, the case maker, the belly man, the stringer, the plinth maker and every other member of the forty-two separate trades which were needed for the making of a piano would all have worked in the same ways as their great-grandfathers, grandfathers and fathers had done before them. The main difference from the organisation of keyboard-instrument making in the Renaissance lay in the fact that in the nineteenth century the journeymen were not dispersed in the town, working at their separate trades and with only a few working under the master's roof but hundreds of them, all gathered together in his factory and united in a single purpose which he alone defined.

78 Tomlinson, 'Piano-forte', *op. cit.*, 314.

79 Modern, treadle-operated saws which worked vertically through a table against a spring had existed for about a hundred years already.