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From Wright Flyers to Aerial Thermography: The 1910 Wright Brother's Hangar at Huffman Prairie

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From Wright Flyers to Aerial Thermography:
The 1910 Wright Brother's Hangar at Huffman Prairie

ABSTRACT: The Huffman Prairie Flying Field, now a National Historic Landmark located at Wright-Patterson Air Force Base, was the scene of many of the Wright Brother's activities between 1904 and 1916. Following their remarkable success at Kitty Hawk in 1903, Wilbur and Orville Wright returned home to develop a versatile and marketable airplane. They used Huffman Prairie as a site to test aircraft and train pilots. There they constructed (in 1904, 1905, and 1910) a series of modest structures to house their aircraft. While each of these buildings is historically important, the 1910 hangar is the focus of this paper. From 1910-1911, this hangar housed aircraft used by the Wright Aeronautical Company in flying exhibitions and in their pilot training school. The 1910 hangar was undoubtedly a focal point for training lectures, demonstrations, long hours of aircraft maintenance and repair, as well as the after-hours camaraderie of these pioneers of modern aviation. Abandoned in 1916, the hangar was remodeled for use as an exhibit in the 1924 Dayton Air Show. The 1910 hangar was demolished during the 1940's and its exact location was forgotten in subsequent years.

From 1990 to 1994, CERL led a multidisciplinary effort to relocate the 1910 hangar and evaluate the nature, integrity, and research value of its archaeological remains. This work combined traditional archaeological techniques with state-of-the-art ground based and aerial remote sensing. Magnetic and electromagnetic surveys conducted by WES identified anomalies associated with a scatter of metal artifacts. A ground penetrating radar survey isolated a rectangular area related to the hangar. NASA used a thermal sensor aboard a small aircraft to record images that identified the rectangular footprint of the 1910 hangar. In
1994, CERL returned to Huffman Prairie to ground truth the remote sensing findings. Excavations encountered building debris and several architectural features, including the well preserved lower portion of one of the hangar's wood wall posts. A GIS supported study of artifact distributions demonstrated that, even though the hangar may have been demolished using a bulldozer, its archaeological remains have some integrity and offer important research potential.

Distribution of all artifacts relative to 1910 Wright Brothers' hangar outline.

This paper synthesizes a wide range of data to develop a unique perspective on the Wright Brother's activities at Huffman Prairie. Archival photographs provide a vivid record of the appearance and details of construction of one of the world's earliest specialized aircraft hangars. Artifacts recovered at the site, including fragments of airplane parts, the strap hinges from the hangar's sliding doors, and abundant building debris verify the identity of the building, and provide a material link with the day-to-day events of a century ago. The use of remote sensing and GIS techniques demonstrates how technology can support traditional methods of history and archaeology to better understand this site's role in the lives and contributions of two of the greatest pioneers of aviation.

Paper presented in the symposium "Following the Footsteps of the Wright Brothers: Their Sites and Stories", at Wright State University, Dayton, OH, 28 September 2001.

**Introduction**

From 1990 to 1994, a team of researchers from CERL, WES, and NASA assisted Wright-Patterson Air Force Base in evaluating the archaeological remains of the Wright brother's activities at Huffman Prairie (Babson et al. 1998). Over the course of several years, this project evolved from a traditional archaeological study into a very "high tech" effort. In some ways, the project exemplifies changes in North American archaeology, where technologies such as GIS (Geographic Information Systems) are now widely used. In other ways, the 1910 Hangar project remains near, if no longer on, the cutting edge of archaeological technology. Archaeologists in the U.S. have been very slow to adopt remote sensing technologies. For example, our study of the Wright brother's 1910 Hangar represents one of the first successful uses of a thermal sensor to detect relatively small archaeological targets (Sever 2000).

In this paper we provide a brief overview of the 1910 Hangar project and discuss the role of remote sensing techniques in the investigation of this important site. We recognize that many of our readers are historians, not practicing archaeologists. We hope to provide an idea of some of the basic issues that accompany an archaeological investigation of recent historic sites such as those related to the Wright brothers and the development of aviation. We begin with a brief review of the 1910 Hangar in the context of the Wright
The Wright Brothers at Huffman Prairie

Wilbur and Orville Wright became the first humans to fly a heavier than air craft on December 17 1903, at Kitty Hawk, North Carolina. The Wright brothers will be forever remembered for this achievement, one of the true milestones in human technology. But their work could not, and did not end at Kitty Hawk. The Wright brothers were gifted engineers who wanted their invention to receive wide notice and extensive use. They were also businessmen who wished to realize a profit from their years of research. To achieve these goals, the Wrights needed to develop a plane that could be flown by any trained pilot, in conditions other than the favorable terrain and winds they had found at Kitty Hawk (Crouch 1989:279). They needed to find a test site near their family home that would avoid the expense of traveling between Dayton and North Carolina. In the spring of 1904, they asked Torrence Huffman if they could perform experiments in his pasture south of Fairfield, Ohio. The Dayton and Springfield Interurban Railroad's stop at Simms Station provided convenient access to this test site (Riddell and Riddell 1896, Wilson et al. 1906).

In 1904 and 1905 the Wrights constructed two small, temporary hangars at Huffman Prairie. It is likely that neither of these structures was used for more than a year (Howard 1987:185, Walker and Wickam 1986:3-4). From 1905 until 1910, the Wrights demonstrated their airplane, tried to interest the U.S. Army in its use, and achieved recognition as the originators of heavier-than-air flight.

By 1910, the Wright brothers had established the Wright Aeronautical Company in Dayton and were manufacturing Wright Flyers--their distinctive, dual-prop, pusher biplanes with bicycle-chain powered transmissions. They returned to Huffman Prairie to establish a test station for newly built airplanes, to train pilots, and to support their short-lived venture into exhibition flying. In 1910 they built a larger, more substantial hangar at Huffman Prairie (Figure 1). From 1910 to 1916, this hangar was used to shelter and maintain aircraft. The 1910 Hangar undoubtedly also played an important role in the Wright Company's training of 116 men and three women as pilots. Many of these people took their places among the pioneers of American aviation (Howard 1987:372, Walker and Wickam 1986:14-15).

Wilbur Wright died in 1912. Orville sold the Wright Company in 1915, although he continued to fly at Huffman Prairie for several more years. The U.S. Army established Wilbur Wright Field in 1917, as part of the national mobilization for World War I (Walker and Wickam 1986:25-27). The hangar stood abandoned until 1924, when it was used to display the Kitty Hawk Flyer during the Dayton Air Show. It then deteriorated in place until it was torn down in the early 1940s as part of reconstruction of Wright Field during the World War II mobilization (Walker and Wickam 1986:14). Today, Huffman Prairie remains a part of Wright-Patterson Air Force Base, the institutional descendant of Wilbur Wright Field and, ultimately, of Huffman Prairie, one of the world's first experimental airfields (Babson et al. 1998).

The 1910 Hangar

When archaeologists investigate prehistoric and, in many cases, historic sites, we typically have to rely on evidence we recover in the ground to make inferences about the kinds of buildings that were once present there. In this sense, the 1910 Hangar represents an unusual site. The Wright brothers left behind a rich photographic record of their
activities at Huffman Prairie. The 1910 Hangar also appears on several early 20th century maps and several aerial photographs (Figure 2). Thus, the general appearance and approximate location of the 1910 hangar have never been in doubt. One of our objectives was to discover the exact location of the hangar. A second objective was to determine whether the archaeological remains could provide information about the site that could not be derived from archival sources.

No construction plans for the 1910 Hangar have been found. However, Stephen P. Brown, an architectural firm in Dayton, produced plans for a possible replication of the structure based on a careful examination of vintage photographs. Their study found that the hangar measured approximately 70 feet long by 49 feet wide, and was 20 feet high at the ridge crest. The framework consisted of five timber trusses supported by 6 to 10 inch wall posts. The hangar was originally constructed with a wood floor. On each side of the main entrance, three substantial posts supported a framework upon which sliding doors were mounted (Brown 1993).

The photographs suggest that the hangar was not originally equipped with electric lights. Windows located at both ends of the building were too small to provide adequate lighting or ventilation. Serious work on the aircraft undoubtedly required opening the large sliding doors at the south end of the hangar. Work on the aircraft was probably conducted outside of the hanger whenever possible.

These details of hangar construction provided us with some expectations about the nature of the hangar's archaeological record. For example, the wall posts and door support posts must have been set several feet into the ground. Their postholes should have survived long after the aboveground portions of the building were gone. The hangar's wood floor would have protected the ground surface beneath the building from being compacted by pedestrian traffic and the movement of aircraft. The floor would also prevent artifacts from being introduced into the topsoil. To some extent, it would have protected the soil from oil and gasoline spills. In contrast, areas just outside the hangar would be more compacted, and should be characterized by artifacts related to the activities that were conducted there. Archaeologists refer to these discrete areas as "activity areas". At the 1910 Hangar, activity areas might be expected to relate to aircraft repair and refueling (Figure 3), socializing among the pilots and students, consumption of simple meals, a privy area, and so forth. We would also expect trash, including airplane parts, to be discarded in particular locations.

Photographs indicate that the abandoned hangar was substantially remodeled to prepare it for use during the 1924 Air Show. This work included removal of the plank floor and framework that supported the sliding doors. The large doors were permanently secured in a closed position and two small personnel doors were installed. A photograph taken during the Air Show shows a small ticket booth at the south end of the hangar and a line of fence posts along the east and west walls. These changes to the hangar are important because they contributed to the building's archaeological record. The remodeling created some new in-the-ground features and resulted in the introduction into the soil of a wide range of construction debris.

The hangar was again abandoned after the 1924 Air Show and demolished in the early 1940s. Despite the growth of Wright-Patterson, no new construction has occurred in the immediate vicinity of the 1910 hangar. The hangar area has been allowed to return to prairie and has been subject to periodic burning but not plowing. Compared to many archaeological sites, the 1910 Hangar has sustained relatively little post-occupational damage (Babson et al. 1998).
1990 Excavations

The initial archaeological investigations of the Wright brother's Hangar, begun in 1990, focused on hand-excavation with shovels and trowels (Babson et al. 1998:25). Long trenches were excavated in hopes of encountering concrete or stone footings or indications of drip lines associated with the hangar. The 1990 excavations recovered a good sample of the artifacts present in the hangar area. Unfortunately, the excavations did not identify any intact architectural remains of the actual building. The 1990 work at Huffman Prairie made it clear that identifying remains of the hangar would require either a substantial amount of additional excavation or the use of technologically sophisticated, noninvasive techniques. Given the desire to minimize damage to this unique site, use of noninvasive techniques was the preferred option.

Near-Surface Remote Sensing

Near-surface remote sensing (also referred to as geophysical) investigations of the 1910 Hangar area were conducted by Dwaine Butler and Janet Simms of the Waterways Experimental Station (WES). This work included magnetic, electromagnetic, and ground penetrating radar (or GPR) surveys (Babson et al. 1998; Butler et al. 1994). Geophysical investigations often employ multiple techniques, since a feature not detected by one instrument may be identified by another. In geophysical surveys, data are collected as the instrument is moved systematically across the site. The data are then used to produce maps. Areas characterized by geophysical values distinct from those of the surrounding area are referred to as anomalies. Some anomalies may be associated with subsurface archaeological remains, and others may relate to natural phenomena. Geophysical surveys can be totally noninvasive. However, it is always desirable to conduct at least some small excavations to verify (or ground-truth) the geophysical interpretations.

Two electromagnetic instruments were used at Huffman Prairie: an EM38 designed for depths of approximately 1.5 meters below surface, and an EM31, suitable for depths of about .5 meters. The EM38 produced the most useful results, identifying 13 anomalies in apparent conductivity. These are low or negative anomalies and are probably associated with shallow metal objects. Nine of the conductivity anomalies occurred within a rectangular area measuring 24 meters north-south by 20 meters east-west. This area corresponds closely to the location of the hangar based on a 1924 air photograph (Babson et al. 1998; Butler et al. 1994).

The ground penetrating radar instrument was pulled across the site surface at 4-meter intervals east-west, and at 8 meter intervals north-south. GPR works on the principle that materials differ in the degree to which they reflect an electromagnetic signal. GPR data are commonly plotted to resemble a profile through the ground. One does not expect subsurface features that may be manifested in the data to "look like" the actual objects, and proper interpretation of GPR data requires substantial experience. The GPR survey identified a roughly rectangular anomalous area that measured about 33 meters north-south by 14 meters east-west (Babson et al. 1998; Butler et al. 1994).

A synthesis of the geophysical survey results indicates that a rectangular area defined by the conductivity anomalies was most likely to be associated with the 1910 Hangar. This area also includes five magnetic anomalies and a number of localized GPR anomalies. The area completely encompasses the hangar location as indicated by the 1924 air photo (Babson et al. 1998; Butler et al. 1994).

Airborne Remote Sensing
The airborne remote sensing study of the 1910 Hangar area was conducted by Tom Sever of NASA (Sever 1998). He used two instruments: a CAMS (or calibrated airborne multispectral sensor) and an Inframetrics hand held thermal scanner. The CAMS collects data in the visible, infrared, and thermal bands. At that time, it was in the final stages of development at NASA. The Inframetrics Model 740 hand held scanner is one of the most powerful thermal scanners that are commercially available. It was originally used by NASA to detect ice on the Space Shuttle. It is sensitive to .1 degree Centigrade and can, for example, detect a hand print on a wall several minutes after the hand is removed. Both instruments were used from a small plane.

The oblique, low altitude air photo taken about 1911 (Figure 2) was used as a reference in examining the CAMS and Inframetrics data. The location of the road that passed very near the hangar was visible in both data sets. The Inframetrics detected the gullies flanking the road whereas the CAMS detected the actual roadbed. The rectangular footprint of the 1910 hangar is visible on the Inframetrics image (Figure 4).

We still don't understand exactly why the hangar footprint is visible in the thermal data. The footprint could, for example, be a result of differences in soil compaction or the presence of petroleum products that affect heat retention. Throughout most of its period of use, the hangar had a wood floor that would have minimized soil compaction and protected the soil from oil and gasoline. In contrast, the soil around the hangar was probably compacted by pedestrian traffic and the movement of aircraft, and it is likely that engine oil and fuel were sometimes spilled there. In any case, the Inframetrics thermal sensor was particularly successful in detecting the hangar and nearby features (such as Simms Road), despite the fact that the study was not conducted during the optimal season and moisture conditions (Sever 1998).

**Ground Truthing Excavations (1994)**

CERL archaeologists returned to Huffman Prairie in 1994 to ground truth the results of the remote sensing studies. We used pin flags to mark on the ground the predicted locations of the hangar based on the 1924 air photo and the geophysical and remote sensing studies (Babson et al. 1998).

We identified three features related to the hangar. Feature 1 was an intact wood post. Made of well-preserved, non-carbonized wood, the post measured 12 to 14 centimeters on a side. The base of the post was not exposed but clearly extended more than 30 centimeters below ground surface. Given these dimensions, Feature 1 could be one of the hangar's major wall posts.

Feature 2, a small pit, was square with rounded corners. It measured about 40 centimeters on a side and extended to about 35 cm below surface. Artifacts recovered from the fill included nails, a shotgun shell casing, flat glass, and uncarbonized wood fragments. The function of this feature is unclear, since it seems to be too large and shallow to have supported a wall post.

The third feature was a pit containing a concentration of nails, glass, wood, and roofing fragments. This pit was located in the corner of a hand excavated test unit and was not completely excavated. A circular feature believed to be a post hole was identified within the larger pit. This feature may have been created when the hangar was remodeled in 1924. The pit may have been dug after the wood floor was removed so that one of the posts used to support the roof could be set in place. The pit was then partially refilled using debris from remodeling activities.
We were curious about what portion of the hangar was represented by the three features we identified. We used the architectural diagrams (Brown 1993) to make a schematic map showing the locations of the major wall posts. The three features we found clearly do not all represent a section of one of the hangar walls. The three features define a fairly straight line that is neither parallel nor perpendicular to the long axis of the hangar. Furthermore, the three features are not evenly spaced. One or more of the features may be associated with minor posts that supported the plank. Although the functions of the three features remain unclear, we are confident that they represent intact structural elements of the 1910 Hangar (Babson et al. 1998).

**Artifacts from the 1910 Hangar**

Archaeologists typically make inferences about the kinds of activities that occurred at a site based on the relative abundance of different types of artifacts. For example, industrial sites like stoneware potteries or blacksmith shops typically have artifact assemblages that are very different from those associated with farm houses. The investigations at Huffman Prairie provided a rare opportunity to examine the artifacts associated with an early aircraft hangar.

More than 6,700 artifacts were recovered during the excavations. The assemblage consists largely of construction materials. Nails make up 31% of the total. Flat glass is nearly as common, accounting for 27%. A large category of "other" artifacts includes many small fragments of asphalt roofing material and noncarbonized wood. Notable artifacts include a large strap hinge that appears identical to those mounted on the personnel doors that were added to the hangar in 1924. Also recovered were large carriage bolts and washers that were probably used to connect major structural elements, or that may represent components of the sliding door assemblies (Babson et al. 1998).

Domestic artifacts, including glass from bottles and jars, and table china, make up only 2% of the assemblage. The smallest but most interesting category consists of industrial artifacts, including airplane parts. Identified plane parts include an aluminum control wire guide, iron turnbuckles for tightening wing struts, and links of drive chain similar to bicycle chain (Babson et al. 1998).

The abundance of architectural materials combined with the extremely low occurrence of domestic artifacts reflects the single function, industrial character of the site. The composition of the assemblage is also compatible with a relatively brief occupation. Historic records document that the hangar was consistently used to shelter aircraft and train pilots for less than six years. Some of the airplane parts are distinctive, but they would probably not be recognized by many archaeologists. If no historical records had been available, it might have been very difficult to infer the primary function of the hangar building.

**Artifact Distribution and Hangar Demolition**

A major focus of the project was to assess the quality of preservation and research potential of the 1910 Hangar. The Wright brothers left a rich photographic record of their activities at Huffman Prairie. We needed to determine whether the archaeological deposits could yield information about construction techniques and/or activities conducted in and near the hangar that could not be derived from the historic documents and photographs. To answer these questions we needed to consider several issues. First, did the various activities that occurred at the 1910 Hangar result in the deposition of distinctive artifacts or in-the-ground features? Secondly, did the manner in which the
1910 hangar was eventually demolished also destroy the archaeological evidence of past activities? Although it has only been about 60 years since the hangar was destroyed, there appears to be no detailed information about how the demolition occurred. Fortunately, data on artifact distributions provide a number of clues about these issues.

Figure 5 shows a GIS-generated, three dimensional contour map of the distribution of artifacts relative to the outlines of the hangar and the excavated units. The details of the distributions are, of course, strongly influenced by the non-random locations of the test units. Here we see that the hangar outline and the artifact scatter overlap considerably but are not coterminous. We can explain this incomplete overlap in two ways. It is conceivable that the building collapsed or was knocked down, and that the debris were simply left where they fell. If this occurred, the incomplete overlap of the hangar outline and artifact distribution may simply reflect a slight error in georeferencing the hangar based on the 1924 air photo.

The distribution of nails indicates that the hangar debris were not simply allowed to remain where they fell. Virtually every board used in hangar construction was held in place by nails. If the hangar debris were left where they fell we would expect to find a roughly even distribution of nails. This does not appear to be the case. A GIS plot of the distribution of nails suggests that there are three concentrations within or very near the hangar outline. We don't put too much emphasis on the exact locations or magnitudes of these concentrations because they reflect, in part, the paucity of excavated units in the intervening areas. Nevertheless, there is clearly a much higher density of nails in units near the north wall of the hangar than elsewhere, and this indicates that the nails are not evenly distributed (Babson et al. 1998).

Flat glass and domestic artifacts are also concentrated at the north end of the hangar. We would not expect for these artifact categories to be evenly distributed across the site. The concentrations of glass and domestic artifacts could represent a refuse discard area immediately behind the hangar, resulting from a tendency to discard trash directly out the back door.

However, we suggest that all of the artifact categories are concentrated at the north end of the hangar as a result of the demolition processes. Although the hangar was quite dilapidated, it was probably still standing at the time of its demolition. We suspect that a bulldozer was used to knock down the walls and then consolidate the debris into one or more piles. The main pile appears to have been located at the north end of the hangar, near the road. Some of the wood may have been hauled away for reuse, but some was probably burned. Evidence for burning is present on about six percent of the artifacts. A plow zone was noted in some of the test unit profiles, and in several units there were concentrations of fairly large artifacts at the base of the plow zone. It seems likely that, after burning, the remaining debris were simply plowed under.

What was the impact of this demolition on the research potential of the hangar? The 1994 excavations demonstrated that the lowermost portions of at least some of the posts associated with the hangar remain in place. Furthermore, several large specimens suggest that wood preservation at the site is good. Archaeological remains of the hangar should therefore represent a source of information on details of hangar construction, at least in terms of the floor plan.

The 1910 hangar was used for a very narrow range of activities and was used for a brief period of time. Factors such as lighting, ventilation, the turning radius of airplanes on the ground, and hazards associated with the storage and use of fuel and engine oil may have resulted in a number of discrete activity areas. Artifact distributions within and
immediately adjacent to the hangar were probably disturbed, at least to some degree, when the hangar was demolished. However, activity areas that were located even a modest distance from the hangar may remain intact. Some of these activity areas were probably not sampled by our test excavations. On balance, the archaeological remains of the 1910 Hangar may be most valuable as a source of detailed information that would contribute to a faithful replication of the structure, and as a source of artifacts directly associated with the Wright brother's activities on Huffman Prairie (Babson et al. 1998).

**Conclusions**

We will conclude with a few comments on how the geophysical, remote sensing, and traditional archaeological excavations contributed to this study of the Wright brother's 1910 hangar. The near-surface geophysical and airborne remote sensing studies were both successful in identifying the location of the hangar. One of the realities of geophysics and remote sensing is that it is difficult to predict which technique will be the most useful at a particular site. At Huffman Prairie, the Inframetrics thermal sensor yielded the most dramatic results in that it produced an image of the actual footprint of the hangar. Hand-held, digital thermal sensors have become more widely available in the past few years. Their use by archaeologists, however, is still very experimental. Recent, unpublished work has indicated that thermal sensors can detect targets as small as individual historic graves. Thermal sensors are thus likely to join the growing array of near surface geophysical and aerial remote sensing techniques that can enhance our ability to detect and study historic (and prehistoric) archaeological sites.

What would Wilbur and Orville Wright have thought about this project? Clearly they were individuals of great intellect, curiosity, and ambition. To be honest, we don't know if the Wright brothers had any particular interest in archaeology. Given their fascination with aviation and their practical use of photography, we suspect that they would be delighted, and perhaps a bit amused, by the sight of a NASA archaeologist leaning out the window of a modern airplane, trying to locate the remains of their modest wood hangar with a thermal camera that was bought for the space shuttle program! They might also feel some pride and satisfaction, since the modern aircraft and the space shuttle program owe a great deal to the Wright brother's work at Huffman Prairie nearly 100 years ago.

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