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Nineteenth-century technical innovations in British country houses and their estates

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The country house was the dominant feature of life in most parts of rural Britain until the early twentieth century, providing the economic and social focus for the whole community. From the late eighteenth century, owners were increasingly motivated to design or upgrade their houses to provide increased comfort for themselves and their guests, and to improve the efficiency of the house's operation. This goal was facilitated by a wide range of new types of domestic technology, which had a profound effect on the lives of the people who lived and worked in these houses. The paper presents some findings of a research project based at the University of Leicester, studying the factors influencing the adoption of new technology in country houses and its impact on the inhabitants. The conclusions are helping to inform changes in the way that country houses are presented to the visiting public.

1. Technology and the country house

The owners of country houses, together with their vast armies of staff, formed the heart of much of Britain's rural society until at least World War I. During the late eighteenth and nineteenth centuries, various technological innovations were becoming available to enhance the comfort and convenience of domestic life, but most country houses were located far from urban centres and so had to be self-sufficient in the provision of services such as gas, electricity, sanitation and water supply. Subsequently, the decline of many country houses in the early twentieth century and the opening of many to the public as historic homes, under the control of the National Trust or other bodies, has often meant that less alteration has taken place to these buildings than in other domestic environments. So considerable evidence has survived for both the nature of these technological innovations and the impact they had on the building fabric, landscape and the social structure of the country house and its occupants.

In the eighteenth century or earlier, a few landowners introduced innovative ways of, for example, providing water supplies to their houses and estates and for using horse or water power to drive farm machinery. However, during the nineteenth century, two separate developments considerably increased the pace of technological change. First, major new inventions such as dry and wet central heating systems, gas and then electricity supplies became available for the first time. Second, the social composition of the landowning classes changed, particularly in the second half of the century, as men who had made fortunes in commerce, banking and industry looked for country seats in reasonably sized estates in which to entertain their visitors, without necessarily encumbering themselves with the obligations of a country landowner. They were the most likely group to take up the new technological developments as they wanted houses that functioned efficiently to meet the needs of their guests, and did not have the same hereditary obligations to their staff and tenants, although there are some notable exceptions to this, which will be discussed later. This paper draws on the work of the Country House Technology Project, which is based at the University of Leicester and funded by the Leverhulme Trust. The aims of this project are to examine both the physical remains and historical evidence of technology in a wide range of country houses throughout Britain to reveal the factors influencing owners' decisions to adopt or to shun particular technologies and to analyse the impact that these technological changes had on the structures of the houses themselves and on the lives of the people who lived and worked in them. The findings discussed here are the results of fieldwork at over 70 country houses throughout the UK; a full list of these properties can be found on the project web site (http://www2.le.ac.uk/departments/archaeology/research/centre-for-historical-archaeology/research-1/country-house-technology/about-the-project).

2. The adoption of new technology

In 'Life in the English country house', Mark Girouard asserts that 'on the whole, hospitals, prisons and lunatic asylums were centrally heated and lit by gas long before country houses' (Girouard, 1978: pp. 262–263). The current research has

largely confirmed this, but suggests that the reasons why landowners, despite their apparent wealth, were slower to innovate than factory owners and those responsible for public institutions are more complex than previously thought. An initial assumption was that country house owners had been cushioned from the necessity of doing so by their large household staffs, and that the increasing difficulty of obtaining servants later in the nineteenth and early twentieth centuries was responsible for their change of attitude. To some extent this is true, but the motivations of country house owners varied considerably. Jill Franklin, in 'The gentleman's country house', suggests that country house owners' adoption of new appliances was motivated by comfort and convenience rather than economy (Franklin, 1981: p. 107). However, many contemporary commentators do refer to the difficulty of obtaining good servants in the last two or three decades of the nineteenth century, when they were needed to cope with the greatly increased numbers of visitors at many houses. As early as 1880, the architect J. J. Stevenson suggested that 'convenience' in country house planning could result in an immense saving of labour: this was 'an object of great importance, not so much to prevent the servants being over-worked …but that the house may be managed with fewer of them' (Stevenson, 1880: p. 49). By 1910, Bannister and Herbert Fletcher, in their 'English home' of 1910, wrote that 'the convenience and completeness of the domestic departments due, no doubt, to the servant problem, also form a conspicuous motif in modern house plans' (Fletcher and Fletcher, 1910: p. 38). However, not all new technology was introduced to save labour; many of the hundreds of country houses that installed their own electricity generating plant from the mid-1880s had to employ extra staff to run the plant and maintain the wiring. Nevertheless, the number of people in domestic service was declining in relation to the general growth in population in the last two decades of the nineteenth century, although it still remained the largest employer of the female workforce.

Many innovations, as Girouard suggested, were introduced by the so-called *nouveaux riches*, those who had made their money in industry or commerce and then sought a country retreat to suit their new status, where they could both relax and entertain. A famous example is Sir William Armstrong, who built a fishing lodge on the River Coquet, which grew over the years to become the large mansion of Cragside (Figure 1). Armstrong was a scientific innovator in his own right, and put his interest in hydraulics to good use at Cragside, as well as installing the new incandescent electric lamps invented by his fellow Newcastle resident, Joseph Swan. The London branch of the Rothschild banking family chose to build a series of houses from the mid-nineteenth century onwards, mainly in Buckinghamshire, because from here they had easy access by rail to their London banks. The three sons of Nathan Mayer Rothschild (1777–1836), Lionel, Anthony and Mayer, built

Figure 1. Cragside, Northumberland: Sir William Armstrong's much-extended fishing lodge

Tring Park, Mentmore Towers and Aston Clinton, respectively, while Lionel's sons were responsible for Halton House and Ascott House, and his daughter Evelina married her cousin Ferdinand, who was the builder of Waddesdon Manor. All these houses were luxurious retreats from the banking world and were equipped with the latest technology, including gas, water, electricity and lifts in what often seemed like a competitive manner (Figure 2).

There were, however, some notable examples of innovation among established landowning families. The 3rd Marquess of Salisbury at Hatfield House in Hertfordshire was a keen

Figure 2. Ascott, Buckinghamshire: buildings erected in the 1890s for Leopold de Rothschild, housing a steam-powered electricity generating plant and sawmill. Nearby are the remains of private water works and sewage plant and an earlier gas works

experimenter with electricity, among other things and, according to one of his staff, 'would scarcely believe it was possible to get an electric shock, until he got one himself' (Hatfield House Archives, *c*. 1908). His experiments with high-voltage AC generation in 1881 resulted in the death by electrocution of one of his gardeners (Gooday, 2008: pp. 76–82). As early as January 1874, he experimented with arc lamps powered by batteries for a ball, and by 1882 parts of the house were lit by electricity from a turbine and dynamo in an old sawmill. The 8th Duke of Marlborough at Blenheim Palace, perhaps influenced by his American wife, sought help from across the Atlantic by corresponding with Thomas Edison over his own early experiments with electricity. Equally, Algernon, 4th Duke of Northumberland, who had served in the navy before inheriting Alnwick Castle in 1847, was another aristocrat interested in technological innovation, and introduced early hydraulic systems for powering lifts into his property, even before Armstrong did so at Cragside (Figure 3).

Bachelordom seems to have prompted some landowners to spend their time and money on the improvement of their houses. Examples include the 6th Duke of Devonshire at Chatsworth, who erected a large gasworks and employed Joseph Paxton to build his great conservatory, and the eccentric 5th Duke of Portland at Welbeck Abbey, who built extensive underground tunnels and suites of rooms there, as well as a piped water supply and gasworks. Another group of lordly innovators were the newly inherited, particularly if their estates had been neglected by their predecessors. One such was Francis Greville, who inherited the title of the Earl of Warwick in 1893. He had married the beautiful Daisy Maynard in 1881 and, for her birthday in 1894, he had the castle lit with electric

Figure 3. Alnwick Castle, Northumberland: hydraulic machinery for dumb waiter, c. 1860s. The castle had many other early examples of hydraulic lifts

Figure 4. Warwick Castle: watermill adapted for electricity generation in 1894

light driven from a turbine and dynamo in the old mill on the River Avon (Figure 4). In other cases, estates previously encumbered by debt were leased out to more wealthy tenants who undertook technological innovations, such as Lord Howard de Walden, who leased Chirk Castle in 1911. One visitor said in 1929, comparing his later visit to an earlier one when they had worn fur coats to sit down to dinner, that 'the old castle was to take on a new lease of life. Wands were waved over it, which in a surprisingly short time transformed it into a model of comfort and luxury. Electricity gave light to its eyes, central heating warmed its heart, giving it an added hospitality, and a profusion of bathrooms seemed to appear from nowhere, till it became once more, surely, one of the most enviable places in the British Isles' (Morritt, 1929).

In the context of all these innovations, it should be noted that many other houses remained surprisingly un-modernised well into the twentieth century, sometimes because of costs but often by the choice of the owner. Felbrigg House in Norfolk was bought by John Ketton, a Norwich merchant, in 1863 and he was reluctant to change the house in any way; electricity only arrived in 1954 and central heating was not installed in this chilly corner of Norfolk until 1967. The Yorkes at Erdigg, despite deploying various technological innovations on their estate, prohibited motor vehicles until the 1960s and did not introduce electricity into the house. A similar state of affairs

prevailed at Calke Abbey in Derbyshire under the notoriously reclusive Harpur-Crewe family. At Canon's Ashby in Northamptonshire, one of the last of the Drydens, Henry, was known as the 'Antiquary' and preferred not to alter the house, continuing to use the earth closet in the Pebble Court until his death in 1899. However, owners like Henry the Antiquary could only continue to do this as long as they still had enough servants to maintain the family in the state to which they were accustomed. The strict life of the servants' hall made domestic service less and less attractive to young girls in particular, when they could earn more and lead a less constrained life in industry or retailing. The First World War exacerbated a trend already in existence, and by the 1920s, labour-saving devices, often previously thought of as the eccentricities of particular individuals, now became a necessity, hence the enormous increase of advertisements for mechanised laundries and piped vacuum cleaning systems in journals aimed at the gentry.

3. Accommodating new technology

The major structural alterations required to install the latest forms of technology, such as heating, sanitation and transportation, in ancient properties added to the expense and often delayed their adoption, so the most striking examples of innovative technology are generally houses that were built or rebuilt in the second half of the nineteenth century, a period of particularly rapid technological change. The prominence of the Rothschild family in this respect has already been highlighted, but another notable innovator was the 3rd Marquess of Bute, whose family's mineral reserves in south Wales made him one of the wealthiest men in Britain. As well as rebuilding the ancestral seat, Mount Stuart, in the 1870s incorporating the latest in modern comforts, he employed architect William Burgess to do the same with Cardiff Castle and to build the nearby Castell Coch.

Mount Stuart was one of many houses that were rebuilt during this period following fires. Such modernisations were inevitably distinguished by their attention to fire precautions, such as the adoption of 'fireproof' construction techniques that had hitherto been used in textile mills, and pressurised rising mains, usually running up the servants' staircases. These were mostly supplied with water from reservoirs on nearby hillsides or from tanks built into ornamental towers. One example of this is Kelham in Nottinghamshire where George Gilbert Scott had been employed to make minor alterations to an essentially eighteenth century house and suddenly found himself rebuilding the entire house following its destruction by fire in 1857. Similarly, Cliveden in Buckinghamshire, bought in 1849 by the Duke of Sutherland for his wife, was burnt down during redecoration in the same year, and the massive clock tower, built in 1861 by Henry Clutton and modelled on Barry's design at Trentham built 20 years earlier, held a tank holding 17 000 gallons of water, which was pumped under the Thames from an artesian well in a model farm the other side of the river (Figure 5). Lanhydrock in Cornwall was devastated by fire in 1881 and rebuilt by Thomas, 2nd Baron Robartes, who employed Richard Coad to rebuild and modernise the house, resulting in a high Victorian interior with the comforts of central heating and running water inside what appears to be a much older house. Coad's scheme included elaborate measures to prevent the spread of fire, including prefabricated mass concrete ceilings and steel roof joists.

Figure 5. Cliveden, Buckinghamshire: ornate tower built in 1861 to hold water for fire hydrants and domestic use

4. Priorities for comfort and convenience

While each house owner had their own individual preferences and priorities for improving the comfort and convenience of their property, current research has revealed some general trends in the speed at which new technology was applied to different aspects of domestic life, some examples of which are described below.

4.1 Water supply and sanitation

Water supply was essential for any household and, although a few houses were fortunately placed to enable water to be fed by gravity from nearby hills, most had to pump it up from rivers, springs or wells to tanks in towers or in the roof spaces of the house. Manual pumps continued to be used for this purpose, in a few cases as late as the early twentieth century, but horse or donkey-powered pumps were employed from the sixteenth century onwards; good examples still survive at Greys Court in Oxfordshire and Houghton Hall in Norfolk (Bowden-Smith, *c.* 1987). Water wheels were being used to drain mines in the early

sixteenth century, but not until the late seventeenth century was thought given to using a similar system to supply water to houses. At Blenheim Palace a water wheel built into an ornamental bridge dating from 1705 pumped water up to a tank in a gatehouse. At Petworth, a water-driven pump was installed in 1782 by the 3rd Earl of Egremont to supply water to the house and Petworth village from the River Rother. The supply to the house was supplemented from a well in the basement, where a donkey-driven pump was installed in the nineteenth century. Examples of pumps powered by water wheels also survive at Belton House in Lincolnshire (Figure 6) and Attingham in Shropshire. Later, hydraulic rams were often used for this purpose; these used water from rivers or springs at a fairly low head of pressure to pump a smaller quantity of water to a higher level. These became common on country house estates during the nineteenth century; one major manufacturer was John Blake Ltd of Manchester, who supplied many country houses and published lists of those they supplied in their illustrated catalogues (John Blake and Co., n.d.). In the 1860s, Sir William Armstrong at Cragside made use of large hydraulically powered double acting pumps, using water from lakes above the house, to pump water collected from springs up to a small reservoir on the hillside and thence into his house, where it was used for sanitation, hydraulic power and fire hydrants (Irlam, 1988).

These innovations made piped cold water available throughout the house, but it was only in the second half of the nineteenth century that heat exchangers or calorifiers were developed to allow hot water to be distributed as well. Even then, most owners and their guests preferred to use hip baths in front of the fire of their bedroom or dressing room rather than using a purpose-built bathroom; often, into the early twentieth century, the only fixed baths were to be found in servants' quarters. A piped water supply was also essential if water closets were to be used; the earliest examples of these were installed in the late seventeenth century. However, even in the late nineteenth century, these, too, were often confined to indoor servants' areas and the 'gentlemen's domain' (the smoking and billiard rooms), while chamber pots and commodes remained widely used elsewhere in the house until the twentieth century.

4.2 Lighting

Lighting was one aspect of the country house where significant investment was often made on new technology. The candles and simple oil lamps that were the only source of artificial light until the late eighteenth century were ineffective, especially for larger spaces. The cost of these was also significant, even for wealthy landowners (and prohibitive for most of the population). The first innovation in lighting technology was the Argand oil lamp, invented in 1780, which used a hollow wick and glass chimney to produce a light equivalent to about 10 candles (Dillon, 2002: pp. 100–102). In towns and cities, Argand oil lamps were generally supplanted by gas lighting from the first decade of the nineteenth century, but the isolated nature of country house estates meant that they usually had to install their own plant if their owners wanted gas (or, later, electric) lighting (Figure 7). Analysis of over 250 country house gasworks indicates that only six are known to have existed by 1850, almost half a century after gas lighting was first introduced, whereas the majority of factories and public buildings had gas lighting by then, which supports Girouard's view, quoted above. Electricity did attract notable early adopters among country house owners, including

Figure 6. Belton House, Lincolnshire: remains of water-powered pump dating from mid-nineteenth century, supplying water to the house and gardens

Figure 7. Culzean Castle, Ayrshire: gas works remains

Sir William Armstrong at Cragside and David Salomons at Broomhill in the late 1870s, followed closely by Lord Salisbury at Hatfield House and brewer Octavius Coope, whose house, Berechurch Hall in Essex, built in 1882, was probably the first house in Britain to have had electric lighting from the outset (Anon, 1882). Electricity was introduced into country houses far more enthusiastically than gas had been; by 1905, only 25 years after the birth of domestic electric lighting, at least 400 houses in Britain had their own electricity generating plant. This enthusiasm might have been partly due to the practical advantages of electric lighting, which did not produce unpleasant and damaging fumes like its predecessors, but was also driven by fashion and a desire for modernity. The introduction of gas and electric lighting did not, in any case, bring an end to the use of candles and oil lamps in country houses. Their light was considered more flattering to female complexions and to have a grand dinner party lit by dozens or even hundreds of wax candles was a conspicuous demonstration of affluence.

4.3 Heating

While householders in western Europe and north America were quick to embrace enclosed stoves as a more efficient alternative to open fireplaces, these were not widely adopted in houses in Britain. A few early examples do survive – for example, at Calke Abbey in Derbyshire and Castle Coole, County Fermanagh, but the main evidence for technological development to replace open fires is to be found in industrial and public buildings in which the traditional open fireplace was less suitable. Foremost among these were cotton mills, where high temperatures were needed to prevent the threads breaking. It was probably for his father's mills in Belper in Derbyshire that William Strutt designed the cockle stove in 1807, an iron stove encased in brick that was placed in a basement and warmed the rooms above by means of flues leading to grilles in the floor. One of these was installed shortly afterwards in the Derby General Infirmary, and publication of a drawing and description of the stove in Charles Sylvester's 'Philosophy of domestic economy' in 1819, undoubtedly helped to promote it, but the large air ducts required made it difficult to install such systems in existing houses and they found more favour among country house owners for heating greenhouses (Sylvester, 1819). However, a few houses built or rebuilt in the second quarter of the nineteenth century heated their principal ground floor rooms with warm air ducted from chambers in the basement containing coal-fired furnaces or boilers and heat exchangers; the remains of such systems can been seen at Wrest Park in Bedfordshire and Penrhyn Castle in Gwynedd. More compact versions of such stoves were made by the firm of G. and J. Haden of Wiltshire from the 1820s onwards, an example of which can be seen at Erddig in Clwyd (Figure 8).

Steam heating was used by Sir John Soane in some of his public buildings, and a great advance was made by Angier March Perkins' patent of a closed high pressure hot water central heating system in 1831, but steam boilers required fairly

Figure 8. Erddig, Clwyd: Haden warm air stove

constant attention, which was probably one reason why such systems were not widely adopted domestically, a rare example being Alnwick Castle (Griffiths, 1992; www.hevac-heritage.org). Circulating hot water systems with radiators (often under the floors) became popular in the last quarter of the nineteenth century but these had to rely on convection to carry the hot water through the system so they were inevitably limited in their range. A large house might have had a number of boilers in the basement, each only circulating hot water to radiators in the rooms immediately above. Aside from the technical limitations of central heating systems until the advent of electric pumps, many householders had a philosophical objection to such heat sources, believing their lack of natural ventilation to be unhealthy; the open coal fire thus remained the main means of heating the country house well into the twentieth century.

4.4 Communications

Communications systems present one of the most interesting and least-understood aspects of country house technology. The

increasing passion for the efficient running of country houses, particularly in the nineteenth century, resulted in a multiplicity of small rooms in the service areas, each with its own function. Together with the desire to make the functioning of the house invisible, this made it much more difficult to keep track of servants and summon them when wanted. Most houses had sets of sprung servants' bells in lower corridors; notable examples include Erddig, Dunham Massey, Penrhyn Castle in Gwynedd, Burghley House in Lincolnshire (Figure 9), Dyrham Park in Gloucestershire and Manderston in Berwickshire. The location of these bells is an important aide in the analysis of the operation of the service quarters. For example, at Calke Abbey in Derbyshire, there are 27 mechanical bells on the ground floor, nine at the top of the stairs down to the kitchen and 18 in the adjacent corridor outside the butler's pantry, a common location for bell boards so that the butler could summon the necessary servants. Another set of bells in the first floor servants' corridor seems to have been used for summoning female staff to the nursery wing and bedrooms. Most bell boards have some bells of different sizes so that servants would learn to distinguish some by sound and know to which room they were being summoned, but usually they would have to run to the board to see which bell was in motion. These mechanical bells were operated by the often elaborate bell pulls and levers that can be seen beside fireplaces and in bedrooms, while the remains of the mechanical wires, often running in copper pipes, and cranks can still be seen at cornice level and in attics. A good example of this is Traquair House, reputed to be the oldest inhabited house in Scotland, where the nineteenth century bell wires are draped across much earlier cornices. Sometimes these bell levers are labelled, for example 'up' and 'down'; the former would summon a house maid from 'upstairs', the latter perhaps a footman from 'downstairs'.

Figure 9. Burghley House, Lincolnshire: mechanical servants' bells

Electrical bell systems were often introduced some time before houses had an electricity supply. Chatsworth's bell system, an early example, was installed at around 1880, whereas their electricity supply dates from 1892–1893. Frederick Allsop published a practical handbook on this subject in 1889, referring to the 'great and increasing demand for electric bells in this country' (Allsop, 1889). These early electric bells were generally powered by Leclanché dry cell batteries. The bells required a great deal of wiring, although this was easier to install than the wires for mechanical bells; the annunciator boards were usually placed strategically, in similar locations to the mechanical bells they supplanted. Bell pulls and levers were replaced by bell pushes, which were still often designed according to the status of the room. Some of the most remarkable of these can still be seen at Cardiff Castle, made in the estate workshops and fashioned into animals such as monkeys, lions and tortoises. Servants still had to consult the annunciator board to discover where service was required and then, often, go to the room indicated to find out what that service was, so electric bells offered no practical advantage over mechanical ones – they were simply more fashionable.

Speaking tubes, examples of which can still be seen at Ickworth in Suffolk and Canon's Ashby in Northamptonshire, offered some improvement in efficiency, because instructions could be relayed directly, but these were limited in range and raised concerns about privacy; they also generally only provided communication between two fixed points, although Attingham in Shropshire has an unusual 'two way' example. Telephones therefore provided greater convenience as it became possible to issue requests directly to the relevant department in the servants' quarters. Early telephone systems were often also powered by Leclanché cells and there are good surviving examples at Chirk Castle (Figure 10), Dunham Massey, Waddesdon Manor, Castle Drogo in Devon and Petworth in Sussex. Most were installed in the first two decades of the twentieth century but there are some earlier examples. As with mechanical and electric bell systems, more research is required to understand when telephones were adopted by wealthy

Figure 10. Chirk Castle, Clwyd: electric bell annunciator boards and internal telephone system

landowners and how they were positioned in the house. Pamela Sambrook records that telephones were hated by the servants at Dunham Massey because they required immediate attention, whereas a certain delay in response to bell systems was expected (Sambrook, 2003: p. 199). Early country house telephones were for internal use only, as there was no external network with which to connect in rural areas until well into the twentieth century. At Chirk Castle, for example, the butler could telephone the garage and electricity generator house (which also happened at Brodsworth Hall and Waddesdon Manor) but telegrams had to be used to place food orders with external suppliers.

5. The impact of domestic technology

These innovations had profound effects on the household on both sides of the baize door. The members of the huge country house parties of the Victorian and Edwardian eras may not have been aware of the many servants, both male and female, who kept the house running, especially as house owners went to great trouble to keep their staff out of sight. The reaction of servants to modern technology was often very mixed. Some lost their positions as a result of it; others had to undertake additional tasks they had not been trained for, such as running gas or electricity plant. One writer pointed out in 1912 that the steam engine required to run the refrigeration plant at one country house had been maintained by the laundress for the past 2 years while, in another house, the gardener had been made responsible for the suction producer gas-powered electricity generating plant (Gordon, 1912: p. 93; Hird, 1912: p. 106). The Great War was, however, a turning point in the history of domestic service. By 1920, Randall Phillips, Editor of *Homes and Gardens*, could write a book entitled 'The servantless house', in which he encouraged those running their houses with minimal staff to adopt various labour-saving devices to make themselves comfortable and eliminate unnecessary work (Phillips, 1920). Initially, the greater houses were insulated from such austerity and, even after that war, domestic service was still the main employer of female workers and the second largest employer of workers of both sexes (Sambrook, 2003: p. 196). However, for the great majority of them, technological innovation had made great inroads into the functioning of country houses and the remaining servants had to learn new ways of carrying out their tasks.

6. Conclusions

Mark Girouard, in his 'Victorian country house', wrote that Victorian houses were 'enormous, complicated and highly articulated machines for a way of life which seems as remote as the stone age, served by a technology as elaborate as it is now obsolete'. He added that 'the houses have now become, only too often, stranded monsters, with abandoned gasworks, abandoned billiard tables, gigantic boilers and miles of pipes rusting in the basement, rows of bells rusting in the back corridors, the butler's pantry, brushing rooms and laundries empty, or occupied in this new society by typists, nurses, schoolgirls or delinquents' (Girouard, 1979: p. 27). However, 30 years later, public taste has changed in that things Victorian, from churches to houses, are now more highly valued, as the National Trust demonstrated with its acquisition of Tyntesfield. Moreover, the composition of the visiting public at country houses has changed considerably in the twenty-first century, with families rather than connoisseurs of furniture or art making up a large proportion of the visitors. While many of them appreciate seeing how the landed gentry lived, they are also interested in the work of the servants; the growing interest in family history has fuelled this as many people have ancestors who worked 'in service'. This has encouraged property staff at both National Trust and privately opened houses to devote more attention to interpreting the 'below stairs' areas, and to organise tours of previously hidden parts of properties like the 'butler's trail' at Dunham Massey. As well as facilitating the interpretation of these remains, research into country house technology also has a more practical purpose as environmental concerns are prompting the National Trust and other

organisations to investigate the reintroduction of 'green' technology such as hydroelectric generation, biomass boilers, rainwater harvesting and reed filter sewage beds.

For more information about the Country House Technology Project at the University of Leicester, visit http://www2.le.ac.uk/departments/archaeology/research/centre-for-historical-archaeology/research-1/country-house-technology. A major book by the authors on this subject is due to be published by the National Trust in 2013. All illustrations in this paper are copyright of the authors.

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