What is a Biosphere?

by Day Chahrohdi

The notion of the biosphere is to make heating and growing food integral functions of a dwelling through the use of solar energy. This would be two large steps in making a swe lling a parent plastic membrane which lets sunlight in but does not let heat or infra-red radiation out. The membrane is a solar energy trap.

See Figure 1 for a possible (rather unimaginative) biosphere configuration. The membrane covers and is stapled to the plywood grid. The walls of the enclosure are covered with aluminum foil to increase the intensity of light falling on the ground.Here it is either absorbed by the plants (the increased light intensity compensates for the short winter days) or else is absorbed as heat in the ground. The heat storage capacity of the ground is greatly increased by laying clear plastic film tubes that are filled with water in between the rows of the garden (see Figure 2). The temperature inside the enclosure is maintained at about 100 degrees F by venting excess heat. Whenever heat is needed inside the living area, the door is opened and air convection removes heat from the ground level and distributes it in the living area.

According to calculations, three overcast days with an average temperature of 25 degrees F or below are needed before the temperature inside the house drops below 70% and then only at night.

The usable garden area is 400 square ft., more than adequate to produce all the fresh fruit and vegetables an average family can eat. (Fruit trees are sold which have five different kinds of fruit on them) The garden is in a tropical environment, but since the system is closed, almost no water is consumed. The garden is self-sustaining and independent of the outside environment with respect to temperature and water. All it needs is sunlight.

The membrane consists of three layers. First, an outer skin of 16 mil clear vinyl. This is the protection against the wind and rain. The angle of the membrane allows it to shed snow and dust. Then, thermal insulation is provided by a 3" thick layer of clear acrylic foam. The cell (bubble) size is ½" and the cell walls are very thin, so that at least 70% of the sunlight gets through. The thermal conductivity of the foam is less than .2 BTUs per hr. square ft. F. The third layer is a paint that is clear to visible light but white to infra-red radiation. This traps the infra-red radiation inside the biosphere.

The estimated cost of materials for the biosphere breaks down as follows. For a house with 1,000 square feet of floor space, the membrane area required in New Mexico is 700 square feet:

plywood grid	11¢
16 mil vinyl	9 sq. ft.
acrylic bubbles	5
infra-red paint	2
aluminum foil	3
fasteners	2
miscellaneous	4
TOTAL	36¢ per sq. ft., or $250.00

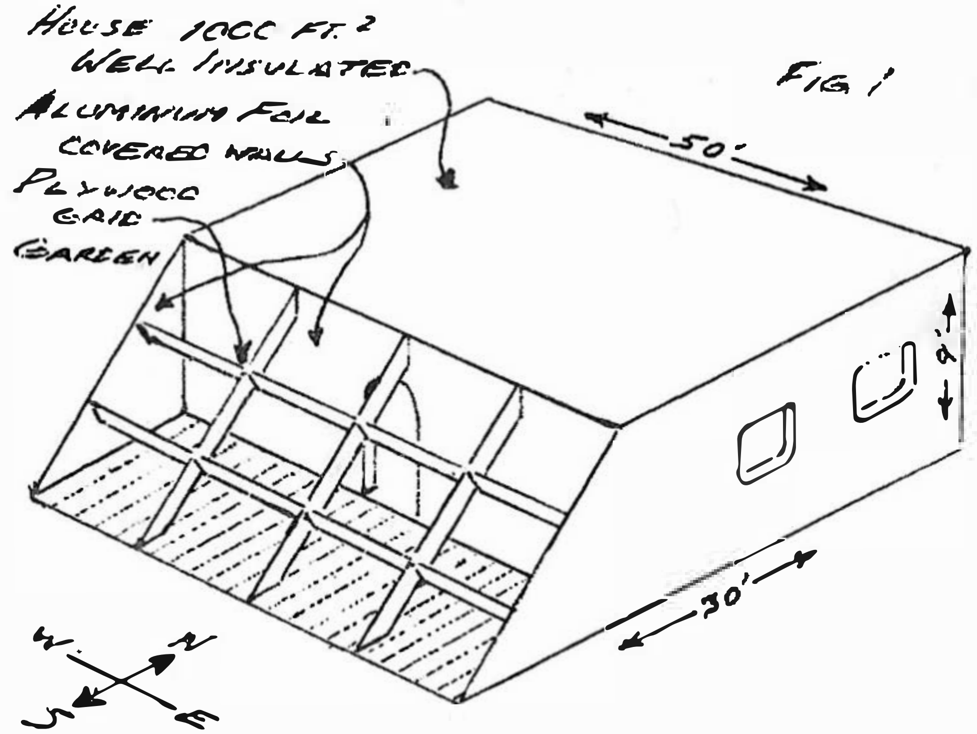


Fig 1

For a lifetime of 10 years, this is $25. per year. Except for the vinyl, the lifetime is at least 10 years. It should not be difficult to find a substitute for the vinyl, glass if nothing else.

The work to be undertaken is to make the acrylic foam and the infra-red paint. I have been in touch with people at the Rohm and Hass labs who are making acrylic foams with a much smaller cell size. I have made foams of uniform ½ inch cell size and very thin walls from gelatin, soap and water. They look just like frozen soap bubbles that don't pop when you touch them and last for months. I have reason to believe it will not be difficult to translate the foaming or bubble blowing process into acrylic, which may be processed in most of the ways plastics can be processed.

The Russians have made a tin oxide coating for glass that is transparent to visible light yet a mirror to infra red. An acrylic paint with a tin oxide pigment would probably be a cheap and satisfactory infra-red paint but this must be experimentally investigated.

A PROPOSAL

Solar energy and hydroelectric power are the only non-polluting energy sources. Hydroelectric power is near its capacity and solar energy has not been widely used because of the high capital investment of solar heating.

The biosphere is designed to provide solar heat and food for a dwelling in below freezing weather. It consumes no water, so areas that are uninhabitable because of lack of water or fuel or short growing season would be habitable. The estimated lifetime is ten years. For a 1,000 square foot house (average family size) this comes to $25. per year for heat, fresh vegetables and fruit. This cost is less than one-third the cost of the cheapest solar heaters now in operation.

The problem in building a biosphere is essentially the problem of how good a membrane can be built that is transparent to light yet is also a thermal insulation. The aircap used in the growhole which is now functioning at Lama Foundation is adequate for a solar heated greenhouse but a more efficient membrane is required for the biosphere, which must also heat a house.

I estimate it will cost $1,800. to make the first piece of this material. The expenses are as follows:

$100. per week, salary
30. per week, phone
(The making of acrylic foams is a state of the art process, which means it's in people's heads, not in print. Thus the phone bill.)

$20. per week, supplies and equipment (This figure is low because the manufacturing process is fairly simple and involves no expensive machinery - This technology will be cheaply accessible.)

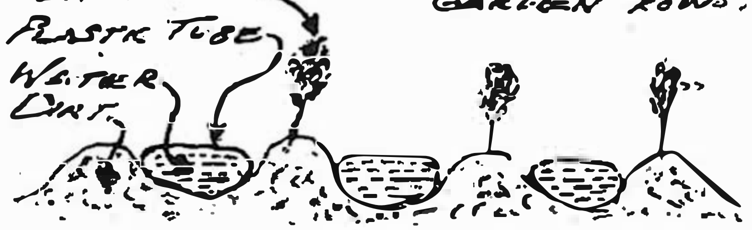
TOTAL $150. per week.

The study should take about 12 weeks (although it is hard to know exactly) for a total expense of $1,800.00. Two problems will be investigated: the blowing of acrylic bubbles and the finding of a good material to make the bubbles opaque to infra-red radiation.

I would guess the odds for success at about 3 to 1. If it is successful, it will then be possible to build a biosphere.

(The above article reprinted from The Astral Projection, issue number 13.)

Fig. 2
End view of garden rows!



Chapter Two

INTERLUDE*

*OF A NEW BOOK BEING CREATED ON THE PAGES OF THE TRIBAL MESSENGER BY STEVE BAER

BASIC TECHNOLOGY

It is difficult for us to see ourselves in relationship to the machinery, equipment, and gadgets of our technology. What would the Board of Directors of IBM think if they visited their headquarters and found their scientists and business men had abandoned work with computers and instead were engrossed in elaborate yo-yo contests? Our own absorption in our technology, abandoning interest in human and moral problems, is similar to the scientists and business men leaving their jobs to play with yo-yos — except that our games with technology are perverse and dangerous.

Then what do you do? You try to improve the situation. A problem today is that we are burning our oil and coal at a terrific rate to provide our economy with energy, the end of the supply of such fuels is in sight. Burning large quantities of oil and coal fills the air with smoke - in many parts of the country you can hardly see. What does one think when he sees energy used to light enormous and hideous advertisements, when it is used to manufacture and transport junk that people most certainly do not need, when it is used by a gigantic military organization which has already perverted the society it claims to defend? Can anyone believe that feeding this sick monster is an urgent task? If someone's body is using energy rapidly to maintain a fever the first order of business is to cure the fever, not to feed it. Our culture is bringing attention to itself crying that it is almost out of its favorite food. For its health it seems it should eat less and also change its diet. Today it is important for us to find new ways to heat and cool buildings, new ways to move about, less extravagant ways to enjoy ourselves. The answers to energy problems are different for different parts of the country. Some places have abundant sunshine, some wind or geothermal energy or hydraulic power. Other parts of the world are barren of energy sources and must import coal, oil, gas or electricity. One of the most dangerous traits of our government, our engineers and businessmen is the compulsion for single nation or world-wide solutions. Thus a heating system is uninteresting to them if it would have application only in the Southwest. They feel compelled to think big, and working on products for specific local problems is a humiliation. How absurd this is, such thinking would lead a man to refuse to buy shoes since they don't fit on his head or his hands.

The response of our government to the energy crisis has been to pour hundreds of millions of dollars each year into atomic energy research and almost nothing into wind, solar or geothermal energy research. Atomic energy would be the answer if the sun were going to black out, but no one is predicting this. The people doing the work with atomic energy admit that it is dangerous and produces radioactive wastes that must be carefully guarded for hundreds of years. Who will benefit from this competition with the sun?

SCIENCE AND TECHNOLOGY

Our large corporations and the war department grasp science like a bandit with a hostage, "If you are going to attack us, you are also going to harm our innocent friend, science." Many scientists have been only too ready to relax in the grasp of their captor - confident that no one would risk injuring them. This is very clearly no longer certain. Perhaps it is time to begin throwing rocks at the pair.

If there has been a perversion of the direction taken by invention and technical development, that it has grown preponderantly in ways that we now are beginning to judge dangerous, then we may take comfort in this --technology branches again and again. It has been trained to grow in a most peculiar course, but is ready to sprout and branch at numberless past forgotten junctions.

As an example I would mention the Yis-sol pump. Levi Yessir demonstrated a very simple elegant solar powered pump at the 1968 Solar Energy Convention that did not greatly differ from Savery steam engines used to pump out the mines in England in 1700. Its promise lies in the huge range of inexpensive liquids with different thermodynamic properties available today that were not available to James Watt and Thomas Savery. When someone such as Levi Yessir or Harold Hay returns to first principles in their work with solar energy they are undercutting more elaborate work done by others. In a field that is young and does not yet have wide and vigorous application the really valuable inventions and techniques may be hidden for years by a dynasty of petty paper writers and paper investigators.

ICE

One business that needlessly consumes millions of dollars of electrical energy is the production of ice. It used to be common practice to harvest ice from ponds and rivers, but with the advent of refrigeration machinery this fell out of fashion. We should get back into the business, this time exploiting modern insulation and modern methods of moving materials.

In almost the entire country ice is made with mechanical refrigerators powered by electricity. Here in Albuquerque ice sells for $ .03 a pound in blocks, and $ .07 a pound crushed. Firewood, hauled from miles away and cut into stove-size pieces sells for $ .015 a pound, adobe bricks, cured and stacked, sell for $ .005 a pound. It is strange that ice is so expensive. Here in Albuquerque at least six feet of ice can be harvested from shallow ponds or water filled trays during a year. This is over 300 pounds per square foot of pond. If the value of ice were $ .01 per pound, each square foot would yield a harvest of $3.00 per square foot or $125,000 an acre. The production of ice with electrically powered refrigerators requires approximately $ .15 per 100 pounds of ice so an acre of ice ponds would save approximately $19,000 in electricity each year.

What work must one do to make the ice? One way would be to have plastic trays filled with a hose during the afternoon and to lift off the ice in the morning. During very cold weather two layers could be harvested each day. Some people would object at first to shards of ice from the top of a pond, "Why this looks like it was pulled off the top of a puddle," but eventually users of such ice, if the layers were still recognizable, would realize that the texture of a bag of ice chunks spoke of the severity of the previous winter and it would be as interesting as a bag of oranges. The storage of such an ice harvest is the most difficult part. If the ice were stored in a huge insulated pit, the mass of ice might lose a rind two feet thick during a year as heat travelled through the walls and melted it. An efficient ice ranch would require considerable capital to make the insulated storage, and also an efficient way to handle the daily harvesting of the ice. Think of the difference in the lives of the crews who worked at an ice ranch with its own peculiar reversed harvesting weather, versus a crew who work in the exact same circumstances year in, year out, handling a refrigeration machine.

There is a texture to reality, good and bad, a mixture of fortune and misfortune. If this texture is presented to people always

← local Refrigerator?

through other people, machinery or prices, then eventually we become bitter about our own species. If it appears as an unavoidable part of reality, a result of the weather, we do not have others to blame.

Such enterprises as an ice ranch, specifically if the activities were visible to passers-by, are interesting. Cold weather is then useful to someone in a productive way.

SOLAR HEATING

I would count Harold Hay's experiment with a styrofoam ice chest as among the most most exciting and illuminating ever done. In Phoenix, Hay filled one of the insulated chests one sees in super markets with water. During the summer he put the lid on during the day and took it off during the night - the water stayed cool for it was protected from the sun during the day, and at night radiated heat to the night sky. During the cool months of the winter, Hay reversed it - he opened the lid during the day and closed it during the night. The water stayed warm. Hay later built a small house in Phoenix with a pond of water on the roof, and an insulating cover which could be moved on or off the pond by means of a rope. The house stayed comfortable all year. This is so simple a child can understand everything about it. Hay reported on his work at the 1968 Solar Energy Convention. I was surprised it caused so little excitement. Hay was asked how people would know when to cover and uncover the pond on the roof during different times of the year. His answer was that people learn when to put on and take off their coats.

This method of heating and cooling is not suitable for all climates, but Hay's approach can inspire simple solutions to heating and cooling in most climates.

At Zomeworks we have developed a very simple engine that opens and closes insulated shutters in response to the warmth of the sun. This allows one to flood rooms with winter sunshine during the day while protecting them from heat losses through uncovered windows or skylights at night. If the rooms in which such skylights shine contain materials of great heat capacity such as adobe walls, the heat gained during the day lasts into the night. The judgement of the engine, guardian and collector of warmth, is interesting to watch as it opens and closes the lid at different times in response to different weather.

Peter van Dresser, a pioneer in solar heating, has stressed that "sun tempered" rather than solar heated is a more sensible goal in the design of a house. Solar heating versus gas, oil, coal or electricity leads people to expect the same kind of performance from the sun as from a tank of oil or bin of coal. The sun is an unsatisfactory commodity seen along side tanks of butane or oil, or bins of coal. We know that clouds interrupt the sun. During bad weather the sun tempered house grows cool unless other sources of heat such as wood stoves are used. How warm do we need to keep our houses? Sometimes we see ourselves as a brood of prize pigs that we want to feed faster and faster and keep more and more comfortable.

The storage of solar heat is a difficult problem. A 55 gallon drum filled with water can comfortably store about three kilowatt hours of heat or 10,000 BTUs. There are materials which promise to provide much greater thermal storage for an equal volume by using the heat of fusion which is given off as a liquid freezes.

* EXPLANATION

*INTERLUDE: We're human - so is Steve. We changed the week we publish, and that interfered with Steve's writing schedule. Last week we ran Chapter Two actually, and next issue we will publish Chapter Three. What else could we call this issue's contribution?

— L.K.

- Experiment for Upland school