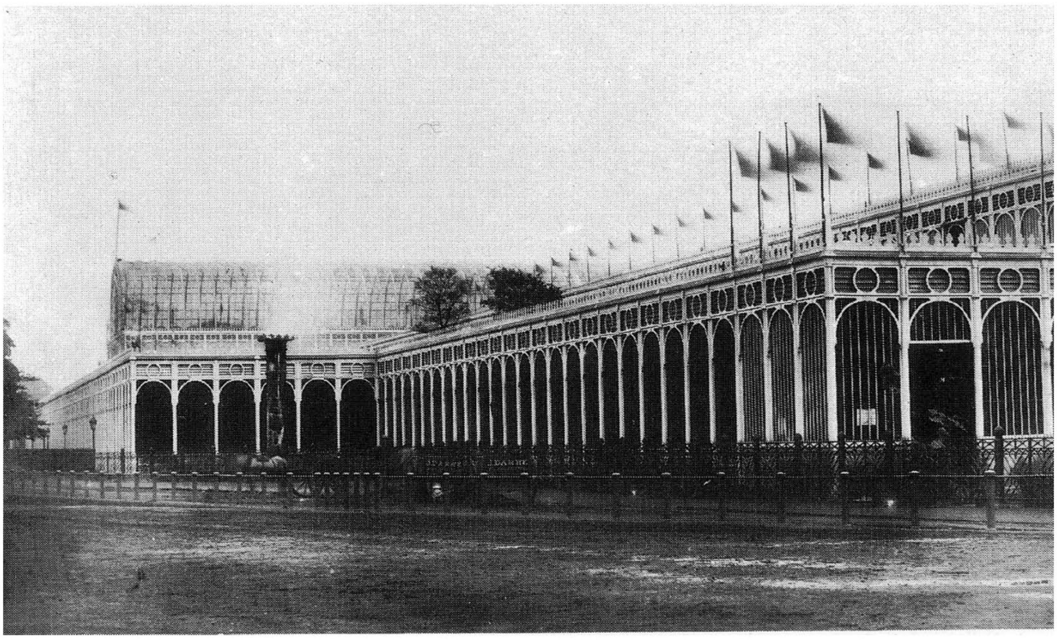
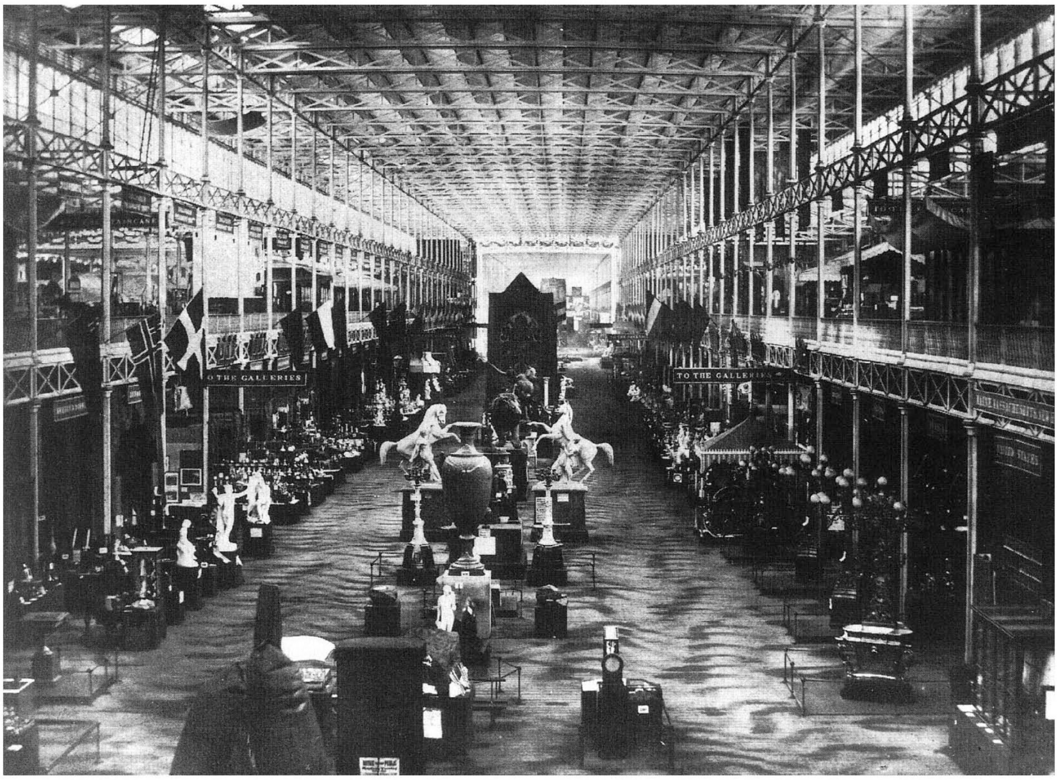
Contesting accepted narratives of the 1851 Crystal Palace



Exterior view. Most of the external wall at ground floor level was boarded in timber. Only every third post was of iron



Interior looking towards the transept

Photos from: McKean, John. 'Joseph Paxton Crystal Palace London 1851' in: Dunlop, B, & Hector, Denis. *Lost Masterpieces*. London Phaidon, 1999, illustration numbers 38 & 41.

NOTE : This paper is included in my thesis as APPENDIX D.

Guedes, P. D. (2006). '**Contesting accepted narratives of the 1851 Crystal Palace'**. In: T. McMinn, J. Stephens and S. Basson, Proceedings [of the] Society of Architectural Historians, Australia and New Zealand XXIII Annual Conference 2006 : SAHANZ 2006 : Contested Terrains. *SAHANZ 2006: The 23rd annual conference of the Society of Architectural Historians, Australia and New Zealand*, Freemantle, W.A., (207-213). 29 September - 2 October 2006.

CONTENTS:

ABSTRACT:

Contemporaries saw the Great Exhibition building as a marvel of the age, continuing to gain status in the Twentieth Century as a herald of prefabrication and industrial standardization. However, careful reading of contemporary accounts and drawings do not entirely support these sometimes exaggerated views.

The Crystal Palace was indeed a benchmark of superb logistics and the orchestration of a vast labour force. Combined with building details derived from mechanical engineering, these innovations made it possible to erect the building efficiently and quickly. Charles Fox focused the expertise of railway contracting on architecture for the first time. Owen Jones and others refined many of the details and helped transform Joseph Paxton's inspired idea into a masterful manipulation of space.

The paper presents evidence that contests some major myths surrounding the Crystal Palace while speculating on why they have been so persistent.

NOTE : This paper is included in my thesis as APPENDIX D.

CONTESTING ACCEPTED NARRATIVES OF THE 1851 CRYSTAL PALACE

Pedro Guedes

School of Geography, Planning and Architecture, The University of Queensland, Brisbane, Australia.

ABSTRACT

Contemporaries saw the Great Exhibition building as a marvel of the age, continuing to gain status in the Twentieth Century as a herald of prefabrication and industrial standardization. However, careful reading of contemporary accounts and drawings do not entirely support these sometimes exaggerated views.

The Crystal Palace was indeed a benchmark of superb logistics and the orchestration of a vast labour force. Combined with building details derived from mechanical engineering, these innovations made it possible to erect the building efficiently and quickly. Charles Fox focused the expertise of railway contracting on architecture for the first time. Owen Jones and others refined many of the details and helped transform Joseph Paxton's inspired idea into a masterful manipulation of space.

The paper will present evidence that contests some major myths surrounding the Crystal Palace while speculating on why they have been so persistent.

.

Popular thinking

In January 1851, in his popular weekly journal *Household Words* Charles Dickens took a poetic view when describing the Great Exhibition building:

> The proposed edifice could be constructed at Birmingham, at Dudley, and at Thames Bank, "brought home" to Hyde Park, ready-made and put up like a bedstead.[1]

This idealisation, adopted by the press and general populous, was far from true, yet somehow, the building seems, even in its own time, to have communicated the idea that it could be made remote from its intended site, brought together immaculately and silently assembled from pre-finished components in the spirit of Solomon's Temple, which was purportedly:

> ….made ready before it was brought thither; so that there was neither hammer *nor* axe nor any tool of iron heard in the house, while it was building.[2]

In the case of the Crystal Palace, the 'nuts ad bolts' story that lies behind such romanticism is grittier and more complex than the legend.

Reality I: Iron components ready to erect

Very little of the building arrived at Hyde Park in a finished state. The cast-iron elements were the exception: among which, 1,074 base plates, 3,300 columns and 2,150 short 24 ft. gallery and roof girders.[3] Structural castings were made in several Midland foundries, while the lighter, largely decorative ones were cast at Messrs Fox and Henderson, the main contractors' works at Smethwick, near Birmingham. Charles Fox and his team had developed all the constructional details and processes by which the building could be put together.

The columns, built up of short storey height lengths and connecting pieces had every meeting surface machined by lathe to ensure a perfect fit. There were nine different variations of column designed to suit different junction demands, heights and loads. In all cases their external dimensions were identical making the intercolumnar space the same throughout the building, greatly reducing variations in beam and girder dimensions.[4] These strategies allowed the castings to be fixed without any adjustment or alteration on site, an expensive and, at the time, unorthodox procedure. This made it possible to bypass normal contemporary practice of pre-assembly and numbering at the foundry, which ensured that the very same pieces would be brought together at the construction site. Clearly with such large quantities of similar components from different foundries, normal methods would have been impractical. These precision assembly techniques, borrowed from machine construction, were probably among the building's major innovations, foreshadowing ideas of rigorously standardized interchangeable parts. In contrast, some constructional decisions seem unusual in retrospect, for example: Every base plate, designed to reconcile the uneven peculiarities of the site with the regularity of the building above, was cast to suit its individual situation, with no standardization involved. This saved on excavation and earth moving, but for this to happen, communications between the site and the foundries must have been absolutely dependable.

Everything else arrived at Hyde Park in a semi-raw state, ready to be worked on, adjusted, cut and fitted, by an army of over 2,000 workmen, assisted by a prodigious number of draught-horses and steam engines all of which were choreographed to complete the building efficiently.

Reality II: Iron elements fabricated on site

Returning to Dickens:

> The promenaders and neighbours of Hyde Park would be relieved of the "click-click" of bricklayer's trowels, the maddening noise of blacksmith's riveting hammers…[5]

All spans over 24 feet required wrought-iron trussed girders. These were fabricated on site from wrought-iron angle and flat-bar stock, delivered in uncut lengths. This iron, rolled by Fothergill & Co. in Wales was cut to length by steam-driven shearing machinery at the construction site. Other machines formed rivet holes by punching and drilling. Contemporary illustrations show this impressively bulky equipment set up seemingly casually in the open air.[6]

> The riveting together of the wrought iron trusses was performed on horizontal supports…laid out on the stages in the proper forms with cast-iron standards, which were temporarily kept in place by bolts passed through the rivet holes.[7]

3,000 rivets could be driven in a ten-hour working day. Even the smallest trusses required 50 'supplied from small portable furnaces, several sets of men being employed upon each truss.'[8]

Certainly, this was not the silent assembly of ready-made components.

Reality III: Carpentry workshops at Hyde Park

Evidence disproving the popular myths of 'ferro-vitreous' construction is found in *The Builder* of May 1852, confirming that wood was the predominant material in the Crystal Palace. By volume nearly 27 times more timber was used than cast and wrought iron combined.[9] Most timber was milled off-site in London by specialised machinery developed specifically for the job by Edward Alfred Cowper, the principal designer at Fox Henderson.[10] The raw lumber was then cut exactly to length, shaped and fitted at Hyde Park by a prodigious numbers of skilled carpenters. Mechanical labour-saving devices, templates and jigs accelerated operations at this hive of activity. There were circular saws, morticing machines and other mechanical tools, but most of the work was done by hand. [Figure 1] Contemporary engravings show large numbers of carpenters hard at it using conventional benches among large stacks of timber. There was no prefabrication or pre-assembly. All this was done on the site, including the fabrication of several hundred wooden, 24 ft. roof trusses designed to match the cast-iron ones in appearance.[11]

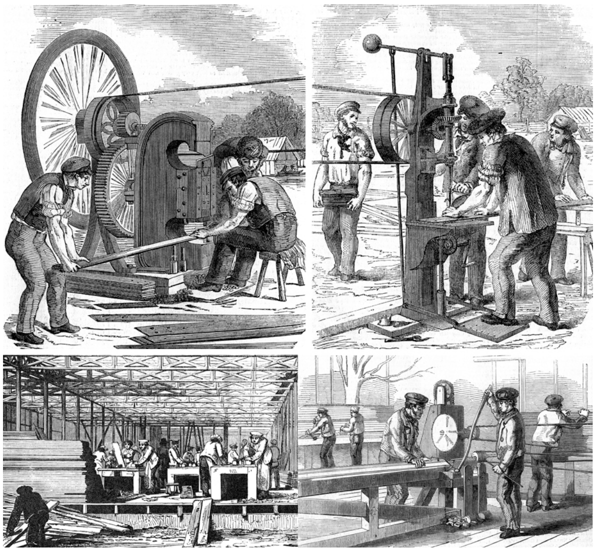


Figure 1. Fabrication on site: Cutting and perforating wrought-iron bar and angle for all trusses over 24 feet span. Carpenter's workshops where the lumber was prepared for use throughout the building. Some steam driven machines were used.

With permission, The University of Queensland Library

These realities do not by any means diminish what was achieved. If anything they show how well organised and productive the site was in terms of materials flow and the minute organization of a very large labour force. Without such superb logistics, careful planning and an ability to respond imaginatively to emerging circumstances, the building would not have met its opening deadline.

Design Process

The competition for the 1851 Exhibition building attracted 240 entries from Britain and abroad. Matthew Digby Wyatt, who was secretary to the exhibition's Executive Committee analysed and reported on the schemes. None was considered entirely appropriate, so the Building Committee set about developing its own design, against the very tight time-schedule. Reconciling the contributions of forceful personalities on the Committee was a difficult task and contributed to the design being less than inspired with its massive masonry walls surmounted by Brunel's gigantic iron dome.[12] The plan, most probably brought together by Wyatt aimed to exploit the potential for grandeur made possible by a colossal un-partitioned space, while also addressing the practicalities of efficient movement of great crowds of people.

The Royal Commission presided over by Prince Albert approved the Committee's design in mid-May 1850, less than a year before the planned opening on May 1st 1851. The architect Owen Jones and brother-in-law, engineer Charles Heard Wild took three weeks to prepare detailed plans and tender documents. Jones, a friend of Wyatt's had worked for Henry Cole one of the principal promoters of the Exhibition. Wild, a highly regarded young engineer had recently assisted Robert Stephenson on the Britannia Bridge.[13]

Paxton, principal Author?

The idea of a large glass structure for the 1851 Exhibition predated Paxton's enthusiasm by several months. William Bridges Adams had published a review promoting 'a great metropolitan conservatory or winter garden' in April 1850 in the influential *Westminster Review* just as competition entries were being received.[14] He later wrote:

> Thirteen months from the date of our writing, there stands the structure….. a sample of rapidity, resulting from earnest co-operation, this building is remarkable… As a structure, though still of an imperfect kind, this erection is indicative of what will be possible….[15]

Paxton was probably aware of this early suggestion, but never mentioned it. Lecturing in August 1850, he is reported to have remarked:

> …. until there was a squabble in the newspapers about the site and plans for the proposed Exhibition, he had never turned his attention to it. He naturally thought that as three of our most eminent engineers and our best architects were on the Building Committee, some design worthy of this great country would be produced….[16]

In November, at the Society of Arts, he added:

> I was at once convinced that the least objectionable structure to occupy a public park would be an erection of cast-iron and glass… The time for receiving designs had expired; but, from having the whole matter already digested, and the system of ridge-and-furrow flat roofs so fully impressed on my mind, it only required the adaptation of the principle on a large scale to suit the vast building of the Exhibition. [17]

Paxton's design went through various stages, starting with the famous June 11th blotting-paper sketch, which he believed contained:

> … the principal features of the building as it now stands, as much as the most finished drawings that have been made since. In nine days from the time of making the blotting-paper sketch, I found myself... with a roll of plans under my arm, on my way to London. These plans, five in number, had, with the exception of one, been prepared by me at Chatsworth; the one not prepared there had been made for me by Mr. Barlow, the eminent engineer of the Midland Railway who kindly gave me his valuable assistance in calculating the strength of the columns and girders.[18]

Before this, Paxton had met with Henry Cole, who had informed him of a clause in the tender conditions, allowing contractors to submit an alternative scheme along with their pricing for the Building Committee's design. Very little time remained however, as July 10th was deadline for submitting tenders. Returning to London Paxton set about vigorously promoting his idea, using his extensive and influential network. After his design had been presented informally to members of the Royal Commission, the Building Committee, the Queen and Prince Albert, Paxton took his drawings to Charles Fox who he knew was planning to submit a tender.

The Design Team

'Mr. Fox was much pleased with the design' and immediately began working on a tender and drawings for Paxton's idea.[19] Fox later explained:

> On the 2nd of July, Mr. Cole, having heard of our intention to make an offer for a building of this kind, and feeling strongly that the success of the Exhibition depended upon having an attractive and suitable building, came down to Birmingham……..to stimulate us to proceed, and to offer such hints in reference to the requirements of the case as would enable us to make the conception of

> Mr. Paxton conform strictly to the condition of tender required by the Commissioners.[20]

Paxton's design was accordingly modified to match the plan of the Building Committee as exactly as possible including the use of the 24ft. structural grid which became such a strong feature of the Crystal Palace.[21] Bridges Adams who happened to call on them captured the atmosphere of activity at Fox Henderson's drawing office:

> The writer … well remembers the scene …. as he opened the door. No conclave of freemasons who may have gathered together …… ever displayed more earnest thought, more persevering energy than that small band, stripped to their shirts in a hot night ….., planning, drawing, and calculating strength, and stress, and cost, and time, with a will and purpose that never looked at the contingency that the labour and expense might be all in vain, and be set aside by a caprice or a formula. There sat the engineer, his keen dark eye glancing from beneath well-stored brows … a bold venturer on the unknown in practice,…. A touch of the Columbus spirit, that knows, or can predict, something of the unknown, and that knows most of the known in the practical world, and all its turns, and quirks, and shiftings, and quibbles—to be on guard against them.[22]

While all this activity was taking place in Birmingham, ironfounders, glassmakers, timber merchants and other suppliers around the country were consulted on technical issues and prices. Fox Henderson were well placed to turn Paxton's idea into reality, having had many years of experience erecting structures using new materials and techniques outside the time-honoured practices of the building industry.

During this phase of the project, Paxton worked closely with Fox and his team, but he also continued his campaign in London where he pulled off a masterstroke in public relations by having an earlier version of his design published in the *Illustrated London News* on June 6th, four days before the tender deadline.[23] The evocative wood engraving conjured up an image of a fresh, light and clean structure in strong contrast to the squat, gloomy and cumbersome Committee design with its over-scaled dome, which the same journal had illustrated barely two weeks before.[24]

Before Fox's tender was accepted on July 26th, changes to the design were discussed and agreed by the Committee, including the addition of the vaulted transept, claimed by Charles Barry as his architectural contribution. A team was assembled to take the project forward. William Cubitt, the President of the Institution of Civil Engineers became the Committee's representative, effectively the client, whose responsibility it was to oversee the project, with rhe assistance of M. D. Wyatt, O. Jones, C. H. Wild and his brother James.

When Fox Henderson received the go-ahead, their experience in railway contracting came into play. They were superbly skilled at deploying large numbers of workers cooperating on diverse tasks. Their experience of iron construction in station structures, bridges and naval buildings was invaluable as was their understanding of logistics and how to exploit the telegraph and railway system to maintain the flow of materials to the site in the right order. All these considerations had to be taken into account in definitive drawings, structural tests of prototypes and a logical program of works. Fox records this period:

> The drawings occupied me about eighteen hours a day for seven weeks and as they came from my hand, Mr. Henderson immediately prepared the ironwork and other materials required in the construction of the Building.[25]

In addition to Fox's 'hand', there were others at work under him whose contributions to the building have remained undeservedly in the background.

The Crystal Palace brought together architects, engineers and industrialists some who had previously worked with each other while also creating the opportunity for long-lasting professional relationships to develop.

Alexander Brodie Cochrane owner of Cochrane & Co., ironfounders and engineers supplied the bulk of the structural cast-iron components while his son; John was resident engineer at Hyde Park, working for Fox Henderson. Relationships of this kind must have helped overcome difficulties when they arose.[26]

Digby Wyatt who had various roles in the Exhibition was invited by Brunel, one of the Commissioners to collaborate on the architectural aspects of Paddington station, the ironwork of which was made by Fox Henderson.

Rowland Mason Ordish who assisted E A Cowper, chief draughtsman and designer in Fox's Company, became a collaborator with Owen Jones on several later projects. His design for the roof of St. Pancras station in association with William Barlow gave him recognition as one of the foremost experts on iron construction. In 1903, Ewing Matheson was still able to write that: 'as a draughtsman under Charles Fox, [he had] made the greater part of the working drawings' of the Hyde Park building.[27]

Jones' contribution to the building included his daring colour scheme using bright primaries, Blue, Yellow and Red, arranged to magnify the vastness of the building and accentuate its lightness.[28] By all accounts his keen understanding of the properties of colour in this most unusual space produced magical 'fairy-like appearance'.[29] In addition:

> Mr. Owen Jones went carefully over every form in the building susceptible of harmonious combination, and has zealously occupied himself of every detail of arrangement likely to benefit by the exercise of his taste and knowledge.[30]

Jones was familiar with multi-bayed columnar space, as was his collaborator and brother-in-law James Wild, from their researches into Islamic architecture in Egypt and Spain where many mosques had these spatial qualities.[31] It is probable that this familiarity helped Jones develop a mastery over control of the unusual and vast space of the Exhibition building. Many of the building's ornamental details such as the arches between columns on the elevations and the cresting against the skyline have a distinctly Saracenic flavour.

Paxton's real contribution

It seems clear that once the contract was underway, Paxton's role in the project diminished considerably. He seems to have lost touch with the way things were changing in detail while retaining the aura of authorship in the public's eye. This growing distance is clear in some of his speeches. He is reported to have said that:

> Since the contract had been taken, by Messrs. Fox and Henderson, he had suggested to them a plan by which they might effect some saving of expense, and also promote their convenience. He recommended them to erect scaffold poles by the sides of the columns to support the canvass, and thus the workmen would be enabled to construct the building under its shelter.[32]

Clearly, he was not up to date on the contractors' ideas of how they were to construct the building, nor does it seem that he was fully in touch with the complexities that the framing of the building had assumed since his concept had been adopted. The design had evolved, as we have seen, to include a large numbers of component variants adapted to their different circumstances, yet Paxton continued to describe them in the following terms:

> The columns are precisely the same throughout the building, and would fit every part……..No numbering or marking would be required, and the whole will be put together like a perfect piece of machinery.[33]

Paxton's experience, ideas and years of research were nevertheless key contributors to the most visible parts of the design. He had perfected the ridge and furrow system, allowing almost any plan shape to be covered, irrespective of size, under what was effectively a flat roof. Bays of structure could be added or subtracted at will offering enormous flexibility.[34] With its integrated drainage system for rainwater collection, roof pitches no longer dictated the shapes of buildings. To make this type of roof economical, Paxton developed machinery for forming glazing bars that earned him a Silver Medal at the Society of Arts in 1840, These bars were the forerunners of those milled for the building's enclosure where over 200 miles were used.[35]

Paxton's longstanding relationship with Robert Lucas Chance, the glass manufacturer, led to the development of large panes measuring 49"X10" capable of spanning between the ridges and gutters of the roofing system without any joints. Two inclined sheets meeting at a ridge would slope into gutters spaced precisely 8 feet apart. This dimension became the fundamental unit of the building, multiplied throughout its structure. [Figure 2] Over a quarter of a million panes were used in the building, its most repeated element, and every one of them was blown by human breath by a craftsman in Birmingham using no machines.[36]

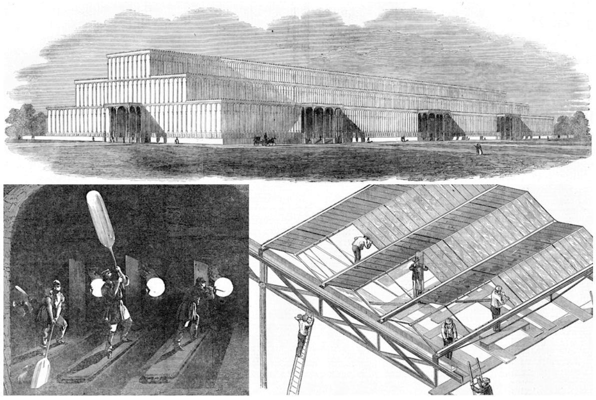


Figure 2. Paxton's design as published by the Illustrated London News. Cylinder glass being made to its maximum possible size. Ridge and furrow roofing.

With permission, The University of Queensland Library

Other ideas from Paxton's horticultural experience embodied in the building were the environmental controls: Very extensive banks of adjustable louvres and the calico covering over the roofs and south facing glazing were incorporated to control the internal climate and regulate daylight. Both had been mentioned in the original publication in the *Illustrated London News*.[37] The use of Mitchell's patent screw piles as the footings for the building seemed an elegant idea at this early stage, but the wide base plates adopted, were probably more practical, facilitating accurate setting-out after concrete footings had been placed.

Public involvement

As it was going up, the press carried regular reports about the building's progress, and until it became disruptive to the works, tickets were issued for visits to the construction site. On the last day of 1850, Professor Cowper, lecturer on manufacturing art and machinery at King's College, London and father of Fox Henderson's principal designer, delivered a talk to invited members of the Society of Arts in an improvised lecture space in the unfinished building while the workmen went to lunch.[38] From the very start, the building had assumed the role of principal character of the exhibition in people's minds.

Digby Wyatt's widely reported presentation and subsequent discussion at the Institution of Civil Engineers, raised doubts about the stability and safety of the building. The contractors, mindful of public concern, especially since a station built by them had recently collapsed, wasted no time in addressing these concerns. Numerous sets of diagonal bracing were added, and squads of Sappers proved the structural integrity of the floors by marching over a sample bay in close formation.[39] Few building projects have ever been so transparent and accessible to the public's understanding and curiosity. This regular and open publicity made it everyone's building and heightened expectations.

When the Crystal Palace opened many felt let down by its exterior as they expected to see it as imagined in idealised views, especially those seen from above. Robert Thorne picks up this theme quoting Henry Mayhew's remarks:

> The mind had imagined something immeasurably more beautiful – for beyond the roof of the transept and the occasional window or two, there is not a pane to be seen; all the sides are boarded up, and it must be honestly confessed, have far from an imposing appearance … the extreme width of the building prevents you seeing the upper storey, so that it has a most unseemly "squat" or "dumpy" appearance.[40]

The building was given a festive air with banners of participating nations flying from flagstaff at the top of the first level, but these touches could not alleviate the boarded ground floor that contradicted the expectation contained in the words 'Crystal Palace' the name given to the building partly in jest by the editor of *Punch* when Paxton's scheme was first made public. The southern elevation was so against expectations – it had calico covering its windows – that the view was never photographed or drawn!

Few, however, complained about the interior, unified and lifted by Owen Jones' inspired decorative scheme, enhanced enormously, as he had anticipated, by the animated visiting crowds, colourful exhibits and moving machinery. It is surprising that Ruskin could not see beyond his ideological frame and recognise that what Jones had succeeded in doing in built space was to deploy the effects of aerial perspective he so admired in Turner's paintings.

Persistent Myths

Despite published evidence and the building itself, informed members of the public like Dickens and even Paxton wanted to believe that the building was made in a way that separated it as far as possible from how things were usually done.

The first myth, that the building was somehow prefabricated, is almost entirely false as has been shown. Instead, Hyde Park became a production facility as well as a building site orchestrated with enormous skill, harnessing machines with handcrafted construction.

The myth of an iron and glass building expanded in the Twentieth Century. In addition to the prodigious use of timber elsewhere, the elevations were largely of wood, including dummy columns at 8^{ft} intervals between iron supports spaced at 24^{ft}. Half the diagonal members in the wrought-iron trusses were in timber for aesthetic reasons, so it cannot even be said that the structural elements were clear expressions of function.

The greatest myth of all is that it was the product of individual genius. The competition threw up useful ideas, the Commissioners' plan survived nearly intact draped under Paxton's glass skin and then Charles Fox, his team and others turned these ideas into a reality, brought to life by Jones' colour scheme and detailed treatment. The whole sequence was like a well-run relay against the clock. No baton was dropped as it passed from one expert contributor to the next.

Since its spectacular destruction by fire in 1936, it has been easier to raise the Crystal Palace on a pedestal. Within months, Le Corbusier wrote a tribute to the Sydenham incarnation of the building, adopting it posthumously as a legitimate ancestor of progressive architecture:

> When, two years ago, I saw the Crystal Palace for the last time, I could not tear my eyes from the spectacle of its triumphant harmony. The lesson was so tremendous that it made me feel how puny our own attempts still are. But I felt, too, how eminently justifiable and practicable are proposals are, *if only they get a chance.*[41]

It very quickly became a memory of something it had never been, its heroes crowned with impossible virtues perhaps best admired through the haze of myth.

[1] Charles Dickens, 'The Private History of the Palace of Glass'. *Household Words,* Nº. 43, 1851, p.387

[2] Kings, Ch. VI, v. 7.

[3] Peter Berlyn, and Charles Fowler jnr. *The Crystal Palace its Architectural History and Constructive Marvels.* London: James Gilbert, 1851. pp. 52-55

[4] Charles Downes, *The Building erected in Hyde Park for the Great Exhibition..* London: John Weale 1852, (HMSO reprint, 1971) p. 3-5 and pl. 8.

[5] Dickens, *Household Words,* 1851, p.387

[6] Charles Fowler Jr., 'The Great Exhibition Building No. 4' *The Illustrated Exhibitor*, vol.1, 1851, p. 130

[7] Berlyn, *The Crystal Palace*, p. 47-49

[8] Berlyn, *The Crystal Palace*, p. 49

[9] Volumes calculated by author from statistics published in: *The Builder*, vol 10, May 22, 1852, p. 326. Timber 600,000 cubic feet, Iron, 22,500 cubic feet. By weight, Iron (4,500 Tons) was less than half that of Timber (Approx. 10,000 tons)

[10] Downes, *The Building erected….* p. 44

[11] Downes, *The Building erected….* p. 7 and Pl. 10.

[12] 'Proposed building for the Great Exhibition' *Illustrated London News* (*ILN*), vol. 16, 1850, p. 445

[13] 'The late C H Wild', *Builder*, vol. 15 1857, p. 422.

[14] Helix, (pseud. William Bridges Adams), Review Art. IV. 'The Queens Commission….' *Westminster Review*, vol. 53, 1850, pp. 85-100

[15] Helix, Review, 'Art. IV, 'Official Catalogue of the Industrial Exhibition', *Westminster Review,* vol. 55. – 1851, p.347.

[16] *Mechanics Magazine*, (*MM*) Vol. 53, 1850, pp. 129-130 and in *Journal of Design and Manufactures*, vol. IV, Sept. 1850 – Feb. 1851 pp.30-31

[17] Lecture by Joseph Paxton at Society of Arts, Nov. 13th 1850. *Journal of Design and Manufactures*, vol. IV, Sept. 1850 – Feb. 1851, pp. 120-124. Also in *ILN,* vol:17, 1850, pp. 385-386.

[18] *ILN*, vol 19, Aug. 9th. 1851, p. 205. The sketch was doodled at a meeting in Derby on June 11th.

[19] *ILN*, vol 19, Aug. 9th. 1851, p. 205

[20] *ILN*, vol. 19, July 5th 1851, p. 21

[21] *ILN*, vol 19, Aug. 9th. 1851, p. 205

[22] Helix, Review, 'Art. IV, Official Catalogue of the Industrial Exhibition', *Westminster Review,* vol. LV. – 1851, p.355.

[23] 'Design by Mr. Paxton…' *ILN*, vol. 17, 1850, p. 18

[24] *ILN* vol. 16, June 22nd 1850, pp. 445-446

[25] *ILN* vol. 19, 1851. p. 22.

[26] Obituaries in the Dictionary of National Biography: William Bridges Adams, William Henry Barlow, Charles Barry, Isambard Kingdom Brunel, Henry Cole, William Cubitt, Charles Fox, Owen Jones, Rowland Mason Ordish, Joseph Paxton, James William Wild, Matthew Digby Wyatt.

Obits in *Proceedings of the Institution of Civil Engineers* (*PICE*) Alexander Brodie Cochrane, vol. 23, 1864, p.506, John Cochrane, vol. 109, 1891, pp.398-399,

[27] Ewing Matheson, 'Progress in the Design of Roofs since 1850.' *The Engineer*, vol. 95, 1903, pp. 29-30

[28] Owen Jones, 'On the decorations proposed for the Exhibition Building in Hyde Park' *Transactions of the Royal Institute of British Architects*, vol. 3, 1850-53. Volume unpaginated, 7 pages.

[29] Queen Victoria's words in a private letter, quoted in: John McKean, 'Joseph Paxton Crystal Palace London 1851', in: *Lost Masterpieces*, [introduction by Beth Dunlop and Denis Hector]. London: Phaidon, 1999. Unpaginated

[30] Matthew Digby Wyatt, 'On the Construction of the Building for the Exhibition….,' *PICE* vol. 10, 1850-1851, p.157.

[31] Michael Darby, *Owen Jones and the Eastern Ideal*, University of Reading, PhD Thesis, 1974. Mark Crison, *Empire Building*, London: Routledge, 1996.

[32] *MM* Vol. 53, 1850. p.130 'Paxton's design for the building for the exhibition of 1851'

[33] *ILN* Vol. 17,1850, p. 126 and *MM*, vol. 53, 1850, pp. 129-130

[34] Joseph Paxton, 'Roofs', *Br. Patent* – 13,186, 1850

[35] 'Machine for making sash-bars', *Transactions of the Society of Arts*, vol. 53, 1839-41, pp. 97-102.

[36] Berlyn, *The Crystal Palace*, p.46

[37] 'Design by Mr. Paxton…' *ILN*, vol. 17, 1850, p. 18

[38] 'Professor Cowper's Illustrations of the Scientific Construction of the palace of International Industry', *ILN*, vol. 18, Jan 4, 1851, pp. 9,10

[39] M. D. Wyatt, *PICE*, vol. 10, 1850 pp. 127-191.

[40] Robert Thorne, Crystal Exemplar, *The Architectural Review*, vol. 76, Jul, 1984, p.53

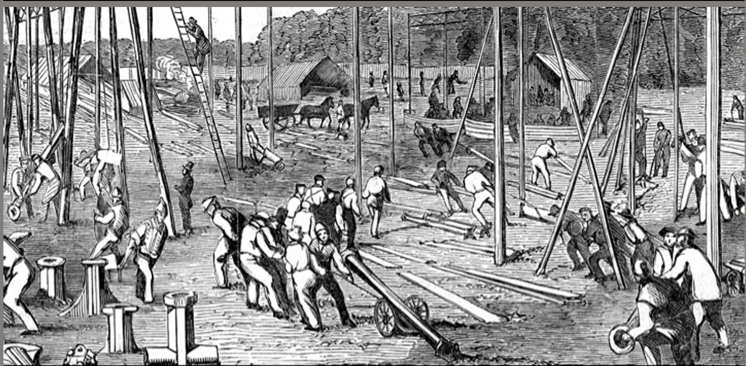
[41] Le Corbusier, 'a tribute', *The Architectural Review*, vol. 81, Feb, 1937, p. 72

INTERROGATING

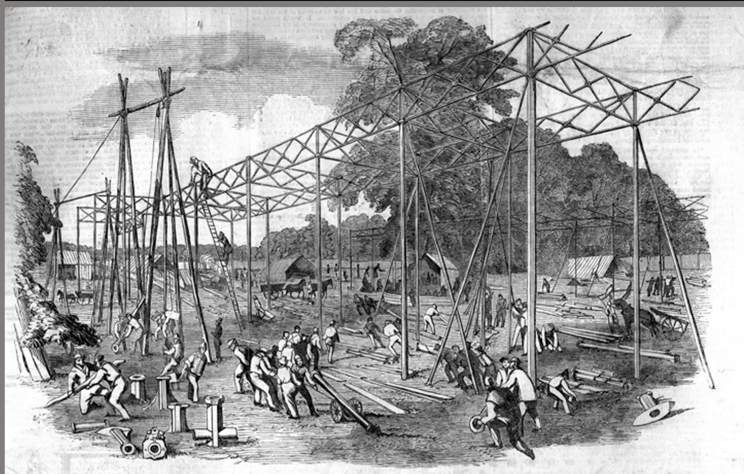
The Crystal Palace:

General View of the Building from the South-West.

Popular and idealized view of the 1851 Great Exhibition building

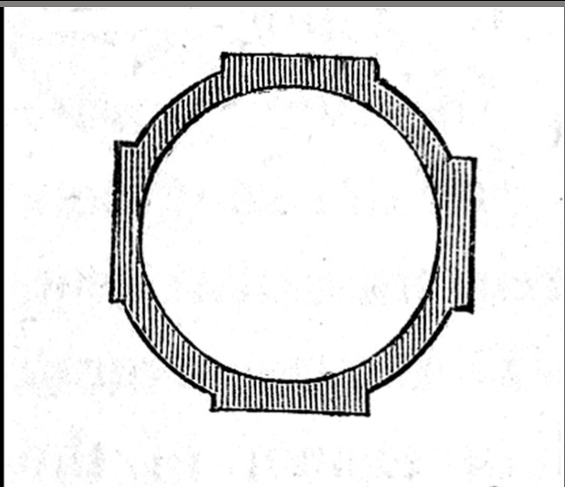


- Arrival of castings & early stages of erection

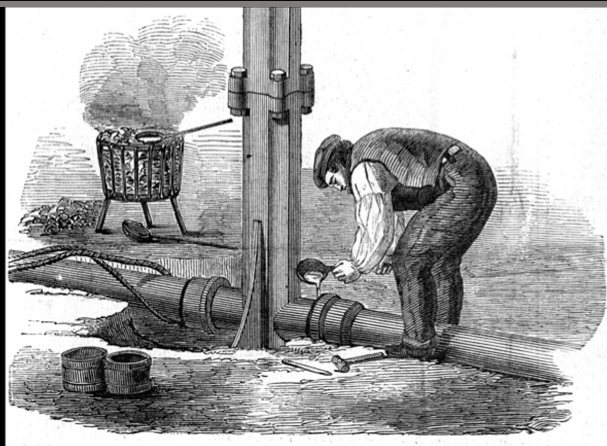


GREAT EXHIBITION OF 1851.—PROGRESS OF THE BUILDING IN HYDE PARK.

The only 'prefabricated' elements:
Cast iron columns and short 24' beams



SECTION OF COLUMN.

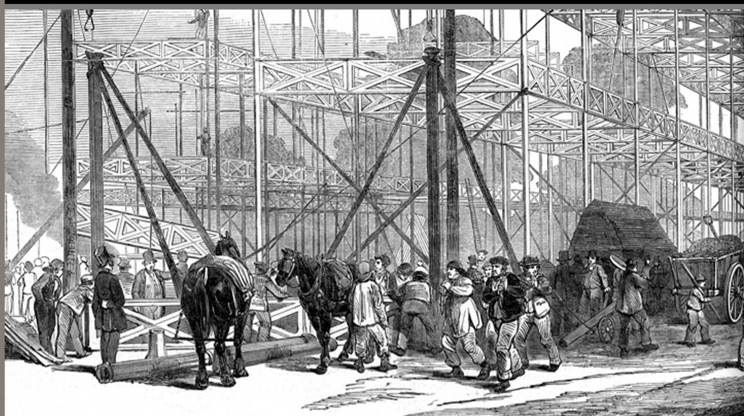


BASE OF COLUMN.

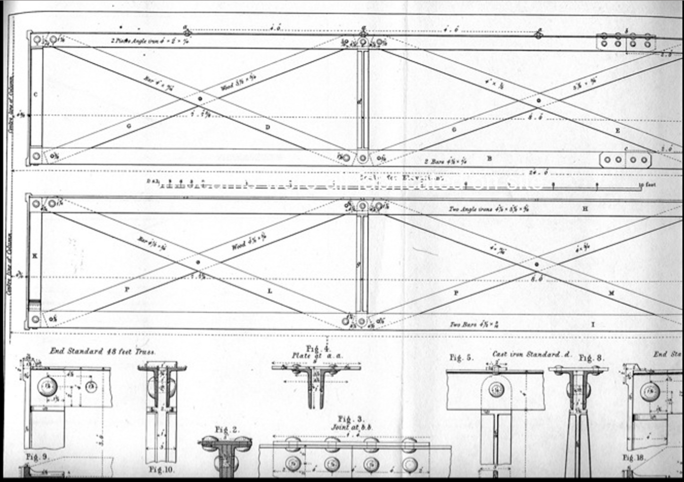
Individual column bases were cast to sizes to suit their location

Workmen waiting to be paid.

Over 2000 were employed on the site at some periods.

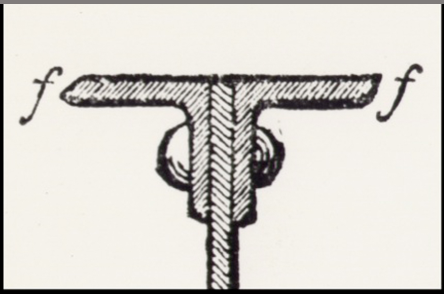


- Horses and men



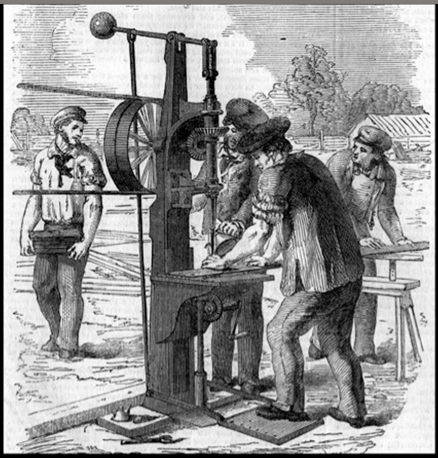
All spans over 24 ft were fabricated on site
from stock angles and flats

Rewly Rd Station Oxford: built from components similar to the
Crystal Palace by Fox Henderson (demolished)

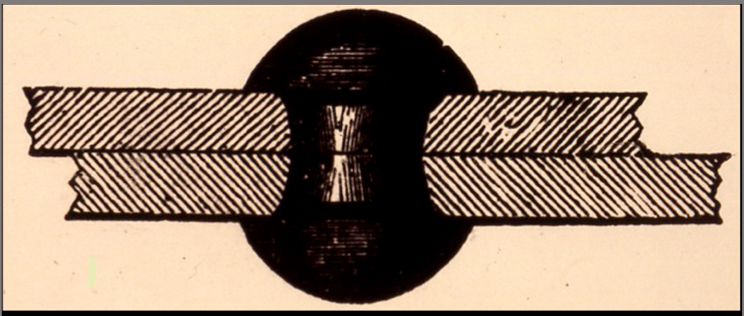


Angles and flats joined together by rivets

Shearing &Punching machine at Hyde Park



Drilling rivet holes on site

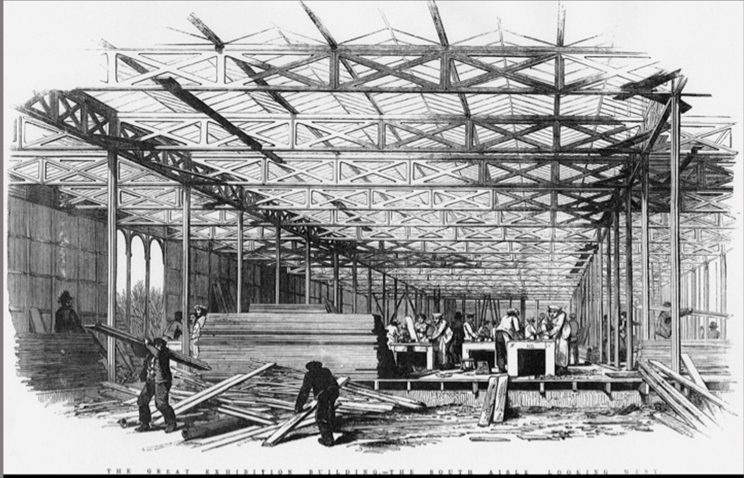


3000 rivets were driven on site in a day

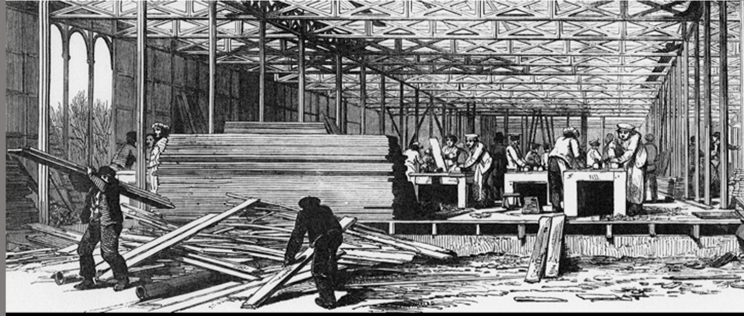
Comparison of volumes of Iron and Timber
used in the Crystal Palace

Iron column - every third 8' bay

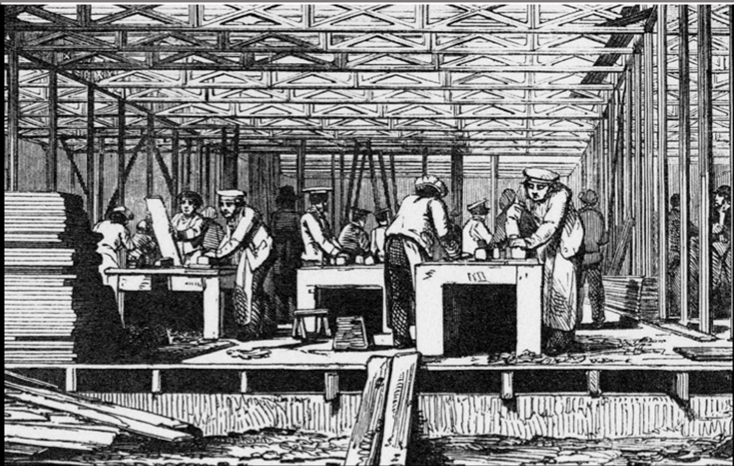
Timber - non structural column
Two dummy columns
between iron ones.



One of the many improvised carpenters' workshops



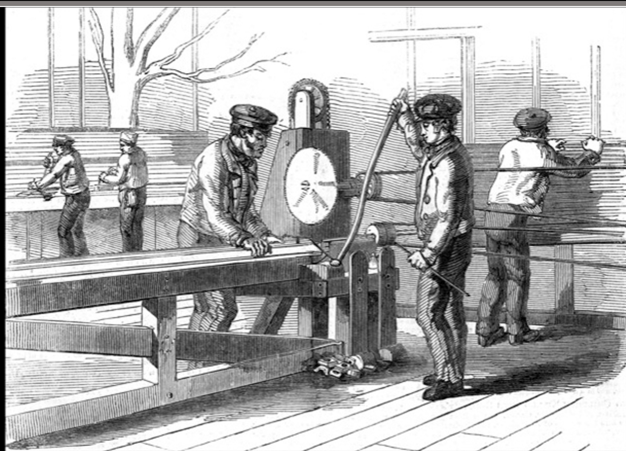
- Stacks of lumber Workbenches



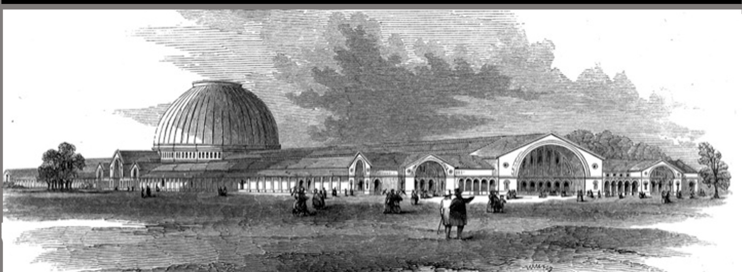
Prefabrication?

Or --------- like most building sites?

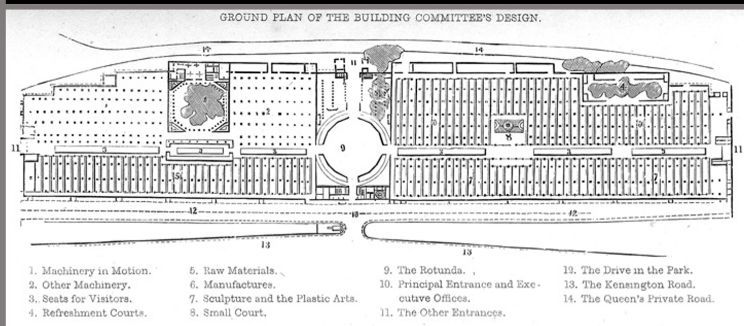
Mostly hand tools



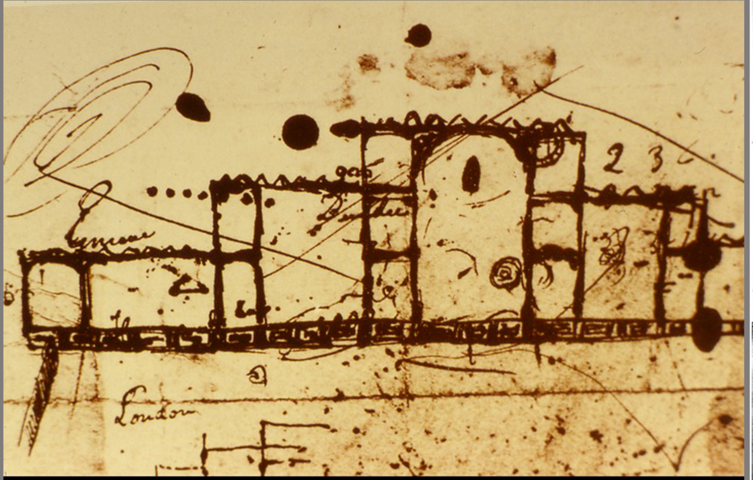
Sometimes machines



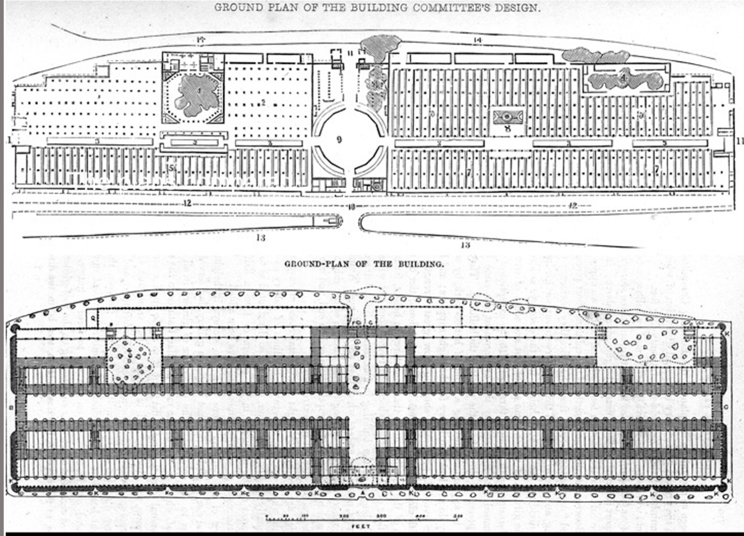
The Commissioner's design with Brunel's iron dome

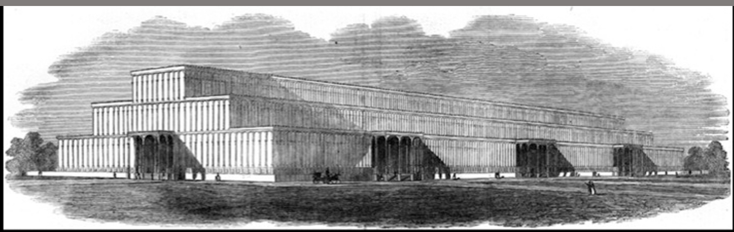


- The Commissioner's Plan

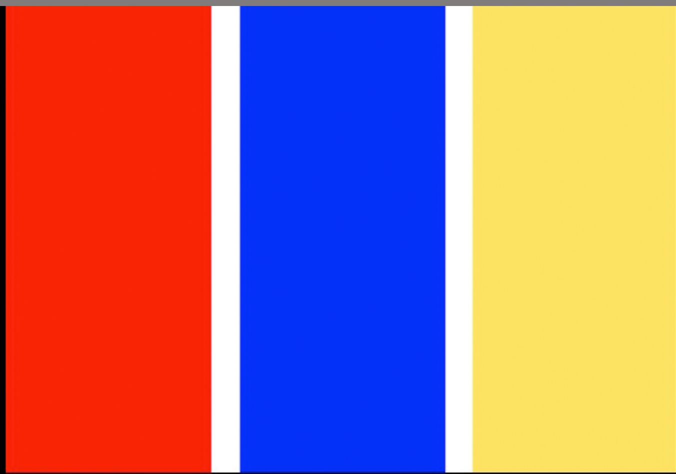


Paxton's sketch



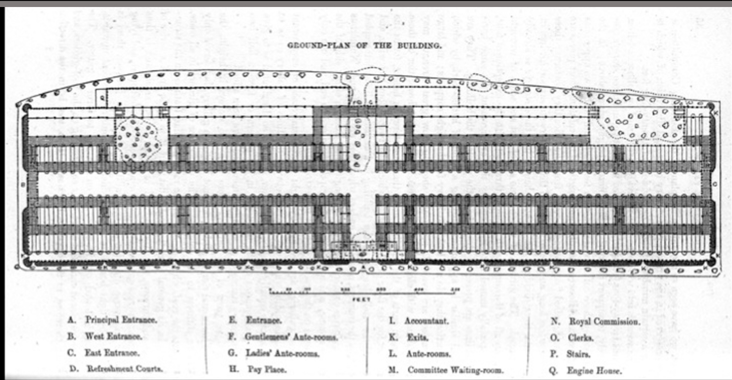


- Paxton's design published in the *Illustrated London News*

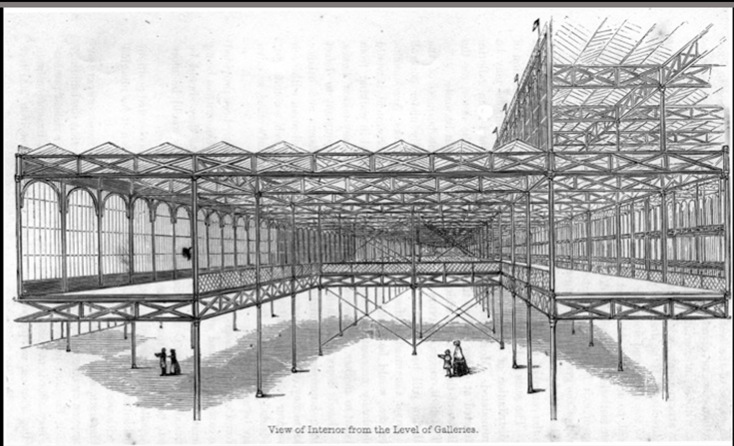


Owen Jones' colour scheme

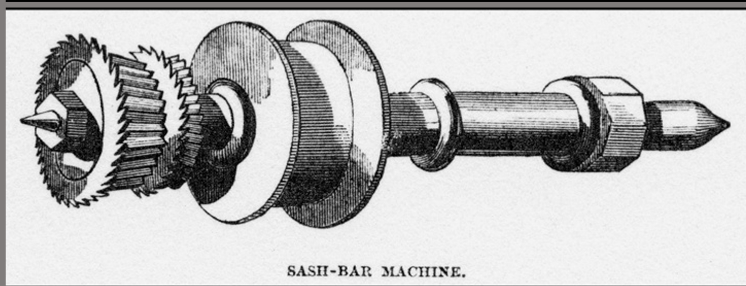
The interior at the opening



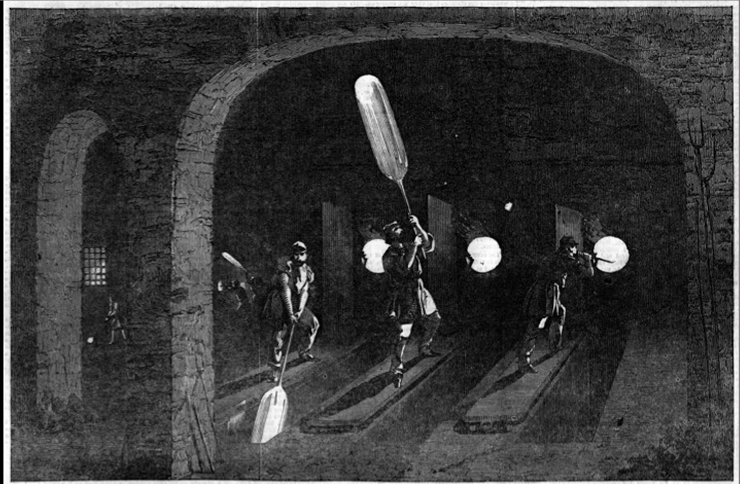
The plan as built



Continuous space under a 'flat' roof

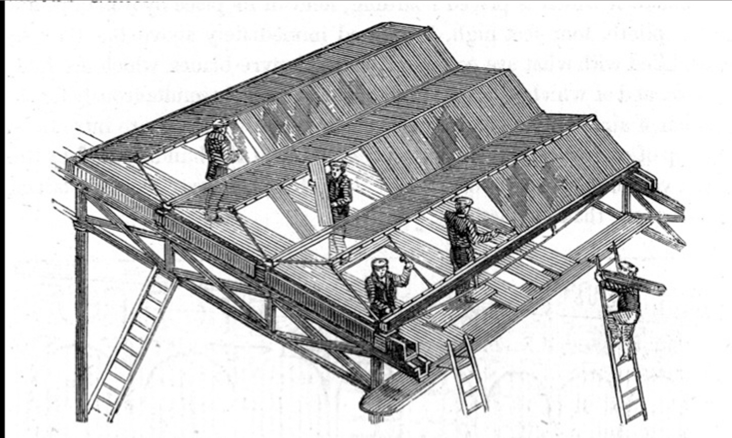


Paxton's sash bar machine
The original principle had been developed by him in the 1830s

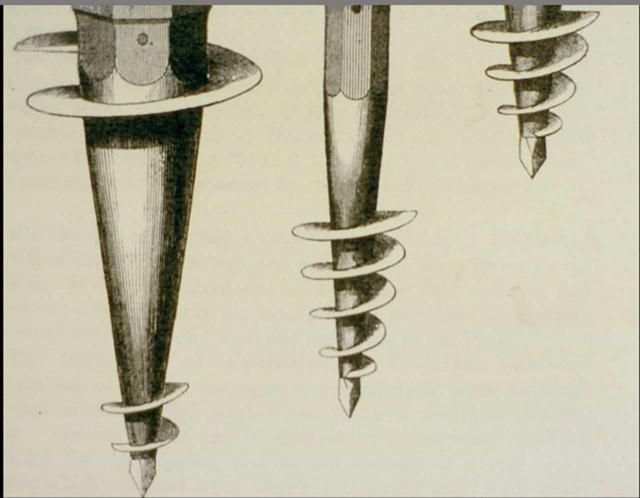


MANUFACTURE OF GLASS FOR "THE CRYSTAL PALACE," AT MESSRS. CHANCE'S WORKS, SPON-LANE, NEAR BIRMINGHAM.—(SEE NEXT PAGE.)

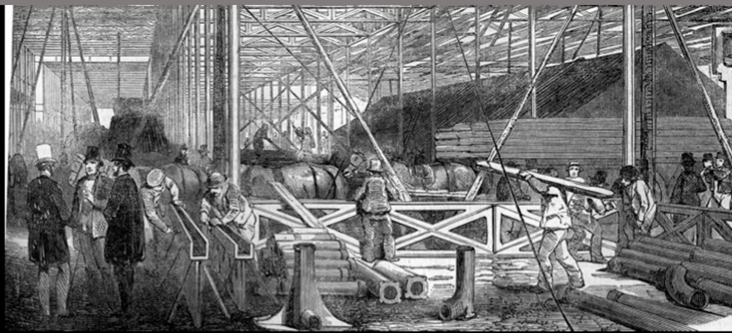
Making the glass -- all by human breath



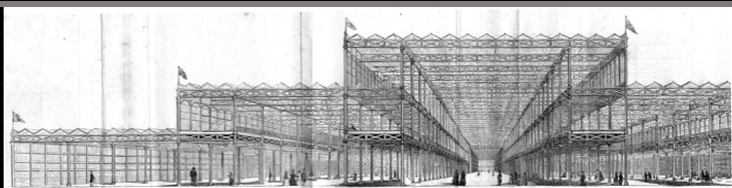
VIEW OF ONE 24-FEET SQUARE BAY OF ROOF PARTLY COMPLETED.



Paxton's intended foundations - Screw piles



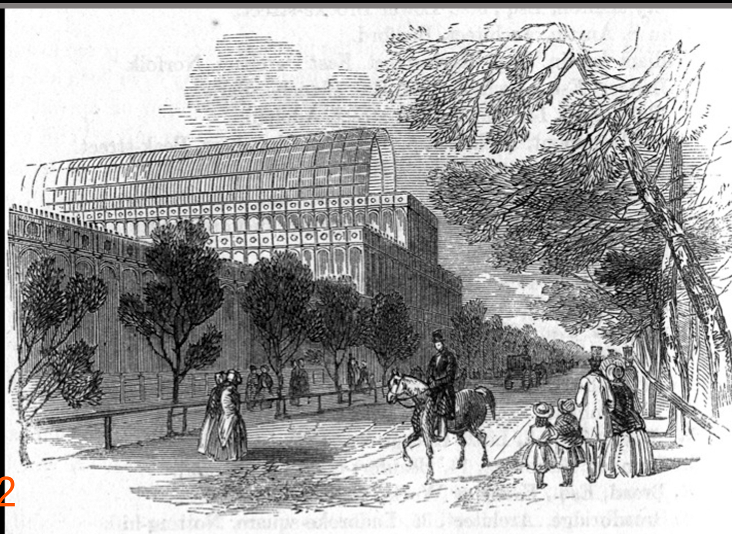
The busy site - little was delivered in a finished state



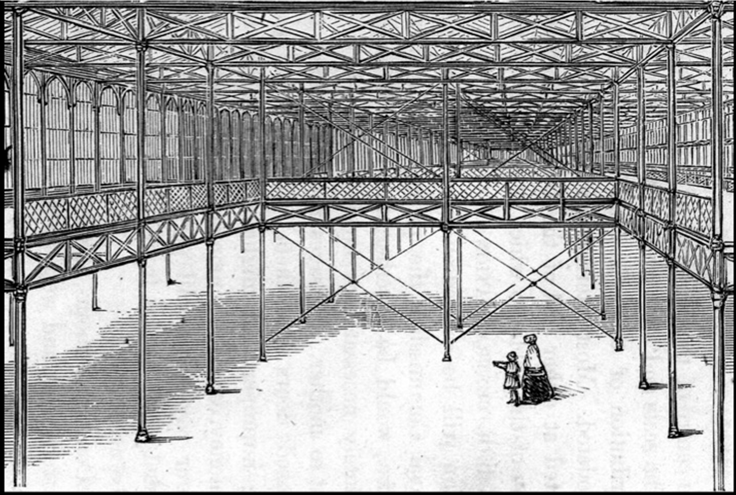
Transverse Section of the Building, showing the Interior completed.

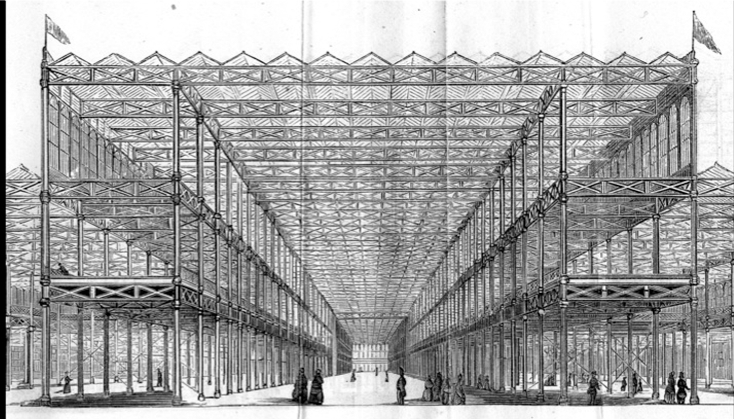
General View of the Building from the South-West.

View of the Building from the North Bank of the Serpentine.



VIEW OF SOUTH FRONT OF THE BUILDING.





Transverse Section of the Building, shewing the Interior completed.