COMING TO GRIPS WITH THE SYSTEMICS OF SUSTAINABILITY:

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Introduction

Four significant resource flows comprise a region's metabolism: materials, energy, money, and information. The built environment represents one embodiment of these flows, and can be used to evaluate the degree to which these flows support or negate regional processes. Given the complex linkages between flows, beginning with sourcing through to processing, manufacturing, use, and post-use, it is easy to understand why there are misunderstandings as to the environmental impacts of any given product, or, historically, why little effort has been made to understand all but the most glaring environmental affronts. The consequent physical and mental detachment between people and the buildings they occupy is reflected in the multitude of environmental crises.

The Function of Linkage

Establishing linkages between examples of regionally relevant resource use, and identifying how these examples affect the local economy, highlights the crucial interrelationship between regionalization and the built environment. The range of practitioners involved in a regionally-based procedure can unite the often isolated steps of planning, design, construction, and manufacturing, making possible an information-rich connection. Even at the home scale, it is possible to integrate individual building processes to enable multiple functions, thus enhancing the home's overall operating efficiency. When these processes are viewed as connectors of several different resource flows, one can establish an audit system based on flows rather than efficiency. When the home is viewed as a utility system, and when passive solar design features are the basis for the grid, one cannot dissect the home into discrete parts, since all parts operate synergistically and are optimized in the presence of others. Such a home can be a micro-manifestation of a region's metabolism.

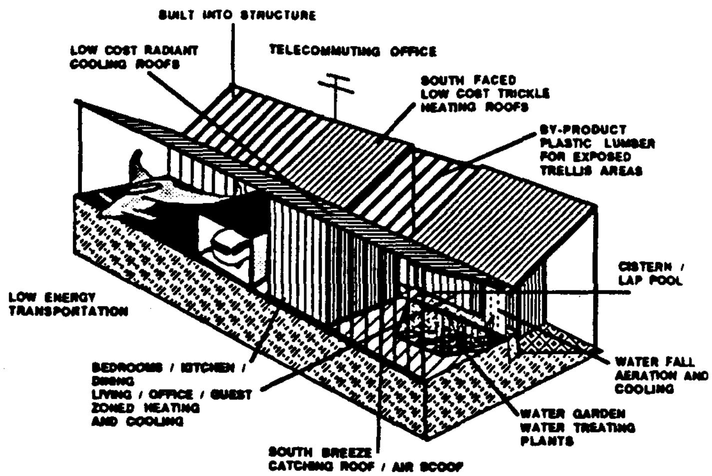
Life Cycle Assessment as an Organizing Principal

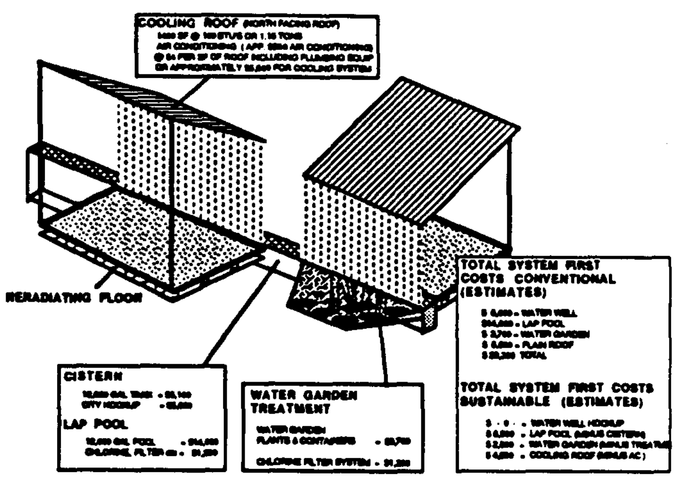
An example of metabolic linkages is a home currently under design, in which we have used a Life Cycle Assessment (LCA) sequence to integrate climate, water, material, structural, waste, landscape, and recreational systems. At each process step of the LCA for a given topic, there are associated issues solved at other topic areas. To better understand the life cycle assessment, the chart below describes the basic format, from Source (S) to Regional Transport (T) to Processing (P) to Local Transport (t) to Use (U) and, finally, Reuse (R). These LCA relationships are fundamental to any physical process undertaken by people and other life forms.

Fisk, 1987

The House at the End of the Runway

This simple building example, illustrated below, provides a good case example. The building offers unusual economic advantages due to a careful integration of multi-functional components. For example, the lap pool is the cistern, the water supply, and the basis of the cooling and heating system. Ornamental landscape plants are used to treat the water before it is used in the home. By incorporating many uses in a single system, such as a lap pool, the economics are transformed, and what was once considered a luxurious custom feature is affordable since it replaces what are basically standard features. A brief economic analysis compares the integrated home with a conventional one.

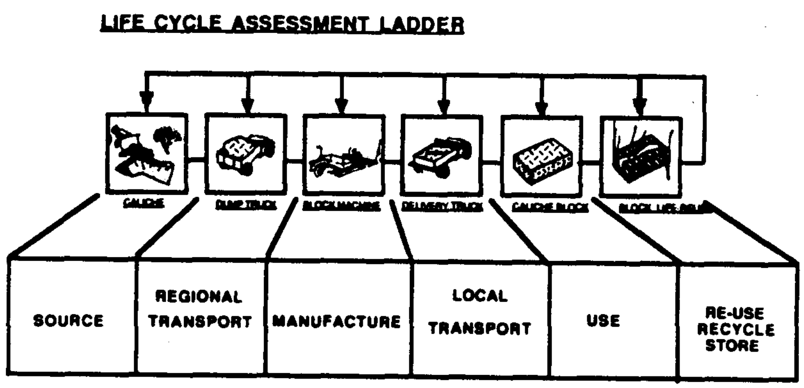


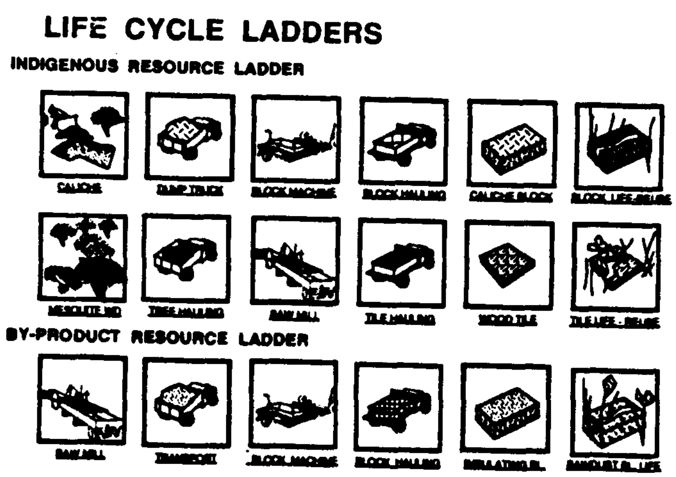


The Flow of Money

The ability to account for overlapping functions has been addressed on a macro-scale through regional analyses by economists such as Walter Isard. Originated by Wassily Leontief, this procedure is generally referred to as "input-output analysis." The application, however, at the scale of an individual house has never been applied, either as an objective such as sustainability issues nor an an operating basis. The passing along of expenses, a traditional economic process which left such issues as waste, or secondary environmental effects out of the picture (which in part responsible for the nation's environmental and debt crises), was rarely challenged but now can be absorbed and understood through a whole systems analysis such as input output analysis offers. The existing macro-system needs a complete overhaul, in order to properly account for nature (food chain, money, energetic incompatabilities) and often it is too much of a task for planners to take on within existing fiscal budgets. It is, however, possible to start at the scale at the home and absorb many of these larger issues using the same principals.

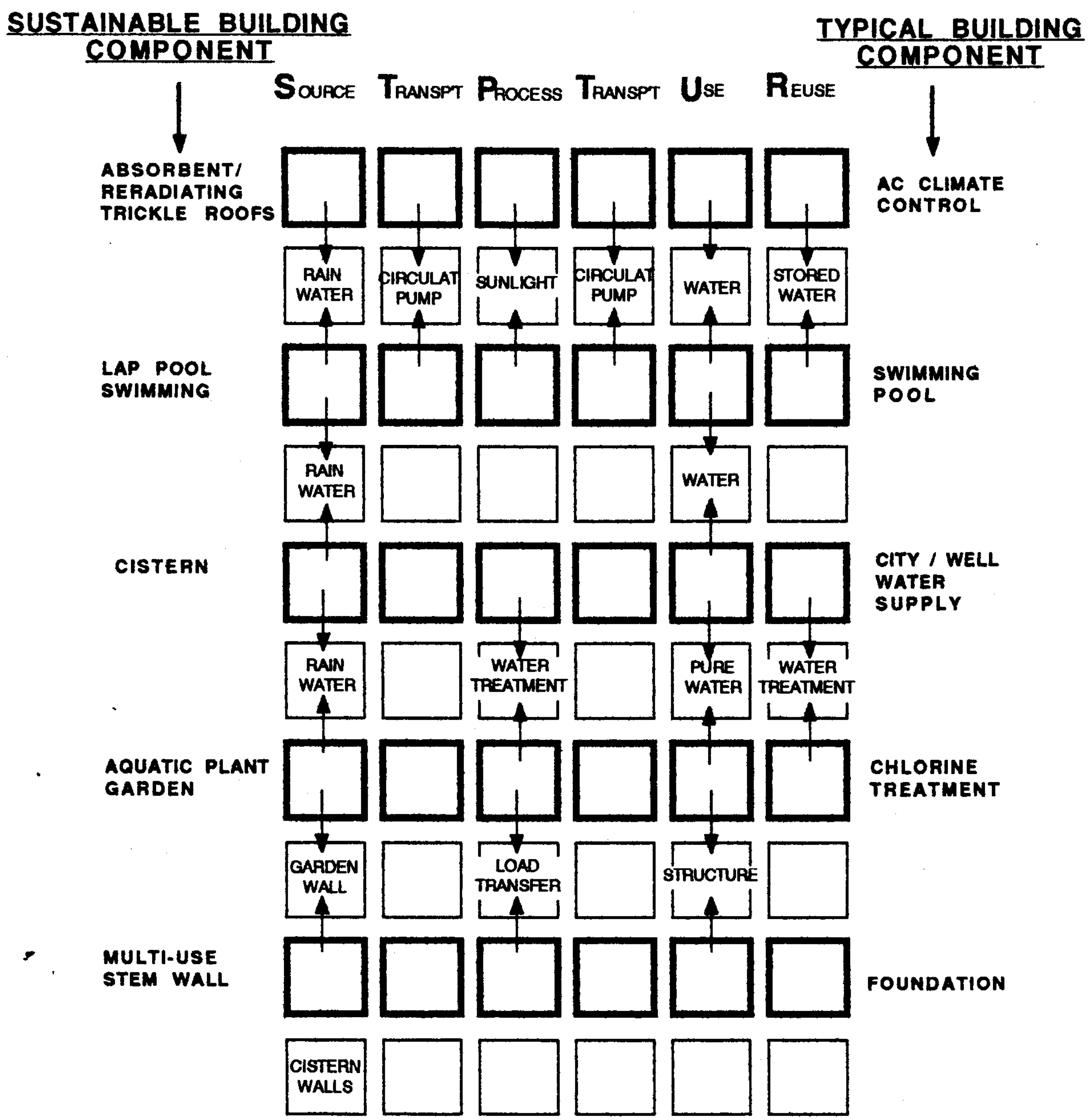
So integrated systems accounting is easier to conceive on a micro-level, such as a home. The objective would be a system based on activities accomplished on the smallest possible scale. This would prevent the inefficiency of long, drawn out linkages described above, whose efficiency loss is the mathematical product of the number of linkages. The benefit to a client is knowing that his or her financial investment is optimized as a result of integrating the home's basic functions and systems. The resulting home environment brings with it opportunities for diversity and many alternative paths for energy and material flows. A graphic representation of this LCA sequence, and then an overlay of these into an illustrative matrix showing where overlapping similarities between one ladder and the next is achieved. This is illustrated below with traditional verses sustainble practices identified.





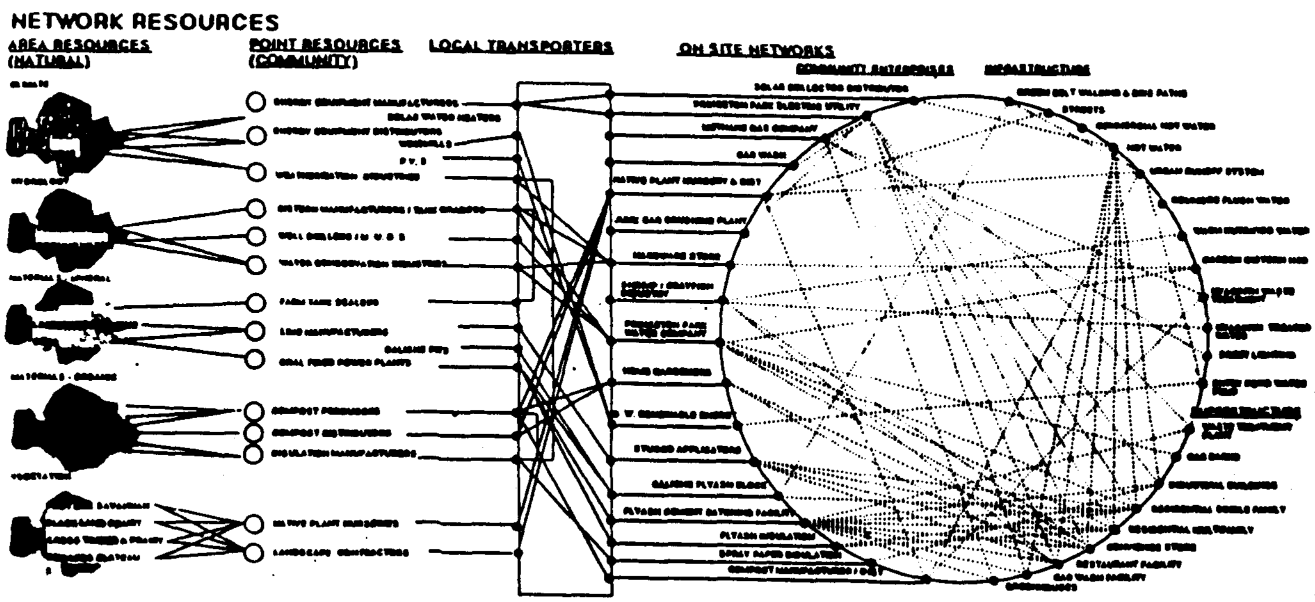
INTEGRATING LCA LADDERS

AN INPUT / OUTPUT MATRIX FOR THE BUILDING PROFESSION



The House and the Region

At the next scale, the community/region, the integrated site economics is extended to show the importance of where puchasing occurs, and how suppliers relate to each other and their region. These relationships can be tracked through a regional input-output analysis. However, the objective of conventional analyses has not been guided by sustainability objectives, which would lead one to "hunt" for material cycle holes and create processes to fill them. To the everyday practitioner, economic integration and other flows are purposefully supported by the people you do business with, who they do business with, and so on down the line. Within a region, material flows are not only virgin materials processed to make building materials, which then can be used in an ecologically-planned and -designed structure, but also wastes that are transformed into by-product resources, with the establishment of appropriate processing facilities. Together, these form a material cycle not unlike those of natural systems. In these finely tuned linkages, survival is dependent on the ability to conserve and reuse material resources in tight loops, allowing for the least amount of material to escape the system, and valuing by-products as if they were virgin resources. The emerging discipline of industrial ecology attempts to mimic this approach. The diagram below represents the integration of various regional businesses in response to design approaches.

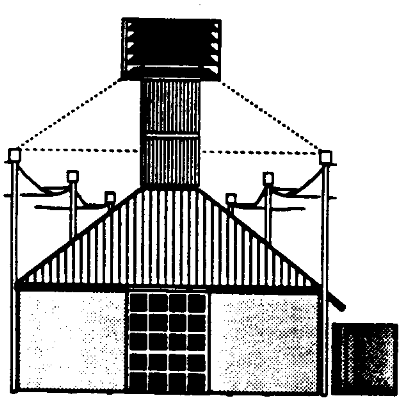


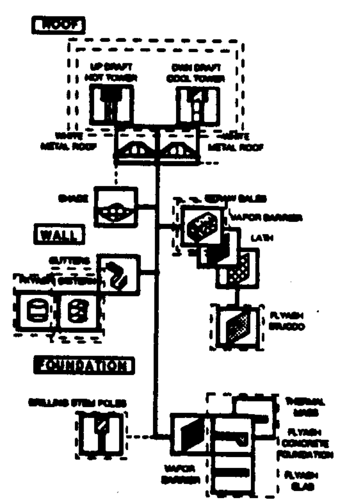
The quality of a sustainable built environment, with multiple overlapping functions in the four resource flow areas -- materials, energy, money, and information -- provides the basis for realigning humankind's relationship with the natural environment. A sustainable built environment is the hallmark of good design, good engineering, and a region whose self-understanding has achieved a level of sophistication enabling it to provide for life support needs with internal resources. The conscious use of a life cycle assessment can have far-reaching ramifications, as we have been fortunate to discover in our work with the City of Austin's Green Builder Program, and in revising the Texas General Services Commissions' Architecture and Engineering Guidelines to incorporate sustainable architectural practices.

Design as Information

The examples above illustrate sustainability in a home relative to materials, energy, and economic transformers. Information flows are manifested by good sustainable design, engineering, and planning, for example, which reflect an implicit understanding of the region. Design which uses information in an ecological context to promote sustainable methods in the built environment we call "information ecology" in the same way as we speak of "industrial ecology." Information ecology can occur in many forms, including the building itself, and can become the basis for an icon-formatted information directory. This directory can provide many layers of information from any single icon, and can be extended as reward systems and as a straightforward database to provide immediate information on material specifications. Essentially, the icon vocabulary establishes the basis for a sustainable design language, with a structure based on LCA.

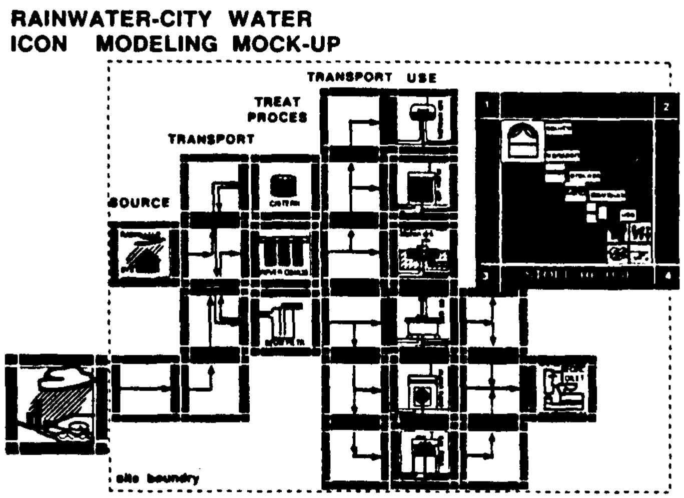
Using this methodology, we can show how building design and planning can be accomplished through iconic representations, using set theory linkage similar to the methods used in the Industrialized Building Handbook, by Rush, as one application, or to demonstrate an operational model as described in the following paragraph.

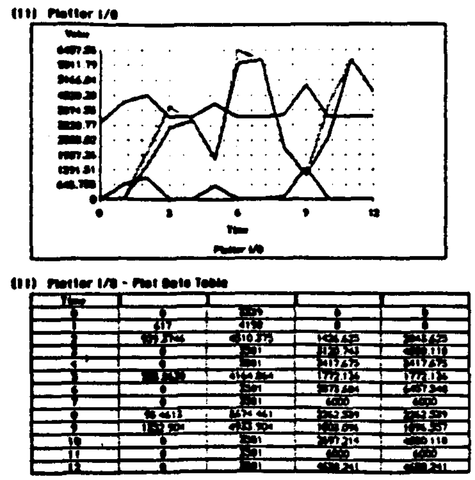




Object Oriented Programming and Life Cycle Assessment

The capacity to structure appropriate icons according to a life cycle assessment, with the icons representing processing products, is illustrated below. The goal is to use only water that falls on the roof. The system is designed to enable a non-technically trained person to change products and consumption patterns until the quality and quantity of water provided from the roof fulfills the family's entire water needs. The model follows the life cycle assessment sequence in graphic and mathematical form (the mathematical is "hidden" behind the graphics). This modelling approach is virtually the same as that use in many software programs. More importantly, it is the basis for "object oriented programming", or OOPs.



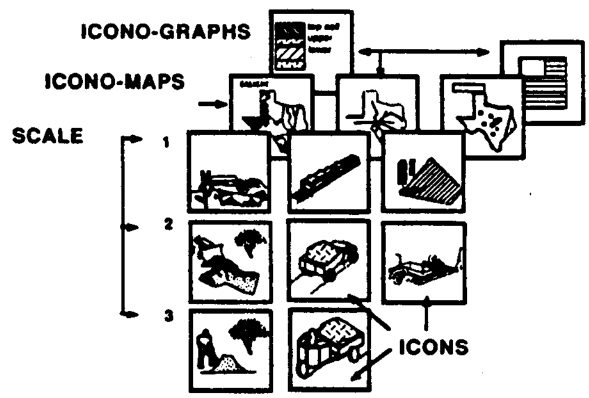


Given this conceptual framework, it is possible to expand our view and envision an entire region establishing sustainable information linkages. This system's basic structure is the life cycle assesment. It is used not only as a tracking tool to determine where materials are coming from and going to in a macro-environmental context, but, more importantly, as the structure for modelling the system's performance. This process sets up a critical bridge relative to sustainability, between the communication arts and the hard sciences/engineering fields.

The Question of Scale and Relational Thinking

Object oriented programming operates in several ways. On one hand, it can operate with a pan-in, pan-out approach, which enables one to think of dealing with sets of information (or sub-models) inside other sets (or sub-models). OOPs also operates with a sub-set of a certain type coupled to another set of a similar type to form large programs through linkage. The rainwater model above is a good example. The model of precipitation is linked through micro-regional transportation (the gutter) to a processing plant (leaf trap and other water treatment devices) to micro-local transportation (house piping) to users (sinks, baths) and, finally, to reuse/recycle (alternative waste treatment systems that actually use the waste as a resource that enables the cycle to continue). The scale changes (by panning in and out) and the relational sets of blocks work at a particular scale. Together, these form the basis of what we perceive as the core of sustainable development, planning, and design.

LCA LADDER - RELATIONSHIP BETWEEN SCALE ICONO-MAPS, ICONS AND ICONO-GRAPHS



Sometimes, to really drive home a point, we insert "quirks" in the icons. For example, how would a four year drought affect a family's sole dependence on rainwater, and what happens if the drought were to continue? If a toxic waste is flushed down the toilet, how does that affect the wastewater treatment system? This type of learning through gaming is the basis for educational software. And enables the principals of sustaianble design to be accessed by a greater number of people.

These issues can obviously be extended from the home level to the neighborhood, community, city, and regional scales, and could address watershed and lakes as easily as roofs and cisterns. This provides a glimpse at the role of information ecology, which, essentially, is information about processes relating to sustaining life on the planet.

The Office In Transition

An office involved in architectural design during this transition towards sustainability needs to be flexible and adept on many levels. Stretching standard operating procedures beyond practices imposed by most training programs is essential, as realigning and redefining linkages will be the manifestation of the new information ecology. This transition may involve engaging in entirely new facets of design and construction, and striving to achieve objectives well beyond those dictated by a standard bottom-line approach. This transition requires trust and faith, and will benefit from an infusion of capital directed to get through the trial and error period. The Center, for example, has been fortunate to garner financial support to move us through these phases, both from public and private sector contracts and clients. Our unique approach to our work is supported by a multi-faceted operation, supported by a shoe-string budget, as described below.

The Components of a Regionally Sustainable Office

To the unsuspecting eye, the Center appears anything but a design office. There is an Earth Lab, a Materials Library, a Fabrication Shop, and manufacturing equipment. Located on the outskirts of Austin, it is ideally suited to relate to both urban and rural conditions. The Earth Lab, for example, consists of materials testing equipment that enables us to learn about the materials in our region -- what is suitable for building and how to safely build with them. We developed our work with caliche in the lab, and continue to test samples of sulphur and fly ash, blocks made from wood chips and waste paper, often relying on old, forgotten recipes. We rely on a range of talented people for back-up technical support, including an engineer who specializes in fly ash cements, a material chemist, self-taught mechanical wizards, and community leaders.

Computers, in our case Macintoshes, and high-tech video equipment help us to get information out to the public. A computer-video interface enables training manuals to be developed from the training itself, and to build client-oriented participatory models by walking through a model before a building is built. We are looking at Fax retrievable greenbuilder vendors and even specification being available through an on-line green builder program.