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Dome Sweet Home

Joys & Challenges of

DOME SWEET HOME

Building & Living in the Round

Carmella Gonnella • Michele Ostrowski • Jean Hirst

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Our homes are mirrors of ourselves. They reflect our interests, our beliefs, our hesitations, our spirit and our passion. They tell a story about how we feel about ourselves and the world around us. A home is more than a place to lay your head and seek comfort from the elements. It is a place where you can interface with the universe. It is a crossing point in time and space that can attract energy or repel energy.

Your home can be a place of renewal and hope.

—Denise Linn
Author of *Sacred Ground*

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Acknowledgments

During the process of building, so many were there for us whose honesty and integrity we will never forget. We have elected, however, to identify only by group membership, with two exceptions. The rest know who they are.

We thank you,

David South, President of Monolithic Dome Institute, for pursuing your vision that made it possible for us to dream a dome home.

Our local work crews and out-of-state crews who labored long days to make our dream homes a reality;

The greater local community, including the merchants, who shared their knowledge and network of available workers;

Our neighbors who related their experiences, or reviewed parts of the manuscript, giving us the benefit of their thoughts and suggestions while this book was in the making; and

Family and friends for their patience, encouragement and support.

Last but not least,

Our gratitude to Spider Publishing and Graphics. Their suggestions on design and layout were invaluable and their preparation of the book and cover for printing—a work of art and a pleasure to experience.

Foreword

It is a pleasure to be invited to write a foreword for this book. It tells a story that is dear to my heart and as I would like to have it told. I am impressed and happy to see homebuilders taking the leap of faith into building dome homes. I am even happier to see some of them turning their experiences into a book. The authors have met and conquered many challenges in acquiring their Monolithic Dome homes. This book would be best characterized as "tell it as it is."

The use of Monolithic Domes as dwellings for people may yet be the greatest use for them. But it certainly was not the way they started. Our first Monolithic Domes were built for storing potatoes, fertilizer, cement, salt and sand. Along the way, a few were built as "houses." My mother's home in Idaho was the first.

My dream was to see domes built everywhere for all kinds of uses. So in 1994 we started to teach and train other people how to build the Monolithic Dome. That dream is coming true as many, many Monolithic Domes are serving now as schools, churches, municipal buildings, animal shelters and dozens of industrial uses. Even so, clearly, everyone needs a home, so the biggest market of all, the greatest use of all, remains the dome home.

It has been wonderful, these years since we offered our first Dome-Building workshop, to see hundreds of willing and able folks learning how to build domes; then, going back to their communities and building them and, even setting themselves up in business to build them for others! Several hundred "students" have taken our workshops; and the enrollments just keep growing. We may yet see the day when the Monolithic Dome home is no longer a strange beast in the realty listings; and anyone who wants one will be able to find a builder in their neck of the woods.

I have been in the Monolithic Dome building business for over 30 years. To me it is all old hat. But I know that the very idea of a Monolithic Dome is not only new but revolutionary to the vast majority of Americans. This book will hopefully make building a

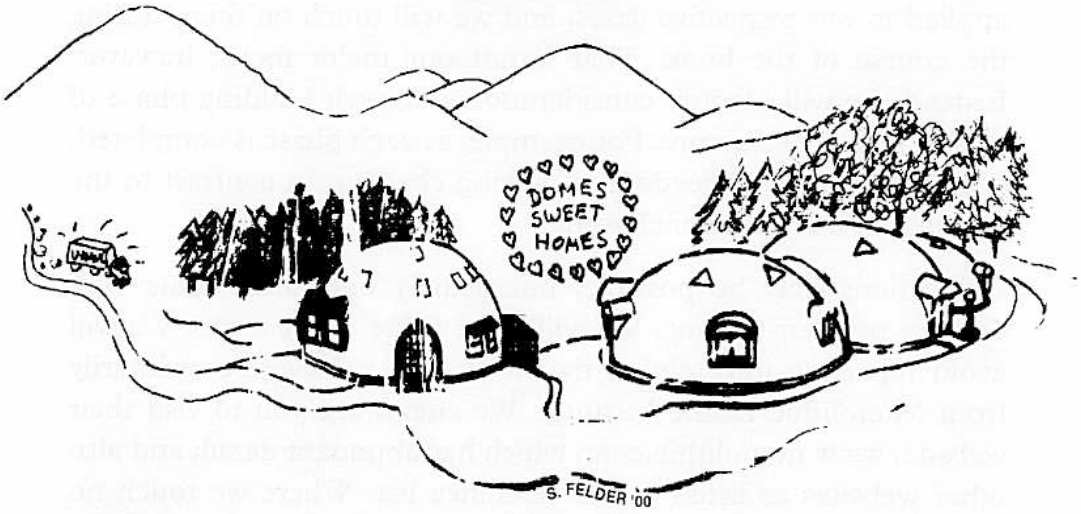
dome a little less daunting or strange to those who read it. The collective experience of the authors is immensely invaluable. They are to be commended for thinking of putting some of that experience in writing and shaping a book that would make it easier for others to build domes for themselves.

No other type of home can stand up to the weather and the elements like a Monolithic Dome. So much peace of mind comes with that degree of structural stability, it is only a matter of time before thousands more step forward and make the investment in the best home money can build.

I wish this book every success. I thank the authors again for writing it; for the insights they present; and for the help it provides for others.

—David B. South
President, Monolithic Dome Institute
Italy, Texas

Preface



Welcome to our dome homes and thoughts about building and living in the round. Two of us, Jean and I (Carmella), each lives in a Monolithic Dome home built in a community of such homes in Northeast Georgia. Jean built hers in 1995 and was most helpful to me. My home was basically completed in late '97. Jean and I speak from personal experience and our research of the experiences of other dome dwellers.

Our domes are quite different. We enjoy living in our domes, despite the challenges in the building process. Michele, not a dome owner, has her own home improvement business in Florida. She provides an additional perspective from having stepped into the middle of the building process for one of the domes, as general contractor.

We would like to think that we would have had fewer problems if a book such as this one had been available at the time. In our research of the literature, we could not find the specifics that we learned from the building process itself and from each other.

We had both common and differing problems. We were told that our problems were not unique. Every homebuilder experiences them, regardless of shape, materials or structure. Amazing! We found little comfort in those ubiquitous thoughts however, given current technology and know-how. To some extent the statement may be true as it applies to the dome home. Many builders and their various crews are less familiar with dome homes.

As Michele, not a dome owner states, "If it isn't square and made out of wood, some builders don't know how to work through the uniqueness of the dome structure."

Nevertheless, some common principles of good building were not applied in our respective cases, and we will touch on them during the course of the book. That is not our major focus, however. Instead, we will identify considerations for each building phase of the basic dome structure. For example, as each phase is completed, you lose degrees of freedom in making changes, in contrast to the building of a conventional home.

Corrections may be possible, but usually only after some very creative problem solving. We will share some of these too. We will avoid repeating information that is available elsewhere, primarily from Monolithic Dome Institute. We encourage you to visit their website, www.monolithic.com, which has abundant detail; and also other websites as listed in our reference list. Where we touch on information appearing elsewhere, we do so from a different perspective that has relevance to the major theme of this book.

Interest in the dome type of structure for residences appears to be increasing. Jean and I have had a number of inquiries and requests to visit our homes. We found confirmation of this expanding interest in the comments by David South, President of Monolithic Dome Institute, on the need for more dome home builders. This attraction to dome homes pleases us. We obviously like the dome type of dwelling and believe it to be one of the solutions to the environmental and ecologic problems facing this planet.

Our major objective is to provide you, the potential dome homeowner, with information to make the experience more fun than otherwise. That means helping you to avoid most, if not all, of the "horror" stories that home owners and builders usually relate. We intend this book to be a one-stop introduction to essential considerations to arm you *before,* not *after* the fact, with information and suggestions.

Our reference list is included, should you wish to explore topics in greater depth. On some topics, we highly recommend that you do so. The text is also well illustrated to help clarify our point or to expand on it. We like pictures. Often they make a point more forcefully than words. And, we hope you will laugh along with us as we illustrate some of our experiences that at first were not so funny.

Would Jean and I build another one? Yes, definitely; and of course, heeding our own caveats.

1 Back to the Future

Ignore history and risk repeating the mistakes of the past.

—Anonymous

Why back to the future, then? Knowledge of history also has a positive side, revealing remarkable elements that remain true and viable for today's world. Modern technology expands in ingenious and imaginative ways these wonderful elements. Foremost, we are motivated to show that the interconnectedness of nature and human experience applies also to dome homes; hopefully, it will generate an appreciation of consistency and continuity over time.

Bear with us. Our dip into history is very brief. Should you choose to build a dome home, know that you are consistent with the flow of nature and in good company.

Living in a dome structure is not a new idea. Is it really a stretch of the imagination to say that the first dwelling, a cave, was a dome? Well, we are sure that Cave Man and Woman were more interested in seeking shelter from the elements and thus shape was not an issue; but who has ever seen a square cave? Interestingly, universal shapes include circles, spheres, and other geometric forms, but not the square.

Did you know that the square is not a natural phenomenon? Connecting two equilateral triangles by the hypotenuse creates a square. Humankind has given these natural shapes symbolic meaning. For example, the circle symbolizes "wholeness." Some dome dwellers say that they feel this sense of wholeness from living in the round; a feeling of openness/expansiveness, a feeling that living in the square simply cannot simulate. How nice to wake up to it in the morning and experience it through the day.

What is touted, as a relatively "new" concept in building is really an ancient one. The dome shape goes far back in recorded history in a variety of ancient forms, across many cultures; for example, African, Mongolian, North American Indian, Eskimos. The construction materials depended on what was available locally. The origins of circular structures, however, are lost in antiquity. According to archeological evidence, the earliest structures in North America on the shores of the Great Lakes, about 10,000 years ago, were circular.

Typically in a dome like structure, the base is round with "walls" going up in a spiral and leaning toward the center; as for example, the tipi of the American Indian. In the tipi, the supporting poles are placed so that they are interdependent; hence, structurally sound (Fig. 1).

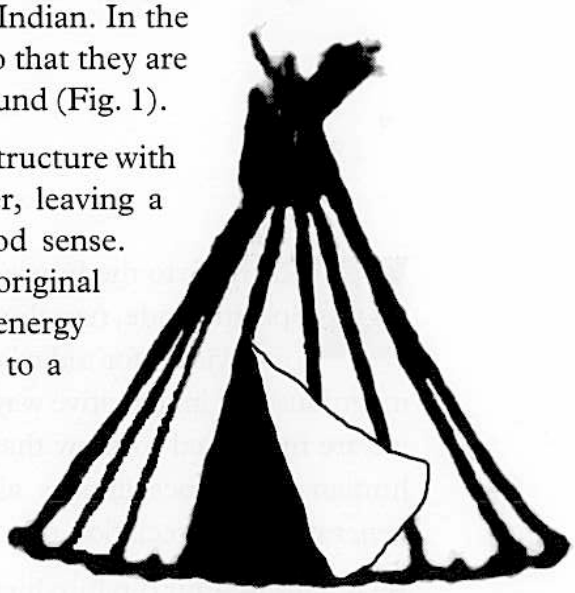


Figure 1 ***Tipi***

When you think about it, the circular structure with its walls leaning in toward the center, leaving a small opening at the top, makes good sense. Recall that an open fire was the original source of heating and cooking. All energy flows in a pattern spiraling infinitely to a center point.

A structure that allows this flow of energy in a balanced fashion is easier to heat. The door was small. The fire was built within a circle of stones in the center of the tipi, an arrangement that allows smoke to exit from the center hole. The Indian sweat lodge was fashioned in a similar manner. In some Indian lodges, the circular base was sometimes stretched into an elliptical shape.

Here in North Georgia, the Cherokees followed the mound builders and built their tipis on a raised platform (Fig. 2). The tipi itself is built on a "stem" reminiscent of the yurt structure (p. 3) and those Monolithic Domes' which are built on a stem.

The igloo of the Eskimos followed the same concept of building in the round. The uniqueness of the igloo is its building materials, ice blocks. The actual shape of the igloo resembles closely the current Monolithic Dome. Unlike the Amerindian style, the top of the igloo had no opening. The igloo was only a temporary "home," used when hunting. They carried their cooked food with them.

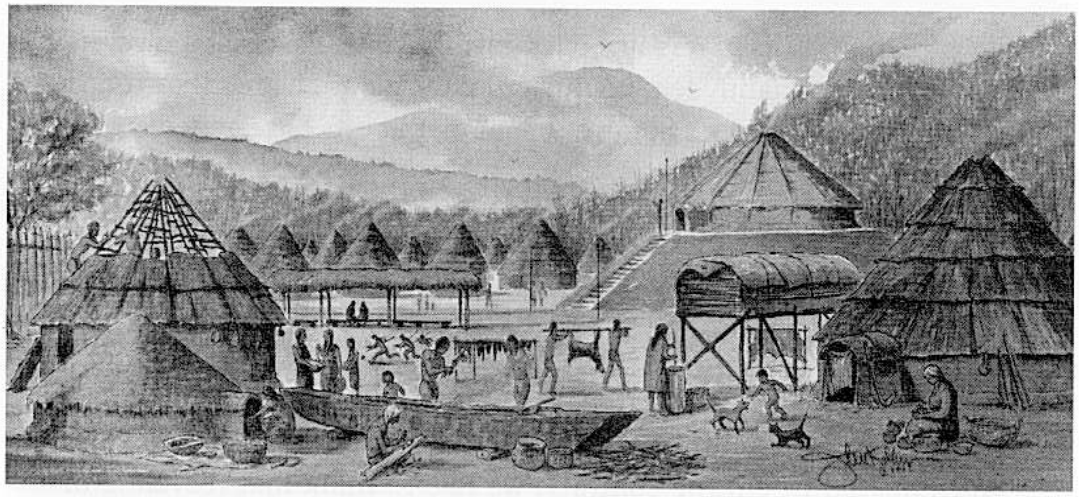


Figure 2 ***Nacoochee – Cherokee Days.***

Reprinted with permission from the lovely book of John Kollock, **Watercolor Memories of the Hills,** *p. 55.*

An example of a different version of the dome shape but still a dome in concept is the yurt or ger, built by the Mongols in northern China. *Yurt* is the Western label for the *ger*, the name preferred by the Mongols. These *domo*-ciles (sorry, we could not resist) are built in two stages.

Originally, a circular base was constructed with a series of poles placed about six feet apart with skins stretched around the poles to complete the exterior walls. The poles stand upright, at the base, in contrast to the Indian tipi. A top that leaned inward then capped the base (Fig. 3).

As in the tipi, a hole at the center top allowed for smoke to exit and permitted airflow. In the modern yurt still built by the Mongols, the

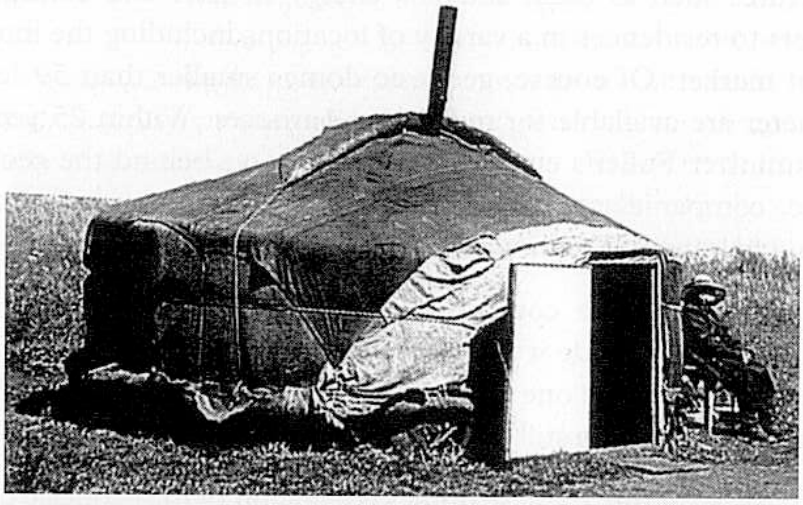


Figure 3 ***The yurt (ger) as built by the Mongols.***

Reprinted with the permission of Jane Schnell, author of **Encourage,** *p. 83.*

construction concept remains the same; the outer covering, however, is now predominantly felt, manufactured locally. The felt they use is really more like canvas. Some of the modern yurts have added a vent pipe as shown in Figure 3; others still have just an opening at the center top of the Yurt. To read a more detailed description of the ger as built today by the Mongols see the listing of websites references (p. 143). A modern day Western counterpart is the Deltec home described on page 13.

As you may have inferred from the above, building a dome home is not tagging oneself as a "new-ager," whatever that means. The Ancients did it. On the contrary, we like to think that recycling of building concepts keeps us more in harmony with nature. Only the methods, materials and complexity of structures now possible have changed. Why has the dome type of structure for homes been rediscovered?

A singular stimulus to the re-emergence of the dome shape for homes is the geodesic dome conceived by Buckminster Fuller (mathematician, philosopher, cartographer, choreographer, poet and tireless lecturer). The geodesic dome evolved from Fuller's fascination with the natural patterns of the universe and his preoccupation with technical fittings and dwelling areas that went far beyond established thinking and practice. The sizes of the geodesic dome, since its first appearance in 1952, have ranged from 59 feet in diameter (Woods Hole, Massachusetts) to 394 feet in diameter (Union Tank Co, Baton Rouge, LA-1969).

The uses of the geodesic dome have expanded from commercial structures such as radar shelters, energy shelters and community centers to residences in a variety of locations including the international market. Of course, geodesic domes smaller than 59 feet in diameter are available for residential purposes. Within 25 years of Buckminster Fuller's enunciation of the ideas behind the geodesic dome, companies specializing in the building of geodesic domes, yurts and concrete domes appeared.

The geodesic dome coupled with the technology and materials available always made it an affordable and attractive alternative for homes. We know of one effort in the early 1970s, "The Domes at Baggins End," which still stands today and is still very much in use.

The basic structure of these domes is a takeoff of the geodesic dome, with wood framing and white fiberglass shells. They were built as a student project at UC Davis, with the guidance of Ecosystems and

the professional assistance of the Central Coating Company. The students, then and now, refer to themselves as the "Domies."

The benefits of building and living in the round were particularly appealing to the growing group of conservationists in the 1960s and certainly today as well. Their concerns, and ours, with more efficient use of material resources, durability of structures and subsequent benefits have only increased in importance as we move into the new millennium.

I am acutely aware and appreciative of one of the benefits of the dome structure right now as I sit here typing. A tornado warning has just been issued. We have been besieged with tornadoes this spring. What a comfort it is to know that my dome is tornado proof.

Van Loon, in his book on geodesic domes, reminds us that, "Mathematically speaking, a sphere is the shape which encloses a given volume of space with the least possible use of materials." The yurt and the Monolithic Dome share this basic characteristic.

All dome-type structures (depending on their building materials) share other common features; for example, resistance to hurricanes and tornadoes, and flexibility in designing the interior because weight-bearing walls are not necessary. In comparing the different types of domes, however, be aware that some of the benefits, such as being hurricane proof, can be considered options beyond the advantage derived from the dome shape itself.

In the Monolithic Dome some of the options offered in the other dome types are inherent in the materials and the process used in its construction. We shall comment briefly on the geodesic dome and the yurt, in particular the Deltec—a modern day version of a yurt, to inform you of alternatives available to those wishing to live in the round and to provide some basis for comparison. Our major focus, however, is the Monolithic Dome that we chose because of its integral structure and other characteristics.

The Monolithic Dome (the process behind its construction) is the brainchild of David South, President of Monolithic Dome Institute (MDI). David, initially inspired by Buckminster Fuller to build a geodesic dome, became committed to taking the idea a step further i.e., "to developing a technique that would combine economy, permanency and efficiency," and to build larger domes.

South's goal was to build large, free-span concrete dome structures. After considerable experimentation with materials and methods, he

Figure 4 ***Even in Russia. Built by its owners after participating in a course at the Monolithic Dome Institute.***
Reprinted with the permission of MDI.

and his brothers discovered the technique to achieve that goal in 1975, nearly 20 years after being introduced to the geodesic dome.

The South brothers call the technique, "building from the inside out." From their first domes built for storage of potatoes, uses of the Monolithic Dome have expanded to include churches, schools, and homes adaptable to all climates and regions. There is even one in Russia, built by the owner who attended the building course given by MDI. Does it surprise you that it looks like this? (Fig. 4)

What of the immediate future for building and living in the round? In our view, the modern history of dome homes and dome communities is just beginning. When we explore the advantages in Chapter 2, the dome as a home is a natural answer to society's concern for the environment: physical, social and ecologic. It is also the natural answer for disaster resistant and self-sustaining dome communities for both living and working.

> The technology is such that architects and dome-owners-to-be can let their imagination run free in designing both the exterior

and interior of domes, from the simple and low cost dome to the simply elegant (Fig. 5).

The simple and the elegant domes share the same basic characteristic of a safe, environmentally friendly and naturally shaped home. Is it so far fetched to envision domes such as the fantasy dome, which appeared on the cover page of the Monolithic *Roundup*? (Fig. 6)

Looks like science fiction, doesn't it? Actually, it can be a reality today. The dome in Figure 6 is a rendering for a visitor center done by MDI in a feasibility study.

Given the history of dome shaped buildings, we feel like we have stepped back into the future with our homes. We hope you will join us.

Figure 5 ***Simply elegant—the "Eye of the Storm."***
Reprinted with the permission of MDI.

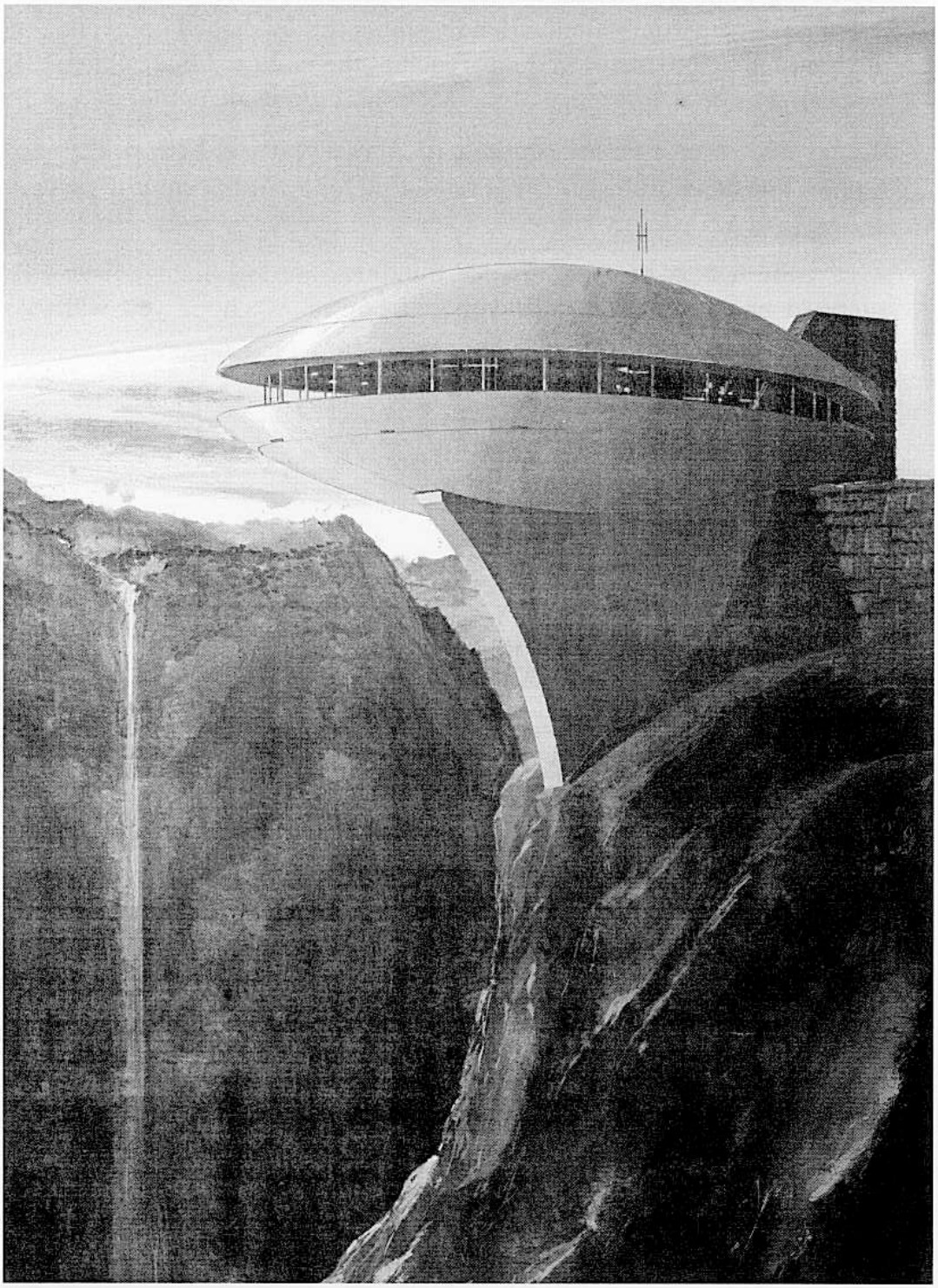


Figure 6 ***The dome of the future, possible today.***

Reprinted with the permission of MDI.

2 Dome Home Types

Domes are just too good of a thing not to gain in popularity. They can withstand just about any force, and they are economical to build and maintain. What more can you ask?

—Dr. Arnold Wilson
Ret. Prof. of Civil Engineering
Brigham Young University

Modern day "round" structures are basically three types: the Geodesic Dome, the Yurt and the Monolithic Dome-style. They are not unique to the United States. All three can be found in other countries as well. Of the three, the geodesic dome and the yurt are less expensive to build than the Monolithic Dome. For those who would like to build their own home, the geodesic and the yurt are also easier to construct. One geodesic dome company even advertises that all one needs are: "socket wrenches, hammers, ladders, scaffolding (desirable) and nail gun (desirable)." Helping hands of friends would no doubt be welcomed.

The Geodesic

The Geodesic Dome has enormous appeal because of the benefits associated with the spherical or dome shape, conservative use of natural resources to build and its availability in a variety of prepackaged kits. The weight of the structure is evenly distributed, eliminating the need for internal support. The Geodesic, while it looks like a dome, is really a composite of planes and straight lines that gives the appearance of a sphere. The basic structure of the geodesic dome is a symmetrical network of struts, forming triangles approximated as closely as possible to a sphere, giving the geodesic its integral strength (Figs. 7a, b).

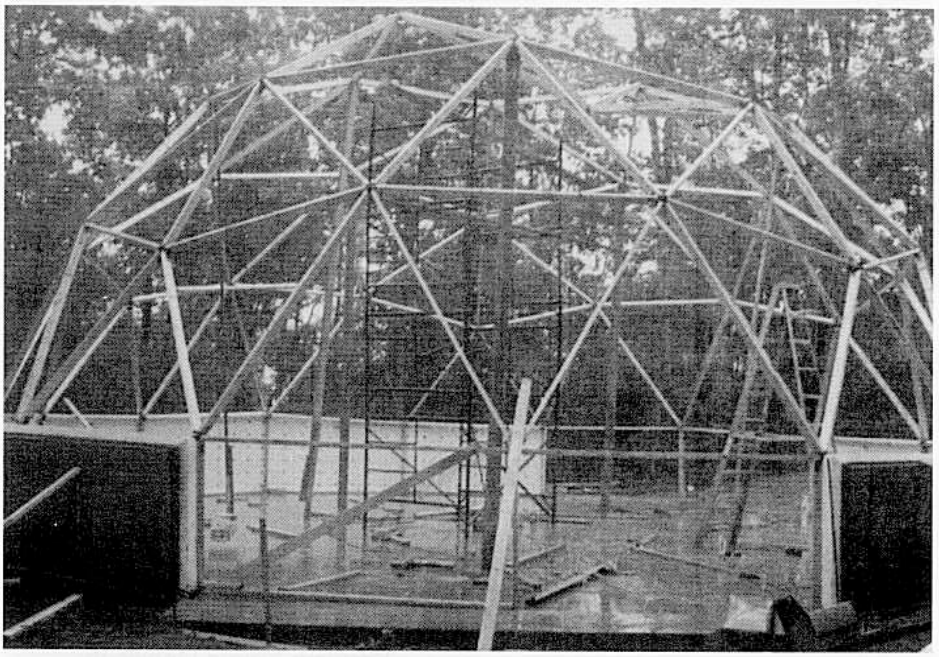


Figure 7a ***A Geodesic Dome home in process.***

Figure 7b ***The Geodesic Dome completed.***

Reprinted with the permission of Mark Woodhouse, PhD.

The combination of the spherical shape and triangular struts makes the geodesic highly resistant to winds, heavy snow loads and earthquakes. It uses about one third less lumber than a conventional home of the same size. It is more energy efficient since less exterior surface (30 to 50 percent) is exposed to the weather.

The foundation can be a concrete slab or a wood sub floor. It can also be erected over a crawl space or a basement. Dome kits fabricated by the geodesic companies usually include all framing for the roof and panels. The dome may be built entirely by the owner/builder or the company will contract to provide onsite supervision and other services as required.

A kit can go up in six to eight hours (i.e., the shell of your home). That aspect is certainly a plus in time saved, costs of labor and interest rates if one has a construction loan. The kits are delivered by truck. Delivery time will vary depending upon the location of the company and your home site. From the west to the east coast of the United States, delivery time is about a week.

The materials used in the construction process of our neighbor's geodesic home are more like that used in the construction of the Monolithic Dome. Before the 1990s, geodesic domes were constructed primarily of wood. The triangular panels with its many angles and seams created leakage problems. One company that we know of changed the construction of its triangular panels to prevent that problem. The triangular panels now have two inches of concrete on the exterior. The interior of the panel is seven inches of Styrofoam.

The building process has been simplified so that panels are placed in a row, overlapping the steel mesh from adjacent panels and the seams are filled with concrete. The exterior of our neighbor's dome is essentially a concrete shell, a much stronger and energy efficient structure than the typical geodesic dome.

The total cost of building this dome in the mid '90s from the slab foundation to the finishing of the interior was $85,000.00 (excluding the cost of the land). This type of dome takes more than "socket wrenches, ladders, scaffolding and a nail gun." As our neighbor commented, a crane would have been most helpful in lifting the concrete panels into place.

The Yurt

The wide availability from several sources of the modern day yurt (outside of Mongolia) surprised us. The Deltec (a brand name) is the version common in our part of the country. Yurt companies including the Deltec have existed since the 1970s. Except for the Deltec, they are located primarily on the West Coast of the U.S.

The yurt, like the geodesic dome, is used for a variety of purposes: ski cabins, vacation homes, small and commercial structures and, of course, residential homes. The yurt is also an attractive, affordable alternative for a home. As described by Nesting Bird Yurt Company in Washington State, the yurt is an "elegant blend of tension and compression members." This characteristic made it a "remarkably strong and stable yet light and portable structure" for the Mongols.

The strength and durability of the original yurt structure remain an integral part of yurt technology today. The basic physics of the yurt are the same across companies with some differences in the technology used to achieve the structural tension and compression characteristic of the yurt. As shown in the figure below, "weight on [the] roof pushes down and out on the rafters" (Fig. 8a); and "the low profile and circular shape allows winds to slip by easily" (Fig. 8b).

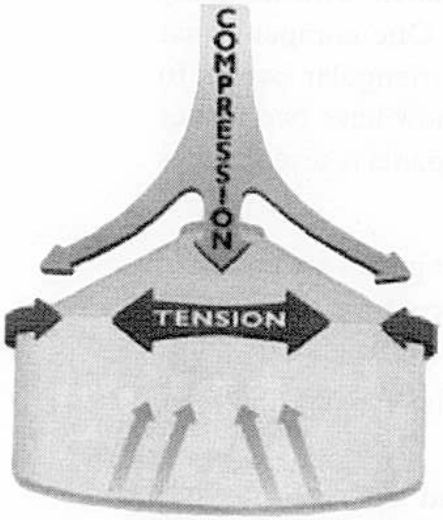


Figure 8a

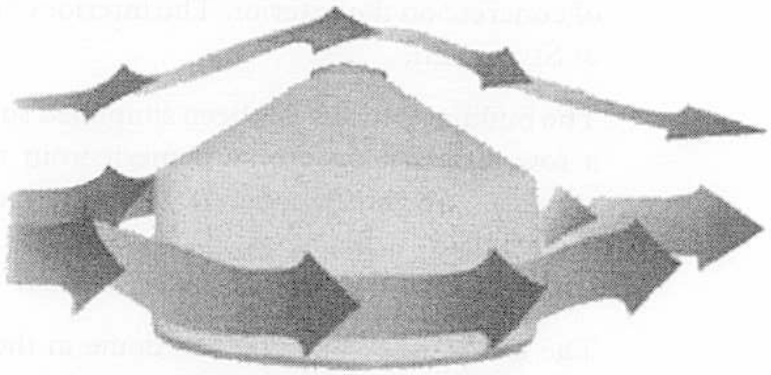


Figure 8b

Reprinted with the permission of Nesting Bird Yurt Co.

Companies specializing in constructing yurts and providing kits for those who wish to build their own offer a number of options to customize the structure to your locale and desires.

We describe the details of the Deltec home (Fig. 9) since we know it best from first hand experience. We hasten to add that in our review of yurts, we found that all the companies stress the quality of their materials, provide quite detailed information on their services and offer a variety of options.

Figure 9 ***A Deltec single story version of the yurt.***
Reprinted with the permission of Deltec Homes Co.

The Deltec (a yurt), like the Geodesic Dome, offers greater cooling/heating efficiency (about twice as efficient), longer and greater durability, and is more economic to build than a conventional home. One estimate is one third less than the cost of a conventional home of comparable size ($15.00–$30.00 psf). This figure applies to the shell only. The cost of the interior will depend entirely on your design layout and your choices in appliances.

The Deltec may be more adaptable to odd or different building sites than the Geodesic and the Monolithic Dome. It can be built on any foundation: a full basement, crawl space, pilings or slab. In addition to a single story home, other choices are possible; e.g., two stories, two connected laterally and a Deltec with one or more wings attached.

The shell, hand made by skilled craftsman, is delivered pre- packaged to the building site. It includes: the insulated sidewall panels, roof system, floor system (if needed) trim and hardware packages. The shell can be erected in less than a week from the time that it is delivered, given that the site is already prepared—a characteristic savings in construction time it shares with the geodesic dome.

Beyond the pre-packaging of the core components of the Deltec home, a number of options are available. Among them: installed windows, siding upgrades, decks, hurricane packages and snow load reinforcements.

One may add hurricane strapping, which allows the Deltec home to withstand sustained winds of 120 mph. In South Carolina, for example, the Deltec Homes Co. has not lost a single home in any of the hurricanes of the last 30 years. If you are not in a hurricane prone area, you still have the comfort of knowing that the Deltec home (and yurts in general) is protected by the structure of the exterior walls. No exterior wall is wider than eight feet. This arrangement simply routs high winds around the home. Deltec engineers and other yurt companies will individualize your home to other needs or features not offered in their current options.

The Monolithic Dome

The Monolithic Dome presents quite a different appearance from the geodesic and the yurt. They are truly dome shaped. The materials used to construct the shell of the dome also differ. They are more expensive than materials usually used for conventional homes, as well as the geodesic and the yurt. The shell of the dome is steel reinforced concrete and the insulation is polyurethane. Polyurethane costs considerably more than standard insulation.

You may recall that dome shaped buildings cover the greatest area with less material than conventional structures, offsetting some of the higher costs for materials. In addition, the efficient method of building the shell helps to lower building costs. The construction of the Monolithic Dome is described in greater detail in the next chapter.

MDI's standard formula for estimating building costs (in the mid 1990s) is $60.00 psf, excluding furniture and land. Add extra funds for site preparation, septic tank and well if you are building in a rural area. Regional building costs may be lower or higher than the $60.00 psf MDI estimates. For a dome shell with roughed-in openings MDI estimates $30.00 psf.

Should you choose to build your own dome, the estimated cost for materials is $15.00 psf. (These figures, from 1999, do not include related expenses: the training workshop and the rental or purchase of equipment for constructing the dome shell.)

The Airform, which shapes the dome, is made by MDI according to your specifications. The Airform remains on the dome after the dome shell has been completed; it is then referred to as the skin of the dome, as we will do here. Like other dome companies, MDI provides other services such as training workshops, referrals of

trained builders of the Monolithic Dome, videotapes on the construction process and evaluations of your plans.

They do not provide onsite supervision, as do companies specializing in the construction of geodesics and yurts. Allow six to eight weeks for the fabrication and delivery of the Airform; two to four weeks for building the dome shell; and three to six months to finish the interior. This time line does not include the "up front" preparations; e.g., site preparation (grading), pouring of the slab, installing primary plumbing and other preliminaries before the Airform is attached and inflated.

In our experience and feedback from others, the building was more costly than expected. One reason is the difference in regional costs. Consider, however that all three types of domes are not your typical looking home. Their appearance can lead to irrelevant perceptions, such as the amount of one's personal income and type of person; hence, the importance of the contract with the builder (discussed later).

The cost of building the Monolithic Dome should be no higher per linear foot than the regional cost, or the formula used by MDI. We still believe that the dome home should be no more expensive than regional costs and, under the right conditions, less expensive. This expectation is not always the case.

Monolithic Dome Characteristics

The dome is essentially a seamless, self-supporting structure. To David South's definition of the monolith as a solid rock we would add unity of structure, which it is indeed as you will read later on the stages of building a Monolithic Dome. It is engineered to take a wind force of 1400 psf. To put this inherent feature in perspective, a 300 mph wind will bring about a 400 psf to bear on a resisting surface, such as the wall of a frame house. That pressure is enough to flatten a trailer or other weak structure, to take the roof off an ordinary house, and to blow down vulnerable trees.

The shape of the dome is part of its strength, under high wind conditions. Its roundness deflects wind coming from any angle, reducing the force the wind can bring to bear on the surface. The fact that the dome is made of reinforced concrete adds further strength to the inherently strong design.

Because of its shape, natural design and the materials used, a number of characteristics, listed below, are attributed to the Monolithic Dome

type of construction. You can assume that no comment means that we agree; and, that we have no current reservations or additional comments.

Weight bearing walls are not required, giving one free rein in designing the interior.

That is true, if the dome is a one-story dome as is mine. It is not true of a multi-level dome home, as is Jean's. In a multi-level dome, standard frame construction and weight bearing walls will have to be part of the interior design. You can indulge in unusual architecture using suspension from the ceilings which the dome structure can take. That was done in the "Eye of the Storm," a dome home in South Carolina, without any additional reinforcements. See Figure 30, page 46.

Energy efficient for cooling and heating.

The combination of the concrete shell and the foam insulation makes the R-value much higher than in the traditional home at an effective R 65 vs. R 19–35, and higher than the geodesic dome and the yurt.

Ecologically friendly.

Use of wood is usually limited to framing of windows, doors and interior framing, unless steel is used for interior framing. More on that choice later.

Shape is compatible with energy flow.

Hurricane and tornado proof.

Hurricanes bash; tornados suck. In both the hurricane and the tornado the vulnerable aspects are the windows and doors. The typical battening down for such structures or intentionally by design in the planning stages as discussed later can protect them.

Earthquake proof.

Earthquakes buckle. An additional saving grace for the Monolithic Dome is the integral coherence of the dome with the concrete slab or perimeter footing. It is essentially all of one piece.

No deterioration.

Not to be confused with maintenance-free. This descriptor is true of the shell, which is thin shell concrete. Maintenance is another consideration entirely.

Maintenance exterior.

The skin protects the polyurethane foam under it from the elements, in particular UV radiation. It will require maintenance such as light scrubbing with a diluted solution of

tri-sodium phosphate (TSP), as recommended by MDI. Other exterior structures such as the windows and doors will require the same maintenance typical of a non-dome home. If they are recessed, expect less maintenance than windows and doors that jut out beyond the exterior of the dome. More on that later.

Maintenance interior.

That depends entirely on your interior design.

Aesthetically pleasing to the eye; feeling of expansiveness.

With these advantages of a Monolithic Dome home, perhaps you can appreciate our choice of this dome, despite the problems that occurred in the building process. Happily, none was irreversible; and we feel safe and secure.

We bask in the brightness and openness of our homes; we delight in the play of light and shadows through the day and also the night when moonlight filters through our skylights. We treasure the feeling, difficult to express, when we step into the dome shape of our homes.

3 The Monolithic Dome

During my last 28 years in the construction industry I have built homes, remodeled homes, and repaired homes—some of which were ravaged by natural disasters. With a clear conscience I can no longer construct homes for people that will not withstand the extreme conditions Mother Nature can offer. Using the same old "vegetable matter" (wood), "air filters" now used as insulation (fiberglass), and square structures (offering less useable floor space per square foot surface area) is antiquated, to say the least! It has afforded me a challenge I gladly accept as my life's work.

—Walter L. Burnham II
Rocky Mountain Dome Co.

The Monolithic Dome is a unique structure, fascinating in the manner in which it is put together. We hope that you will have the opportunity to see this process for yourself. Meanwhile, a brief description of the major aspects follows. Understanding how the dome is constructed will be immeasurably helpful in your preparations to construct such a home—from site planning to the day you move in.

Note below that with each stage of erecting the shell of the dome, you become locked into the prearranged configurations for the plumbing and the wiring. Hence we stress the importance of careful planning from the very beginning.

The time to change your mind about plumbing is before the slab is poured. The time to change your mind about your layout for wiring is before the walls are sprayed with shotcrete, a specially prepared mix of concrete. We shall stress throughout the importance of planning. You may find the planning tiring but we'd rather you felt that way, than to regret any of your decisions.

A contractor should know what is described in this section but don't take that for granted as we discuss in the section on contracts. Surprising what an enthusiastic worker or contractor/builder can do that is not what you expect. So we repeat, do not take anything for granted in building your home, despite the presumed expertise of all involved. Adopt a diplomatic "show me" attitude, before and after anything is done.

The foundation for the dome shell can be either a concrete slab or concrete perimeter footer. In the latter approach, the remainder of the floor is poured after the walls have been sprayed, an advantage in two primary respects. The "droppings" from the spraying of the foam and the shotcrete become part of the foundation; and changes in the primary plumbing layout are still possible since the slab has yet to be poured. Jean's experience was with the two-step pouring; mine, the one-step pouring of the slab.

We will focus our description on the one-step pouring of the concrete slab as the foundation. This approach does not require a return visit, which saves money. Some dome builders feel that a one-time pouring of the slab would be more resistant to potential cracks.

We will comment on the two-step foundation when it is relevant. The same general principles and warnings apply regardless of the method used to pour the foundation for the shell.

A level site is a must, with the exposed dirt well compacted. The surface is covered with a polyethylene sheet that acts as a vapor barrier against the dampness of the earth. The forms that will contain the concrete are put in place, according to the size of the base of the dome shell. Gravel is spread to provide a base for the concrete. Then, reinforcing mesh is laid over the bed of gravel. When the concrete mix is poured, the mesh will be shimmed up so that it is imbedded within the mix.

The laying and securing of the primary plumbing follows the spreading of the gravel. In the two-step approach, the plumbing is laid after the walls are sprayed. All the debris and the shotcrete which have splattered onto the inside floor of the shell becomes part of the bed of gravel. In either instance, be very sure that the drainpipe stubs are well-secured, extended six to twelve inches above the surface of the concrete and capped. The pouring of the concrete mix exerts a tremendous amount of pressure against the plumbing.

Unless the plumbing is well secured and the drainpipe stubs extend above the surface, several problems may occur. A drainpipe stub

may be shifted laterally from its position to the extent that it may not exit into the intended space. When a drainpipe exited into the wrong room, the solution was to jack hammer a tunnel in the slab from the drainpipe to the intended exit. Then, an extension was added to the drainpipe—an additional day's work and materials.

The second potential problem is a missing drainpipe, lost somewhere in the pouring of the concrete mix; another good reason for extending the stub above the surface as recommended.

A third problem may occur when the slab is poured in a single session and the drainpipe stubs are not capped or covered. These caps should not be removed until after the walls have been sprayed with shotcrete and the floor has been swept clean of the debris and shotcrete that have splattered onto the floor. (This caveat does not apply, of course, in the two-step procedure of pouring the foundation.)

Soft debris, such as dirt in the drainpipes, is the lesser of the two consequences of a clogged drainpipe. Dirt can be easily flushed out but does add to time and labor cost. The more serious consequence is the clogging of a drainpipe with sprayed shotcrete. Drilling out the concrete may not work, as one of us discovered.

To fix a clogged drainpipe you would need a creative plumber to do bypass surgery—a process which again requires tunneling through the slab to make a working connection—extra labor, time and materials. You don't need that.

After the primary plumbing is laid out, secured and double checked for correct placement, rebars (iron struts) are placed vertically around the circumference of the intended slab or the perimeter footer (Fig. 10a).

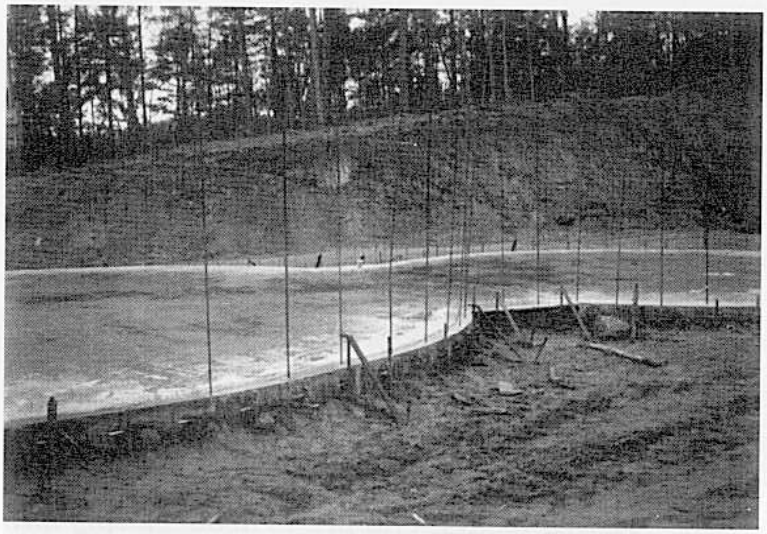


Figure 10a ***A finished slab with embedded steel rebars.***

Once the slab or footer is poured, the rebars will be bent over the slab or footer (Fig. 10b) and wrapped to prevent them from cutting into the Airform (Fig. 10c) during the process of inflating the Airform, which is the next phase.

Six inches is the usual recommended depth for a concrete slab. (Be sure that you have the specifications for your slab, as noted in the section on contracts.) The curing time is dependent upon temperature.

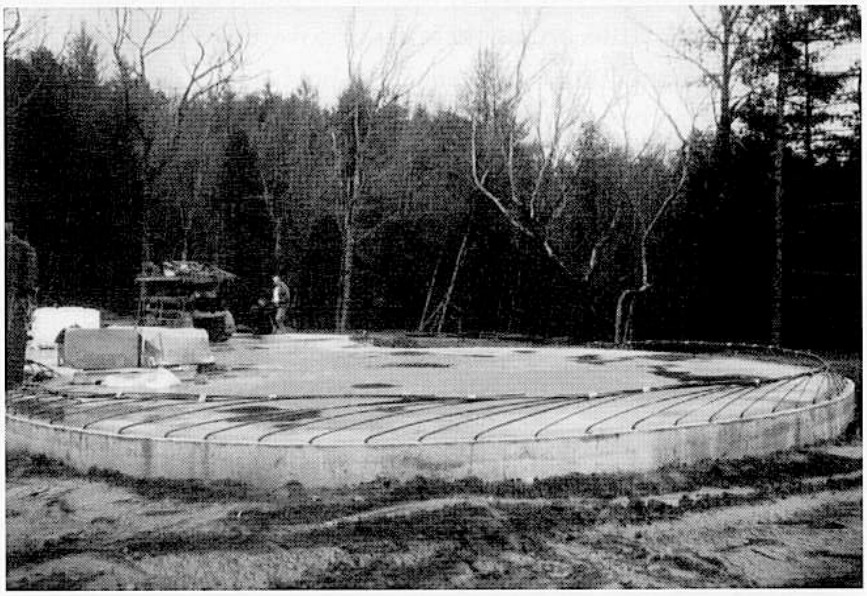


Figure 10b ***Rebars folded over.***

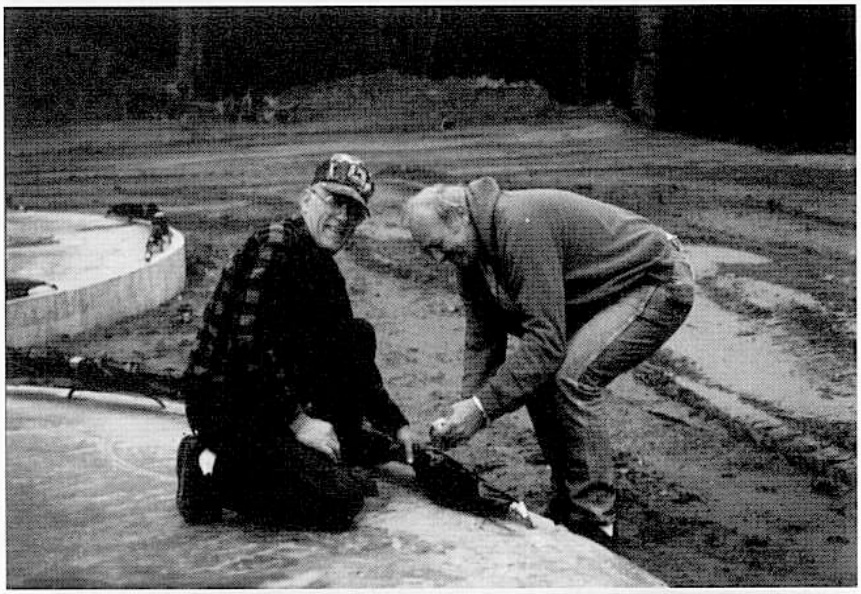


Figure 10c ***Folded rebars wrapped to avoid cutting into the skin.***

TIP

We suggest that you mark or have a rod inserted into the measured center of the dome (no eyeballing, please) so that it will extend above the surface of the slab. Including a rod bisecting the circle at the four middle points may save you some headaches later. When you step inside an empty dome, all you will see are curves. Without a reference point, you can become disoriented. We will elaborate on this tip in our discussion of the interior framing in Chapter 6, p 78.

Concrete slabs should not be poured below the temperature of 45 degrees without provisions made to keep them from freezing. Never pour concrete on frozen ground. The recommended minimum curing time is a factor that should be built into the time schedule for completion of the dome shell.

The next major step is constructing the dome shell itself. We shall not go into the details of construction (a builder should know them). To give you some sense of what is involved, we describe it simply. Erecting the dome shell comprises several stages, all critically important: securing the Airform to the foundation; inflating the airform; spraying the foam; attaching the rebars; and spraying the shotcrete.

Your dome builder will have his or her own checkpoints at each of these steps and during the process itself. These checkpoints are sketched or described very clearly in the training manual on dome building by MDI.

The Airform, the skin of the dome, is inflated very carefully. By the way, it is not politically correct to say, "blowing up the dome," even though that is how the process looks. The Airform, a polyurethane material, is constructed according to the specs sent to Monolithic Dome Institute, by your contractor/builder/architect, or by you if you are building your own dome. It is delivered by truck within six to eight weeks of the order in a neat little bundle (Fig. 11), its size belying the area it will enclose.

Figure 11 ***The Airform as it arrived for my tri-dome home.***

The Airform is fabricated with a preset flap that will allow the workers to enter and exit to complete the shell of the dome, while the Airform is inflated; and also a preset hole, for the air hose. The Airform must first be secured i.e., tacked to the circumference of the slab or footer (Fig. 12). A steel band is placed around the bottom edge of the Airform and attached to the side of the slab with lag bolts through pre-drilled holes. With a nail gun, cement nails are shot into the concrete slab between the preset holes for additional reinforcement.

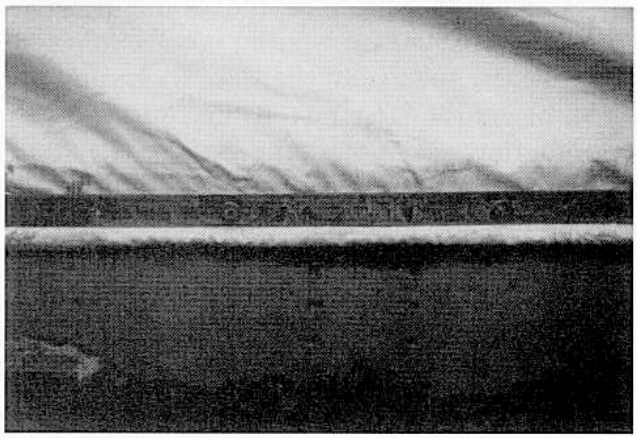


Figure 12 ***The Airform is attached to the perimeter of the slab.***

The Airform is inflated under pressure to a specified PSI. The recommended PSI must not be exceeded or the skin will tear at the seams and collapse. The inflating of the Airform is quite a sight to experience (Fig. 13a).

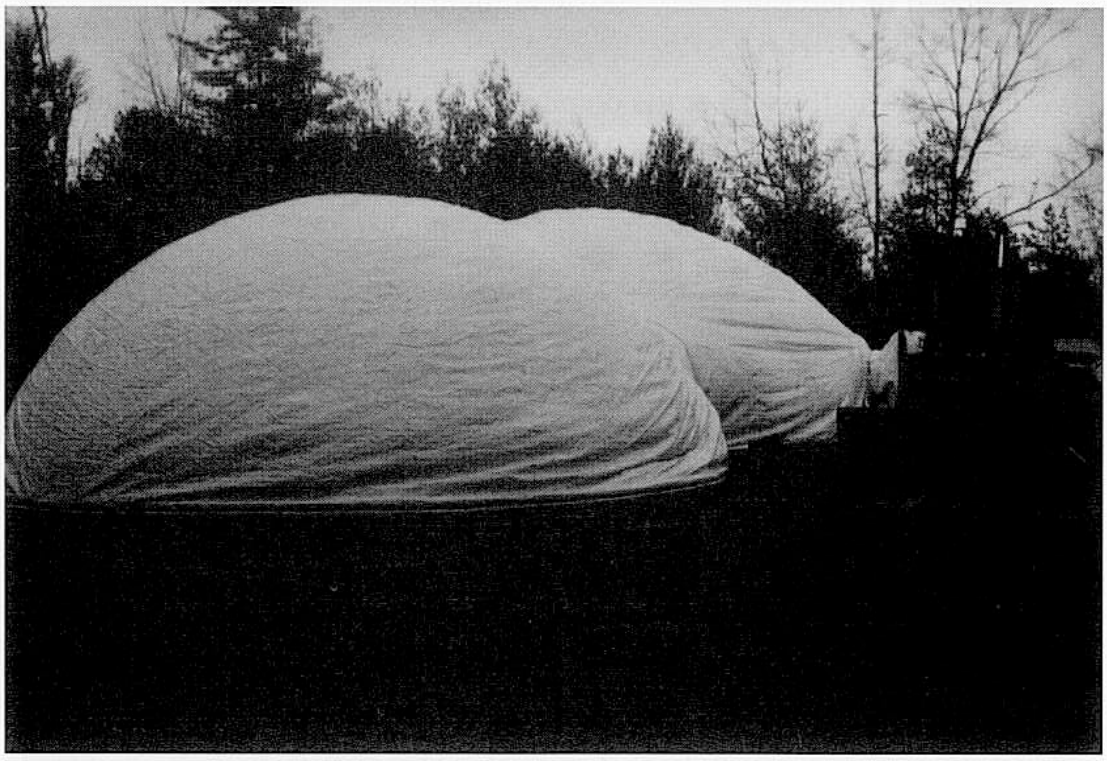


Figure 13a ***Early stage of inflating the dome skin.***

The Airform is inflated partially several times to ease out the wrinkles and to check for any air leaks. Air leaks, if any, are patched before the Airform is fully inflated.

Equally spectacular is the view from the inside of the dome once the skin is inflated (Figs. 13b, c).

Once inflated, the interior of the Airform is sprayed with several layers of urethane foam from the bottom up to a thickness of approximately two to three inches. Workers wear protective gear (Fig. 14) for all spraying.

The work crew essentially works in a fog, from the mist generated by the spraying. One worker holds a high-powered lamp and guides the sprayer, also known as the "nozzle man."

Apertures are cut in the foam for placement of the "bucks," the structural framing for the doors and windows as shown in Figure 15. The layer of wood, which is held firmly in place by the foam and the concrete around it, also provides a useful surface for attaching the window and door frames.

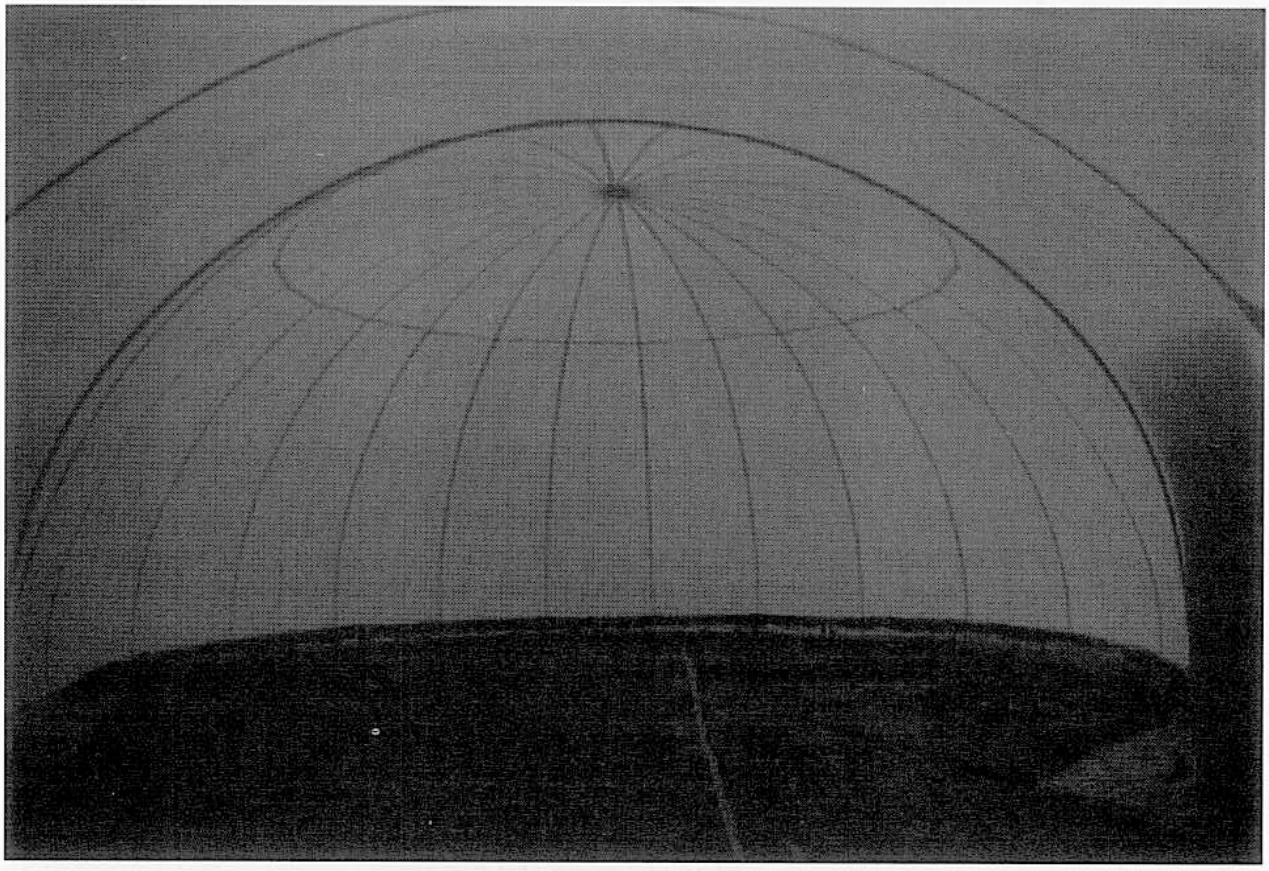


Figure 13b ***The view from the inside once the skin was inflated.***

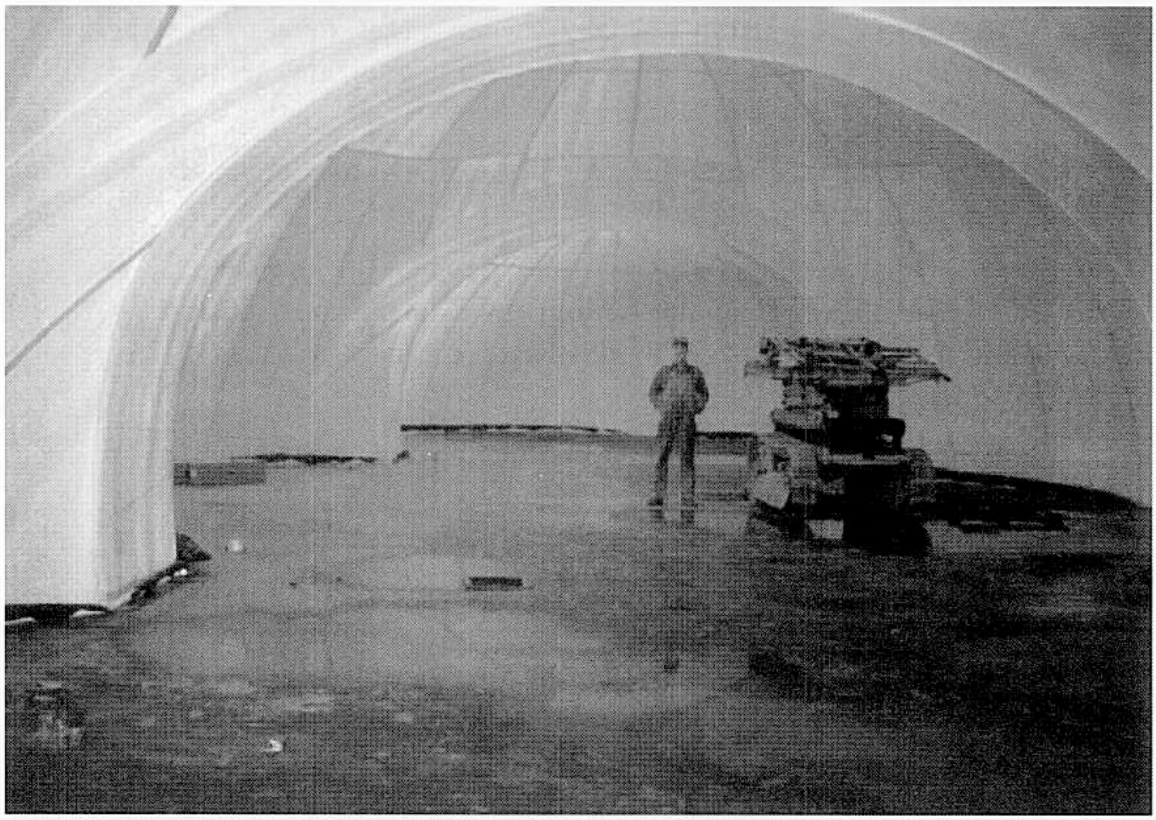


Figure 13c ***This view, taken from West dome toward the center and East domes, shows the comparative heights of man to dome and the hydraulic scaffold, the top of which, when opened, allows workers to spray the upper sections of the dome. (Note: The scaffold is driven onto the slab before the Airform is attached to the slab.)***

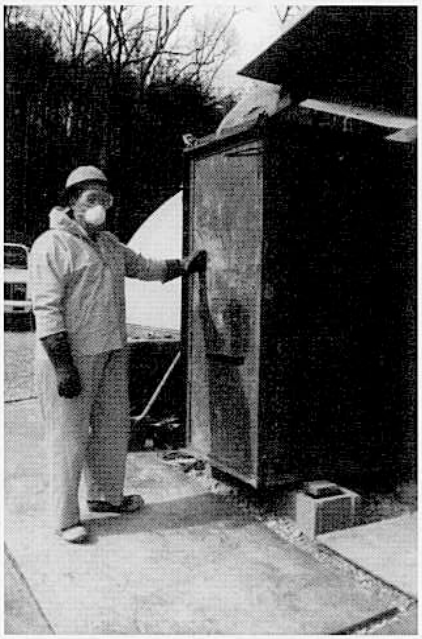


Figure 14 ***A worker in protective gear entering the inflated dome through the airlock.***

These apertures are covered with plywood until after the spraying of the shotcrete is completed. Rebar hangers are inserted into the first layer of foam. The rebars will be attached to these hangers (Fig. 15).

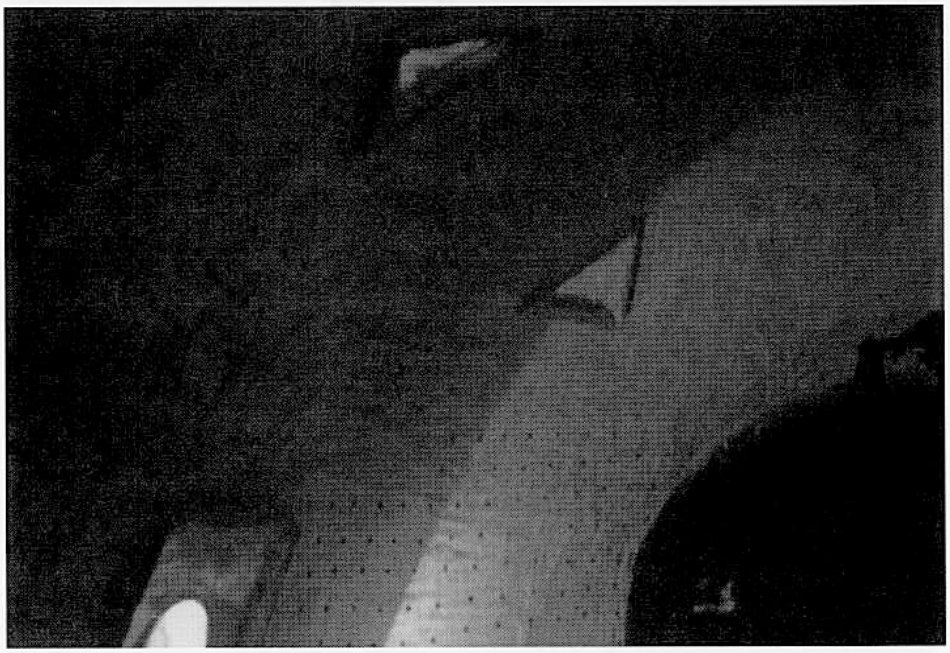


Figure 15 ***The interior wall and ceiling showing the bucks (frames) for the windows and doors. The dot-like spots are the rebar hangers that have been inserted into the foam.***

After the second layer of foam is sprayed, the bottom/vertical rebars are straightened (Fig. 16).

The interior of the shell is then reinforced with vertical and horizontal rebars (Fig. 17).

Conduits for the primary wiring and outlet boxes also are attached to the rebars during this stage, as shown in Figure 18.

The spraying of "shotcrete," a specially prepared concrete mix follows. It covers the rebars, the electrical conduits and provides the finish of the exterior walls of the dome. It is the last major phase in constructing the shell of the dome. The shotcrete must be mixed to a particular consistency to obtain the desired smooth finish. We have seen contractors and builders refuse a load if the mix is not the correct consistency.

The current process in spraying the shotcrete is awkward and exhausting. The crew is working under limited lighting conditions.

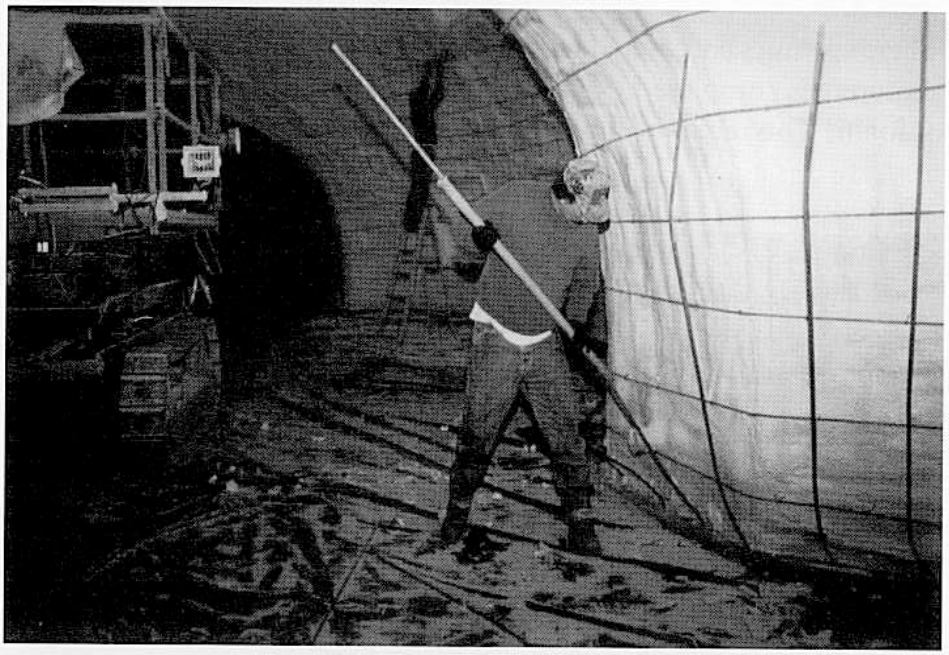


Figure 16 ***The rebars are straightened with the aid of a PVC pipe. A worker in the background is attaching the rebars to the hangers.***

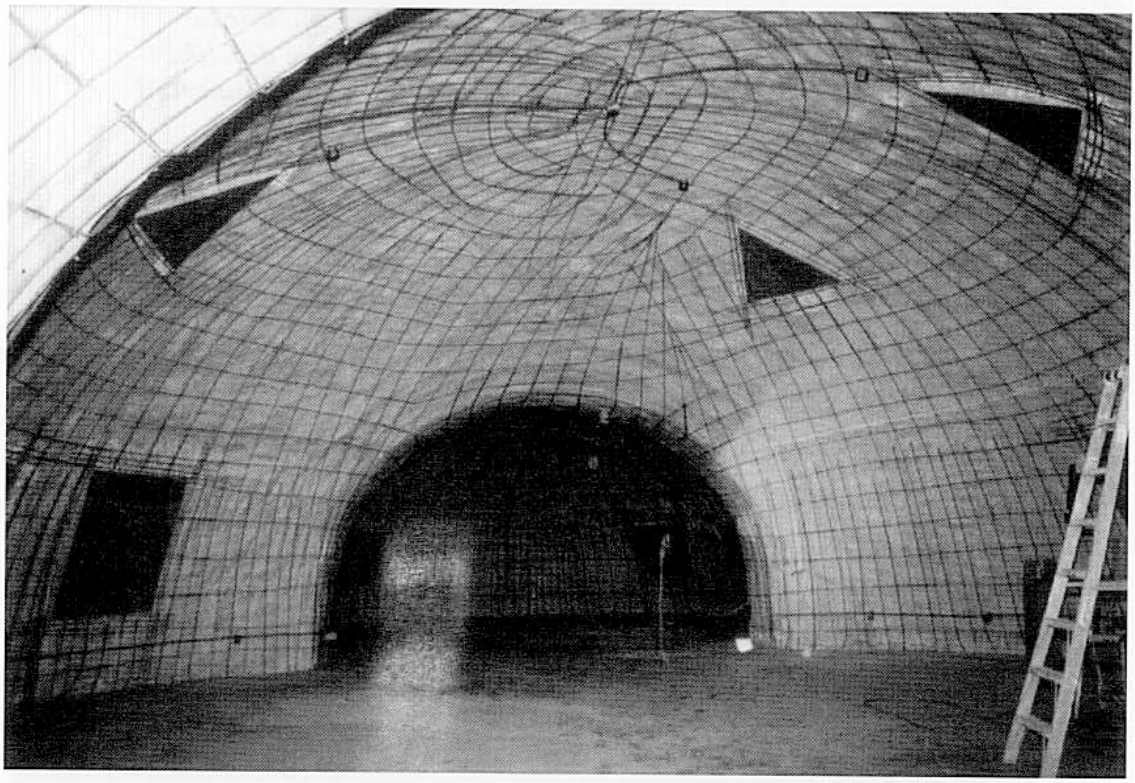


Figure 17 ***This view from the west dome toward the east dome shows the lateral and vertical rebars in place. Openings for the doors and windows have been covered with plywood.***

The mist generated by the spraying fogs their protective facemasks; and they are holding onto and directing a nozzle under a great deal of pressure. In Chapter 6, we point out some of the less than desirable results in the finish of the exterior walls that can result with inexperienced sprayers and we offer solutions.

Recently, a tool has come on the market, developed by a dome builder, to minimize or eliminate problems that could occur in the spraying of shotcrete, including safety issues. The CoPlace Tool is designed specifically to provide a greater level of precision in the spraying, reduce the amount of concrete that falls to the floor and ease considerably the workload for the crew (Appendix A). The purpose and design make sense. Reports of its effectiveness in actual use should be forthcoming shortly.

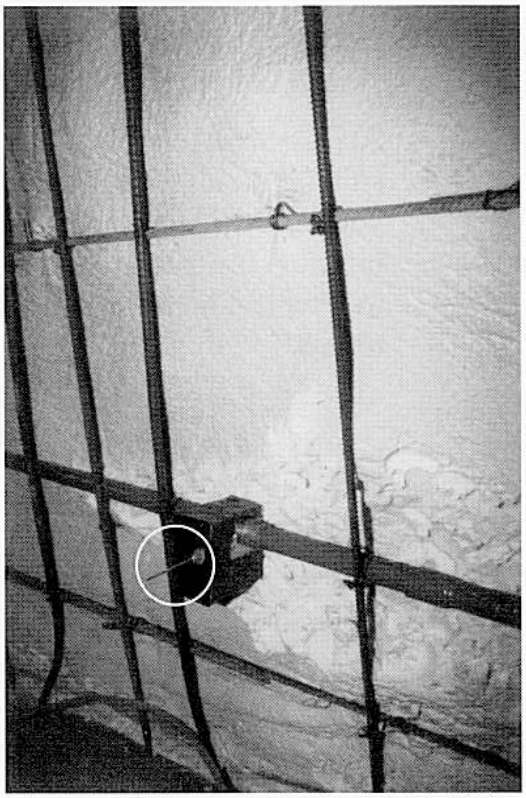


Figure 18 ***A closer view of the attachment of rebars to the rebar hangers, an electrical conduit and outlet box with the recommended extended tip circled.***

The spraying of the shotcrete is done from top to bottom so that the thickness at the base will be approximately four and one half inches tapering to two and two and a half inches at the top and center of the dome. Depth gauges are used to monitor the thickness of the shotcrete as it is being sprayed.

BE AWARE

Make sure to clarify with your builder how the base of the interior wall will be finished. The shotcrete will clump at the bottom of the wall. It should be smoothed while still wet, preferably with a layer of grout. The smoother edging that results from this additional layer will make it so much easier and attractive to tile a floor or lay a carpet to the edges of the wall.

Again, temperature is a consideration for the spraying and curing. Running lamps day and night supports the latter. Twenty-four hours after the last layer of shotcrete is applied, the pressure is turned off; your

electrical use goes down considerably. Then, you can have your "raising of the roof" party.

At this point, the shell has become completely independent of any support. With the subsequent installation of the doors and windows, your dome is now dried in and the interior construction begins. The interior construction follows basically the principles of construction in a typical home with a few exceptions, discussed in chapters that follow.

BIG TIP

Given the above process, we urge you to adopt the following strategy. We are assuming that you will have, in your hot little hands, detailed plans for each major phase of the building of the shell to the turn key stage when all the workers have gone home. Then the dome becomes yours alone.

After each major phase, have the contractor review with you what has been done, according to the plan. That's the time to catch errors or oversights. That's not the time to change your agreed plans if everything is right, unless of course, you have changed your mind and are willing to bear the added expense and delay in completion. (For example: before the concrete is poured have your contractor review with you the layout of plumbing to be sure that the drainpipes are in the specified locations.)

Adopt this suggested strategy before the apertures for windows and doors are cut. Be sure, for example, that they will be located as intended and free of obstruction from a planned interior structure.

ANOTHER BIG TIP

Take a lot of pictures of the building stages. In addition to their sentimental value, they provide a graphic record that may be helpful for future remodeling or tracking a problem that may arise. The next owner will probably appreciate having a pictorial history of the dome. Who knows, you may even find yourself unexpectedly writing a book.

Review the wiring conduits and placement of the outlet boxes with your contractor/builder before the final spraying of the walls of the shell to be sure that they are located correctly and properly installed.

Using this general strategy throughout the process of building will make you and the contractor much happier campers.

4 Monolithic Dome Choices

We shape our dwellings, and then our dwellings shape us.

—Winston Churchill

Most of us have grown up in boxes, attractively arranged in endless combinations. Some have flat ceilings; others have cathedral ceilings; and still others have pitched ceilings with clerestory windows. All are variations of straight lines enclosing space. The same holds true for walls.

Most houses have vertically straight walls; ninety-degree angles are the norm. Consider the perceptions that we have developed over the years by living in the square. We see primarily straight walls around us and squared off spaces.

The Monolithic Dome*, in contrast, has long smooth flowing curves. Its curving walls eventually become the ceilings. Having a dome built will require a new way of thinking and visualizing your home. Living in a dome requires no change other than an increased enjoyment of your "surround home."

Be prepared for an exciting, sometimes challenging experience as you wrestle with decisions to be made. Sometimes it will be puzzling as you put the pieces together in your design but it should be mostly fun. To help make it so we discuss the basics in shape and size of domes and ways to bring the two together.

Dome Shapes

Domes come in a variety of shapes, combinations, and sizes for almost any use that one can imagine. A dome home also can be

*Hereafter, we will use the term *dome* to refer to Monolithic Dome.

buried—as in an underground home or a bermed home. We do not see the advantages to those choices, given the unique features of the dome in shape and materials used.

Essentially, a dome is a sphere cut somewhere on the rounded side and placed either on a slab or a perimeter ring footing as described in Chapter 3. Two common proportions are the five-eighths spheres, as is Jean's dome and the one-half elliptical, as is my dome.

To increase the vertical height of the wall at the base of a dome a "stem" may be included in the design of the dome. Stems are used to add vertical height to the base of the dome, thus adding height to the interior walls.

The height of the stem must be specified at the time that the skin of the dome is ordered. Allowance for the stem will be part of the fabrication of the dome skin. The dome shell will cover the stem. The subsequent spraying of the foam and shotcrete makes the stem an integral part of the dome.

With the addition of a stem, walls are more vertical, closer to the base; thus providing more headroom on the upper level(s) in a multilevel dome interior. Jean's dome is a three level one-half and five-eighths sphere built on a four-foot stem. Any proportion, however, that suits your needs can be used as long as the structural integrity is not compromised.

Most of the pure geometric forms from which dome shapes are derived are shown in Figure 19. Actual dome shapes will vary slightly from the pure form by design or by the inflation process.

Dome Combinations

For residential purposes, we have seen the following three combinations beyond the single-level, single dome: the one-level, multi-interconnecting domes; the single dome, multilevel; and the multidome, multilevel (Figs. 20a, b, c).

The single one-level dome would be, of course, the easiest, quickest and least expensive to construct. Single level domes are also more easily rendered handicapped accessible. Single domes with multiple levels require less land and slab than two or more interconnecting single level domes. Central heating may also be more efficiently installed and may be more cost-effective since heat rises. Whether costs would differ for plumbing, electrical work and heating would depend on the interior design. The multilevel single dome would have the added cost of stairs.

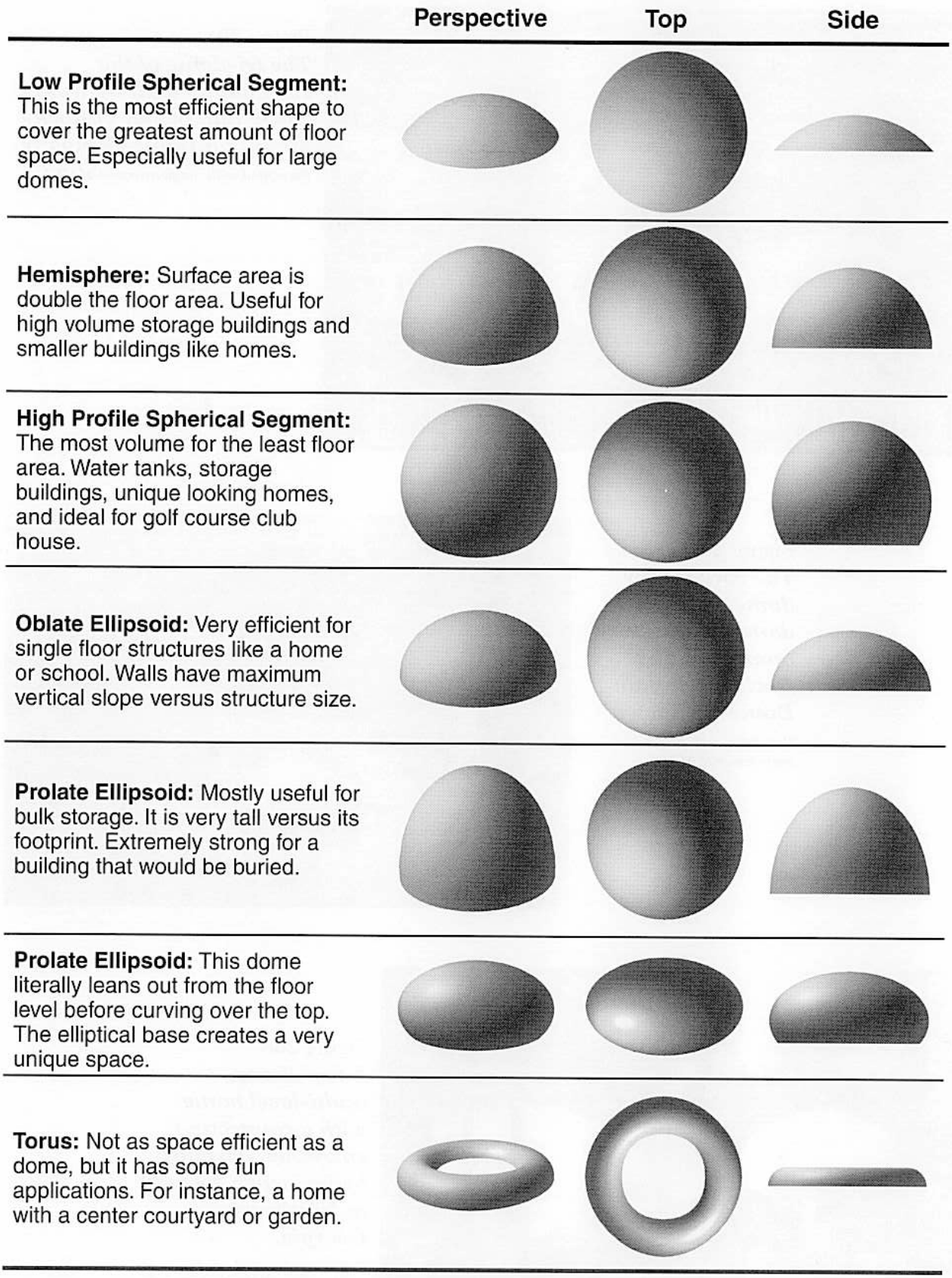


Figure 19 ***Geometric forms, the starting points for dome homes.***

Reprinted with the permission of MDI.

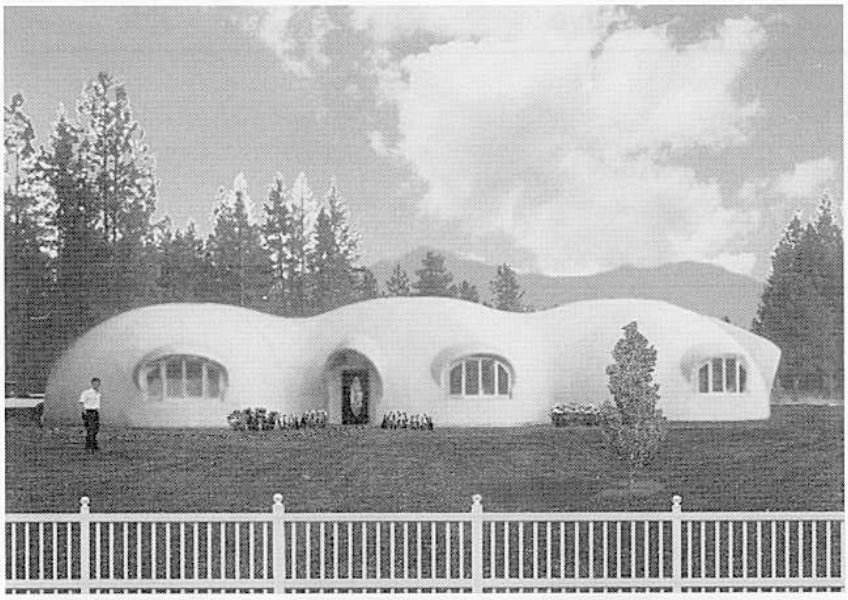


Figure 20a
The tri-dome of the Burnham's built by Walter Burnham, owner of Rocky Mountain Dome Company.
Reprinted with the permission of MDI.

Figure 20b
The Rice family dome, a single dome "three story" home, built by Rocky Mountain Dome Company.
Reprinted with the permission of MDI.

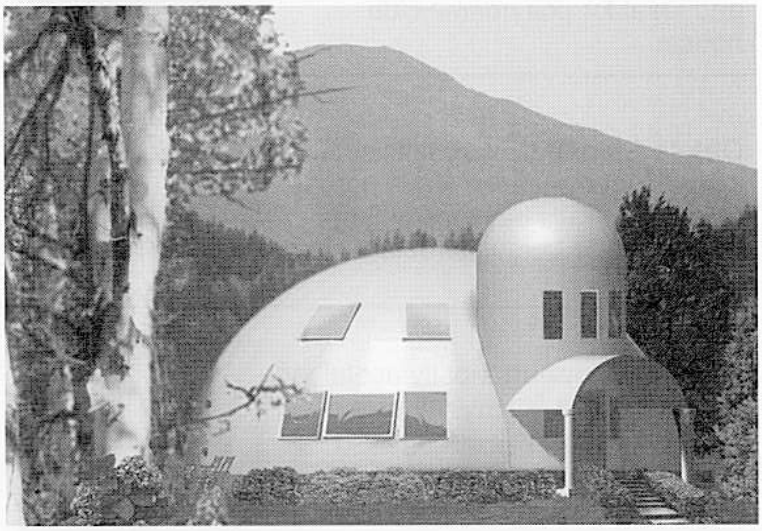


Figure 20c
A two-dome, multi-level home with a connecting entryway, designed by its owner, located in Northeast Georgia.
Reproduced with the permission of John R. Richards, Capt. USN (Ret).

All of the combinations mentioned can have the more "traditional" interior style; i.e., full walls sectioning off various living spaces. In a dome home with all living areas partitioned by full walls, one would lose a good bit of the uniqueness of a dome home and the feeling of openness that is a particular characteristic of a dome home.

The interiors of domes tend not to be "traditional" in style. Interiors are usually a combination of partial walls with full walls for more private living areas. The remaining space may be sectioned off by partial walls of any height from one half to three quarter in height and or visually defined with furniture and other accessories.

Interaction of Dome Shapes and Size

The curvature of the dome is shaped by the size of the base and the height at the center top. Some adjustments in curvature can be made as long as they do not compromise the structural integrity of the dome. A more conical shape may be of advantage in a dome of smaller base, especially if you want a second floor. In the conical shape dome, the second story walls will be more vertical than otherwise, allowing you to get closer to the outside walls.

In a larger dome, the height required for straighter walls may become less advantageous, depending on the construction engineering of the dome and number of floors desired. Often, the curvature of the dome wall will be such that the point at which you have at least eight feet in height is about two feet away from the wall at floor level.

Overall size, of course, is determined primarily by your space needs and or desires. And here we caution you to determine your space needs first in actual footage, as discussed in Chapter 5. Then, determine the final size and shape of your dome.

Do not pick a size and shape and then fit your rooms into the space. This strategy, which some have used, reminds me of an experience in which a researcher, fascinated with a piece of laboratory equipment, tried to design a project around the equipment. It doesn't work. Tools are selected to answer a question and or fit a need; the same is true for your dome home.

Our Domes

Our different needs are evident in the shape of dome we each selected and the interior layout. Jean's home is a single tri-level dome, 46 feet in diameter. The basement level, the front side of which backs up

Figure 21a ***Jean's home, front view.***

against a slope, contains her office, a food storage room, a treatment room, a bathroom and classroom area (Figs. 21a, b).

The ground level contains her kitchen, dining room, living room, guest bathroom, master bedroom and bath, library, a hallway closet accommodating a full washer and dryer, and a deck off the living

Figure 21b ***Jean's home, side view.***

room. The ceiling of the living room is the top of the dome. A hallway balcony flanks the inner side of the living room.

The upper level of her dome home is reached by a lovely open stairway, as is the basement level. On the upper level are three bedrooms, one of which has an in-suite bathroom. A second bathroom is off the hallway.

My home, in contrast, comprises three interconnecting domes.

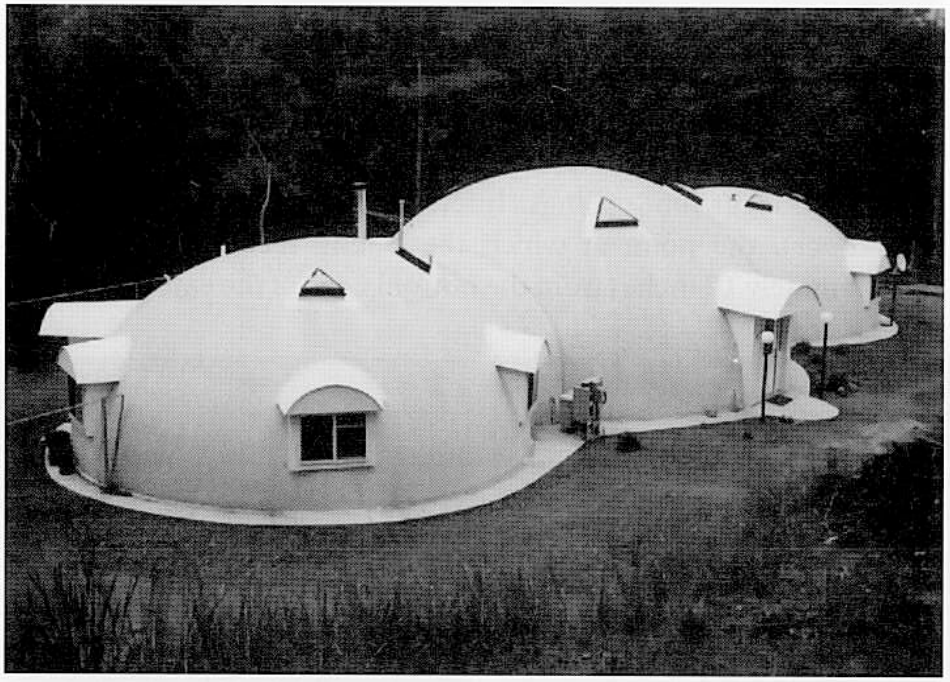


Figure 22 ***Carmella's tri-dome home.***

The center dome is forty feet in diameter, housing my kitchen, living and dining area, with an entryway, entry closet and pantry off the kitchen. The connecting east dome, 32 feet in diameter, is the master suite with bedroom, bath, study and a utility closet.

The connecting west dome, also 32 feet in diameter, is a two-bedroom guest wing. It contains a bath/sauna and a utility room. One guest bedroom has been converted into a stained glass studio.

A major consideration in selecting the shape of your dome is the point at which the dome begins to curve inward. The curvature and greater depth of concrete at the bottom of the dome will affect the usability and layout of the interior.

The shape of Jean's dome home, a tri-level, single dome, and mine, a single level tri-dome home, differ considerably. Jean's dome is a

hemisphere, five-eighths cut with a stem; my three connecting domes are each a one-half ellipse. In Jean's home, the straight sides of the dome, viewed from the exterior, extend higher than the sides of my dome (Figs. 23a, b).

Because of the slope of the land, Jean's basement is below ground level at the front of her dome. To achieve the height that Jean wanted for the third level, her dome is built on an approximately four-foot stem. Consequently, the exterior walls at the basement level are fairly straight. Both the original shape of Jean's dome (a five-eighths sphere) and the addition of a stem to the base allows for straighter walls.

At the basement level, the exterior of Jean's dome begins to curve very subtly at approximately four feet above the ground. Room height at the basement level is essentially normal as in a traditional home with eight foot ceilings. Interiorly, at the ground level, (the main floor), the point at which the ceiling reaches eight feet is approximately 12 inches from the bottom edge of the exterior wall.

Figure 23a ***Exterior walls of Jean's dome are relatively straight before the dome begins to curve in.***

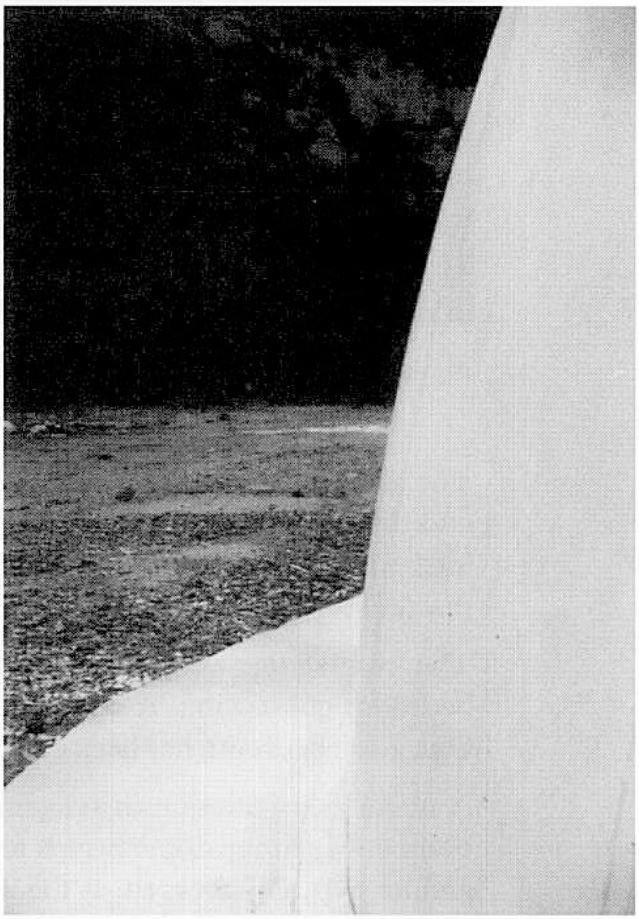


Figure 23b ***Exterior walls of Carmella's dome curve in almost immediately, from its base.***

At the upper level of Jean's dome (third floor), the point on the floor at which the curvature reaches eight feet is approximately eight feet from the exterior wall; at the curvature point of seven feet, the distance at floor level is six and a half feet; at the six foot curvature point, the distance is five feet; and, finally, at the curvature point of five feet, the distance at the floor level is three and a half feet.

Inside my center dome, the walls begin to curve ever so slightly at floor level. The distance at floor level from the exterior walls at normal ceiling height is approximately 27 inches—a greater distance than Jean's at her main floor level. That means my taller friends, if they are inclined to lean on walls, would have to pick the interior walls. In the two side domes, which are lower in height than the center dome, the distance from the exterior wall is approximately 32 inches—an even wider span.

Those measurements may imply considerable loss of usable space and more so for me than for Jean. Not really, don't panic. Most furniture averages about 36 inches in height. As an example, my study is in one of the side domes. I have a three-unit storage cabinet under the window in the study. That unit measures 36 inches in height. At the floor level, it is five and a half inches away from the wall; at the top surface it just barely touches the wall itself (Figs. 24a, b, c).

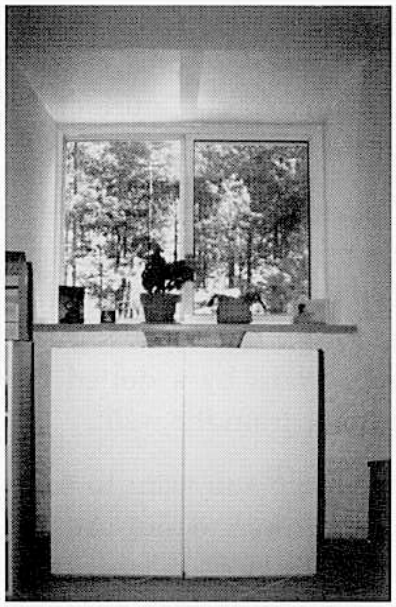


Figure 24a ***Front view of cabinet fitting against the curved wall.***

Figure 24b ***Side view of same cabinet.***

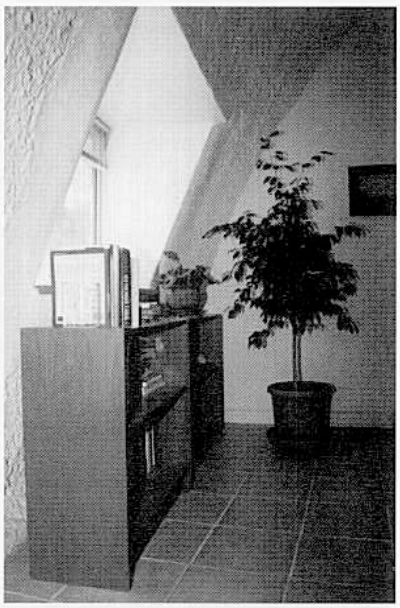


Figure 24c ***Side view of book case against a curved wall.***

In two-story domes, the curvature at the upper floors is greater and the ceiling is lower for a greater distance from the exterior wall. Headroom is not as generous as it is for lower floors. As an example, Jean does not have a door on the in-suite bathroom on the third level of her dome. Even a door narrower than the standard would hit the ceiling when opened, not allowing sufficient space to enter, unless one did a side shuffle.

Usually, an open entry into a bathroom is not good Feng Shui. (More on Feng Shui in Chapter 5.) Jean, however, has designed the interior of the bathroom to avert that possibility, and attractively so. All anyone will be able to see from any direction in the bedroom area will be a built-in vanity, topped by lovely plants. The commode, lavatory, and shower are neatly tucked into the opposite space.

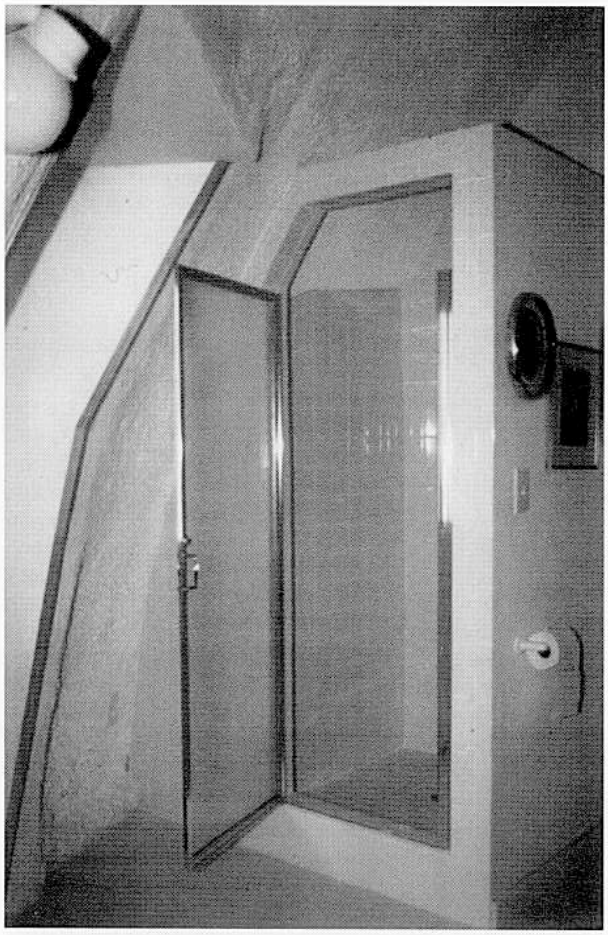


Figure 25 ***Top of shower door touches the exterior wall but ample room remains for entering shower.***

Even in a single level dome, the placement of a shower door, as an example, must be considered carefully, if the shower is located against an exterior wall. As shown in Figure 25, the shower door cannot be opened completely; but it does open sufficiently to allow ample space to enter the shower.

Whether you choose a single level or a multilevel dome, check height lines carefully. In a multilevel dome, height lines at the upper level would be more of a concern because of the increased curvature of the exterior walls at that point.

Your architect or designer should provide you with side elevations and cross sectional profiles. If not, please request them. Wall height calculated from the floor is usually identified in floor plans by a dotted line marking the distance from the wall.

In your planning stage you want to make sure you have ample room to move around with ease. Consider: How tall are you? How tall are your guests likely to be? What activities are likely in the area?

Jean is tall; her family and many guests are also tall. Hitting your head on the "ceiling"

or protruding casement windows is not fun! Having to be on guard for such possible head bumping is not our idea of comfortable living. Neither one of us has to worry about that as our domes are designed with body size in mind to include our taller friends. Don't overlook this in your planning.

Your architect or interior designer should be informed on the interaction between dome shape and dome size. Nevertheless, you want to be prepared to consider this aspect. Some people are good at visualizing a three-dimensional space. If you are one of those people, wonderful. Most are not. Jean has a suggestion that is very effective for visualizing your new space:

> Take a long pole or a broom handle; add an extension so that you can mark it at the five, six, seven, and eight-foot level. Eight feet is the height of ceilings in most conventionally constructed homes. Tape a small bubble level to the pole to show you when you are leaning the pole in one direction or another. You need to keep the pole straight.
>
> With broom or pole in hand and your proposed plan, walk all the rooms in your current living space. Note how far away from the walls at floor level you would need to be to transform the square space into circular space. This exercise is most important when considering an upper floor in the dome.

The amount of space we humans need is surprising. Standing up straight and stretching requires a six-by-six-by-six space, even if you are smaller in frame. Walk around the bed. Imagine the bed placed in your proposed space. Can you walk around this proposed space without ducking your head? Could the bed be placed just under the curvature? Would you be able to get in and out of the bed without hitting your head? Otherwise you are in for a rude awakening. (I couldn't resist the pun.)

What about your dresser? Your dresser, without a mirror, could be placed conveniently on a curving wall and the mirror placed elsewhere in the room, or both pieces may be on an interior straight wall. As another example, check out your easy chair. The chair itself may fit well in a chosen spot but can you sit into and stand up from the chair without bumping your head?

The broom-pole method is also invaluable in determining the space required for opening doors. Where will the open door hit the wall of what slopes up to become the ceiling, a most important consideration

for the upper level. The placement of the door on the plan may look fine. But it may not work in three-dimensional space.

In a dome home you have a two-way curve to consider. Doors may stick or may not lie flat when open. Curved walls are a big change for someone accustomed to square rooms and the usual placement of furniture. Taller pieces will fit very nicely against interior walls; they can also be used as room dividers. Don't forget to check the bubble level on your pole to be sure that it is straight.

If you are beginning to think that placement of furniture in a dome is different than in a "square home" you are right; and it can be done very attractively and effectively. It does mean changing one's perceptions on the use of space. You can let your imagination run freely to use "empty" space as part of your decor to complement "used" space. Cats love spaces behind bookcases and furniture in which to hide, in particular from the resident dog. Owners, too, like empty space for a different reason. Dust balls that accumulate behind furniture are easier to reach.

The placement of furniture, you will find, adds to the open, expansive feeling of dome homes. A dome home can mean getting back in harmony with nature; it also can encourage one to simplify one's lifestyle and focus on the essentials.

The natural curves of the dome also offer the opportunity to become creative with custom built-in furniture. Counter top storage in kitchens and bathrooms can likewise be formed to fit the wall shape (Fig. 26).

Figure 26 ***Kitchen shelves fitted to the curve of the wall.*** *Reprinted with the permission of Suzanna Felder.*

Figure 27 ***Arch over a recessed shelf wall and arched entrance to west dome.***

Figure 28 ***Arched entrance to east dome also showing arched doorway to bedroom.***

Shelves can be added to any curved space for books or for accessories. Such additions are not only attractive but they also provide interest compatible with the dome style and add warmth. Consider also arches over hallway openings, shelf walls (Fig. 27), and doorways (Fig. 28).

Walls do not have to go completely to the ceiling (Fig. 29).

Weight bearing walls are not needed in a dome; floors can be suspended from the ceiling. Nor do room walls have to be on the square (Fig. 30).

Figure 29 ***Partial walls.***

The inherent integrity of the dome structure and shape allow for tremendous flexibility in design, limited only by your imagination and of course, your budget. The latter may not be as limiting a factor as it would be for a conventional home.

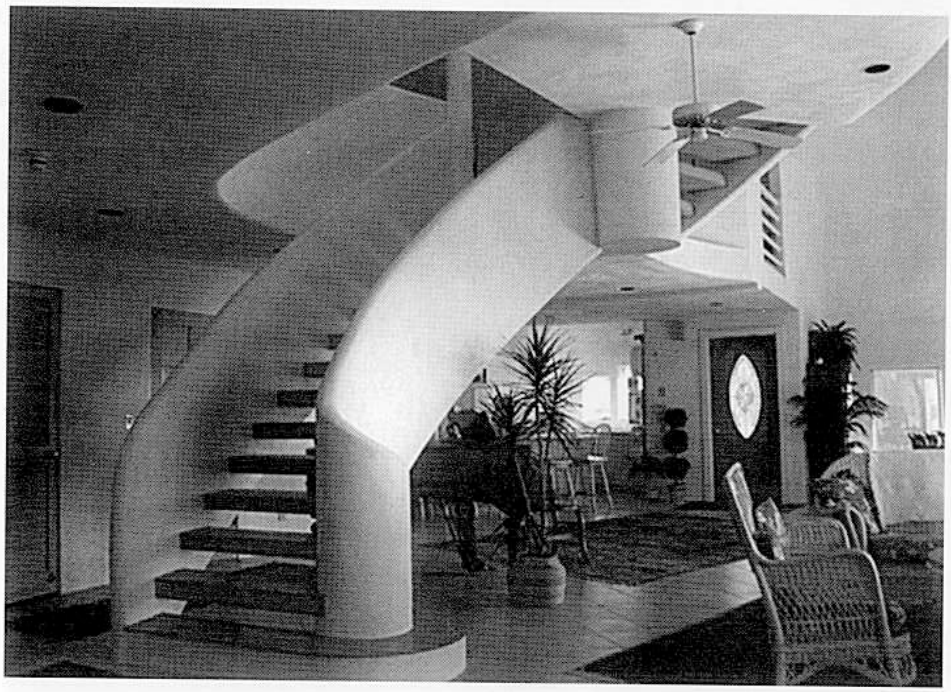


Figure 30 ***One view of the interior of the "Eye of the Storm." Ceilings are suspended from the roof of the dome. Note also the curved walls and staircase.***

5 Exterior Design Elements

The future of our civilization depends upon our ability
to select and control our heritage from the past,
to alter our present attitudes and habits, and to
project fresh forms into which our energies may be freely poured.

—Louis Mumford
Author of *Sticks and Stones*

One might think that living in a home or even remodeling a home would be adequate preparation for building one's own from scratch. Not so, based on our experience and from the many stories we have heard from others whether building a conventional or dome structure.

Consider what your experience to date may mean for building a dome home. Is planning the exterior of your dream dome any different from that for a traditionally built home? Yes and no. Some of what we present in this chapter applies to any home.

Other information is specific to the dome home. Even for a typically built home, you may omit important steps; and it bears repeating —many building basics apply to such aspects as windows, doors and, of course, the interior. The respective building dynamics blend into each other. In this chapter, we present several steps we consider essential before you sign any agreements. After that we present considerations in planning the exterior of your dome.

First Steps

Ideal pre-planning would include: walking the property and engaging a landscape architect before purchasing it. We strongly recommend both. We also recommend four other preliminaries

before you talk with a contractor/builder and architect; and certainly, before you sign any contracts.

The first step is reading a basic introduction to general building dynamics for a home and for landscaping. At the least, speed read or skim through a basic book. Basic building dynamics, aside from the unique construction of the shell itself, apply to the dome home, contrary to what a builder may think or say. Some adaptations will be necessary, but nothing that is extraordinary.

The information that you will glean from reading the basics of home building coupled with information in later chapters will help you to visualize realistically what can be done structurally. The better informed you are, the less likely you will be misled.

If you are already online through the Internet, access any of the book sites. They are excellent resources for books of all kinds. A second alternative (other than a friend who does have access to the Internet) is the book/magazine rack in your local home building store. Look especially for the book on *Interior Home Improvement Costs* by the RS Means Company. It is an illustrated guide of the most popular remodeling and repair projects and their costs. Why such a book? For several reasons. It provides an excellent description of the building process, even though the examples are remodeling or repairing projects. The examples, such as different kinds of bathrooms, kitchens, flooring and wall coverings, are also those you would be considering for your dome home even though you are building from the ground up. A pricing guide accompanies each project whether you are having the project done by a contractor or without a contractor. It also includes material and labor costs. You will find other relevant information such as working with a contractor.

The third alternative is, of course, your local library, still one of our favorite stops despite our access to the World Wide Web. If your library has good resources you can save the money ordinarily spent on books and put it aside instead for a plant or two for your new home.

Now, landscaping: why read about it at this stage of your dreaming and planning? First, and most important, you need basic information about the topography of your property before the grader comes in and the foundation is poured. (We discuss this aspect later in greater detail.)

Second, investigating your landscaping options will provide information for problems you may have in the lay of your land requiring such additions as retaining walls and drainage ditches. It will also allow you to mark out those spaces in which you will want your walkway, driveway, garden and other lovely additions like an outside quiet space.

Some people and contractors/builders think about landscaping last; that is simply not a cost effective idea. True, that part of your vision of your dome home and its surroundings is the last phase in the actual completion of your home. Nevertheless, we urge you to plan ahead. It will help maintain a sense of wholeness in your vision of your dome as it is being built.

With your preplanning, you know what your dome home's surroundings will look like. You will have allowed for the appropriate spaces to create your outside environment. Do not let yourself be surprised afterwards by an outdoor pump infringing on your proposed driveway. That spot may be convenient for the builder during the building of the dome but certainly is not convenient for you. With a little forethought, a spot convenient for both the contractor and owner can be found.

Plan ahead and look forward to a harmonious relationship between your home and its surroundings. Think in terms of creating an environment inside your dome that will interconnect with the outside.

> "Careful landscaping lets you plan and plant a private world. In that private world, you decree where the sun shines and shadows fall and breezes blow."
>
> —James D. Blume, Editor
> *Step by Step Landscaping*

The second preliminary step is describing your personal lifestyle in a set of questions to ask yourself. Your personal lifestyle will influence the type of dome you select, how it will be oriented, the interior design, and other decisions that go into building a home. A set of questions is listed below to consider. It is not exhaustive; you may have other questions based on your current lifestyle. A helpful strategy is to list each question on a separate page of a book, indicating your choices, advantages/disadvantages of options, potential costs and sources.

You may want to have two main divisions, exterior and interior, in which to write your questions and answers accordingly. If compromises become necessary before or during the building process, you

will be way ahead of the game. All you need do then is flip to the relevant pages. So much is going on during the building process and sometimes relatively quick answers are necessary. A memory jogger on all your reasons for your choices is indispensable.

Who will be living in the dome: one person, a couple, or a family with children, pets and older adults? And, what special needs should be considered?

> My dome has an utility/mud room with a pet door installed in both doors, giving my cat and dog buddies free access to the main living area and to the yard. At the same time, the arrangement minimizes tracking dirt into the dome.
>
> A neighbor had an entryway for his dogs built right into the dome itself at the time of construction.

Will you be working at home, now or in the future? How do you wish to accommodate that possibility?

> Jean organized her basement floor to contain her office, general meeting space and workshop areas.

How much space would you like for entertainment, TV, surround sound?

How much storage, type and location (seasonal closets, pantry) do you need?

How about utility space for washer, dryer, tools?

> Jean's washer/dryer is conveniently tucked neatly at the end of a hallway with bi-fold doors. My washer/dryer is in my utility room. That room originally contained my tools and a small workbench. They have since been moved to the new addition of a detached unit, which became necessary with the purchase of a generator. The freed space in my utility room now is a garden workspace and exercise room. Changes in original plans do occur after the fact, as any homeowner can attest.

What kind of appliances will you be bringing with you or will you be purchasing? What features do you like? What are the implications of your choices for space and maintenance?

> In Jean's home, the door to the basement room where she intended to put a food freezer, dictated the size of freezer.

Eventually, she found a freezer that would pass through the doorway.

TIP

Standards for sizes of doors and entrances into various areas have been changed in recent years to facilitate access by wheel chairs. The designer of my kitchen, adhering to those guidelines (federally mandated) insisted on a minimum of three feet and six inches between the edge of the refrigerator and the edge of the bar counter.

Do you want a garage or carport? Where? With or without an attached closet at one end? If a garage, do you want it to be a dome structure?

Are you frustrated now by insufficient electrical outlets or outlets not in the right place? Do you want to get rid of all those extension cords?

I did. I made sure, for example, that outlets were installed in the kitchen at counter height in several places. I was not that thoughtful in one respect (see tip). What about exterior outlets for various purposes and locations?

TIP

If you have the choice of two options for your appliances or accessories and can't decide which will be better, have outlets installed in both places. This flexibility is particularly important if one of those walls is an exterior wall.

It is less expensive and less time-consuming to add features than having to correct shortcomings. Such happened to me. As you might guess, my choice for locating my stereo system after moving in was the exterior wall without the outlets. The telephone wire, electrical wire and cable to the satellite receiver now snake along the outer wall. They will be covered with plaster and painted to match the wall.

What kind of flooring would you like? Are installation costs a factor? Do you want low maintenance?

> I selected ceramic tile, not the least expensive flooring. It is easier to keep clean, however, and a consideration if you do not want to spend more time than you like on house cleaning. The choice, however, amplified an acoustic problem (see Chapter 6).
>
> In addition, I have a carpet runner for the heavily trafficked areas in the entryway and the short hallways, complemented with area rugs. Both add a practical and decorative touch. They also are one of the ways in which I am resolving the acoustics problem.

What are the seasonal aspects of the region in which you are building?

> We live in the North Georgia Mountains in the foothills of the Appalachians. Winter storms can play havoc with the power supply. Jean and I each have a wood stove as a back up for heat as well as for the pleasure of a wood fire. We each have since added a generator; and generators need to be kept out of the weather.
>
> Noise also dictates that a generator is located as far from living quarters as possible. For me, that meant additional wiring and an enclosed shed to house it, an after-the-fact addition that could have been done more cost-effectively during the building process.

As you proceed with these and other questions identify costs from which you develop your budget for building, including appliances, lighting fixtures, towel holders and all the other little items that you take for granted in an existing home. Keep in mind where you are willing to compromise, if necessary, but don't let on to your contractor.

I had to compromise on several occasions. The builder's recommendation to install his chosen grade of commodes was not one of the compromises. Jean had forewarned me of potential problems with builder's grade, one being the sound carrying amplification in dome homes. I then researched other characteristics of available commodes, weighing the advantages of different flushing systems, one piece vs. two piece commodes, seat contour and height. Surprising the variety available and the interesting bits of information one can acquire.

Did you know that the shape of the toilet bowl makes a difference in the cleaning power of the flush? Are you living in an older home with a perfectly good commode that predates the federal mandate to conserve the amount of water per flush? Manufacturers had to redesign commodes to be in compliance with new regulations. If you are not careful in your commode selection, you may have to scrub harder or flush twice; and there goes conservation down the drain.

Comparisons of different appliances are often in kitchen and bath magazines, and can be found in a number of places: local drug stores, near the check-out in grocery stores and building supply stores. This resource is a good check on individual conversations you may have with suppliers, who are, of course, most interested in their brand. They will, however, give a good comparison between models within a brand—leaning you toward the more expensive model. But that's your choice to resist.

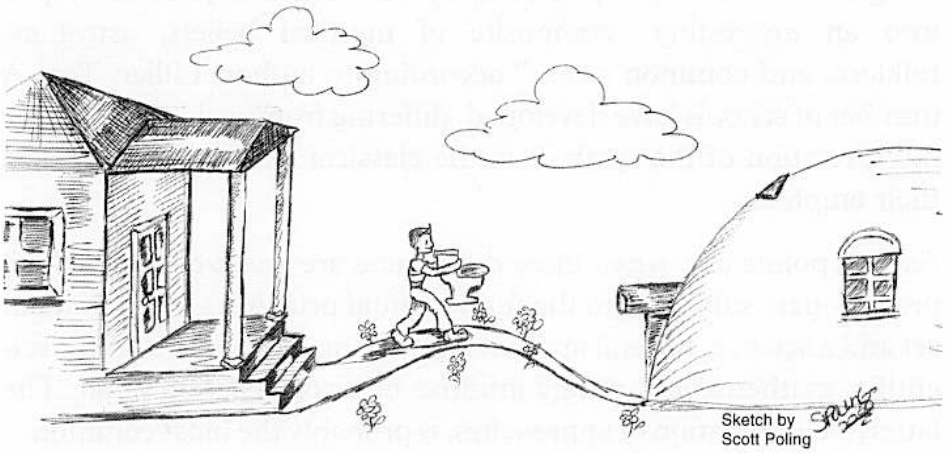


Figure 31 ***New is not necessarily better.***

Another part of the second preliminary step is optional but we urge you to consider it. Take a look at *Feng Shui,* (pronounced *Fong Schway* by some and *Fong Shoy*—rhyming with toy—by others). Perhaps the difference in pronunciation depends on local dialect as in Georgia versus New York. Feng Shui is the ancient (really ancient, about 4,000 years or more) Chinese art and practice of designing one's living and working environment in harmony with nature to promote health, wealth and happiness.

In selecting a dome home, you are already a step into living in harmony with nature by the very shape of the dome. In building your home, you are truly creating your own world, designing your space to best meet your lifestyle. Feng Shui is a practical, useful way to design your living spaces. Time, thought and consideration given to your personal lifestyle and desires will help assure joy and prosperity for many years.

To quote a common saying: "If you keep doing what you have always done you will keep getting what you have always had." Something must change to attain a new and different result.

The principles of Feng Shui give you that opportunity as you design your home. Its popularity in the United States is evidenced by an increasing number of books, consultants, and more recently television programs on Feng Shui. Even here in the rural part of North Georgia, we have at least three consultants who will evaluate your living space.

Feng Shui, from its inception and over the centuries, has developed into an interesting "composite of mystical beliefs, astrology, folklore, and common sense," according to author, Lillian Too. A number of schools have developed, differing from each other in their interpretation of the symbols in the classical texts and differing in their emphasis.

As Too points out, when these differences are analyzed, "almost all practitioners subscribe to the fundamental principles." It is both an art and a science. Several approaches to Feng Shui can be taken: scientific, mathematical, purely intuitive or a combination of all. The latter, a combination of approaches, is probably the most common.

However one proceeds, organizing one's space according to Feng Shui is centered on flow—flow of movement or traffic, and flow of energy which is unseen by most people. The latter can be likened to air currents that move throughout the house and grounds.

Three of the many good books available are: *The Complete Illustrated Guide to Feng Shui: How to Apply the Secrets of Chinese Wisdom for Health, Wealth and Happiness* by Lillian Too; *Feng Shui: Harmony by Design* by Nancy Santo Pietro; and *Feng Shui Today, Earth Design the Added Dimension* by Jami Lin.

The Illustrated Guide, more traditional in its exposition, is an excellent overview of the philosophy, principles and applications of Feng Shui. *Harmony by Design* and *Earth Design the Added Dimension*

are more eclectic. All are written clearly and give helpful examples in the practice of Feng Shui.

To tease you into the idea of applying Feng Shui, we describe briefly the Bagua, a focal tool in Feng Shui, to use as a guide along with some examples. Do indulge yourself and become better acquainted with Feng Shui through reading or engaging a consultant. The Bagua (a.k.a. Pa Qua) is an octagonal diagram divided into sectors (Guas). Jean has converted the octagonal Bagua to one in the round (Fig. 32). Note that each sector or Gua represents a particular major domain in life, thought to influence contained or defined space.

The person is the center of her or his world. Standing in the center of the Bagua, the space surrounding the person radiates out as defined by the spokes of a wheel. The section, Journey, is the area through which the individual both enters and leaves the space.

The center of the circle in which the person stands is considered to be the point of unity where all mingles. Indigenous people the world over have believed that we humans are not separate from the

Figure 32 ***A Bagua in the round.***
Adapted from William Spear's **Feng Shui Made Easy: Designing Your Life with the Ancient Art of Placement.**

influences of the world around us; and all individual elements are an integral part of the whole.

The Bagua can be likened to a map which, when positioned correctly, helps you to plan future space or evaluate current space as represented by the individual sections within it. Whether placing the Bagua over your floor plan or in your current living space, the diagram is oriented so that Section 1, Journey and/or Career, is at the entranceway to the home or room. A very clear description of correct placements of the Bagua can be found in any book on Feng Shui; but you may find the examples in Santo Pietro's book and Lin's the easiest to follow.

What you will not find is the application of the Bagua for "living in the round." The examples are all on the square. These examples on the "square" are still helpful, however. Note, interestingly, that if you connect the endpoints of each of the 45 degree sections of a Bagua as it is typically drawn, a circle fits very neatly around the Bagua. Similarly, if you bisect the midpoint of each section and connect those points a closely fitting circle is also the result.

The Bagua can be applied to the property, the overall house plan, the entire home, and individual rooms or areas inside the dome. When considering the interior design of your home, note the most

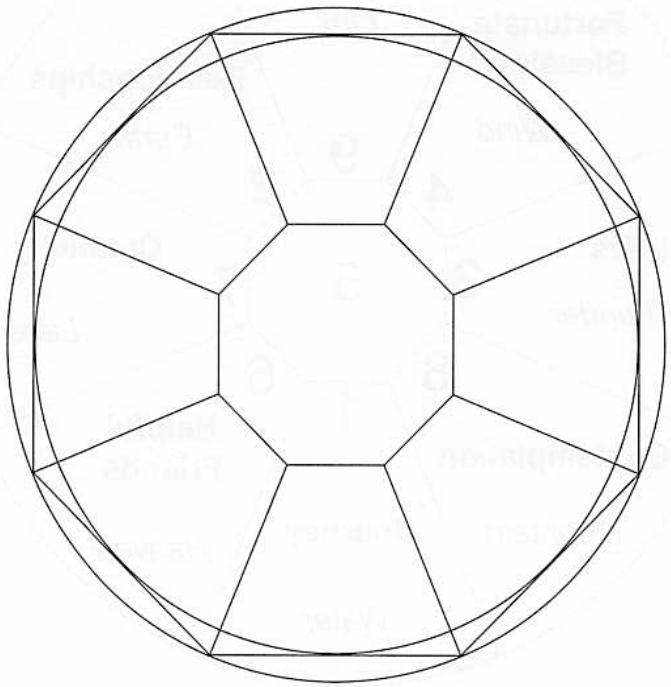


Figure 33 ***The Bagua within a circle and a circle within the Bagua.***

appropriate spaces in the dome for placement of rooms and areas according to the activity anticipated. If you have a library, you may want to place it in the knowledge area of the Bagua. That space also may be where your TV is located and where friends congregate—both, a source of knowledge.

If you want to try out the idea of the Bagua right at the moment, consider an aspect of your life you would like to improve. With the Bagua in hand, stand at the entrance to that room or your home. How does your home, the room, or area look as represented by the relevant section? Is it missing? Is it cluttered? Is the furniture correctly placed? Apply one of the solutions offered and check whether it really makes a difference; see what happens over the next month or so. We found that the references mentioned earlier on Feng Shui and several others provide a number of simple solutions to correct or enhance an area (see reference list). A Feng Shui kit designed specifically for use over layouts for dome homes is also available. (Appendix B)

With these preliminaries researched, you are ready then for the third initial step—playing with designs for your dome home. An easy and fun way to begin this process is by drawing circles. Remember you are going to be living in the round, not in a square; hence, identifying size and shape of rooms/living spaces and placement of furniture will be a new experience.

Include in your circles such features as locations of basic plumbing, appliances, electrical and phone outlets. For ideas, take a look at regular house plans you like and adapt them to living in the round. Of course, also look at plans specifically designed for dome living. Two such resources are "Dome Dwellings '99" and "Dome Living" published by MDI (see reference list).

No amount of planning will substitute completely for the actual experience of living in a dome. That experience is not possible usually; dome homes are relatively new in the housing industry and rental domes are generally not available.

An excellent alternative, however, is to visit dome homes. Ask the owners what they would do differently now. Take a camera with

BE AWARE

Avoiding the preliminary homework suggested will add considerably more time than necessary in the actual building process and be more costly in the long run. The added time or bite it may take out of your budget now will seem minuscule by comparison.

you. Before taking the final plunge, you may want to have MDI evaluate your plans. This service was not available when we built our domes. Without a doubt, we would not proceed with another dome home without taking advantage of their evaluation services.

Exterior Considerations

Our comments in this section focus on site preparation: location on your property, orientation of the dome, any grading or excavating that may be necessary, installation of windows and doors, check points during the building of the shell and after the shell is completed and an essential addition often overlooked. The consequences of decisions on grading your land, and orientation of your home are essentially the same regardless of the type of structure. Windows and doors require other considerations because of the curvilinear surface of the dome.

Dome Site

Since the dome home is built on a slab, information on the topography and the sub-surface characteristics of the site is essential. In determining the best location for your dome home, consider very thoroughly the consequences of the options you have for your site. Following are the kinds of questions to ask.

Is the land level or does it slope? That question should be asked before purchasing your land.

If the land is not level, how much dirt will have to be excavated to level the building site?

> For example, if the preparation of the site requires excavating into the side of a hill in order to level the building site, three potential problems arise: erosion of soil from the excavated hillside; relocation of the excavated dirt; and damage to surrounding trees.
>
> In the instance of soil erosion, you should have the hillside immediately hydro seeded. Hydro seeding is a process by which seeds are pressure sprayed into the side of an embankment to stabilize it and prevent soil erosion. At a later date, you can plant wild flowers, ajuga or other soil-holding and colorful plants. The green coloring that you see on embankments during highway construction means they have been hydro seeded.
>
> The excavated dirt can either be hauled away or relocated on your property. If your contractor chooses the latter with or

without your input, (preferably with your input of course) then consider the consequences. One result may be a sharp drop to the next level of your site or gullies of wash with the next torrential rain if the dirt has not been well compacted and seeded.

Unless you have an ecologically minded contractor, very little thought is usually given to the impact on trees neighboring the excavation and trees covered with the excavated dirt. In both instances, you may lose trees you really do not want to lose. The fact that the life of a tree has been compromised will not be immediately obvious. That process usually takes two years.

TIP

If tree removal is required: arrange to have the wood cut, stacked out of the way, and protected from the elements. The few extra hours spent at the time of tree removal saves time and costs ultimately, with less deterioration of the wood.

In the instance of the excavated site, trees may be weakened because their root site has been disturbed and removal may be necessary, not an inexpensive process (but you will have lots of firewood). Where dirt is relocated, trees will also die off in about two years if the relocated dirt exceeds six inches in depth under the umbrella of the tree. Your landscape architect can advise you on those issues.

Is the chosen site on bedrock?

If so, blasting may be necessary to establish a level site. The less costly choice is to move the proposed building site if possible. The original site may still be preferred even though an extra cost is involved; and that was Jean's choice.

Be sure that the contractor/builder has arranged to have construction debris removed from the construction site. The debris should not be used as fill-in either under the construction site or covered by any dirt that has been excavated and relocated on your property. Your state may be among the states that have a law against the practice of burying construction debris at the building site; still, check for

BE AWARE

Under no circumstance should you allow yourself to be persuaded to build a dome on other than hard undisturbed dirt. A related warning is to check that the property you are considering has not had dirt pushed on it from a nearby road construction project.

yourself that all debris is being removed from your property and properly disposed. If a contractor/ builder is known to have a dumpster delivered to his/her building sites to collect the debris as it accumulates, put a check on the plus side by that contractor's name for further consideration.

Orientation of Your Dome

Standing at the proposed entrance to your property, how do you see your dome home becoming part of the chosen site? Orientation of your home is usually a decision based on composite factors that will differ from individual to individual. Here are some questions to ask yourself:

Where does the sun rise and set? How does the arc of the sun traverse your proposed site?

What is the North-South/East-West orientation of your property? Doors, windows, driveway, garden will all be affected.

Where is your front door going to be?

Storms come from which direction? What is the prevailing wind direction?

Do local hills, mountains or plains affect the weather? What effect does the local topography have?

Does topography provide some protection and shelter or, do they funnel the weather toward your home?

Will the snow drift down your driveway?

Where are the mature trees and water sources? What is the quality of soil, lay of the land and proximity to streets and roads?

How much level space is available for the style of dome home you have chosen?

How do you see other aspects of your environment, such as a carport, storage unit, garden, public access to your property and outdoor entertainment area, fitting into your living space?

What about your personal idiosyncrasies?

Certainly, you would want to take advantage of features of your property and plan accordingly; for example, a view and natural barricades from prevailing winds. You also want to avoid such potential problems as steep slopes and grading that can bring a cascade of water toward your home in a downpour. Look for gullies and collection of debris as an indication of water flow.

You may want to have your bedroom face a particular direction so that the bed can be placed in a north/south or east/west orientation (as one of us did). The amount of level space and the selected dome style did not leave much maneuvering room. That particular preference took a good bit of playing around with layouts of the interior.

Having said what we have on choosing a site and orientation of your dome, we feel compelled to add also a thought from Lin's book, *Sacred Space*.

> "Even if all the Feng Shui and the geomancy signs are right, the whole thing can still be wrong if it doesn't feel right to you. When Native Americans were choosing a place to put their tepee, hogan or lodge, they did not look at all the Feng Shui rules. They just knew when a place felt right. This is a most profound method for planning the location of your home area. Trust your intuition."

Looking In/Looking Out: Doors and Windows

A dome is a lovely sight to see. In a morning frost, it will sparkle; in the moonlight, it will look like a snowball or blooming white flower and give off a snug comforting aura. Add doors and windows and some of that charm may be lost. Their design can blend into the whole ambience of the dome or it can give off too many angles disrupting the flow of the curve. On a more practical side, the design and installation can leave you with leaks, a troublesome feature of some domes.

Are choices in doors and windows any different for a dome home? Not really. You may find yourself considering a style much different from what you have had in the past, simply because of the different lines in a dome home. Doors come, for example, in solid wood, metal, with glass inserts (decorative or plain), side glass panels and even rounded at the top. Our exterior doors are metal, chosen to avoid the deterioration of wood doors that occurs in our area.

Windows may be casement, sliding, up/down, hinged, fixed and skylights, the last of which appear to be popular with many dome

owners. They also may be octagonal, rectangular and just about any geometric shape. Some shapes are more expensive than others.

With so many choices for both doors and windows, you need to consider their function. Do they provide light and fresh air or, light only? Each non-fixed style differs in the airflow to your home and protection from the elements; you may want to review those aspects before selecting your windows. The challenge is in the installation; how your choice will fit into the design of your dome.

Both Jean and I have aluminum framed, double-glazed windows, although their styles differ. I have had some minor problems with condensation, as other dome owners have had. Our local road grader thinks the best solution (based on his experience in building three conventional homes) is regular windows (i.e. not double glazed) with storm windows added. He may be right.

On the other hand you may want to consider the latest recommendation from MDI, which is to install vinyl-clad windows to avoid condensation. Should you be thinking about installing a fixed window, check very carefully into the type of installation being recommended. Problems of leaks have been reported with fixed windows of different shapes.

The type of installation you choose for your doors and windows will affect the looks of your dome and will also provide differing degrees of protection from a hurricane or tornado. MDI describes three types: recessed, the dormer, and the augmented door and window.

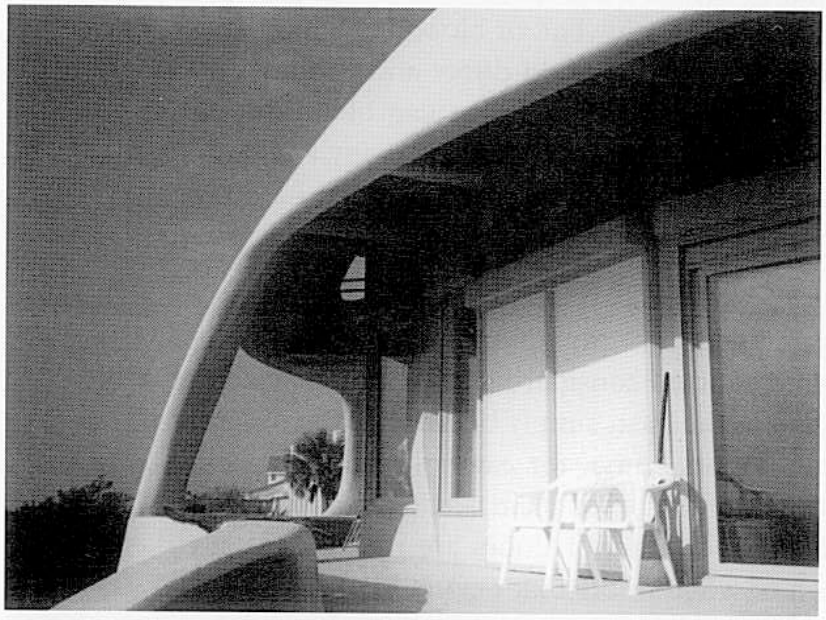


Figure 34 ***The recessed windows and doors in the "Eye of the Storm."*** *Reprinted with the permission of MDI.*

In the first type, recessed, doors and windows are designed and installed to fit inside the line of the dome; that is, installed in a secondary wall. The dome shell extends beyond the opening for the windows and doors (Fig. 34).

In the recessed design, you lose some interior space, depending on the amount the window or door is recessed. The window is protected from the weather—an important consideration.

In the second method, a dormer window is added after the shell is completed. Dormer windows require a frame (bucks) constructed out of pressure treated wood or redwood, which is installed before the shotcrete is sprayed. In the installation of a dormer window, a piece of the dome fabric is glued to the dome and extended onto the roof of the dormer and sealed in the conventional manner (Figs. 35a, b).

Interior space is not lost with the dormer style window or door since it projects out away from the dome shell. From the inside, this type of window installation gives you more than the usual size of a windowsill.

Jean and I both have windows that project outwardly.

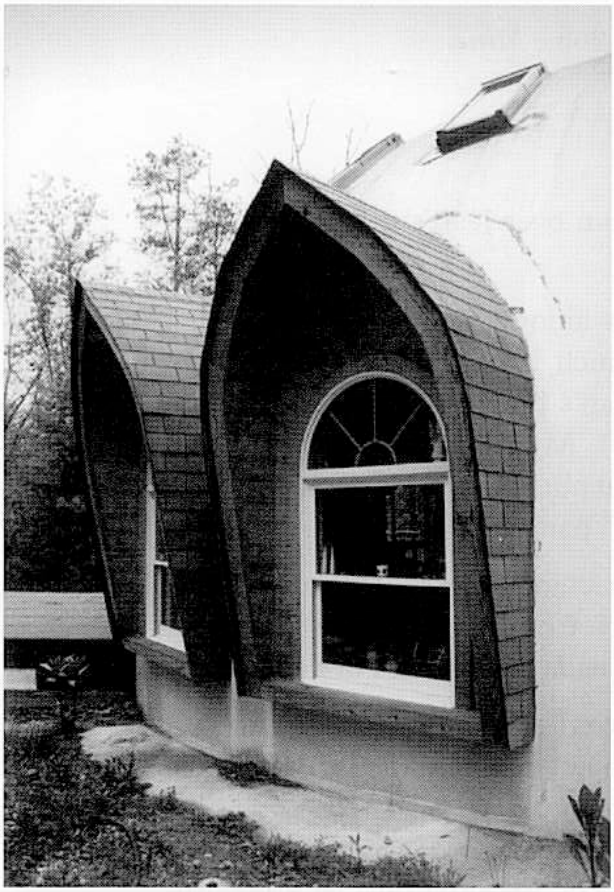


Figure 35a ***One of the dormer styles in Jean's home.***

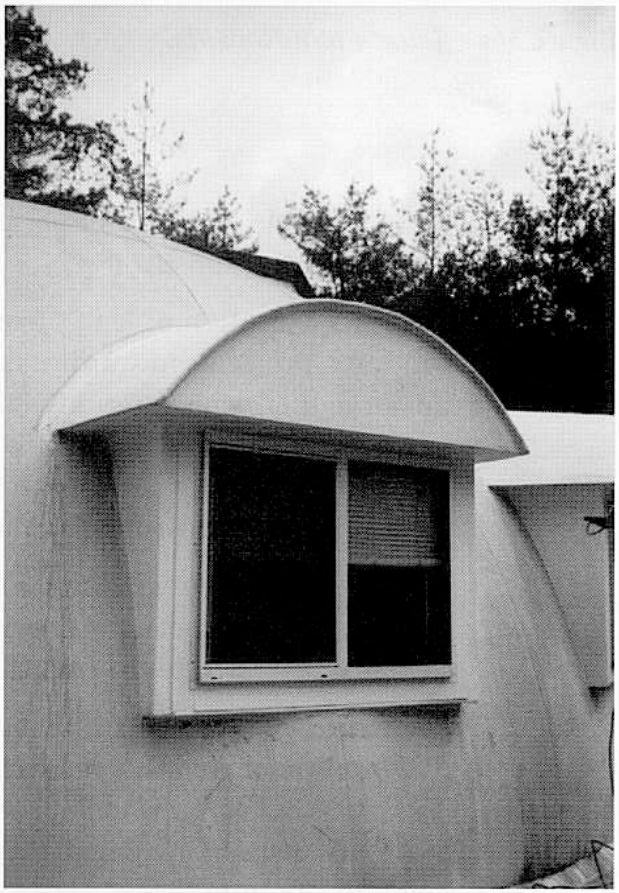


Figure 35b ***My dormer windows.***

Figure 36a ***Jean's windowsills.***

Figure 36b ***Mine.***

Note the style and type of projection over Jean's front windows, a most attractive finish.

With the exception of Jean's front windows, none of her remaining windows projects outwardly as much as Carmella's. Because of the straighter walls interiorly in Jean's home, her window sills are narrower than mine (Figs. 36a, b). My sills are 12 inches deep, enough room for a cat to look out, to put an occasional plant, books, binoculars, or a "lost-for-two-days" pair of boots.

The rest of Jean's windows are rectangular skylights that hinge outwardly from the top. The rest of my windows are triangular skylights, installed in the "roof" of each of the three domes.

The third method of installing windows and doors is one that MDI has pioneered. It's referred to as "augmentations." When the Airform is being fabricated it is augmented or "blistered." This blistering allows for the fitting of the window or door in a straight frontal plane in the dome envelope (Fig. 37). Like the dormer style, this method also requires a wood frame. As mentioned elsewhere, augmentations must be specified at the time the Airform is ordered.

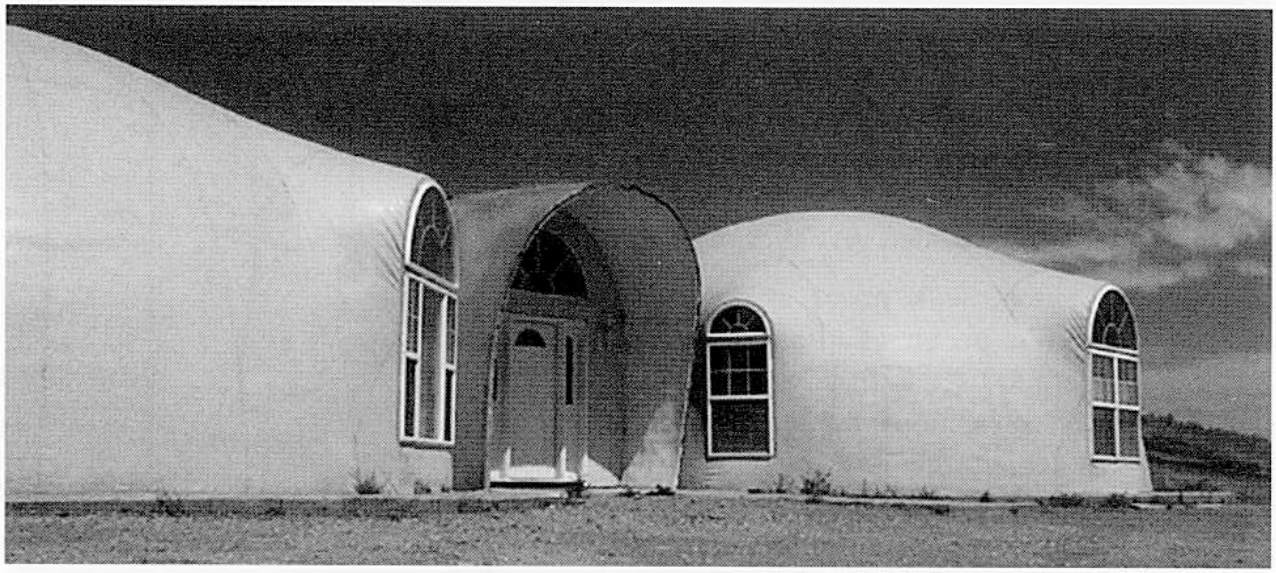


Figure 37 ***Augmented windows in the home of Randy and Karen South in Idaho.***
Reprinted with the permission of MDI.

Of the three methods for installing windows and doors, the first, (recessed) and the third, (augmented) would provide the most trouble free installation. Each augmentation will increase the price of your Airform; we believe, however, that the additional cost would not be more than the cost of adding dormers, and probably less. They also would be less prone to leaks. Based on our experience and current technology, we believe that the augmented windows and the recessed windows are the better options.

Given a sound design and installation, serious leaks should not be a problem. Visualize the careful engineering that must be done to build the bucks and the extended overhang (the dormer) on a two way curved surface: up and down, side-to-side. The projections must be precisely measured to fit the curve in two directions, vertically and horizontally; otherwise some fairly large gaps can occur, and have.

In addition, we think the missing critical element is proper flashing, like the kind used in a conventional home. It's really a very simple installation and if done correctly will eliminate leaks

Flashing normally consists of aluminum bent to fit around the object protruding from the structure, roof or wall, as in skylights, window enclosures and chimneys. For a conventional home, the flashing is bent around the skylight and onto the subsurface of the roof before the roofing material is applied, as shown in Figure 38.

In a dome home, a piece of dome fabric is glued to the dome and then extended over the dormer roof, covering the joint between the dome shell and the top edge of the dormer window. Then the edges are sealed very thoroughly.

A more leak proof arrangement should be an adaptation of the method used in flashing windows in a conventional home structure in which the flashing would be under the skin of the dome and then extended over the dormer roof about 4 to 6 inches. That method, we believe, would be possible if done after the foam has been sprayed on to the interior surface of the dome skin.

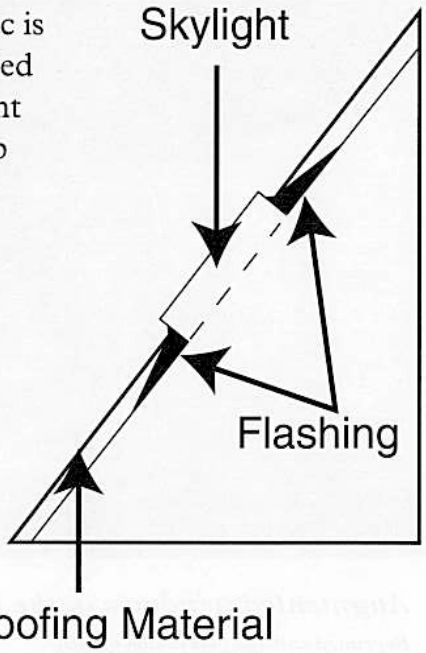


Figure 38 ***Flashing as ordinarily done in a conventional home.***

At that time, the skin of the dome is cut back at the intended openings to install the wood bucks for the doors and windows. The skin flaps are hanging away from the openings. Metal flashing could be slipped in under the skin of the dome above the opening. Envision an L-shaped piece of aluminum extending above the crease in the middle about four inches. A series of v-shaped cuts made with metal shears at the top of the arc of the L would allow it to conform smoothly to the shape of the window (Fig. 39).

Jean's doors and windows were partially installed as described above. Dome fabric was glued onto the dome skin and extended over the dormer roof. The additional sealing was missing. Jean has since had the additional sealing done and has not had any leaks. She anticipates having to reseal the edges periodically as

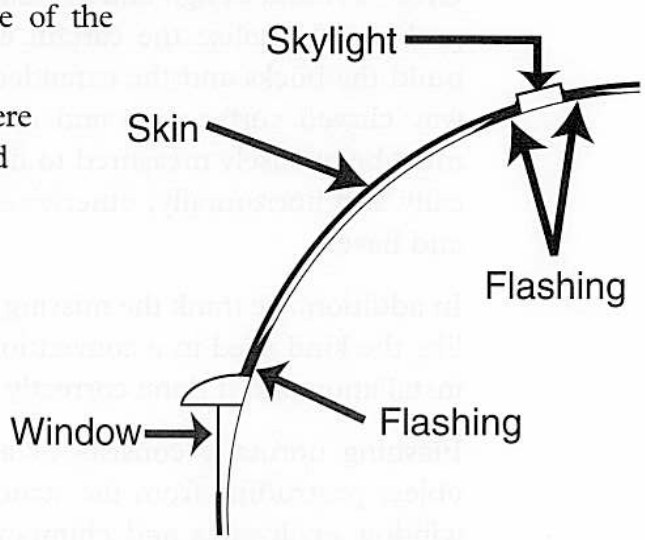


Figure 39 ***Possible flashing solution for dome skylights and windows.***

is done routinely for windows in a conventional home, because of the effects of weather over time.

TIP

In the installation of windows and doors, caulk the screw holes and the screw as it goes in. Just caulking the top of the screw exposes the caulk to the weather and it will work free in a couple of years. Caulk in the hole and sealing the screw in the hole will last indefinitely.

A persistent leak remained around her chimney. A local roofer resolved the problem by using the typical method for traditional roofs; i.e., the flashing as described above in Figure 39 and as also recommended by Michele. In that installation, the copper insert had to be molded to fit the curvature of the dome.

In my dome, flashing was not done and the initial seal of the joints with caulk did not hold. Part of the problem was the size of the gap between the two adjoining surfaces and the incompatibility of the caulk with the materials of the two adjoining surfaces: the dome skin and the stucco-like surface of the dormer.

The joints between the dormer edge and the shell of the dome have since been resealed with a caulk compatible with these two surfaces. In addition, several coats of a waterproof substance called elastomeric have been applied over the caulked joints and adjoining surfaces. This approach requires repeated applications, following carefully the recommendations of the manufacturer.

Eventually, the method of flashing dormer windows recommended by MDI will have to be done, unless another alternative under review proves to be a more lasting solution. Since Jean's solution to the leaks around the chimney has worked so well, it too, is under consideration for my windows.

BIG TIP

The best waterproofing is BUILT IN. Make it part of the design of your home. It will work automatically, without fuss and bother about flashing and caulk and all the rest of the problems that are common to home and dome owners.

A final consideration in the design of your doors and windows is the protection they afford from severe weather. In the "Eye of the Storm," the windows and doorways are protected both by design and by electrically controlled "battens" (Fig. 5, p. 7). In the last hurricane to hit South Carolina, the owners were permitted to remain in their dome home; all others were ordered to evacuate the area.

An enterprising couple developed a less costly solution for added protection for their double dome home in Texas.

> First, all doors are steel except for the French doors off the living area. To protect their French doors and windows, which are recessed about 6 inches, the owners made covers from insulation material that provide a lightweight, easily handled and stored solution.
>
> Each cover is doubled, giving the covers a thickness of four inches. When the need arises, these covers are secured to the windows with "two spring-type curtain rods;" it takes only 10 minutes to "pop" all the covers into place.

If you are at all concerned about hurricanes or tornados, then consider working recessed doors and windows into your design.

Outdoor Lighting

Your plan for outdoor lighting may include any number of wonderful devices now available for security lights, path lights, motion detectors, front and rear door entrance lights and lights by the driveway. The choices are fun and limitless.

What is important to consider in your planning is the location of your fixtures, in particular those that will be installed by your front and rear doors. If your doors will be the dormer type of installation, and you are planning to have dual floodlights or motion detectors, check the proposed wiring path for those fixtures. The wiring must exit at the front edge of the dormer—not alongside the dormer in the space between the back edge of the dormer and the shell of the dome. In such an installation, the side of the dormer will restrict the rotation of one of the floodlights and you will have lost 50 percent of the effective range of light (Fig. 40).

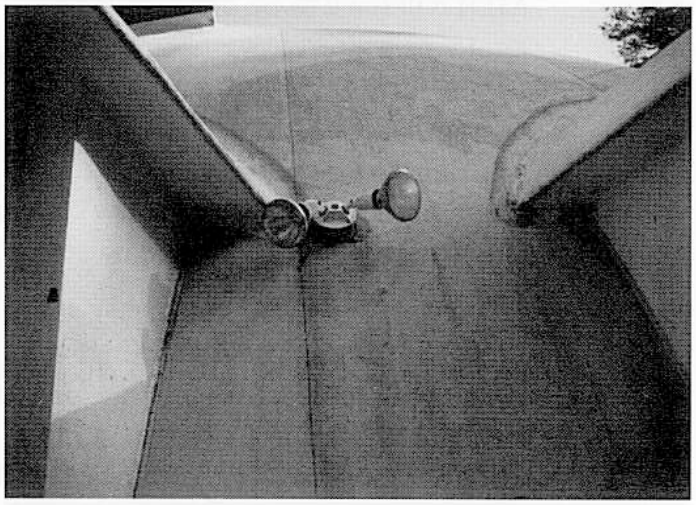


Figure 40 ***Location of this floodlight at the rear of the dormer limits its effective range.***

Retrofitting is possible but at an additional cost and it's not as esthetically pleasing. One solution is to extend the wiring through a channel attached to the

side of the dormer, relocating the fixture to the side/front edge of the dormer and capping the original junction box.

A better option may be to extend the wiring from the current junction box through a short conduit to the side of the current location and capping the original box. The capped box can be a conversation piece with some outlandish story behind its origins. Of course our admonition here is to avoid all this extra brainwork by checking with your architect or contractor/ builder on the location of all the exit points for your external lighting system.

Shell Checks

Once the shell is completed and the doors and windows installed, you begin to get the feeling of a home. The freshly completed dome glistens in the sun and all looks well. You feel great. Extend that feeling. Compliment the builder and express your hope that the dome skin can remain that clean. One of the checks for dome builders, as recommended by MDI, is inspecting regularly the skin of the dome for spots, paint drippings and any other smudges not part of the skin surface, and immediate removal of those spots. Be sure to specify that in your contract (see Chapter 7).

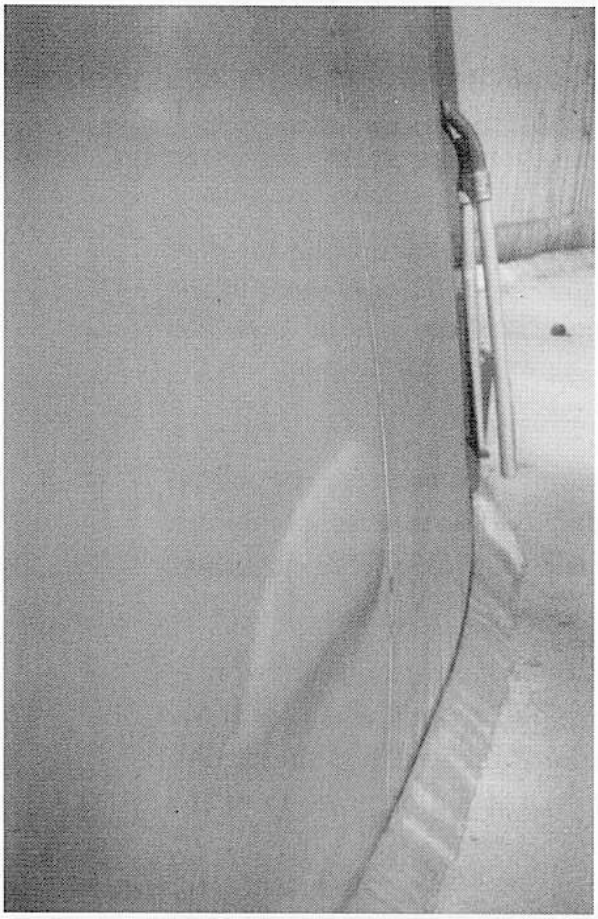


Figure 41 ***Quite a large bubble/blister.***

Take a walk around the dome with your builder. If you see smudges remaining from workers' hands, drips of paint and streaks of caulking, have them removed. Check that the paint on the doors and windows has not been sprayed onto the rubber molding, both inside and out. Paint reduces the flexibility of the insulating rubber molding. The longer such stuff remains where it is not supposed to be, the harder it is to remove. Have it done now. The longer you wait to have it removed, the more the cost in time and money.

On your walk-around the dome, also inspect the integrity of the skin. Sometimes a bubble or blister, as MDI refers to this condition, may appear (Fig. 41). A bubble or blister is considered primarily a cosmetic problem.

What causes bubbles? Originally, (1994) MDI stated it did not know. What was known at that time was their occurrence in all seasons and in varying conditions. Possible reasons given were water trapped beneath the Airform, excessive probing of the foam to determine proper thickness during the spraying process or moisture from the spraying of the urethane. MDI suggested water traps in the air supplying the gun for spraying.

MDI's solution was to use an ice pick in the blister at its lowest point. The trapped water can then get out. As the vapor pressure decreases, the blister will shrink. With the shrinking all signs of the blister will disappear.

One builder who has had some experience with building domes suggests that blisters result when the foam is sprayed improperly. Having watched the foam spraying process, we recommend that a professional do it with considerable experience in spraying. These professionals are almost working in the blind in an enclosed area, with only artificial lighting available as they move along the walls.

More recently MDI elaborated on the problem, reminding us first that blistering is common to all types of roofing. It is minimal, however in the Monolithic Dome because of the materials used. Not all domes experience blistering. MDI describes the process producing blisters as follows.

> "Blisters are caused by water vapor driven through the roof membrane or trapped under the roof membrane and in the very top layer of the urethane. The sun's heat turns the trapped water to steam. Until the water vapor is released, the blister will continue growing."

That explains why the blisters in my dome , with one exception, did not begin to appear until a year after the building was completed and several more have since appeared. I tried their solution on the blister shown in Figure 41. It worked.

As you continue your inspection, also look for any patching that may have been done in the dome skin, which can pull away from the underlying foam. I discovered such a patch in the skin of the section connecting my two domes but only after it pulled away from the underlying foam as shown in Figure 42.

Repairing a patch is simply done using special glue available through MDI. But that should not be your responsibility. Neither of the two

conditions, bubbles and blistering may occur immediately; hence, the importance of a warranty (see Chapter 7).

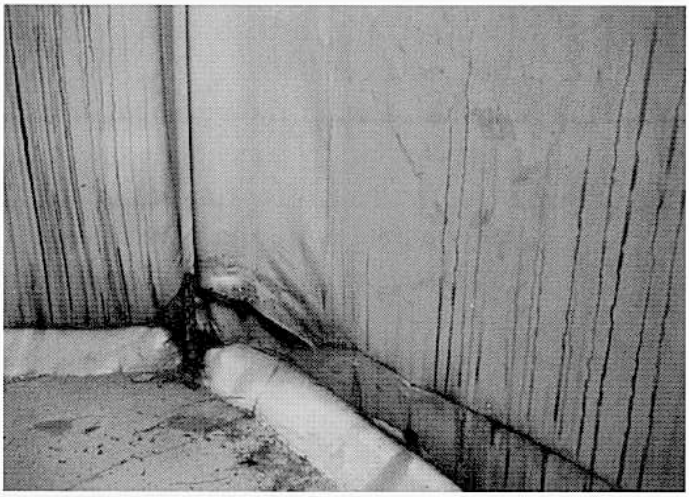


Figure 42 ***Pulling away of the skin from tension on the patch.***

Finally, in your walkabout you may not notice that "something" is missing. It may not be missing if you have a savvy contractor/ builder! Or you may not miss it until the first rainstorm. As the water flows beautifully down the domes on all sides you suddenly become aware of the pooling of water in various spots depending on the lay of the land. Aha . . . the "it" is down spouts! No, they won't work for a dome home.

Owners of dome homes either slope the land away from the dome to allow for drainage downward or, do as several of us have done here. Build a concrete pathway, all around the dome, smack up against the side of the dome. My pathway is about 18 inches in width, and slopes a bit from front to back. At the main entrances of my dome, front and back, the pathway extends out in a semicircle to provide a wider entry surface (Fig. 43).

Figure 43 ***Footing around the dome, expanded at the entryways.***

The footpath to both doors will be sloped to meet the extended entry surface. Both entrances, front and back, will then be handicapped accessible. Our neighbor who lives in a Geodesic dome has what we think is a neat example of a footing. He did not slope his pathway to allow for run-off. Instead, he had small channels cut into the concrete at appropriate intervals, to match the angled spots of the geodesic dome where run-offs occur (Fig. 44).

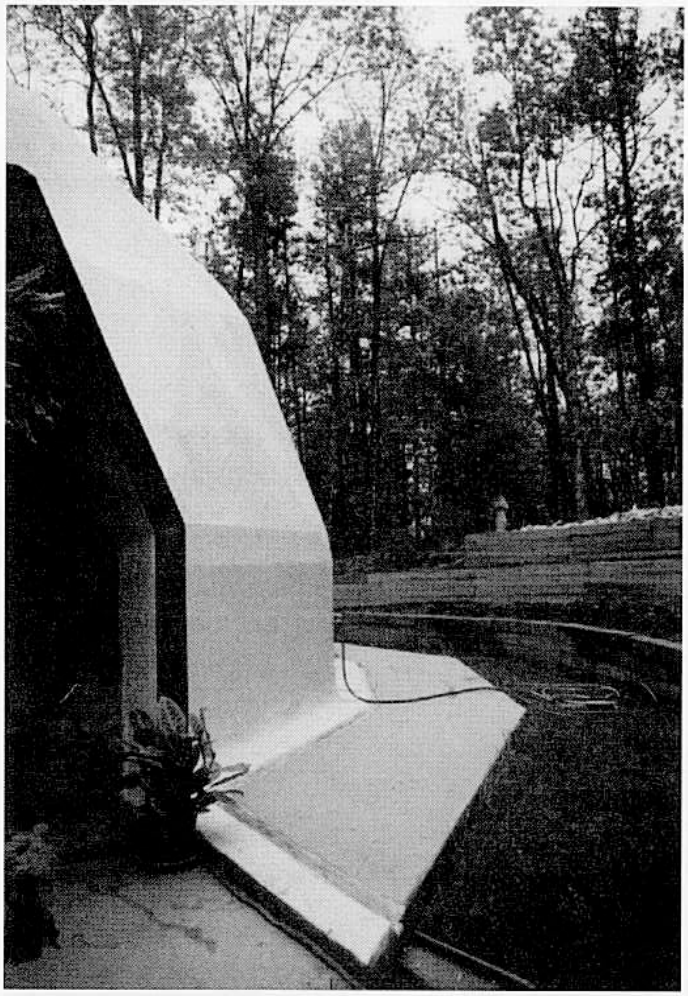


Figure 44 ***Footing around a geodesic dome.***

Figure 45 ***A snow capped dome.***

One of the pleasures for dome dwellers is insulation from outside noises. We become accustomed to a quieter environment than one finds usually in a conventional home. Imagine my alarm the first time I heard a very loud and unfamiliar "swoosh" sound. That alarming sound became a delightful one once I identified the source. It was snow from the previous day cascading down the sides of the dome with the warming of the sun (Fig. 45).

6 Interior Design Elements

When a mistake occurs, work it into your design.

—A seventh grade art teacher
to a forever grateful pupil

You have thoroughly inspected the exterior and are feeling quite good about the work done thus far. The windows and doors have been satisfactorily installed; your dome home is now snug. You are inside the shell of your dome.

The interior has been swept clean of all construction debris, without lopping off the tops of the extended drainage pipes. This can happen when a strong and diligent worker scrapes off the shotcrete that splatters onto the slab during the spraying process. Eliminating that cleanup is the one advantage we see to the two-step process of pouring the slab (see Chapter 3).

Materials for finishing the interior may have arrived and are neatly stacked for the next and final stage—completion of the interior as you dreamed and designed it. Make an effort to be in your dome home by yourself, after the workers have gone home and before the interior work begins. Your dome is yours only for the moment, until it is completely finished. It's a special moment, not to be experienced again (unless, of course, you decide to build another one several years down the road)!

Sit in the center of your dome; your view of the interior is unobstructed. It is peaceful and so quiet. You are insulated from outside noise. Sing, tone, call out; check the sound as it reverberates in this beautiful bowl-like structure. Savor the moment and know that it is the beginning of a happy dome home. Tomorrow, the workers will

be back, hammering away, transforming the empty space into the shapes that you designed for it.

Now what practical thoughts must be your focus and what are the "red alerts?" In this chapter we zoom in on those aspects particular to the dome style of home as we experienced them. These include:

- a recommended finish to the exterior walls;
- interior framing and walls;
- interior lighting plumbing and heating;
- flooring; and,
- acoustics.

Interior Walkabout

The capped drainage pipes are clearly visible. None appears to be missing or been "relocated" during the pouring of the slab. The locations to complete the interior wiring are also clearly evident.

What you need to look at very carefully is the bottom edge of the exterior walls. Are they ragged and lumpy or are they smooth? The difference is an indication of the skill and experience of the sprayer. You want a smooth bottom edge. Tiling up to or carpeting to the outer walls will be so much easier.

Compare the differences between the two photographs that follow. In the former, the bottom edge is smoother than the latter (Figs. 46a, b).

Be sure to specify the kind of bottom edge you expect in your contract with the builder. Despite that foresight, you may still have ragged edges. The simplest and most cost effective solution is smoothing the bottom edges while the concrete is still wet. After that

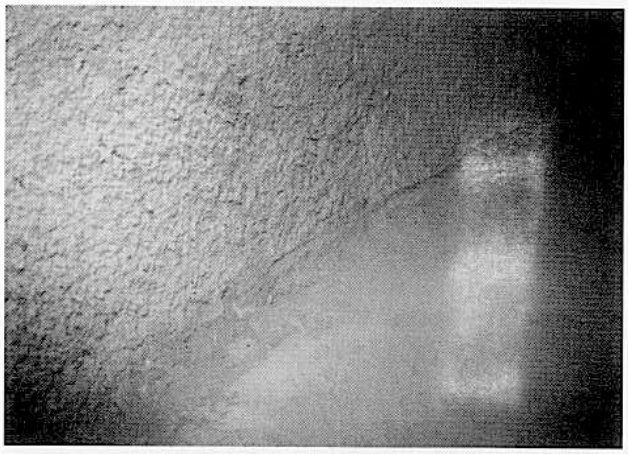


Figure 46a ***Smooth edge.***

Figure 46b ***Rough edge.***

opportunity is missed, the lumpy edges can be smoothed with a layer of cement over the bottom edge; then painted to match the rest of the wall, preferably before any interior work is done. It's a messy job. MDI published a more elegant version of smoothing out the bottom edge in their summer issue of the *Roundup* 1997:

> *A concrete adhesive was applied to the dome wall, about 4 inches up the wall, followed by cement grout with a quarter round edger (known also as a bull nose edger). The edger is available in several widths and offsets. The one recommended is a four-inch edger with a ½ or ¾-radius offset. The grout is smoothed with the edger until one gets the desired shape. When set, the "baseboard" can be painted.*

A nice solution but it may not apply to all situations. For example the rough edges, shown in Figure 46b, will require cementing at an angle because of the variations in depth, horizontally and vertically. The method described previously also should be done before interior work begins. It can be done after the fact if one has a tile floor, without creating too much of a mess. If you plan to have the exterior walls troweled to a smooth finish or stuccoed, as discussed below, that would simultaneously take care of the bottom edge.

TIP

The same care must be taken with electrical outlets in an exterior wall. The surface area surrounding an outlet box should be troweled while the shotcrete is still in a relatively wet stage. Otherwise, you may have problems fitting the surface plate to the outlet box.

Interior Framing and Walls

Interior framing in a dome is generally quite basic, except for several important exceptions: squaring your walls, the finishing of the exterior walls and the problem created by butting a wall to the curved surface of the dome. Before any interior work begins, other than the finishing of the edges of the exterior walls discussed above, the location of the interior walls needs to be identified.

Imagine you are preparing to mark the lines on the slab for the framing of the walls. At this stage of building, you and the contractor are within a circular structure. The only reference points are the doorways and the windows. A straight line can be eyeballed (as has been done) from a reference point that has also been eyeballed. Or

the chalked string method of placing the lines on the concrete floor can be used, assuming that the chalked string has been dropped from a true reference point. We do not recommend either of these two methods.

A more accurate approach would be to use the rods that you had installed before the slab was poured as reference points. If you have done that and the builder then proceeds to mark the lines for the interior framing with the aid of a transit, a giant step has been taken to assuring straight frames vertically and horizontally.

Doorways and windows can also be used as initial reference points, assuming an accurately scaled blueprint and the contractor's adherence to that blueprint. Whichever reference point is used, the most important aspect is the use of a transit to sight and mark the lines.

You might also want to mark the locations of major items such as a commode, lavatory and a sauna. You may be surprised how the location of these and other items can differ from what you thought were their locations on the plan or blueprint.

Three-quarter walls or less in height adds to the open feeling of a dome; their height also helps to distribute available light over a wider area—a very nice effect. If you choose to have walls that are three-quarter or less in height for a good part of your dome then the next point at which you want to be sure that the framing remains true is in the actual installation.

The framing, although guided by carefully marked lines, can be literally knocked out of alignment using the nail and hammer method. To avoid this, be sure to use the right tools and hardware. The secret is threaded wood screws and driving the screws with a powerful drill such as a hammer drill. This approach avoids banging on the two by fours, which will shift the walls laterally and from top to bottom. So simple yet so effective and easier than hammering in six penny nails. The same care must be taken when the interior walls are hung, whether they are wallboard or panels.

The importance of squaring the framing with the proper tools cannot be over emphasized. It makes a difference, for example, in the installation of the kitchen cabinets when corners are not squared. It makes installing a full-length mirror on a curved surface more of a challenge than you would like; it makes a very visible difference if you choose to tile most, if not all of your floors. Don't let the potential problems of three-quarter walls keep you

from enjoying them to their fullest, because now you know what can be done to avoid those problems.

Many dome dwellers choose to leave the pebble-textured surface of the exterior walls as sprayed, liking the effect. If the spraying is expertly done the problem with butting an interior wall to the curve pebble surface is greatly lessened. The more experienced the sprayer, the smoother the texture.

Some dwellers choose to have the exterior walls troweled to a smooth finish after the spraying has been completed. It's a messy and expensive job and should be done before any interior work is begun. If you choose to leave the exterior walls as sprayed, butting an interior wall to the curved surface will really reflect the craftsmanship of the carpenter. The craftsman will have a smooth fit with very little caulking necessary between the wallboard and exterior wall (Fig. 47a). The less skilled individual will rely heavily on caulking to fill in the many gaps (Fig 47b).

Figure 47a ***Smooth joining of interior wall to the exterior wall.***

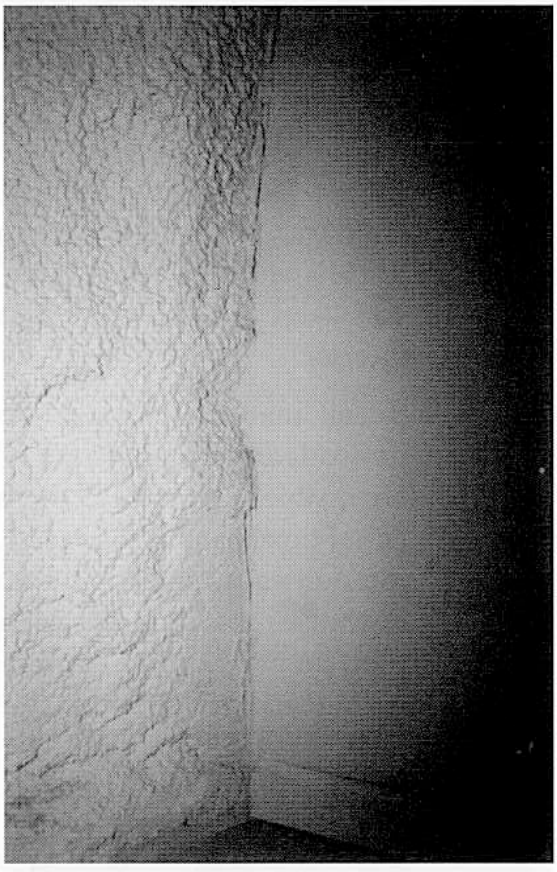


Figure 47b ***Rough joining. Note the excessive caulk needed to fill the gaps.***

We have seen both types of installation. Go for the craftsman. He or she may charge a bit more, and the time involved may be longer, but it's worth it.

There is another alternative that would make the fitting of an interior wall to an exterior wall easier. First, let's assume that the placement of the interior walls has been marked correctly on the slab. That mark can be extended up the exterior wall and the marked wall section can be troweled smoothly with some additional mud, but still use a skilled carpenter.

In your general reading of building basics, you may not learn much about the materials available for framing. The more familiar framing material is wood. It is the more traditional and commonly used material.

Although metal framing is less familiar, you may wish to consider it. It does not burn; it is less expensive, easier to work with and is movable. It is also more malleable, making rounded corners possible. I would have chosen this option had I known about it. For Feng Shui advocates, sharp edges and corners are perceived as "poisoned arrows" cutting into the energy of the room or area.

Lighting

Interior lighting in a dome home is probably not like anything you have ever done. Lighting, properly installed, will only enhance your dome's unique interior How to do that is really not complicated, if you keep in mind the uniqueness of the dome structure and its interior.

Recall that the primary wiring is in the conduits that are now imbedded in the shotcrete (Chapter 3). Only the tagged extensions are visible to complete the wiring for the interior lights, electrical panel boxes and appliances. Any additional wiring, except for the interior walls, is possible but not without some retrofitting (to code, of course) that does not detract from your lovely dome home. What then do you need to know to ensure good results and avoid future wiring challenges and frustrations?

Wall Light Fixtures

The mounting of lighting fixtures on interior walls is obviously not a problem; standard practice applies here (Fig. 48a). Installing lighting fixtures on exterior walls, however, is an entirely different matter. If you want fixtures for your exterior

walls, plan very carefully. Remember, the walls are curved; and the extent of curvature depends on the height of the installation. Imagine my surprise when I walked into my guest bathroom and saw how the light by the door leading to a back patio had been installed (Fig. 48b).

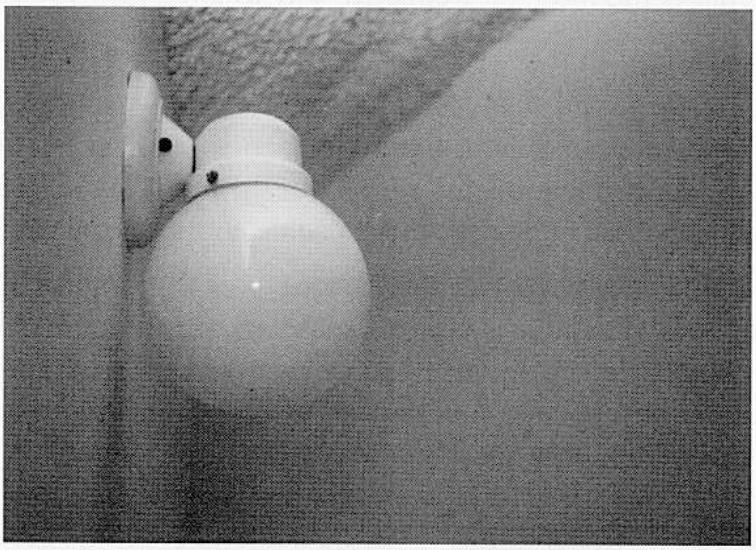


Figure 48a ***Light fixture on an interior straight wall.***

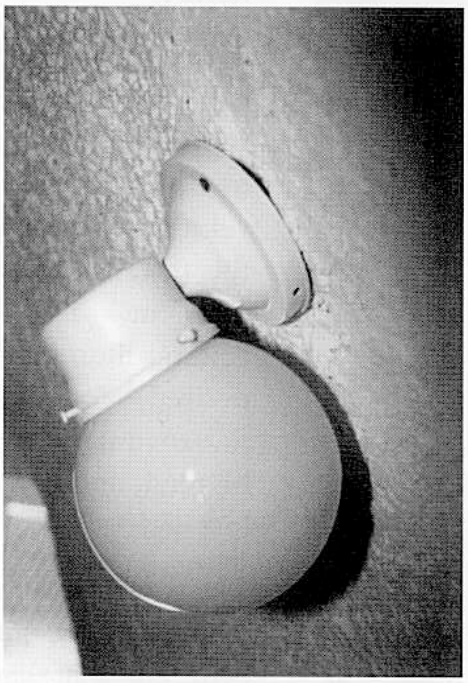


Figure 48b ***Same fixture on an exterior wall.***

Fixtures on exterior walls have to be fitted to the curve. That means customizing the installation; for example, a non-flammable addition to the fixture, shaped to the curvature to bring the bottom edge of the light away from the wall.

The cost of customizing will be less if you have planned ahead. Or you can design your interior lighting without fixtures on the exterior walls. That is the more cost effective way to go.

Ceiling Fixtures

The effectiveness of ceiling fixtures depends in great part on the height of their installation and the size of the light source. Consider using the expertise of an architect to achieve the lighting effect you anticipate.

In a multilevel dome, installation is standard and the lighting works, as you would expect because of the built-in ceilings from which lights can be suspended. Your choices are many, including recessed lights. On the upper levels where the ceilings are sloped, or as in a single level dome, three variables, in particular, determine the ease of installation and the effectiveness of lighting: height of the ceiling, the degree of slope, and the type of fixture.

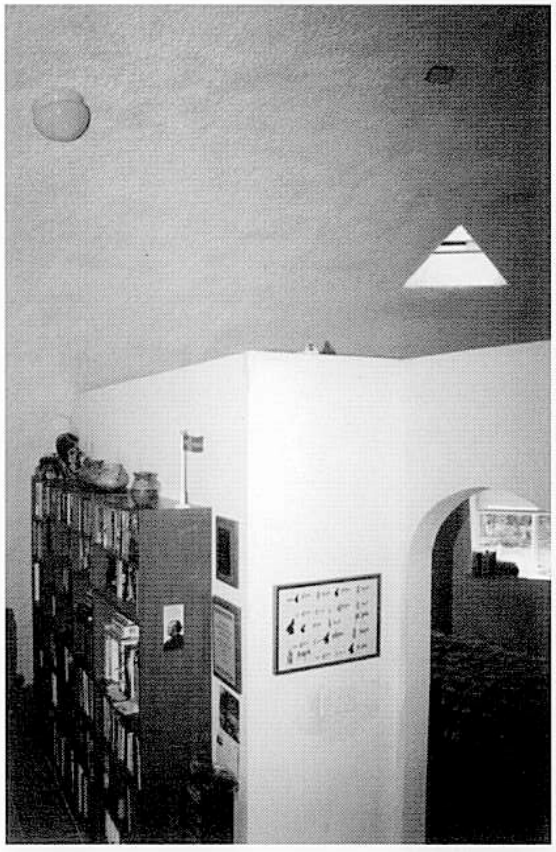


Figure 49 ***Ceiling fixture, slightly off center of a twelve foot high dome.***

The light in Figure 49 is on the ceiling of a single, 32 foot dome. Its ceiling at the center is 12 feet high. The fixture is off centered, yet a neat fitting was possible and the installation did not pose any problem. This light provides general illumination (all that was desired) for removing piles of folders and papers off the floor to be filed; and sometimes, to find a lost article.

The two dark squares to the right by the skylight are outlets in the master bedroom that have been capped. Lighting needs are met effectively in that room through fixtures other

than a ceiling light. For general reflected lighting, two fluorescent lights were installed on the top of the partial wall—a bookcase/bedroom closet wall. This arrangement provides softer lighting and supplements the light from the one ceiling fixture, when necessary.

In a single level dome, two characteristics in particular need to be considered from the perspective of effectiveness and aesthetics: the slope of the ceiling and the size of the light source.

I capped off all wiring outlets in the ceiling in all three domes, with two exceptions—one in my studio and one in my study. I found them ineffective, even for mood lighting. The three single-track bulbs in separate locations on the ceiling in my center dome appeared to me as "pimples" against the expanse of the ceiling. Above all, they really did not provide any lighting advantage worth the cost of the original wiring and the fixtures themselves.

I solved my lighting challenges (aside from the usual table, study, bedside lamps) with small halogen floor bulbs to wash the walls and plants with light, a torchiere and fluorescent bulbs (hidden) at the top of my kitchen cabinets and other three-quarter walls to illuminate the ceilings. Washing the walls with light from top down or bottom up gives off very nice effects (see earlier photo, Fig. 29, p. 46).

Consider also the validity of the ideas to which you have been exposed and to which you are accustomed from living in a conventional home. Before living in a dome home, I lived in a two-story, contemporary home. Most of the living spaces were walled in. It made sense then to have light switches strategically located from which I could light an area before entering into it. I liked that and had this capability added to my lighting design for my dome home.

As sound an idea it was to make sure I had enough switches, it was overdone. Only three of the several switches installed are used regularly. Unless you are familiar with dome home lighting conditions, natural and artificial, have an architect evaluate your ideas for adding light.

If you are interested in the latest technology in lighting difficult places to reach (like replacing light bulbs in dome ceilings) check out fiber-optic lighting. It is just beginning to be applied to the home market. It is still very new, expensive, and not all electricians are trained in this technology. Eventually, entire homes may be lit with fiber-optic cables.

Interaction of Wall Colors and Lighting

The colors of the walls can either enhance or dampen lighting and affect the amount of available light. Painted walls will also affect the hue of the color reflected into the room. The concrete walls with their pebble texture can give off interesting effects, depending on the color selected for painting.

Our walls are "white." Have you been to a paint store lately and looked for "white" on those little sample tabs? You then have to choose which color "white" and that is a matter of personal taste.

Jean alerted me to the refraction of light from the walls, and the color that may be reflected into the room. Jean's first choice of white gave off a yellow hue not to her liking. After painting the walls with different versions of white, she finally got the light refraction she wanted.

I was not about to experience the same! Fortunately I liked Jean's walls. Prompted by Michele, I simply picked up the many white swatches at the local home building and supply company and compared them to Jean's walls to help me select the correct "white" paint . . . an easy solution that worked, saving time and money. All we can say here is be careful in your selection of color for your walls.

Jean's walls, however, have benefitted from all those extra coats of paint. Every depression appears to have been well covered. Not so on my exterior walls. They have only a primer coat and a finish coat. Another coat would have helped to get more paint into and over the textured surface, which is more "textured" than Jean's exterior walls.

The shotcrete finish (smooth/rough) seriously impacts the painted finish. The rough finish will require at least two to three times the paint and will still result in an uneven look because of the exaggerated peaks and valley. Our admonition here is to check the coverage of the painted exterior walls immediately after the paint has dried. If another coat is necessary, spraying the additional coat will be much easier to do before interior framing begins. Better yet, do all that is necessary to get a smoother sprayed finish of the shotcrete, as we discussed earlier.

Plumbing

Generally, plumbing installation in a single dome, single-level or a single dome, multilevel is not different from a conventional home. As we recommended in Chapter 3, however, be sure to familiarize yourself with the basics. You still need to know what is going on from the time that the primary plumbing is laid until all appliances are installed.

You also need to know the options you have in energy sources and appliances because of the air tightness and extremely efficient insulation of a dome home. You may find yourself considering energy sources and appliances that you possibly would not consider if you were building a conventional home.

In this section, we comment on plumbing layouts for interior needs, and special considerations for heating and air-conditioning, water heaters, the standard energy sources—gas and electricity—venting to the outside.

Proper location and appropriate types of major plumbing appliances can save you money. In the design stage, consider carefully the location of your bathroom(s) and kitchen; location and type of water heater; and gas vs. electricity for cooking and heating your dome.

A general rule is to concentrate the bulk of your plumbing needs in one area. Doing so reduces the cost of materials and labor. That is why in many plans you will see a kitchen back-to-back with a utility room and/or bathroom. The most efficient layout would be in a single-level, single dome.

In a multilevel dome home, such as Jean's three-story dome, the plumbing layout can be laid out pretty much as in a conventional three story home. As mentioned earlier, the primary plumbing in the dome structure is embedded within the concrete. The secondary plumbing layout is primarily vertical. Drainage pipes and ductwork are routed though the ceiling and within walls, from one level to the next.

TIP

In Feng Shui practice, plumbing is best kept away from the core of the dome. Your good fortune will not drain away through your sewer system.

In a multidome, single-level configuration, as in my home, the primary plumbing is laid out horizontally across three domes. I was able to minimize some cost by back-to-back plumbing in two areas.

In the east dome, the kitchen and master bathroom are back-to-back. In the west dome, the utility room and the guest bath are also back-to-back. The sauna did not require any plumbing. The only plumbing not connected in this manner is that for a sink located in the third bedroom, which was converted into a studio (Fig. 50).

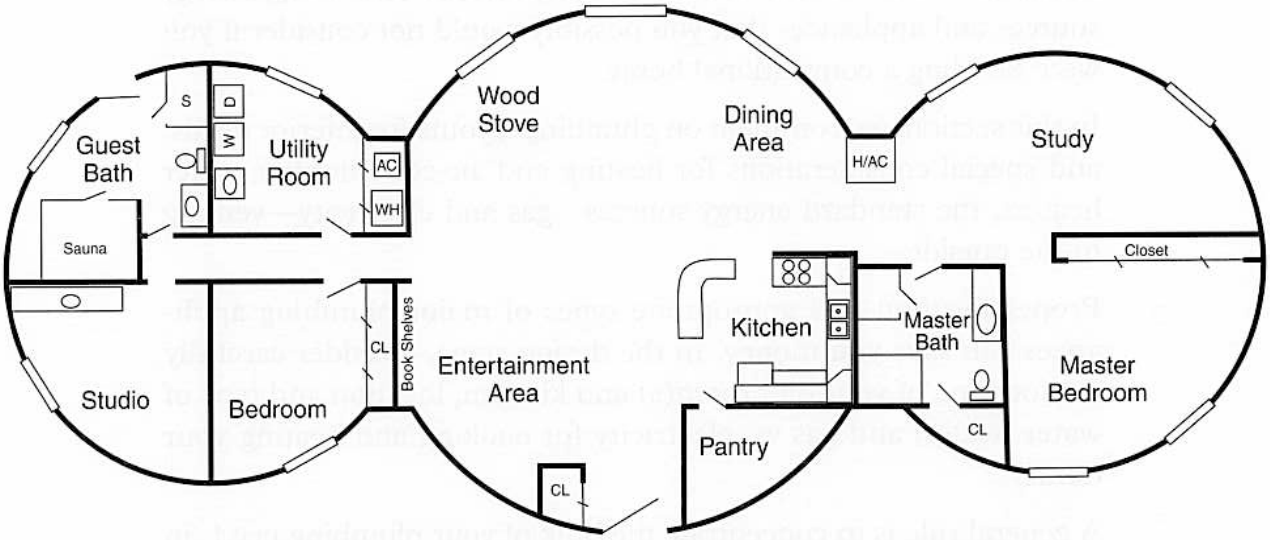


Figure 50 ***Interior layout showing locations of major plumbing to conserve installation costs.***

Water Heater

In dome construction, the source for hot water must be specified before the primary plumbing is laid and covered by concrete. To supply hot water, Jean and I both installed a gas water heater, run by propane gas, with proper ventilation. Natural gas, piped in, was not an option; we live in a rural area that does not provide that service. Our general heating source is electricity.

MDI discourages the use of natural gas or propane for hot water and general heating. One reason is economics; domes use so little heat that savings are little in using gas. Gas furnaces usually cost much more than small electric heaters. The savings in gas do not equal the costs of electricity.

Another reason is safety; gas is dangerous in confined spaces. No home is as air tight as a dome. Health problems could occur if the Monolithic Dome is kept closed and gases do not escape. A worst-case scenario would be . . . an explosion.

Gas can be used if it is properly vented. MDI suggests using a separate structure just outside the dome to house the furnace, water heater and any other utilities. If you are considering electric generators and battery storage for solar cells, a separate structure is also recommended. Even when such appliances are housed in a separate structure, proper ventilation is most important.

We were not aware of MDI's reservations in using gas as a source of energy in a dome home. In our part of the country, the use of propane gas is common practice; our builder made certain that our water heaters were properly vented.

The location of the water heater does not present any problem in Jean's dome, with secondary piping running through walls from one level to another. In my dome, hot water must travel a good distance through the primary plumbing in the slab to get to the kitchen and to the master bath. Consequently, the water takes considerably longer to become hot. This layout results in wasted water and energy while waiting for the shower, or tub water to get hot. One solution would have been to have the main water pipe come in at the utility room that is opposite the adjoining border of the kitchen and master bath, the area of greatest daily usage.

A more efficient and cost effective option would have been a "tankless water heater," not to be confused with "point-of-use" electric water heater, as commonly happens. One such "point-of-use" electric water heater, the Ariston, as advertised by Jade Mountain, Inc., is intended for limited use in a bathroom far from a water heater, or for a sink in an outside building, garage or workshop. It is a four gallon plug-in unit, 14" × 14" × 12".

The tankless water heaters (a.k.a. Demand Water Heaters) are replacements for conventional water heaters. These units turn on only when one wants hot water. They have long been very popular in Europe, and may become more popular here. One of the home improvement chain stores in the Southeast has begun carrying the "AquaStar," one of the brands advertised as tankless water heaters.

The on-demand water heaters are more expensive than the conventional type but presumably pay for themselves in two years in reduced energy costs. They last a lifetime in contrast with the

conventional water heater, which has a limited warranty—between five and 10 years. Conventional units may last much longer than the warranty period, depending upon the condition of the water, the amount of use and general maintenance. Nevertheless, its lifetime is less than that of Demand Water Heaters. Warranties are, after all, designed to protect the manufacturer, primarily. The manufacturer really expects his or her product to last longer than the stated period.

In the "Ask Norm" column in *This Old House*, the following response was given to a reader asking about switching from a gas-fired 40 gallon water heater to a tankless water heater, for a family of four:

> " . . . you get continuous water for one person taking a shower, but if you have more than one shower going at once and try to run the dishwasher at the same time you'll likely need more than one point-of-use heater if you switch from a more conventional system."

We have experienced such a system in a small rental dome and found the immediate hot water delightful; but we were not running the dishwasher at the same time. The key in the above quote appears to be assessing your need for hot water and then determining whether you can get by with one unit or whether you will need additional units.

Jade Mountain makes this comment referring to a full size tankless unit; "Easily provides enough hot water for showers and washing machines but more effective when only one demand at a time." Evidently a retrofit with a tankless water heater is possible; and certainly is worth considering when replacement time comes around.

Our former neighbor incorporated both solar energy and hot water on demand units in the design of her dome. Based on her assessments she had two units of the Paloma installed (Fig. 51).

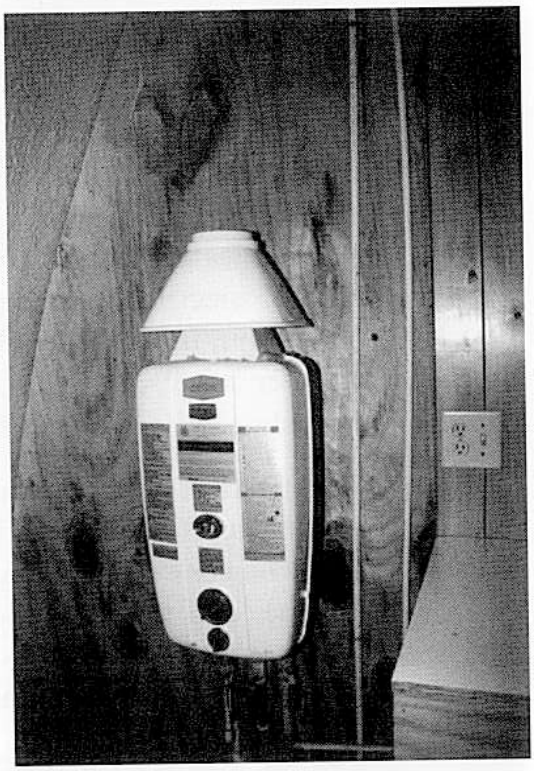


Figure 51 ***The installed Paloma, water on demand unit.***

One unit services a bathroom on the main floor and a bathroom on the third level of her dome; the second unit services the kitchen. The availability of hot water is not a problem.

Heating and Air Conditioning

For Jean and me, dual heat pumps were recommended and installed in our domes. We know of one other dome dweller who also has the same system. The three of us have found them effective; however, we do not use them as a source of heat and air conditioning as frequently as one would in a conventional home.

Our energy bills are one-third that of others in our county. We do wonder, nevertheless, whether a more cost effective and efficient method would have been possible, with at least savings in initial unit costs, plumbing and space.

How were the BTU's determined? By guess and by golly. Seriously, in our review of the literature and current practice in heating dome homes, we did not find a standard formula for determining BTUs as it exists for the conventional home. Recommendations appear to be based on experience. When I consulted with a representative from a local heating and air conditioning company and from the local power company, I was told that the standard formula did not apply. And that continues to be the case according to an article on Heating and Cooling Systems that appeared in the Spring 2000 Issue of the *Roundup*. We suggest you read it in its entirety. In this article, David South discusses why "factors that mean almost nothing in conventional structures are important in Monolithic Domes" and he presents the results of their experiences in heating and cooling commercial and residential domes.

The example is given in which heating a conventional home in the northern United States would take approximately 10 watts per square foot. A 1200 square foot, well-insulated conventional home would take then about 12,000 watts of heat. The same square footage in a Monolithic Dome can be heated with about 2 watts of heat psf. Heating systems are not designed for that small amount of output; hence, their recommendation "of using small electric heaters throughout the house or better yet, a circulating hot water heat system in the floor." For cooling, the recommendation is one ton for every 1000 square feet of space.

The company I consulted was aware of the much higher effectiveness of the insulation in a dome home, in comparison with the

conventional structure. So they gave a best guesstimate based on their experience of installing dual heat pumps. That recommendation was one-half to one-third the BTU's ordinarily required for a conventional home of comparable square footage.

For me, however, the recommendation was two separate units, because of the configuration of the interior layout of my tri-dome home. One dual heat pump was placed in the utility closet in the west dome (not to be confused with the west wing of the White House) and one was placed in the utility closet in the east dome.

Each serves the dome of its location and both feed into the center dome. Obviously, two such units increase the initial costs of installation and the later costs of maintenance, unless one is a do-it-yourself kind of person.

The ductwork was no problem in Jean's home, a tri-level single dome. It was a bit tricky for my home. I chose not to partition each living area with walls going up to the ceiling, except for the bathrooms and the utility room. The location of full walls in the two hallways was sufficient, however, to construct space for the ductwork and still blend with the general aesthetics of the interior structure.

The placement of these ducts are high, about 8 feet up, in a center dome that reaches a peak of 16 feet and the two side domes that reach their peak at 12 feet. The location of the ducts is not the most efficient, given that heat rises but the circular nature of the dome prevents the usual stagnation of airflow.

One neighbor has a solar energy unit in her tri-level single dome and no air conditioning. Another, in a geodesic dome, has an electric heater and a window air conditioning unit. Both neighbors find their systems for heat and air very effective and comfortable.

You might find it difficult to get any standard guidelines about the installation and use of alternative sources of energy and small electric heaters and air conditioners. But there is no need to be discouraged. The saving grace in installing a small electric unit is the simplicity in adding additional heaters, as may be indicated after experiencing dome living for a full year. Even with additional units, both the initial cost and operational costs will still be low.

Research your needs in heating and air conditioning very carefully; look at all options. Heating and air systems as in conventional homes do not apply but where they have been used, energy bills have been one-third of the usual costs.

Just about every energy source available is in use by dome dwellers. The common comment is the lower cost regardless of the system used. So when deciding on a system that will work for you and your dome design, factor into your decision:

- a comparison of initial cost for the various systems;
- cost of installation;
- amount of space taken;
- maintenance and life of the systems;
- climate; and,
- your comfort needs.

The amazing changes in technology and increasing experience with dome homes, no doubt, will give you even better options and information than we had.

Plumbing, Sins of Omission and Commission Thereof

What follow may be examples of infrequent occurrences. The fact that they happened, even with the best of intentions, compels us to inform you of these interesting tidbits. What's wrong with these pictures of bent pipes (Figs. 52a, b)?

Figure 52a ***Vent pipe for a bathroom exiting into a utility room.***

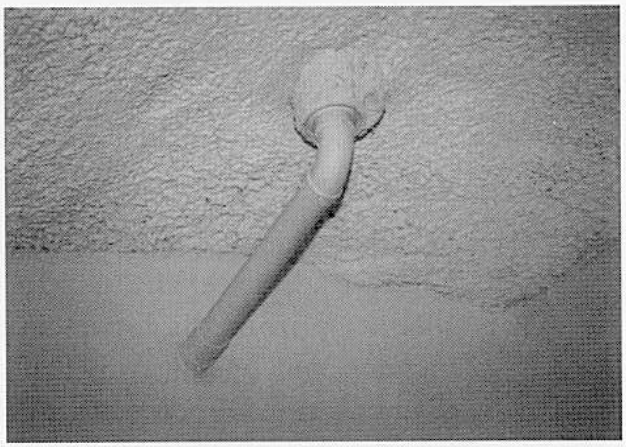


Figure 52b ***Vent pipe for a kitchen exiting into a bathroom.***

Correct, the vent pipes are not inside the walls of the rooms—where they were intended to be.

Surely, that can't happen. Obviously, it can. A mismatch occurred between the plumbing layout and the pre-cut aperture for the

outside venting. The "before it happens" solution is to cut the aperture for the vents after the interior framing has been marked along the floors, the exits for the vents have been identified, and of course, before the shotcrete is applied. A certain amount of shifting may occur as the skin of the dome is being inflated—another reason for checking the plumbing layout before the framing is completed and the apertures cut for the vent pipes.

After the fact solutions, in situations as shown in Figures 52a and 52b, include painting the pipes the same color as the walls and ceiling, for the camouflage effect; painting them in a contrasting color, for the "pop art/warehouse" look; or having the wall moved over during the framing stage to accommodate the exit of the vent pipe. The downside to that last option is the possibility of having to move plumbing or adjust the interior layout at an additional cost to you. The more cost effective and simplest solution is to find a skillful carpenter who can box in that angled vent pipe and have the shape of the box artfully curved so that it blends into the ceiling. Only you will know.

In the situation where the exit for the range vent did not match the location of the range a flexible duct snaked from the range hood to the exit point was suggested—a solution which was unacceptable for aesthetic reasons. Whether to vent or not vent to the outside was reviewed thoroughly in the planning stage. The stated advantages favored outside venting. MDI also recommends venting to the outside for both kitchens and bathrooms because of the air tightness of dome structures.

When outside venting is no longer possible, the solution is to cap the aperture and select an attractive recirculating range hood. The consolation prize is the lower cost. Fortunately, in my instance, the location and openness of the kitchen with windows and outside doors nearby did not make the air tightness of the dome a problem for the inside venting of the range hood.

Our last example was missed during the final walk through. At that time, the work crew and I assumed the building was completed and we were checking that all vent pipes properly exited the shell of the dome. From the inside, the installation of the vent pipe through the ceiling appeared complete.

Now what could happen here? Well, several months down the road while checking something else at "rooftop level," we thought that a vent pipe was missing. Our impression was correct. One of the work

crew had failed to cut the skin of the dome to complete the exit of the vent pipe for the commode. Not good Feng Shui to say the least.

Flooring

The important aspect of the flooring is the slab; the rest is personal preference. The slab must be level; no bumps, rolls or rough high spots especially if the flooring is to be wood or tile. We were fortunate in having an excellent concrete man who poured our foundations.

A concrete slab no longer restricts choices in the type of flooring. One can use wood, carpet, ceramic tile, Formica-like materials and linoleum, alone or in combination. Linoleum, in case you haven't noticed, has come a long way and is competitive with the other choices in flooring. It is fabricated from all natural materials in contrast to vinyl flooring, has equally attractive designs, its durability is fifteen to twenty years and it's less expensive than the other types of flooring available.

Jean's basement floor is carpeted. The remaining floors are a combination of wood, carpeting and ceramic tile. My first choice was wood. Installing wood over a concrete slab in a single-level dome home can be more of a problem than in a conventional home, thus adding to the overall cost. I went with my second choice of ceramic tile throughout with carpet runners for the more heavily trafficked areas.

Ceramic tile floors are cooler than other types of floors. I have not found this characteristic to be a problem. Perhaps my friends do. In our neck of the woods, people usually take their shoes off in the entryway and walk around in their stocking feet; and a tile floor is on the cool side. It is great in the summer time; but a bit cool in the winter, especially if you walk barefoot.

If you are considering a ceramic tile floor, then you may also want to think about having a radiant heating system installed before the slab is poured. In addition, acoustics in a dome home are different than in a traditional home (discussed later in this chapter); and a ceramic tile floor is not a sound-absorbing surface. You may not wish to contend with the reverberation of sound that does occur unless you are prepared to dampen sound in other ways.

If you do not have carpeted floors you may find yourself with an unexpected dust problem; dust bunnies everywhere. Carpeting absorbs dust and keeps it from flying on to other surfaces. To cut

way down on the dust in this situation, get a top-of-the-line room air filter—a healthy addition with or without a tile, linoleum or wood floor. Spot sweeping helps too, as do those wonderful disposable magnetic cloths that attach to a long broom-like handle.

Stairs

Having a multilevel dome or a loft means having stairs. Interestingly, MDI asks that you consider carefully the option of a second, or even a third floor. MDI believes that having a "series of low-profile domes connected together and using only one floor can provide the same floor area at a similar cost."

You may still choose a multi-story dome because of the land costs; or that may simply be your preference. Then you must consider type and location of your stairs carefully, preferably with your architect. The architect will be aware of the potential problems and what can be done to prevent bumps on the heads of the taller people climbing the stairs.

Two types of stairs are commonly used: stairs built along a wall following the curve of the dome and the spiral staircase. They usually are constructed either of wood or wrought iron. The spiral style is the style that could present the problem of insufficient headroom. We know of one such instance that required the owner to put up signs warning the stair climber.

Then there is a third type of stairs, the "Jean type" (Fig. 53), artfully placed so that they also visually define the functional spaces on either side.

If you insist on having stairs, be good to yourself and your tall friends by having the headroom checked out before building. We recommend that you go to companies that

Figure 53 ***"Jean type" of stairs.***

specialize in building stairs. The cost may be considerably less than having stairs built locally.

Acoustics

A friend referred to a dome home, as a "House of No Secrets" and it can be that. In a dome, sound travels in an arc and bounces off the exterior walls in a random fashion. Sound will continue to reverberate until absorbed and/or reflected. Recall how an empty room will reflect sound until furnished with carpeting and furniture.

A problem with acoustics develops when few interior walls exist to help absorb sound. It is further compounded when you have a ceramic tile floor throughout. Slap the counter top (also ceramic tile) and the sound will reverberate. Add a barking dog and you will be driven to find a solution. Such is the situation for me.

The best area from which to listen to television is not the usual sofa or chair distance; instead it is either just in front and to the side of the television or on the other side of the dome—in the kitchen, in the pantry or by the wood stove—not the best seating arrangements.

The stereo music in the center dome, although at low volume, sounds just lovely in the study, which is in the side dome—a good distance away. Surprisingly, just the addition of carpet runners in the heavily trafficked walk spaces has helped some. I expect the addition of area rugs to also dampen the reverberation that now exists.

Full carpeting would help, as would window curtains. Neither is an acceptable option or complete solution to the problem. If you live in the country as we do, you'll try to get by with as little window dressing as possible to enjoy the view of the countryside.

Insulating the walls is not usually done because of the exceptional insulation that already exists in a dome home. It's worth considering, but would have to be done during the interior framing of the walls. The recommendation that I was considering was spraying the ceilings and walls of the center dome with acoustical material. That option may not be a viable one, however, based on a recent article in the *Roundup*, "Bouncing Off the Walls."

In that article, MDI describes the Monolithic Domes as "shaped perfectly to reflect all sound through their focal point—their centers," meaning, that sound can be captured and be absorbed at its center. Because of this characteristic, MDI offers several solutions to dampen the sound. The simplest is a "*cloud* of sound

absorbing material hung in the center (focal point) of the dome." It can be done esthetically as a "series of small clouds or as a single hung ceiling. They have also found "flagging, vertically suspended," to work well.

Whatever the treatment to control sound, MDI cautions that the dome's *"huge heat sink"* not be compromised. The heat sink is the "*passive solar* part of the building." Material draped as suggested earlier must be done in such a manner that air flows freely.

How about the option of insulating the ceilings and walls with acoustical material as is done in symphony halls and other large commercial structures? MDI has this to say.

> "Spraying the dome with fuzzy sound absorbers is a quick fix for short sound waves. It does not help much with long sound waves. And it definitely will foul up the quick heat sinking ability of the concrete shell. The shell stores enormous quantities of heat."

Jean's problems with sound carrying in her dome is minor and may be no more than what would occur in a contemporary conventional home with a good bit of open space. Jean was not aware of any problem until a guest leaned over the second floor balcony and asked about the strange crunching noise she heard while in the back bedroom.

The sound source was Jean who was sitting on the couch eating a bowl of cornflakes while watching the morning news. So even in a multilevel dome with primarily carpeted floors some sound will carry. Jean's solution was to stop eating cornflakes in the living room when guests are visiting.

7 Architects, Contractors and Contracting

Use the right people and the right tools for the job and problems will be fewer.

—Anonymous

Odds are, you have a good idea of what you like and do not like in your home, whether it was one you built from scratch or a rental. Getting what you like and expect will depend in part on the contractor you hire. Even if you are already quite familiar with contracts and their implications, we strongly recommend reading this chapter. Your contract is insurance for you and the contractor. Because the dome home is a newcomer to the housing scene, it's all the more important.

In this chapter we provide information to help you to:

- fine tune your knowledge;
- evaluate what the architect and contractor-builder are proposing;
- evaluate the accuracy and quality of the work in the construction stage; and,
- increase your understanding why specifics are important.

Most people are not familiar with the subtleties in the building of a dome structure. A good first start is to ask these questions. Should you engage an architect? Should you build your dome home; that is, be both contractor and builder? Should you be your own contractor and engage a builder? Or, should you engage a contractor/builder?

We strongly urge that you not proceed with any of the "building" options until you have hired an architect familiar with the building of dome homes. As mentioned in preceding chapters, the differences are many in the building of a dome and you should give yourself the benefit of experienced advice. The architect's in-depth

knowledge can protect you from your lack of information or misinformation in pertinent areas. He or she can also help you to avoid potential complications from relatively inexperienced dome homebuilders.

We have heard that an increasing number of architects are becoming interested and involved in the building of the Monolithic Domes. The involvement of more architects will certainly enhance the results for the individual dome owner. Concurrently, we should see additional aesthetic architectural contributions to dome technology and building in general.

Will you be able to find an architect familiar with dome structures in your area? That is a good question. We suggest that when you are ready to build a dome home, contact MDI. They work with several architects and know of others who are adding dome architecture to their expertise. Also, check out the website, www.domebuilders.com for a listing of architects.

An excellent option in seeking architectural help is the evaluation service now provided by the Monolithic Dome Institute (MDI). Two types are offered, one of which is free. The free evaluation requires that you describe your dream dome. A sketch accompanying your description would be helpful. MDI's evaluation staff will let you know the approximate cost of building that dream dome.

The second type of evaluation is a Home Feasibility Study. It takes about two to four weeks. The floor plan that they will draw for you will come with elevations, notes, details and itemized construction costs. That service cost is $195 and definitely worth it.

Perhaps you are thinking of using a plan that is already published. Even if the design and specs seem to fit your needs, be aware of a potential copyright issue. You may have modified the plan in some respect to fit your needs, and you consider it a "different" plan. But unless you have permission, in writing, to use the original or modified plan, you are violating the copyright.

Let's assume you have that permission and proceed to make changes. Your changes can present structural problems and possibly require adjustments in the interior layout. As an example, you decide to change the location of the windows and doors. MDI can help determine whether the changes will produce complications and adjustments that may be required.

An architect and the evaluation staff of MDI will know how the openings for the style of windows and doors you have selected must

be engineered to fit into a curvilinear surface. They can also advise you on the implications of the changes for the interior layout.

Many choose not to have an architect, thinking that they will save money. You will not eliminate the design fee by not having an architect. The contractor will still charge for his or her work with a design, more or less than an architect, but you usually will not get the other benefits that come with having an architect.

These benefits are, primarily and most important, another layer of checks on the construction and a set of blueprints for each major aspect of construction, especially plumbing, wiring and interior framing. Keep your copy of the blueprints forever or at least until you sell the dome and present it to the next lucky owner.

You can employ the services of an architect at two levels: as an evaluator with input on other ideas or as a provider of "turnkey services." The first level of service is fine if you have already sketched your exterior and interior layout or, have a published plan that you will be using (with permission). The architect in that instance will evaluate your plan, troubleshoot for potential problems and offer his or her suggestions.

Once mutual agreement is reached, the architect will draw up the final plans. They will still need to be certified by an engineer before you hire a contractor or contractor/builder and before you or the contractor can get the required building permits. The estimated cost for such services is about four percent of the budget.

If you have neither the time nor inclination to do the initial work-up, then the higher level of service is for you. In that instance, an architect will do all the design work according to your expressed desires and he or she will also monitor the progress of the building to make certain that the plans are being followed. This level of service should include detailed drawings, elevations, computer renderings and possibly models with the blueprints. The fee, is higher—about twelve percent of your budget.

Should You Do it Yourself?

Anyone who has done repair and remodeling jobs around the house is justifiably proud. But those experiences do not begin to prepare a future dome home dweller for the enormity of building a dome home from the ground up. Being your own contractor requires that you have the time and energy to plan and obtain permits (which

means knowing state and local regulations and the idiosyncrasies of obtaining those permits).

For example, to obtain a builder's permit, building inspectors require specific information on the engineering process and materials to be used. As Scott McNulty, a building inspector and a general contractor in North Carolina explains, "if the type of building to be inspected is not in a jurisdiction code, then relevant information about the building must be furnished to the authorities having jurisdiction."

The dome home does not fall into the category of standard types of homes; it would be classified as an "alternative structure." Therefore, you would have to submit an "engineering sheet." This sheet, which details the specifications of construction and materials usually must be stamped by an engineer or architect licensed in the state in which the dome is being built.

The architect or the engineer, through the seal or stamp, affirms the structural integrity of your dome. Should some structural aspect fail, then the architect or the engineer would be held responsible. The engineering sheet now serves as the building code, to which the inspector will refer.

If you have complete blueprints (stamped), you may be able to submit those in place of an engineering sheet. You would have to check out that possibility with the building inspection department in your locale. If you do not have complete blueprints, an engineering sheet carrying the seal or stamp of either an architect or engineer is acceptable. McNulty stresses the importance of providing the appropriate information and required stamps to avoid having a permit denied.

If you choose to be your own contractor you'll need to:

- obtain adequate insurance coverage for possible injuries on the job site;
- know the local resources for subcontracting;
- be literally on the job for the entire building process; and,
- have experience in dome building or subcontract the construction of a completed shell (with doors and windows installed).

How do you become experienced in building a dome? MDI provides an excellent training workshop for builders and for laypersons who want to build their own. MDI also offers a set of instructional videos and an introductory tape. You should review, at least, the

introductory video, even though you may be planning to have the dome built for you. Don't plan on doing it yourself unless you have the time, energy and expertise for the actual physical building of your dome home.

We have watched the building process. We know first hand that it requires special equipment and in particular, hands-on expertise. That expertise is not acquired in the short number of classroom hours that are suggested in the introductory videotape. Even going through the workshop experience does not prepare you for the unforeseen circumstances.

A wiser choice would be a compromise: engage a professional dome builder/engineer to do, at least, the construction of the dome shell. Once the exterior dome is complete you can finish the interior of the dome yourself.

Many have successfully built their own dome homes. If you want to actually build the exterior yourself, take the time and spend the money to familiarize yourself with all of the techniques and equipment necessary to complete this phase properly. Research the availability of the equipment in your area and practice the techniques before the actual construction phase. Above all, get on-the-job experience with an experienced dome builder.

As the general contractor on your home, be certain to inspect the work of the local labor you hire on at least two other projects. Ask the area residents if they are familiar with the work of subcontractors on your list. Do not be afraid to ask the subcontractor for references. If he or she is reluctant to supply those, move along to the next choice. Remember, you are the one paying the bill and you are the one who must be satisfied; do not be intimidated.

When interviewing a subcontractor, be sure to have several face-to-face meetings with him or her so you feel comfortable that both of you are speaking the same language. Be precise in your definitions of what you are expecting, whether that be color of paint or brand of dishwasher.

Remember, building is a competitive business. If the first individual is unwilling to work with your terms, there are others who will.

If you have decided to employ a dome contractor/builder, you should be as careful in the selection process as you would be in selecting a contractor for a conventional home. Currently, very few dome contractors/builders are available who have good solid

experience; a certificate only indicates that the person has participated in the training workshop.

What to Look for in a Contractor

Your contractor is a vital link to what is happening in the building of your dome. Communicating well and understanding each other is essential to an effective working relationship. In your interviews of contractors one of your criteria for the final selection is how comfortable you feel with that person as your contractor. If you feel any discomfort, then move onto the next person on your list.

Do not stop the selection process because you feel comfortable with the contractor. Your bottom line concern is whether he or she will do the job right. That decision should not be based solely on your intuition or comfortable feeling but also upon the following information:

When did the dome contractor take the initial training in dome building?

> If that training was more than two years ago, then you need to know whether he or she has taken a refresher course on changes and advances in dome technology and residential construction.

Is he or she a member of the local Home Builders Association?

What continuing education has this individual taken through these and other related organizations?

Have you seen his or her work?

> The potential contractor/builder may show you a portfolio of past domes built. Nice; but do not limit your research into this aspect by viewing only the portfolio. It is worth whatever travel may be necessary to actually visit domes the builder has already built and see for yourself the quality of the work done.

As you probably know by now, contractors with dome building experience are few and far between. A certificate indicating that he/she has taken a course in dome building is not enough. The contractor/builder may also have a license. Be aware that in some states just paying the required fee is all that is necessary for a building license. Fortunately, more established builders are going into the dome building business. Some dome builders are willing to travel outside their geographic area to build a dome.

If you "import" a dome builder who does just the shell itself, you will then have to find someone who does not think that finishing the interior of a dome will require special materials and skills. What matters are the quality of the craftsmanship and dedication of the workers. If you can get a contractor/builder who cares about building your dome home as though it were his or her own, you're in luck.

Other considerations that should go into your decision include:

Financial stability: How financially stable is the contractor?

Request a list of references within the past year. Call and ask about the contractor's work schedule, specifically whether any delays occurred and whether the work schedule matched the payment schedule.

Never pay for any work that is incomplete and which has not been checked personally by you. If you discover that a contractor has been known to ask for payment ahead of schedule, go on to the next choice.

Contractor's work style/reputation.

Ask the contractor if he or she will keep you informed on important issues as they occur.

A related question is whether the contractor will follow the specifications in the plan. Otherwise you may be in for a surprise or two that may mean ripping out and rebuilding.

Cover yourself through the contract by specifying that contractor's mistakes are paid for by the contractor, just as you are expected to pay for changes that you make that were not in the original plans.

Once you have settled on the method that suits you for the building of your dome, get contracts from all the players. If you are acting as general contractor, be certain to obtain a written, itemized, signed contract that you and the builder have gone over, as many times as necessary, to assure that you are both visualizing the same finished product.

Allowing room for "interpretation" on the contractor or builder's part will undoubtedly leave both of you with a bad taste in your mouths. The more specific you are the more unlikely that you will be disappointed in the final product.

Do Nothing Without A Contract

Do Absolutely Nothing Without A Contract. Your contractor may present you with a proposal, impressive in all the details it contains, including costs. A proposal is not a contract. The contractor is obligated to provide you with a fully completed contract signed by all parties before any work is begun.

If you are the contractor, you can obtain a standard contract form at your local office supply store in either a printed format or in software. If you are drawing up the contract, computer software may serve you better. It will allow you to make changes according to your needs and the agreement between you and the builder. A good contract should include the following:

- date agreement is signed;
- your name and address;
- contractor's name and address;
- contractor's license number;
- copy of all pertinent blueprints, drawings, etc.;
- designation of person who will obtain all permits and inspections;
- all promises, guarantees, etc. made by contractor in writing, including a one year warranty;
- starting and completion dates for all phases of work to be done;
- appliance specifics including model number, color, size;
- daily and final cleanup procedures;
- payment schedule;
- waivers of mechanics liens;
- insurance information;
- payment and completion bonds;
- late completion penalties; and,
- responsibility for final inspections, zoning/building compliance.

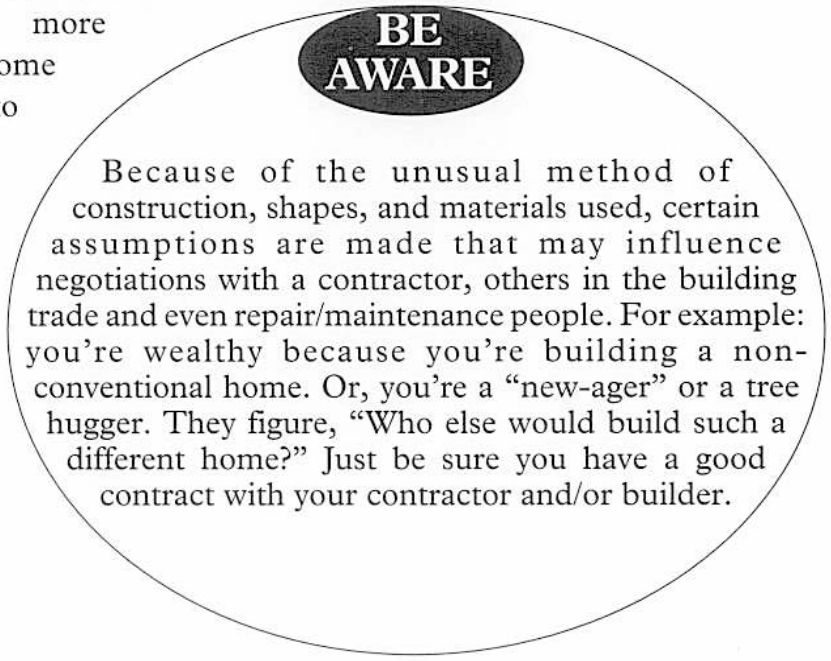
Always remember that you are the one with final control in all stages of this process. The dome being built is your home. You are responsible to make certain your wishes are being followed. Arrange periodic inspection visits at each crucial phase. If you see errors or omissions they may be rectified then before any additional work continues. Above all, do not make the scheduled payment until the work is done on time and in a satisfactory way.

Some contractors do not like to have the dome owner onsite when the crew is working. Remember it is your money that is being spent and you must protect yourself. Regular site visits are in your interest. The contractor may quote OSHA regulations (Occupational Health and Safety Association) to you that presumably prohibit you from being onsite. If he or she does, put on a hard hat and arrange with your builder an acceptable time to review what is going on. The time of those visits should not be charged to you.

You should be doing an onsite evaluation before and after each major phase of construction, at the least. It's best if you can check daily, after the workers are gone for the day. Any concerns you may have can be discussed with the contractor/builder immediately and action taken promptly.

The contractor is committed to doing a good job, of course. The results of that contract precede his reputation; but remember, the contractor is also obligated to look after the interests of the work crew who remain as part of his or her work force long after your home is completed. His or her concern for them, however, should not compromise the work being done for you. If the contractor is from another state, be sure you have covered your self in the contract on timely repairs as part of the warranty.

Builders of conventional homes are expected to give a warranty for one full year following the building. The same should be expected of dome builders. We do not recommend, however, the kind of home warranty that a homeowner may purchase after the year is over. It is expensive; more important, the dome home is too good to need that kind of insurance.



8 Building in a Rural Area

Let me be—
Whether sun, rain, or snow,
Where birds sing, winds blow,
The smell of woods everywhere,
Delight my senses, renew my soul.

—Anonymous

Our homes are in the foothills of the Blue Ridge Mountains in rural North Georgia. We appreciate those sentiments daily.

Building in a rural area, particularly a dome home, has its own set of challenges. All the Monolithic Dome homes that we know about are in relatively rural areas. Chances are, so will yours. In this chapter we touch on the purchase of land, its accessibility, covenants/restrictions, septic tanks, accessories for rural living, energy sources, local work force and local culture.

Land

Buying land in a rural area is far more complicated than buying land within the city limits or within a new development. Because of the complications, the National Association of Realtors established the Realtors Land Institute. This institute trains and accredits brokers who intend to specialize on undeveloped property and farmland.

When you buy land in a new development then you know, with little or no research, the availability of public services such as water, sewer, gas, electricity and telephone lines. In that situation, the question is only the cost of hooking up to such services. The type of home you can build and restrictions, if any, are commonly quite

clear, as part of the sales contract. A developer is obligated to provide full disclosure.

If you are buying raw, undeveloped land, much of that information and more is not as readily available. You will need to examine thoroughly all conditions that affect your intent to build and the type home you have in mind. This effort will involve quite a bit of research, including visits to the local County Court House. You can expedite this process by engaging a land broker. Among the benefits is the information a broker can provide from his or her knowledge of the area and the County's future plans.

In our instance, we bought our property from a developer who was selling three-plus acre lots. We were provided with a copy of the entire plat (map) plus the survey of our individual property. Roads were already cut in; electricity and telephone lines were available. The only cost to us was that of bringing the lines to our properties.

BE AWARE

Should electrical power be readily available, check the location of the power lines and the proposed installation of the lines and transformers to reach your property. This check should be done because of the concern that high voltage lines may be dangerous to your health. Although the results among studies have varied in their conclusions, consumer guru, Clark Howard, mentions that high voltage lines are a potential problem in his book, *Consumer's Survival Kit.* Since you have some choice in the location of your lines and transformers, it's well worth considering.

A community well was available; some owners have elected, however, to have their own wells. In our instance, Jean and I were able to tap into underground springs, located on our properties, for our water source.

A sewer system was not available which meant that part of our total cost for building would be the installation of a septic tank. We also

knew, through the land developer that a building permit (paid by us) would not be issued until the installation of the septic tank had been approved by the Public Health Department.

A clear deed to the land was guaranteed. A copy of the covenants (restrictions) was also part of the developer's disclosure before the land was purchased. Our property is Zone A, (Agriculture and 100 year flood plain). Buying land under these conditions is similar to buying a new home in a new development. We had less to look up than the person who is buying "raw land" isolated from a development area. If you will be purchasing raw land, then you need to protect yourself with other information, which follows, to avoid being unpleasantly surprised.

The Land Itself

Is the property suitable for development? The answers come in the form of three tests:

- a perc test (percolation) which determines whether the soil drainage is sufficient to sustain a septic system;
- a soil stability test to ensure that the land can support a home which is particularly important if the land slopes; and,
- a drilling test to determine whether an adequate water supply will be available.

Environmental tests for toxic waste or other pollutants may be indicated, depending on the location of your property in relationship to other property and possibly nearby industries.

Accessibility

If you have made your way to the proposed land purchase, then be prepared to pay for the cutting in of a road and its maintenance, not an inexpensive venture but perhaps negotiable in the purchase price of the land. Should you have to cut in a road to access your property, you will need to check with the local authorities and/or State Government on possible restrictions for intersecting your road with a County or a State maintained road.

In our development, the owners share in the cost of maintaining the main road, which is a gravel road. The road to my dome (a very long one) is a branch off the main road, currently used only by me and I bear the expense of its maintenance. The secret here is to have it graded when the main road is being graded; it's less costly to do it

then. The other is to pray for "down line" neighbors to help with the expense of road maintenance.

Restrictions

In purchasing land in a new development, any restrictions such as the type of home that may be built, are specified in the developer's sales contract. Even then, you must be careful. Gary Belsky, a columnist for *This Old House*, in his article on Land Rush, cites an unfortunate result of not paying attention to all details in a contract.

> A couple knew that their house plans had to be approved by the developer and what he required for the exterior. They also knew that they could not have a detached garage and freestanding sheds. But they failed to notice that no trees could be cut. Their plans, drawn by an architect, called for the removal of a one hundred year old oak tree. The developer's approval was not forthcoming. To avoid removing the oak tree meant putting the garage on a steep slope, which, in turn, meant structural enhancements costing an extra ten thousand dollars, an unexpected expense

Our sales contract did not specify restrictions. It is a standard form. A list of restrictions, known as covenants in our part of the country, did accompany the sales contract. Our land developer inherited these covenants from the person who sold the tract of land to him.

Sometimes specific items in a covenant are no longer applicable or acceptable. Should you find yourself with that problem, the removal of the restriction is possible but must be done before you purchase the land. When that happens the change will also apply to all the others in the specific community. Your attorney will be helpful here as in all other aspects of purchasing land.

Changing zoning restrictions/ordinances require action by the local zoning board. If your plans require a zoning change then we recommend that it be done before the purchase is finalized. Unless you know that your neighbors and the city elders will not take exception to your request, you are putting yourself at risk for accomplishing your intentions.

In some counties, the zoning board meets once a month. The application for a change in zoning is published in the weekly local newspaper for three successive weeks before the request is considered. These zoning requests are published specifically to inform the community. They give others interested in the requested change the

opportunity to appear at the appointed time to speak their piece for or against.

In addition to local restrictions, State and Federal governments also impose restrictions, as in the example mentioned earlier on intersecting your road with a state road. Perhaps the most widely known restrictions, in rural areas, are the "set back" restrictions. These setbacks have been put in place to protect land development from impinging on sensitive areas such as wetlands, lakeside and riverbank property. You need to know whether setbacks apply to your property.

Purchasing land in a rural area requires a series of thoughtful actions:

- be certain that the land is indeed suitable for building as shown by the appropriate tests;
- make sure that the title is clear;
- check that existing restrictions will not interfere with your plans; and,
- be sure that other parties are amenable to changes you're seeking.

Minding the preceding and the contents of Gary Belsky's "A Land Lover's Checklist," below, should help you to proceed with your plans to build your dream dome without any glitches:

> "Like a house on the market, land should be researched, appraised and otherwise checked to make sure it's not a minefield of hidden development costs and restrictions.
>
> Pull a land survey from county or municipal records and look for conditions that could impede development, such as wetlands, easements, utility hookups and setbacks.
>
> Get estimates on how much it will cost to put in a road, and find out about requirements on location, size, drainage, and access to the main road.
>
> Check with government authorities to determine if the land is in a protected costal area or if it is classified as wetlands. Ask about other environmental issues such as animal habitats and tree preservation.
>
> Confirm with the building department that you can obtain a building permit and find out what it will take to get one. If the land survey shows no easements, ask whether any exist for utilities or roads, or if there are other restrictions.

> Commission an appraisal to assess the parcel's true market value. For $175 to $500 you can learn a lot about selling prices for comparable lots, and you can tap the appraisers knowledge of what nearby landowners are up to."
>
> —Gary Belsky, *Land Rush*

Septic System

Jean and I have both lived in homes before that required a septic system. For those who have not, the idea of having a septic system may be unsettling. Luckily, a more efficient system has been developed, known as an infiltrator system. Drainage field lines distributed over a predetermined area from the septic tank itself are no longer required; consequently, less land and fewer trees are disturbed in the installation. It looks like field lines that have been rolled into a tube-like structure (Fig. 54).

Figure 54 ***The latest in Septic systems Technology (the infiltrator system).***

Our preventive maintenance for the healthy functioning of our septic systems consists of pouring a biologic product, "harmless to humans, animals, plant life and all piping," once a month, into one of the commodes. What you can dispose into a septic tank is limited, other than natural waste products. "Baby wipes," for example are usually forbidden. If the youngsters in your family are still in the "baby wipes" stage, you will be pleased to know that a product is on the market that is safe to use. Just be sure that you read the label carefully.

Before any building can take place, the septic system must be approved by the Local County Health Department, a variable that must be factored into your time line for building your dome. The application form for approval, available through the Local County Health Department, contains information typically required for construction and site approval for onsite sewage management systems.

Accessories for Rural Living

A primary concern for anyone living in a rural area is the loss of electrical power, which is more common in winter. You should provide yourself with the insurance of back-up power. We have experienced power failure from ice storms, wind storms, a tree crashing onto a power line and a car knocking over a power pole. As a result, generators are a very popular item in our county and other rural areas.

Before looking at generators, determine the number of appliances you want to be able to use during a power disruption. The wattage required for each appliance is on the unit. In the literature on generators, you will find the formula to determine the size generator to fit your needs. Dealers also have that information.

We each bought a ten thousand watt generator, gasoline powered. Most of our appliances are covered including the operation of our individual wells. We have, however, another back up—a wood stove, which will take care of heating should we choose not to run the heating system off the generator. A wood stove is also a very popular item. Our criteria for that purchase were safety, ease of use and maximum production of heat.

After you purchase your generator, you will need a shed or some other type of enclosure to house it. Generators need to be protected from the elements; at the same time, they must be in a well- ventilated space.

A generator also throws off a lot of heat. In my set up, ventilation is provided through the lattice side along the length of the generator shed and a fan at the rear of the shed. Additional wiring to the generator separate from the main power source was necessary. Again, had this need been anticipated, the cost would have been less at the time of the original building. City folk, as was I, need to look at living conditions and requirements when moving to a rural area.

Generators are also very noisy. You would want your generator as far from your living quarters as conveniently possible. Gasoline is

stored in five-gallon cans. Adding a stabilizer to the gasoline increases the life of the gas. Despite that addition, we recycle our gasoline every six months through our cars.

Jean's installation was much simpler. Her generator was installed in the open space below her side deck. The only additions were wiring separate from the main power source and an outlet for the generator.

An addition to my installation is a line monitor that was put together by a neighbor, who was also our consultant on generators. Through his expert advice, we were able to identify our generator needs, purchase the generator and configure the entire installation system.

Any electrician can reproduce the line monitor my neighbor built, but it is not routinely done. Our own excellent electrician had never seen one installed and considered it a very good idea. For that reason, the instruction and materials list are given in Appendix C.

The line monitor is located inside my home (Fig. 55). Its purpose is to let me know when the main power source has been restored with beeps and flashes. Without it, I might not know when the main power source has been restored and the generator will have been running unnecessarily. When the monitor is activated, I know to flip the transfer switch in the panel box, which activates the main power switch. Then I turn off the generator.

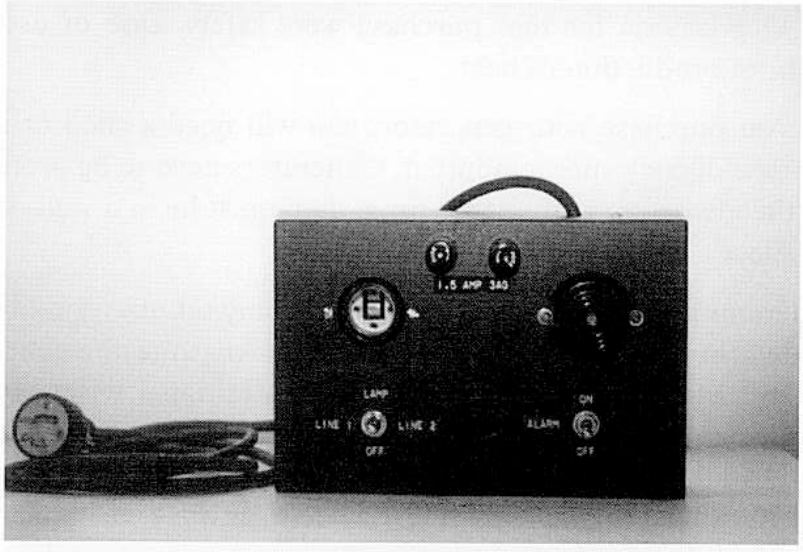


Figure 55 ***Line monitor to be constructed andlor approved by a licensed electrician. It should meet local electrical codes.***

Be sure to have a licensed electrician to help you with your set up. If not installed properly, you could have a surge of power to your home or to the power line that could possibly harm a line-person who may be working on the lines.

Energy Sources

This topic was discussed briefly in Chapter 6 with the issues that must be decided before the slab is poured. The choices mentioned were electricity, gas (natural and propane) and solar. We encourage you to research alternative resources thoroughly before designing your energy plans. We chose propane gas for the range, the water heater, and the clothes dryer. The water heater and the range will continue to operate should the power fail.

The range oven will not work, however, because it has an electrical ignition. The range top also has an electrical ignition but it can be bypassed easily with a match applied to any one of the burners, making stove top cooking possible. With a generator as a backup all of the above will work, if your generator supports the wattage required.

Availability of Local Labor

Perhaps the biggest delay in the construction of a dome home is the availability of work crews for the various phases of building the interior of your home. You will have fewer problems, if any, if your contractor/builder has his or her own work crew. You should also have a time commitment to start and stay on the job until the interior is finished.

Delays in delivery of materials, however, may occur. If so, the contractor will pull his crew off to squeeze in work on another job, while waiting for materials to arrive. The solution is to anticipate and order materials well in advance. The minor delays that may then occur should be brief.

Significantly greater delays occur in the situation where a contractor subcontracts various jobs. Building of some sort is always going on; in particular, in an area that has many summer residents, as ours does. Building new homes is a year round activity. In spring and summer, the part time residents place a heavy demand on local labor with their add-ons and repair work.

Sundays and usually Saturdays are not workdays, except for homeowners with their weekend projects. Some workers are known to

prefer working with some contractors and not with others. If it is hunting season, expect some delays. Hunting is more than a sport; it also puts food on the table.

If you are your own contractor you can expect even longer delays in completing your home, for the same reasons as just mentioned. In addition, if you are a newcomer, you will have to spend time finding the right people for the jobs.

Our neighbor who lives in a Geodesic dome was his own contractor and did approximately ten to fifteen percent of the actual work. Still, his home took much more time to complete than it should have. The workmen were not always available at the time materials arrived or when a specific job was ready to be done. Matching availability of local work crews with the job to be done also takes time and can be frustrating.

The Local Culture

Jean and I are both transplants into the county in which we now live. We can appreciate why the local people are protective of this land in which they and their forebearers have lived for generations. The country is lovely. Life is so much less complex than life in the city. The hectic city pace simply does not cut it here.

We have become like the locals; we do not want to see rampant growth in the area. Those born here are intensely loyal, proud of whom they are, what they do and what they have accomplished. A long tradition colors their perspective. At the same time, we have not met anyone who is not willing to listen. They may still hold to their own viewpoint but will respect ours. A network of families and long time friends exists which is just delightful to experience and a helping hand is not too far away.

The people in the community to which you may be moving may have traditions and mannerisms different from yours. It is important to learn about these. You will not only come to understand and appreciate them as the good individuals that they are but also will not inadvertently offend them with a remark from the city culture which has shaped some of your perspectives. The workers on your dome, in all likelihood will come from the community into which you have moved.

Here you are, a relative stranger, building this strange looking home. Reactions are not any different from what you would expect in any area, including the city environment. Let's face it. Dome homes are

not yet in the mainstream of building. The most common reaction is curiosity.

Once inside your dome, the reaction is one of pleasant surprise. Problems, if any, are of a different kind. They are primarily the cost of building and a mind set/gender bias. We hasten to add that we believe that these two potential problems would exist, more or less, in any community, rural or city.

Assuming that you must be wealthy is a prevalent myth. True, the shell costs more than a standard frame home. Local builders will know that. Given the perception of wealth, some contractors and workers may be tempted to charge higher than whatever the market will bear. You need to know the area or regional building cost to negotiate from an informed position. If you are negotiating with a subcontractor then you should know the hourly cost for such services as plumbing and electrical.

Remember to compare the estimates that you have from at least two, preferably, three contractors or workers; analyze the reasons for the differences. Your knowledge of their reputation and previous work is indispensable in negotiating the cost of building or even a small part of the work to be done.

Proceed only with an estimate in writing. Workers' estimates may be on bits of paper; but to them it is their word and they will stand by it. Sometimes a worker is reluctant to give an estimate, not knowing what problems may occur or how the costs of materials may escalate. Building in a clause or understanding of plus or minus five percent eases the mind of both parties concerned.

The potential problem of a gender bias also depends, more or less, on the community, rural or city. Again, man or woman, your knowledge of what you are doing, what needs to be done, some sense of how it is usually done and approximate costs improve your position to negotiate fairly.

If you are a woman, by all means, be well prepared in all of the aforementioned and never make the final payment until you have checked every bit of the work done. If you sense any discomfort with a contractor, subcontractor, or worker, move on to the next person on your list. We were fortunate to be able to tap into the local network for references to complete or take on new work. We strongly suggest you try and do the same.

9 Financing and Insuring Your Dome Home

Never doubt that a small group of thoughtful, committed citizens can change the world; indeed it's the only thing that ever has.

—Margaret Mead

Anyone wishing to own a home has a variety of resources to draw on when it comes to financing a home, getting an equity loan and for obtaining home insurance. For example, one can get a FHA loan (the Federal Housing Authority), a VA loan (Veteran's Administration), and a Conventional Loan available through local banking institutions.

The application requirements vary from one type to another. All, however, look at two pieces of information in particular, to determine your ability to meet your loan obligations. The first is your debt to income ratio, from which lenders assess your ability to make the house payment. That estimated house payment includes taxes and insurance. The acceptable range is twenty eight to thirty percent of your *verifiable* income.

The second bit of information is other debt service; for example, car and credit card payments. Add that information and the ratio is increased from thirty six to thirty eight percent.

Many other mortgage products are available for those such as the self-employed and for those whom income varies (and therefore is not verifiable) but other aspects look good to the lender. That type of financing comes at a higher interest rate.

You, however, as a potential dome owner, do not have access to those same resources. How come? You meet all the criteria for any of the type loans mentioned above. You are building a home that is

extremely energy efficient and ecologically sound; hence, your maintenance costs will be much less than the average homeowner.

What is the problem? It is simply this. *You must have a certified appraisal* whether you are buying a dome home, seeking refinancing after you have built your home or, a construction loan to be subsequently converted into a mortgage loan. In the last instance, your blueprints would have to be pre-approved. A certified appraisal means an appraisal based on "comparables"; i.e., what is the history of the resale value of such homes in your area. And that is the first catch-22.

An example: One of us did have a certified appraisal (at twice the going rate, an after the fact revelation). The comparables cited and photographed for the appraisal included a Deltec home and two other resort type structures that looked a little different from the conventional home. None, however, was built using the same method, the same materials, or general style as in a Monolithic Dome. The homes used as comparisons were also obviously less expensive to build.

How can one get comparables when dome homes are not as common as a conventional home or clustered in one area to provide a comparison? Where several dome homes may exist, such as in our community, none has been sold. Dome dwellers are not inclined to move.

How, then, have dome dwellers financed their homes? Some have done so through their personal resources. Other dome dwellers have either completed the building though their own labor or, have designed the dome to be built in stages as money became available.

Yet others have found ingenuous ways to build their dome home. For example, one enterprising individual took the credit card approach and was later fortunate enough to arrange an equity loan to repay the credit card debits incurred.

Still others have gone to brokers who are in contact with private investors willing to finance dome homes. In those instances, the interest rate may be anywhere from three to five percent higher than that of traditional lending resources. An appraisal and home insurance would still be required. Our guess is that these requirements would be less stringent if the borrower is a good risk.

One source for identifying such brokers is the advertising section of the Monolithic *Roundup*, a magazine published by the Monolithic Dome Institute (MDI). If indeed, one has to finance at an interest

rate higher than the prevailing one, the thought has been expressed that a later refinancing at a lower rate may be facilitated. Whether that strategy is a viable one we don't know.

The second catch-22 is obtaining home insurance. Insurance and obtaining a mortgage are interconnected. You will not have any problem, if you are financing your dome home yourself or, are building it in stages on a pay as you go plan. If you look at the reasons for home insurance, dome owners don't need it. If, however, you want to finance part of the cost of building your dome home or refinance it, then you must have home insurance. The lending institutions require it to protect their investment.

The greatest portion of an insurance policy is to cover damages to which the dome home is not susceptible. Here you are building or have built a home that is virtually indestructible. (Witness the Roman built concrete buildings still standing.)

Your home can withstand tornados, hurricanes, earth quakes, and is essentially fireproof. Still, home insurance is required. I had to buy a home insurance policy because of the home mortgage requirements.

In my instance, all the standard insurance companies except one refused to write an insurance policy. My previous home insurance company refused because my home is located in Zone 9, meaning that it is more than a mile away from the volunteer fire station. (My home is less than two miles away.) The others refused stating briefly, "We don't insure dome homes."

The one company that wrote a policy surprised me a year later at renewal time with a termination letter. Their reason: my home is "not constructed with conventional materials or methods."

The bank holding my mortgage was finally able to find an insurance company. As you might guess, the premium rate is higher than is available for homeowners of conventional homes. The insurance purchased covers only the amount of the mortgage, thus reducing my monthly premium.

In the second example, the dome owner has access to insurance services provided to retired military officers. The letter that followed the underwriter's visit to his dome, essentially denying his application, was confusing. With the officer's approval we quote directly from his response to that confusing letter referring to the issue of insurance and the structure of the dome home:

> The first floor is a very thick concrete base. The roof and walls are 2.5" to 5" (top to base) thickness of gunnite concrete, surrounded by a 3" layer of insulation overlaid with the nylon skin. Of course, it was built in the reverse direction: first, the skin, and finally the concrete.
>
> Houses don't get much tougher than this unless you're building missile silos. It's overall outside wall R-value is 54. I will wager my house ranks in the top ten of the most structurally-sound-above-ground homes insured by [insurance company] anywhere in its system. It can withstand a lingering, direct hit from a Class 5 tornado. Of course, the windows, skin, and insulation may get brutalized a bit from flying debris, but you'll have far less to repair here than you would with a conventional house.
>
> It should be livable after a major earthquake. Were a tree to fall on this house, it should break before the house does. And I'm above any flood plain, including the asteroid-generated tidal wave in *Deep Impact*. Can you say *all* of these things about your own [insurance company] office space or any other [insurance company] insured domicile elsewhere in the Southeast Region?

As you might guess, his policy was approved almost by return mail.

A good lesson is to be learned from these experiences. The approach used in wording and ideas expressed in the officer's letter to the insurance company merit additional comment. First, the writer does not refer to his dome; instead he uses the words, house and home. The image these words convey is more familiar than the use of the word dome.

Second, he describes the materials only briefly and to make a point in the consequences of the use of such materials during typical disasters, as compared to other "homes." Then, his punch lines, noting that damage claim is minimal if any; and, can his insurance company office say the same for the building in which it is located and for the other homes insured by the Company.

Your choice of words is very important. We did not appreciate the importance until after our individual experiences in seeking home insurance. Since that time, we have read MDI'S response to the question, "How Do I Find Insurance for a Monolithic Dome?" Their response also emphasizes describing the dome with words that are already in the agent's book. As MDI cautions:

> "When you call for insurance on a Monolithic Dome, you have to remember the agent will not have a page in his book for Monolithic Domes. He will have a page for 'an all masonry constructed' building. The buildings are constructed with reinforced concrete walls and roof.
>
> You need to be prepared to tell the agent what materials are utilized for the interior framing. Is it steel studs and sheet rock? If there are second floors—are they made out of concrete, steel or wood? You should also be prepared to tell them that the roofing is single ply roof membrane. This is the roofing system used on many commercial buildings."

What is the answer for dome owners and potential dome builders who want to be able to finance their home? The Monolithic Dome home is an example of technology ahead of institutional rules. Anything different is initially viewed with skepticism. Obviously, the more dome homes built the more familiar they become to others.

The interest in increasing numbers of traditional builders is encouraging. One suggestion floated is the idea of nationally based appraisals. This suggestion may not be comfortable for local financing institutions that are concerned with resale value in the local market. The flip side is low risk to the local financing institutions since dome owners are less likely to move than the conventional homeowner.

Another idea is establishing a category for builders and owners of alternative home structures, as long as they are credit worthy and the home has been soundly constructed. The long-term answer, we believe, is in a concerted effort at the grass roots and at higher levels where guidelines/regulations are developed to institute changes that will include dome homes.

It does not make good sense from the perspective of economics and quality of life to exclude from the home market and financing institutions a home that is ecologically sound, energy efficient, easy to maintain and such a pleasure in which to live.

Afterword

"The Journey is the Destination"

So states the title in the introduction by Margaret Quenemoem, President and CEO and Paula Quenonemoen, Executive Vice President, to their catalogue, "Jagged Edge Mountain Gear." Interesting the places one finds expressions that mirror one's own thoughts or value system.

They go on to say how the Chinese character (depicted above) has come to beautifully "represent . . . so many things in life—concepts that usually require hundreds of words to express." For these entrepreneurs, the experience in their company to conduct business consistent with their philosophy has proved to them "that the point of the journey is the experience. It's not about achieving the summit. Rather, it's everything that goes on in your heart, body and mind."

We could not think of a better way to close this part of our individual journey into dome building and living than sharing it with you. We hope that you have found this bypass with us worth your while.

In the process of dreaming your home, "find a path that captures your heart" and enjoy the journey.

Carmella Gonnella
Michele Ostrowski
Jean Hirst

Appendices

APPENDIX A

COPLACE TOOL

A sprayer specifically designed for safe and efficient application of shotcrete in the building of concrete domes.

Designed and developed by Peter J. Kelly

For more information write or call:

Peter J. Kelly, President
Farside Land & Development Co.
P.O. Box 128
Lakemont, Georgia 30552

706-782-5986

APPENDIX B

KIT: FENG SHUI IN THE ROUND BY JEAN HIRST

Contents:

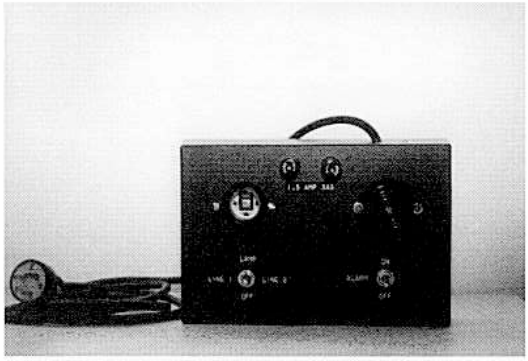
- Bagua Transparency overlay to locate areas of influence within your proposed design.
- Graph paper showing various diameters of domes.
- Templates of furniture, appliances and stairs.
- Entrances using Feng Shui principles.
- Notes on helpful hints for the planning stage and suggestions that follow Feng Shui principles that will allow for happy, successful living.

For further information contact:

Jean Hirst
P.O. Box 365
Lakemont, Georgia, 30552

APPENDIX C

IN-LINE MONITOR



N = Neutral

L_1 = Line 1

L_2 = Line 2

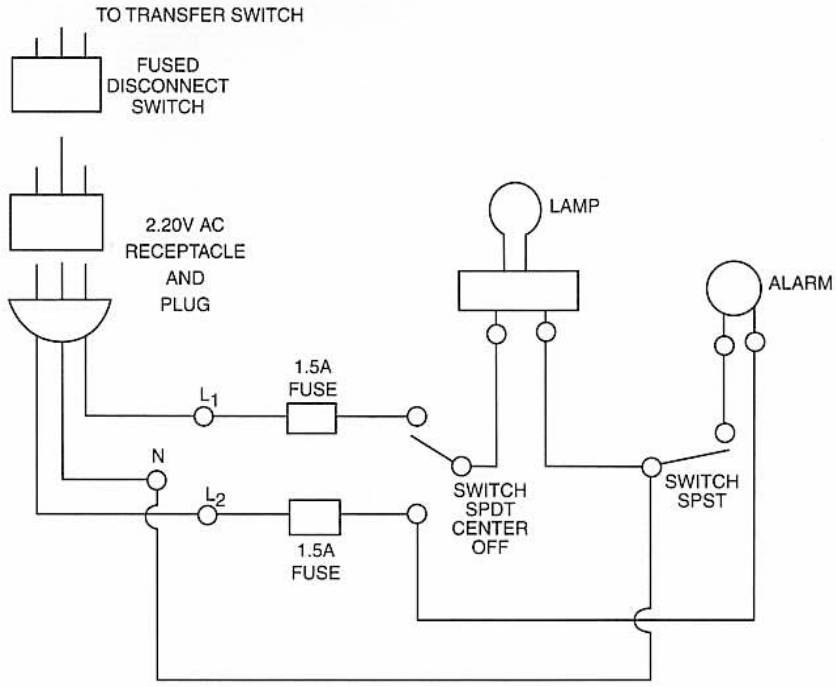
SPST = Single pole, single switch

SPDT = Single pole, double throw

Fuse = 1.5 Amp Type 3AG

Switches and toggle type —low current

Lamp = Standard 115 volt house lamp, up to 100 watt



Materials cost list:

Buzzer	$ 6.95
SPDT-SW Center Off	4.00
SPST-SW	4.00
Box	19.00
Cord - (8 ft.)	2.10
Light Socket	2.50
Fuse Holder × 2	5.00
1.5A 3AG Fuse × 2	1.20
	44.75
Labor	24.00
Total	68.75

To be constructed and or approved by a licensed electrician. Should meet local codes.

Source for materials:
Tech America except for lamp socket.

Glossary

a collection of explanations and related bits of interesting information

Every word was once a poem. Each began as a picture. Our language is made up of terms that were all originally figures of speech. Sometimes the pictures can be rediscovered and restored . . . . At other times the attribution of the ages has worn them away and obliterated them so that no trace is left.
It can't surprise us that our language began with metaphors. Words are being made today under our own eyes in precisely the same fashion . . .

—Wilfred Funk, Litt.D.

And that is true also in the housing industry. Words are fashioned to reflect advances in technology and the changes in our way of viewing the world and our place in it.

In the list below we have restricted our explanations to those terms used in the dome literature generally and those specific to the Monolithic Dome. Modern day usage of "domes" for residential purposes, as discussed in this book, is of three "dome types."

The Geodesic Dome: The brainchild of Buckminster Fuller which first appeared in 1952. No doubt, the concepts that led to this practical structure were germinating in the mind of this Renaissance man long before their translation into the very practical structure of the Geodesic Dome.

The Monolithic Dome: The innovation of David South who was inspired by the work of Buckminster Fuller. The Monolithic Dome is the most recent of the three modern versions of ancient circular structures.

The Yurt: The westernized version of the *Ger*—the label preferred by the Mongols for their native homes—the oldest of the three circular structures still in use in Mongolia.

Alternative structures/Non-conforming: Descriptors used by the Banking Industry to describe the Monolithic Dome; hence, the difficulty in getting the traditional financing afforded other homeowners. The Monolithic Dome is a newcomer and has not made it into standard "rule books" specifying qualifications for construction loans, mortgages and home insurance. (See discussion, on how to do an end run to improve your chances to qualify, p. 122–123.)

Airform: Like what you might guess it means—construction by using air-supported forms. The Airform, the polyurethane covering which is inflated to provide the first layer of the dome shell, is a trademark of Monolithic Dome Constructors, Inc.

Augmented windows: The original meaning of augment is to "make greater" as in size, strength or quantity. As applied to Monolithic Domes, however, it is not the windows that are augmented but the Airform at those points in which doors and windows will be added. This augmentation of the Airform allows windows and doors to be installed in the frontal plane within the shell of the dome, a much more leak proof construction than the dormer type window.

Bubbles/blisters: And that's what they look like—the portion of the dome skin which has puffed up from the surface of the underlying foam by collection of water vapor. Bubbles or blisters are not unique to the dome construction; it occurs in all types of roofing—less so in the dome. Its solution is simple and effective. (See p. 70 for discussion.)

Bucks: The usual definitions do not apply here (male deer, goat, rabbit; young man—especially one who is vigorous and lively). What does apply? I am still researching the origin of this word as it is used in construction. Meanwhile, we know the word "buck" as it refers to the wood frame (preservative or redwood) for windows and doors. They are built to size and then installed after the foam has been sprayed. The windows and doors, themselves, are installed after the shotcrete has been sprayed. At that point the dome shell is "dried in."

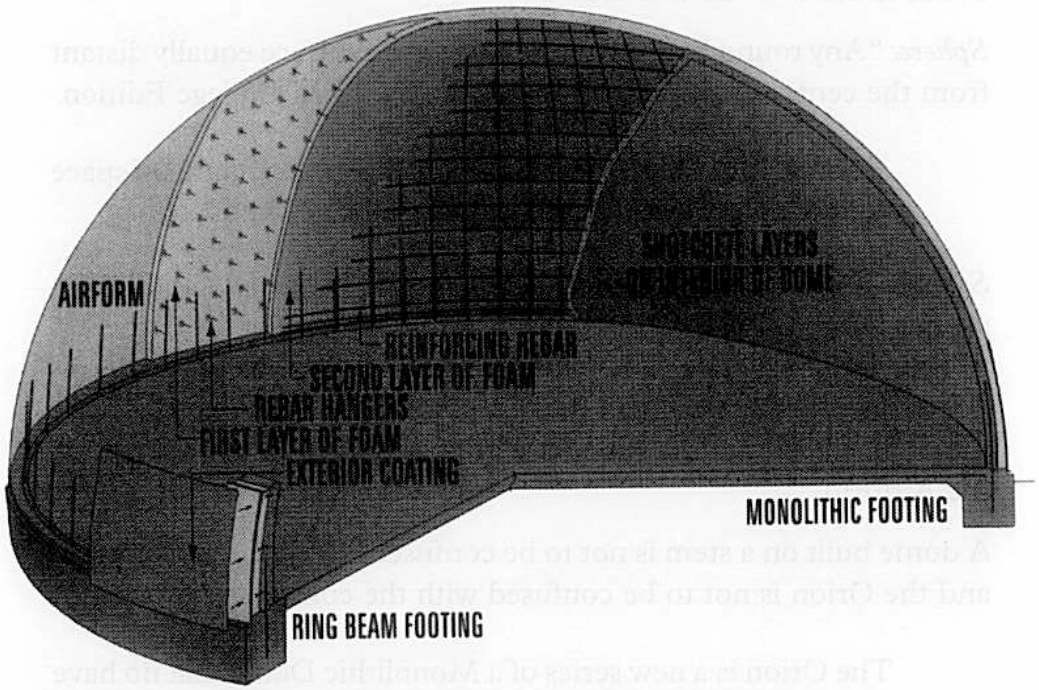
Dormer window. Like dormer windows in conventional homes, the dormer window also projects outward from the dome shell. It is an add-on with the bucks for the openings installed during the construction of the dome shell. If not installed correctly it is the most

prone to leaks of the three primary window types in the Monolithic Dome. (See Recessed windows.)

Dome: Interestingly, the origin of the word "dome" is the Latin word Domus, meaning house, applied to any structure with a hemispherical roof and a round or many sided base. In less recent times, this definition described primarily churches and cathedrals, not homes.

> Monolithic Dome is the name given by its developer to emphasize the unity of structure (monolith) that is the result of the special process and materials used in constructing a dome shape building.
>
> Of the three domes described, the Monolithic Dome is truly a sphere cut somewhere on the rounded side and placed either on a concrete slab or a concrete perimeter footer.
>
> The Geodesic Dome, in contrast, is a series of symmetrical network of struts forming triangles connected to approximate the shape of a sphere, with all the benefits of the geometry of a sphere. It is not a sphere in the true sense of the definition, but similar enough to have the benefits of the shape of a sphere.

Dome shell: The completed exterior dome structure which makes the Monolithic Dome unique among domes in shape, materials and process.



Cross-section of the dome shell structure.

Reprinted with the permission of MDI.

> The dome shell includes the outermost layer, the dome skin/Airform; the inner layer of polyurethane foam with rebar hangers inserted; second layer of foam, then reinforcing lateral and horizontal rebars, installation of the primary plumbing and electrical conduits; the innermost layer, the shotcrete; doors and windows. Complete unto itself.

Rebars: Reinforcing steel rods installed horizontally and vertically in a grid-like matrix before the last layer of foam is sprayed. Extra reinforcing rebars are used in other places, e.g., around all openings and under doors.

Rebar hangers: Steel hooks, a specially designed patented system used for attaching the reinforcing steel rods.

Recessed windows: As this label implies, windows and doors are set back instead of projecting outward as dormer windows do. Recessed windows and doors are installed to fit inside the exterior line of the dome; that is, installed in a secondary wall. The Eye of the Storm, a dome home in South Carolina is an excellent example of this kind of construction that allows recessed windows (See Fig. 34, p. 62).

Shotcrete: If you are thinking that shotcrete has something to do with shooting concrete, you're right. Shotcrete is a specially prepared mix of "cement, three-eighths inch minus aggregate and water projected at high velocity onto a surface." This mix is used for the final layers of the interior of the dome shell.

Sphere: "Any round body or figure having the surface equally distant from the center of all points." — Webster's Third College Edition

> A natural geometric form enclosing "a given volume of space with the least possible use of materials." — Van Loon

Stem: If you wish to add vertical height to your interior walls then the stem is for you. The stem is an extension of the base of the dome, up to four feet in height. It is part of the fabrication of the Airform. Consequently, the stem and the rest of the dome shell are all of one piece. The height of the stem/base must be specified in the order of the Airform.

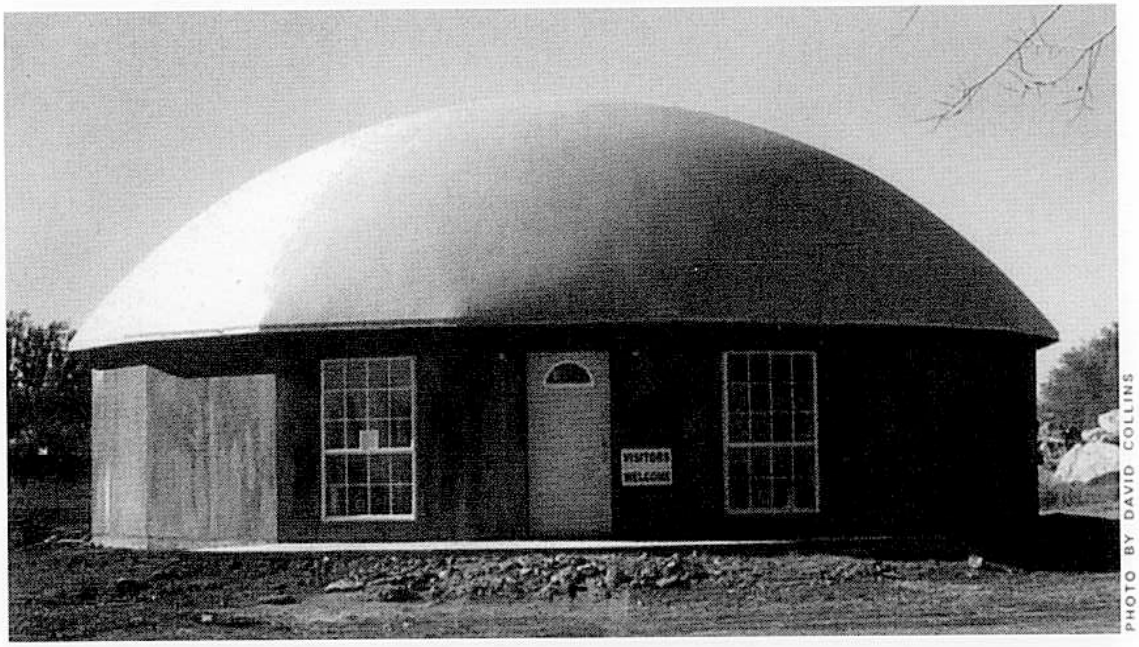
A dome built on a stem is not to be confused with the dome, Orion; and the Orion is not to be confused with the constellation.

> The Orion is a new series of a Monolithic Dome that do have a straight wall base. The first model, described in the Winter '99 issue, has a base constructed from 17 panels, 8' x 8'. In

shape, externally, it resembles a circle. Interiorly, the wall is circular as in other Monolithic Dome types but more vertical in height. A concrete dome caps this base. This model is 47' in diameter.

Because of the straight-sided panels, fitting doors and windows is obviously not the problem it can be when fitting windows and doors into a curved surface. Hence, the Orion should not have the potential for water leaks that domes with dormer windows have, as an example, when the installation has not been engineered correctly. (See discussion, p. 65–67.) The Orion is a great alternative.

Looks like a dome capped Yurt or Deltec. Interesting how the Orion is constructed (See Reference #12). It may look like a Yurt but it is constructed quite differently, still true to the Monolithic Process.



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Why call it the Orion? In mythology, Orion is the hunter and lover whom Diana kills accidentally. In astronomy, Orion is an equatorial constellation. In modern day literature, Egyptologists provide fascinating evidence that the pattern of Orion's belt mirrors the "pattern and alignments of the three Giza Pyramids" (See Reference #2).

But MDI's choice was simply based on their practice of naming all their models after celestial bodies.

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Websites

If you have ever done a search on the Internet then you have already experienced the overwhelming number of sites that exist for a particular search. We purposefully present only a select number to get you started. Often you will find that one site will lead you to another, perhaps a much more relevant one for your question.

All the sites quoted were checked for continued accuracy in September 2000. Websites do change names sometimes and their site host. In such instances, a forwarding link is usually provided that will take you to the new site.

We have deviated from the norm in citing references by including addresses, telephone and fax numbers, whenever available. You may wish to contact one or more directly and may not have access to the Internet.

www.chaingang.org/yurtquest.com

This site is still developing. It has much interesting information on Mongolia; and, of course, the Yurt—the original and its current form. It even gives instructions on how to build one yourself.

www.concretedomes.com

The website of the contractor whose philosophy on building we quoted.

Rocky Mountain Dome Co. 208/267-8596
HCR 85 Box 170-M Fax: 208/267-1037
Bonners Ferry, Idaho 83805

www.deltechomes.com

All about the Deltec/Yurt type of home with many illustrations and other good information for the potential owner/builder.

Deltec Homes 800/642-2508
604 College Street Fax: 828/254-1880
Asheville, NC 28801

www.dnaco.net/~ michael/domes

This site, (personal web pages) is a very informative web site. It includes the basics of the Geodesic Dome; a comprehensive listing of manufacturers, books, and a list of related sites.

www.domebuilders.com

This new website lists dome builders, dome architects, engineers and designers. First making its appearance in the Spring of 2000, it is one more example of the growing interest and developments taking place in Monolithic Domes. It is

linked to the website of the Monolithic Dome Institute. (See www.monolithic.com for contact information.)

www.domehome.com

You will be greeted with music with this website of Timberline Geodesics, another good site.

Timberline Geodesics 800/DOME-HOME
2015 Blake Street
Berkely, CA 94704

www.ecotopia.com/baggins.end

This web site relates and illustrates the building of a dome by students at UCLA in 1972. It has since been expanded and continues to be used today as student housing. It is linked to www.ecotopia.com, the parent home page.

Eco Systems 408/332-5375
PO Box 7080 Fax: 707/221-1859
Santa Cruz, CA 95061

www.jademountain.com

If you are interested in alternative sources of energy, supplies and related environmental friendly developments, this site is an excellent one to start your search.

Jade Mountain 800/442-1972
717 Poplar Ave Fax: 303/222-3599
Boulder, CO 80304

www.monolithic.com

This is the site where we dome dwellers keep up to date on happenings in dome technology, building, architectural developments . . . Here you will find conference/workshop information, photos of interesting homes in various stages of construction, articles, a frequently asked question (FAQ) column and more.

Monolithic Dome Institute 972/483-7423
177 Dome Park Place Fax: 972/483-6662
Italy, TX 76651

www.nbyurts.com

This company features Yurt structures that look more like the original yurt than the Deltec does. It has its own distinct technology for the Yurt. They also show clearly the compression forces in the Yurts (See Fig. 8a, p. 12). The site information includes an interesting set of illustrations showing the "raising" of a yurt in one day, a completely do it yourself event . . . with the help of friends.

Nesting Bird Yurt Co. 360/385-3972
731 West Park Avenue Fax: 360/344-3857
Port Townsend, WA 98368

Meet the Authors

Carmella Gonnella Carmella looked forward to her "mid-life" career shift (a.k.a. retirement) to venture into a long held dream: living in a rural area in a dome home, continuing research, writing and creating stained glass art. Retired from her position as a university professor in Rehabilitation Medicine with a PhD in Psychology and many years as a clinician, educator and researcher in Physical Therapy, Carmella knew that plans, hopes, dreams, don't always turn out in the way one would like. She also knew that one must have faith in the rightness of the eventual outcome. Not anticipated was the side trip into writing a book about dome homes; yet side trips can be fun, open up new learning experiences and friendships, as this one certainly did.

Jean Hirst Jean has had a long-time interest in designing homes, including dome homes. She got an early start as teenage helper to her uncle in the real estate resale market; later she and her husband built a log cabin, log by log, in Canada. Finally, in 1994, her interest in domes became a reality. Unforeseen, however, were the consequences of being called out of town during the initial stage of building: the attaching of the skin to the slab foundation and inflating the dome shell. She returned to a dome shell rotated 45 degrees from the planned orientation. Her previous experience came in handy in redesigning the interior with minimal costs and preserving the essence of her original intent. As Jean laughingly relates this experience —she made "lemonade out of her concrete lemon."

Michele Forbes Ostrowski Michele grew up in the building business, and has always been interested in all types of home construction. Her small remodeling and renovating business in Florida was a far cry from building in the round, especially stepping into the middle of the building of a dome home. A Monolithic Dome was a totally new idea and a daunting challenge. Years of experience did not prepare her for all of the new ways of thinking that finishing this dome would entail. But with help from friends in the trades, and an open mind, she is now able to add this unique construction style to her life experience.

The Future is Now

Dare to Live Your Dream In A Home for the Millennium

A Dome Sweet Home that is:

- Energy Efficient
- Environmentally Friendly
- Hurricane and Tornado Proof
- Earthquake Proof
- Easy to Maintain

with Infinite Design Possibilities

"It tells the story as I would like to have it told. The authors have met and conquered many challenges in acquiring their Monolithic Dome Homes. This book would be best characterized as 'tell it as it is'."

—David South, President
Monolithic Dome Institute

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