Data Article

Drawing data for a 3D historical reconstruction of Shakespeare’s first Globe Theatre

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ABSTRACT

The first Globe Theatre was one of the main outdoor playhouses in London in the early 17th century. Although it was built in 1599 and was destroyed in a fire in 1613, its history has survived to the present day as the theatre that was able to accommodate most of William Shakespeare’s plays. Extensively studied during the last century, it has been attempted to be reconstructed several times in different parts of the world, although the information present does not allow for an exact reconstruction. The data presented here have been collected from the various interpretations offered in literature by the main scholars of the first Globe Theatre and re-elaborated according to criteria of coherence with vernacular building techniques and ease and feasibility of construction. What is presented is the methodology probably used by the Globe’s carpenter Peter Street to draw the plan and then build the theatre. The data presented were used to provide a virtual reconstruction of the first Globe Theatre, featured in the article “Towards reconstructing the Shakespeare’s first Globe Theatre: A virtual model for research and development”, published in the Frontiers of Architectural Research by the same authors [1]. The data can be used to confirm, improve, or reconstruct the first Globe, as well as most Elizabethan theatres, similar in type and form.

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Specifications Table

| Subject                | Building Engineering |
|------------------------|----------------------|
| Specific subject area  | Vernacular timber-framed buildings |
| Type of data           | Images and Figures   |
| How the data were acquired | Bibliographic research, CAD drawing and 3D modelling on AutoCAD by Autodesk Inc. The model was then rendered with 3ds Max from Autodesk Inc. |
| Data format            | Analyzed, Filtered   |
| Description of data collection | The data were collected through:  
  • analysis of surviving images of the first and second Globe Theatre  
    (mainly preparatory drawings and etchings of early 17th century London in which the Globe appears incidentally);  
  • analysis of the contract for the construction of The Fortune Theatre  
    (built by the same carpenter as the Globe);  
  • analysis of vernacular construction techniques;  
  • reading of the bibliography of scholars on the subject. |
| Data source location   | Original site of the Globe Theatre  
  • Anchor Terrace, 125 Park St, London SE1 9EW  
  • U. K.  
  • 51°30′24.7″N 0°05′41.0″W |
| Data accessibility     | Repository name: “3D model of Shakespeare’s first Globe Theatre and geometric study of the plan layout”, Mendeley Data, V1  
  Data identification number: DOI: 10.17632/yg6rhtfr5.1  
  Direct URL to data: https://data.mendeley.com/datasets/yg6rhtfr5/1 |
| Related research article | P. Croce, F. Lecese, M. Mordagà, G. Salvadori, Towards reconstructing the Shakespeare’s first Globe Theatre: A virtual model for research and development, Frontiers of Architectural Research. (2022).  
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Value of the Data

• The data in this article represent one of the few attempts at a virtual reconstruction of the first Globe Theatre based solely on historical and constructional considerations.  
• The data can be used by anyone wishing to study the Globe Theatre and Elizabethan outdoor playhouses in greater depth.  
• The availability of a three-dimensional model can provide a basis on which to make modifications as discoveries on the subject evolve and encourage the study of acoustic, structural, fire resistance and escape route calculation aspects of one of the most emblematic theatres in English history.

1. Data Description

The data contained in the repository and shown in this article are related to the article "Towards reconstructing the Shakespeare’s first Globe Theatre: A virtual model for research and development" by the same authors [1]. There are two dwg files in the repository [2]. The data, although created with closed source software, can still be visualised with open source software specific to dwg files.
Fig. 1. Circumference of radius 3 rods.

Fig. 2. Square inscribed in circumference of radius 3 rods.

The first, named “Ad quadratum Scheme.dwg”, contains a step-by-step drawing of a plausible plan drawn on the ground by Peter Street, carpenter of the Globe, following the ad quadratum method. In this article, the various steps are shown. Fig. 1 shows a drawing of a circumference of radius 3 rods (about 15.1 m) which could easily be made on the ground using a rope with a knot for each rod. Fig. 2 shows the construction of a square inscribed in the circumference. Fig. 3 shows the creation of a new inner circle, inscribed within the square drawn previously. Fig. 4 shows the dimensions of the stage, obtained by dividing the square inscribed in the inner circumference in half. Figs. 5 and 6 show the construction of an approximate pentagon starting from the achtort figure. By rotating the construction of the pentagon by 90° (Fig. 7) and repeating the construction two more times, four pentagons are obtained, each rotated by 90° with respect to the previous one (Fig. 8). The 20 points thus found represent the vertices of an
Fig. 3. Circumference inscribed in the square. The ratio of inner to outer circumference is $1/\sqrt{2}$.

Fig. 4. Square inscribed in the inner circle, half of which represents the measurements of the stage.

icosagon (20-sided polygon). Fig. 9 shows the projection of the 20 vertices onto the outer circle, to find the corresponding outer icosagon. Fig. 10 shows a first schematic construction in plan of the first Globe Theatre. Fig. 11 shows the addition to the plan of the external turrets, built at the diagonals of the square. Fig. 12 shows the complete schematic plan of the first Globe Theatre. To confirm the hypothesis made about the positioning of the turrets, Fig. 13 shows the superimposition of the oriented planimetric scheme with the drawings related to the findings of the foundations of the Globe.

The second file of the repository, named "3D_First Globe Theatre.dwg" contains instead the complete three-dimensional model of the proposed reconstruction of the first Globe Theatre. All the hypotheses concerning the accesses to the yards and the internal structures of the Tiring House have been deliberately omitted, in order not to influence future works with elements
whose reliability was less certain. Fig. 14 shows the construction of the main frames of a bay of the Globe. Fig. 15 shows the addition of bridging beams, side joists and external bracing. Fig. 16 shows the addition of the planking. Fig. 17 shows the infill of the external lath and plaster frames and the addition of the internal handrails, which also acted as the only stiffening element in the internal frame. Fig. 18 shows the assembly of the rafters, on which the thatched roof would later be placed (Fig. 19). Fig. 20 shows the structure of the stairs, contained at the point of intersection between two consecutive bays and the turret. Fig. 21 shows the stairs, the turret and the two bays in their final form, as they could be seen from inside the theatre. Fig. 22 shows the view of the turret from the outside. Fig. 23 shows the structure of the Tiring House, clearly distinguishing the trusses of the Tiring House, taken from multi-aisled buildings to cover
Fig. 7. Construction of the second approximate pentagon, rotated by 90° from the first.

Fig. 8. Construction of 4 approximate pentagons rotated 90° to each other. The points found on the circumference correspond to the vertices of an approximate 20-sided polygon.

a larger span, from those of the bays. Fig. 24 shows the complete Tiring House as seen from inside the theatre.
Fig. 9. Extension of the vertices of the 20-sided polygon to the outer circumference.

Fig. 10. Schematic plan of the basic structure of the first Globe Theatre.
Fig. 11. Drawing of the footprint of the turrets on the extension of the diagonals of the inscribed squares.

Fig. 12. Schematic plan of the structure of the first Globe Theatre.
Fig. 13. Rotation of the plan according to the presumed orientation of the structure that emerged in [6], from Ollar’s considerations in [3], and superimposition of this with the excavation drawing taken from the Globe ACT89 excavation archive [7].
Fig. 14. Render of the bay without the external bracing, mounted on the exposed part of the brick foundations.

Fig. 15. Render of the bay to which external bracing and floor structure have been added.
Fig. 16. Render of the bay, the planking was added to the floor structure.

Fig. 17. Render of the bay with addition of lath and plaster infill and handrail.
Fig. 18. Render of the bay with added roof rafters.

Fig. 19. Render of the bay with the addition of the thatched roof, from which the fire will start and raze the theatre to the ground. In the second Globe Theatre the roof will be replaced with a tile one.
Fig. 20. Render of the structure of the staircase block made by joining two bays with the turret.

Fig. 21. Render of the staircase block created by joining two bays with the turret.
Fig. 22. Render of the staircase block made by joining two bays with the turret, external view.

Fig. 23. Render of the Tiring House structure. The internal stairs have been deliberately omitted as there is almost no information about them, although their existence is known. The doors have been left in the render to be able to identify the position.
2. Experimental Design, Materials and Methods

The design of the plan of the first Globe Theatre started from the hypothesis of the use of the ad quadratum method, formulated by Orrell in [3] analysing the measurements present in the contract of the Fortune Theatre. Peter Street, the carpenter at both the Globe and Fortune, could, with the tools available to him at the time, easily draw a circle of radius 3 rods (about 15.1 m) on the ground using a rope with a knot on each rod (Fig. 1). Then he could, using a square, draw a square inscribed within the circumference (Fig. 2) which in turn circumscribed an inner circle (Fig. 3). The ratio between the inner and outer circumference is $1/\sqrt{2}$ as verified by Orrell in [3] from the orthogonal projections made by Hodges [4] starting from Hollar’s drawings. The stage could therefore be obtained by continuing the ad quadratum construction, as half of another internal square (Fig. 4) or by introducing the ad triangulum method, as was probably done in the case of Fortune [3]. In this proposal the hypothesis of the stage built on half of the inner square was preferred following assumptions of ease of execution and knowing that Elizabethan actors were accustomed to performing in street shows and large spaces. The structure of the Globe was then hypothesised as a 20-sided polygon, easily constructed by drawing 4 pentagons rotated 90° from each other. Starting from the achtort figure, made up of two squares of equal size arranged one horizontally and the other diagonally with respect to the same centre [5] and very similar to the ad quadratum construction, the pentagon can be drawn by drawing four lines that meet the inner circumference at the same number of points (Fig. 5). Drawing the line $cd$ it can be found the point $i$, drawing the line $be$ it can be found the point $g$ and so on. Joining the five points ($f$, $g$, $i$, $d$ and $j$) found in this way, one obtains a pentagon as shown in Fig. 6. It can be easily noticed that this type of construction does not produce an exact pentagon, but an approximate version of it with sides of slightly different sizes. In fact, this method, taken from the medieval construction tradition [5], did not allow for an exact construction, but a construction close to it with considerable speed, starting with the ad quadratum method. By rotating the construction by 90°, a second pentagon was obtained (Fig. 7) and so on until the 20 vertices of the icosagon were obtained (Fig. 8). Starting from the centre, the vertices could then be projected onto the outer circumference, finding at the same time the sides of the bays (Fig. 9), to obtain a first planimetric scheme (Fig. 10). The turrets were obtained by starting from the diagonals of the square constructed with the ad quadratum method and extended from the middle of the previous bay to the next one, as can be guessed from the remains of the
foundations of the Globe (Fig. 11). The final diagram thus obtained (Fig. 12) presents an inner circumference relative to the top ring of the Globe, which widened as it went towards the base, thanks to the presence of the jetties, until it reached the width of 12 feet 6 inches (about 3.8 m) of the ground floor gallery, as described in Fortune’s contract [3]. To verify the accuracy of the turret position, the plan was laid out at 25° East of true North [6] and superimposed on the Globe foundation excavation drawing [7].

The construction of the three-dimensional model, made from solids in the AutoCAD 3D environment and then exported to 3ds Max to be rendered, began with the extrusion of the foundations, which had to protrude from the ground by about 30 cm. The frame of the bay was built on top of these (Fig. 14), using elements of classical dimensions in timber-frame structures, obtained from the squaring of oak trees [8]. Queen post trusses were assumed. The bridging beams of the floor slabs with side joists and bracing on the external frame were added following the hypothesis of the presence of decorative frames (Fig. 15). The floors were completed with wooden planks (Fig. 16) and then the lath and plaster infill and internal handrails were modelled, which were also intended to stiffen the internal structure, as there were no braces on this floor that would obstruct the view (Fig. 17). It should be noted that on the first floor there is a row of windows, as suggested by Hollar’s drawings [6], which served to illuminate this floor, which was probably the one with the greatest need for openings. The rafters were modelled (Fig. 18), on top of which a schematic roof was then modelled (a real thatched roof would have been about 60 cm thick) representing the thatched roof (Fig. 19). Separately, the stairs were constructed, assumed to correspond to the meeting of the turret with the two bays, thus making it possible to use the outer post of the bay as a Newell post and the turret itself as a space for part of the staircase and landings (Fig. 20). To allow the ascent, part of the upper floor at the stairs was opened to guarantee the necessary height. Also, in this case the model was then completed with the lath and plaster infill (Fig. 21), leaving openings at the first floor and at the top of the turret (Fig. 22). The Tiring House was modelled as a structure strongly interconnected with the bays of the rest of the building and as much as possible of its characteristics was exploited (Fig. 23). The ground floor is connected to the stage by three entrances, one main and two side entrances. On the first floor the almost circular structure forms a balcony (Fig. 24), widely present in Shakespeare’s plays. The second floor has instead been partially obscured, hypothesising it as a possible Heavens from which the music of hidden musicians or a deus ex machina could arrive by means of special stage machinery, as hypothesised by Hodges [4]. The span of the Tiring House, being wider, required a different type of truss, hypothesised here as a hammer beam truss, so that its features could be exploited at the roof of the stage to create a vault, probably at the time frescoed with depictions of the day and night sky [6]. The modelled elements were then put together.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper

Data Availability

Drawing data for a 3D historical reconstruction of Shakespeare’s first Globe Theatre. (Original data) (Mendeley Data).

CRediT Author Statement

Paolo Croce: Conceptualization, Formal analysis, Methodology, Investigation, Data curation, Writing – original draft, Writing – review & editing; Francesco Leccese: Conceptualization, Formal analysis, Methodology, Investigation, Data curation, Writing – original draft, Writing – re-
Mirko Mordagà: Conceptualization, Formal analysis, Methodology, Investigation, Data curation, Writing – original draft, Writing – review & editing; Giacomo Salvadori: Conceptualization, Formal analysis, Methodology, Investigation, Data curation, Writing – original draft, Writing – review & editing.

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