

Development of Basic Housing Systems for Maximum Affordability

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RECEIVED**MAR 25 1999****OSTI****Conclusions**

The ability to provide safe, habitable, comfortable housing for very low income residents within the target budget of \$10,000 presents unique design and construction challenges. However, a number of preliminary conclusions have been inferred as being important concepts relative to the study of affordable housing. The term "affordable housing" can have many meanings and research is needed to define this explicitly. As it is most often used, affordable housing refers to an economic relationship between the price of housing, household income and current interest rates available from a lending institution. There is no direct relationship between architectural style, construction technology or user needs and the concept of affordability. For any home to be affordable the home owner must balance the combination of housing needs and desires within the limits of an actual budget. There are many misconceptions that affordable housing must be defined as "housing for those who cannot afford the free-market price". The concept of affordable housing must also include a component that recognizes the "quality" of the housing as an important element of the design and construction. In addition, responses to local climate impacts are necessary and are always part of a regional expression of architectural design. By using careful planning and design it may be possible to construct a limited dwelling unit today for a sum of approximately \$10,000. Since the organization of the construction process must involve the owner/occupants as well as other volunteers, the project must not only be well conceived, but well developed and coordinated.

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Introduction

Undergraduate students at Tuskegee University, at Tuskegee Alabama are currently investigating a variety of methods to produce affordable housing in order to find low-cost solutions to the housing problems experienced by very low income individuals and households. This project is sponsored by the U.S. Department of Energy (DOE) through the Oak Ridge National Laboratory.

Most regions in the US are experiencing shortages of affordable housing that addresses the needs of this segment of the population who are not qualified for opportunities offered through many low income housing providers such as Habitat for Humanity. These very low income individuals include single parents, senior citizens, twenty-something individuals new in the job market, and others whose life circumstances severely limit their earning abilities. This research project at Tuskegee University will address the issues involved in the development of an affordable dwelling unit to meet the needs of this segment of the population.

Over the next two years the research and development work currently underway is planned to result in the design, construction, and evaluation of a prototype dwelling unit to be constructed on the Tuskegee campus. The overriding and challenging question currently being tackled is: "Can

a decent, safe housing unit that meets the physical and other needs of the occupants be constructed for an initial cost in the neighborhood of \$10,000?"

This research builds upon work undertaken 50 years ago at Tuskegee University that developed a construction technology to produce a small home for poor Alabama farmers for about \$2,000 [1]. At that time, the focus of the effort was on the production of concrete masonry units, the "Tuskegee Concrete Block." During the seasons when other farm tasks were minimal, this "low-cash cost" housing concept allowed local farmers to use readily available natural resources to reduce drastically the cost of constructing a dwelling unit [2]. A typical floor plan as well as a photo of a constructed unit which currently exists at Tuskegee University are shown in Figure 1 a and b. This construction system has been used for single-family and multi-family dwelling units in Alabama.

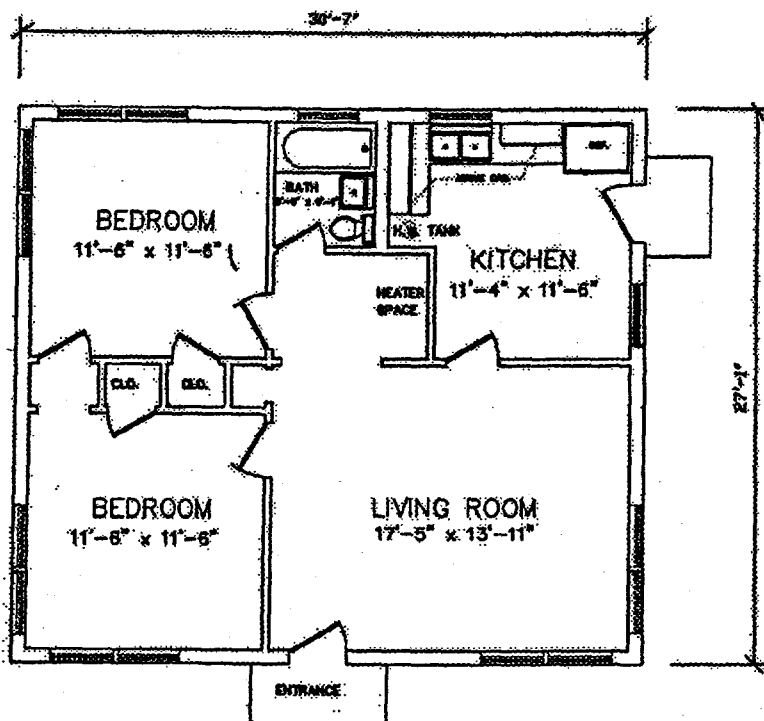


Figure 1a. Floor plan for typical "Tuskegee Concrete Block" House.

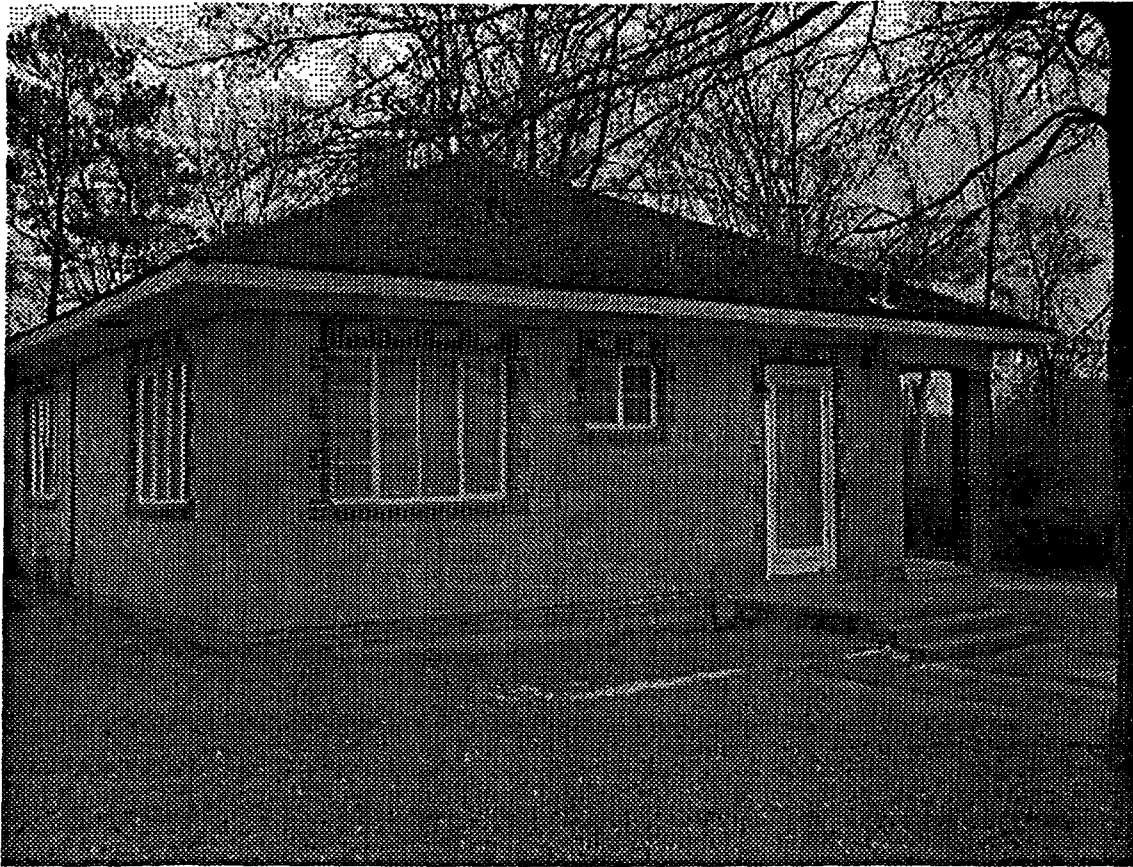


Figure 1b. An example of the "Tuskegee Concrete Block" House developed in 1950.

The Problem

To provide housing for very low-income households, the fundamental issue to be resolved is that of reducing the initial and on-going cost of housing. The influence of income on housing selection and quality is obvious. All households use available resources to purchase goods and services, including housing, within their economic means. People live in low-quality housing when they cannot afford to pay for better housing that approximates the "norms" within our society [3].

Three typical sub-standard dwelling units in the black belt of Alabama are shown in Figs. 2-4. It should be mentioned that these houses contain approximately 400 to 600 s.f. of living area, each. Some of these houses have no public utility connections and have a general deteriorated appearance.

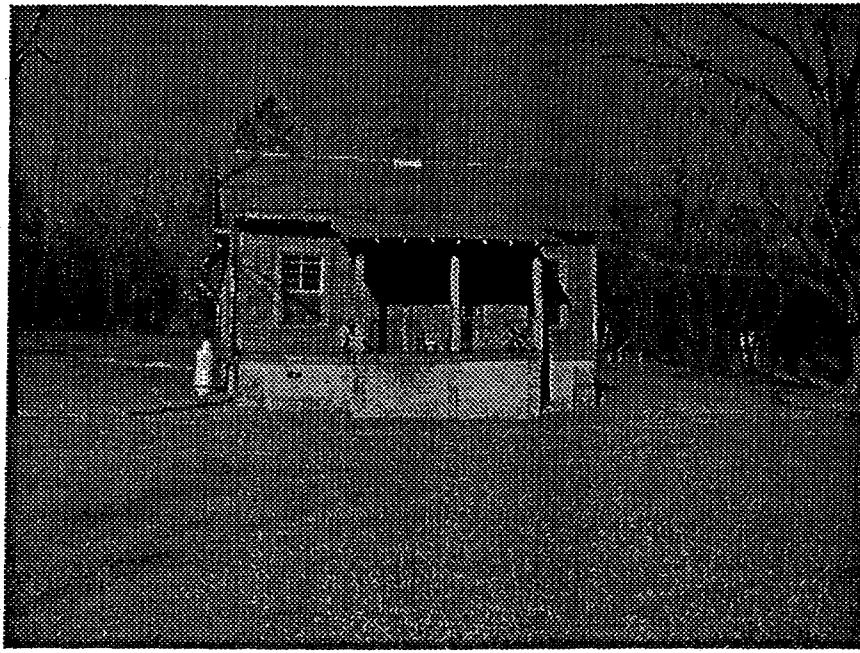


Figure 2. Typical sub-standard dwelling located in a rural area in Alabama.

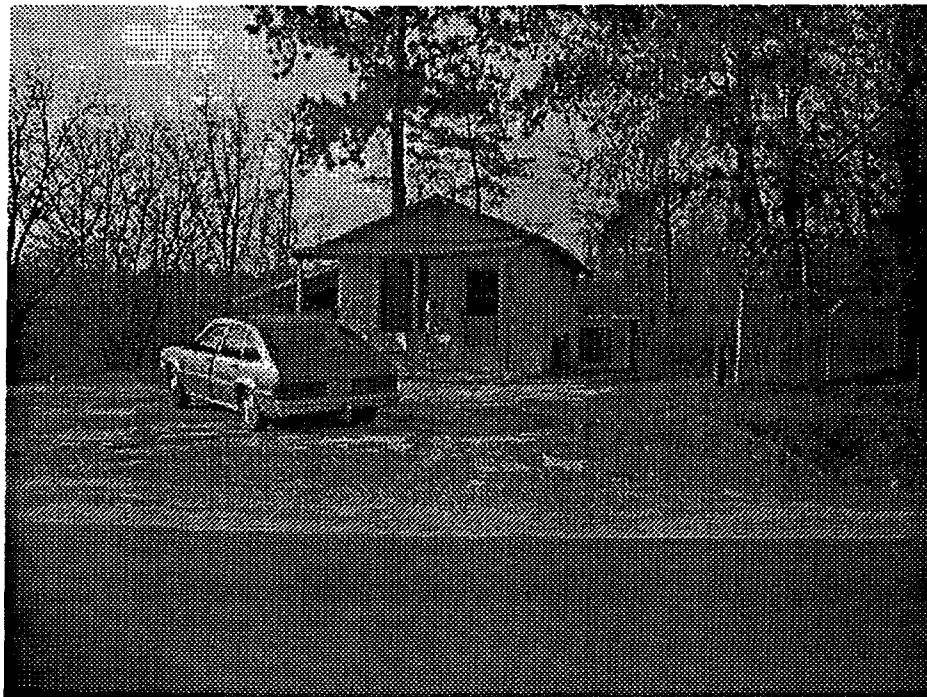


Figure 3. A small house of approximately 400 s.f. located near Tuskegee, Alabama.



Figure 4. Located near the downtown area of Tuskegee AL, this house contains about 400 s.f. of living space. Amenities for this dwelling are minimal.

According to the National Association of Realtors (NAR), when the NAR housing affordability index is 100, a family earning the median income is able to buy a home at the median price, using conventional financing and a 20-percent down payment. In February 1999, the National Association of Realtors reported that the median price of an existing home was \$132,600, and median family income was \$45,735. While these figures may portray "affordability" at the national level for our society as a whole, they far exceed the potential of the very low-income group throughout the nation. This group has an income that may be 25 percent of the area median income, and in Alabama this is considerably less than that of the national median income.

Generally housing is considered "affordable" if it consumes no more than 30 percent of a household's income for rent or mortgage (payment on principal, interest, taxes, and insurance), utilities and housing maintenance. This figure does not appropriately reflect the very low income family's financial abilities since they must allocate a disproportionately large portion of their income to meeting other basic needs such as food and clothing.

As it is currently used, the term affordable housing does not take into account the quality of the dwelling unit. Housing may be affordable, but not adequate. Typically, very low-income households suffer from both quality and affordability problems with respect to housing, whether they are located in urban or rural areas [4].

The development of a very low cost building system must consider and integrate the divergent and sometimes conflicting concerns of physical performance of components, architectural design, construction technology, management, and economics. Truly, the understanding of this development must be holistic in nature. The production of a building prototype must address specifically these necessary characteristics:

1. physical performance: strength, stability and maintainability in addition to environmental concerns of thermal insulation, acoustic isolation, and fire resistance,
2. architectural design: aesthetic and functional considerations,
3. building technology: selection of materials, production methods, and assembly techniques,
4. construction management: planning and coordination at the job site, erections, and quality control, and
5. economics: initial and life cycle costs.

A new system of construction alone will not significantly alter the production cost of a typical housing unit unless there is a reduction in labor costs and a building system consisting of products that are also low in cost. Land must be available at reasonable costs and necessary training in the appropriate construction techniques must be provided. The desired end result is not the provision of

a structure, but a home. The home provided must satisfy all of the essential needs of a household: physical, economic, social, and cultural.

The Research Project

A multi-phased project to develop and demonstrate basic housing systems for maximum affordability is under way with the first phase funded. The project will address the issues involved in the development and construction of a standard, affordable dwelling unit to fulfill the needs of the very low-income homeowner.

In the present project "very low income" is defined as a household with an income level approximately 40 percent of the local area's median income. This could represent a family or individual earner who has a full-time job paying the minimum wage. The goal of the research is to demonstrate that an affordable dwelling unit can be constructed for approximately \$10,000 (excluding land costs, which are highly variable). This figure represents the actual cost of materials and labor required for a unit that will meet the essential needs of a typical household of two adults. It is assumed that one or more of the household members will be employed in an occupation paying at least a minimum wage.

The research project being undertaken is planned to be accomplished in three phases: research and development, prototype construction, and monitoring and evaluation. Work on this project began in the fall of 1998 and is planned to be completed by the end of summer of 2001. Senior level students in various disciplines in the College of Engineering, Architecture, and the Physical Sciences at Tuskegee University will participate in this project.

The project will achieve its objectives by focusing on the basics of housing to provide living space with a combination of low initial cost, minimal cost of utilities, and low maintenance costs. Basic housing needs as opposed to normal amenities will be identified and provided. The optimum methods of delivery, ranging from construction by local volunteer/owner labor to premanufactured

elements delivered to the site for assembly will be investigated. Additionally, the differences between urban and rural site conditions are to be considered, such as size, context and existing infrastructure. These considerations may result in the use of unique building systems involving both the use of locally available materials and differing methods of construction.

Current Activities

As part of the initial research phase work on a number of specific tasks is underway to provide the parameters necessary to complete the work. Gathering existing and new data will assist in the identification and characterization of a target population. The needs of very low income people in the "Black Belt" counties of Alabama, in both rural and urban areas, will help define the housing needs of this region. Site visits to key locations in the study area is yielding an inventory of the housing conditions, in both qualitative and quantitative terms. Existing very low income housing in the area is being documented. Due to a vigorous effort by local authorities to remove abandoned and derelict structures, fewer sub-standard housing units are being found. However, in many cases, poor choices in current building design, site planning, and materials applications have lead to more rapid deterioration of some building components. The housing stock is newer and is becoming more expensive.

A review of recent efforts by other investigators indicates some common concepts applied to the notion of affordable housing. Work by Avi Friedman and Witold Rybczynski at McGill University, in Montreal, Canada produced a small house intended for first-time buyers with an income of about \$30,000 per year. Total construction for the Grow Home was US\$36,386, excluding land costs, or a square foot cost of approximately \$36 [5]. Donald MacDonald, a San Francisco architect, has developed a starter home, the Studio Home, which occupies a footprint of 14 x 17 feet. The cost of this design concept, except land, site development, and utility connections, was less than \$15,000 in

1995. Through a program of expansion, the initial unit could grow to the size of a typical single-family dwelling unit of about 1500 square feet [6]. Another noteworthy effort is the Rosebud Reservation Core House. This single-family detached house on tribal lands of the Lakota Sioux contains 576 square feet of living space and acts as a base that expands as the family's resources improve. The significant feature of the concept is that the core was constructed for less than \$11,000, excluding labor [7]. However, this house was constructed using straw bales which may not be readily acceptable in all environments. Additionally, a study of a house built in western Alabama by architectural students from another university has illustrated the needs of the client group. The occupants when asked to comment on their favorite feature of this new dwelling indicated that it was the indoor plumbing system [8].

Local, county, and state agencies and private groups will be asked to participate in delineating future housing trends and requirements. Selected user groups are being interviewed to gain a better understanding of unmet needs and desires. Personal lifestyle issues require a match in the spatial and physical organization of the housing to be developed. Economic issues, sociological issues, and building code issues will also be part of the focus of this phase. It is recognized that conventional financial mechanics may not be appropriate for the participants of this program. Other acceptable financing options must be identified and tested. All of these needs and issues are to be identified during this early stage of the work.

Current building code requirements and future anticipated changes will be identified. Variances may be required to produce a non-traditional structure using alternative materials and systems. To define the range of potential useful materials and systems to be considered for the prototype development, it will be necessary to identify appropriate construction materials and methods. A survey of existing materials and construction methods and technologies will be performed. Studies of both traditional and non-tradition approaches to construction are required. Unique approaches to site related costs and development issues are necessary in order to reduce the total cost of the project. The

ultimate objective in these early tasks is to establish the specific criteria for the evaluation of the proposals that are to be generated in the development process. Based on an analysis of the individual tasks, a set of criteria will be developed to guide the work of the other phases of the project.

It is necessary to be aware of the technical constraints of construction, especially when the occupant may be involved in the actual construction process. One major objective is the involvement of the owner/occupant group in the entire process of development. A selected group of households will act as surrogate clients for this demonstration project. This group will work with the researchers to determine the specific issues and constraints that will most directly affect the design and construction of the prototype unit. Several households in Tuskegee have been interviewed to learn about their concepts of an affordable housing unit. Most have expressed concern about basic amenities such as plumbing, sewer connections and utility costs.

Future Activities

Beginning in the 1999 spring semester, a group of students will focus on the development of a dwelling unit prototype. Several tasks will assist in reaching the objective of an appropriate prototype within the budgetary and other constraints. The criteria established in the earlier part of this phase will guide this effort. To satisfy the life-cycle requirements of the occupant lifestyles typical user needs will be considered in order to develop an overall scheme for the proposed dwelling unit. These typical needs include the functional requirements for the everyday activities of life. Spatial and other programmatic requirements will be finalized at this stage.

A selection of the most promising construction alternatives will be reviewed and this selection will form the basis for the final development of building construction systems. This selection will be based both on initial project cost and the ability of a owner/occupant to perform the major portion of the required construction. Additional effort will be placed on the definition of the environmental

control systems, equipment, appliances, and other system requirements. The "minimal set" of equipment and systems will be established and a plan for modifications to the basic housing unit to include future components and systems will be generated. The size of the basic unit will accommodate current needs of the occupants. Typically a family will grow in size and the future needs cannot be fully anticipated in the beginning stage of construction.

A final task will involve the development of a probable building life cycle. Alternative viewpoints will be considered to determine the areas that have the most significant impacts on the life cycle of the building. Economic impacts such as first costs and life-cycle costs, along with their relation to social and cultural values will be investigated.

Two additional phases of the work are planned for the sequential two-year period. Upon completion of the initial phase, the construction documents necessary to build a habitable prototype will be developed. A final design prototype of a limited building system for a specific site is the objective. All of the preceding phases are planned to lead to a well-defined prototype that can be constructed by individuals and groups having minimal construction skills. Undergraduate students in architecture, construction science, and engineering will participate in hands-on activities that will produce the finished product. The prototype is planned on the Tuskegee University campus as a demonstration of the appropriate design and construction techniques and methodology.

Following the construction phase, for a short-term period, the dwelling will become a display for use in public awareness and education relative to low-cost, affordable housing. A year-long monitoring program will record interior and site weather conditions. Also, records will be maintained of the energy consumption of the dwelling. It is proposed that the dwelling be occupied by a university employee or volunteers. At the end of the monitoring and evaluation phase, the dwelling will serve as a display and a test facility for long-term monitoring. Maintenance costs as well as life

cycle costs can be validated. The physical conditions of the dwelling will be observed and recorded photographically for a permanent record of the entire process.

Conclusions

The ability to provide safe, habitable, comfortable housing for very low income residents within the target budget of \$10,000 presents unique design and construction challenges. However, a number of preliminary conclusions have been inferred as being important concepts relative to the study of affordable housing. The term "affordable housing" can have many meanings and research is needed to define this explicitly. As it is most often used, affordable housing refers to an economic relationship between the price of housing, household income and current interest rates available from a lending institution. There is no direct relationship between architectural style, construction technology or user needs and the concept of affordability. For any home to be affordable the home owner must balance the combination of housing needs and desires within the limits of an actual budget. There are many misconceptions that affordable housing must be defined as "housing for those who cannot afford the free-market price". The concept of affordable housing must also include a component that recognizes the "quality" of the housing as an important element of the design and construction. In addition, responses to local climate impacts are necessary and are always part of a regional expression of architectural design. By using careful planning and design it may be possible to construct a limited dwelling unit today for a sum of approximately \$10,000. Since the organization of the construction process must involve the owner/occupants as well as other volunteers, the project must not only be well conceived, but well developed and coordinated.

Acknowledgment

Funding and administrative support for this project was provided through the efforts of Jonathan Stone, Program Manager, U. S. Department of Energy, Office of Buildings, State and Community Programs, Washington, D.C.

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