Out of soho : reading Joseph Paxton's 'great victorian way', part II

OUT OF SOHO: READING JOSEPH PAXTON'S 'GREAT VICTORIAN WAY', PART II

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IV.

There is another history that can be written of these representations, a history not of non-existent structures, but of the technologies which would have comprised them. The two most obvious have already been mentioned - glass, the *visible* technology, and sewers, the occluded. For the second part of this study I will focus on two more, of intermediate modes of implicature.[1] The first is gas-lighting. All three projectors mentioned in their evidence before their respective committees that the structures would be gas-lit. So why is gas-lighting machinery not shown? Why are there no sconces and fittings visible in either Paxton or Moseley's arcades?

Then there is the problem of the trains. These are visible, indeed they dominate the Crystal Way. But how were they to work? Paxton and Moseley mention in passing that they are to be operated on 'atmospheric' principles. Pym makes an even more off-handed reference to 'magnetic' traction. What were these technologies, and how did they slot in to the architects' remit?

We'll start with a journey, a walking tour undertaken on the cusp of the railway revolution. In hindsight it seemed to the traveler to have taken him backwards in time, and to have presented him with a measure of what would be lost and, with luck, gained under the coming technological dispensation. However, among scenes of industries and ways of life heading towards oblivion, he was to catch a glimpse of a tangential futurity - tangential to the steam future mapped out at the journey's beginning - the futurity represented by the GVW.

On 9 September 1830 James Nasmyth, a twenty-two year old apprentice engineer, left London on the outside of the Liverpool coach. He arrived on the evening of the 10th, but the length of the trip did not deter him from waking early

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1 The 'Rules of Implicature' state that what is not spelt out is more informative about the context of an utterance than what is. See Steve Fuller, *Social Epistemology,* 2nd Ed, (Bloomington: Indiana University Press, 2002), 109-113.

the next morning to witness the final trials of the Rocket before the opening of the Liverpool & Manchester Railway on the 15th. Remaining in Liverpool for the occasion he greeted the birth of the railway age, and no doubt shared the general consternation at the death of William Huskisson. He then walked to Manchester before turning south and stepping into a vision of the now superseded industrial past.[2]

Through "a highly picturesque country" full of old timber houses Nasmyth reached the iron works of Coalbrookdale. Travelers in the final quarter of the previous century had been much taken by the contrast between the beauty of the Severn River and the "horrors" of human artifice: "the noise of the forges, mills & c. with all their vast machinery, the flames bursting from the furnaces with the burning of the coal and the smoak of the lime kilns." J.M.W. Turner and Philippe de Loutherbourg had painted pictures, showing human hands overmatched by the wild energies of the furnaces.[3] But Coalbrookdale was now, fifty years on, a forgotten place. Nasmyth's visit coincided with a slight upturn in the company's fortunes under Abraham (IV) and Alfred Darby, but in comparison with what he had witnessed in Liverpool, and what was to come in the region between Wolverhampton and Birmingham, the enterprise was on a minor scale. He found it quaint: "I was particularly impressed with the cheerful zeal and activity of the workmen and foremen of this justly celebrated establishment."[4] What followed had no such innocence.

As Nasmyth crossed into Staffordshire he became disquieted. "The Black Country is anything but picturesque," he wrote. The earth seems to have been turned inside out. Its entrails are strewn about ⋯ By day and by night the country is glowing with fire." The forge tenders had none of the charm of the Coalbrookdale workmen. "Covered with smut and with fierce white eyes", they

2 Samuel Smiles, ed, *James Nasmyth, Engineer: An Autobiography,* (London, 1883), 155-157. Details of his stay on Liverpool are provided by R.Dickinson, 'James Nasmyth and the Liverpool Iron Trade', *Transactions of the Historic Society of Lancashire and Cheshire,* 108 (1956), 83-104. On the opening of the Liverpool & Manchester Railway see Simon Garfield, *The Last Journey of William Huskisson,* (London: Faber & Faber, 2002).

3 Francis Klingender, *Art and the Industrial Revolution,* (New York: Curwen Press, 1968), 83-86, 102: the quote is from Arthur Young in 1776.

4 *Autobiography,* 162-163. On the condition of the foundry in the early 19th century see Arthur Raistrick, *Dynasty of Iron Founders: The Darbys and Coalbrookdale,* 2nd Ed, (Ironbridge: Sessions Book Trust, 1989), 242-244. For its moral economy see Anthony Wallace, *The Social Context of Innovation: Bureaucrats, Families and Heroes in the Early Industrial Revolution,* (Princeton: Princeton University Press, 1982), 78-96.

"are seen moving about amongst the glowing iron and the dull thud of forge hammers ⋯ running about amidst the flames as in a pandemonium." At the old town of Dudley, "The venerable trees struggle for existence under the destroying influence of sulphurous acid; while the grass is withered and the vegetation everywhere blighted."[5] Two years later the antiquarian John Britton would travel across the same ground and see exactly the same thing: "a sort of pandemonium on earth - a region of smoke and fire filling the whole area between earth and heaven." For a man like Britton the aesthetics of the trope fit the familiar conventions of the industrial sublime (though the horrors were doubtless deeply felt).[6] The scale of the "human or divine" offered no purchase on such a landscape: "something like horses, men, women and children occasionally seemed to move in the midst of the black and yellow smoke and flashes of fire; but were again lost in obscurity."[7] But for Nasmyth the workers are a challenge, not a lacuna. People deprived of opportunities for improvement will *of course* revert to a state of feral sub-humanity. Thus, the language of Milton is deployed less as critique than as an expression of anxiety that in the Black Country industrial processes had become too visible, leaving the destruction wrought upon nature and the human frame unassuagable by utilitarian apologetic. When Nasmyth recalled his earlier self gazing on a blighted prospect and reflecting on "the price we have to pay for our vaunted supremacy in the manufacture of iron. We may fill our purses, but we pay a heavy price for it in the loss of picturesqueness and beauty", he was surely aware of the irony. He was, after all, an industrialist who at his death was worth over £250, 000.[8]

North of Birmingham, on the Wolverhampton road, Nasmyth arrived at the Soho Manufactory. Like Coalbrookdale, its glory was past, but it wore its decline with greater dignity. After the dispiriting turn his journey had lately taken, Nasmyth was comforted by what he saw. "The sight which I obtained of the vast series of workshops of this celebrated establishment," he wrote, "filled with

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5 Nasmyth, *Autobiography,* 163-165.

6 Herbert Sussman, *The Victorians and the Machine,* (Cambridge, Mass.: Harvard University Press, 1968), 29-30; Morton Paley, *The Apocalyptic Sublime,* (New Haven: Yale University Press, 1986); Stephen Daniels, *Fields of Vision: Landscape Imagery and National Identity in England and the United States,* (Cambridge: Cambridge University Press, 1993), 68-72.

7 John Britton, *The Autobiography of John Britton,* (London, 1849), 128-129.

8 Nasmyth, *Autobiography,* 165. On Nasmyth's riches see A.E.Musson, 'James Nasmyth and the Early Growth of the Mechanical Engineering Industry', *Economic History Review,* 2nd series, 10 (1957), 121-127.

evidences of the mechanical genius of those master minds, made me feel that I was indeed on classic ground, in regard to everything connected with steam-engine machinery." After the chaos of the Black Country forges Soho was clean and smoothly ratcheted.[9]

Boulton and Watt, the "master minds" in question, were both dead. Watt had garnered most of the posthumous plaudits.[10] Boulton's talents had been organizational: he had believed in discipline, harmony, and order.[11] His "senses were so acute that, sitting in his office at Soho, he could at once detect the slightest derangement in the machinery of his vast establishment." Machinery in at least two of its nineteenth-century connotations: a set of procedures for the minimization of waste, temporal and material, and a *habitus* in which desired aesthetic and moral qualities might be nurtured.[12] After the fashion of Josiah Wedgwood's Etruria, the other paradigmatic eighteenth-century manufactory,[13] the buildings at Soho were neo-classical in design, and a lot of money was lavished on landscaping. Similar attention was paid to morals: at the time of Nasmyth's visit the "little army of labourers" was still noted for its "orderly and citizen-like behaviour": "All is decorum, cleanliness, and decency throughout the works: the pleasing effects of good example and wise regulations."[14] Nasmyth took careful note. The Bridgewater Foundry, set up six years later in partnership with Holbrook Gaskell, was also to be "surrounded on all sides with green hills", on the principle that pure air was conducive to clean minds and healthy bodies amongst the operatives, and organized along a "straight line" production system.[15] The virtue of Soho, for Nasmyth as for other visitors (although few would grasp the moral with such spectacular later effect), was that it showed that environmental and ethical blight

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9 *Autobiography,* 167; Jennifer Tann, *Selected Papers of Boulton and Watt, Volume 1, 1775-1825,* (London: Duploma, 1981), 19.

10 For the early growth of the cult of Watt see, e.g., 'Statue of James Watt', *Penny Magazine,* 1 (1837), 209; Francois Arago, *Historical Eloge of James Watt,* transl. J.P.Muirhead, (London: John Murray, 1839); [Samuel Smiles], 'James Watt', *Quarterly Review,* 104 (1858), 410-451.

11 Tann, *Selected Papers,* 12-13, on work-discipline at Soho under Boulton the elder.

12 Smiles, 'Watt', 439. On 'machinery' see Berg, *The machinery question,* and for the more positive connotations of the term Stefan Collini, *Public Moralists: Political Thought and Intellectual Life in Britain, 1850-1930,* (Oxford: Oxford University Press, 1991), 91-118.

13 E.J.D.Warrilow, *History of Etruria, 1760-1951*, (Hanley, 1953), 22-45; Samuel Smiles, *Josiah Wedgwood, FRS: His Personal History,* (London: John Murray, 1894), 84-87.

14 Richard Warner, *A Tour Through the Northern Counties of England,* (Bath: R.Crutwell, 1802), 212-216; 'Soho - Birmingham', *Penny Magazine,* 4 (1835), 345-346.

15 Benjamin Love, *Manchester As It Is,* (Manchester: Love & Barton, 1839), 213-219.

was not a necessary accompaniment to the filling of manufacturers' purses.

The first lesson of Soho, then, was to suggest that by attending to *appearances,* the worst of the environmental and human costs of industry could be defrayed. But what most fascinated him about Soho was machinery in a narrower sense. He was particularly taken with an "admirable system of transmitting power from one central engine to other small vacuum engines attached to the machines they were set to work." The ingenuity of this arrangement was that it utilized both stages in the Newcomen engine cycle, and did away with friable transmission mechanisms (shafts and belts), while enabling the master to regulate separately each of the machines so connected, "the required speed being kept up or modified at pleasure without in any way interfering with the other machines." Here as elsewhere at the manufactory Nasmyth was struck with the "evidences" of the life and work not of Watt, the engineer as culture hero, but of a man who had "always kept himself in the background, for he was excessively modest": Boulton & Watt's factotum, the still living William Murdoch.[16]

When Murdoch had arrived at Soho in 1777 it had boasted a rich culture of speculation in natural philosophy and its industrial applications. Soho House hosted meetings of the Lunar Society, drawing to the complex such luminaries as James Keir, Josiah Wedgwood, Erasmus Darwin and Joseph Priestley. Engineers were also common visitors, including the brightest of the coming generation, John Rennie. But in this company Murdoch was accepted as neither a social nor an intellectual equal: he was a fixer, a breaker of heads, no gentleman. For most of his first two decades of employment with Boulton & Watt he was in the Cornish badlands, installing pumping engines and dealing, sometimes violently, with the natives.[17] Rebuffed by Watt in his attempts to exercise his own considerable mechanical faculties (notoriously, the development of a steam carriage),

16 *Autobiography*, 167-168. The now-standard biography of Murdoch is John Griffiths, *The Third Man: The Life and Times of William Murdoch, 1754-1839,* (London: Andre Deutsch, 1992), but see also A.Macpherson, *Light Without a Wick: A Sketch of William Murdoch, the Inventor,* (Glasgow: Glasgow University Press, 1892).

17 On Murdoch's early career see Griffiths, *Third Man,* 3-19, and Samuel Smiles, *Men of Invention and Industry,* (London: John Murray, 1884), 124-130. On his exclusion from the Soho elite, see Robert Schofield, *The Lunar Society of Birmingham: A Social History of Provincial Science and Industry in 18th Century England,* (Oxford: Oxford University Press, 1963), 152. This neglect has extended to scholarly treatment of the group: Murdoch is accorded very little space in, for example, Jenny Uglow, *The Lunar Men: The Friends Who Made the Future,* (London: Faber & Faber, 2002): he was not much of a friend, yes, but his eventual impact was greater than that of any of the others, saving Watt.

Murdoch had turned to pursuits tangential to the main business of the enterprise. Around 1790 he became interested in applications of the researches of Black, Priestley, Cavendish and Lavoisier on the various gases produced by the chemical decomposition of matter.[18] He began experimenting on coal gas, the inflammable byproduct of the destructive distillation of coal. By 1792 he had fitted up his house at Redruth with a rudimentary gas-lighting system. On his return to Soho he did the same in the factory and then, famously, in a display to celebrate the Peace of Amiens in 1802. This was the first public demonstration of the potential of this new source of light, and it was a spectacular one. On the basis of these successes, Murdoch convinced the company to turn its hand to the manufacture of gas-making apparatus, against Watt junior's better judgment. Murdoch was vindicated: demand was high, especially from Lancashire mill-owners whose vast establishments were expensive to light with oil.[19] Carbureted hydrogen proved an effective agent of his social advancement, in a way that steam had not. His ground-breaking paper, *An Account of the Application of the Gas from Coal to Economical Purposes* (1808), won the Rumford medal; in 1810 he accepted a £1000 salary from the firm, in lieu of a full partnership.[20]

Murdoch had also experimented with another gaseous medium: common air. From 1802 he channeled the air compressed by the action of the foundry Blast Engine to drive the pattern shop lathe, and later designed a lift, again worked by compressed air, to transport castings from the bearing-mill to the canal bank. Air pressure differentials, he reasoned, would prove more efficient for the transmission of mechanical effort than arrangements of shafts and belt drives. In Watt's condensing engines vacuums were produced on both strokes of the engine cycle, as well as in the condenser itself, and Murdoch's idea was to put these to use. The machinery Nasmyth so admired on his visit to Soho was a rare survival, but in Murdoch's heyday the experiments had been legion. Most pertinent to our present purposes, Murdoch had devised a method of "transmitting letters and packages through a tube exhausted by an air pump" - a pursuit of the logic of the

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18 Jan Golinski, *Science and Public Culture: Chemistry and Enlightenment in Britain, 1760-1820,* (Cambridge: Cambridge University Press, 1992).

19 William Matthews, *Historical Sketch of Gas-Lighting,* (London: Hunter, 1827), 20; Smiles, *Men of Invention,* 138-141; Archibald & Nan Clow, *The Chemical Revolution,* (London: Batchworth Press, 1952), 428-430; Arthur Elton, 'Gas for Light and Heat', in Charles Singer, ed, *A History of Technology,* (Oxford: Oxford University Press, 1954-84), Vol.4, 258-279

20 Tann, *Selected Papers,* 11.

medium one step further. Not so much came of this in the immediate term: but the Soho internal mail system was a direct if distant ancestor of the smokeless trains that were to ply the GVW.[21]

Out of Murdoch's investigations at Soho came an extremely influential set of techniques for the transmission of power. Like his employers, Murdoch had to systematize mechanical and human operations. He "organized space", as Rosalind Williams has put it.[22] But while at Wedgwood's Etruria and Boulton's Soho this organization had been local in extent, Murdoch's "space" was unbounded. Gas and air pipes would extend both the spatial and temporal dimensions of cause and effect. Coal-gas produced in that retort then burned in this Argand light now; gas stored in that reservoir there generated light at the turning of this light here. And alongside the abstraction of apprehended effects from hidden causes developed disciplines for the production of those very effects and occlusion of those very causes. *The medium was the thing*: gas and air pressure differentials, or water in the anticontagionist ideologies described by Roger Cooter and Christopher Hamlin,[23] or instantiations of transparency in Isobel Armstrong's 'poetics of glass'. As the nineteenth century progressed 'mechanical' experiences and understandings were to be superseded by more totalizing, less apprehensible structures for the working of technology in society (such that, for example, it becomes increasingly difficult to talk of a 'context' for technology).[24] The old aesthetic/moral responses, such as those imputed, with some unease, by Nasmyth to his younger self, were no longer adequate. A new paradigm for relating to the appearances of technology was in the making.

This was not immediately obvious in the early social experience of gas-lighting. As Wolfgang Schivelbusch has shown, the perceived quality of the illumination was very much a matter of shifting tastes and expectations.[25] Gaslights were high

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21 Smiles, *Men of Invention,* 145-153; Macpherson, *Light Without a Wick,* 53-54. On the subsequent development of pneumatic tube technologies in Britain see below, pp32-36; C.E.Lee, 'The Pneumatic Dispatch Company's Railways', *Transactions of the Newcomen Society,* 45 (1972-3), 67-88; and D.G.Clow, 'Pneumatic Tube Communications in London', *Transactions of the Newcomen Society,* 66 (1994-5), 97-119.

22 Williams, 'Large Technological Systems', 384.

23 Christopher Hamlin, *A Science of Impurity: Water Analysis in Nineteenth Century Britain,* (Berkeley: University of California Press, 1990).

24 Thomas Hughes, 'The Order of the Technological World', *History of Technology,* 5 (1990), 1-16.

25 Schivelbusch, *Disenchanted Night*, 14-50. See also Nead, *Victorian Babylon,* 73-146.

oxygen burners and gas lit rooms hard to ventilate. Coal-gas had a "disagreeab le foetid odour", and condensed droplets of sulphuric acid during burning. Murdoch in 1808 had admitted that during the investigations at Soho "some inconvenience was experienced from the smell of the unconsumed or imperfectly purified gas", but had had no doubt that these problems could be "obviated". Nevertheless, techniques for ridding coal-gas of impurities were slow to develop: what came to be known as the "Soho Stink" was a long-term feature of gas machinery.[26]

The material shortcomings of the technology were compensated for by rhetorics exploiting the paradoxes of visibility. Gas-lighting, it was claimed, conformed to an ideal natural standard: "It so completely penetrates the whole atmosphere, and at the same time is so genial to the eyesight, that it appears as natural and pure as daylight, and it sheds also a warmth as purifying to the air as cleansing to the spirits."[27] By its very modesty, the ease with which it could don the garb of the familiar, the medium would make visible behaviours and conditions it was desirable to expose to reformist scrutiny. In 1829 the *Westminster Review* could claim that "Old Murdoch alone, has suppressed more vice than the Supression Society; and has been a greater police officer than old Colquhoun and Sir Richard Birnie united."[28] Gas-lighting was also one of the more significant of the array of technologies - clocks, whistles, horns, turnstiles, punch-cards - being developed for the inculcation of time-discipline.[29] Trials at Salford cotton mills conducted by Murdoch and his apprentice Samuel Clegg (of whom more anon) in 1805-6 had convinced the former that "[t]he peculiar softness and clearness of this light" would bring it "into great favour with the workpeople." Gas afforded "a brilliant and pleasing light to the numerous workers" at the Pollockshaws mill in Glasgow

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26 William Murdoch, 'An Account of the Application of Gas from Coal to Economical Purposes', *Philosophical Transactions*, 158 (1808), 124-132: on 129-130. See also Thomas Peckston, *The Theory and Practice of Gas-Lighting,* (London: T&G Underwood, 1819), 202-219; and 'The First Use of Gas in London', *All The Year Round,* 18 (1867), 349-355.

27 Samuel Clegg, *A Practical Treatise on the Manufacture and Distribution of Coal-Gas,* (London, 1841), 20-21.

28 'Gas-Light', *Westminster Review,* 11 (1829), 290-303: on 302. See also Frederick Accum, *A Practical Treatise on Gas-Light,* (London, 1815), 147; and Macpherson, *Light Without a Wick,* 60. Sir Richard Birnie (1760-1832): magistrate, breaker-up of the Cato Street Conspiracy (*DNB,* II.548-549). Patrick Colquhoun (1745-1820): magistrate, instigator of soup-kitchens, police reformer (*DNB*, IV.859-861).

29 E.P.Thompson, 'Time, Work-Discipline, and Industrial Capitalism', *Past & Present,* 38 (1967), 56-97.

when installed around 1812: it reduced headaches and the number of accidents, and was less of a fire hazard than oil-lamps.[30] Gas-lit workers were more productive workers, and easier to police. Night-shifts became a possibility. In Andrew Ure's perfect manufactory there would be no windows: fans would supply a constant breeze, and gas-lighting a perfect "substitute for the sun." Contact with the ungovernable outdoors would be kept to a minimum.[31]

All this points to another paradox, one that goes some distance towards explaining why in the Great Victorian and Crystal Ways gas-lights could only be implied. Because gas-lighting approximated the natural ideal, it marked an important stage in the development of circulatory economies: thenceforward, they were sundered from any necessary connection to nature. George Dodd, visiting the Westminster Gas Works in the early 1840s, reflected that comparisons with Chadwickian machineries were misleading. On hydraulic systems Dodd quoted Neil Arnott: "The supply and distribution of water in a large city, since the steam engine was added to the apparatus, approaches closely to the perfection of nature's own work in the circulation of blood through the animal body."[32] The analogy to gas, Dodd noted, was "true so far as regards the emanation from a centre, the branching out of minor pipes from those of larger diameter, the lateral small pipes leading into the houses, and the concealment of the whole assemblage beneath the pavement and road-way." The difference was that water supply was an ecological function, nudged in a productive direction by artifice: water was never lost. Coal-gas, by contrast, was something consumed, depleted in the act of use, and because there were no reserves to be tapped, it had to be made and stored as and when required. As a result, the technology would always fall short

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30 [J.Pillans], 'Pamphlets on the Gas-Lights', *Edinburgh Review,* 13 (1809), 477-488; Clow & Clow, *Chemical Revolution,* 432.

31 Andrew Ure, *The Philosophy of Manufactures,* (London: Charles Knight, 1835), 380-384; Mumford, *Technics and Civilization*, 168-169. Mumford recalls Ure's conviction that factory children who spent all their time indoors were healthier than "the Mexicans and Peruvians, regularly exposed to sunlight." See also R.S.Rosenbloom, 'Men and machines: some nineteenth-century analyses of mechanization', *Technology and Culture,* 5 (1964), 489-511.

32 George Dodd, *Days at the Factories,* (London, 1843), 411; G.M.Binnie, *Early Victorian Water Engineers,* (London, 1981), 4-30. For the cultural context of Arnott's metaphor see Sennett, *Flesh and* Stone, 255-270, 324-338. The shift could also be conceptualized along the lines suggested by M.Norton Wise and Crosbie Smith, from the symbolic economy of the *balance* to that of the *dynamo*: see M.Norton Wise, 'Political Economy and Natural Philosophy in Nineteenth-Century Britain (I)', *History of Science,* 27 (1989), 263-301 and (with Crosbie Smith), '(II)', *History of Science*, 27 (1989), 391-449.

of optimal concealment. The productive process would always resist effacement. Hence the need for gas-holders, already by the 1840s conspicuous blots on English urban landscapes. And, what really disturbed Dodd, the industry's visibility gave rise to a modified aesthetic of the sublime, in which the old fiery heedlessness to the human scale had been transformed into icy indifference. In the Westminster retort house, "the iron roof, the iron floor, the absence of windows, the absence of machinery and work-benches, the strange appearance of the walls speckled over with complicated iron work (whose purpose is not clearly discernible) - all have an aspect of strangeness."[33]

This was akin to the strangeness of Pym's Super-Way, a structure at once visible to the degree of vulgarity and impervious to sense. It was not an aesthetic congenial to Paxton and Moseley. Gas-lighting can be construed as poised between sublimity - smokes and stinks baffling to the eye and nose - and the social logic of in/visibility. The latter made it indispensable: how else were the arcades to be safe at night? Equally, the former meant that it was imperative for lamp fixtures to be left out of the presentation drawings. For what would have been read into their presence, other than a besmirching of the sociotechnical utopia?

V.

The bridge between the pneumatic machineries at Soho and the atmospheric trains that were to grace the GVW was Samuel Clegg, an apprentice under Murdoch around the turn of the century. Clegg had been Murdoch's assistant in the early, experimental stage of gas-installation. He left the firm in 1805 and entered the nascent industry as an independent contractor. In 1813 he became chief engineer to the London & Westminster Gas Company, and insofar as it was a technical accomplishment, the gas-lighting of London was *his* accomplishment.[34] Nevertheless, he was prone to ill-luck and financial misjudgment, and for most of the 1820s and 30s his career was in the doldrums. Then, in the late 1830s, he entered into partnership with two marine engineers, Joseph and Jacob Samuda, and together they developed the atmospheric system of railway traction.[35]

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33 Dodd, *Days at the Factories,* 411, 422.

34 Clegg is another of the forgotten men. There is no modern, and no full contemporary, biography. Details of his career have been gleaned from Samuel Hughes, 'Memoir of Mr. Samuel Clegg', *Quarterly Papers on Engineering,* 2 (1844), 1-14; and Matthews, *Historical Sketch of Gas-Lighting,* 52, 61-83.

Previous attempts to develop transportation technologies based on air pressure differentials - notably those of George Medhurst in the 1810s and John Vallance in the 1820s - had come to nothing.[36] The problem was that the train was to be enclosed in the vacuum-tube, and this had given rise to the same concerns that stymie the Super-Way. What would it be like to travel in total darkness? How were the passengers to breathe? Wouldn't the sight of six-foot iron tubes be insupportable to lovers of the English countryside?[37] In the Clegg & Samuda system, by contrast, the vacuum-tube would be a couple of feet in diameter and lie between standard railway tracks. It would contain a piston attached to the leading carriage by a connecting rod, via a valve mechanism running longitudinally along the top of the tube.[38] It was a simple, ingenious mechanism. Prominent engineers greeted it with approbation: I.K.Brunel, Charles Vignoles, William Cubitt, François Arago, amongst others. In the course of the 1840s four atmospheric lines were built, in Dublin, Croydon, Devon and Paris. (The last alone, though, was still operational by the time Paxton unveiled the GVW in 1855.)

The atmospheric system had three advantages over locomotive traction, all attractive to reformers of metropolitan communications. The first was safety. Head-on train collisions would be impossible (a given length of tube could not simultaneously carry two pistons in opposite directions), and derailments next-to-impossible. The second was hygiene. On an atmospheric line the production of motive force was separated from the site of operations: the engines were located in the pumping-houses, spaced at discrete three mile intervals. There was no smoke, no smuts, and none of the juddering and rattling that accompanied the passage of locomotives.[39] The atmospheric railway thus fed into a utopian discourse of *rus in urbe*. Here was a technology that could be introduced to the

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35 The standard history of which is Charles Hadfield, *Atmospheric Railways: A Victorian Venture in Silent Speed,* (Newton Abbot: David & Charles, 1967). See also R.A.Buchanan, 'The Atmospheric Railway of I.K.Brunel', *Social Studies of Science,* 22 (1992), 231-242; and Henry Atmore, 'Railway interests and the 'rope of air'', *British Journal for the History of Science* 37 (3) (2004), 1-35.

36 George Medhurst, *A Plan for the Rapid Conveyance of Goods and Passengers, By the Power and Velocity of Air,* (London: D.N.Shury, 1812); *London Journal of Arts and Sciences,* 10 (1825), 13-19, on Vallance's scheme.

37 François Arago, 'Report on the Atmospheric Railway System', *Quarterly Papers on Engineering,* 3 (1845), 2.

38 The mechanism is described in detail in Samuel Clegg, *Clegg's Patent Atmospheric Railway,* (London, 1839), and in Joseph Samuda, *A Treatise on the Adaptation of Atmospheric Pressure to the Purpose of Locomotion on Railways,* (London: John Weale, 1841).

countryside without the usual aesthetic offences, and that would alleviate the problems consequent upon urban dependence upon machinery. From the mid-1840s numerous schemes were bruited for the 'atmospheric' regeneration of London; in this respect the crystal arcades of the mid-1850s were not novel.[40]

The third advantage was more ambivalent. There were no drivers on atmospheric trains. They were 'driven' from the next pumping-house up the line, up to three miles away. For adherents, this was an unmitigated good. Responsibility for safe transit was vested in systematized arrangements and procedures, rather than with low-status on-site operatives.[41] There was a good deal of angst in railway circles in the mid-1840s about just how much responsibility bore upon the shoulders the engine driver,[42] and the atmospheric didn't just relieve him of his burden, it did away with him and the burden altogether. On the other hand, many found something uncanny in the driverless trains. George Airy, the astronomer, jocularly suggested a demonic agency; Charles Vignoles, later one of the system's staunchest supporters, admitted on first encounter to being disturbed by the "fact that it was the man in the engine house, rather than the driver on the train, who was in control of the motive power."[43] Atmospheric traction presaged a dual revolution in railway practice. There would be no scope for individual operative initiative: there were no individual operatives, in the old sense. But at the same time existing hierarchies, with their very precise adumbrations of duty, were to be supplanted by de-centered structures of response and command. (Telegraphic communications between the pumping-houses were vital; when these failed, as they would on the South Devon atmospheric line, the result was paralysis.) It is no wonder that for engineers of a Tory stamp, such as Robert Stephenson, the atmospheric was anathema. It represented a distraction from the practical business of improving locomotive technologies, and an abstraction of

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39 See Brunel and Joseph Samuda's testimony to PP.1845.X.*Select Committee on Atmospheric Railways,* 14, 39; 'The Atmospheric Railway', *Westminster Review,* 15 (1843), 470-474.

40 Barker & Robbins, *History of London Transport,* I.100-104.

41 The best expressions of this are to be found in Samuda, *Treatise*, 30-35; and M.Mallet, 'Rep ort on the Railroad Constructed from Kingstown to Dublin', *Quarterly Papers on Engineering,* 2 (1844), 30-31.

42 L.T.C.Rolt, *Red for Danger: A History of Railway Accidents and Railway Safety,* 4th ed, (Newton Abbot: David & Charles, 1982), 15-16.

43 George Airy, *Autobiography,* ed. W.Airy, (Cambridge: Cambridge University Press, 1897), 156-157; Vignoles qu. in K.H.Vignoles, *Charles Blacker Vignoles: romantic engineer*, (Cambridge: Cambridge University Press, 1982), 98.

labour and machinery to disembodied managerial intelligence. In the land of atmospheric traction the systems-builder, not the mechanical engineer, would be king. For passengers the abstraction showed itself in a classic image of 'technics-out-of-control': a new land-speed record was set at an atmospheric trial in Dublin during the course of which the train shot off, unpremeditated, over the brow of a hill.[44] It would also have meant that, in case of accidents, a trusty scapegoat - the negligent, drunken engine-driver - wouldn't have been to hand, and railway-users would have been confronted with profounder questions about their technology-dependence. However, in the absence of anxiety about accidents there was pleasure as well as apprehension in the experience of giving oneself up to the machinery, and all the atmospheric lines were popular with the public.

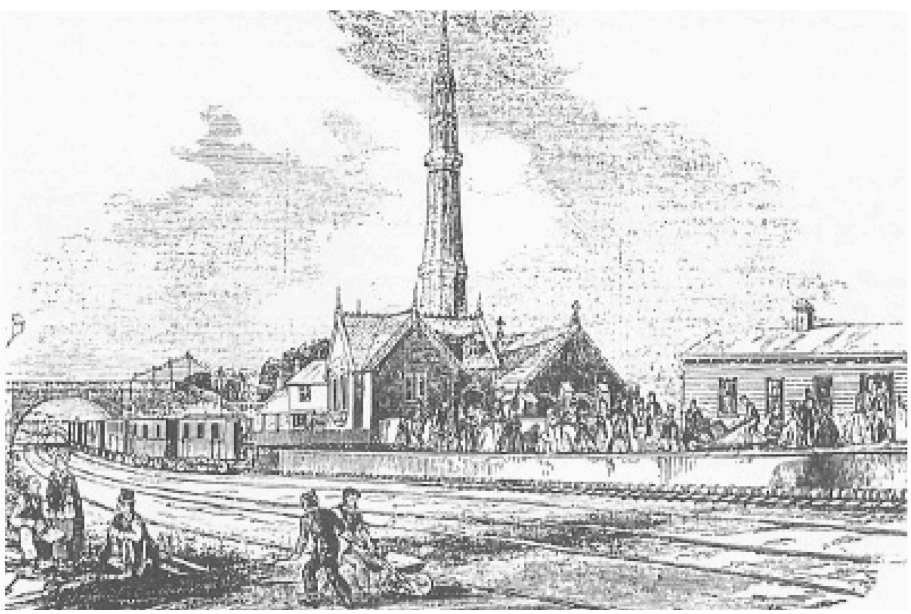

Figure 1 - Atmospheric Railway Gothic

It will by now be apparent what atmospheric trains were doing in Paxton and Moseley's arcades. Much of what was to be excluded from the streets of glass - dirt, smoke, labour - was also excluded by atmospheric traction. The system *did* involve dirt, smoke and labour, but these were invisible at the site of operations, which is what the projectors, dealing above all in appearances, needed. But there is one more mystery to clear up. Why isn't it obvious, in the presentation

44 Hadfield, *Atmospheric Railways,* 110.

drawings of the Great Victorian and Crystal Ways, that the driverless trains are indeed running on the atmospheric principle? Where are the vacuum-tubes? As with the gas-fittings, I don't think this absence is accidental. There were both practical and aesthetic grounds for not being too concerned with fidelity in representing the mechanisms of atmospheric traction.

Figure 1 shows a station/pumping-house on the Croydon & Epsom atmospheric line, ten months before it was to open for traffic in January 1846. Trees flank the scene, birds wheel overhead, and the travelers are solitary and unhurried. The building looks like a medieval manor house. As with the gothic forms and adornments of the crystal arcades, the anachronism was deliberate.[45] This kind of architecture assuaged the impact of new technology, connecting it to a nostalgic past of craft traditions, social hierarchy, conviviality and community.[46] What is missing is machinery. There are rails in the foreground, but no engines, carriages, steam, soot, clocks, flags or turnstiles. Those machines that are not absent have been disguised. The steeple is a chimney. The black jointed tube at bottom left does have a function: it's just that here it seems ornamental. We are dealing, in other words, with the same aesthetic of secrecy and disclosure as manifested by the GVW. The point is, when the aesthetic did not demand absence it demanded vagueness. Atmospheric trains might have been fitting instruments in Paxton and Moseley's imagining of sociotechnical relations, but one of the conditions of that imagining was the denial of anything but an idealized instrumentality.

The contrast with Figure 2 could not be greater. This picture shows an atmospheric trial at Kingstown, near Dublin, in January 1844. The platform and bridge are crowded with people, of high status one infers from the preponderance of top-hats. On the edge of the crowd a small boy and a dog watch the show. They are the mainstays of kitsch: another common form of the mid-Victorian disinclination to show things as, we imagine, they really were.[47] But the train is the op-

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45 *Illustrated London News,* 1 March 1845.

46 Jeffrey Richards & John MacKenzie, *The Railway Station: A Social History,* (Oxford: Oxford University Press, 1988), 22-24. On neo-gothic more generally see Peter Mandler, 'The Victorian Idea of Heritage', in *The Fall and Rise of the Stately Home,* (New Haven: Yale University Press, 1997), 21-69; and Mark Girouard, *The Return to Camelot: Chivalry and the English Gentleman,* (New Haven: Yale University Press, 1981).

47 Thomas Richards, *The Commodity Culture of Victorian England: Advertising and Spectacle, 1851-1914*, (Stanford: Stanford University Press, 1990).

posite of kitsch. Aesthetically, it is an outrage in this setting. It seems to repel the spectators, who all keep a safe, healthy distance from it. For despite presenting a challenge, the train's sleek, opaque surfaces resist interrogation. The restrained excitement of the scene - the gesture of the bearded gentleman in the foreground and the solemnity of the people leaning over the parapet - does not mitigate the urgency of the question: How does this machine work? There is no engine: the ghostly figure in the window is not driving the train.

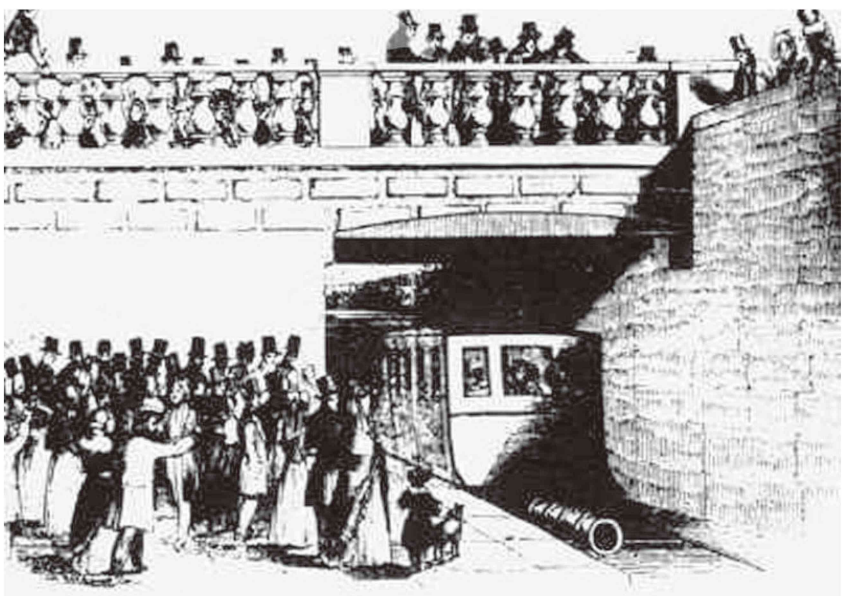

Figure 2 - Atmospheric Railway Modernity

In the disjunction between modernity and kitsch we reach the limits of absence. An autonomous technology is a technology abstracted from human use and understanding, and by the 1850s atmospheric traction was just such a technology. For various reasons, too complex to go into here, it had failed. The traveling public never did receive the answer to the question: It works because you have seen it working. Paxton and Moseley could not represent atmospheric trains clearly because neither they nor their interlocutors had a clear idea of what they should look like. (The same was even truer of Pym's 'magnetic' railway, not a failed but an untried technology.) In one respect, as already suggested, this vagueness was auspicious. But in another it is telling. It shows the danger of a strategic set of absences - absences necessary to regenerative efficacy - becoming a posited absence - the absence of the 'social' from the 'sociotechnical' equation. I don't

think it detracts from Paxton and Moseley, and maybe Pym as well, as having had the best wills in the world, to note that the best wills in the world can be forgetful of those whom they are exercised upon.