Module 13 – Assignment

Integrating Landscape and Buildings

For one of the projects listed below, describe the methods used by the designers (planners, construction managers) to achieve integration of human and natural systems. To what degree were they successful? Why?

- Army National Guard Earthship

In keeping with the Arizona Army National Guard’s (AZ ARNG) commitment to conservation, pollution prevention and energy reduction and efficiency, the AZ ARNG envisioned constructing a functional, self-sustainable office building at Papago Park Military Reservation in Phoenix, Arizona named the Eco-building. A low-tech building design and “Earthship construction” methodology was chosen to offset cost and embody pollution prevention objectives.

The mission of the project is to embrace technological advances that enable a modern office to function independently. More detailed goals of the project can be counted as follows:

- To maintain or increase mission readiness. Create a facility using innovative concepts and evolving technology, which is not only compatible with modern office practices, but generates an atmosphere conducive to creativity, motivation and productivity.
- To be economical and ecological throughout the life cycle of the facility. Erect a facility at a cost below that of conventional building practices, and constructed to simplify upkeep, requiring fewer funds than needed to maintain standard structures. Base the
facility standards upon the principles of sustainability and reuse, adapting to the natural environment, while also responding to functional demands.

- To improve the quality of life. The environment of the facility will enhance overall user satisfaction and quality of life, while also maintaining high standards for conservation and the reduction of energy consumption.
- To adapt this approach to other construction projects within the state, and champion successful sustainable building practices.

The design and the construction of the building can be described through the following 7 items:

- Building envelope
- Grey water
- Black water
- Cooling and heating
- Domestic hot water
- Lighting
- Solar and wind power

Used vehicle tires compacted with earth are the primary building components of the building walls. Approximately 4,500 used tires have gone into construction of the building’s ten-foot walls. Almost 700 tons of dirt has been compacted into the tires to make “round adobe bricks incased in rubber”. These “bricks” are inserted like any other brick in a wall system and covered with earth behind it, thus serving the dual purpose of building wall and retaining wall.
The ability to apply large quantities of earth against these “brick” walls is paramount to the building envelope as it provides a thermal mass. This thermal mass is what regulates the building’s temperatures whether it’s storing heat during the winter days or reflecting heat during the summer. The roof has one main function other than providing weather protection and that is of rainwater catch. The roof is built up type wood trusses with 12 to 1 pitch down-sloped towards the courtyard. Rainwater drains into the gutter and is carried to the cisterns.

As a result of improper or poorly designed systems, much of our fresh water is contaminated. The Army National Guard Earthship solves several problems at once by incorporating a grey water recycling system. Grey Water is a term to describe water, which has already been used typically from the sink, shower, washing machine, etc. Grey water from the bathroom sinks goes into a 2" pipe to a grease and particle filter. The water then drips into a bed of rocks and pumice and travels through and below the garden surface at the roots of the plants. Thus, the plants are watered and fed whenever the sinks are used for washing.

The sewage treatment system for the building consists of a conventional septic tank that is outfitted with solar activator or incubator to encourage decomposition of solids. Solids which are converted to liquids discharge into a lined, in-ground planter, which consists of pumice, sand, topsoil and indigenous plants, respectively from bottom to top. The logic here is that, water which is filtered in the treatment area, is also transpired and oxygenated by the indigenous plants, while the pumice creates a “bacteria housing” for micro-organisms that attack bacteria in water.

Cooling is a big problem for a building located in Arizona. A method called “Cool Tubes” is used to solve the cooling problem of this building. This method takes advantage of the phenomena of natural heat convection where warmer air rises. Two 48" diameter metal culverts
are placed in the ground and as the building air warms up, it rises and forces cool air to enter the tubes. The inlet of the cool tubes is located approximately 30 feet to the east of the building and is surrounded by shrubs and trees to pre-cool the inlet air. DC powered ceiling fans are also installed to assist in circulating the air. Due to the climatic conditions very little or no heating is required for this building.

A residential solar hot water system independent from the main solar system with a tank and solar powered pump is used to meet the requirements of hot water. Hot water usage is projected to be minimal, as it is needed only for the bathroom sinks. On the other hand fresh water is supplied by the design of the building Earthship itself. This system provides independence from the utility companies and demonstrates how Earthships can be built anywhere without an external water source. 10 or more inches of rainfall a year is enough to provide clean water for living.

The main sources of lighting in this project are the courtyard windows, skylights and solar tubes. The courtyard windows are designed to receive some direct sunlight during winter and indirect during the summer to minimize heat gain. There are 6- energy efficient, double dome, operable skylights for lighting and ventilation. The primary lighting for work areas are designed to be 13” solar tubes that are quite effective at minimizing solar gain. AC and DC electrical lighting also can be utilized when there isn’t or low natural lighting. The building obtains its electrical needs from the sun utilizing a photovoltaic system. It was estimated that a successful photovoltaic system would need to accommodate a 23 kWh load to meet the energy requirements of a very automated office of up to 14 personnel.
Figure 1 Plan of the building

Figure 2 Model of the building