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Archaeological excavations have taken place for more than twenty years at the Colonial Period Moland House site in Hartsville, PA (36BU301). These have unearthed thousands of artifacts, and numerous buried features, that support historical accounts pertaining to the site. In the summer of 2009, field school students from Penn State University Abington College deployed a balloon-elevated digital video system to gather remote imagery of the site at altitudes from 10-100′ above the ground. The resulting images gathered by the aerial videography suggest a variety of potential additional buried structures on the site. These data will guide future excavations aimed at locating additional structures from throughout the history of the site.

Depuis plus de vingt ans, des fouilles archéologiques ont lieu au site de la Maison Morland, une maison de la période coloniale située à Hartsville en Pennsylvanie (site 36BU301). Ces fouilles ont mis au jour des milliers d'artéfacts de même que plusieurs éléments ensevelis qui appuient les comptes-rendus historiques à propos de ce site. Lors du chantier-école du collège Abington de l'université Penn State, les étudiants ont déployé une caméra vidéo numérique à l'aide d'un ballon pour tenter de capter des images du site depuis des altitudes entre 10 et 100 pieds du sol. Ces données guideront les prochaines fouilles qui auront pour but d'identifier des structures additionnelles témoignant de l'histoire du site.

Background

The Moland House is located in Hartsville, Pennsylvania. It is named for John Moland, who was commissioned as King's attorney in Pennsylvania before the Revolution and became leader of the Pennsylvania Bar in 1748. He went on to become an influential attorney in Philadelphia and Bucks County, a member of the Pennsylvania Provincial Council in 1759, and, eventually, a justice on the Pennsylvania Supreme Court. About this time (ca. 1760) he had a stone farmhouse constructed in Warwick Township, Pennsylvania, for the purpose of a county seat and summer retreat (Millbrook Society 2009). Soon thereafter, in 1761, Moland died and his widow, Catherine, continued to live in and maintain the house and property.

During the War of Independence, General George Washington commandeered the home as a military headquarters from 10 to 23 August 1777. It is this occupation that has become the focal point of a long-term and ongoing archaeological field research program conducted by volunteers of the Millbrook Society, a nonprofit society with interests in local history, archaeology, and historic preservation. Historical research by society members has shown that an "estimated 11,000 troops were camped [immediately outside the Moland House] and in the surrounding vicinity while waiting for reports as to the place where General Howe's Army would land to attack Philadelphia" (Millbrook Society 2009). While encamped at the Moland House, both the Marquis de Lafayette and Count Casimir Pulaski met General Washington and joined the Continental Army. When Washington learned of Howe's intentions, he moved the army through Philadelphia and onward to what would be the Battle of Brandywine Creek on 11 September 1777 (Higginbotham 1971: 181–186).

Field Research

In June 1997, the Millbrook Society was designated as the "Archaeology Department" for the Moland House property. In this role, the society has excavated in areas around the house where renovations had taken place, were underway, or were planned to define the character of the colonial period landscape and any surviving archaeological materials from Washington's two-week occupation of the property. As an integral part of this mission, the Millbrook Society hosts educational programs in conjunction with schools and institutions, including nearby Penn State University Abington College's undergraduate

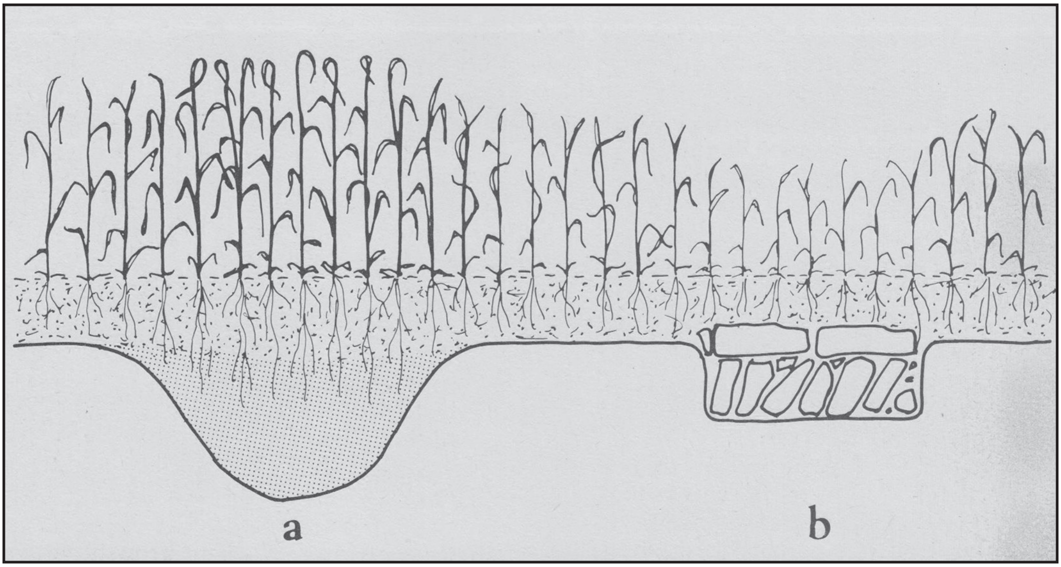

Figure 1. Effects of buried structures on vegetation growth (Wilson 1982: 54). (Image courtesy of BT Batsford Ltd., London.)

programs in American studies and anthropology. Hundreds of undergraduate students have received their first taste of archaeological fieldwork in this way.

These excavations have unearthed several thousand artifacts dating to the colonial period, ranging from pottery sherds, coins, pipe bowls and stems, to buttons and other pieces of nondegradable apparel. As reported in the society's "Summary Report for 2008," that season alone yielded 3,522 pieces of pottery, including porcelain, creamware, and redware; assorted colors of glass; 957 pieces of metal, including nails, straight pins, and buttons; along with 1,255 miscellaneous items, including bone, shells, charcoal, and teeth (Shannon 2008).

Many of these recovered artifacts are displayed at the Moland House. As stated in the methodology section of the society's summary report, the intention of this discovery-mode archaeology is to collect and display as many artifacts as possible to "aid in the future interpretation of the Moland House to the visitor" (Shannon 2008). This mission reflects Harrington's observation that "projects undertaken at historic sites have often had as their primary, and often sole, purpose the securing of data for use in interpreting the sites to visitors" (Harrington 1978: 3). By locating colonial period structures on the site and associating a wide range of artifacts directly to such structures, the society is beginning, as Hayes (2007: 34) put it, "the weaving together of documentary, material, and spatial threads to produce rich interpretations of the past."

During a summer 2009 archaeological field techniques course, several Penn State students participated in excavations at the Moland House. These excavations uncovered a multitude of additional artifacts and what appears to be a stone walkway or remains of a foundation wall that connects to an as-yet unknown structure. This potential wall or walkway has been tentatively dated to the late 18th or early 19th century due to its depth of burial (approximately 18–24 in.) and a George III halfpenny coin dating between 1780-1820 found in association with the stones. The excavation was performed in relatively close proximity to the location of what is tentatively identified as a summer kitchen.

In addition to learning the basics of surveying, excavating, screening, cleaning, and preservation, students also developed and deployed a system to collect aerial imagery to assist in locating any as-yet undiscovered structures. A high-definition video camera was lifted over the site by a small helium-filled blimp that was controlled by hand via tether

lines. It was thought that low-level aerial archaeology could be used at the Moland House to generate supplemental areas for potential excavations as was done at Sylvester Manor, where excavations began in 1998 based on information from aerial photos. As Kvamme explains, these images revealed "principle features and geophysical survey areas" (Kvamme 2007: 57).

Methods

Vegetation will grow consistently over uniform ground. Where a ditch or similar earthworks once existed and was subsequently filled in, both water and root systems will penetrate more deeply and vegetation will grow taller and be more lush (FIG. 1*a*). Where a wall is buried, the ground will hold less water and not allow root structures to grow as deeply, thus stunting vegetation growth (FIG. 1*b*).

When photographed remotely, as from the air, differential vegetation growth can reveal patterns of buried structures or features that can be used to guide archaeological excavations. The earliest remote sensing for archaeology was accomplished just as the Penn State students experienced it, through photos taken from balloons. The earliest aerial photographs were "photographs of Stonehenge taken by Lt P H Sharpe from an Army war-balloon in 1906" (Wilson 1982: 10).

In 1923, the British archaeologist O. G. S. Crawford pioneered the method of using photos taken from fixed-wing aircraft to guide excavation of archaeological sites. Crawford's photos were taken from a camera mounted vertically on the aircraft. The use of aircraft allowed for greater maneuverability of the field of focus than a balloon with a still camera attachment.

> Excavations undertaken [by Crawford] with A D Passmore in September 1923 at three points along the lines seen on the photographs [of Stonehenge] proved the existence of buried ditches at each place, despite the fact that no surface relief had been visible for at least two centuries. (Wilson 1982: 10).

After Crawford's pioneering work, photographing sites from the air became an accepted component of archaeological reconnaissance, at least in Europe, and its use has increased in North America as well—see, for example, Ebert (1997), Eriksen and Olesen (2002), Schlitz (2007), and Verhoeven (2009). As Wilson (1982: 72) states: "Some of the oldest archaeological sites in Britain [were] … discovered by aerial reconnaissance, and [their ages] … confirmed by excavation." Other aviation imagery pioneers, like Squadron Leader G. S. M. Insall, simply "recorded with a hand-held camera pointed at an oblique angle to the ground" (Wilson 1982: 11). This technique had the advantage of ease while revealing a great amount of unexpected detail, as with Insall's discovery of the site of Woodhenge in 1925.

Adapting the methods of Crawford and Insall, the Penn State Abington students mounted a high-definition video camera (Canon Vixia HV30 HDV) beneath a helium-filled blimp to acquire aerial footage of the Moland House site. The 15 ft. long blimp was originally a component of a Floatograph elevated imaging system, purchased for $4,000 in the 1990s for low-level aerial archaeological surveying. By the time two of the authors (Capelotti and Notarfrancesco) were organizing the 2009 archaeology field experience, the infrared transmitter for controlling the camcorder from the ground was no longer functional, and resources were unavailable for the purchase of a newer or more sophisticated system, such as the thermal imaging balloon-elevated system used successfully in the southeastern U.S. by Haley, Johnson, and Stallings (2002), or the powered parachute evaluated successfully in the southern and midwestern U.S. by Hailey (2005: 69–78). Our original small blimp was also ideal for imaging archaeological areas where obscuring vegetation and overhead power lines rendered larger blimps or powered parachutes unfeasible.

Given these considerations, Gambler fabricated a new platform to mount a digital video camera that would be slung under Penn State's original Floatograph blimp and used to gather aerial video imagery without any ground control. The camera was mounted to Gambler's customized rig by means of its tripod attachment point (FIG. 2*a*). The main component of this rig is a custom aluminum bracket that was fashioned to allow adjustment of the camera angle from

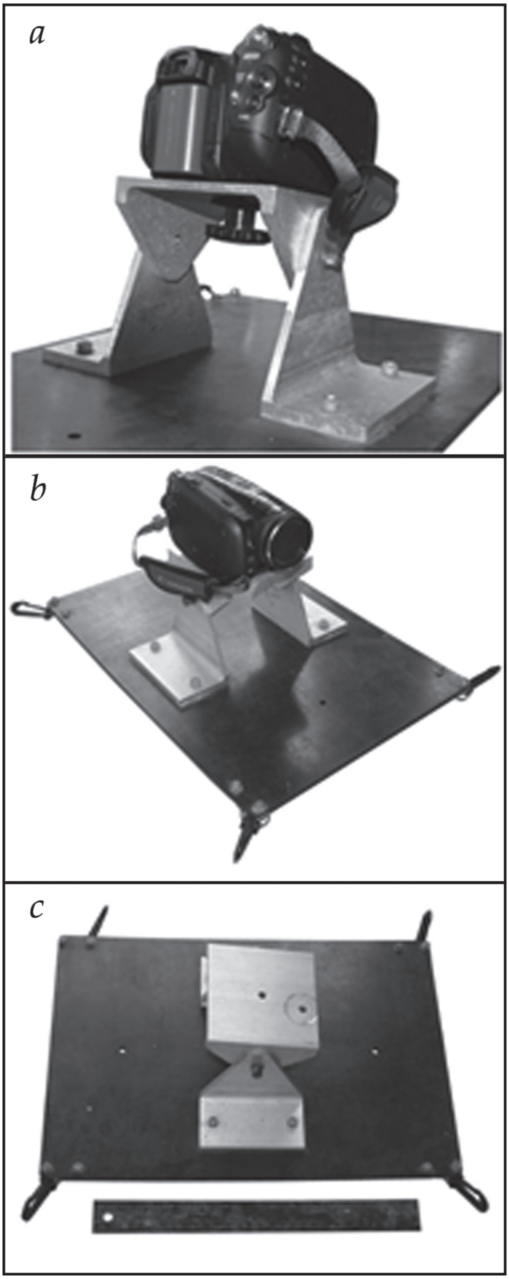

Figure 2. (*a*) Digital video camera mounted to platform by means of tripod attachment. (*b*) Aluminum bracket allows adjustment of the camera angle from perpendicular to near parallel to the ground. (*c*) Formica plate with rings and plastic clasps at the corners for attachment to blimp. (Photos by P.J. Capelotti, 2013.)

perpendicular to near parallel to the ground (FIG. 2*b*). This bracket was then mounted to a 16 x 11 in. Formica plate with rings and plastic clasps at the corners for the attachment of cording (FIG. 2*c*). The whole assembly was then rigged beneath the blimp and could provide stable footage as long as there was little to no wind.

The camera and blimp were then elevated over the site and anchored to the tether line. This was done as soon after sunrise as possible for two reasons: even slight winds added difficulty to blimp control, and the amount and angle of sunlight determined how much contrast could be seen in vegetation growth. Therefore, students had to be at the site before 6 A.M. to take advantage of both favorable lighting and minimal wind conditions. This required close monitoring of local weather conditions in the days prior to any planned ascensions to avoid wasting helium, which cost approximately $250 per inflation.

If weather conditions appeared favorable, the inflation process began before sunrise to have the blimp inflated and the camera rig ready to fly shortly after sunrise. Students then guided the blimp around the site at different altitudes to acquire both perpendicular and oblique digital video data. Multiple passes were made to gain the best images possible for later analysis.

The 15 ft. long helium-filled blimp provided adequate lift to raise the camera approximately 100 ft. above the ground and was controlled by the students via a tether line (FIG. 3). Higher elevations were problematic. As the field experience occurred in May and June, the 50–70 ft. maple trees that surrounded the site were in summer foliage. This foliage threatened to entangle the tether once the winds began to pick up in late morning. Therefore, all aerial operations had to be halted by midmorning.

Once the site had been covered, the blimp was reeled in and the resulting footage downloaded to a 21.5 in. iMac desktop where it was reviewed using iMovie '09. (It should be noted that the freeze frame feature was removed from iMovie '11.) iMovie allowed the video clips to be reviewed in a number of different modes (such as black and white, to enhance contrast), speeds, and through the capture of freeze frames.

In this way, the data gathered could be employed for archaeological, pedagogic, and public scholarship purposes. Archaeologically, surface features could be noted and any gaps in the aerial coverage identified. Pedagogically, we could quickly identify any gaps in the video coverage and elevate the blimp again to gather data at different angles or heights. As part of a state university, we were also mindful to produce short videos to present the results of our work to the public quickly.

Including the helium, the total cost of the system with the blimp, video camera, and platform was less than $2,000. This system was by far the most cost-effective system for a summer field experience designed both to gather low-level aerial archaeological data at a site surrounded by 50–70 ft. trees and to introduce undergraduate students to the strengths and weaknesses of aerial data gathering.

Figure 3. Blimp ascension showing camera rig and control tether. (Photo by P.J. Capelotti, 2009.)

Data

Review of the aerial video footage taken at an oblique angle toward the east showed differential vegetation growth beside what is believed to be the summer kitchen of the Moland House. One rectangular area immediately adjacent to the summer kitchen is clearly visible in the aerial footage and, once identified from the air, was quickly recognized at ground level. This area was thought to be either the remains of a modern garden that had been removed recently or the result of a ground covering, such as a large tarp, put in place for an extended period to kill off the

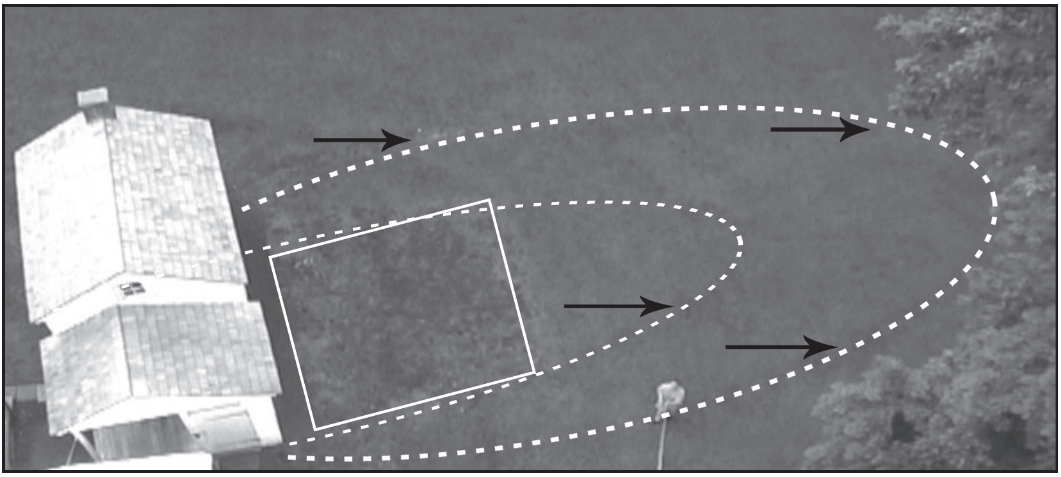

Figure 4. Concentric rings seen from the blimp as it hovered south of the presumed summer kitchen building looking north. Arrows indicate areas of differential vegetation growth. (Photo by P.J. Capelotti, 2009.)

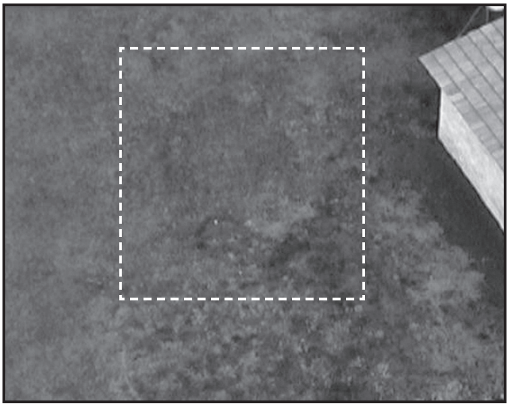

Figure 5. Circular feature adjacent to the corner of the presumed summer kitchen building looking southwest. (Photo by P.J. Capelotti, 2009.)

surface vegetation. It was later learned that the disturbance in this area is the remnant of test excavations conducted more than a decade earlier.

Of more interest were two concentric rings that can clearly be seen beginning at the corners of the presumed summer kitchen building and then extending downslope toward Neshaminy Creek (FIG. 4). The smaller inner ring extends approximately 60 ft. from the wall of the summer kitchen to its farthest point. The outer and larger ring begins at nearly the same points at the corners of the building and extends to approximately 90 ft. from the building at its farthest point. Further analysis may help to determine the source of these rings and tell us whether they were contemporary features or one was subsequent to the other.

A smaller ring adjacent to the corner of the building also can be seen clearly (FIG. 5). This ring is approximately 6 ft. in diameter and appears to be within the perimeter formed by the two larger rings.

Analysis

Prior to the aerial remote sensing, none of these features, with the exception of the test excavation area, had been known. The undergraduate field team suggested a variety of hypotheses to account for the large concentric rings seen in Figure 4. These include (1) remains of a garden wall where herbs and vegetables were grown for use in the summer kitchen; (2) a corral for animals that were then butchered and prepared in the summer kitchen; and (3) more recent remains of landscaping, water run-off or drain lines, or a modern swimming pool that had been removed. Hypotheses suggested to account for the small ring adjacent to the summer kitchen as seen in Figure 5 include (1) an oven, (2) a well, or (3) a granary or other storage construction.

Subsequent to the aerial reconnaissance and as a direct result of it, Millbrook Society researchers located an aerial photograph of the property dating from the 1930s (FIG. 6). This image shows indeterminate structures in the same areas as indicated by the anomolies in the aerial imagery from 2009. In fact, the structure that extends from the Moland House itself is aligned atop a portion of the walkway revealed during excavations.

Further research may answer the question of the nature and purpose of these structures. Ground truthing to test these data should reveal the existence of further buried structures and allow the evaluation of the numerous hypotheses suggested by the aerial survey. Such future field research may be able to connect the patterns seen in the aerial imagery to the colonial period walkway or wall that was discovered during the 2009 excavation. If so, these variations may prove to be extensions of that same walkway or wall, and additional hypotheses and explanations will have to be formed to explain the rings observed from the air.

Conclusions

Remote sensing operations at the Moland House produced significant data on potential structures that have heretofore gone unnoticed by observers on the ground. The balloon-elevated digital video rig was effective within a narrow band of time and weather. The project allowed students to experience the logistical and meteorological challenges involved in deploying such technology for archaeological research and research in the history of aerial remote sensing in archaeology.

Data produced by this method can also be used for site conservation and interpretation. Details attained from analysis of the aerial footage can be used in planning any additional development of the site to avoid damage to or destruction of previously unrecorded features.

Figure 6. Detail from the 1930s aerial photograph of the Moland property showing indeterminate structures. (Courtesy, Millbrook Society, Hatboro, Pennsylvania.)

It is anticipated that the research will be followed by a test trench dug to intersect the patterns discerned in the aerial footage. If evidence of as-yet undiscovered features is unearthed during ground truthing, more extensive excavations can be anticipated at these areas of the site.

If subsequent excavations do indeed yield the remains of colonial period structures, this information can be used to further the reconstruction and education goals of the owners of the site and the Millbrook Society.

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