dog trot:
a vernacular response.

dog trot house constructed circa 1840, located in French Camp, Mississippi

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The following case study is an investigation of an architectural response to regional conditions. The study focuses on the vernacular typology of the southeast represented by the dog trot house. Developing in response to its environment, the dog trot house is successful in providing cool shaded space in the southeast's hot, humid climate. This is accomplished primarily through its successful passive ventilation strategy. This study attempts to identify, understand and test the characteristics of the passive ventilation system using simple means that could be available to anyone. The tests were conducted using the dog trot house located in French Camp, Mississippi as an example of this building type. Tests were carried out on the actual building as well as a scaled physical model. The results of the study show the geometric disposition and orientation of the dog trot house to be extremely successful in creating passive ventilation. It is for this reason that we feel the dog trot house should be considered an important prototype for designers concerned with energy efficiency.

Located throughout the southeast, the dog trot house represents an important example of vernacular architecture. The traditional dog trot house is characterized by two log houses with a central connecting passage way, a porch at either side, and a chimney at either end (see diagram in appendix). These characteristics developed over time as Robert M. Ford describes in Mississippi Houses: Yesterday Toward Tomorrow. “A one room cabin would suffice during the first year or two and then the settler would need to build more space. Since it is exceptionally difficult to join log houses together, the next pen was detached, but with a roof built to connect the two log pens, thus forming the ‘dog trot’ “. The connecting passageway was discovered to be particularly comfortable in providing shade and ventilation. When oriented to the south, the dog trot house maximizes its potential in taking advantage of the prevailing southerly winds. Wide overhangs and porches at either end provide shade to the interior and allow windows to remain open during frequent summer rains. Additionally, the fireplace would be used for both heating and cooking. For this reason, chimneys can typically be found in each cabin to provide heat during the winter. However, when fire was necessary during the summer for cooking it was important that the fireplace be positioned with maximum external surface area to radiate heat away from the interior spaces. These factors represent a few of the strategies employed by settlers in response to the southeast’s hot, humid climate. Recognizing its successes, the building type was repeated in various representations long after log construction became replaced by frame and weatherboarding. However, with the development of modern air conditioning, the central breezeway was lost in subsequent formal developments. The modern version of the dog trot house resembles the original version, but the central passage is closed off.

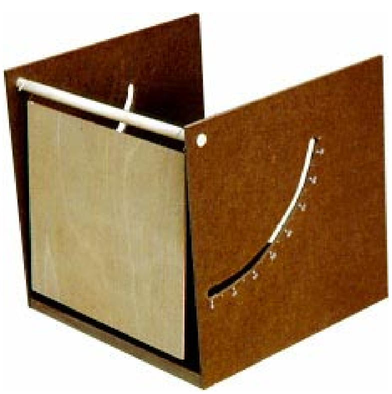
It is unfortunate that this successful ventilation strategy has been overlooked in the implementation of technological systems. It is important that designers learn from the lessons to be found in vernacular architectural types. This investigation will attempt to demonstrate the success of vernacular architecture. In particular, the success of the dog trot’s ventilation system.

Hypothesis: It is our contention that the passive ventilation strategy of the dog trot is essential to its success as a southeastern building type. This study will examine the characteristics of wind flow through the geometric disposition of the dog trot. It is our intention to observe the phenomena of wind flow and understand its effects in creating the ventilating effect that can be experienced inside the dog trot. Based on our experience, we expect the study to show that the shape of the dog trot actually increases the wind speed as it passes through the center of the house. Additionally, the study will make use of easily constructed instrumentation with which to carry out the measurements.

the anemometer.

The anemometer is used to test to actual wind speed on site. This is the most technological testing device used in the case study. The anemometer provides the actual readings of wind speed in feet per min; however, it is not used to determine the wind direction. The anemometer was also used to provide a comparison with the data obtained using the pendular wind measuring device constructed for this investigation.

the pendular wind measuring device.



Images of the actual device used to conduct on site measurements.

The idea of making this instrument came from the pendulum, and considering the nature of wind as providing a force. Our “pendular” wind measuring device is composed of two parts: 1) a hanging panel that catches the wind; and 2) a stand that holds the panel, provides places for readings, and acts as a tunnel for testing the wind direction. The panel is made of aeroplane plywood and balsa so that it has a light weight and can be raised by the wind easily. The stand is made of a 1/2" dowel, supporting the hanging panel, and 5 pieces of 12"x12" 1/4" thick masonite which supports the dowel. There are slits cut at a radius which corresponds to the movement of the panel as it is lifted by the force of the wind.

the pendular wind measuring device (continued)

When the wind strikes perpendicular to the panel's surface, a positive air pressure on the windward side will push the panel up. Increases in wind speed push the panel higher. The speed of the wind is represented by reading the degree of how much the panel is raised. Moreover, when wind is not blowing perpendicularly to the panel's surface, the stand which is shaped as a tunnel, will block the wind off and the panel will not be raised. Therefore, the wind direction for each location can be determined by positioning the stand such that the stand is raised to the highest degree.

This device is designed to make visual comparisons between different locations. It cannot test the actual velocity because it is only made to indicate different wind speed in proportional relationships. These proportional relationships can be adjusted for particular conditions because the weight of the panel can be raised by adding coins in the hollow space inside the panel. By testing the pendular device (with an unweighted panel) and the anemometer simultaneously at a constant wind velocity created by a fan, the ratio of the two readings is found to be approximately 1 to 15 (15o=230 ft/min).

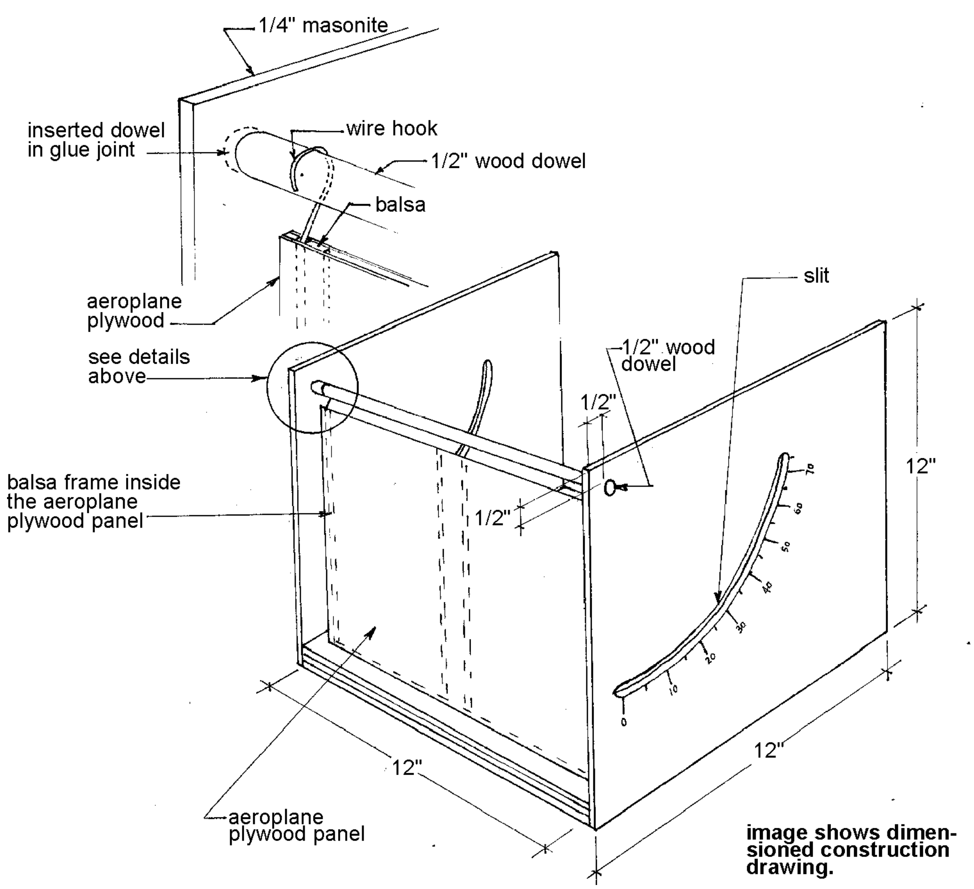


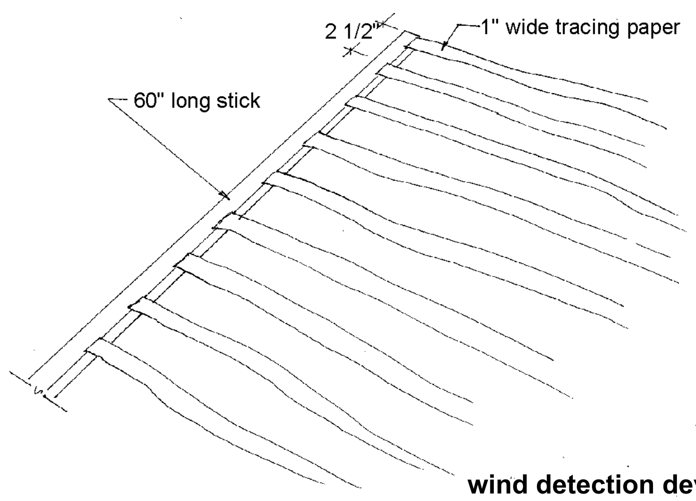
image shows dimensioned construction drawing.

the scaled model wind test

The scaled model wind test is composed of three main parts: 1) a 24" diameter fan; 2) a 3/8"=1' scaled model of the dog trot; 3) wind movement indicators. The fan is used to generate a constant wind speed. Most parts of the models are made of opaque materials such as chip board, cardboard, and balsa. The roof and the ceiling of the model is made of plexiglass to show the wind movement inside the model. Tracing paper and smoke are used as indicators for air movement. Tracing paper is mainly used to graphically demonstrate the general air movements around the model, and smoke is used to study the more detailed movements inside the model. The tracing paper test involves 1" wide paper strips taped to a long (60") stick to indicate air movement on a plane, while smoke is used to indicate air movement in a line.

This test is designed to reproduce the general air movement at the dogtrot building in the summer when wind mainly comes from the south. Since wind speed is not the concern for the test, the wind speed generated from the fan is adjusted for clear demonstration of flow using the indicator. The test is performed in an interior space where there is no significant air movement other than the wind generated from the fan. The indicators (tracing paper and smoke) are placed in different positions to test each location.

aerial model view demonstrating transparent roof providing interior visibility.



wind detection device using tracing paper strips.

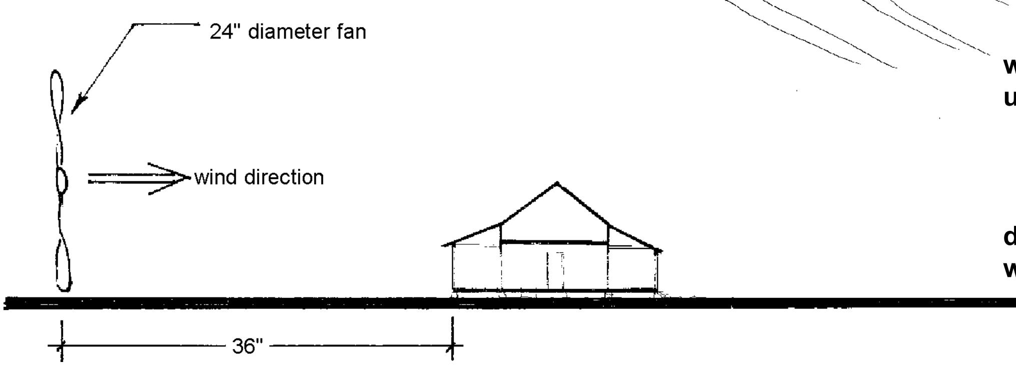
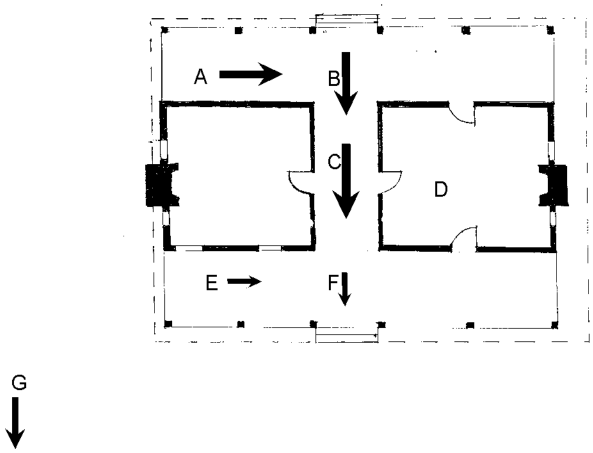


diagram of scaled model wind test set-up.

the anemometer / the pendular wind measurer.

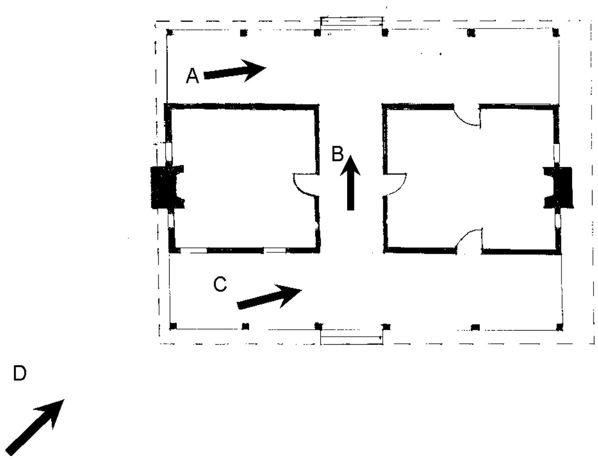
Two sets of data were collected at the dogtrot in two days. The first set was collected on March 5th at 3:00pm; it was a sunny day with little wind (10° from the pendular wind measurer) mainly from the north. The second set was collected on March 27th at 4:00pm; it was a sunny and windy day (70° from the pendular wind measurer and 912 ft/min from the anemometer); wind mainly came from southwest. With north upward, the diagrams below show the two sets of data; the arrows shows the wind direction of each position which are labeled with letters, and the sizes of arrows are proportioned to the wind speed. In the key of the each diagram, BOLD letters represent readings from the anemometer, and italic letters represent readings from the pendular wind measurer. The last measurement shown in each case represents the outside wind speed and direction. Other measurements provide information on how the wind moves through the dog trot house.

March 5th @ 3:00pm note: the pendular measuring device was unweighted for the tests performed on this date. The results from this device are given in degrees. The results from the anemometer are shown in ft/min.



A: 387 ft/min
25°
B: 376 ft/min
25°
C: 429 ft/min
30°
D: 8 ft/min
0°
E: 82 ft/min
5°
F: 73 ft/min
5°
G: 139 ft/min
10°

March 27th @ 4:00pm note: due to the variable wind during the second test day, measurements are less accurate and inconsistent. additionally, the pendular measuring device was weighted for results on March 27.



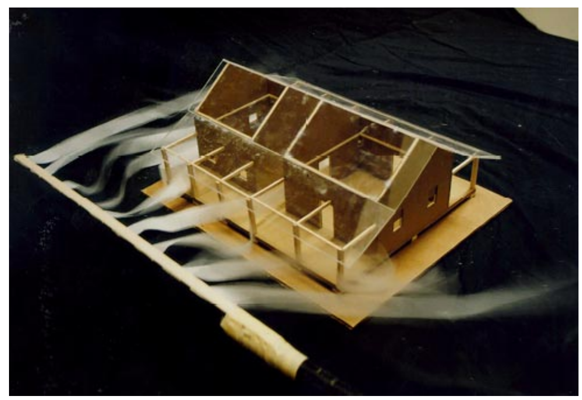
A: 744 ft/min
65°
B: 530 ft/min
55°
C: 667 ft/min
30°
D: 912 ft/min
70°

the scaled model wind test.

All results are taken with all windows and doors open because the effects caused by closing doors or windows are not visually significant at this scale and with the method used. These images represent the air flow as it moves over the roof, around the spaces, and through the central breezeway. The wind indicator is placed at heights to demonstrate the characteristics of both ground level and roof level wind conditions.

The image above shows air above ground mainly flows above and on the east or west side of the dogtrot. A smaller volume of air travels through the breezeway but at a greater velocity.

Turbulences are created on the leeward (north) side of the roof.

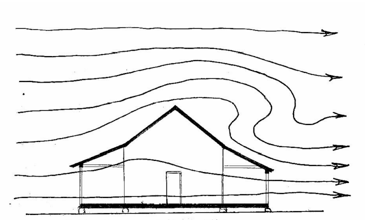


The image above shows the central portion of air near the ground flows through the dog trot space, while the rest of the air flow is pushed to either side of the building.

Air is directed over the roof, creating turbulence and then it is directed down after it passes over the roof.

The image above shows most air travels up and over the roof while some continues level and moves around the house.

the scaled model smoke test.



air flow diagram showing section through the central breezeway.

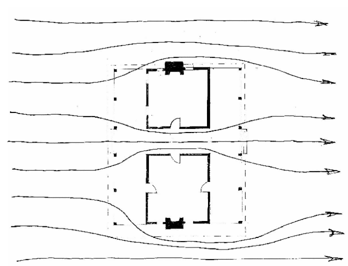


image demonstrating smoke test technique.

air flow diagram showing plan view of dog trot house.

In the same conditions, smoke tests were carried out on the model. This was done using a smoke gun which shoots an extremely fine dust at the model. The wind carries the dust allowing observations to be made demonstrating the path of air flow. Tests were conducted at varying heights from the ground plane to the roof to develop a sectional analysis. Additionally, tests were conducted in plan view relative to the ground plane. This illustrates how the air would be distributed across the facade, then around and through the masses of the building. The two illustrations shown above represent the results of this analysis. The images show lines representing the flow of air as it moves through the dog trot house.

The investigation consisted of three primary methods. The pendular measuring device was constructed and used on site to test the wind flow conditions throughout the dog trot house. Secondly, measurements were taken in addition to and along side the pendular device with the anemometer to determine what proportional relationship might exist between the two methods. Finally, a scale model was constructed with a transparent ceiling and roof to perform some visual tests in a simulated wind condition.

The pendular measuring device showed the dog trot to be extremely successful, especially with respect to north and south winds. Our measurements demonstrate increases in interior wind flow of up to three times that of the external wind flow. The measuring device was useful in determining wind direction and proportional relationships of magnitude quickly and easily.

The anemometer was used primarily as a means of comparison in studying the performance of the pendular device. The anemometer gives readings of air speed in feet per minute. The pendular device gives read out based on an arbitrary scale. In a controlled test of constant wind speed, the two methods demonstrated comparable proportional relationships (1 to 15 with an unweighted panel). The findings of this experiment gave us confidence that the pendular devise provides reliable, comparative data.

The scale model allowed us to produce a controlled condition and simulate the flow of wind over a dog trot. We believe the phenomena of differential air pressure cannot be accurately demonstrated in a smaller scale model. However, the method of using thin paper strips positioned in a row can demonstrate in a diagrammatic sense the distribution and flow of air. The paper strips were positioned in various relationships with the model to show the conditions at the ground level as well as at the roof. The major findings in these images shows the flow of the wind as it confronts the model at the windward side, the distribution of wind as it moves across the forms, and the resultant turbulence developed at the leeward side from differential air flow and pressure.

The results show visual and quantifiable data in support of our contention that the orientation and geometric configuration of the dog trot increases central air flow. Additionally, we are confident that the simple methods employed (i.e. pendular measuring device and scaled model wind simulation test) are reliable and potentially useful to anyone interested in conducting similar tests.

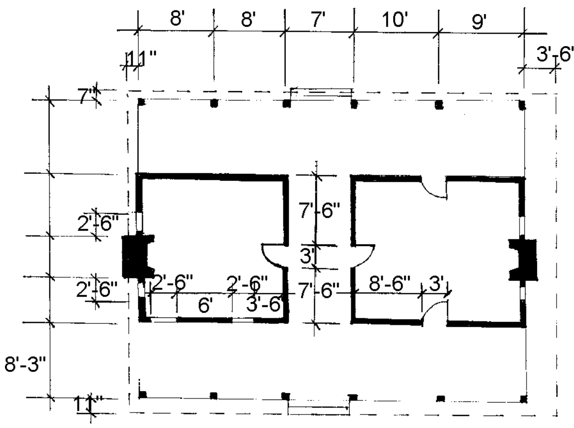
Our investigation shows the dog trot's ventilation system to be successful both in terms of quantified data and experience. Orientation plays an important role in the performance of the system. During instances of westerly winds, the air flow on the porches often exceeded the air flow in the central breezeway. However, it is typical to find that dog trot houses are oriented north and south as is the case with the one found in French Camp, Mississippi. The significance of this orientation is that is takes advantage of prevailing wind patterns in the southeastern region. In addition to its southerly orientation, the geometric layout of the dog trot is essential in creating the dramatic wind effect. The tall roof and solid spaces at either side of the breezeway create differential pressure as wind passes over and through the house. This differential pressure forces air to move through the central passageway at a greater speed. Measurements show wind speeds at the central breezeway to be substantially greater than those at the exterior of the house. This strong breeze pulls air through the adjoining connections to the log cabins, keeping the interior spaces cool.

Data collected in studying the dog trot house backs up our assumptions made empirically. The pendular measuring device developed for this study does not present accurate scientific data, however, it proved successful both in comparing the force of the wind in different locations and ascertaining the direction of wind flow. Comparisons were made that demonstrate the proportional relationship between measurements made with the anemometer and the pendular measuring device to be very similar. The scope of the device is limited to the point at which the wind blows the hanging air flap to a near horizontal position; but this can be adjusted and accounted for by weighing down the air flap to relate to the different conditions. It is important to note however, that comparative analysis can only be made between two variables with the wind flap weighted equally. In addition to the measuring device, the model wind test provides actual graphic representation of wind behavior. The conditions of air flow are difficult to simulate both accurately and graphically. We believe the phenomena of differential wind pressure is impossible to accurately model at a small scale. In addition, natural variables important to the character of wind flow cannot be portrayed in a simulated condition. This experiment provides no quantifiable data, but instead enables someone to position the strips of paper in different orientation with the model in order to understand the nature of the wind flow as it moves over an architectural model. Our intention was to seek out methods that could be easily reproduced and accomplished with basic equipment. Experience and quantified data both show the ventilation system to be extremely successful.

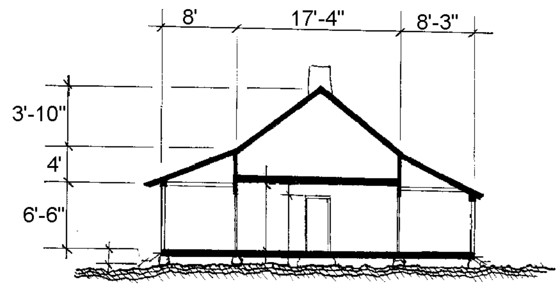
In retrospect, there are a couple of improvements that could be made to enhance the quality of the data collected. More than one pendular measuring device could be constructed and measured simultaneously against another in a different location. Additionally, the effects the central breezeway has on developing circulation through the adjoining rooms could be more closely examined in a large scale model. A larger model in a simulated wind condition test could allow for study into the effects of opening and closing doors and windows in various configurations.

Passive systems are too often overlooked in modern designs. This case study of the dog trot house demonstrates the relative ease with which ventilation strategies can be implemented and examined. Additionally, the dog trot is an important example of how passive systems can contribute greatly to a building's thermal performance and improve energy efficiency. This and other vernacular typologies represent an important link that must be acknowledged in designing energy efficient, sustainable architecture.

dog trot house.



plan.



section.

The images above show a plan and sectional view of the dog trot house located in French Camp, Mississippi and used in this case study. Dimensions are provided for reference. This example represents the typical dog trot house that can be found throughout the southeast. references.

references.

Robert M. Fort, Mississippi Houses: Yesterday Toward Tomorrow (Mississippi State University Printing Department, 1982)

French Camp visitor center. South of Ackerman, Mississippi.

Fuller Moore. Environmental Control Systems, Heating, Cooling, Lighting (New York, NY McGraw-Hill, Inc. , 1993)