Arts & Humanities Research Council

Lotherton Hall

UNIVERSITY OF LEEDS

Electrifying the country house: taking stories of innovation to new audiences

Cragside animations - supporting information

As part of the 'Electrifying the Country House' project at the University of Leeds we have developed animations depicting three electrical artefacts or systems at Cragside, a National Trust property in Northumberland. These are: the cloisonné vases in the Library, the arc light which hung for a few years in the Gallery before the Armstrong installed Joseph Swan's incandescent filament lightbulbs, and the hydroelectric system which provided electricity for the house. In the hope that these might be useful as teaching resources, links to each of these are given below.

1. The cloisonné lamp

The four cloisonné vases in the Library were first electrified in December 1880, before which they were oil lamps. This animation depicts the workings of the vases at this time, and in particular how they were turned on and off. The animation is based on a letter written by Armstrong to the *Engineer* journal in January 1881, which specifically describes how the vases were electrified. This letter is not entirely clear, but it is the only record we have.

At this time, switches were not readily available, so another method needed to be found to switch the lamps on and off as required. The animation illustrates how this was achieved using mercury. As the front of the vase fades away, we see the bulb is illuminated and electricity is flowing (represented by arrows). The vase was placed on a metal base (depicted as a disk) which was connected to the electricity supply by two wires - the second to return the current and thus complete the circuit. In the centre of the metal disk was a small dish of mercury, which is a metal, and so is a conductor of electricity, but is also a liquid at room temperature.

A wire ran down from the bulb at the top of the vase and dipped into the dish of mercury. Because the vases themselves were made of copper, the body of the vase could be used as part of the circuit, to return the current. The flow of electricity is thus depicted by the arrows: up the central wire via the mercury dish to the bulb, and then back down the sides of the vase. The vase could therefore be switched off by lifting it up off the metal disk, thereby breaking the circuit, or switched back on by putting it down again, as the animation illustrates.

This raises a question, namely: didn't people receive an electric shock when moving the vases? We're not really sure about this, although we suspect that the enamel over the copper should have acted as an insulator sufficient to protect the user. Otherwise it is possible that insulated gloves would have been used. Perhaps tellingly, Armstrong did not mention this in his letter: possibly he didn't think the issue of electrical safety would be the most interesting thing for his readers!

The rather unusual way in which these vases were electrified tells another interesting story about the history of electricity in the home: Armstrong worked with his friend, the Newcastle-based inventor Joseph Swan to install the new lightbulbs throughout Cragside, but, as the very experimental nature of the electrification of the cloisonné vases indicates, this was done in a hurry. The reason was that Swan was involved in a race with his rival, Thomas Edison in America, who had also recently perfected a lightbulb for commercial use. Both wanted to be the first to be able to demonstrate a practical, working installation in order to establish primacy and to market their inventions. In this Swan was successful, partly due to Armstrong's support and assistance.

2. The arc light

Although there is nothing left to see of this system at Cragside itself, the first electrical light in the house was not provided by lightbulbs, but by an arc light which Armstrong hung in the Gallery from 1878 until it would have been replaced by lightbulbs in late 1880. Arc lights were very bright lights usually used to illuminate outdoor spaces: the ancestors of today's street lighting.

The animation depicts a Siemens arc light which became commercially available in the mid-1870s. This light worked using two vertically mounted carbon rods, as seen in the animation, through which an electrical current was passed. The rods had a gap between them, and as the current jumped across this gap it created a bright spark of electricity called an arc. The gap had to be just the right size: if it was too big the current would not be able to jump across and the light would dim and go out; if it was too small the arc would be too small to generate sufficient light. However, as the arc light was used the carbon rods burned away, so it was important to ensure that the gap between the rods remained constant. Therefore, as the animation shows, a clockwork mechanism was employed to move the upper rod down as the gap increased. Eventually, however, these rods would need to be replaced.

It was not common to bring such a light as this indoors – for comparison teachers might ask pupils whether they would like a street light in their living room! The light was harsh,

inconstant, and flickery, and buzzed noisily, as you can hear in the animation. It was even smelly as the carbon rods burned away. When Armstrong installed Joseph Swan's lightbulbs in December 1880, he compared them favourably to the arc light, saying:

> "…the light produced by [Swan's lightbulbs] is free from all the disagreeable attributes of the arc light. It is perfectly steady and noiseless. It is free from harsh glare and dark shadows. It casts no ghastly hue on the countenance, and shows everything in true colours. Being unattended with combustion and out of contact with the atmosphere, it differs from all other lights in having no vitiating effect on the air of a room."[1]

We don't know what others thought of Armstrong's use of an arc light indoors, but another man who installed an arc light experimentally indoors was the 3rd Marquess of Salisbury, Robert Gascoyne-Cecil - three times Prime Minister - at his residence Hatfield House, near London in 1880. We know from his daughter Gwendolen's biography of her father what his female guests thought of being made to eat their meals underneath the arc light he had installed in the dining room, and it wasn't complimentary!

> "For a brief period [Salisbury's] family and guests were compelled to eat their dinners under the vibrating glare of one of these [arc] lamps in the centre of the dining hall ceiling. No exertion of goodwill or courtesy could silence the plaintive protests of his lady visitors, and he would gird with growing despondency at the obstructions which feminine vanity offered to the conquests of science."[2]

Indeed, Armstrong's experiments with Swan's bulbs encouraged Salisbury to try using them instead. Armstrong powered this arc light using a hydroelectric system built at Debden Burn in 1878. It used a Siemens dynamo, an example of which can be seen in the Power House. It was this system which earned Cragside the distinction of being the first house to be lit using hydroelectricity.

[1] W[illiam] G. Armstrong, 'Description of the Swan Incandescent Lamp, as used in Country Mansions, &c', in the *Engineer,* letter dated 17 January 1881.

[2] Lady Gwendolen Cecil, *Life of Robert, Marquis of Salisbury* vol. 3, (1880-6), 5 vols. (Hodder and Stoughton, 1931) pg. 3-4

3. The hydroelectric system

This animation demonstrates how the hydroelectric system at Cragside worked, focusing on the later 1886 Burnfoot Power House rather than the earlier 1878 hydroelectric installation at Debden Burn (although this was similar, and was used to power the arc lighting Armstrong installed in the Gallery). Armstrong had Nelly's Moss Lakes built at the top of the hill, and these supplied water via an underground pipe down the hill to turn a turbine in the Power House, below the main house. This turned the dynamo to generate electricity, which was then conveyed by wires to the house.

The dynamo used was a Crompton DC generator, producing 110 volts, although by 1895 demand had grown such that a second generator was required, a Thomas Parker dynamo installed by Drake and Gorham, London (150 volts).[3] The dynamo was also used to charge up the batteries, of which there would have been many in the Power House. These were lead acid batteries, like those used in cars. The batteries were used to supply more electricity when demand was higher (for example when more lights were in use) or when the dynamo was supplying less than expected due to reduced flow of water through the turbine.

The animation then depicts some of the lights in house coming on, but not all of them. We then zoom in on the telephone in the Butler's Pantry, which was connected to one in the Power House. When more electricity was needed to power more lights, the butler could use this telephone to ring the Caretaker of the Electric Light (as the man in charge of the generator was known) and ask him to supply more electricity. The animation shows this simply as the movement of a lever: this operation might have been performed by switching resistance coils out of the circuit (thus decreasing the resistance and effectively making more current available for the lights in the house), or by switching the batteries into the circuit. After this happens in the animation we see more lights coming on in the house, represented by the cloisonné lamp in the Library, until it is entirely illuminated.

Sometimes the supply of water from the lakes was insufficient to power the dynamo, and this was why Armstrong later installed a gas engine as well to generate electricity as a back-up. Systems like this were fairly common at this time; early electrical installations needed to be self-sufficient, with generators often installed at a distance from the house because they were so noisy. From the 1890s there were some smaller local centralised electricity supplies in urban areas, but there were not many of these and even when they became more common houses such as Cragside in remote rural areas still needed to generate their own electricity.

[3] Geoffrey A. Irlam, 'Electricity Supply at Cragside', in *Industrial Archaeology Review,* 11:2 (1989), pg. 187-195

Hydroelectric systems became quite a common way to do this in the late nineteenth and early twentieth centuries. Most estates had a source of running water which could be used for the purpose. The appeal was that once the initial costs of installing the plant had been met, generating the electricity was free. Indeed, in some ways this may have encouraged innovation: Armstrong, writing to the *Engineer* journal in January 1881 about his installation admitted that the way in which he worked his system was quite wasteful, but noted that "I can afford to waste that which costs me nothing, and is always sufficient in quantity." As he wasn't paying for the electricity he wasted he was better able to experiment in order to find the best way to run his electrical plant.

For those interested in some more technical details about the system, Armstrong gives these details in his 1881 letter:

> "The generator used is one of Siemens' dynamo-electric machines, and the motor is a turbine which gives off 6 horse-power, the distance of the turbine and generator from the house is 1,500 yards. The conducting wire is of copper, and its section is that of No.1 Birmingham wire gauge. A return wire of the same material and section is used, so that the current has to pass through 3,000 yards of this wire to complete the circuit. The number of lamps in the house is 45, but as I can switch off the current from room to room, I never require to have more than 37 in light at once. For this number of lamps, 6 horse-power proves to be amply sufficient, notwithstanding the great length of the conducting wire."

To read more about the work done as part of the 'Electrifying the Country House' project, please visit our website and read our blog at www.electrifyingthecountryhouse.org.