

The French Romantic novelist George Sand, born Aurore Dupin, wrote *The Seven Strings of the Lyre* during the early days of her decade-long affair with Frédéric Chopin. This ‘woman’s version of the *Faust* legend’, published in 1839, featured a magical instrument – not a piano, but a richly ornamented lyre of ivory. The heroine, Hélène, receives it at her birth, though she is forbidden to play it. Mephistopheles, disguised as an antiques dealer, tries to get hold of the harp and through it, the souls of Hélène and her protector, the philosopher Albertus.

When Hélène at last plucks the lyre’s strings, she awakens its spirit. Its vibrations immerse her in ‘powerful harmonies’ and a ‘dazzling spectacle’ which evoke sorrow and joy, the entire chromatic scale of human emotion and experience. A gloomy ‘sea of sand’ becomes a glorious cityscape of gleaming towers, fountains, and a river like ‘a serpent of gold and azure’, while the ‘confused clamour’ of human activity modulates into an ‘imposing concert’:

myriads of terrible or sublime harmonies are confused in a single roar, a thousand times more powerful than that of the tempest: this is the voice of industry, the noise of machines, the hissing of steam, and the blow of hammers, the rolling of drums, the fanfare of military phalanxes, the declamation of orators, the melodies of a thousand different instruments, cries of joy, of war and of work, the hymn of triumph and of might.¹

Sand’s enchanted lyre was one of the many magical instruments, tools, and machines that danced through the music of the long nineteenth century: from Mozart’s *Magic Flute*, the charmed bullets in Carl Maria von Weber’s *Der Freischütz*, or the 1805 collection of folk songs, *Des Knaben Wunderhorn* (*The Boy’s Magic Horn*, set to music by Mendelssohn, Schumann, Brahms, and Mahler), through to the animated machines and toys in Offenbach’s *Tales of Hoffmann* and Tchaikovsky’s *The Nutcracker*. Yet Sand, the great Romantic author, set her play not in the time of childhood or fairy tales, but her own: the early Industrial Revolution. In the mid-nineteenth century, production of all kinds was being concentrated and amplified with new forms of organisation and new inventions, much of it driven by steam engines and other inventions.

In the Romantic era, critics and theorists sometimes portrayed music as ideal and transcendent, as the sound of feeling, a force striving to realise the purity of immaterial spirit or abstract form. This strand of interpretation, focusing on works' pure musicality, runs from German Idealism and the writings of Romantic authors such as E. T. A. Hoffmann through to Richard Wagner and his followers. Yet the composers, performers, critics, audiences, and promoters of Romantic music – including Hoffmann and Wagner themselves – were also sharply aware of the unavoidable necessity and importance of concrete technology, in new instruments, stage design, architecture, and printed publicity. Inventions and technical adaptations, from new and improved instruments to new lighting and staging techniques, were at the heart of many of the defining characteristics of Romantic music: the sense of wild, dangerous, creative energies in both nature and human arts, the exploration of the most exalted and sombre of human emotions and visionary states, restless formal invention, and appeals to both the intimacy of the individual soul and to vast audiences.

George Sand's vision of the harmonies of labour and industry was partly inspired by the ideas of the social philosopher Pierre Leroux, who envisioned the ongoing spiritual evolution of humanity through symbolism, the arts, and the redistribution of property. Leroux was one of many utopian thinkers of the early nineteenth century, including such early socialists as Charles Fourier, Etienne Cabet, Flora Tristan, and the young Karl Marx, all of whom were imagining a more just and equal society in which industrial machinery would play a central role. This was also an era of intensified European imperial expansion, with organised military technology making possible the violent acquisition of new territories and subjugation of their inhabitants. In the sounds and visions summoned by Hélène's lyre – of steam, banging hammers, and marching armies – Sand conjured up the creative, destructive, world-changing powers of industry, oscillating between dissonance and consonance.

The cultural critic Edward Said wrote that Giuseppe Verdi's 1870 opera *Aida* – whose central plot concerns the doomed love between an Egyptian general and an Ethiopian slave – 'is not so much *about* but *of* imperial domination'; in complicated ways, Said argued, every aspect of the work participated in the logic of the conquest and colonisation of foreign peoples.² At the end of this essay, we will return to Said's suggestion about Verdi's opera. More generally, we might adapt his formulation to think about the relationship between Romantic music and technology. Romantic music is *of* technology: entirely dependent on well-established and radically novel arrangements and uses of material implements for its

effects. Yet Romantic music is also frequently *about* technology. Its conception, performance, and reception often directly or indirectly reference, portray, and allegorise the promises and dangers of machines and technical domination, participating in wider logics of analysis, production, and control.

Romantic music often presented itself as a consolation against the violent changes, profound uncertainties, and fierce social tensions of industrial modernity – an entertaining or distracting flight into a nostalgic past, the comforts of nature, erotic bliss, spiritual uplift, or dream-like mythologies, including fantasies of national unity. Through its dependence on technology, and its ability to reflect upon its consequences, Romantic music was also an exemplary manifestation of its age.³

An Extended Palette

Romantic artists used all available technical means to create strong impressions and remarkable experiences in their audiences. For musicians and composers, this meant an obsessive focus on instrumentation, selecting the instrument which would provide the exact colour or timbre for each moment. At the time of Haydn and Mozart the orchestra typically contained two dozen instruments, with melodies largely carried by the strings, and brass filling in background tone, led by a seated performer – often the composer at the harpsichord or fortepiano. Instruments like the clarinet and trombone were introduced in certain works by Mozart, but by the middle of the nineteenth century the orchestra had expanded greatly. Beethoven introduced the contrabassoon, Mendelssohn the ophicleide (a kind of tuba), while Berlioz brought in the cornet and the harp, and further deepened the low end with the gigantic ‘octabass’. The early nineteenth century saw technical developments in wind instruments, introducing new valves and keys as well as pad extensions in woodwinds and brasses, allowing performers to play notes more rapidly and to allow the brass to remain in tune in multiple keys. Using methods of mass production and assembly lines, instrument makers such as inventor Adolphe Sax rolled out new horns, including brasses with reeds, as in the saxophone.

Instrumental innovations often involved collaborations between composers, performers, instrument makers, and scientists. The field of acoustics was on the rise, with studies and treatises from scientists including Ernst Chladni, Felix Savart, Jean-Baptiste Biot, and Ernst and Wilhelm Weber paving the way for Hermann von Helmholtz’s monumental work

on the physics of sound and music in the 1860s. Similar partnerships were formed to examine the anatomical dimensions of musical performance.⁴ Devices were applied to teach and trace ideal hand posture on the piano; the 'laryngoscope' made it possible to inspect those aspects of soprano's throats that allowed them to soar into higher registers, and created science-based norms of good vocal performance. Studies of the ear – including the building of artificial ears – informed the design of instruments as well as the theorisation of the chain of musical transmission, from instrument to vibrating air to the ear's 'tympani' and onwards to the nerves, brain, and soul. The scientific study and optimisation of musicians' bodies implied a treatment of human performers as tools or machines within a wider technical assemblage.⁵

A remarkable development of late eighteenth-century music, with profound implications for the following century, was the consolidation of the orchestra as a relatively standard form, defined by several performers on each of the string, reed, and brass instruments, accompanied by percussion. Haydn's works did much to explore the capacities of the orchestra, effecting an 'orchestral revolution' which carried into the next century. Haydn demonstrated the flexibility of a large ensemble, playing one set of instruments off the other, moving themes across instruments, drawing out the unique meanings and tones of each – their 'personalities' – to assert a harmonious order to nature's diversity and a 'harmony between individuals and the collective whole'.⁶

The orchestra itself came to be seen as a single instrument, a machine composed of specialised parts – skilfully arranged by the composer and governed by the conductor, a role which became increasingly prominent in the early nineteenth century.⁷ This conception was reinforced in actual machines built around the turn of the nineteenth century, such as the Orchestrion, which could be programmed to perform multipart symphonies to amused crowds. Beethoven's 'Battle Symphony', *Wellington's Victory*, Op. 91, was originally composed for the Panharmonicon, built by Johann Maelzel, a Bavarian instrument maker who also designed a metronome, a mechanical trumpeter, and a speaking machine. It has been said the two loudest sounds anyone had ever heard in the early nineteenth century came from the battlefields of the Napoleonic wars and the concert halls in which the modern orchestra performed; the 'Eroica' Symphony, which Beethoven originally dedicated to Napoleon himself, linked both forms of technological bombast.

Some of the new instruments used in Romantic music came from other cultures. Musical treatises of the eighteenth century, such as Charles

Burney's *General History of Music*, had inventoried the world's musical offerings. Romantic music was often set in exotic locations – the Middle East, Asia, Africa – and composers added instruments from the musical traditions of these places in order to produce 'local colour', in a kind of auditory tourism – though often with the instruments' uses and meanings altered from their original settings. For example, the tam-tam or gong was traditionally used in South East Asia and China in court ceremonies and processions to mark the rank of different nobles and officials. In Romantic music, its sudden and shocking sound could mark endings and beginnings, as well as signifying magic and a violent entrance from another metaphysical realm.⁸

New and modified instruments were crucial for the high-impact mass performances of symphonies and operas. If the classical music of the eighteenth century most often involved command performances in royal and aristocratic courts, Romantic music was a central part of the nineteenth century's emerging mass entertainment aimed at the rising bourgeoisie. New concert halls were built with acoustic impact in mind; opera houses became sources of civic pride, showcases for architectural beauty and technical prowess, featuring indoor gas lighting which could now be lowered, focusing attention on the stage and away from the crowd. There was furthermore a large marketplace for printed music, along with abundant criticism in specialist and general journals, carried forwards in unprecedented floods of mechanically printed words.

Technological innovations also played an important role in the more intimate settings of parlour and salon music. A steady stream of improvements to the pianoforte made it far more responsive than the harpsichord or clavichord – including the sustaining pedal, dampers to mute the sound of each note after being struck, and the double escapement mechanism, introduced by Sebastian Érard in 1821, which made it possible to sound the same note in very quick succession without waiting for it to return to its starting position. The result was a supple instrument with a wide dynamic range, covering several octaves, which allowed for extremely rapid successions of notes as well as sustained and resonant tones. Paganini dazzled audiences through his virtuosic mastery of the violin; with the improvements to the piano, the space was cleared for Liszt to demonstrate his prowess on the larger instrument, making it an extension of his own individuality. The music of figures such as Chopin and Schumann likewise made use of the piano's effects and dynamics to convey a wide range of emotional states, from melancholy and perplexity to exuberance and devotion.

Music in the era of Romanticism went beyond merely an ‘application’ of technology to being defined by what the media scholar Jonathan Sterne calls ‘technicity’: every aspect of music, in its production and its reception, whether sensory, emotional, philosophical, or critical, operated within a logic of mechanical manipulation and enhancement, precision and repeatability.⁹

Pipe Dreams

The exploration of imagination and fantasy, of pathological and altered states of mind, defined the arts of the Romantic era. The ‘pipe dreams’ of the opium addicts Samuel Taylor Coleridge and Thomas de Quincey, and of the ‘Club des Hashischins’ which included Charles Baudelaire, Théophile Gautier, and Eugène Delacroix inspired major works, while Berlioz’s *Symphonie fantastique* musically conveyed the effects of opium. Yet in even Romantics’ lush internal reveries, industry and technology were not far away. Experiments with drugs were taken as data in the emerging field of psychology, while philosophy inquired into the foundations of consciousness.¹⁰ Nitrous oxide, or laughing gas, was the first hallucinogen discovered in a laboratory, by chemist Joseph Priestley; it was tested by Coleridge’s friend, the chemist and poet Humphry Davy, and refined in a process developed by James Watt, the steam-engine inventor.

Explorers of the psyche – whether artists or scientists – also investigated the possibilities of mesmerism or animal magnetism. First popularised in the late eighteenth century by the Viennese doctor Anton Mesmer, in animal magnetism, sensitive individuals claimed to be able to access and control the invisible fluid responsible for life and thought. The magnetiser’s rhythmic magnetic ‘passes’ upon a patient placed him or her into an altered state, bringing about ecstatic pleasures and medical cures. Although a commission at the French Académie des Sciences in 1784 attributed Mesmer’s effects to patients’ overactive imaginations, a new generation of practitioners appeared in the 1820s and claimed new powers – reading and seeing at a distance, telepathy, communication with spirits – and suggested links between animal magnetism and the new science of character, phrenology.¹¹ Animal magnetism also resonated with the lightning-quick, elusive qualities of electricity, and both mesmerism and electricity helped inspire a musical aesthetics focused on ‘effects’. The electric telegraph’s ability to communicate and command at a distance

formed a further link: figures ‘entranced’ or hypnotised appeared on stage in musical opera, likened to automata or androids acting under invisible but mechanical command.¹² In a performance of 1844 Hector Berlioz actually employed an ‘electric metronome’ to transmit an impulse from a conductor to ‘subconductors’ of a large orchestra, while electricity was integrated into such musical spectacles as Luigi Manzotti’s 1881 ballet *Excelsior*, which featured a ‘Dance of the Telegraph Operators’.¹³

Both telegraphy and mesmerism drew upon the invisible forces, fluids, and ethers being actively researched in the mechanical sciences. While in the late eighteenth century, electricity, magnetism, heat, and light – called the ‘imponderable fluids’ – were seen to be independent of one another, after 1800 a wave of researchers in what has been called *Naturphilosophie* or ‘Romantic science’ examined the interrelations of these phenomena and the ways they could be converted into each other. A path-breaking discovery was made in 1820 by Hans Christian Ørsted, who showed that electricity and magnetism were modifications of a single underlying principle. Later researchers including Michael Faraday, Charles Wheatstone, and Joseph Henry investigated the relations amongst electromagnetism, light, and heat, while fundamental research on steam engines by Helmholtz, Sadi Carnot, and James Joule laid the foundations of thermodynamics, the laws of conversion of heat into motive force. By the middle of the century, physicists had embraced the notion of a single ‘energy’ which could be converted into any one of these forms with the proper technical interface. These phenomena were understood to travel as vibrations in an ether which surrounded and penetrated all bodies. This concept informed the understanding of music, and spurred reflections on the nature of the mind, soul, or spirit, and its ability to act upon the world. Ether was the vibratory medium within which all other media, including thought and feeling, made their impact.¹⁴

In these ways the fantasies of Romantic dreamers were closely tied to technical and scientific developments. Even more widespread ‘pipe dreams’ captured public attention in the Romantic era, in visions of industrial expansion: the Industrial Revolution was in fact a matter of pipes – tubes, valves, and cylinders, as in the cycle from hot to cold in the steam engine.¹⁵ Industrialisation meant conveying forces, fluids, and other materials from one location to another – from one end of a factory to the other, from sites of extraction to those of production, sale, and consumption. Engineers and scientists worked out calculations to maximise the efficiency of forces, goods, and people as they moved through a reticulated system of intersecting flows.

The general concept of ‘communication’ underwrote schemes to design large technical systems and networks to join distant places. Saint-Simonian engineers, including the political economist Michel Chevalier, and Prosper Enfantin, who led a mission of engineers to Algeria and Egypt, saw roads, railroads, and waterworks as the blood vessels for a new, peacefully organised civilisation, which would make national and regional boundaries obsolete; they devised plans to open canals in Panama and Egypt, joining East, West, North, and South, in a vast system of efficient circulation. Industrialisation, properly administered, would liberate the productive forces of the earth and society; guided by the emotional works of artists, the slumbering power and idealism of humanity could be awakened, to create a new, harmonious global society. The reflections of composers, instrument makers, architects, and performers to improve, direct, and increase the flow of sound were in keeping with these other forms of industrial speculation.¹⁶

Romantic Audiovisuality

In the Romantic era, music was deeply embedded in the culture of urban spectacle. Cities were drastically increasing their populations; the growing middle class had money to spend on entertainments: magic shows, comedies, tragedies, and ‘vaudeville’ stages. Industrial expositions promoted machines to make clothing, books, sculpture, and music, such as Maelzel’s mechanical trumpeters and harpsichordists. A wide audience grew for scientific lectures, in Paris’s Athenée and Conservatoire des Arts et Métiers, and in London in the Royal Polytechnic Institute, where Davy, Michael Faraday, Charles Wheatstone, and John Tyndall expounded the principles of chemistry and the physical sciences. Their performances featured striking experiments and demonstrations including explosions, demonstrations of electric lighting, magic lantern displays, optical illusions such as ‘Pepper’s Ghost’, and the seemingly self-playing ‘magic lyre’ display of Wheatstone, with harps suspended in the air which appeared to play themselves.¹⁷ In such spectacles, the sonic and visual were closely entwined.

Other new popular entertainments in London included the Cyclorama, which simulated geological catastrophes, and the Colosseum, which housed concerts, plays, and natural history collections. Many cities hosted the panorama – a large cylindrical building containing an elevated viewing platform from which spectators viewed 360-degree realistic painted

landscapes, city views, or battle scenes. The scale and optical principles of the panorama were repeated in painting, as in Géricault's *Raft of the Medusa*, and employed in stage design, where gigantic realistic painted backdrops sought to transport viewers to distant regions in line with the aesthetic ambitions of Romantic music.¹⁸ One prominent Parisian stage painter, with a studio near the vaudeville theatre and panoramas, invented a new entertainment he called 'the diorama', a painting on a semi-transparent screen of a landscape or interior, connected to a lighting system which gradually shifted to bring out different colours and shadings, changing a scene in spring to one in winter, or a daylight view into one of night, often accompanied by music and props – a technology of contrasts, of transformation. The inventor was Louis Daguerre, whose more famous invention, the daguerreotype – the first commercially viable form of photography – was originally intended as a technical aid for painting stage sets, including for operas.

Already in the late eighteenth century popular entertainments were fusing optical devices with music. Deirdre Loughridge has shown how a series of optical inventions, such as the microscope, shadow play, peep show, and phantasmagoria, created new visual experiences – picturing the very small; projecting images; separating spectators from the space of the objects they observed – which affected musical imaginaries: Haydn's *Creation* was the sonic equivalent of a 'magic lantern', while Beethoven created phantasmagoric musical effects heard as the interplay of dark and light. As the nineteenth century began, popular displays took on encompassing views of nature, including orreries and planetariums, machines which showed the moving order of the planets around the sun.¹⁹

Musical and visual technologies were brought dramatically together in Romantic opera, where it was impossible to separate appreciation for the music from the reception of the plot, acting, dancing, costumes, lighting, backdrops, sets, or special effects. The full suite of techniques of Romantic audiovisuality were brought together in the Paris Opera, notably in the work of Giacomo Meyerbeer. Meyerbeer's brother was the director of the astronomical observatory in Berlin; he was also in correspondence with the great scientist Alexander von Humboldt, who had a hand in most of the scientific and sensory inventions of the time and was an enthusiast of the panorama, daguerreotype, and telegraphy.

In his smash Parisian opera of 1831, *Robert le diable*, Meyerbeer joined audacious orchestration with new sights. A ballet of lascivious nuns cavorted in flesh-coloured tights to the sound of sinister bassoons; a diorama-like backdrop shifted its appearance from light to dark; explosions were made

by blowing clouds of seed on to gaslights; the entrance of the chords of a church organ was an unexpected 'sublime invasion'.²⁰ Critics and audiences commented as much on the visual spectacle as on the music. The libretto offered a compelling character who was the son of a devil; Robert worked witchcraft with a magical branch, which he broke to free his soul. This theme of Meyerbeer's opera cemented the impression, already made prominent in *Faust*, that there was something both magical and diabolical about technology.

The emphasis on technical control was taken yet further by Richard Wagner, who defined opera as a *Gesamtkunstwerk* – a total work of art – where material technologies of all sorts ensured an organic, ideal unity (even though Wagner sneered at the 'materialism' of Meyerbeer's works in a notorious anti-Semitic broadside, 'Jewishness in Music', a source for later attacks against Meyerbeer). To place all elements of the opera under his control, Wagner had a new hall built in Bayreuth where he could be the supreme master of puppets. The audience at his Festspielhaus, pilgrims in a religion of art, adopted a reverent awe towards Wagner's musical dramatisations of Norse mythology.

Technology was indispensable to Wagner's instrumentation and the design of the hall. Wagner also ordered brilliant lighting arrangements, flames, and hidden wires to simulate flight, and made use of billowing clouds of steam for the breath of a dragon and as a 'fade-out' in the transition between scenes. The special stage drapery that came to be associated with Bayreuth, the 'Wagner Curtain', performed a subtle but swift demarcation between dramatic units.²¹ The quasi-sacred aura of Wagnerian opera, with its aspiration towards a spiritual experience of pure musicality, was inseparable from an incomparable technological investment in every aspect of the performance. As if to bury the contradiction, unlike in previous concert halls, where the musicians were in the audience's line of sight, in Bayreuth Wagner hid his orchestra in a lowered space before the stage, making the source of the music invisible – a technical invention through which the technological dimension of music was either sublimated or denied.

Music and Technology as Show of Force

Our discussion so far has primarily shown how Romanticism was of technology: thoroughly dependent on technical interventions to realise its aims. The extent to which it was *about* technology is a somewhat

different matter. Can we say that a Schumann lied or a Chopin nocturne is 'about' technology? Each explores the sonic, emotional, and semiotic affordances of the voice and piano, and might be understood – at least by critics today – as a commentary on them. Likewise, the use of audiovisual technologies to produce enthralling visions, ecstatic transports, and uncanny or magical access to a supernatural realm – all recurrent themes in critical responses to Romantic arts – could be seen to reinforce a new understanding of the relationship between humans and nature: that art is nature continued by other means. Such a view recalls Renaissance theories of art as both a mirror and an improvement of nature. Yet with the vast new scale of the nineteenth century's 'mechanical arts' – and after passing through the Enlightenment's polarisation of art and nature, in which art was often considered a corrupting influence – the deliberate surpassing of nature in Romantic art often took on uncanny, colossal, or monstrous aspects.²²

Some works of Romantic music explicitly took technology as their theme, as in Berlioz's programme for the National Exposition of the Products of French Industry in 1844, which included his 'Hymn to France', praising his homeland's technological achievements. He repeated the feat in 1855 for the opening of the Palais de l'Industrie, France's answer to the Crystal Palace, with an orchestra of 1,200 instruments performing in a 'gallery of machines'. The Crystal Palace, at the Great Exhibition of the Works of Industry of All Nations in London in 1851, proclaimed a new control over nature: a gigantic transparent structure in which the entirety of the natural and human worlds could be presented as an interior, a mastered environment. In this enormous hothouse, plants from around the world thrived, while well-behaved masses observed, evaluated, and were suitably awed by the technical inventions and commercial goods produced by nations and their colonies. Other international expositions and World's Fairs soon followed. In 1861, Berlioz planned another 'monster-concert' to be performed in the Crystal Palace itself with a chorus of 10,000; his composition, 'The Universal Temple', with lyrics by Viard, proclaimed European unity and freedom for 'all the children of labour and art'.

Such works praised the benefits of technical progress. Yet the fascination in Romantic arts with demonic and diabolical technologies suggested a fundamental ambivalence about the 'magic' of new industrial forces and their staggering ability to accelerate production, shrink distances, and ferry information at lightning speed. Both sinister and optimistic portrayals of nineteenth-century technology highlighted anxieties about

agency and personhood. New inventions promised mastery, yet could easily escape those who used them, as in the legend of the sorcerer's apprentice. The recurrent image of mechanised (or mesmerised) subjects highlighted the blurring of boundaries between humans and machines, as well as technology's power to dominate and enslave.²³

Meyerbeer's opera *Le Prophète* premiered in Paris in 1849, during the period when the Provisional Government was in power in France after the worker's revolution of 1848. Technically, it was a wonder: Berlioz praised its orchestration, it packed delirious special effects onto enormous stage sets, including an ice-skating scene using roller skates; it concluded with a stunningly bright artificial sunrise, produced by an electric arc-lamp invented and operated by the physicist Léon Foucault. Thematically, it was read as a commentary on recent events. In the French Revolution of 1848, echoed worldwide, impromptu armies of republican and socialist workers, inspired by utopian aspirations for a just reorganisation of labour and industry, had overthrown the Orleans Monarchy. The revolution was violently repressed in the bloody 'June Days' of 1848, followed by a tense return to order under the imperially inclined President, Louis Napoleon Bonaparte. Meyerbeer's opera, about a revolutionary messiah manipulated by power-mad conspirators, could be seen to condemn both the uprising and the forces of order it opposed.²⁴

The new arrangements of industry had created new fortunes for owners and investors. They also threw thousands of labourers out of work by replacing them with machines or re-employing them at unliveable wages. The promise of improved sanitation, an abundance of consumer goods, an end to hunger, and beautiful new habitations were held out and, to widely varying extents, realised in projects of urban renewal such as that directed by Baron von Haussmann in Paris after Louis Bonaparte's *coup d'état* in 1851. Yet these changes to everyday life came at the cost of the destruction of traditions of guilds and artisanship and local networks of support, and contributed to a sense of dislocation and disorientation with the new pace and intensity of urban life. The progress of national industry also made possible imperial expansion – the growth of the British Empire in Asia and Africa, France's new acquisitions in the South Pacific and North Africa, and Germany and Italy's projects of unification, quickly followed by dreams of colonial acquisitions. The growth of industry was inseparable from the growth of empire.

To return, in conclusion, to the opera *Aida* – a work that is 'not so much *about* but *of* imperial domination' – we might also consider the ways in which Verdi's landmark work is both *of* and *about* technology. And while

musicologists' rising interest in the technological and scientific dimensions of music might seem to direct attention away from the politics of colonialism and race, *Aida* suggests how technology and empire often went hand in hand in Romanticism and music.

The original invitation for Verdi to compose a work for Egypt came from the ruling Viceroy, Ismail Pasha, in 1869, who wished to commemorate the opening of the Suez Canal – a technological project long dreamed of by the Saint-Simonians as a step towards increasing peaceful communication and exchange throughout the Mediterranean. Verdi declined, but he later accepted an invitation to debut a work in 1871 to open the new Opera House in Cairo. Arrangements were negotiated by a French archaeologist, Auguste Mariette, who had in 1867 co-ordinated Egypt's exhibits for Paris's International Exposition of 1867, where the Egyptian display had taken the medal for best in show.²⁵ With his support of Verdi, the Viceroy was exhibiting the modernity of Egypt and participating in the international culture of Romantic music and opera. The opera house was situated in the 'new city' of Cairo, a Haussmann-style enclave of wide avenues, gas lighting, and civic halls.

Verdi's work, too, was a colossal, technologically enhanced spectacle – a show of forces. The imposing sets reconstructed ancient Egyptian buildings to Mariette's specifications. Verdi sought to evoke exoticism and archaeological authenticity, and to create distinctive orchestral effects by writing parts for a newly constructed 'Egyptian trumpet' (with an extra-long stem and bell) and 'hyper-flutes', both of which were louder and stronger than normal, and which were to sound as if by magic when a giant statue in one of the stage-set's temples was struck by sunlight. Following Wagner, Verdi chose to hide the orchestra, burying the 'indecent' view of the 'tops of the harps, the necks of the double basses, and the baton of the conductor all up in the air'.²⁶ Verdi exerted a dictatorial command over all aspects of the production; its grandiosity was a testament to the largesse, power, and glory of the Viceroy.

In the opera's processions, ballet, and victory march (following the Egyptian army's victory over Ethiopia), viewers were subjected to a protracted display of a gigantic, disciplined organisation of human labour and technical prowess. Whether this was meant to inspire or repulse the audience was unclear; likewise, just what the story of *Aida* says about imperial domination is notoriously ambiguous. Ralph Locke has identified nine distinct interpretations, including either celebrating *or* protesting Egyptian domination over its southern African neighbours; European domination over North Africa and other non-European regions; Prussian

domination over the French; or Austro-Hungarian domination over Italy.²⁷ However it is read, though, the opera undeniably dramatises technically co-ordinated domination and its effects.

In the final scene – containing some of the most moving music in the operatic canon – Aida is locked in a tomb with her lover, the Egyptian general, Radames, who has refused to give her up and has thus been condemned by the Pharaoh and his jealous daughter. Above them, in the high-ceilinged temple, Egyptian priests conduct a ritual of immortality, singing out in low monotones. In contrast, the lovers duet in soaring, even eerie harmony, announcing the opening of heaven to receive them; above them, the Egyptian princess who loves Radames sorrowfully prays for peace.

Aida's finale enacts power, labour, and control on a stunning scale: in the complexly divided stage design lit differently above and below, in the philologically researched and realised Egyptian sets, painting, and costumes, in the gigantic company of singers who have crossed the stage on their way to war and back – and, of course, in the virtuosity of the singers, musicians, and composer. This power and control reflected and communicated with the power on display in the gaslit streets of the new city of Cairo, the gigantic engineering feat of the Suez Canal, and the international race to develop and deploy the powers of industry and invention to remake the world and gather up its wealth. In just a few years, crippled by debt to European banks for the building of the canal, Egypt would fall under French, then British rule, making *Aida's* portrayal of Egyptian supremacy – and its colonial domination of the Ethiopians – newly ironic.

When the lights go out on the tragic lovers, the ravished audience explodes in applause. Romantic music and spectacle, made possible through technology, glorify technology's reign. They draw attention to its destructive, suffocating potential and its mesmerising, nearly irresistible appeal.

Notes

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1. George Sand, *A Woman's Version of the Faust Legend: The Seven Strings of the Lyre*, trans. George Kennedy (Chapel Hill: University of North Carolina Press, 2013), 126, 145.

2. Edward Said, 'The Empire at Work: Verdi's *Aida*', in *Culture and Imperialism* (New York: Vintage, 1994), 138.
3. Carl Dahlhaus argued that early Romantic music was well-attuned to the early nineteenth century, but later 'neo-Romanticism', appearing after mid-century, was 'untimely': out of step with the later era's positivism and realism (*Between Romanticism and Modernism: Four Studies in the Music of the Later Nineteenth Century*, trans. Mary Whittall (Berkeley and Los Angeles: University of California Press, 1980), 5). Instead, throughout the century, scientific, realist, 'positivist', and technical interests were closely woven into the aesthetic aims and meanings of Romanticism; on the situation in France before 1848, see John Tresch, *The Romantic Machine: Utopian Science and Technology after Napoleon* (Chicago: University of Chicago Press, 2012).
4. See David Trippett, 'Sound as Hermeneutic, or Helmholtz and the Quest for Objective Perception', *19th-Century Music*, 43/2 (2019), 99–120; Julia Kursell, 'Visualizing Piano Playing, 1890–1930', *Grey Room*, 43 (2011), 66–87; Benjamin Steege, 'Vocal Culture in the Age of Laryngoscopy', in David Trippett and Benjamin Walton (eds.), *Nineteenth-Century Opera and the Scientific Imagination* (Cambridge: Cambridge University Press, 2019), 44–62.
5. Studies of the relations of music, science, and technology (often focused on the nineteenth century) have multiplied in recent years. See collections including Alexandra Hui, Julia Kursell, and Myles W. Jackson (eds.), *Music, Sound, and the Laboratory from 1750–1980*, *Osiris*, 28/1 (2013); Sarah Hibberd (ed.), 'Music and Science in London and Paris', special issue of *19th-Century Music*, 39/2 (2015); James Q. Davies and Ellen Lockhart (eds.), *Sound Knowledge: Music and Science in London, 1789–1851* (Chicago: University of Chicago Press, 2016); Karen Henson (ed.), *Technology and the Diva: Sopranos, Opera, and Media from Romanticism to the Digital Age* (Cambridge: Cambridge University Press, 2016); Trippett and Walton (eds.), *Nineteenth-Century Opera and the Scientific Imagination*.
6. Emily Dolan, *The Orchestral Revolution: Haydn and the Technologies of Timbre* (Cambridge: Cambridge University Press, 2013), 160.
7. John Spitzer, 'Metaphors of the Orchestra – The Orchestra as a Metaphor', *The Musical Quarterly*, 80/2 (1996), 234–64.
8. Gundula Kreuzer, *Curtain, Gong, Steam: Wagnerian Technologies of Nineteenth-Century Opera* (Berkeley: University of California Press, 2018), 109–20.
9. Jonathan Sterne, 'Afterword: Opera, Media, Technicity', in Karen Henson (ed.), *Technology and the Diva*, 159–64.
10. Francesca Brittan, *Music and Fantasy in the Age of Berlioz* (Cambridge: Cambridge University Press, 2017); Jacques-Joseph Moreau de Tours, *Du hachisch et de l'aliénation mentale: Études psychologiques* (Paris: Fortin, Masson, et cie., 1845); Wolfgang Schivelbusch, *Tastes of Paradise: A Social History of Spices, Stimulants, and Intoxicants* (New York: Pantheon Books, 1992).

11. Céline Frigau Manning, 'Phrenologizing Opera Singers: The Scientific "Proofs of Musical Genius"', *19th-Century Music*, 39/2 (2015), 125–41.
12. Sarah Hibberd, "'Dormez donc, mes chers amours": Hérold's *La somnambule* (1827) and Dream Phenomena on the Parisian Lyric Stage', *Cambridge Opera Journal*, 16/2 (2004), 107–32; Alison Winter, *Mesmerized: Powers of Mind in Victorian Britain* (Chicago: University of Chicago Press, 2000), 314–20.
13. Ellen Lockhart, 'Circuit Listening', and Gavin Williams, 'Excelsior as Mass Ornament: The Reproduction of Gesture', in Trippett and Walton (eds.), *Nineteenth-Century Opera and the Scientific Imagination*, 227–48 and 251–68.
14. Carmel Raz, "'The Expressive Organ within Us": Ether, Ethereality, and Early Romantic Ideas about Music and the Nerves', *19th-Century Music*, 38/2 (2014), 115–44.
15. Helmut Müller-Sievers, *The Cylinder: Kinematics of the Nineteenth Century* (Berkeley: University of California Press, 2012).
16. Armand Mattelart, *The Invention of Communication* (Minneapolis: University of Minnesota Press, 1996); Richard Wittman, 'Space, Networks, and the Saint-Simonians', *Grey Room*, 40 (2010), 24–49; Ralph P. Locke, *Music, Musicians, and the Saint-Simonians* (Chicago: University of Chicago Press, 1986).
17. See David Trippett and Benjamin Walton, 'Introduction: The Laboratory and the Stage', in Trippett and Walton (eds.), *Nineteenth-Century Opera and the Scientific Imagination*, 1–18, esp. 10–13.
18. Sarah Hibberd, '*Le Naufrage de la Méduse* and Operatic Spectacle in 1830s Paris', *19th-Century Music*, 36/3 (2013), 248–63.
19. Deirdre Loughridge, *Haydn's Sunrise, Beethoven's Shadow: Audiovisual Culture and the Emergence of Musical Romanticism* (Chicago: University of Chicago Press, 2016), and 'Celestial Mechanisms: Adam Walker's Eidouranion, Celestina, and the Advancement of Knowledge', in Davies and Lockhart (eds.), *Sound Knowledge*, 47–76.
20. See Emily I. Dolan and John Tresch, 'A Sublime Invasion: Meyerbeer, Balzac, and the Opera Machine', *The Opera Quarterly*, 27/1 (2011), 4–31.
21. See further in Kreuzer, *Curtain, Gong, Steam*.
22. See M. H. Abrams, *Natural Supernaturalism: Tradition and Revolution in Romantic Literature* (New York: Norton, 1971); Darcy Grimaldo Grigsby, *Extremities: Painting Empire in Post-Revolutionary France* (New Haven: Yale University Press, 2002), and *Colossal: Engineering the Suez Canal, Statue of Liberty, Eiffel Tower, and Panama Canal: Transcontinental Ambition in France and the United States during the Long Nineteenth Century* (Pittsburgh: Periscope, 2011).
23. On the close connections between slavery and industrialisation and the impact of both on nineteenth-century musical imaginaries, with sound as 'the primary nexus of race and technology', see Louis Chude-Sokei, *The Sound of Culture: Diaspora and Black Technopoetics* (Middletown, CT: Wesleyan University Press, 2015); on uncanny aspects of mechanized singers and performers see Carolyn Abbate, *In Search of Opera* (Princeton: Princeton University Press, 2001).

24. Sarah Hibberd, *French Grand Opera and the Historical Imagination* (Cambridge: Cambridge University Press, 2009), ch. 6; John Tresch, 'The Prophet and the Pendulum: Sensational Science and Audiovisual Phantasmagoria around 1848', *Grey Room*, 43 (2011), 16–41.
25. Katherine Bergeron, 'Verdi's Egyptian Spectacle: On the Colonial Subject of Aida', *Cambridge Opera Journal*, 14/1–2 (2002), 149–59.
26. Giuseppe Verdi, quoted by Gabriela Cruz in 'Aida's Flutes', *Cambridge Opera Journal*, 14/1–2 (2002), 177–200 at 186.
27. Ralph P. Locke, 'Aida and Nine Readings of Empire', *Nineteenth-Century Music Review*, 3/1 (2006), 45–72.

Further Reading

- Davies, James Q., and Lockhart, Ellen (eds.). *Sound Knowledge: Music and Science in London, 1789–1851* (Chicago: University of Chicago Press, 2016).
- Dolan, Emily. *The Orchestral Revolution: Haydn and the Technologies of Timbre* (Cambridge: Cambridge University Press, 2013).
- Dolan, Emily I., and Tresch, John. 'A Sublime Invasion: Meyerbeer, Balzac, and the Opera Machine', *The Opera Quarterly*, 27/1 (2011), 4–31.
- Henson, Karen (ed.). *Technology and the Diva: Sopranos, Opera, and Media from Romanticism to the Digital Age* (Cambridge: Cambridge University Press, 2016).
- Hibberd, Sarah (ed.). *19th-Century Music*, 39/2 (2015), special issue: 'Music and Science in London and Paris'.
- Hibberd, Sarah. 'Le Naufrage de la Méduse and operatic spectacle in 1830s Paris', *19th-Century Music*, 36/3 (2013), 248–63.
- Hui, Alexandra, Kursell, Julia, and Jackson, Myles W. (eds.). *Music, Sound, and the Laboratory from 1750–1980*, *Osiris*, 28/1 (2013).
- Kreuzer, Gundula. *Curtain, Gong, Steam: Wagnerian Technologies of Nineteenth-Century Opera* (Berkeley: University of California Press, 2018).
- Loughridge, Deirdre. *Haydn's Sunrise, Beethoven's Shadow: Audiovisual Culture and the Emergence of Musical Romanticism* (Chicago: University of Chicago Press, 2016).
- Müller-Sievers, Helmut. *The Cylinder: Kinematics of the Nineteenth Century* (Berkeley: University of California Press, 2012).
- Tresch, John. *The Romantic Machine: Utopian Science and Technology after Napoleon* (Chicago: University of Chicago Press, 2012).
- Trippett, David, and Walton, Benjamin (eds.). *Nineteenth-Century Opera and the Scientific Imagination* (Cambridge: Cambridge University Press, 2019).