THE TEXAS "RECYCLED CONTENT" / ADVANCED GREEN BUILDER DEMONSTRATION HOME PROJECT

Pliny Fisk III, Gail Vittori
Center for Maximum Potential Building Systems, Inc.
8604 F.M. 969
Austin, Texas 78724 USA

ABSTRACT

This paper presents an overview of principal issues addressed in the Advanced Green Builder Demonstration Home Project, with units to be constructed in Austin and Laredo. The project's objective is to introduce these distinct communities to a range of "green" housing materials and methods, emphasizing opportunities for recycled-content and by-product based construction materials. The project, principally funded by U.S. Department of Energy Oil Overcharge Funds administered by the Texas Governor's Energy Office, also is supported by several state, regional, and municipal agencies. As such, the project reflects a regional process, as open to adaptation to a region's natural resources as it is to its peoples.

The design is specifically intended to bridge issues of social and family concerns, such as affordability, expandability, and economic development. This is a result of a modular-based design framework, coupled with reliance on environmentally-conscious regional manufacture of by-product based materials. Environmental issues are addressed by establishing a user for pollutants considered major contributors to global concerns of acid rain (due to release of sulphur dioxide), global warming (due to release of carbon dioxide) and deforestation. The homes will be built without virgin wood products or portland cement.

1. INTRODUCTION

The Center for Maximum Potential Building Systems initiated a sustainable rating program, in partnership with The City of Austin, in 1990. The program, now called "The Green Builder Program," was honored at the 1992 Earth Summit. It extends the City's successful "Energy Star Program" to include water, solid waste, and building materials. By using a life cycle assessment (LCA), the new rating procedure establishes a link between how each resource category relates to the region's resource base. This procedure tracks the "life" of a product through the stages of sourcing, manufacture, use, and, finally, reuse, recycle, or disposal. The procedure enables an understanding of environmental impacts at every stage of its "life," and has been adopted in scientific circles to better understand the relationship between resource use and environmental impacts.

The success of the Green Builder Program is evidenced by the increasing number of builders, manufacturers, and vendors wanting to enter the "green" marketplace. The Advanced Green Builder Demonstration Homes (AGBDH) will be physical manifestations of the range of design methods and materials advocated by the Green Builder Program.

2. BRIDGING ISSUES IN THE ADVANCED GREEN BUILDER DEMONSTRATION HOME

The demonstration buildings go beyond singularly focused environmental issues by purposely bridging social and environmental concerns, and by becoming catalysts for evaluating the ways that architecture can impact the problems of:

- Affordable housing through efficient building practices;

- Outgrowing a home by incorporating spatial flexibility to enable the home to respond to a family's changing spatial needs;

- Economic development by supporting regional businesses and manufacturers and vendors of "green" products;

- Environmental issues associated with sulphur dioxide and carbon dioxide emissions by providing sinks.

As important as understanding how to design around these significant issues, is understanding how to communicate the approach. As a result, a

sustainable design vocabulary is being developed that is able to link what are often disparate issues with a new set of "building blocks." These building blocks relate to all scales of sustainable design, from planning neighborhoods to large urban and rural areas. The language methodology uses the life cycle assessment as its basic framework.

3. ENVIRONMENTAL & REGIONAL CONTEXTS

Three basic macro trends provide the cornerstones of the Advanced Green Builder Demonstration Homes: global, regional, and urban environment conditions. Each of these scales relate to imbalances in particular metabolic conditions. One cause of this is inappropriate use of natural resources; a second is an absence of looping by-products back into production, resulting in what is generally termed pollution. The AGBDH will demonstrate how the adoption of specific materials and methods could substantially lessen the environmental impacts of the built environment.

3.1 Global Conditions

As a single source, the production of portland cement is responsible for 2.4% of global warming. The AGBDH will replace portland cement with an almost 100% coal fly ash cement, and restrict its use to applications which will not compromise human health.

Sulphur, another by-product from coal-burning plants, will be used as a binder for concrete masonry units (CMUs). In its elemental form, sulphur is benign (and is edible). In its gaseous form, however, such as SO2 emissions from coal burning plants, sulphur is poisonous and causes the condition known as acid rain. Acid rain destroys forests, lakes, and buildings, and is responsible for as many as 60,000 deaths a year in the U.S. caused by lung cancer.

As industrial by-products, both coal-derived fly ash and sulphur have low embodied energy, since no additional energy is expended in their production. Integrating passive solar design features and the use of these low-energy materials results in low operational energy costs for the building. As a result, the building's overall contribution to global warming is significantly reduced, and is even enhanced by the landscape design.

3.2 Regional Conditions

For the purposes of this paper, regional area resources are defined as two types: those which are available in abundant quantities such as certain soil types; and renewable resources, such as high yielding crops, that can be grown in three seasons and, with proper crop rotations, do not deplete arable soils. Use of regional resources within the region from which they are derived reflects well on their life cycle assessment, since transportation costs are lessened, and the distance between source and sink is reduced. Thus, overall production is efficient, and lends itself to be balanced with the region's ecological land planning. This junction between ecological and economic planning becomes linkable again through the use of a life cycle assessment "ladder," through which regional sources are mappable entities subject to planning procedures. In turn, these resources become the bases for job production in the building materials, water, waste, and climate-control manufacturing sector.

3.3 Urban Conditions

The combination of a region's virgin and by-product resources resulting from urbanization introduces an entirely new product potential. This resulting building approach is referred to as a regionalized building system. Inventorying existing and potential by-product reuse opportunities can result in a resource base at least as diverse as that offered by virgin resources. Moreover, the resulting pool of resources (combining virgin and by-product sources) achieves an enhanced level of building technology that is more technically sophisticated and ecologically benign than that which relies solely on virgin materials. This especially applies to those virgin materials that come from highly concentrated sources that use extensive processing energy, and the dependence on enormous resources as a result of their transportation requirements.

Planning by-product resources in this way is often referred to as "industrial ecology," which becomes the urban facsimile of "ecological land planning" on a regional scale. This new perspective on urban planning involves a systematic reconceptualization of how to balance a region's waste and virgin resources within the context of the region's carrying capacity. This process is constantly evolving as a result of an enhanced knowledge base. The new technologies and refined identification of technology-associated problems resulting from this enhanced knowledge form the basis of the balancing procedure, which, when acknowledged and worked with, becomes is a

balance of dynamic equilibrium. The Advanced Green Builder Demonstration Home is a time fractal of this process.

4. RESOURCE EFFICIENCY & LOCAL ECONOMIC DEVELOPMENT

Factors which serve as litmus tests of a region's economic development potential are:

- The waste economy
- The quantification of the life cycle assessment ladder
- The vertical integration of the local economy

4.1 The Waste Economy

"An ecological system is a network of food and mineral flows that involves major pathways of populations including animals, plants, and microorganisms each specialized to live in a different way."[1] In healthy systems, these sectors of producers, consumers, and recyclers each have equal but distinct roles. Only in "bloom populations," or those in which one sector dominates all others, is this balance disturbed. The disruption is often the result of an overabundance of a given resource, such as has been created by petroleum in human systems for much of the 20th century.

The imbalance in human systems is partially a result from overdependence on petroleum resources. The presence of pollution can reflect a lack of effectiveness in the recycling sector, manifested by a physical lack of opportunities, or by a cost accounting system that fails to factor in environmental costs, or externalities.[2] An enhanced recycling sector should reflect well on the long-term health of the economy.

4.2 Quantification of the Life Cycle Assessment Ladder

The number of transformations from initial sourcing through to use influences the efficiency of delivery. This phenomenon is summarized by saying that the overall energy efficiency is the arithmetic product of the conversion efficiencies at each stage. For example, the difference between three, five, and seven transformations in the LCA ladder (assuming equal efficiencies in each) is respectfully, as follows: .34, .17, .08. As one can see, there is more than four times the efficiency between steps three and seven.

The basis for supporting a regional building system approach lies in both increased efficiency as skills are learned and re-learned, and increased knowledge facilitating the understanding of a range of indigenous potentials. When this is achieved at the level of virgin and by-product sources, the energetics of the delivery system improves, and jobs are increased due to the diversity of potential products resulting from overlapping systems. The Advanced Green Builder Demonstration Home emphasizes this diversity potential, and the resulting limit of the number of steps in the life cycle chain.

4.3 Vertical Integration of the Local Economy

Even though we often refer to material cycles and keep these cycles going (given that integration is fundamentally a more important resource conservation concept than conservation), the entire production sequence is "captured" from raw material through to final product. When this capturing takes place, (i.e. all sourcing, transporting, processing, manufacturing, using, and reusing steps occur within a region's boundaries), the job multiplier is increased.

5. SIGNIFICANCE OF INFRASTRUCTURE MINIATURIZATION & REPLACEMENT

Approximately 60% of the nation's wastewater treatment plants do not meet U.S. Environmental Protection Agency (EPA) standards; five to nine percent of gas flowing through the nation's pipelines leaks in the form of methane, which some believe to be a more significant contributor to global warming than industrial sources of carbon dioxide; water pumped from slow recharge aquifers to meet the water needs of some of the nation's largest urban areas indicates an unstable resource future, particularly in the southwest.

The Advanced Green Builder Demonstration Home with the assistance of regional and local agencies, will present a miniaturization of sustainable infrastructure systems. These include:

- An on-site rainwater catchment system, designed to provide for 100% of the home's domestic water needs. Recent studies by Texas A&M University have determined that the potential exists in central and east Texas for a standard home to provide for all its water needs by capturing rainwater from the roof. This potential is realized by utilizing water

conserving fixtures and recycling and reuse techniques. In addition to a cistern attached to the house, a pond serves as additional cistern capacity and also functions as a lap pool, fish pond, and heat sink for the heat pump.

• An on-site black and grey water treatment systems, with the treated water reused for plant and animal production. The wastewater treatment system, for example, will be designed as a "low-pressure dosing system." Designed in collaboration with the Austin-Travis County Health Department, the system requires little energy input, and is the excuse to plant a "living fence" on the property, which, in addition to metabolizing the gray and black water, provides privacy, security and a haven for wildlife.

• On-site renewable energy systems for heating, cooling, electricity, and transportation. The structures' roofs are reradiating to the north and adsorptive to the south, incorporating simple technologies for chilling and heating water. Depending on the season, the roofs are connected to the cistern water and counteract heat pump temperature variation.

6. BALANCING HUMAN & ENVIRONMENTAL HEALTH CONCERNS

There are sometimes conflicts between using by-products to relieve environmental stresses, and the consequent impact of these uses on human health. Conversely, some of the materials and methods acknowledged as appropriate for "healthy homes" have been demonstrated to have disastrous consequences for the planet's environmental well-being.
Fly ash from coal-burning plants can possess radiation levels considered dangerous for human exposure, depending on the source of coal. Similarly high radiation levels are also found in some samples of portland cement, granite, and soil, all having uses in conventional construction practices. Because of the particular concerns raised about fly ash, and an uncertainty as to the specific consequences of long-term, low-dose exposure to radiation-emitting building materials in interior environments, the use of fly ash in the Advanced Green Builder Demonstration Home is limited to non-contact surfaces, such as columns and beams which are permanently sealed from exposure to people. Fly ash will not be used in slabs. As a further safeguard, fly ash samples will be tested for radiation prior to use.

7. GROWTH

As we approach the 21st century, demographic trends point to dynamic trends relative to family size and needs. However, design methodologies have remained static, making it difficult to "grow" a house once the initial structure has been built. Few building systems have been designed for ease of expansion by owners or small contractors. By following a grid that becomes responsive to a wide range of pre-manufactured panels, or to the use of indigenous infill materials, the AGBDH building system is intended to sustain the family's life over time. The modular components are designed for ease of use by an owner-builder, being lightweight (about 20 pounds), and able to be stacked without mortar. Additionally, the modular units can be formed together to create a foundation, columnar or beam forms that are then poured into for a sturdy post and beam framework.

8. DESIGN METHODOLOGY

A variety of applications are being developed, based on the LCA ladder. These applications fall within the framework of a sustainable design process. The process is based on icons, or symbolic pictures, of processes and products sequenced together in the LCA format. Connections to the region, and interconnections among each other, are significant in terms of sustainability. The spatial conditions of resources, for example, can be identified by tracking back to the "source." How the components fit together becomes a conceptual model for the building elements and their connectivity to each other and their region.

The clustering of icon ladders form major building blocks similar to the sectors discussed in natural systems. In this way, sources, processes, and sinks (or reuse) conditions are accounted for within the building, neighborhood, or urban context. These clusters include all metabolic components, and view the building as an organism responsible for heating, cooling, cleansing, treating waste, producing food, providing water, and more.

9. ACKNOWLEDGEMENTS

This project is made possible through funding provided by the Texas Governor's Energy Office, Oil Overcharge Funds, and support of the City of Austin's Environmental & Conservation Services Department, and Electric Utility Department; Lower Colorado River Authority; Austin-Travis County Health Department; Centro Aztlan; Texas

Department of Health; Southern Union Gas; and The Urban Consortium. Rich MacMath continues to provide valuable insights on the Center's design methodologies.

10. REFERENCES

(1) Howard Odum, Environment, Power & Society, Chapter 3, Wiley Interscience, 1971.
(2) Scientific American, August 1992.