Premise

To successfully bring about the technical improvement deemed necessary, ie. to improve the safety of housing through changes in either planning, design, construction or material use, means to successfully and lastingly intervene in housing development processes. Often technical programs are too narrowly focused for profoundly impacting these developmental processes.

Informal housing processes (self-help, owner built or indigenous housing) provide the overwhelming amount of shelter in third world countries. When trying to improve housing built through informal processes, it is especially important to realize that the owners/builders have strong reasons for what, when and how they build. Improvements will only be accepted by these owner/builders if, within their cultural, social, economic and material context, the improvements make sense. The benefits clearly must outweigh the costs in eyes of the "client population".

The paper discusses aspects of the Carnegie-Mellon University (CMU)/ INTERTECT (I) and Oficina de Investigacion y Normalizacion (OIN) Project in Peru which illustrate the need to understand the development process, to identify the costs and benefits of the proposed intervention and to achieve an awareness of what kind of changes on the social, political, economic, material and technical levels have to occur in order to make proposed interventions successful, that is to positively affect present day practices as they occur in the informal sector.

Project Background

Building on the experience in post-disaster assistance of INTERTECT and a joint Carnegie-Mellon (CMU/INTERTECT (1) Feasibility Study of An Approach and Prototype for Ultra Low Cost Shelter (1) in relief situations in Bangladesh funded by the U.S. Agency for Development (AID), CMU/I received a contract (2) from AID in 1976 to explore typical disaster situations in various environments. Specifically, the contract called for the investigation of housing and shelter needs in earthquake-prone areas and drought situations, and an evaluation of the work undertaken in the Bangladesh feasibility study - a high wind and flood environment.

In examining the methods of producing emergency shelter units that could easily be incorporated into more permanent type housing, CMU/I identified five support activities:

1. Materials Research

   Varied methods of producing walls, including fabrication with various types of block machines, ferrocement and rammed-earth processes, as well as examining means of improving traditional construction, such as the improvement of bamboo detailing and the use of stabilizers in earthen block construction, was an important support activity.

2. Information Sharing

   Once the project was underway, it was realized that existing information was fragmented and unavailable at any central source. Therefore, a centralized information base and a system for classifying housing-related information for use in disaster-related programs had to be developed. An attempt was made to correlate data with specific information needs and to develop data where insufficient information existed.

3. Information Transfer

   A major emphasis of the program was a review of information. Different media for teaching housing skills were investigated and the project relied heavily on practical experience obtained from a review of the work by OXFAM (3) and World Neighbors in Guatemala (4); the Save the Children Alliance in Guatemala (5); the Foundation for Cooperative Housing in Nicaragua (6); the Appropriate Reconstruction Training and Information Center (ARTIC) (7); the Salvation Army in Andhra

Pradesh, India (8); and the Government of Turkey (following the earthquake in Lice and Gediz). (9) In addition, information on technology transfer, materials, and training aids was obtained from sources such as the Peace Corps and the Non-Formal Education Information Center of Michigan State University.

4. Methodologies

The development of working methodologies, used to provide housing and shelter in various post-disaster situations, was a fourth activity. This work encompassed the review of strategies and approaches normally used by relief agencies in shelter provision, evaluating their effectiveness, and correlating the experiences of each organization. Parallel research being conducted by the United Nations Disaster Relief Office (10) regarding the provision of emergency shelter and post-disaster housing (a portion of which was undertaken by INTERTECT), and the work of Paul and Charlotte Thompson (11) under a research fellowship from the Organization of American States, was of great assistance. In addition, Major William Mitchell's (U.S. Air Force Academy) (12) study concerning the earthquake reconstruction programs in Gediz, Turkey, was an invaluable source and provided new insights. INTERTECT'S other operation activities in disaster situations in Honduras, Lebanon, Guatemala, and India provided further information on strategies and approaches which were incorporated into the final work.

5. Field Work

In many aspects the most important activity carried out under the contract, was the field work. This field work, provided the opportunity for viewing disaster types and environments, and participating in a number of operational programs designed to test concepts developed in the program. By 1977, these field investigations led AID to conclude that it would be beneficial to shift the project's emphasis away from post-disaster response toward pre-disaster mitigation, by concentrating on the improvement of existing housing stock in disaster-prone regions. It was realized that this approach would be more difficult since a greater receptivity to new materials and techniques designed to meet specific needs, exists in post-disaster situations. However, it was felt that a greater contribution could be made by developing strategies, approaches, and diverse training materials that could offer new opportunities for materials use in pre-disaster situations, and in the long run, would facilitate a greater housing change.

In late 1976 and early 1977, a number of potential study areas, where these ideas could be tested, were investigated. After visiting a number of potential areas, Peru was chosen as the study site for the project. In response to the 1970 earthquake in Huaraz, a number of new building techniques had been developed and the Government of Peru wanted to incorporate these into a demonstration project. The government hoped to integrate these new construction methods with existing building technology for use in earthquake-prone regions of the country. A technical cooperation agreement (13) was developed between Carnegie-Mellon/INTERTECT and the Government of Peru to jointly develop this program.

CMU/I/OIN Project In Peru

Summary

In 1977, Cmu/I initiated a study that developed into a two-year project with the Ministry of Housing and Construction in Peru. The purpose ofthe study was to work with the Housing Ministry in developing approaches ana technical materials to promote housing changes in high risk, vulnerable areas of Peru and to develop strategies and materials for immediate post-disaster response in providing housing in rural, mountainous areas. CMU/I worked with the Housing Ministry to develop a complete package of training aids for use in both pre- and post-disaster programs concerned with improving traditional adobe housing. In the course of the project, numerous technical reports were produced on program approaches and strategies for intervention, as well as reports providing comprehensive information about traditional housing and potential improvements for reducing its vulnerability. (14)

In addition to the development of training aids and technical reports, two tests of the training aids in actual building projects in rural areas with high seismic risks were to be conducted.

In 1977, a memorandum of agreement was signed between the Ministry of Housing, (Ministerio de Vivienda y Construccion) of Peru, CMU and INTERTECT. The research office of the ministry (Oficina de Investigacion y Normalizacion, OIN), had been coordinating major research and demonstration efforts involving the National Engineering University and the Catholic University in Lima, Peru. The activities were supported by the AID mission in Lima. (15)

COBE - Construccion Con Bloque Estabilisado

Stabilized and horizontal shear resistant adobe construction was to improve the quality of earthen construction and reduce the vulnerability of housing in earthquake prone areas. The asphalt stabilized adobe, which was at the base of this work had originally been developed by Fresno State University, the U.S. National Bureau of Standards and Chevron Oil Company. (16)

By 1977 numerous tests had been conducted in Peru which determined the compressive strength of stabilized adobe block, water permeability, as well as resistance to horizontal shear of wall assemblies and building configurations. Housing Demonstration projects using the improved methods were complete and the Government was ready to begin a program for dissemination about stabilized adobe construction throughout the country.

OIN/CMU/INTERTECT in their contract with AID were to help in the dissemination of COBE building practices, with the aim to lastingly introduce these practices into the formal and informal building sectors.

However, when CMU/I began work the price of stabilizer agent, while still affordable in various areas, was rapidly rising. It therefore appeared that soon the price of the material would prohibit its use in any but a few select areas. As a result, CMU/I began examining various alternatives to the use of asphalt. The alternative, which was developed in the Chemical Engineering Department at CMU, was calcium acrylite. (17) Here too, however, the projected costs were not encouraging. Because of the cost increases of petroleum based chemicals in general, the team expanded the focus to include the reconnaisance of indigenous material usage in an effort to developing an understanding of how to improve the performance of indigenous building techniques. (18)

Approach

Responding to previous experience and contract requirements, the CMU/I/OIN team attempted to introduce technical improvements in adobe construction in both the formal and informal sectors of the Peruvian building industry through three means:

1.) Appropriately selected sites for pilot test programs; and

2.) Reconnaissance of indigenous building practices, material usage and improvement potential.

3.) Development of training aids.

1.) Site Selection for Pilot Test Program.

Given the dual focus on predisaster planning and post disaster assistance the team concentrated on the outset on selecting high risk seismic areas for potential sites of the pilot projects. In addition to reviewing objective data such as frequency and strengths of individual earthquakes, geological patterns (faultlines, history of avalanches) and disaster histories it was important to achieve an appreciation of the perception of the inhabitants regarding earthquake risk. A high risk area was then defined by being both objectively and subjectively high risk.

Within such high risk areas the following local reconnaissance was to be conducted:

*Structural analysis including housing types, history of vulnerability, material quality and type, joining techniques and quality of building components, traditional building configurations and layout.

*Site analysis including relationship of houses to general environment: climatic suitability (cannot any longer be taken for granted particularily in areas of increased population mobility).

*Geological suitability (i.e. is the site on an ancient, but potentially active avalanche, or the potential target of rock fall?)

*Housing Demand Analysis; indicators are degree and pace of urbanization, strength of local economy, percentage of young population in household forming age, migration patterns, potential loss of housing in disasters.

*Sociological Profile Analysis including identification of coping mechanisms (i.e. social mechanisms of individual or community response to disasters or normal life situations, description of social structure, identification of receptivity to innovation and the social obstacles potential new ideas might be faced with as well as the identification of a potential target group for the housing program. (The target group should contain key decision-makers in indigenous housing processes such as carpenters, masons, etc.)

Finally, it was recognized, it was of outmost importance to select a community with a high commitment towards participation in the construction and demonstration program.

2.) Reconnaissance of Indigenous Building Practices, Material Usage and Improvement Potential.

Before recommendations for changes in either housing design, construction or material usage can be made, with the intention to lastingly improve housing, a full understanding of present housing processes must be achieved. Key questions are who are the participants? (builders, owners, renters, community officials, etc.) What building skills are available? Which materials are used? Which are the preferred materials for construction? Is there a preferred building season? Is housing financing available? Is housing built on a mutual aid basis? What shortcomings exist in present practices? How are these shortcomings perceived by the affected people - if at all? Is there a potential to combine existing building techniques in innovative ways to achieve higher performances under earthquake loading?

3.) Development of Training Aids

Training aids were developed in response to the requirements of two potential user groups:

a) instructors and community leaders; and

b) builders (carpenters, masons as well as self-help builders.)

Both sets of training aids were based on an understanding of the normal building process. In order to guage the effectiveness of different visual aids, brief field tests were conducted to see whether potential users understand the message to be communicated.

In developing the aids much emphasis was placed on evoking within the user, an identification with the new ideas. The representations of people, places, tools and materials were to be culturally familiar in both appearance and method of representation, this was to encourage the viewer/reader to comprehend the project within his own cultural milieu rather than suggesting a foreign setting.

The teaching aids were available in draft form at the start up of construction of the field tests. Through discussion and observation the aids were refined and finalized during and after the period of construction in order that all recommendations which came from the field experience could be incorporated.

During construction a series of video tapes were taken in order to document the construction process of the model house for future demonstration projects.

Field Test - Acomayo

For reasons other than the project objectives (demonstration, dissemination, technical improvement); OIN selected the Department of Huanuco and the town of Acomayo as the site for a demonstration project.

Acomayo is a small rural town of about 1,000 total inhabitants, 45 minutes by car from Huanuco, Department of Huanuco, on the new road to Tingo Maria.

Almost all buildings in Acomayo are constructed to tapial. A few buildings along the road are constructed of Quincha and almost none are made of adobe. (rammed earth, see plate)

Most people work in agriculture. A handfull of small stores exist. A few dozen people appear to work as drivers of collective taxis and trucks. Acomayo appears to have lost population as there are vacant houses.

Acomayo also functions as a school center for approximately 300 children. Part of the existing school building was rendered useless through a flood caused by an overflowing aquaduct which eroded a part of the foundation and 4 out of 10 classrooms had to be abandoned.

Acomayo is located in a zone of low earthquake risk. The people of Acomayo do not perceive earthquakes as a threat.

Demonstration Project:

Again, for reasons other than project objectives, it was decided for the team that the project was to build additional classroom space for the community.

The model house which was also contemplated, since there was no apparent need for housing, was to serve as another community facility.

Considering these basic site conditions and the demonstration project's focus it became clear that the site and the demonstration project (school additions and model house) were in-appropriate for the overall project's intentions for the following reasons:

1) The department of Huanuco was not subject to frequent, violent earthquakes. People, therefore, did not perceive earthquakes to be a major risk factor. Consequently, any proposed alterations of existing construction techniques for reasons of earthquake safety would likely be viewed as unnecessary.

2) Acomayo did not appear to need new housing.

3) Present building techniques in Acomayo favored tapial construction.

4) Additions to a school building did not constitute an adequate vehicle for the demonstration of housing improvements.

In summary, it was felt that no spread effect of the improved adobe construction techniques could be expected because earthquakes posed no serious problem, little if any new housing would be constructed, and adobe was not a major building material in Acomayo.

While there existed a need for additional classroom space, the process by which the community was invited to participate in the demonstration project turned out to be counter productive. The community was not sufficiently required to collaborate in the planning, financing, and construction of the school. All in all, seven classrooms, a new toilet facility, and an eating area were to be constructed. Almost two years after the beginning of the project, the two aulas (classrooms) (Phase I) are not complete. While they are being used, both miss plastering of inside and outside, concrete floors, and windows.

There is no indication that the remainder of the project will be constructed. The attitude in the Alcaldes office is that the community is poor and the government promised seven classrooms. The model house was completed and served as a useful test for the teaching aids, but since it did not respond to a fundamental need in Acomayo, it's effect on construction after its completion has been negligeable.

Results, Lessons and Recommendations

From a community development point of view the fieldtests were a failure, generating expectations in the community which cannot be met by the government, given present resources. The projects were not embedded in a community participation and development process because there existed no appreciable need for construction improvements to reduce earthquake risk, no appreciable need for new housing, and because the major building material was tapial (rammed earth, plate) and not adobe. Improvement suggestions on the basis of adobe must have appeared esoteric at best.

In retrospect it appears that even though additional classroom space was being produced, it would have been better not to have a project in Acomayo at all, instead of encouraging selfhelp, the project might have created greater dependency. Clearly a need to build must originate within the community itself. It should not be "stimulated" from the outside.

In the case where such a need exists it is no less imperative that:

* the need to improve present practices must be able to be recognized by the community;

* the material usage is compatible with the proposed material usage of the demonstration project (do not demonstrate improved adobe practices in a place which builds with tapial);

* the costs of the improvements clearly do not exceed the benefits in the eyes of the people to be assisted; and

* that the costs of the improved material do not begin to approach the costs of the material just above in the materials hierarchy. (Example Peru: in most areas of the country the following perceived values exist: steel/glass, concrete, concrete block, brick, adobe, tapial, wood, quincha, (plate) in decending order of perceived value and status). Therefore if the cost of improved adobe begins to approach the cost of brick, people would prefer to build with brick instead of adobe.

While team members were aware of this fact, the project selection process did not allow for sufficient interaction between technical project personnel and political decision makers.

Technical Lesson With Political Dimension:

Besides the more obvious political dimensions of a large scale technical improvement program in housing, such as socio economic status of target population, resources to be devoted to project, degree of local participation and determination, etc., great care should be devoted to determine precisely where and how in the housing development process the intervention to improve that process should be carried out.

In the general case of housing construction in Peru, what are the social dynamics of building materials and assemblies; including status, affordability, etc.? What role does earthen construction play in this context? What are future trends affecting earth as building material? Where does adobe fit in all this? In the case that adobe emerges as a highly prominent building material with a certain future, in order to increase it's safety where should the intervention be placed? In material improvements, joining techniques, or building design recommendations? If in all of the above, what are the most important factors? How many changes can one technical program advocate with a good chance for social acceptability, reasonable cost, etc?

The Importance of the Development Process

To successfully bring about (to lastingly introduce) the technical improvement deemed necessary (generally from the point of view of the outside technician) - ie. in the case of housing in seismic areas to improve the safety of housing through either alterations in planning, design, material usage, construction practices or use-means to successfully and lastingly intervene in what is always (from the point of view of the users) an extremely well worked out and efficient housing development process.

Informal housing processes (self-help, owner-built, or indigenous housing) provide the majority of shelter in 3rd world situations. When trying to improve housing built in the informal sector, it is especially important to realize that owners/builders have very good reasons for what and how they build.

Improvements will only be accepted as necessary and desirable, by these owner/builders if, within their own cultural, social, economic, and material context, the improvements make sense. The benefits must clearly outweigh the costs in the eyes of the people affected.

Technical programs often fail to profoundly impact informal housing development processes because:

they are too narrowly focused on technical concerns;

they reflect more the view and needs of the donor organizations than the view of the people to be assisted;

giving other pressing needs - food, employment, etc., safer housing by necessity may have to assume a lower priority in the eyes of the user than is assumed to be acceptable by donors and/or technicians;

they try to change too many things (materials, structures, components, joints, etc.) at one time.

As a general rule, housing programs should try to take the point of view of the ultimate users. When this point of view is taken, solutions can be attempted which satisfy technical requirements of governmental and donor organizations and which have a chance of user acceptance. The following might serve as an illustration of this point. In many locations in Peru, population migration and scarcity of land have led to high population densities. Consequently owner built houses tend to be two and more stories high and because of the high cost of street frontage tend to be narrow and deep. In the case of earthen construction this leads most of the time to houses which are unsafe in earthquakes. Instead of advocating housing "solutions" which are one story high and square in plan, which, given earthquake considerations only, would be desirable, users should be presented with methods that accept that houses are two or more stories high, long and narrow. Then, other technical solutions to the problem of safety offer themselves to the technician, such as the layering of construction techniques - for example adobe or tapial construction for the first floor and quincha above, and the "breaking up" of one long and narrow structure into two square parts through the introduction of crush zones.

At the end the CMU/I/OIN project in Peru posed more questions than answers. Despite the obvious shortcomings of the field test, useful training aids were developed and far better insights into the development process were obtained than were available before. Observing the lessons discussed here in future projects, and creating strong bi-national multi-disciplinary teams in close touch with appropriate target populations, should provide the setting for further work in pre-disaster assistance.

Discussion Of Plates

The following plates were arranged to illustrate some of the points made in this paper. There are seven plates. Plates 1 - 4 relate to recommendations made in The Report Indigenous Building Techniques of Peru and their Potential to better withstand Earthquakes. Plates 5 - 7 are sampling of the visual teaching aids.

Tapial Construction

Plate One - gives impressions of this technique practiced in pre-Inca cultures on the coast of Peru (example Puruchucu, close to Lima and prevelant in present day Peru in the Alti Plano and mountainous areas.

Plate Two - the rural house pictured represents a common example of present day construction. The example here is located on the outskirts of Cusco. The house is two stories high, made of adobe. The long walls are weakened through unevenly spaced window and door openings. Fortunately the roof is relatively light weight. The 19th century house in Lima, exhibits an interesting potential to better withstand earthquakes in that it's second floor is made of quincha, thereby reducing the weight of the second floor and having the potential to absorb quake induced movements through deformations in the flexible structure.

The model house located in Acomayo and constructed in the field test described in the paper demonstrates how to build a single story adobe building using most of the techniques illustrated in the teaching aids, examples of which are given in Plates 5 - 7.

On a country-wide basis single story demonstration projects do not appear to impact present day construction methods because most rural and certainly urban counstruction is at least two stories high.

Plate Three - is an illustration of some of the recommendations made in the report named above. Material combinations, advantageous under earthquake loading, are presented with the idea to promote adaptations of indigenous techniques while encouraging self-help construction, instead of importing foreign, more costly technologies.

Plate Four - shows the use of some of these adapted techniques in a two story structure. This structure would be composed of square about 6 x 6 m building segments. The first floor could be of either adobe or tapial, the second floor of quincha; produced in methods as shown. The lighter second floor would create lesser forces acting on it under earthquakes, and the flexible structure would tend to absorb forces through flexure.

Plates 5 - 7 are examples of the graphic teaching aid entitled "How to Build a House of Modern Adobe." The booklet contains 23 drawings in toto, 9 of which are reporduced here. The accompanying text is in a didactic question and answer form. The illustrations are by the artist A. Andia of OIN, Lima Peru.

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