Henry Fuller's Glued Laminated Timber Roof for Rusholme Road Congregational Sunday School and other early Timber Roofs

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Introduction

This paper is mainly concerned with the method of construction of the timber roof of Rusholme Road Congregational Sunday School in Chorlton-on-Medlock, a suburb of Manchester. At the time of its demolition in June 1963, it was reported that the Sunday School roof incorporated laminated timber components: on limited evidence it was suggested that the building was erected in 1827 and that it was possibly the first use of such components in buildings in Britain.

Three aspects of a subsequent investigation by the author are described in this paper: the first aspect, which is reported briefly here and in full elsewhere[1], is the date of construction of the Sunday School building, the second aspect is the method of construction of the roof and the third is the other buildings by the then unknown architect of the Sunday School, Henry Fuller.

The date and construction of the Sunday School were the subject of an investigation that took place mainly from 1968 to 1970. It was discovered that the Church and the Sunday School were not, as has often been stated, erected at the same time: the revised date of construction of the Church was tentatively placed at the end of the 1820s and the Sunday School building was dated as post-1849.

The investigation of the Rusholme Road buildings then lay dormant until recently when an examination of church records in Manchester and London firmly established the dates of construction of both buildings. The Church was opened in August 1826. The Sunday School, with its novel curved glued laminated timber roof components and its more important, but previously unrecognised, novel two-way grid of intersecting trusses, was opened in 1864, a date some thirty five years later than the often quoted incorrect one of 1827.

The date of construction of Rusholme Road Sunday School is now firmly placed at 1864, and consequently the roof is no longer the earliest known example of *curved* glued laminated timber construction in *buildings* in Britain. The Marriage Room at Southampton Register Office (formerly part of King Edward VI School), which was built in 1860, is now not only the earliest use of glued laminated timber arches, but it may also be the oldest existing example. Although the Sunday School has now lost its claim to priority in the use of glued laminated timber, its use of a grid of trusses for the roof structure is important and appears to have been novel.

The name of the architect for the Sunday School, Henry Fuller, has remained unknown prior to this investigation and consequently no previous search has taken place to discover if he designed other roofs that contained glued laminated timber components and that used two-way grids of trusses. A detailed search of church records in London and Manchester established that the design or refurbishment of 16 churches, some of which incorporated schools, can now be attributed to Fuller during the period 1860 to 1872. References to several open timber roofs were found, including the use of semi-circular laminated ribs at Lower Clapton

Congregational Church in north-east London in 1863. Disappointingly, the references were vague and examination of the four buildings that remain in use as churches failed to provide any evidence that Rusholme Road Sunday School was other than a one-off example.

The Roof Construction of the Rusholme Road Congregational Sunday School

In June 1963 the *Timber Trades Journal* published the following contribution by Thomas Hesp:

> *'A very interesting roof structure has been brought to light during the demolition this week of the old Rusholme Road Congregational Church and Sunday School room at the corner of Rusholme Road and Brook Street, Manchester.....(Figs. 1-4).*

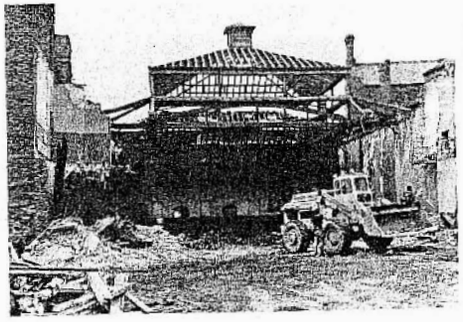


Fig 1: Rusholme Road Congregational Church Sunday School: General view during demolition, June 1963 (T. Hesp)

Fig 2: Rusholme Road Congregational Church Sunday School: Internal view of intersection of roof trusses; June 1963 (T. Hesp)

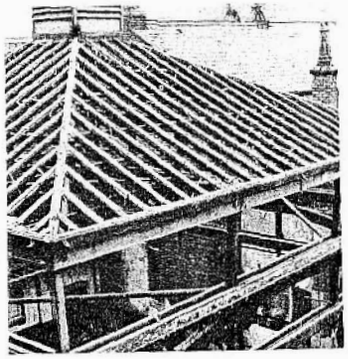


Fig 3: Rusholme Road Congregational Church Sunday School: External view of roof trusses, vertical glazing frame and upper sloping roof, June 1963 (Hesp)

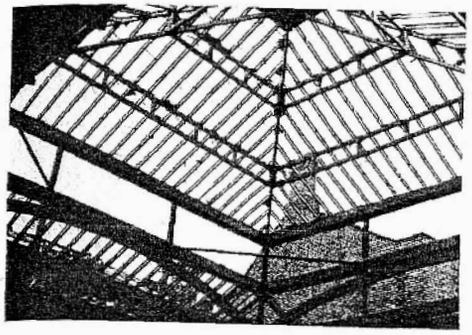


Fig 4: Rusholme Road Congregational Church Sunday School: Internal view of upper sloping roof and trussed purlins, June 1963 (T. Hesp)

The school room roof....was a beautifully framed roof in the form of a large lantern, slated on top and lower slope and glazed on the vertical face and surmounted by a louvred ventilator at the apex. The whole covered an unobstructed area of approximately 55 ft. square (Fig. 5).

Fig 5: Rusholme Road Congregational Church Sunday School: Isometric drawing of components and complete roof

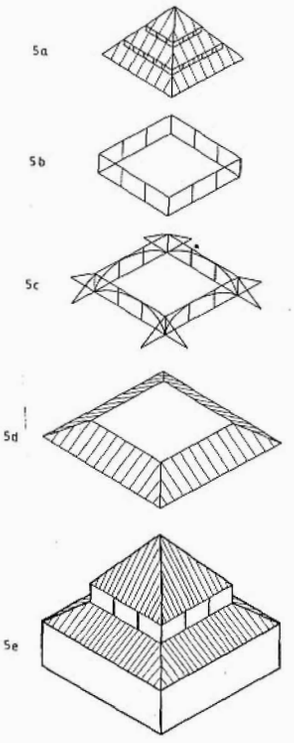
(a) Upper slope rafters and trussed purlins

(b) Vertical glazing frame

(c) Two-way grid of intersecting roof trusses

(d) Lower slope rafters

(e) Complete roof (apex ventilators omitted)



Particularly interesting was the inclusion of four laminated arched beams which were incorporated in the vertical framing. These, like the whole of the framed members, were made of pitch pine and had a span of 33 ft. and a rise of 4 ft. (Fig. 5). They each had nine laminae of 1/4 in. by 6 in. pitch pine boards, apparently full length, and were presumably either screwed or bolted together, but as all evidence of this was concealed it was thus not possible to confirm it. They were secured to the tie-beam by stout wrought iron straps.

The purlins were framed, or "trussed", of 3 in. by 5 1/2" in. pitch pine, mortised and tenoned together and neatly mitred at the hips; they had a depth of 24 in. and along with the rest of the framed portion were hand plane finished and varnished, having been exposed within the school room.

While it is not claimed that the use of laminated wood beams is entirely unique in the last century, it would appear from a little research on the subject that Colonel Emy first designed one for the roof of a building erected at Marac, near Bayonne, France, in 1825, and as this school room was erected in 1827, it could conceivably have been the first in this country.'[2]

A section of one of the beams was taken by Hesp to his laboratory at University of Manchester Institute of Science and Technology (UMIST) and he subsequently reported as follows:

'It was discovered that the laminae were glued together with Scotch-animal glue; the gluing area was confined to a 2 in. wide band along each edge, and then nailed with square hand-cut nails. There were roughly three rows of nails at a staggered pitch of about 5 to 6 in. Two of the laminae located near the centre of the beam were made up of a 4 in. and a 2 in. wide piece – which prompts the thought that the carpenter ran out of full width pieces.'[3]

Hesp's special interest was in wood machining and, as far as is known, he confined his examination to the glued laminated members: he did not have a strong interest in structures and consequently he did not examine the grid of trusses (particularly the joints) in detail.

The Rusholme Road Congregational Sunday School Building

From 1827, Sunday School classes were

'....conducted in a low cellar room underneath the chapel, where, even on a bright May morning, gas lights were often necessary. Here, under great disadvantages, the teachers have toiled on for five-and-thirty years.'[4]

The gloom of the room in the basement of the Rusholme Road Church was not its only disadvantage: the room was also unsatisfactory for the increasing number of students who wished to attend. The pressure of numbers was partially relieved in 1849 by the erection of several classrooms; although these additional rooms were found to be very useful, the need for a large room to replace the stifling atmosphere of the gloomy cellar was paramount. *The Congregational Year Book* for 1864 describes the next step as follows:

'After waiting many years a plot of land, immediately adjoining the chapel and old class-rooms, came into the market, and was purchased. It contains about 1,000 square yards, nearly the whole of which has been covered by the new buildings. These consist of one large school room to hold 800 adults, lighted entirely from a handsome lantern roof of open timbers, stained and varnished, and enclosed on two opposite sides by two ranges of class-rooms, each two stories high.

.....the total cost has been £2,440. The estimate made by the architect, Mr. Henry Fuller, of Manchester, being £2,470.'[5]

So far as is known, the building behaved satisfactorily until its demolition in June 1963, a life of very nearly one hundred years. Sadly, no photograph of its exterior has been found.

The Glued Laminated Timber Components and the Grid Roof Structure

The emphasis of this paper is on the use of curved glued laminated timber members in the four roof trusses that formed part of the novel two-way grid of intersecting trusses (Fig. 5). The specification for the 55 ft. square assembly hall is not known: however, bearing in mind the gloom in the cellar of the Church, the specification probably demanded that the hall be well lit.

Before considering the trusses with their curved glued laminated timber members, it is appropriate to note briefly the state of the art in the late 1820s (when the Church opened) and to mention some examples of the structural use of timber in the period 1826 to 1864 (the respective dates of opening of the Church and the Sunday School).

Laminated arches, in which the laminations were cut to profile and then notched or bolted to the adjacent lamination without being bent, were frequently used for bridges in Europe in the eighteenth century. The use of timber in arch bridges in which the laminations were bent into position was pioneered by Wiebeking in Bavaria during the years 1807 to 1809. Mostly the laminations were thick (12 in.), but for the bridge at Altenmarkt 2 in. thick laminations were glued together to make the 145 ft. span arch. The same method was used by Emy in France for arch roof structures in the 1820s; in his structures the laminations, which were typically 55 mm thick, were bent and then bolted together. Full descriptions of Wiebeking's and Emy's structures can be found in a previous paper by the author.[6]

The advent of the railways in Britain provided the spur to the use of mechanically laminated timber arch construction (usually bridges with 3 in. thick laminations bolted together).[7] The way was led by John Green and followed by, amongst others, Robert Nicholson, Brunel, Locke and Valentine, the last named designing an 121 ft. span glued laminated bowstring truss over the River Ouse in 1847.[8] Amongst railway buildings (typically train sheds) were Green's 25 ft. span arches at North Shields Station in 1839,[9] and Lewis Cubitt's King's Cross Station, whose 105 ft. span arches were built in 1852.[10]

It is now appropriate to return to the Rusholme Road Sunday School to describe the members (solid and curved) and the joints in the trusses, and to consider the possible structural action, and interaction, of the trusses (Fig. 5).

The emphasis of the discussion so far (an by previous writers in their brief comments on the Sunday School) has been on the novelty of the use of curved glued laminated members in the roof trusses. Another novel feature of the construction, which has passed unnoticed, is the two-way grid of intersecting trusses that transferred the roof loads to the perimeter walls.

Most buildings are rectangular on plan (i.e. the breadth less than the length) and most small churches follow this pattern. In these cases, the primary load-bearing members (say

trusses) span the breadth of the building and are repeated at close centres (say 15 ft.) along the length of the building. Typically, the load on the roof tiles is distributed to secondary members (say timber purlins) which in turn transfer the load to the primary members, and then to the walls and foundations.

Fuller's problem was to cover (and to top light) a 55 ft. square area without any internal supports. A routine solution would have been to use two load-bearing end walls and four 55 ft. span trusses as primary members at 11 ft. spacing. Solid timber secondary members could have spanned 11 ft. and carried the glazing. Presumably, there was no preferred direction for the primary members and Fuller was unwilling to adopt a visually unsymmetrical structure over the square area. Fuller maintained the symmetry of the area by using a two-way grid of 55 ft. span trusses, the four trusses being located at the $^1/_5$th points of the span.

The primary structural members (i.e. the four 55 ft. span trusses) were subdivided into five 11 ft. panels. Each truss had a twin-member bottom (tension) chord: the top (compression) chord, which was also a twin-member, was horizontal in the three central panels (Fig. 3). The two internal vertical members, which were solid timber, lay in the same vertical plane as the curved laminated member in the three central panels (Fig. 2). The vertical members passed through the twin-member top and bottom chords but were butted against the curved members (Figs. 2-3). The spatial relationship between the chords and the vertical end posts at the ends of the chords and the vertical end posts at the ends of the first panels cannot be determined from the photographs.

Pieces 33 ft. long would have been easily obtained for the top chords: 55 ft. long pieces for continuous bottom chords could also have been obtained without too much difficulty: obtaining the vertical members would have presented no problems. The curved glued laminated members have been described in detail at the beginning of this paper. There would, therefore, have been no problems with the members themselves.

The major problem facing Fuller would have been the joints in the four trusses themselves and at the intersection of the trusses.

In the trusses, the joints between the two internal vertical members and the chords would have been satisfactorily made with single bolts (Fig. 2): the compression joints at the meeting of the sloping and horizontal top compression chords (at the ends of the first panels) could have been made with butt joints and fairly simple iron straps. The two most difficult joints in a truss would have been in the bottom chord at the ends of the first panels where the vertical end posts, the bottom chord and the curved member met (Figs. 2-3). The transfer of load from the curved member to the bottom chord appears to have been made with a metal strap and possibly some birdsmouthing.

The most difficult joints to design in the roof would have been where the bottom chords intersected. Although it was visually a symmetrical two-way grid, the loads would have been carried equally to the two supports on each of the perimeter walls only if the four trusses had been of equal stiffness: to ensure this two-way action the problem would also have been to provide equal strength in the intersecting chords at these points. One pair of chords could have been continuous with the other pair butting up against them, but if this was the case it is difficult to envisage how the tension forces in the discontinuous chords were transferred. Both pairs of chords could have been continuous if they had been notched: whether the joint would have been strong enough is debatable. A likely solution is that both pairs of chords were discontinuous with the tension forces being transferred by means of bolts (Fig. 2), plus a metal cruciform in the space between the twin members.

In the absence of details of the actual joints it is not possible to say with certainty that complete two-way action was achieved but adequate joints, such as the cruciform, were available.

Returning to the trusses, if each of the primary members was intended to act as a 55 ft. span truss, then it is difficult to know why the curved members were used instead of straight pieces to triangulate the panels: they might have been incorporated for visual reasons. It may be that Fuller wished to emphasize the symmetrical rooflight and perhaps it was for this reason that he incorporated curved members springing from the corners of the rooflight.

The structural action of the curved members is debatable. If they acted as the top chords of three panel 33 ft. span trusses that carried the loads on the three central panels to the end of the first panel, then there would have been large bending stresses in the twin bottom members at those panel points. The bending stresses would have been relieved if the loads at the springing of the arch could have been subsequently transferred to the top chord by the vertical end post (the post would have needed adequate straps at both ends): with this arrangement the behaviour would have been similar to that of a conventional 55 ft. span truss.

Once it had been decided to incorporate curved glued laminated timber, the use of a bowstring truss with a curved laminated top chord for the full 55 ft. span would have simplified construction. The visual effect would, of course, have been quite different and the spatial relationship between the trusses and the rooflight may not have been so satisfactory. There would have been no difficulty in making the trusses, but once again the designer would have been faced with the problem of continuity in the top and bottom chords where they intersected at the first panel points. This problem would have been inevitable for any two-way grid with bottom chords in the same horizontal plane.

So far in this discussion nothing has been said of the way in which dead loads (of the ventilator and the pyramid roof) and the superimposed design load on the roof would have been applied in practice to the four trusses. These loads might have been uniformly applied by the sloping rafters to the horizontal member at the head of the vertical glazing, with the vertical component being transmitted via the mullions to the top chord of the truss: the horizontal outward thrusts would also have had to be resisted by the head member (Fig. 3). Much would have depended on the stiffnesses of the two sets of framed purlins (Fig. 4): with sufficient stiffnesses all the loads would have been carried to the four sloping edges and the pyramid would have been supported at its four corners only, and then the loads would have been applied to the trusses at the ends of the first panels. In practice it was probably a combination of both modes.

A close examination of Figure 3 suggests that the glazing head member is bowing out and that the mullions are out of plumb. This would happen if the trussed purlins, which were not triangulated, were too flexible and the rafters applied an outward thrust to the head member. These apparent deformations may, however, be a result of the demolition or even camera distortion. The presence of the metal tubes across the corners is interesting. Was their purpose to stabilize the compression chords; were they part of the original design or a later addition?

Returning to the problem of the interaction of the trusses, a solution suggested to the author by Newby is that only one pair of trusses spanned 55 ft. and that this pair supported a pair of 33 ft. trusses at the ends of their first panels.[11] If this was the case, the roof structure would have been a two-way system visually but a one-way system structurally. Once again, the behaviour would have depended on the joints and the way in which the loads on the pyramid were distributed.

Finally, perhaps there is a clue to the construction in Figure 1. During demolition the ends of two trusses were unsupported and the dead load of the timber was carried in one direction. Unfortunately we cannot see whether there was excessive deformation and once again no firm conclusions can be drawn.

Whatever the structural action, we have no idea how the member sizes were determined by Fuller. We do know that the roof was unlike any other known structure designed by him. The use of detailed calculations seems unlikely for 1860, and full-scale testing as practised by the railways seems even more unlikely for a one-off structure. There is the possibility that the roof was a copy, or an adaptation, of a similar structure previously designed by someone else.

The method of design is an intriguing matter and we end with some speculation of possible links between Fuller and two railway engineers who would have been capable of designing the roof. Henry Fuller's partner was James Cubitt (1836-1912): James Cubitt was the first cousin once removed of the first wife of Sir William Cubitt (1785-1861), consultant to the Great Northern Railway (GNR): Sir William was the father of Joseph Cubitt (1811-1872), Chief Engineer of the GNR: in 1848 Joseph Cubitt designed the bridge over the River Witham, at Bardney, a 100 ft. span timber truss bridge with a bolted laminated top chord! The links are tenuous, and without any evidence it would be very unfair to deprive Fuller of the credit for a novel design.

Summing up, although the Rusholme Road Sunday School roof was not the first example of the use of curved glued laminated timber in buildings in Britain, it appears to have been one of the earliest to use timber trusses that incorporated curved glued laminated timber members. Additionally, the novelty of the two-way grid structure is an important feature of the building and Fuller's pioneering contribution must be recorded. Having noted the novelty of the roof structure, it must be pointed out that the roof was small compared with the timber structures, particularly the bridges, designed by the railway engineers of that era.

Despite the criticism voiced above, the Rusholme Road Sunday School roof trusses outlived the contemporary railway bridges, and gave one hundred years service before they fell victim to Manchester's town planners.

Henry Fuller, Architect (1832–70), Manchester and London: His Life and Buildings

The initial purpose of the investigation described in this paper and elsewhere was to establish the date of construction of Rusholme Road Congregational Sunday School, Chorlton-on-Medlock, Manchester. During that investigation the name of the architect, Henry Fuller, emerged for the first time. Understandably, the scope of the investigation was extended to discover something of the personal and professional life of this hitherto little known architect, and to see whether Rusholme Road Sunday School was a one-off structure, or whether he had used the same techniques in any of his other buildings.

Little is known of Henry Fuller's personal life: the following leans heavily on information provided by Binfield. [12,13]

Professionally, Fuller might be described as a minor Victorian architect whose belated claim to fame is as the architect of the novel timber roof of Rusholme Road Congregational Sunday School. His professional life was short (some fourteen years) and consisted of three phases: training in Nottingham, some early design work in Manchester and finally the bulk of his work in London, particularly in the north-east of the Capital. It is easy to speculate about the links between these phases (which, of course, overlapped) by noting that the family had strong Congregationalist beliefs and good connections; significantly all his known buildings were associated with the church.

Henry Fuller was born in 1832, the fifth child of a Congregationalist family with no previous architectural connections. His father was a clockmaker in Clerkenwell in London and it is thought that Fuller's early life was spent in north-east London.

For his training in the 1850s, he went to Nottingham as a pupil of Isaac Charles Gilbert who had an established architectural practice (1840s to 1860s) and who was an active

Congregationalist.[14] During this period, Fuller's name first appeared in a professional role when he entered several architectural competitions.[15] In 1858 he entered competitions for Ellesmere Memorial (at Worsley on the outskirts of Manchester) and for a cemetery at Runcorn in Cheshire. Both were small projects and in both competitions he was unsuccessful. In 1859 he entered a major competition for the design of the Manchester Assize Courts: this competition attracted a large entry and was won by Alfred Waterhouse then also at the beginning of his career. From 1859-1860 Fuller was employed as a draughtsman in Waterhouse's practice: whether he moved to Manchester before the competition, or as a result of the expansion of Waterhouse's office following his success, is not clear.[16] Whatever the reason, Fuller's own career was, like Waterhouse's, launched from Manchester and his association with Waterhouse must have been helpful.

It is difficult to give a precise date for a building; however, most of Fuller's churches (see Appendix) were described in the *Congregational Year Books* and it is the year book date that will be used as a nominal date for a building.

The first design attributed to Fuller, which is the Brunswick Wesleyan Church in Newcastle-under- Lyme, was built in about 1860.[17] This was followed in 1862 by another Wesleyan Church and School at Stretford on the outskirts of Manchester.[18] The inactivity of the early 1860s was broken in 1863 when the *Congregational Year Book* noted that the Lower Clapton Congregational Church was about to be built to a design by Fuller. At about the same time, Fuller would have been working on the Rusholme Road Sunday School (opened April 1864). His career was about to blossom and presumably he was in a sound financial position as he married Eliza Bradley of Chorlton-cum-Hardy. The Manchester connection was firmly established and about this time he was appointed architect for the refurbishment of the Rusholme Road Church.

In the *Congregational Year Book* description of Lower Clapton (1863) and the Rusholme Road Sunday School (1864) Fuller is described as "of Manchester", and from 1865 onwards he is usually described as "of Finsbury Place (London) and Manchester" By 1864, with two jobs completed in Manchester, and one completed in London, he was, at thirty two, poised to expand his practice in these cities.

In the three years from 1865 to 1867, the *Congregational Year Books* described nine jobs, seven of which were in London suburbs and two in Manchester. There was also a Wesleyan Church in Matlock, Derbyshire.[19, 20] This middle period culminated with the design of the International Memorial Church in Stoke Newington[22] and its redesign as Devonshire Square Baptist Church.[23]

Fuller died, at the early age of forty, in 1872. The *Congregational Year Book* makes no mention of any jobs by him in 1868, 1870 and 1871: perhaps he was already ill. There were, however, two jobs still to be finished: Clapton Park Church (CYB, 1872)[24] and Emmanuel Congregational Church, Cambridge (CYB, 1873 and 1874).[25, 26] Both are still in use as churches.

The *Congregational Year Book* attributes Emmanuel to Fuller and Cubitt: in Binfield's opinion the style indicates that Cubitt was probably the major influence.[27] Similarly, Cubitt probably played a major part in Clapton Park. Both Fuller and Cubitt had been pupils of Gilbert in Nottingham, Fuller in the 1850s and Cubitt from 1851 to 1856.[28] They had the same address in London (26 Finsbury Place) prior to Fuller's death in 1872 but the exact nature of their partnership is not known.

Details of all the known buildings designed by Henry Fuller are given in the Appendix: the name and location of the building, the nominal date and source of the description, the condition in 1993 and source of the information are recorded. All the buildings are associated with the church: surprisingly no secular building has been found.

The names adopted are generally those used in the source of the description and are not always the ones currently used by those churches that are still *in* use. Tracing the precise locations proved to be difficult; in some cases the original descriptions were vague, in others the roads no longer exist (e.g. Rusholme Road, Manchester and Sydney Street, Bethnal Green, London). Ideally, a consistent date would be that of the opening service of a church, but this is rarely known, and generally the date of the Congregational Year Book containing the description has been used. The condition in 1993 indicates whether the building still exists and, if so, its current use; if the building has been demolished, the approximate date of demolition is given.

Of the sixteen churches in the Appendix, only four are still in use as churches. Of the remaining twelve, ten have been demolished and two have different uses (synagogue, furniture store).

The use of Timber by Henry Fuller

One of the purposes of this investigation was to see if the glued laminated timber used in Rusholme Road Sunday School was the forerunner of similar uses in later buildings. Another purpose was to see if the roof construction using a two-way grid of intersecting trusses had been repeated. This has proved to be a difficult task because the majority of the 17 buildings listed in the Appendix have been demolished or have been significantly modified when their use has been changed.

The original descriptions from the *Congregational Year Books* give some indication of the roof structure, but sadly lack detail. Lower Clapton Congregational Church is chronologically the first: it is also the most interesting from the point of view of the use of timber and, as such, it will be discussed separately. The following quotations (see Appendix for references) are the only ones that mention timber roofs: of the six buildings, three have been demolished, two have suffered major alterations and Emmanuel Church Cambridge was refurbished in 1992.

Pownall Road Chapel, Dalston, London
"...stained Baltic red deal for the pewing and open timbered roof." Demolished

Trinity Congregational Church, Stoke Newington, London
"The pewing and roof will be stained red deal." Major alterations: now a synagogue.

Stanstead Road Congregational Church, Forest Hill, Kent
"The ceiling is of the form of a waggon head, and is constructed in wood...". Demolished.

International Memorial Church, Stoke Newington, London
"The interior....[has] a flat coffered ceiling of wood." Redesigned prior to construction as Devonshire Square Baptist Chapel. Partly demolished.

Emmanuel Congregational Church, Cambridge
"...there is a wooden panelled ceiling beneath the roof of a rather lower pitch; the greater part of the roof trusses will, however, be visible under this." Still a church.

The Congregational Year Books made no mention of any unusual roof structures. All the Churches are likely to have adopted the traditional plan (length greater than breadth); with this geometry transverse glued laminated arches are feasible (as perhaps used at Lower Clapton) but the use of a two- way grid structure is unlikely. A likely conclusion is that Fuller's only opportunity of designing an unusual roof was at Rusholme Road Sunday School.

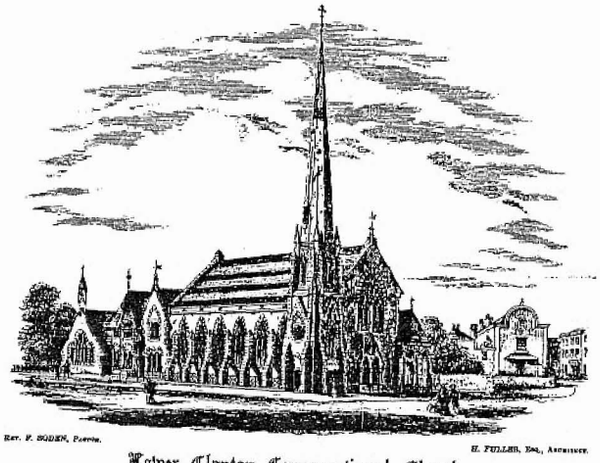


Fig 6: Lower Clapton Congregational Church: Proposed church and school buildings (Congregational Year Book 1863)

Lower Clapton Congregational Church, Clapton, London

The Congregational Year Book for 1863 reported that Lower Clapton Congregational Church was about to be built to a design "submitted by [Fuller] in competition" and it went on to note that "The roofs of both chapel and school are open-timbered, that of the former being carried by semi-circular laminated ribs....."[37] (Figs. 6-8). No other reference to the competition has been found: no mention of it is made in Harper's list of competitions advertised in the *Builder* and it may be that the competition was a low-key affair run by a local group of future members of the new congregation.

It must be pointed out that it has not been possible so far to find another source to check that the construction used glued laminations. (Sometimes the *Congregational Year Book* description was published prior to the actual construction and, if money ran out, a reduced size, or less elaborate, building was erected.) Frustratingly, the buildings were demolished in 1931. The search for more details about it continues.

After Henry Fuller

Rusholme Road Congregational Sunday School, with its successful inclusion of curved glued laminated timber members in the roof truss and its adoption of a two-way grid, could have been the precursor of a new era of timber engineering in buildings. However, the building does not seem to have received any mention in the technical press and we must conclude that Fuller's novel structure had no influence on the design of future timber roofs. In contrast, it could be seen as the end of three decades of timber engineering that included such major uses as the bolted laminated arch railway bridges, mentioned earlier in this paper, and Brunel's structures for the Great Western Railway.[38]

The reason for the decline in the use of timber in major structures is outside the scope of this paper and must wait for a further paper which would, amongst other aspects, examine the relative roles of the architect and engineer in the design of timber structures in the

second half of the nineteenth century. It may be argued that the next dramatic era of timber engineering in Britain had to wait for the development of waterproof adhesives in the late 1930s; the availability of such adhesives led to the birth of the glulam industry in the late 1940s and the development by engineers of timber space frames and shell roofs in the late 1950s, and their frequent use in the 1960s and 70s.

Conclusion

The date of construction of Rusholme Road Congregational Sunday School, Chorlton-on-Medlock, Manchester (previously thought to be 1827) has been established as 1864.

Despite the change in the date of construction, Fuller's use of curved glued laminated timber members in the roof trusses is still the earliest known example in buildings in Britain. (The Marriage Room at Southampton Register Office, which was built in 1860 as part of King Edward VI School, continues to be the earliest known use of glued laminated timber arches.) The roof construction is also thought to be the first use of a two-way grid of intersecting timber trusses: despite its life of nearly one hundred years, the system did not inspire later designers to follow suit.

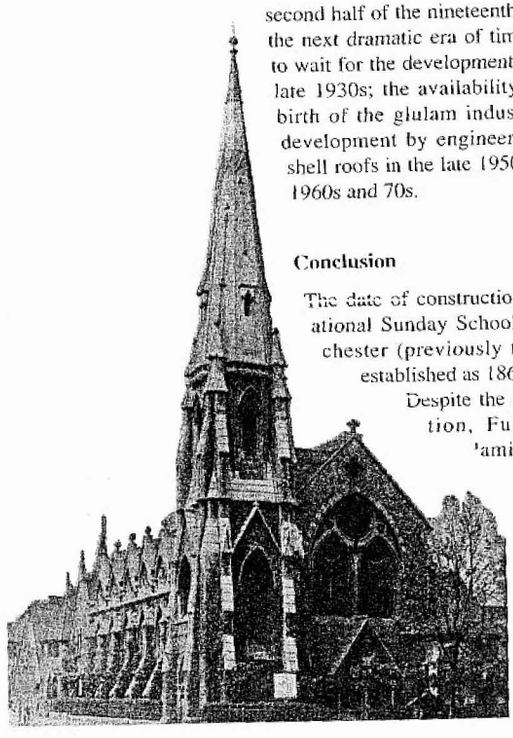


Fig 7: Lower Clapton Congregational Church: Front of church and spire as built, c.1880 (Hackney Archives Department)

A search for other buildings designed by Fuller revealed that he was the architect for the design or refurbishment of 16 churches, some of which incorporated schools, mainly in Manchester and north- east London, between 1862 and 1872. The search for further examples by Fuller and other architects continues and the author would welcome details of other nineteenth century buildings containing curved laminated timber arches, trusses and grids.

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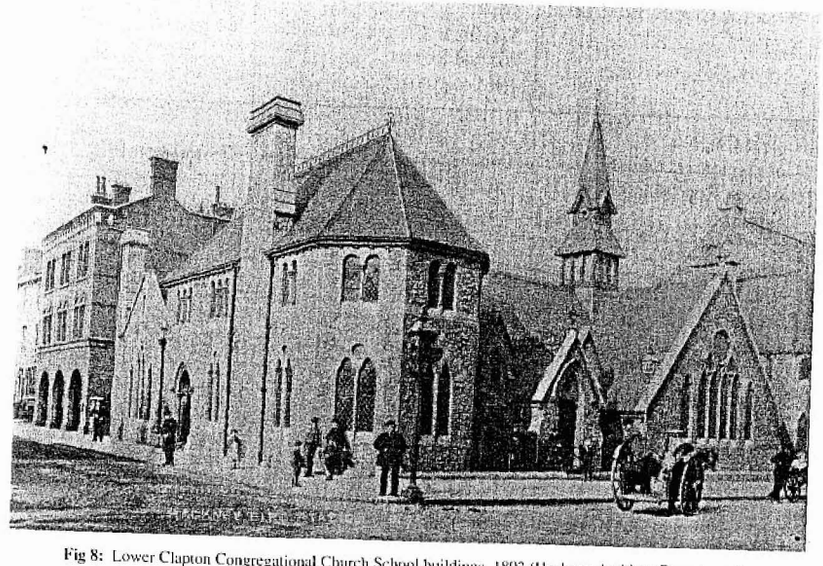

Fig 8: Lower Clapton Congregational Church School buildings, 1893 (Hackney Archives Department)

Appendix

BUILDINGS DESIGNED OR REFURBISHED BY HENRY FULLER (1860 to 1872)

NAME AND LOCATION	NOMINAL DATE / SOURCE	CONDITION IN 1993 / AUTHORITY FOOTNOTE REFERENCE
Wesleyan Chapel, Brunswick, Newcastle-under-Lyme	1860: Wesleyan Chapel Committee Annual Report 1860 pp.102-3* 1861 pp.96-7*	Demolished c.1960 Binfield[12]
Wesleyan Chapel, Edge Lane, Stretford	1861: Wesleyan Chapel Committee Annual Report 1861 pp.100-1*	Demolished 1966 Massey[18]
Lower Clapton Congregational Church, Amhurst Road, Clapton, London	1863: Congregational Year Book 1863 pp.312-3* (see Figs. 6-8)	Demolished 1931 Matthews[30]
Rusholme Road Congregational Sunday School Chorlton-on-Medlock Manchester	1864 Congregational Year Book 1864 pp.278–9	Demolished 1963 Hesp[2]
Pownall Road Chapel, Dalston, London	1865: Congregational Year Book 1865 p.306*	Demolished c.1950 Mander[31]
Trinity Congregational Church, Walford Road, Stoke Newington, London	1865: Congregational Year Book 1865 p.307*	Synagogue Visit by author
Wesleyan Chapel, Matlock Bath, Derbyshire	1866: Wesleyan Chapel Committee Annual Report 1866 pp.110-11*	Furniture store Barton[32]
Proposed Congregational Chapel, City Road, Hulme, Manchester. Redesigned and refurbished and known as Russell Street	1866: Congregational Year Book 1866 p.305* 1868 and 1876:[21]	Demolished 1965 Ayton[21]
Church, City Road, Hulme, Manchester		
Sydney Street Chapel, Bethnal Green, London	1866: Congregational Year Book 1866 p.310	Demolished Watton[33]
Selhurst New Congregational Church, Selhurst Road, South Norwood, London	1866: Congregational Year Book 1866 p.317*	Seventh Day Adventist Church Visit by author
Ponders End Congregational Church, High Street, Ponders End, Enfield, Hertfordshire	1866: Congregational Year Book 1866 p.323	Demolished c.1955 Paul[34]
Rusholme Road Congregational Church, Chorlton-on-Medlock, Manchester	1866: Congregational Year Book 1866 p.331*	Refurbishment of 1827: Demolished 1963 Hesp[2]
Battersea Congregational Church, Battersea Bridge Road, London	1867: Congregational Year Book 1867 p.349*	Demolished c.1970 Cherry & Pevsner[35]
Stanstead Road Congregational Church, Forest Hill, Kent	1867: Congregational Year Book 1867 p.357	Demolished 1968 Homan[36]
International Memorial Church, Stoke Newington, Road, London Redesigned prior to construction as Devonshire Square Baptist Church	1869: Congregational Year Book 1868 pp.349-50* 1871:23	Rebuilt 1992 Visit by author
Clapton Park Congregational Church, Lower Clapton Road, London	1872: Congregational Year Book 1872 pp.403-4*	Church Visit by author
Emmanuel Congregational Church, Trumpington Street, Cambridge	1873: Congregational Year Book 1873 pp.424-6 1874 pp.414-5	Church Visit by author

* contains illustration

† in partnership with James Cubitt

References

1. L.G. Booth, 'An early use of glued laminated timber in buildings in Britain: Rusholme Road Congregational Sunday School, Manchester (1864-1963)', *Journal of the Institute of Wood Science*, 13 (1994), pp.418-25.
2. T. Hesp, 'Laminated beams nearly 150 years old', *Timber Trades Journal*, 245 no.4528, (22 June 1963), p.42.
3. T. Hesp, 'Glue-lamination 135 years ago: investigation reveals methods of construction of old beams', *Timber Trades Journal*, 246 no.4532, (20 July 1963), p.43.
4. 'New Independent Schools, Rusholme Road, Manchester', *Congregational Year Book*, (1864), p.278.
5. ibid., p.278.
6. L.G. Booth, 'The development of laminated timber arch structures in Bavaria, France and England in the nineteenth century', *Journal of the Institute of Wood Science*, 5 (1971), pp.3-16.
7. L.G. Booth, 'Laminated timber arch railway bridges in England and Scotland', *Trans. Newcomen Soc.*, 44 (1971-72), pp.1-23.
8. J.S. Valentine, 'Description of a timber bridge erected over the River Ouse, at Hilgay, on the line of the Lynn and Ely Railway', *Proc. Inst. Civ. Eng.*, 9 (1850), pp.149-50.
9. B. Green, 'On the arched timber viaducts on the Newcastle and North Shields Railway, erected by Messrs. John and Benjamin Green, of Newcastle-upon-Tyne; and the further application of the system to skew and other bridges, as well as to the roofs of railway stations and other large buildings', *Proc. Inst. Civ. Eng.*, 5 (1846), pp.219-32
10. 'The King's Cross terminus Great Northern Railway', *Builder*, 2 October 1852, p.625–7.
11. F. Newby, personal communication, letters to author 17 July, 3 September 1993.
12. J.C.G. Binfield, personal communications, letters to author July 1993.
13. J.C.G. Binfield, 'A chapel and its Architect: James Cubitt and Union Chapel, Islington, 1874-1889', in Diana Wood, ed. *The Church and the Arts: Studies in Church History*, 28 (Oxford, 1992), p.417–47.
14. Anon. *Architects, Engineers and Building Trades Directory*, (1868).
15. R.H. Harper, *Victorian Architectural Competitions: An index to British and Irish Architectural Competitions in the 'Builder': 1843-1900* (1983), p.222.
16. C. Cunningham and P. Waterhouse, *Alfred Waterhouse, 1830-1905: biography of a practice* (Oxford, 1992), p.285.
17. J.H.Y. Briggs, ed., *Newcastle-under-Lyme: 1173-1973* (Newcastle, 1973), p.68.
18. S. Massey, *A History of Stretford* (Altrincham, 1976), p.133.
19. D.A. Barton, personal communication, letter to author 8 July 1992.
20. Wesleyan Chapel Committee, *Annual Report* (1866), pp.110-111.
21. J.M. Ayton, personal communications, letters to author 16 December 1993, 7 January 1994.
22. 'International Memorial Church and Lecture-Room, Stoke Newington', *Congregational Year Book* (1868), pp.349-50.
23. 'Devonshire Square: Three hundred years witness for Christ: 1638-1938', *Baptist Church* (n.d.).
24. 'Clapton Park Chapel', *Congregational Year Book* (1872), pp.403-4.
25. 'Congregational Church, Cambridge', *Congregational Year Book* (1873), pp.424-6.
26. 'Emmanuel Congregational Church, Cambridge', *Congregational Year Book* (1874), pp.414-5.
27. J.C.G. Binfield, personal communication, letter to author 12 December 1993.
28. Royal Institute of British Architects (RIBA), Application form for admission of James Cubitt as a Fellow of the RIBA, 8 December 1890.
29. Anon. *Architects, Engineers and Building Trades Directory* (1868).
30. E.N. Matthews, personal communication, letter to author 11 August 1992.
31. D.M. Mander, *London Borough of Hackney in Old Photographs* (Gloucester, 1989), p.80.
32. D.A. Barton, personal communication, letter to author 8 July 1992.
33. H. Watton, personal communication, letter to author 21 August 1992.
34. R. Paul, personal communication, letter to author 1 November 1993.
35. B. Cherry and N. Pevsner, *Buildings of England: London 2: South* (Harmondsworth, 1983), p.666.
36. R. Homan, *Victorian Churches of Kent* (1984), p.59.
37. 'Lower Clapton Congregational Church', *Congregational Year Book* (1863), pp.312-3.
38. L.G. Booth, 'Timber Works', in A.G. Pugsley, ed. *The Works of Isambard Kingdom Brunel* (1976) pp.107-135.