

Fore! GPR survey of the Belhus Tudor water gardens

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Abstract

Covid-19 restrictions allowed unique access to this site on a temporarily closed golf course. Vehicle towed ground penetrating radar survey provided rapid coverage of the site. Geophysical survey helped support local volunteer research groups. Significant remains survive despite demolition of the Tudor mansion and landscaping for the golf-course. Detailed topographic data was generated from UAV based photography through Structure from Motion.

Keywords

Elizabethan water gardens; garden archaeology; ground penetrating radar (GPR); structure from motion (SfM); tudor mansion; UAV

Introduction

Belhus Park is in the borough of Thurrock, east of London where the site is bounded by the M25 orbital motorway. A manor house was first tenanted here from the 14th century and passed through marriage to the Barrett family who rebuilt Belhus House towards the end of the 16th century, obtaining a licence in 1618 to create an extensive park and elaborate parterre garden, shown on an estate map of 1619 and a bird's-eye view of the property in the early 18th century (Fig.1). Following a period of neglect, the house and grounds were brought up to date by Lord Dacre between 1744 and 1777, with Lancelot 'Capability' Brown commissioned to remodel the grounds between 1753 and 1763 (Historic England 1987). During the Second World War Belhus was damaged by military occupation, and the house was demolished in 1957. The site has been used as a municipal golf course and leisure complex since 2000, with renewed interest in the historic designed landscape generated through a volunteer research project run jointly by 'Land of the Fanns' and the Gardens Trust. A subtle, circular depression was identified during the research project on one of the golf course fairways to the west of the demolished mansion, possibly associated with the Tudor garden design. Geophysical survey was requested to help support the project and has proved successful for the identification of similar garden remains (Cole et al. 1997).

Methods

Access to the site is normally very limited as the active golf course is in use continually throughout the year. A brief window of opportunity occurred in March 2021 immediately prior to the lifting of covid-19 pandemic restrictions that had kept the course closed for the preceding year. Given this limited access a vehicle towed ground penetrating radar (GPR) survey was conducted with a 3d-Radar (Kontur) MkIV GeoScope Continuous Wave Step Frequency (CWSF) system with a multi-element DXG1820 vehicle-towed, ground-coupled antenna array (Eide *et al.* 2018, Linford *et al.* 2010) 2010. Data were acquired at a 0.075 m by 0.075 m sample interval across a continuous wave stepped frequency range from 40 MHz to 2.99 GHz in 4 MHz increments using a dwell time of 3 ms (Bristow et al. 2021).

Additional aerial photography was acquired using a DJI Mavic Pro quadcopter Uncrewed Aerial Vehicle (UAV) capturing 305 overlapping 12-megapixel JPEG images each from an altitude of about 50 m above ground level, resulting in a ground resolution of 1.54 cm per pixel. These images were processed in Agisoft Metashape to create a high-quality orthomosaic photograph and a Digital Terrain Model (DTM) of the wider survey area. Targeted analytical earthwork survey was used to record the circular garden feature and the outline of the house foundations, using a Trimble R8 survey grade GNSS receiver (Fig. 2).



Fig. 1: a) Belhus Mansion Painting, c1710 unknown artist in the style of Jan Siberechts with permission from Thurrock Museum. Formal gardens are shown to the north and west of the central mansion incorporating elaborate water features, together with b) the site of the water gardens under the golf course today.



Fig. 2: Analytical earthwork survey hachures superimposed over an extract from the orthomosaic photograph.

Results

Figure 3 shows an extract of the GPR time slice where high-amplitude anomalies confirm the survival of significant elements from the original Tudor garden. The central circular anomalies correlate with the slight depression recorded by the earthwork survey (Fig. 2) and corroborates

detail shown on the contemporary, false perspective painting of the gardens. The GPR survey suggest the location of the gardens to the north are slightly offset to the west compared to the painting and the survival of structural remains to the east is more fragmented, perhaps due to the later remodelling of the gardens together with the Second World War activity at the site. The GPR survey has also

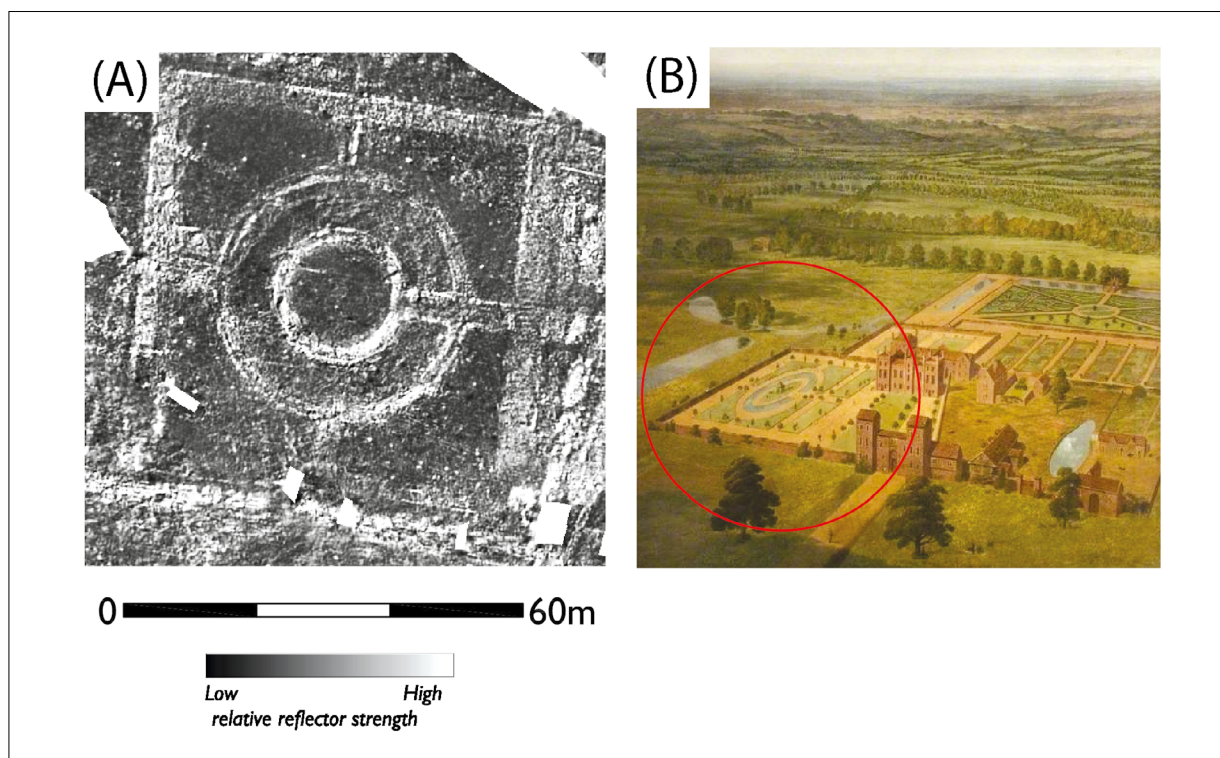


Fig. 3: a) Extract from the GPR survey from between 10.0 and 12.5 ns (0.53 to 0.66 m) showing the survival of garden features in comparison to b) detail from the contemporary painting.

revealed a substantial network of buried conduits and services that may well, in part, be associated with the water supply or drainage from the original house and water gardens. Surviving architectural elements in the wider landscape, including a brick built Tudor ‘stench pipe’ may also be associated with the drainage conduits.

Conclusion

Actively managed landscapes, such as golf courses, can often pose a threat to unrecognised historic design features, through remodeling to incorporate the necessary greens, fairways and bunkers. Access for geophysical survey is also often limited necessitating the use of rapid acquisition vehicle-towed systems to provide accurate location of any surviving remains compared to the use of more traditional, hand-held instrumentation. The GPR survey at Belhus Park has proved particularly successful in confirming the fidelity of a contemporary painting together with additional details of the wider Tudor garden and designed landscape. The survey results suggest an exceptional level of survival that will assist with the ongoing management of the site. —

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