RESPONSES TO CLIMATE AND CULTURE

Healthy vs. Sustainable vs. Durable vs. Affordable: A Practitioner's Quandary

Debrah L. Walker
Debrah L. Walker, Architects, Seattle, WA

Over the past four years I've been working on a home on Whidbey Island in Washington State for a client with a complicated and diverse group of allergies known as Multiple Chemical Sensitivity, (M.C.S.), or Environmental Illness (E.I.). It's been a very interesting and challenging project and the entire team including the designers, builders, and clients worked very hard to meet not only the health needs of our client, but also to create an attractive, quality-built residence and a natural, sustainable environment that reflects the beauty of the site and the integrity of its rural setting.

As I came to understand more and more about the issues involved with building a non-toxic home there are questions that surfaced again and again. Designing and detailing healthy buildings requires research into every material used, and in this process I found that many green and sustainable products were too toxic for my client. I also found that one of the big issues with using low-toxic materials is that they are often less durable than standard materials. This issue requires increased attention to detailing and careful construction methods that can add considerable cost to a project.

Fig.1 View of the front porch and the house from the south meadow.

Since World War II developing construction materials and methods have been geared towards long term durability and ease of construction. As a responsible architect this fits one of the primary goals of designing and detailing buildings. Buildings that not only meet a client's aesthetic and program requirements, but will also be durable. We have become accustomed to products that are wonderful in their ability to resist weathering and decay. Products that often deliver on the promise of less maintenance required. We've become accustomed to using the same details over and over that depend on these products, because these products have preformed well over time. For years my criteria in specifying materials was cost, how it would look, and how it would perform over time. These will always be primary concerns, but they can no longer be the only concerns.

Universal Principals for Building Healthy Homes

There are several principals that need to be understood and practiced when designing and building a healthy house. I would encourage these principals to be considered and applied to any project. In working on this MCS house on Whidbey we had to make these principals a priority in all aspects of our work.

There are four, universally accepted, principals in building any healthy home that we employed on this project:

1. Eliminate toxic materials as much as possible
2. Separate sensitive or toxic materials that can't be eliminated by sealing them off from the living spaces.
3. Ventilate with fresh air.
4. Filter the air to remove any pollutants, particulates and gases.

One of the key understandings of using these principles is that extra time and attention had to be taken to ensure that the separation, encapsulation, ventilation and filtration were done correctly. Further, to determine the exact specifications for this project, all materials and systems were researched and tested for toxicity. And because accidental contamination would defeat everything we were trying to do in creating a healthy house, extreme care had to be taken constantly.

Healthy House Principal No. 1 Elimination

Our client has known sensitivities to most synthetic and petro-

chemically-based materials including fungicides and pesticides, most adhesives, smoke particulates, all perfumes and scents, toluenes, solvent based materials (including cleaning solvents), mildew and molds, cedar, pine, and formaldehyde (especially the urea form). This eliminated the use of most of the construction and finish materials used in standard building practices today.

Every material that was used in this house has been researched, and then reviewed and tested by the client. Her involvement in this process was essential. For every product used in this project, two to four other products were considered, researched and rejected. We kept an ongoing log of materials that had been tested and approved in a Quick Reference List. Throughout the job the contractor and subcontractors referred to this list to verify acceptable products.

There is an increasing group of non-toxic and less toxic materials available to substitute for standard items. We obtained and reviewed the Material Safety Data Sheets (MSDS) describing all

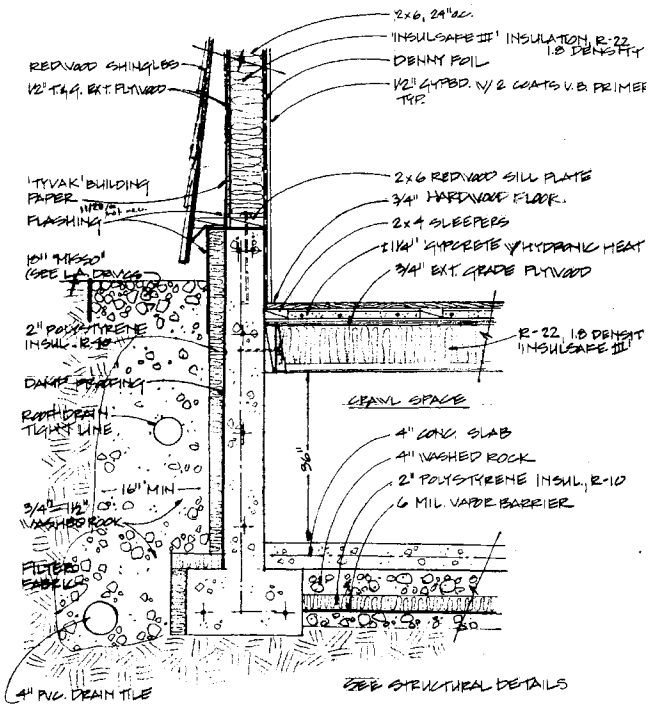

Fig.2. Wall and foundation construction section

materials that were in any products we were considering to determine if they contained unacceptable materials. Whenever possible we chose products that were not only non-toxic, but also considered sustainable. Too often, however we would find resins, adhesives, or preservatives used in these products that prevented us from using them. This was particularly a problem in composite, and engineered products.

We also used construction methods commonly used prior to WWII. For example, use of solid, natural materials such as stone, solid wood, etc., thick-set mortar rather than mastic, and overall, an absence of synthetic, tar-based, quick-drying, composition, and solvent-based materials.

Healthy House Principal No. 2 Encapsulation

Once we knew what materials could be used, and which ones would be a compromise the next step was to detail ways to encapsulate or separate the more toxic materials from the interior living spaces.

Standard exterior products that create good moisture-barriers were very toxic to our client. However, we were also very concerned with the long term durability of the exterior of this house. After serious consideration we chose to use an oil based stain on the exterior shingles because it out gasses quickly, will hold up longer to the destruction of wind and rain, and allow more years between repainting. In the roof sheathing we decided to use a toxic but standard building paper which is tar impregnated under a metal roof. We made this decision for durability and warranty reasons.

We were willing to compromise the non toxic aspect of the exterior wall and roof assemblies only because we could keep these products several layers away from the interior spaces. We achieved this separation by wrapping the exterior plywood sheathing with Tyvek, and the framing of all interior spaces with a moisture and vapor barrier foil-backed kraft-paper. All joints in the framing including the mud sills of all exterior walls were caulked to the plywood subfloor. The gypboard and plywood sheathing also were caulked at the seams, and a vapor barrier primer paint was used to seal the gypboard. Finally, through out construction all holes and cracks from gaps in the framing,

electrical, ducting, or plumbing penetrations were filled with either a silicone caulk, silicone foam seal, backer rod, or insulation.

Healthy House Principal No. 3 & 4:Ventilation & Filtration
Constructing a building this air tight was done both to separate the living spaces from more toxic products, but also as part of the controlled environment for a whole house ventilation system.

As we investigated all the issues of building a healthy house for someone with MCS, and toured other MCS homes the one universal aspect for every home was its air filtration system. Air quality plays a major role in the health of a building, especially with the high standards for tight, well insulated buildings. Sensitivities may vary from person to person, but the single most effective thing that can be done to create a healthier environment is to have a good quality air filtration system.

To achieve the air quality needed for this project several levels of filtration were installed. When the ventilation system is closed, and all the doors and windows are shut, air is brought from the forest edge side of the house. It comes into the attic into a heat recovery ventilation unit that preheats then pre-filters the air. The system also includes a whole house fan to keep the air filtered, circulating, and the interior space pressurized. The air filtration uses both hepa and charcoal filters to absorb microscopic pollutants and gases (such as formaldehydes). All exhaust is vented towards the garage and driveway. In addition there is a 3500 cfm whole house emergency fan to evacuate pollutants quickly if there is accidental contamination.

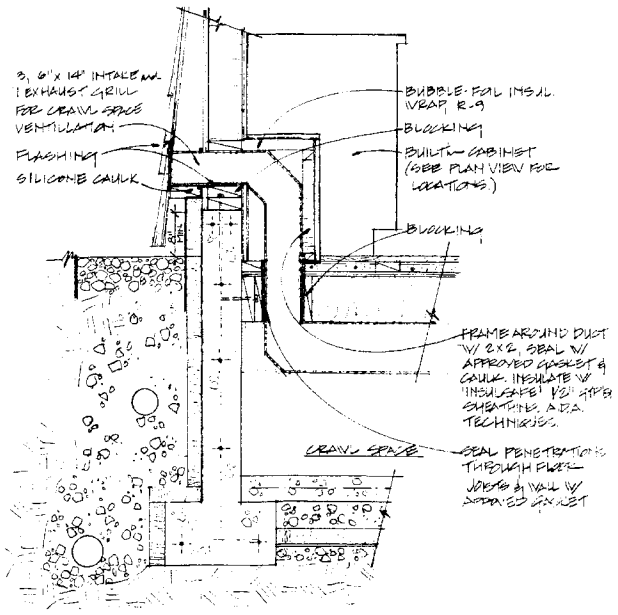

Fig. 3. Crawl space ventilation detail.

One of the major sources of formaldehyde pollution in today's environment is fabric and clothing. Virtually every piece of fabric, clothing, upholstery, drapes, carpeting, sheets and linens, bath towels, etc., are permeated with formaldehyde as a finishing agent. This is not an inert agent, but outgasses for an indefinite time, and our client is sensitive. For this reason, and because both moisture and other solvents are a problem, the crawl space, all closets, bathrooms, and the utility room are also individually vented.

Examples of Methods and Materials
Volatile chemicals linger. They can be absorbed by anything porous; lumber, insulation, gypboard, and fabric are a few examples. These agents include all smoking materials, colognes/perfumes, and hair sprays. So first and foremost we needed to require that there be no smoking or any of these products on people entering the site. Every material and product used and detailed in this house was carefully considered, and before any subcontractor came on the site we met with them to review protocols, the Quick Reference List, and further specifications pertaining to their trade.

Occasionally subs would recommend other products, and if research and testing proved the product met our clients health requirements we would switch products. The time involved with these necessary protocols and product reviews is one of the main contributors to increased costs. Another contributor is the special handling or manufacturing some times required.

Framing Materials
Our client had at least two known wood allergies which were cedar, and pine. All framing lumber had to be redwood, fir or hemlock, and it had to be of pre-treated stock; i.e. kiln-dried and not dipped in

preservatives, fungicides or insecticides, and not stamped (sensitivity to the inks). For the mud sills and all wood in contact with concrete we used redwood. This required advanced planning by the contractor to contact appropriate mills and secure adequate pre-treated framing lumber on a timely basis

Exterior-grade plywood was used both for exterior and all interior work. Most particle board products and interior grade plywood were unacceptably toxic because of the glues and resins used in these products. Exterior grade plywood does have formaldehyde in its glues but it is not the urea type so it out gases relatively quickly and completely, and can be sealed with water based sealants or non-toxic wraps.

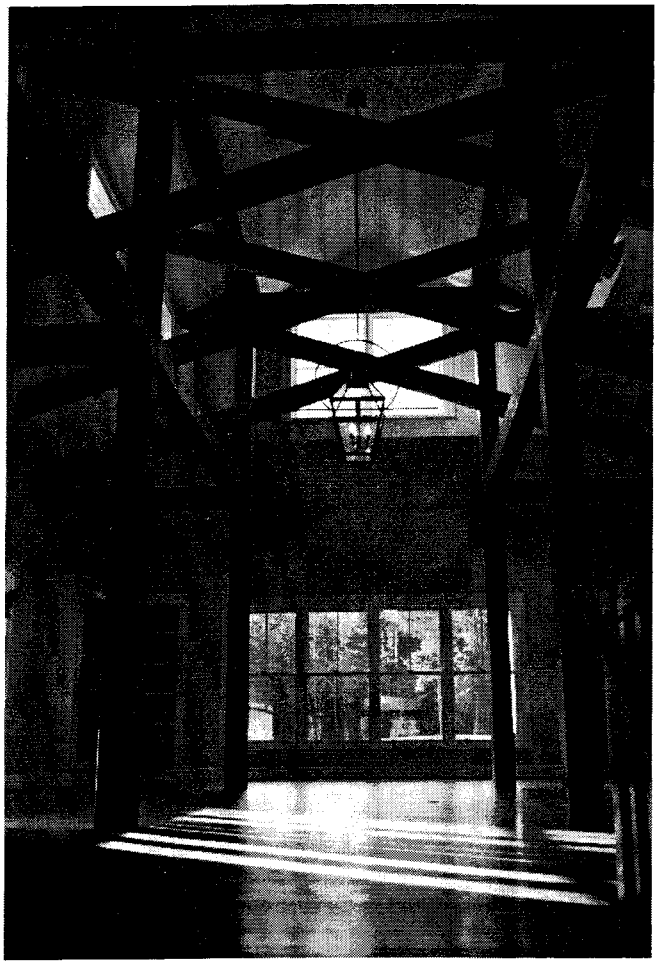

Fig. 4. Living room truss made from recycled timbers.

Finishes

Many of the finish materials for this house are solid natural stone or wood. All interior wood is either fir, maple (flooring), poplar (all painted trim), or alder (all cabinetry). All sealants for these materials are water-based, non-toxic sealants. Natural wood stains and sealants were a wood wax product from Germany, which we sometimes mixed with a natural shellac. All interior paints were no v.o.c. products. This paint does have a limit in color choice, and is not available in deep, dark colors. It also does not harden to the degree standard latex, acrylic and oil based paints will. Less durability is a concern when choosing non-toxic finishes, but the clients are aware of this trade off and the need for careful maintenance.

We used heavy timbers in the living room and kitchen and these were recycled from a hundred year old dock that was demolished. They were recut, assembled into the truss, and hand hewn in a shop in Seattle. They were then disassembled, shipped, and reassembled and finished on site.

The counter tops, shower stalls, and fireplace surround are either solid stone slabs, or stone and ceramic tile. There are no epoxies used in the seams, but instead have a sanded hydromix grout or silicone caulk in all the joints.

Crawl Space, Showers and Water Protection

Building homes that are water tight and can effectively handle the destructive effects of water are often at the heart of why we choose to use toxic materials. The additives, glues, and sealants that add to the durability of a building were not options for the interior spaces of this project. This meant we occasionally used non-toxic materials in unusual details to assure the water tightness needed. The greatest areas of concern were the crawl space, the showers, and at the perimeter edges at thresholds and sill plates.

Special care was given to the crawl space under the house, to ensure it will be kept dry and free of mold and mildews. Although it is a crawl space, not a basement, it has a 4" concrete slab floor, with extensive layers of rock, sand, and a vapor barrier underneath

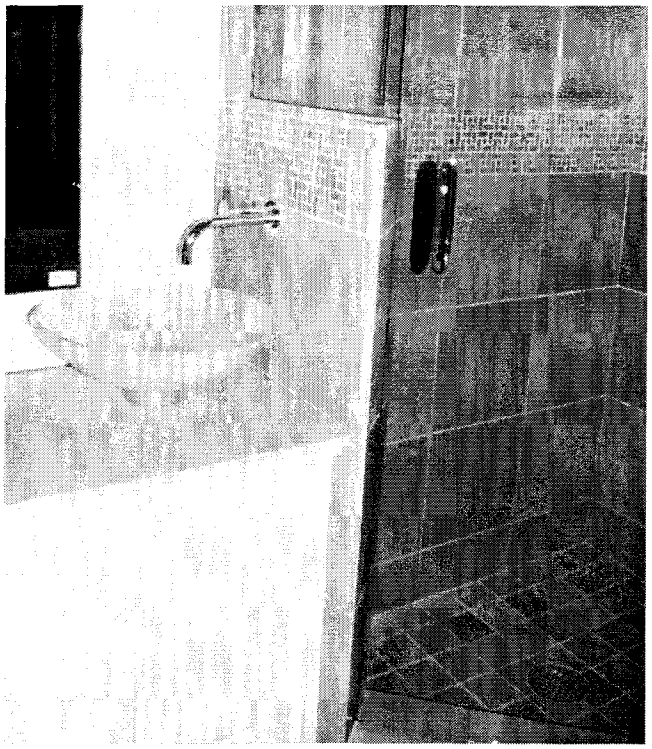

Fig. 5. Stone tiled shower set with thick set mortar and sanded grout.

it. The perimeter foundation has extra layers of moisture protection and subsurface drainage installed to make sure the water is directed away from the crawl space. The crawl space is mechanically vented, and the access to the crawl space is from an interior room where it is weather protected. See figure 2.

We could not use many of the standard materials used to build water tight custom showers. The showers are all made with stone tiles set in thick set mortar instead of mastic, and sanded grouts without additives. Stainless steel pans with an integral drain were fabricated to replace the conventional neoprene sheeting, or fiberglass pans. Each shower has a separate ventilation fan in its ceiling Even with all this, because we did not use the water resistant additives or sealants in the grout our clients understand that they will have to pay special attention to the maintenance of these showers.

Furniture

For this home furniture is either custom made or old enough that it has outgassed all toxins. If the furniture is custom made, and made of wood (the dinning room table for example) it is made of alder and stained and sealed with the German wood wax products and shellacs. Other waxes such as Bri-wax, or Carnauba were toxic to our client.

Upholstered pieces are all custom designed and built by a shop that is clean and non-toxic. The frames are built with fir. The padding is constructed with a combination of organic unbleached cotton batting, down, or pure natural latex rubber. This is covered with unbleached cotton muslin, and then covered with the finished

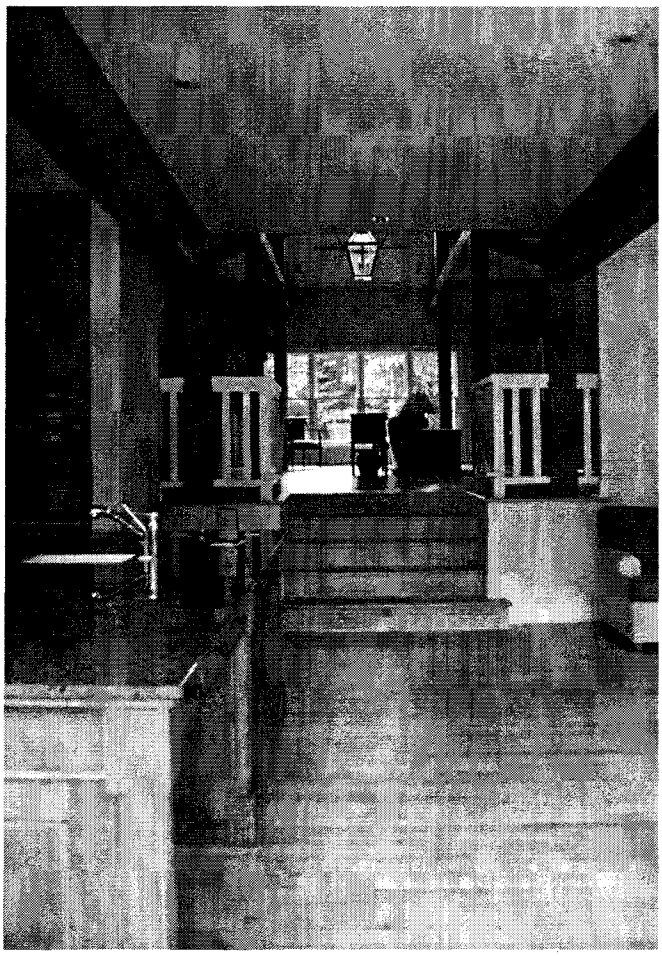

Fig. 6. View of the kitchen island cabinet, and sitting area in the dining area. The living room furnishings can be seen in the background.

upholstery fabric.

The upholstery fabrics were selected from design showrooms, but are all only natural fibers. Because all the fabrics, including the unbleached muslin, have been treated and sized they required a three step soaking process to remove the formaldehyde before the furniture could be constructed.

Finally

A project like this forces a reexamination of all previous assumptions about construction assemblies, construction procedures, and the materials themselves. The owners played an active role in making decisions about substitute products, and understand the additional maintenance some of those choices will require. It's a trade off they have been willing to make to assure their health in this home.

There are many lessons from the design and construction of this home and some are very specific to the sensitivities of this client, but many are applicable to the health of all buildings. I am delighted that the product lists of low toxic and nontoxic products continues to grow