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D Acres of New Hampshire

Alternative building workshop, September 11 2004

Welcome to the September 11th Alternative Building Workshop! We are glad that you arrived safely at D Acres and are interested in learning about natural building. Before we jump into details regarding the hands-on work you will be doing today, it helps to know a little more about the general design goals of this building. The idea of the structure emerged from the need for more shelter for animals during the winter season, as well as the extension of the growing season for many of our plants. It made sense to combine these functions into a single building. We realized that this design would not only allow for an ideal exchange of heat, oxygen, and carbon dioxide between plants and animals, but the structure's efficiency would also limit our time spent doing chores in the cold New Hampshire air.

After the initial conception of the project, the first thing to consider was the location and alignment of the building. Since one of the objectives of sustainable building is to maximize the natural resources that are available to us, the placement of the structure is an extremely important decision. The building should be efficient both in what resources it utilizes and what resources it does not, as well as satisfying our practical needs. We had to consider several things. In regards to topography, we did not want to sacrifice any pasture or agricultural land, plus we wanted to capitalize on natural land slope for drainage ease. We also sought to place the building as close to our community house as possible so that it would be feasible (and warmer!) to feed the animals during the cold and snowy winter months, and to care for the plants during their growing life (approximately early March to late October). With these things considered, we decided that the location of the structure would be approximately 50 feet to the southeast of the community building, with the southern wall set into the side of a slope. The alignment of the greenhouse was the next thing to address. Basically, it was necessary to maximize the building's exposure to the late fall and early spring sun. Since the winter sun moves closer along the southern horizon in the winter season, we want most our windows facing the south. Therefore, it made the most sense to attach the greenhouse to the southern face of the animal husbandry building.

The next step was the foundation of the earthen animal shelter. Living in the northeast, the most important challenges to consider when designing a foundation are frost and rainwater. Of course supporting the load of the building is a universal issue for foundations, but we were more concerned with the deterioration of our earthen walls from excessive moisture. To keep water away from our walls, we chose to design a stone and mortar foundation with an Alaskan slab concrete floor. The bottom of our foundation, or "footing", spans the perimeter of the building, has the widest cross section of the wall, and is dug to just above the frost line (See Options A-D for basic floor plan). The concrete slab floor is set on this footing, and the whole structure rests on the ground much like a float rests on water. This design is beneficial for ground that is susceptible to consistent periods of frosting and defrosting because it will move as one when the groundwater expands or contracts, protecting the walls of the structure from excessive pressures. To support the load and impermeability of the structure, a 12"-24" wide stone base was decided on for the remaining foundation. A cement mortar was used to lay the stone to a height of three feet.

Now we really start getting down and dirty. As you know, the aim of this project is to be as resourcefully sustainable as possible. By focusing on the use of what we have on D Acres property and what local businesses can provide otherwise, we continuously seek to maximize efficiency. With this in mind, we decided to use a conglomeration of alternative building techniques to complete the walls of our animal husbandry building. Thus far, we have used cob and cordwood for the structure. You can access more information about these techniques and the use of adobe from our previous workshops on the D Acres website (www.dacres.org).

Economic efficiency, including both fiscal cost and human labor, is also extremely important in any building project. We have spent a total of $1,645.71 so far. This is very reasonable considering our undertaking, however, it is a trade off for the amount of physical labor we have put into the project. The total number of hours of human labor is now up to 552. Earthen building is typically of this nature; you pay for your house in sweat, not in money. It is a matter of opinion, but here at D Acres we consider this to be beneficial in terms of both economic and social sustainability. Plus, buildings become a lot more personal when you use your own two hands in the creation process. We will finish the building by mid-November, making its construction life approximately 5 months.

Decisions, Decisions!

So here you are, at our Alternative Building Workshop on September 11th. What's next? Glad you asked. We have a lot of ideas swimming around our heads, but need your thoughts and discussion on what makes the most sense. Now that we have made it to the second floor of our husbandry building, we are in the position to make pertinent decisions. These decisions deal with the following considerations: doors, windows, ventilation, and heating.

Primarily, we need to develop a way in which to access the chickens, our second story inhabitants, during the winter months. Things we need to consider are door placement, door height, adverse weather conditions, and the ease with which we can get to the door from the community house. At this point, it is critical to make a decision because it will be necessary to frame the door prior to raising the earthen walls much higher. Right now we have four options; for a clear description and illustration of these alternatives, see Options A-D. Tell us what you think!

We also need to plan if and where we want to place more windows in our structure. Not only are windows aesthetically pleasing, but they also allow for heat transfer and sunlight. However, keep in mind that heat can be both gained and lost through windows. A balance needs to be reached in order to keep the animals warm in the winter. Proper ventilation is an issue as well. Currently, we have no vents in our structure, but it is necessary that we include them. Again, a balance must be reached; these spaces need to allow fresh air to infiltrate the building, but not chill the animals. On the other hand, in the summer, openable windows will cool the greenhouse when it overheats.

To supplement the passive solar design for the structure, we will install two wood stoves. We will make them accessible through the greenhouse, but intend for the stoves to heat both spaces. We also seek to optimize the heat retaining quality of the earthen walls by running the pipes through the walls. However, if we desire to maximize the heating potential of this proposed system, we need to think about pipe placement now, before our walls are too high to capture sufficient heat.

Now for the easy (and fun!) part, we must build up! The second story walls will be composed of adobe bricks on the rounded southern face, cordwood on the northern face, and cob to fill in the spaces. Today at the workshop we will make and apply cob, set the adobe bricks in a sand and clay mortar, and learn plenty of alternative building techniques that will prepare you to get dirty on your own!

Cob Preparation and Application

During the cob-making process, it is not always apparent when the ideal sand-to-clay ratio has been reached. Keep in mind that the particles of sand are the building blocks of the cob mix and the clay is the mortar that holds those blocks together. Too much sand and the mix becomes crumbly and difficult to sculpt; too much clay and the cob cracks when it dries. Fortunately, there are a few different tests that can give a pretty good indication of how ready the cob mix is.

Snowball test

Gather a small sample of the sand-clay mix and add just enough water so that it sticks together when squeezed tightly. It should still be quite dry, though-drier than pie crust dough. Then, form a compact two-and-a-half inch “snowball” with the sample. A good ball should be dry but firm and neither pliable nor crumbly. Now for the test: drop the ball a meter above soft ground, like a lawn. If it shatters, it has too much sand or is too dry. If it flattens or deflects on contact, it has too much clay or too much water. If, however, it holds its shape, then you have an ideal mix!

Crunch test

Because the particles of sand in an ideal cob mix touch one another-with the clay acting as mortar-we can use a very simple test to determine the relative density of the sand. Grab a sample of the mix and hold it next to your ear. Then, squeeze the sample in your hand and listen. If an ample amount of sand is in the mixture, you will hear crunch, crunch, crunch, like scraping sandpaper. There is usually a noticeable difference between samples that have enough sand and those that do not. Perform this test with various batches and train your ear to the sound of a good, crunchy cob mix.

Test bricks

A more thorough, and less instantaneous, way to test which mix works the best is to make several different test bricks. Mix a few small batches of clay, sand, and water, using slightly different proportions of clay and sand for each. Form a test brick from each batch (approximately 4 x 8 x 2 inches) before adding straw, and then, form a test brick from each after adding straw to the remainder of each batch. Be sure to keep track of which batch the bricks came from. When the bricks completely dry (a process that could take up to several days), they are ready for scrutiny. First, look for surface cracks, as they indicate too much clay. Then, scratch the non-straw bricks with a nail or knife to test for hardness: they should not score or crumble easily. Finally, try breaking the straw brick by twisting it between your hands: a good cob brick will be nearly impossible to break. By examining and comparing these test bricks, you can more easily determine which sand-to-clay ratios will make the best building material.

While these tests can be helpful at times of indecision, remember: cob making is more an art than a science. By actually doing the practice of cob-mixing, you will learn which mixtures work better than others and, eventually, you will simply have a feel for good cob. Fall back on the tests when you have to, but, as much as anything else, trust your instincts.

Applying the Cob

Cobbing is a lot of sculpting. It is shaping a structure by joining earth. The cohesive nature of a successful mix must be transferred to attach to the wall. Good walls of cob are monolithic (or 'one piece'), each layer has been formed together.

As we mix cob we need to be thinking of how it will apply to the wall. To accomplish this process we need to be knowledgeable of the material and how it performs. Cob can be 70% sand and 30% clay and be too wet to put on the wall vertically. It will SLUMP...or if the mixture is too dry then we will not be able to sculpt and join it to the previous layers.

The layers are joined by prepping the previous layer with an adequate amount of moisture. A watering can works great to add some dampness to the area that is about to be formed. The idea is to make the dryer wall accept the cob that has just been mixed, since they will bond better in this way. Add water until the surface has softened and the clay glistens. As long as the existing wall does not slump then all is well.

Knowing the material allows you to judge how much can be added at a time. Generally 2-4" per layer is possible. Apply the cob in large handfuls. Use one hand as a guide to prevent slump. The hand will support the cob as the fingers of your other hand massage the cob into place. Do not overwork the cob. Excessive movement/vibration will bring the water to the surface of the mix and promote cracking. Overworking on the wall also increases the slumping factor. The supporting hand provides firm pressure from the palm. If a slump occurs use your palm in a pushing movement along the wall in a attempt to correct the slump. The cob needs to adhere to the wall by the action of your fingers which push the mix into the previous layer's fingerholes. Often a 1" diameter blunt stick is poked through the mix to assure that the cob is adequately joined to the previous layer. Thus as it dries the clay bonds uniformly and the straw is pushed into the previous layer making a monolithic wall.

Walls must be vertical to support weight. The vertical nature of the wall must be maintained and corrected as we go. Cob walls will always have minor variation but it is important to maintain structural integrity. Applying cob at waist level helps. This allows a lot of strength in your fingers and provides for a good view of how the wall is shaping. If the wall has slumped and dried, this area can be removed with a machete by cleaving off with a chopping action. The material can then be put in the next mix.

Future Possibilities

As you can probably tell, we have not yet started to build the greenhouse portion of the structure. Once the animal shelter is to a desirable level (to support the ceiling of the greenhouse leaning on it), we will halt our earthen building and begin work on the greenhouse. As you might imagine, our first priority is to dig and construct a foundation. Although both designs aim to resolve the freeze/thaw issue of a harsh winter, the greenhouse will have a different foundation than the animal husbandry building. The foundation we decided on is a rubble trench/ bond beam design. It is cost efective and with minimal concrete it is suited for adverse weather conditions. Primarily, a trench is dug below the frost line and filled with stones (or rubble) almost to the surface. The spaces between these stones are responsible for the elastic nature of this foundation. Water is free to expand and contract without disrupting the structure due to these pockets of space. Set below the frost line, on a bed of washed stone, is a perforated drainage pipe. This pipe travels the perimeter of the structure and has one or more outlets into our natural drainage pattern. Set on top of the rubble trench is the footing of our foundation; in this case a concrete bond beam. The bond beam is a continuous concrete pour, 12 inches deep by 16 inches wide, around the perimeter of the greenhouse and will be the strength of our foundation. Lastly, we will build a stem wall, most probably of stone, on top of this bond beam for water resistance and stability.

Once we've established a strong footing, we are ready to start placing the wall posts, ceiling joists, glass panels, and a clear fiberglass roofing material (we're using a brand called Lexan). The posts and joists will be supporting the load, while the glass panels and roofing will be protecting the building from various weather conditions. Again, in the design for the placement of the framework, we had to consider how to maximize the capture of sunlight. The noonday sun is at an angle of 39 degrees in early March and late October, when it will be most important to have maximum exposure. Therefore, it would be ideal for our posts to be at an angle of 51 degrees from the ground (See Figure 1, below). As soon as our framework is set, we can begin fastening the glass panels. Since we retrieved them from a local transfer station, they are neither uniform nor designed as greenhouse panels. Although we will probably adjust our placement scheme as we experiment more with the material, our plan for right now is to adhere the panels to each other with one notched and one flat piece of wood. Since a picture will probably better articulate this design scenario, we have included a cross sectional diagram of the configuration (See Figure 2, below). The basic idea is to create a seal to prevent water seepage and to allow for ease in changing a broken pane of glass.

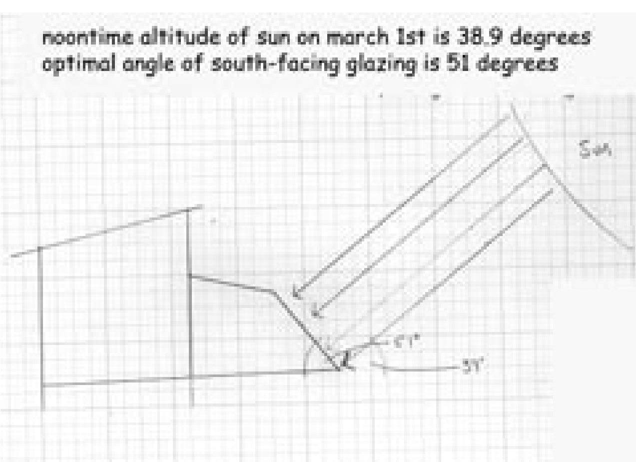


Figure 1: Maximizing the capture of sunlight

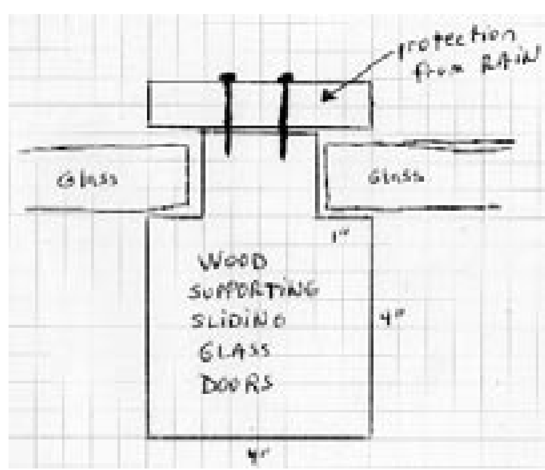
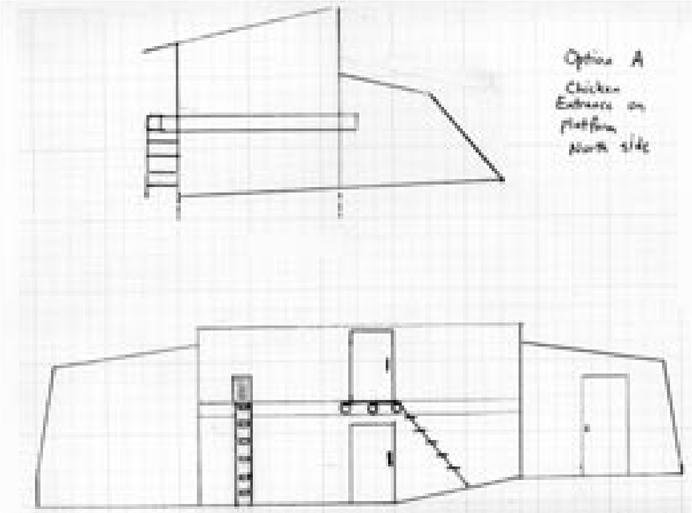
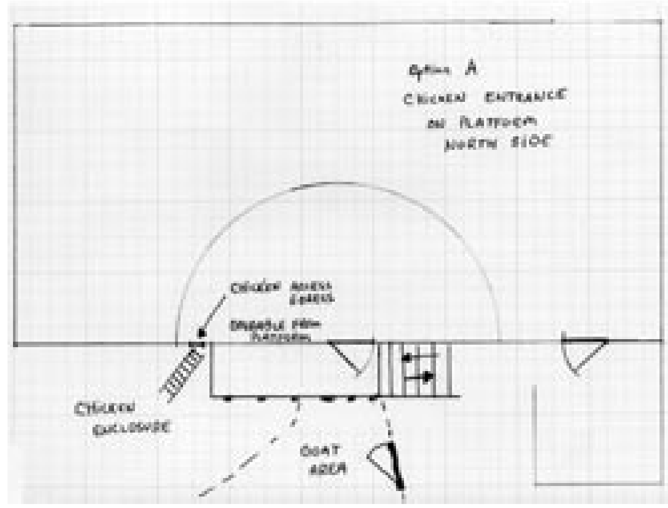


Figure 2: Connecting glass panels

Finally, we will design and build our roof. Because the greenhouse roof will already be in place, and our earthen walls built up as high as we desire, the only thing left is the structure and covering of our animal husbandry roof. Most likely we will design a shed roof, which is significantly higher on one side than the other. Since we can construct one wall much higher than the other with relative ease due to the nature of our building material, this seemed like the best choice. We will slope the roof down from south to north so that the water runoff follows the natural drainage of our site. The joists will be wooden members and will structurally support the weight of the roofing material as well as any snowfall. However, as far as the protective covering, we narrowed down the options to sod or metal. A sod roof has good insulative value and is the naturally beautiful choice, but it is a heavy protective layer and can be hard to waterproof. On the other hand, metal is relatively inexpensive, durable and lightweight, yet is not exactly the most natural building material.

So, this is where we stand. Looking back, things are shaping up beautiful and strong. The road ahead seems just as promising. You are a big part of the progression, glad you could make it!

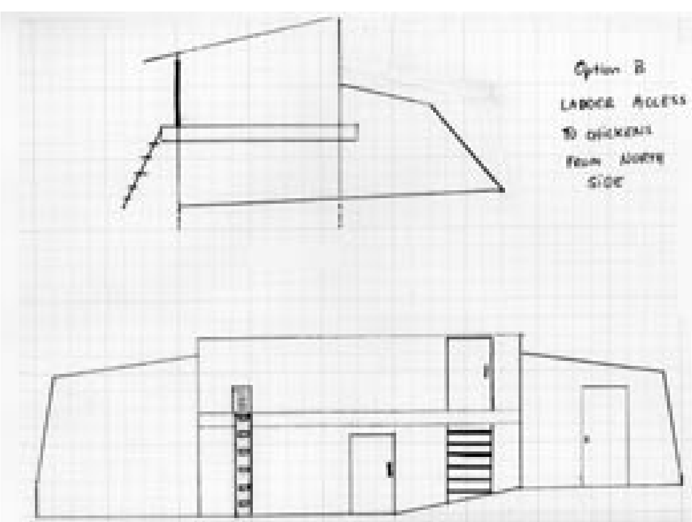


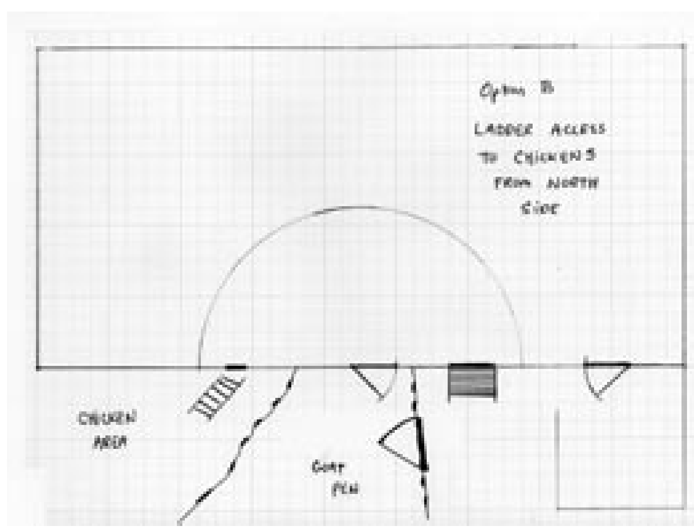


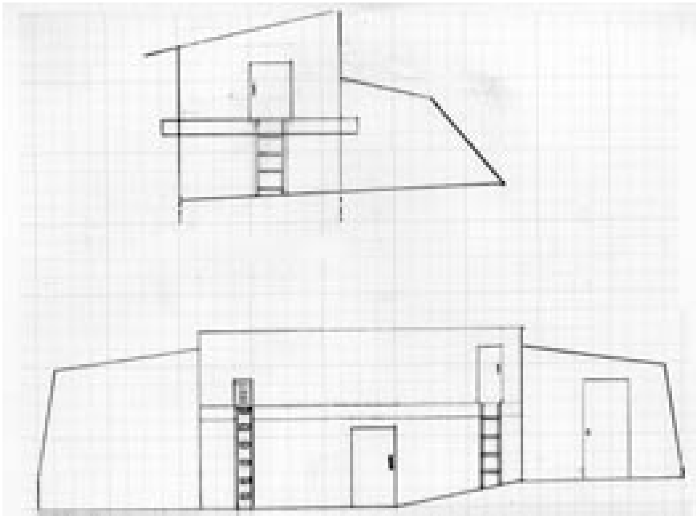
Options for Entrance to the Chicken House

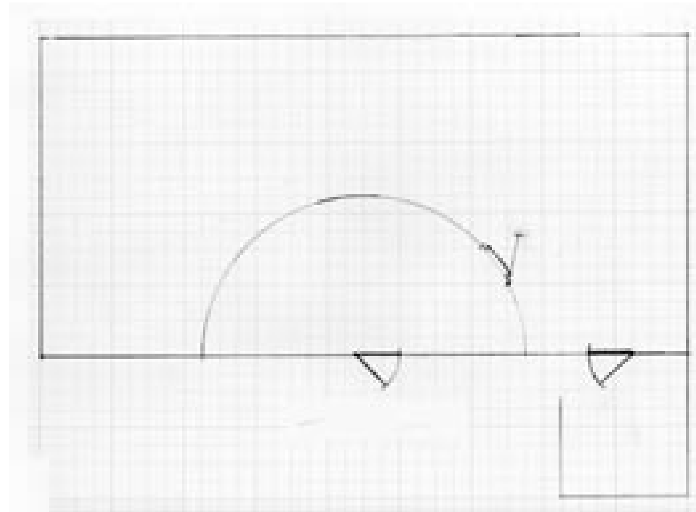
Option A: Rear Entrance on North Wall with Staircase
Pros:
No animals, plants, objects, etc. crowding entrance
Staircase easier to ascend than ladder
Feasible, though not comfortable, door height (3.5 - 4 feet)
Cons:
Additional staircase must be constructed
Entrance, including staircase, is exposed to elements: ice, snow, rain, wind, etc.
Outside cold air can enter and inside warm air can escape readily

Option B: Rear Entrance on North Wall with Ladder
Pros:
No animals, plants, objects, etc. crowding entrance
Feasible, though not comfortable, door height (3.5 - 4 feet)
Cons:
Entrance, including ladder, is exposed to elements: ice, snow, rain, wind, etc.
Outside cold air can enter and inside warm air can escape readily









Option C: Side Entrance From Inside the Greenhouse
Pros:
Protected from elements
Route to entrance is simple
Cons:
Considerably short door height (2.5 - 3 feet)--will practically be forced to crawl through entrance

Option D: “Trap” Door Above Goat/Pig Pen
Pros:
Plenty of headroom clearance
Not exposed to elements
Airflow between 2 warm rooms, so no warm air escaping/cold air entering
Cool feeling of being in a pirate ship
Cons:
Must pass through the pen of potentially unruly goats and pigs (although, this problem could potentially be avoided by keeping animals outdoors until after chickens have been fed)
Awkward storage of ladder inside goat/pig pen
Must pass through two entrances to reach the chicken area
Chickens could potentially be sitting or standing on top of the door while it is being opened
Expose goat/pig pen to outside air