The Changing Rural Habitat

Volume 1 Case Studies

Proceedings of Seminar Six
in the Series
Architectural Transformations in the Islamic World
Held in Beijing, People’s Republic of China
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### Introduction

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Cover Illustration  The cover photograph represents the celebrated town of Kashgar (Xinjiang province, P.R.C.) on the ancient Silk Route linking China with the West. The oldest parts of the town, where this view was taken, are essentially constructed of mud brick and wood. The children in the foreground are members of the Uygun population, of Turcomen stock, which inhabit this region. (Photo: C. Little)

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Preface

Brian Brace Taylor

Presented in this volume are the proceedings from the sixth seminar in an ongoing series organized during each three-year cycle preceding the Aga Khan Award for Architecture. Like the five previous seminars whose themes addressed the phenomenon of contemporary architectural transformations in the Islamic world, the present theme, "Changing Rural Habitat", was chosen as a focus for deliberation partly because the 1980 Awards had underlined the importance of changes taking place in the rural environment, and partly because the design profession in the developing countries has had difficulty in defining the relevant, not to say crucial, roles it might play in solving rural problems.

That the People's Republic of China, whose population is 80% rural and among which there is a significant Muslim minority, should want to host our seminar on this topic seemed altogether appropriate. The Architectural Society of China, who co-sponsored the international conference with the Aga Khan Award, emphasized repeatedly that the theme corresponded to new areas of reflection adopted since 1978 by its own membership, and to realizations in governmental policy in China. Thus, such a scientific gathering dealing with problems of the rural habitat represented a "first" in what was sincerely hoped on all sides would be a continuing dialogue.

The principal intellectual force on behalf of the Aga Khan Award Steering Committee in conceiving the programme of case-studies was Professor William Porter of Massachusetts Institute of Technology. He was assisted in his task by Ms. Deborah Allen of the Award office, and the present writer. Authors from a variety of cultural and professional backgrounds were asked to prepare papers in such a way that the mechanisms producing change in the rural sector, as well as the participants in, and the outcome of, this change should be apparent. The wide range of approaches reflected in the papers collected and published here, whether it be an interpretative description of spaces in a cave-dwelling, a technocratic stance by a civil servant, or an ideological critique, attest to the fact that all are operative (even in China) and generate information for thoughtful debate. Portions of these debates are included in the Discussions.

An extraordinarily enriching series of experiences, rarely made possible anywhere, concluded the seminar: a ten-day visit to actual sites of rural development in China was undertaken by the foreign and Chinese participants. The opportunities for observation, discussion, and comparing of prior experience while actually in the field were indeed unique.

For having extended the original invitation and afforded such opportunities for fruitful dialogue the Aga Khan Award for Architecture wishes to express its profound gratitude and appreciation to the government of the People's Republic of China, to the Architectural Society of China, its members and logistical staff who worked so tirelessly to make the seminar and field trip tremendous successes. Special thanks are due also to Mr. Paul Collard and Brig. Iqbal Shafi for their services on behalf of the Award.

Finally, the Proceedings, which will appear in French and in Mandarin Chinese languages for the first time, as well as in English, are in large measure the result of the dedicated efforts of Ms. Beatrice Grou - Radenez, Portia Steele, Patricia Theseira, and the principals of Viscom Graphics, in Singapore.
Opening Remarks

Mr Han Guang
State Capital Construction Commission, People’s Republic of China

Your Highness, delegates, friends and comrades, the colloquium which opens today under the auspices of the Aga Khan Award for Architecture in Beijing is devoted to the evolution of housing construction in rural areas. This event has great significance. The solemnity of the occasion is underscored by the very presence of His Highness who has come personally in order to participate. I wish to extend, on behalf of the State Capital Construction Commission which I represent, our warm greetings and best wishes to His Highness and the delegates to this scientific conference.

The construction of dwellings in rural areas constitutes an important activity in the development of man’s habitable environment. In modern times industrial progress has been accompanied by an increase in overcrowding of cities and a myriad of other difficulties. Under such conditions the disparities between cities and the countryside become even more glaring. Moreover, this phenomenon is particularly striking in developing countries. People today are more aware of regional planning, and economists, sociologists, architects and planners in China are exploring the ways to accomplish a more balanced development of cities and rural zones. In this context the construction of dwellings for rural use is a relatively new and important problem which has drawn the attention of the whole world. This conference on “The Changing Rural Habitat” is an opportunity to pursue these issues, and to stimulate others to take up the problem of rural housing.

China is a populous country of nearly 1 billion inhabitants, of whom 800 million live in the countryside. We need to clarify the living conditions of this sector of the population, and the Chinese government is resolutely committed to a concerted development of rural areas. We began by analyzing the existing differences between small towns and the villages in order to improve the rural environment, housing conditions and life in general. The government will continue its efforts in this realm.

After the founding of a New China, the State has relied on overall economic gains to aid people in building new dwellings. It has intervened in radical ways to correct the inadequacies in housing which were inherited from the former regime, as well as the notorious differences that existed.

Presently, the government is building hospitals, schools, stores and all the necessary public facilities across the country. Water supply and hygiene in general have been vastly ameliorated, and the overall physiognomy of the landscape has undergone enormous transformation. However, we have rather neglected the rural economy in recent years and now we must encourage production by farmers and agricultural laborers.

The countryside, since the creation of the People’s Republic of China, has only been a subject of minor interest. During the last few years, however, the rural economy has prospered and the income of those who work the land has increased remarkably.

Dwelling construction has entered a new phase of development. In actual fact, 1.9 billion square metres of housing has been built between 1978 and 1980 across China, and 15 million rural households moved into new residences. The rhythm of housing construction is accelerating in the cities as well as the rural sectors. The masses of the population are requesting that improved housing be given maximum priority.

The supervision of building construction must be enhanced, and plans must be drawn in relation to well-defined programs. The State has the important task of providing building materials to rural inhabitants. Initial achievements in the field of architecture must contribute in the long run to the modernisation of China, and its future as a balanced, highly civilised power. It is as important to build modern cities as it is to shape a modern rural environment. This is why rural dwelling construction is such an important aspect of the socialist development of China.

Nevertheless, it will not be sufficient to rely entirely on the government. The country as a whole must stimulate individual and collective enthusiasm for these tasks. It is crucial that we base ourselves upon the achievements of the farmers and unite with them. While the State offers aid in the form of indispensable building materials, our policy is to rely upon a method of self-help assisted by the State. Thanks to a unique national programme, people are urged to depend upon their own forces in order to build their house.

We are conscious of the vast extent of our territory, the diversity of national groups, the natural conditions of each locality, of our economic level and of various customs. In order to support building programmes in the countryside, we must take existing local resources into account, as well as preserve the original qualities of each site and the architectural characteristics of different cultures that compose our society.

Contradictions, linked to the dual problem of scarce cultivable land and large population, have become even more acute with rapid demographic increases. Consequently, during the planification of rural zones for development we carefully undertook the protection of agricultural land against misuse. This was done in the long-term interest of the farmers.

Although the rural habitat has undergone unprecedented transformations compared to pre-1949 China, we still remain a country on the road to development. In comparison with the rest of the world, the level of our rural habitat and of living standards generally is below what we are aiming to attain. There are gaps to fill in our programme for rural planning.

This symposium on the specific problems of rural housing construction will undoubtedly contribute in significant ways to our project, and it will offer our Chinese colleagues who work in this field a rich opportunity to learn from others. We hope that all our friends, professors, and experts will have precious comments to make on our endeavors, and that we shall be able to reinforce this with future cooperative efforts in the realm of scientific exchange and mutually beneficial development. I wish success to the conference, and a pleasant stay here in China to all our visitors.
Opening Remarks

Professor Yang Tingbao

Vice-minister, Jiangsu province

Your Highness The Aga Khan, Ladies and Gentlemen. Today marks the opening of a scientific symposium under the auspices of the Aga Khan Award for Architecture devoted to the evolution of dwelling construction in rural areas.

I would like to take this opportunity, in my capacity as representative of the Architectural Society of China, to express my best wishes and warm welcome to Your Highness and all of the delegates here present.

This is the first time that a symposium is being held in China devoted to the development of rural housing construction. Such scientific activity is of great significance, and we are honored that Your Highness has come in person to preside at the meetings. We would like to express our warm thanks to you and to the delegates.

Our industrious inhabitants have acquired over the centuries an immense amount of experience in the field of rural building techniques. There are numerous examples of buildings which reflect excellent techniques, utilisation of locally-available materials, and ingenious means of execution. Such unity between function and architectural expression was economically and rationally achieved, one which took account of the diverse life-styles of the local people and the natural conditions. Architects have been careful that popular rural housing should be built with modesty and good taste, with respect for traditions, and of course, economically.

In spite of the historical development of ancient Chinese society, rural areas remained isolated, which explains their poverty and backwardness over many centuries. During the last 30 years since the founding of the People’s Republic of China, the life of the Chinese population in general has progressively improved, in the wake of developments in agricultural and industrial production. Architecture and the built environment of rural areas generally have become important concerns in the creation of basic structures for rural living.

China is a populous country, rich in resources, with a variety of geographic, climatic and economic conditions. The number of agricultural producers alone is 800 million, which explains why the government is so vigilant in matters of architecture and construction of rural dwellings. It has given special priority to building large quantities of housing and public facilities, as well as improving the quality and security of these.

How is one to solve this tremendous problem of rural construction?

We must first and foremost study and eventually solve those questions related to industrialisation (which is also, by the way, a source of pollution), to the scale and the rational organisation of plans for living units, to the materials and other necessary resources for rural planning and construction, to the role of tradition in rural architecture, as well as to the question of innovation. Today, we shall have the opportunity to discuss together with the world-renowned specialists gathered here these extremely interesting and compelling issues. Our own specialists are particularly receptive to such exchanges of scientific points of view, for they feel that working sessions will ultimately lead to great insights for the future. And for this opportunity we are all most grateful to our visiting experts and scholars.

Historical developments and progress in our era, reflected in the rapidity of industrialisation, social advancement and environmental issues are contemporary phenomena to which the world is paying greater and greater attention. Architects are not the only ones discussing these problems; so too are the sociologists, economists, psychologists, environmentalists, planners and engineers, all of whom have undertaken research in the field of the social conditions of housing. Architects must extend their range of knowledge, raise their scientific awareness, and adapt themselves to the realities of today.

The Architectural Society of China held its Fifth National Assembly last year (1980), during which representatives discussed problems of architecture, of humanity and of the environment. It was in the spirit of "a thousand flowers blooming and hundreds of schools competing" that an animated debate took place. Thus, the Chinese delegates who participate in the present symposium will certainly benefit from discussing the theme "The Changing Rural Habitat", by frankly expressing their individual scientific points of view.

During their stay delegates will visit rural constructions dating from antiquity to present-day China, in Beijing, Xian, Xinjiang province and elsewhere. I trust that each and every one of the experts will contribute to an understanding of these edifices.

This kind of exchange of ideas will aid in the advancement of human civilisation, of progress and prosperity. It will be a symbol, like the evergreen pine or the blossoms of springtime, representing the friendship among different peoples, but also the ways in which scientific inquiry regenerates education, particularly architectural education.

Even though I am an 80-year-old man, I rejoice and I am honored to be able to participate in this symposium. I wish this reunion the greatest possible success.
Opening Remarks

His Highness the Aga Khan

I want to begin by saying, quite simply, how delighted we are to be in China. China is a nation we constantly read about and discuss. But for most of us, myself included, it is the first time we have actually seen and visited this fascinating country. For that privilege we are indebted first to our hosts, the Architectural Society of China and especially its charming and most gifted President, Mr. Yang Ting-bao.

I know that Mr. Yang and his executives in the Society have taken immense pains to make the visit a success — in numbers we comprise a dauntingly large delegation — and I speak for all our visitors when I say how immensely grateful we are for the Society’s unstinted help and warm welcome. I would also like to express my deep personal appreciation to the Government of the People’s Republic of China for the generous hospitality they have extended to myself, to my brother, Prince Amyn, and to my staff. I should also mention the helpful and friendly introductions I received before arriving from the Ambassadors of China in France and the United States.

This is an historic occasion. The people gathered here represent a unique concentration of intelligence and expertise in the topic that is to be dealt with and on the questions that will be raised and must be answered. The place — the People’s Republic of China — will provide the stimulus to encourage the innovation so desperately needed to solve the problems of rural peoples all over the world, but especially of the poor; and it will also supply the kind of perspective that only a country with millennia of history behind it can inspire. Finally, the occasion coincides with — and is indeed a response to — the increasingly urgent demands on the part of rural peoples in the developing world not only for a longer, happier and healthier life, but for achieving it without violating the regional differences, obliterating the traditional cultures, and destroying the natural environment that make that life worth living. In many parts of the world, I venture to say that the rural population has suffered either neglect or the uncertain ministrations of national and international bureaucracies.

Things will change, and no doubt they will change radically. It is the responsibility of people like yourselves — the planners and designers of our built environment — to mobilize your intelligence and your technologies to ensure that they do not change for the worse. For if the events of the twentieth century thus far have taught us anything at all, they have taught us that technologies unguided by intelligence and compassionate understanding invariably create more problems — and more insoluble problems — than they remedy.

The subject of this seminar is the changing rural habitat. The word “habitat” refers, of course to places where people live, but especially in recent parliance it has taken on the additional meaning of suitability — that is, it has come to mean the places where people ought to live. Here we will be concerned with both its meanings as we seek to reach an understanding not only of what is, but what ought to be. For obviously, if we are to plan for the future, we have first to decide what it is we are planning to achieve, and I believe that the solutions and conclusions we come up with will be equally applicable to all of the developing world.

We chose to deal particularly with the rural habitat largely because the attention of professionals in both West and East has hitherto been so concentrated on — even distracted by — the problems of our ever-growing and ever decaying cities that the plight of the rural poor has thus far been almost entirely ignored. In the industrialised West, the latter problem might be said not even to exist, comparatively speaking, and this may be part of the reason behind its neglect elsewhere in the world. It has not received, in my view at least, the level of attention, the input of thought and creativity, which it demands, and indeed must receive.

A few statistics taken from a development report compiled by the World Bank in 1979 can demonstrate the point. According to that report, four-fifths of the population of the non-industrialised world live in rural regions — less than a quarter of the population in industrial nations live in the countryside. Seventy-three per cent of the labour force is in agriculture in low-income countries, as compared to a mere seven percent in the industrialised nations. Of those rural peoples of the Third World, easily half survive under condi-
tions that most of us cannot even contemplate: fully seventy-two percent can have no access whatsoever to a safe water supply. No one is so deprived in the industrialised nations. The implications of this fact alone for the levels of health and life expectancy in those countries need not be spelled out — suffice it to say that most of the people in those regions cannot expect to live beyond the age of fifty at best — fully twenty years less than the rest of us can expect to enjoy — and that there is only one doctor per ten thousand people to serve this sick and suffering population. In a survey carried out some years ago by my own organisation in the Indo-Pakistani subcontinent, we discovered that those who had a net disposable income were many times more wealthy in the urban area than in the rural countryside.

All nations aspire to develop policies which will better the social and material welfare of their peoples. China is not only the world’s oldest civilisation, it identified its major national problems (and often found solutions for them) long before most of today’s nation states had even been thought of. As a country with a vast rural population it is in the vanguard of those who give the highest priority to the welfare of its countryside, and it has done so with courage and originality. This fact alone, it seems to me, makes the choice of China for a seminar on the rural habitat a most felicitous one.

The problem of the rural habitat is an almost overwhelming one for the developing countries of Asia and Africa. Their enormous rural populations make it inconceivable that a similar process can take place with them as occurred a century or more ago in the much smaller nations of the industrialised world whose cities managed to absorb — however painfully — the people who flooded in from the countryside. The great cities of Asia and Africa are already at the point of collapse beneath the unremitting pressures of immigration from the rural hinterlands. Somehow ways have to be found to make the countryside itself a more desirable place to live in, which in turn demands an ability to earn more and to save enough, as individuals or families or communities to begin the process of self-generated economic growth and thus social well-being. The Aga Khan Award for Architecture seeks to identify and promote all successful efforts in the resolution of man’s built environment, and clearly the fate and future of the rural habitat must be of prime concern to us.

As the Imam of a Muslim community which lives in twenty different countries around the world I have seen for myself the immense importance of meeting the needs of those sections of my community which live by the land. For the past ten years or so they have received priority in all our social and economic development plans.

As patron of the Aga Khan Award for Architecture, and as successive seminars took place in different countries, I quickly became aware that the problems of the rural habitat were general throughout almost all of Asia, Africa, the Near and Far East. The priorities which architecture in its broadest sense would bring to bear in resolving those problems would be influenced not only by religious faiths, but just as much by tribal cultures in Africa, for example, and by the different national, historical and ideological forces which dominate man’s environment across the globe.

Unless change takes account of rural life in all its aspects, unless it respects the past and the heritage of rural areas and peoples, unless it recognises the intricate ties between the physical and the social environment, it will fail to achieve planning and developing goals for each nation. It will also fail to provide attractive alternatives to migration and thereby fail to stem the tide of people flooding into the cities adding to the already almost unsurmountable social problems the urban areas are facing.

I am hopeful that this seminar will have a very particular significance for the Aga Khan Award for Architecture. Two village development projects have already won Awards in 1980. Without any prompting on our part, therefore, rural change has already pressed itself upon our attentions. Yet if the Award is to continue to recognise excellence in rural projects, it must develop improved criteria for their evaluation and these criteria can become of great use to individuals and agencies throughout the world. This would be the most important result of our meeting.

We hope, indeed we expect, that all of you who have prepared case studies and each delegate who contributes through discussion and criticism during the next few days will also help significantly to generate the development of those criteria. The seminar is also important for the Award because it symbolises its ongoing search, a process of “reaching out”. In one sense the seminar is reaching out by opening up new areas related to architecture and planning but not commonly recognised, let alone rewarded. In another sense this seminar will reach out by drawing upon extensive experience and valued counsel — particularly from China — on a set of problems which extend beyond any national or cultural or religious boundary.

Our central purpose here, then, is to increase understanding of the rural habitat and, from that understanding, to devise appropriate strategies for change, both for our colleagues in planning, architecture and other related fields, and for a wider audience of decision makers and concerned people everywhere. To achieve this end we have chosen to present and to discuss both case studies and papers on selected technical problems. The case studies have been drawn from a variety of cultures ranging geographically from Africa to Southeast Asia. They portray a variety of situations, since we believe that there is no single answer to guide our planning for rural change. Ideas about modernisation are often in conflict and theories are almost always untried. Local cultures and ecologies vary. This is why we have chosen first to present specific experiences through the case-study approach, and specific aspects of technology through the technical papers, and then call upon you all for whatever wisdom you can provide.

To guide that discussion and to lead it toward valid generalisation, we suggest that you keep three aspects of rural development and a number of questions that result from them in mind: the aspects are technology, expertise and ideology. Let me ask some of the questions: what technologies should be employed in changing the rural habitat? What
materials and techniques of building were used and how valid are they still in terms of cost and availability? Whose expertise was, or should be, employed in the building and planning processes, and how should the use of that expertise relate to traditional crafts and their development? Where experts are drawn from many backgrounds, and often cultures, how can an amicable and fruitful working relationship be guaranteed? In terms of ideology, what were the reasons for the changes that were initiated? How were these rationales perceived by the different actors in the building and planning process? Finally, how do cultural values and social expectations become modified through contact with the outside, urbanised world, especially as revealed through the processes of changing the rural habitat?

Following the seminar itself we shall visit Xian, China's ancient capital and centre of culture, and then venture forth to travel parts of the Silk Route of Western China to experience life at first hand in some of the rural areas of this great country still harbouring the culture of the Islamic civilisations of the past.

We have much to learn from that journey. We also have much to share with China, for we both have the obligation to understand our past, to respect and preserve it, and to learn to recognise the appropriateness of architectural innovations we introduce into it. As a prime civilising force for thousands of years, China's cultural heritage is rich and fascinating. Its significant Muslim heritage will also enrich our knowledge of Islamic culture in general and provide a dimension of which few of us have hitherto been aware.

Many of you have joined me earlier in the quest for cultural appropriateness in architecture, and especially in the architecture of the Islamic World. Many others are joining us for the first time to provide their expertise in the area of rural development. I trust that all are committed to gaining a heightened understanding of architecture in all its manifold forms. Most important of all, perhaps, by your diversity and talent you can indicate to the rest of us how best to achieve an appropriate physical environment in rural regions and how to guide the relentless process of change.

In a few days' time delegates from the industrial nations of the North will be meeting once again with the developing countries of the South in Cancun, Mexico. This is not the first and certainly not the last attempt to re-dress the balance between rich and poor nations. I am deeply convinced that money by itself will not solve our problems.

The nations of the South themselves must identify their own priorities — of which the imbalance between urban and rural development is surely the foremost — and establish the human and professional infrastructure which alone can make outside financial assistance, or indeed local resources, both meaningful and productive.
Let me ask your indulgence, because I am neither an architect nor an expert in anything, and yet I have been given the honour of coming here to make a speech on something which concerns us all, and that is the house we live in, the space we occupy. It is a very important subject indeed, and I was extremely moved by the speech of His Highness the Aga Khan which put so well all the emotional, psychological, cultural, social implications of the simple word “habitat”. Habitat is not only for the body, it is not only an economic factor, it does not depend only on material things: it is also our concept of space and of ourselves. It is also the way we handle the world in which we live, this is the meaning the word habitat has for me. For as the world grows smaller, and yet larger, as man’s dimensions of power enlarge and yet pettinesses are still with us, we can do a great deal of harm if we do not understand that we are bound to live together finally in that same house, the Earth, the planet which is ours and which we cannot destroy. And so today it gives me particular pleasure to be able to come and say a few very uncultured words, yet to exchange with you, perhaps, these words so that in a way I shall feel that I have also contributed a very minute share to this most magnificent, most significant, most important assembly.

I would like to go back a little into the past to make a few remarks about the great explorations which led men to know each other, men of various communities and cultures. For it is only with a spirit of exploration and innovation that we can move forward: it is the ongoing process which His Highness mentioned. This ongoing process is not new; it started a long time ago. However, today I wish to address myself to the one which went on between the countries of the Near East, the Arab, Turkish, Persian and other cultures of that region, and this land, China, which at that time was known as Sircie or “the country of silk”. There have been many records of mutual communication between these areas, both by land and by sea: over land by the Silk Road, that great artery of communication across Asia which existed two centuries before this era; and communication by sea, when the great galleons sailed from Persia and from Arabia to China. China sailed to Zanzibar and to the coast of Africa, where Ming Dynasty porcelain can still be found. As a result of this, there was cross-fertilization of ideas and things which is today one of the objectives of this very seminar.

There were no barriers. Language was not a barrier, for man can always communicate in spite of differences of language, as long as there is goodwill, as long as there is commerce and trade, and man’s extraordinary curiosity which keeps pushing him to discover his own universe. The earliest records in China of that era date from the Tang Dynasty. Of course there were records long before these of trade and commerce, since silk from China was known to Rome way back 2,000 years ago. The records I particularly want to speak about are those of the Tang Dynasty (618-907 A.D.) that came to power in 618 after a long period of war and tumult. China’s great particularity is its extraordinary coherence and unity between periods of tumult during which it appears fragmented, but always comes together again. Thus the Tang dynasty once again ruled over a united China which had already been unified by language and culture way before the Tang Dynasty. One thing that the Tang Dynasty lacked was horses. There were only 5,000 horses recorded for all of China when the Tang emperors took power. Now, the Tang were great horsemen. In Xian one can see the frescoes of those times, where many horses are to be seen. Where did the famous Tang horse come from? It came from the Muslim world, and within 50 years there were 700,000 horses recorded in the archives of the Tang Dynasty. Not all came obviously from the original 5,000, but many of them were brought over the Silk Road. Horses were a great object of commerce. Moreover, the records of those days speak of the great horses of Heaven”, for perhaps at that time it was considered that Heaven resided somewhere in the west.

Many things then were exchanged besides horses. There were also soldiers who were recruited, as well as guards for the palace, and this also you will see in your peregrinations throughout China in the Tang paintings and statues. A testify to a free exchange of people who went and hired themselves to the Tang Imperial Court as palace guards and soldiers.

We see also from that time onwards many patterns and decorations chiefly from Persia, which are also important; for instance, the grape pattern. And why do I mention the grapes? Especially because they came to China from Persia, and in my native city of Chengtu only two years ago I found a little box with a typical Persian pattern of grapes, which had been handed down from that far off time. The mirrors of the Tang Dynasty have a vine pattern of them as well, and this also was imported. In Xinkiang province you will find near Turfan, a valley there called the Valley of the Vineyards, where the seedless raisins which you know well from the Near East are also grown. And so, all of these things were always articles of trade, commerce and conversation many years ago. There are records of handicrafts from the settlements where artists, weavers and spinners from the Near East came to this area. Silk and brocades from China exported to Arab countries are also recorded as having been sent across the Silk Road.

City development was also affected, for many cities in China had their settlements of traders and merchants and handicraftsmen from all over the rest of the Asian world. For instance Yang Chow which is at the junction of the Grand Canal with the Yangtze River was known as the jewel city of the world in the eighth century. It had a very large Arab settlement of 200,000 to 250,000 people. It was very famous for its metalwork, silver crafts and felt hats. The habit of wearing fedoras or felt hats, which afterwards spread to the west, came to China from Arab countries. In Luoyang city there were a million inhabitants in the eighth and ninth centuries, and there was a large Arab community of 100,000 people in Luoyang. There were 2,000,000 immigrants then in Xian, and a very large foreign population from all parts of the world who attended the universities, who studied in the monasteries. There was also a large population of Islamic people who wanted to worship at the mosques there.

Literature also was affected. There was a great deal of exotic literature which appeared in the ninth century, and which was very much appreciated. Even today there are apparently
still, according to some scholars, but not others, what is called Pusaman, a form of “song-poem” said to have been inspired by Persian tunes, and which is still discussed among scholars today. There were great tales and legends, especially legends of benevolent millionaires from the Far West doing good deeds. So this seems to have been a pattern which has been followed until today.

Finally, to touch the women’s hearts, there were cosmetics. I have found a poem, apparently from the Tang Dynasty, in a book written by an English scholar (I have not found the Chinese original) that talks about the grapes, the watermelons packed in snow, the date farms, the roses, and also cosmetics. It says how bad it is that the women of China are now putting on cosmetics, a habit they have learned from the West. Much can be said just on this little item of commerce and trade across the Silk Road, by the Arab galleons and Chinese galleons that circulated in the Indian Ocean during those centuries. Chinese knowledge spread abroad, for instance, with the discovery of smallpox in inoculations. I found records of this when I was studying the Mediterranean Sea. Inoculations were done in hospitals during the period of the Arab empires, and these inoculations, apparently learned from China, prevented a great deal of smallpox.

And so my friends, this past is a past which today still haunts the imaginations of many men through its greatness and beauty. I am sure that this seminar is in the tradition of communicating this great past and we should be very proud that we are participating.

Your Highness and my Chinese friends, Mr Han Guang, Mr Yang, you have spoken in a way that inspired me to mention what has been done more recently. To speak of present-day China, to speak of what has been accomplished, is also to open many minds. It is quite true to say that China has tried to do much for its rural populations, much more than many other countries. In fact, all that has been written in the last fifty years in China by Chairman Mao Zedong, Premier Zhou Enlai and many other leaders of the Chinese Communist Party, has always reflected a thorough understanding that it was the majority of the population, some 85% living in the countryside, which had the right to a better life. They believed the distance between city and village must be reduced, and we have seen the enormous efforts here to try to make this come true. In other words, it is to elevate the economic situation of the countryside, to improve the life of the peasantry by supplying hospitals, doctors, schools in all the villages and the communes of China, by trying to make it possible through an enormous amount of effort to develop an infrastructure of water which would make life secure where it was most insecure. People like myself who have lived in old China, before 1949, and who were midwives like myself in the Chinese countryside for three years during the Sino-Japanese war, who can tell you how miserable, how dreadful and inhuman was the life of the peasantry then, and how happy many of us were that so much was done for the people of the Chinese countryside after Liberation in 1949. This goodwill always remains despite the fact, of course, that when one does anything there will always be errors. It cannot be avoided. There is no blueprint for development in the Third World, and one has to proceed by trial and error, by experiment. I will not speak very much about what has been done because my Chinese friends, the architects of China, are far more able to do so than I am. All I should like to say is that China and the Third World are today racing against time. The race is pressing upon us because our populations are increasing but the quantity of land does not increase. Therefore, the whole question of rural habitat must be rethought. Otherwise, if the old ways of constructing houses continue, more and more land will go for housing, and there will be less land for cultivation. This is the problem in China, and all architects are very much aware of it. Only 13% of China’s land is cultivable at present. Very little indeed. China has only 7% of the world’s total cultivable land, and yet she feeds almost 25% of the world’s population on this relatively small amount of land. These are enormous problems. A great deal of effort has been made in the last few years to tackle these issues. There is the effort of re-housing which must be planned, because without planning, there would be a considerable difficulty with
arable land being taken up by houses. When
one puts money in the pockets of the pea-
santry, as is happening now, and farmers in
some areas even get quite wealthy by Third
World standards, then of course there is a
resurgence of the old traditions in dwelling
which reflects a social and a psychological
phenomenon.

The phenomenon is this one: on the whole,
the peasantry does not like to live in high-rise
housing. The old courtyard type of house,
which is 2,500 years old and is so beautiful is
preferred, but it takes up a lot of space. If you
tell a peasant to go into high-rise buildings of
two storeys, three storeys, four storeys, he
doesn't like it. How can he be persuaded to
change? In other words, it is not only a
question of rebuilding individual dwellings or
groups of these, it is a total rebuilding of the
countryside which is before us. One of the
things which has to be done therefore is the
concentration of scattered villages into towns
where all the amenities will be located and
where a larger population can be accom-
modated than in scattered villages. Can this be
done? How can it be done? Much depends
upon transport, because the peasant who
has to cultivate his field cannot live too far
away. He cannot be obliged to walk two or
three hours to his field. Thus, we must have
enough tracks to take him to the fields under
cultivation and then come back again to his
residence. Such are the problems involved in
changing the rural habitat. I will not speak
further on this subject because I am quite sure
that the architects of China have a great many
excellent ideas on how to solve this problem.

Let me now turn and say a few words about
the future. Just as the past conditions the
present, the present conditions the future. The
future, in fact, is already with us without our
knowing it. When I was in America recently, I
met my friend Alvin Toffler, who has written
a book called The Third Wave, and it
frightened me a great deal. It also elated me.
The idea of a "third wave" is that another
revolution is coming which is called the
Knowledge Revolution. The significance of
the Knowledge Revolution is the following:
with computers, with the micro-electronic
processes, with the silicone chips, with audio-
visual means and television, with all the
technologies of bio-genetics, everything is
going to be changed very soon. Actually it is
beginning, of course, in the affluent world in
such a way that very soon we shall not
recognize our world anymore. For instance,
schools will no longer need to have the
children assembled in schoolhouses. There
will be small communities with a few families
bringing their children together to look at a
television screen for fun and for education.
Television universities will make it unnec-
sary for children to be bussed or to walk to
school. Offices will become redundant. Those
great office buildings which you see in New
York today will be empty of secretaries; the
computer will take over. Already businessmen in
London and Paris are going around with
their computers and talking to their wives on
their computers, sending messages while
travelling all over the world. It will not
therefore be necessary to have large offices
anymore. (I wonder whether the computer
will be more competent than women secre-
taries, but people assure me that it is already).
Moreover, people will be able to work at
home, which ultimately will make the big
cities redundant. There will be no more need
of these enormous cities which are indeed, as
His Highness the Aga Khan said, very often
near collapse. In some countries, many are
surrounded by slums, slums that are inhabited
by starving populations from rural areas. In
other words, the best kind of habitat will be
small village towns, scattered evenly all over
the world, with parks and other amenities,
housing a few thousand people. This is the
dream of the future of the 'third wave' or the
Knowledge Revolution.

Is this possible, is this feasible? It is happening
already in certain countries. It is going to hit
the Third World very soon. Perhaps in
thinking about rural habitat we should think
about this. One way in which China's education
problem — and there is an education problem
in China since 62% of China is under
29 years old — can be solved by television.
There is not time enough to train the teachers
to go into school and to teach the children. It
has to be done by television, since television
can reach every village.

This new Knowledge Revolution in front of
us, which is so widely discussed in the West
and especially in America, does not fill me
with dismay, although it's coming so quickly.
It also fills me with hope. I hope that with
bio-genetics it will be possible to use less land
for cultivation. Already it is not necessary to
use land to cultivate many things: these can be
cultivated practically in air. Field crops can be
multiplied twenty times by manipulation of
genes. Life therefore, and the machines of
today, will all have to be altered, and in the
course of this alteration, it seems to me, the
rural habitat may possibly become "the"
habitat of a future in which man will refuse to
live in those enormous beehives of congested
cities where things are running down. He will
want, in fact, to live in the countryside where
there will be much more fresh air, where
industrial factories and agriculture will be
linked together in small units everywhere.

And so having said this today, you will forgive
me if I seem to be talking nonsense. If it is
nonsense, then some of the books on elec-
tronics, on computers, on bio-genetics are also
talking nonsense, but I don't believe so. I
think we are entering a period of a "great
leap" in knowledge, and I think that architects
can lead in this realm by imagining both the
future as it will come and by making pro-
visions for it. I wish again to thank His
Highness the Aga Khan for asking me to
come here, and I wish to thank you all for
listening to these remarks.
Introduction

William Porter

The rural habitat is changing. It is changing because of actions consciously or not consciously taken by individuals and by institutions. A major dimension of our task in China indeed an opportunity afforded by our having been there together, was to become aware of the different circumstances of rural change, and to speculate upon the roles which architectural professionals might usefully undertake to increase the benefits from that change.

The cases you will read about are meant to depict the rural habitat both in its sense as house or dwelling, and also in its sense as the larger environment in which people reside. Included, therefore, are questions of utilities, roads, public buildings, places of work and specific technologies for their achievement, as well as less tangible, symbolic aspects.

Three rather different circumstances of change are illustrated by these cases. These might be called “indirect”, “direct” and “complex”. In Cholistan, Yemen and the case of the loess region, the rural habitat changes as an indirect result of deliberate societal action. Agricultural reclamation, foreign remittances and the slowly rising wealth of the commune create new circumstances within which individuals and families make choices about their dwellings and their dwelling environment. Their actions are seldom guided by outside technical expertise.

In Algeria, Nubia and Senegal the rural environment is changed abruptly as a direct result of the work of professionals not local to the area in question. Easy to criticise because there are often mistakes, and there is someone to blame, many situations do require and many more in the future will continue to require direct intervention.

Third is what we call the complex function of change where residential environment results from an interaction between those local to the area and non-local technical, administrative or ideological systems. Indonesia’s pesantrens and China’s own rural development program are instances of this.

We would like to call attention to roles for architectural professionals in each of these three circumstances of change, which seem both challenging and appropriate.

Where change of the habitat results indirectly from broad social and economic changes, architects can encourage good analysis of the change processes, can help to adjust government programs in transportation, infrastructure and services to fit the better needs of rural populations, and can help to develop policies guaranteeing respect by government and private sector groups for local culture and place. An architect may also be able to encourage interaction between local and outside people, in effect turning the first circumstance of change into the third, which we have called complex.

Where change of the habitat occurs abruptly as a direct result of outsiders, the most important role for the architect may be to question the speed, the scale and the price of the planned change. Slowing down projects would permit more thoughtful analysis of the needs of people, and would permit more careful and individualised design. Reducing the scale of projects would help to avoid depersonalisation. And, reduction in prices would help to reach lower on the economic ladder, and might open up construction technologies in which local residents could participate physically and economically in the building of their own environment. This is the significance of recent developments in China’s rural building strategy, where outside technicians previously were called in at the commune or brigade level to advise; and now, it is training courses in planning and building for members themselves of the communes or brigades that are being discussed.

Too often architects have to accept as an accomplished fact the program and schedule of a project from large institutions in the public or private sector. Too often these same institutions are unique in society for being able to carry out large-scale projects quickly and have a natural self interest in projects of this type. Illustrative of the possibility for relaxing scale and time constraints, we have seen that in the case of Nubia there could have been more time.

If intervention is abrupt and direct it should be carried out against a backdrop of prior work, as in Senegal. In the laboratory, in the technocrats’ own offices, and in the field careful and systematic work was substituted for the historical processes which ordinarily produce and modify the rural environment. It is bold and risky to attempt to substitute for hundreds (or more) of years of historical development. Yet when one sees as viable a building system as this, one must applaud.

Finally there is the question of the architects’ role in the third or complex circumstances of change. Here the situation politically is more mature than in the other circumstances we have discussed. Programs usually cannot be implemented unilaterally; people themselves have a strong voice in the shaping of their own environment. The architect’s role is, therefore, less problematic because society has certain checks and balances built into how it makes decisions. Since, in rural situations architectural services are not usual — at least they have conventionally been rendered — the architect may participate, as in China, in the design of building prototypes or in their adaptation to local needs and circumstances. In the rendering of these or other services the architect needs to ensure that the process of design is sufficiently open to permit participation of local people as well as administration and technicians in review and decision.

To summarize, the architect can help to articulate a humane and responsible policy to guide the changing rural habitat — like that which Mr. Zhao Bonian articulates for China’s own development programme. The architect can ensure that programmes affecting the rural habitat reflect an understanding of the local society and the pressures for change upon it — like that which Dr. I. Serrajeldin describes for Yemen. And, the architect can open the process of designing to the participation of others in review and decision.

The cases were selected from a wide variety of cultures ranging geographically from Africa to South-East Asia. They were selected to illustrate the varying types of change processes and varying types of professional role, and we have described a few of these above. We also chose to present specific aspects of technology through technical papers addressing themselves to the problems and opportunities of the rural environment. Finally, we called upon
the participants to discuss the cases and the technical papers.

To guide the discussions and to lead them toward valid generalization, we suggested three aspects of rural development and a number of questions that result from them. (We provided these ideas to those who prepared the papers as well as to the discussion leaders.) The aspects of rural development are: technology, expertise, and ideology. The questions are the following: What technologies—whether drawn from traditional methods or from new and perhaps industrialized processes, have been employed, or should be employed, in changing the rural habitat? What materials and techniques of building were used, what were the reasons for their selection, and how well were they adapted to the local environment? Regarding expertise, whose expertise was, or should be, employed in the building and planning processes, and how did, or should, the use of that expertise relate to traditional skills and craft technologies and contribute to the development of skills in the local population. How did the people indigenous to the area and those drawn from elsewhere work together, and how would one assess the effectiveness of their working relationship? How can an amicable and fruitful working relationship be guaranteed? And, finally, in terms of ideology, what were the rationales underlying the changes that were initiated? Were those ideas regarded as improvements by all the participants? If not, whose ideas were dominant? And were they the ones that ought to have dominated? How do an individual’s and a community’s spiritual beliefs influence their relationship with the built environment and the techniques used in its creation and maintenance? How do these beliefs interact with the changes being introduced into the habitat?

Do organized religion, especially Islam in Muslim areas, or other systems of belief influence attitudes toward change, or impinge directly on building and planning? How do cultural values and social expectations become modified through contact with the outside urbanized world, especially as revealed through the processes of changing the rural habitat?

The technical papers deal with practical considerations, such as earthquake-related design problems, energy-conservation schemes, and materials of construction. While many of the same questions can be asked of them, they are offered mainly as a means of sharing information among those of us most directly involved in rural improvement.

Following the symposium in Beijing, the Chinese hosts accompanied the foreign visitors to a series of sites along the ancient Silk Route westward through Central Asia, to Xian, Turfan, Urumchi, Kashgar, where examples of rural environments were seen and discussed. The international exchange began during the seminar itself was continued on another, more immediate plane, through a shared learning experience, since many of the hosts were also coming to grips with the diversity of China’s rural habitat in these regions for the first time. Some of the visual documentation from this joint field trip is included in the present volume.
Rural Architecture in the Yemen Arab Republic: The Impact of Rapid Economic Growth on Traditional Expression

Ismail Serageldin

Until the 1960s the Yemen Arab Republic (Northern Yemen) was one of the most isolated areas in the world. Partly as a result of this isolation, a unique form of architectural expression had developed, especially in the rural areas, with a characteristic type of stone or mudbrick building that was suited to the environment, and indeed organically linked to it, and which was also aesthetically striking.

The author had occasion to study these buildings in detail in 1972, and to observe in many subsequent visits the gradual changes introduced into the pattern and type of building as the country broke out of its isolation. During the 1970s, one fifth of the Northern Yemen labor force sought employment in Saudi Arabia's booming economy. The migrants have remitted vast sums that today account for over 90 percent of the Yemen Arab Republic's income from abroad. The migrants have also significantly affected the traditional construction techniques as well as the traditional social demands made upon local architectural expression and design standards. These incursions of modernity represent a laboratory case of accelerated development, where the agents of change are the people concerned themselves. This case study does not show an external will or expertise intervening in the rural habitat.

The people of Yemen are clearly split along the great divide of the eastern Tihamah escarpment. To the west, all along the coastal region, called "Tihamat Al-Yamani", are established farmers of Arab descent intermixed with peoples of clearly African origin. The present discussion will concentrate on the evolving patterns of the villages (and towns) of the mountains of the central (and southern) uplands, stretching from Sadah in the North to Taiz in the South, whose distinctive and even unique forms have come to be associated most closely in everyone's mind with the word "Yemen".

Indeed, the very name taken up by the contemporary Yemen Arab Republic may stem from the root YMN. This means "prosperity", and is a reflection of the region's traditional status as a land of plenty — it was known as Eudaimon Arabia and Arabia Felix, both signifying "Fortunate Arabia" to, respectively, the Greeks and the Romans. The environmental correlates of the ancient image of prosperity lie in the presence of enough rainfall to make possible systematic cultivation and a remarkable soil fertility, at least in contrast to the rest of the Arabian Peninsula. Nowhere is this more apparent than in the central highlands, a rugged belt of between 1800 and 3000 m. in elevation where well-weathered, nutrient soils often reflect volcanic origins. This is the most fertile part of the country, a land of greenery whose intensive cultivation is reflected in the numerous terraces traditionally cut from the steep slopes. Not surprisingly, this zone is also the home of three-quarters of the resident population of some 5 million, and nurtures the capital, Sana'a.
Before the process of development got under way in earnest in the mid- and later 1970s, the Yemen was truly isolated. The highway network, for example, had to be built almost from scratch. Indeed, at the time of this writer's first visit to the Yemen in 1972, only one complete sector of paved road was in place, the Hodeidah-Sana'a link, having been constructed with assistance from the People's Republic of China. The vast majority of the population was found in the rural areas, many of them in remote villages: such urbanization as had taken place in the central highlands was concentrated in Sana'a and Taiz to the south, both ancient fortified settlements. Literacy was very low, and traditional ways of life and of conduct prevailed. The traditional four social groupings of the Sayids (aristocracy), tribesmen, townspeople, and the servile class prevailed. The unwritten code of conduct, the *urf, was still passed from father to son, and the power of rural shaikhs was undiminished. Everyday life and family behavior was still strongly influenced by the precepts of the Qur'an and the Shari'a. Many males still carried arms, notably the *jambiya, a short curved dagger. Traditional medicinal and healing practices continued as they had for centuries.

Three-quarters or more of the recorded labor force was concentrated in the agricultural and non-formal sectors. The public and private urban sector together accounted for barely 6 percent, about the same proportion as those unemployed or seeking work for the first time. But, significantly, almost 19 percent were employed abroad by the mid-1970s, and the cash inflows from migrants were starting to grow from the $40 million a year in the late 1960s to the $800 million they were to reach by the mid-1970s. An age-sex profile of the population would show a preponderance of workers abroad as being concentrated in the category of young, productive males. Those workers were found predominantly in Saudi Arabia and also in the states of the Gulf — all countries whose massive development programs were about to get underway.

To summarize the most important aspects of the socio-economic conditions in the Yemen Arab Republic in the early 1970s, nine points can be made. First, the inhabitants of the

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**Map indicating the borders and principal urban centers of the Yemen Arab Republic.**
Source I. Serageldin.

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**Terracing for agricultural production in the Taiz region of N. Yemen**
Photo I. Serageldin

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**Defensive character of Old Yemeni architecture**
Photo I. Serageldin
country were sharply divided on tribal and sectarian lines. Second, this was a rural nation. Over 80 percent of the people made their living from the land, simply and effectively, without outside technical needs, producing coffee, qat (a mildly narcotic leaf), and vegetables. The importance of this point is further emphasized when one notes that there are few real distinctions in architecture, lifestyle or organization between the small towns and the villages, although the former are classified as “urban”. Third, the political elites (and the plural is necessary) were mainly urban-based, including the Zaidi ulama not at all noted for theological innovation, although the small class of merchants, traders, and craftsmen offered the potential for social disaffection. Fourth, rural and tribal authority was fragmented and rarely extensive, and indeed the whole society had a reputation for endemic conflict; communications were still very poor. Fifth, peripheral regions resented even tenuous central authority; this applied to the Sanbas of the Red Sea coast and the fiercely independent tribes of the north and east (who were embroiled in a 1934 war with Saudi Arabia). Sixth, there were significant minority groups in the society: some 50,000 Jews, who, after a millennium or more of co-existence with the Zaidi Imarnate, departed to Israel in 1948; the communal society of the Ismailis, isolated in the mountains of Jabal Haraz, and a shadowy underclass of slaves from the Horn of Africa and the caste known as akbdan, or menial servants. Seventh, skilled modern manpower, if needed, was painfully absent, and the educational and training system was extremely undeveloped. Eighth, a trickle of students going abroad, especially for military training, became something of a stream in the post-World War II international environment Ninth, and ultimately most significant, there was a more general emigration which is to snowball later in the 1970s.

1) Sites, the choice of location in relation to the natural and man-made environment;
2) Building construction, the system of building, the materials and the technology employed;
3) Agglomeration, how individual buildings relate to each other and the resulting collective effect;
4) Style, key design features (such as verticality) and key architectural elements that help define architectural character, and
5) Decoration, key decorative features that reflect the individual and communal aesthetic sense.

Each of these five basic aspects has been buffeted by the winds of change. Yet the differences between traditional and contemporary will not be as devastating as might be expected at first glance, perhaps because the key agent of change remained the individual.

Sites

Traditionally, Yemeni villages have tended to be clusters of stone and/or brick structures in high commanding locations. There they stood in splendid isolation, like eagle’s nests, perched, sometimes literally, amidst the clouds. The basic reasons for the choice of such locations were defensive. They enabled the inhabitants to have a clear and unencumbered view of the surrounding territory. They also made such agglomerations very difficult to attack. These practical considerations have now been completely assimilated into the Yemeni cultural idiom, and have led to notable feats of both construction and architectural composition such as the late Imam’s palace in Wadi Al-Dhar.

Agglomerations

Traditionally, Yemeni villages have displayed a closely-knit organic pattern of agglomeration reminiscent of Italian hilltowns, and which any urban planner would be hard pressed to replicate. The patterns are the result of family patterns, both nuclear and extended, inter-
acting with land ownership patterns and the exigencies of the site. These unique formations yield a rich texture, and an interplay of voids and solids that articulate the space between buildings in a series of compositions that emphasize the main central space, location of both trade and prayer, and with few private courtyards in the architectural sense, although a number of houses have enclosed courtyards on which the house opens on one side only.

An alteration in the patterns of site selection and in the configuration of settlements is naturally difficult to notice since the fixed investment already made mitigates against movement and change. Nevertheless, certain trends are still documentable. Sites in proximity to roads, with their implicit promise of accessibility to utilities and services, are becoming increasingly prized, as the need for tribal defense, individual and communal, decreases in the light of the growing strength of the central government's authority, and as newly acquired wealth makes the value of proximity to utilities (especially electricity) and services, translatable into such immediate amenities as piped water and television.

The impact of migration and urbanization described earlier cannot be ignored. As Sana'a, Hodeidah and Taiz are growing rapidly they draw upon the populations of small towns and villages, as does the external migration to Saudi Arabia and elsewhere. Villages become depopulated initially of active working males, subsequently entire families. Wholly deserted villages can now be found, especially in the north where agriculture is poorer and the Saudi "Eldorado" closer. More importantly, the carefully manicured terraces are falling into disrepair and disuse. The traditional agricultural base is being destroyed by externally earned income and the now ubiquitous qat which is rapidly displacing many traditional cash crops, such as coffee.

_Dwelling in northern region of Yemen, illustrating traditional system of construction with rammed earth._

_Photograph 1 Serageldin_

_View of the city of Saadah depicting the general verticality of the architecture._

_Photograph 1 Serageldin_
Style

Traditionally, the architecture of Yemen has been most noted for its verticality, where tall narrow structures reached unusual heights (over 100 feet in Shibam, South Yemen) and created a distinct architectural style, very different from the lower courtyard houses of the Mediterranean basin. These vertical structures tended to be functionally divided by floors. In urban areas, they housed multiple families, or frequently had commercial activities on the ground floor with residential spaces above. In rural areas, the structure frequently had granaries and stone houses in the ground floor, with few, if any, windows, while the upper floors are maintained for residential use. This not only enabled the residents to have a more privileged view of the scenery but was also efficient for defensive purposes. Clearly, this kind of design was also made possible by the remarkably temperate climate of the uplands (averaging 19°C in winter and 27°C in summer) that made such structures quite pleasant without the need for specific environmental modifiers, either passive or active.

Changing patterns of life have been reflected in the pattern of construction, affecting that notable verticality. It is this writer's hypothesis that as rural centers become more urbanized, the proximity to roads puts a premium on frontage, resulting, as noted above, in a horizontal extension of the structure. Subsequently, as the value of land further increases, in keeping with mounting urbanization, the pattern shifts back to a more intensive exploitation of the land, with vertical structures and ravine-like streets which are so distinctive of old Sana'a. A further development occurs with lower structures growing at the periphery of the city/town (urban sprawl) again in response to mounting land costs and increasing security. This hypothesis of shifting vertical to horizontal to vertical emphasis needs additional data to be proved or disproved. At present, it is advanced as a personal impression of one observer which seems to fit the facts.

Decoration

Traditionally Yemeni architecture has been notable for its heavy use of decoration. This resulted in elaborate facades with complex geometric designs. When structures are made of stone masonry, the design tended to be made of stone. Similar complex designs of bricks are observable on brick facades. In more rural areas the same pattern obtains. On less solid (expensive) structures, made of mud bricks, the facade is covered with a mud-lime "plaster", and a gypsum-based, white-colored plaster is used to accentuate the windows and provide a basic part of the facade decoration. This, incidentally, also serves to strengthen the window openings to fit the wooden frames, or plaster and glass mosaics which are prevalent in certain parts of the country. In some urban areas this type of stained glass mosaic can have very elaborate designs and notably beautiful impact. Changing patterns of decoration reflect both economic pressures and constraints of skill. The rising costs of decorative work, and the scarcity of skilled labor, have tended to make modern facades much less elaborate, much less sophisticated. Yet the presence of wealth generated from migrant labor has inevitably led to ostentatious displays of affluence, leading in one distance to painted facades. This type of decoration eschews subtle design for bold patches of color and a primitive assertiveness.

Building Construction

The characteristics of the traditional construction are the use of local materials and the employment of indigenous methods and techniques. The buildings may have as many as eight storeys and they have load-bearing walls constructed either with exposed bewn stone or rammed earth or earth-blocks, depending on the material available in the region. Their roofs are flat, made of timber beams, branches and a layer of 40-50 cm of earth.
The walls and the ceilings are plastered with gypsum plaster and the floors are usually paved with flagstone in halls and circulation areas but with plaster in the rooms. Doors and windows are made of imported hardwood. Hardware is made locally.

The traditional Yemeni architecture is well adjusted to the hardships of the different climatic regions of the country. In dry climates with big differences in temperature between day and night, houses are built with stone, brick or mud walls of a thickness of 50 cm and over. The high thermal inertia of the walls reduces the differences in temperature of the interior spaces to the minimum. In hot and humid areas, the traditional buildings have high ceilings and large openings for cross ventilation.

Most structures outside of the big towns are usually built with the traditional construction methods which give very satisfactory results. One major handicap of applying the traditional construction methods to non-residential structures is the roof, which cannot have a span wider than 3.00-3.50 m because the local timber, a kind of acacia, comes in irregular shapes and in pieces not longer than 3.50 m.

The “modern construction” refers to edifices built in Yemen recently, mostly in towns, and whose main characteristic is the reinforced concrete frame. Walls are made of concrete blocks and sometimes an additional facing of local stone, a kind of “modern/traditional”, which is extremely expensive. Where walls are made of cement blocks only, they are usually plastered inside and outside with cement plaster. Floors are covered with Terrazzo tiles and doors are made of imported hardwood or softwood or steel, and are frequently oil painted. Hardware as well as material and fixtures for electrical and plumbing installations are all imported.

The buildings designed and constructed in the “modern” idiom described above, are usually unsuitable to the various climatic conditions of Yemen. Their design often ignores the environmental conditions. As a consequence, there is no adequate protection against the climate, and the comfort is minimal. The climate in the Sana'a area is dry with considerable differences in temperature between day and night.

Articulation of spaces between buildings in Saadah.

Photo 1 Serageldin
and night. The reinforced concrete buildings with concrete block walls do not have enough thermal inertia. Hence, they are warm during the day and cold during the night. The stress caused by the extreme differences in temperature very quickly deteriorates the construction and the appearance of the building. Buildings of the same design constructed in the hot and extremely humid climate of Hodeida offer very little thermal comfort because of inadequate ventilation. Concrete and plaster disintegrate very quickly under the humidity and salinity of the air. Unfortunately, the craftsmanship that marked traditional Yemeni stone and brick construction, is rapidly disappearing. Magnificent examples of quite recent craftsmanship and pride such as the Guest Palace would be almost impossible to replicate today, as would the elaborate brick-decorated facades of old Sana’a, which were built from the inside without exterior scaffolding.

Skilled workers have all but disappeared from the local labor market. The cut stone and decorated brick facades have become too time-consuming and too costly to build. The “modern” style is gaining ground primarily under the impetus of technology (roof spaces, speed of construction — 42 weeks vs. 85-95 weeks) and economics, not personal taste. Public officials have tried, whenever possible, to have facades of public buildings made of stone, even if they masked a reinforced concrete frame. Individuals who can afford a stone construction still prefer it to the cement block.

Construction Costs

What is most remarkable is that whereas traditional construction was more economical in 1972, it became considerably more expensive by 1982. In 1982 construction costs were about 1800 YR/m² for traditional (stone and slab) construction vs. 1200 YR/m² for modern (cement block walls) construction, and these would be low estimates by prevalent market standards. This reverses the relationship established by the author’s own detailed estimates in 1972 which yielded 581 YR/m² for modern construction vs. 435 YR/m² for traditional (stone and slab) construction, the latter figure being further reduced to 310 YR/m² for the traditional stone and beam type of construction. Part of the general increase is attributable to increased prices for materials, but the vast bulk of it is due to the scarcity of skilled and semi-skilled labor resulting from massive migration to neighboring countries that followed the 1973/74 oil-price boom. The costs of construction have been rising much more sharply than any other economic indicators, with labor costs being the most important factor in this escalation.
Analysis

The process of change in the various aspects of architectural expression that we have documented in the preceding sections can really be explained as the collective impact of individual responses to changing economic, social, technological and institutional conditions. Each of these will be discussed in detail below, but what is important here is that the documented changes do not reflect the effective intervention of an external technician (the architect) or the public authorities in terms of public construction or effective regulation of construction activities. The process of change can therefore be termed endogenous, with exogenous factors, such as exposure to "modern influences" abroad, being first "endogenized" (internalized) before being reflected in terms of changing tastes in cultural expression. This subtle process is the same that takes place in the evolution of traditional architecture everywhere, as it evolves a vernacular response to changing conditions which are very gradually assimilated in the culture. The sabiety of the traditional processes of change is here made blatant by an artificially accelerated change: one fifth of the labor force abroad, remittances rising from $40 million to $150 million and incomes almost quadrupling all in less than seven years.

Economic considerations have affected Yemen in various ways. To take some illustrative figures: from 1972/73 to 1977/78 the resident population increased by a factor of 1.12; GDP by a factor of 4; GNP by a factor of 4.5; set remittances by a factor of 10; the Sana'a consumer price index by a factor of 3.5; the Sana'a rent plus water index by a factor of 5; the urban wage rate for unskilled labor by a factor of 8; and construction costs per square meter for high quality structures by a factor of 6. Most flagrant has been the massive emigration of labor. This first took a cyclical pattern of short-term migration of males, subsequently an increasingly number of Yemeni workers have generated a "second wave" of migration where families have joined the male wage earner. The effects of this migration have already been noted. Its economic impact has both direct aspects (income, remittances) and indirect aspects.

### Wage Rates by Category and Occupation in 1977, 1978 and 1979 (In Yemeni Rials)

<table>
<thead>
<tr>
<th>Category and Occupation</th>
<th>1977</th>
<th>1978</th>
<th>1979</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unskilled laborers</td>
<td>45/daily</td>
<td>50-60/daily</td>
<td>50-60/daily</td>
</tr>
<tr>
<td>Skilled Operator</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(heavy equipment)</td>
<td>1,320-1,660/m</td>
<td>1,520-1,820/m</td>
<td>1,660-2,000/m</td>
</tr>
<tr>
<td>Drivers</td>
<td>1,000/monthly</td>
<td>1,250/monthly</td>
<td>1,500/monthly</td>
</tr>
<tr>
<td>Mechanics</td>
<td>1,000-1,800/m</td>
<td>1,200-2,000/m</td>
<td>1,500-2,500/m</td>
</tr>
<tr>
<td>Welders</td>
<td>1,000/monthly</td>
<td>1,250/monthly</td>
<td>1,500/monthly</td>
</tr>
<tr>
<td>Blacksmith</td>
<td>700/monthly</td>
<td>900/monthly</td>
<td>1,100/monthly</td>
</tr>
<tr>
<td>Machinist</td>
<td>800/monthly</td>
<td>1,000/monthly</td>
<td>1,230/monthly</td>
</tr>
<tr>
<td>Carpenters</td>
<td>140/daily</td>
<td>200/daily</td>
<td>240/daily</td>
</tr>
<tr>
<td>Masons</td>
<td>120/daily</td>
<td>180/daily</td>
<td>220/daily</td>
</tr>
</tbody>
</table>

Source: Ministry of Public Works, 1979

**YAR: Indicators of socio-economic change: 1972/73 — 1977/78**

<table>
<thead>
<tr>
<th>Indicator</th>
<th>1972/73</th>
<th>1977/78</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Resident Population (in 000's)</td>
<td>4,994</td>
<td>5,518</td>
</tr>
<tr>
<td>2. GDP, at current market prices (YR million)</td>
<td>2,514</td>
<td>9,080</td>
</tr>
<tr>
<td>3. GNP, at current market prices (YR million)</td>
<td>3,019</td>
<td>14,300</td>
</tr>
<tr>
<td>4. Net remittances (YR million)</td>
<td>505</td>
<td>4,905</td>
</tr>
<tr>
<td>5. Consumers price index (Sana'a)</td>
<td>100</td>
<td>348</td>
</tr>
<tr>
<td>6. Rent plus water index (Sana'a)</td>
<td>100</td>
<td>513</td>
</tr>
<tr>
<td>7. Urban wage rate (unskilled labor; in YR)</td>
<td>6</td>
<td>50</td>
</tr>
<tr>
<td>8. Construction cost/m² (high quality structure; YR)</td>
<td>450</td>
<td>2,900</td>
</tr>
</tbody>
</table>

Source: Compiled from various studies and sources, including author's field observations

This include artificially constraining the labor market and fuelling a phenomenal inflation in costs and prices as the economy generally and the labor market specifically became increasingly tied to the Saudi development juggernaut. Such changes have also induced some undesirable phenomena such as the weakening of the traditional productive agriculture and an unhealthy dependence on the Saudi market that is hostage to the process of labor adaptation in Saudi Arabia. The economic costs of the migration process include contributing substantially to the severe inflation experienced in the mid-to-late 1970s, and of longer term significance, the changes in taste and consumption patterns acquired in the course of the migration experience, e.g. the shift from consumption of domestically produced millet and sorghum to imported wheat and rice.

The patterns we have observed are, at least partly, the results of sweeping social changes that have affected the Yemeni first as a result of the civil war in the 1960s and second as a result of the international migration of the 1970s. The former with its after effects in terms of successive changes of government gradually saw the collapse of the traditional tribal system of authority and the appearance of a modern central state bureaucracy. This process of social modernization means that the traditional individual identification with tribe and village was being broken, replaced by a wider national identity as Yemeni. This was subsequently reinforced by the migration experience, where Yemeni identity per se was reinforced vis-a-vis an international context that blurred all local regional distinctions. Furthermore, the process of urbanization in the Yemen cannot be overlooked as an effective introducer of change and as a catalyst.
and reinforcer of a new national identity that is effectively superseding the local tribal or geographical affiliations.

No less important has been the social change that has taken place as the traditional extended family structure has been undermined by the migration process, and as the community itself became increasingly exposed to modernization. The change at that level may also extend to the greater emancipation of women. International migration also generated a rapid change in attitudes and consumption patterns. The desire for visibility and conspicuous consumption seem to be a universal phenomenon in the behaviour of enriched returning migrants in Yemen and elsewhere. While it may be argued that such “modernizing influences” may well generate a cultural backlash, or at the least a compelling, even wrenching, sociocultural disorientation and anomie, as far as its immediate impact on the people’s life-styles and behavioral (not just consumption) patterns, it cannot be denied that in the Yemen, this modernization has meant:

1. Movement to the cities;
2. Value placed on accessibility to services and sources of goods;
3. Smaller families, requiring less space;
4. Footloose, mobile individuals (and families) that move according to economic opportunity;
5. A premium on modern stone construction as a form of expressing wealth, but demand for new construction of any kind whenever possible;
6. Less interaction with neighbors (as extended family links were destroyed by movement and resettlement).

Three types of technological factors have affected the Yemeni village and its physical pattern:
1. Transport technology, which made people more mobile, has affected the physical isolation of rural Yemen;
2. Communications technology, primarily radio and TV, has broken the centuries-long cultural isolation of the Yemeni village; and
3. Building technology has affected the traditional ways of construction and architectural expression.

Without minimizing the importance of the first two factors, it is pertinent to concentrate on the last, remembering that here technological and economic factors are deeply interwined. The impacts have been in three broad areas:

- building systems, materials, and decorative elements. As for building systems the notable features are the appearance of reinforced concrete and steel, the latter primarily as a spanning element in the form of light-weight trusses. This was forced upon local builders by a demand for wider spans for such buildings as schools and small factories as well as the general shortage of the traditional wooden beams. Reinforced concrete, which is disastrously handled by unqualified local contractors, was introduced on a large scale as the adjunct of modernizing urbanization. It has now appeared in small towns but not yet in remote small spaces.

- Building materials have likewise been affected more in the small towns and urban areas than in the remote villages (where stone and mudbrick are still the rule). The traditional dressed stone and bricks are now being widely replaced by the ubiquitous cement blocks. This is mostly a result of the scarcity and consequent high costs of skilled workers. With that development, some of the unique heritage of Yemeni architecture is being lost. Decoration is also falling prey to the same developments. Elaborate brick and masonry facades are built no more, and the traditional stained glass windows are giving way to aluminum windows.

In all the preceding cases it appears that individual choices are swayed by the presence of economically competitive modern alternatives at a time when skilled labor is in acute shortage. Unaided self-help techniques were not viable originally given Yemen’s relatively sophisticated traditional construction methods, but are almost completely unthinkable today in view of the present labor shortage.

Institutional Factors

In Yemen, Local Development Associations (LDAs) played a very strong role in the lives of ordinary people. These LDAs undertook the execution of public works aimed at improving the community’s living standards. They were overlaid on a complex system of tribal and geographic allegiances, but nevertheless were successful in mobilizing resources and channelling them to productive uses. As the tribal system weakened, the LDAs continued to play a strong role throughout the early 1970s. Thus in 1974 about 40 percent of all domestic school construction was financed by the LDAs. Yet the modern state tends to behave and to be looked upon as a natural monopolist in the provision of public services, even when it is hobbled by a weak administrative structure and severe shortages of personnel at all levels of the bureaucracy. Accordingly, the local inhabitants have tended to increasingly rely on the central government to provide them with basic services and the LDAs were also severely affected by the
international migration which deprived them of their most dynamic members. As stated before, worker remittances have tended to go to consumption or real estate investments rather than productive investment. Therefore, all these factors have tended to reinforce a rugged individualism, which in this context meant that individual building activity has been a direct result of individual wishes molded by individual aesthetic concepts of status and modernity and constrained by individual economic means. The long delays in extending public services mean only that the central government has foregone its opportunity to affect agglomeration patterns by timely interventions that precede individual residential building. This is definitely more true of urban areas and small towns than remote rural villages per se which have been, and remain, beyond the reach of any Yemeni central government.

The accelerated change observed in the Yemen Arab Republic has been a mixed blessing. The unique architectural expression found in rural and urban Yemen is being lost, at least partially to rising costs and loss of building skills. We may as architects regret this — but, above all, let us not over-romanticize the rural way of life, let us not mystify the past. What we as outsiders find quaint and attractive is no more than a rational and economic solution to conditions that existed once, but which may not exist today. It is possible, if not probable, that these solutions are not responsive to the wishes and aspirations of the sons and daughters of those who built them, nor are they competitive in today’s market conditions. Yankees today use cement blocks because they produce buildings that cost about YR1s 1200 m² of building area rather than YR1s 1800 m² for the traditional dressed stone and slightly less for bricks. If they can afford it, Yankees still prefer to build in a peculiar modern-traditional, that uses dressed stone facades but eschews detailed ornaments, which are too costly anyway. The real effects of modernization and change are more subtle and run much deeper than such a surface comparison. They are found in the emergence of small mobile nuclear families, whose needs for electricity and water replace their parents’ concern with defense, granaries and storage spaces. They are found in the urbanization of the villages and the ruralization of the towns as all become part of the global village whose perimeter is defined by the transistor radio’s range. They are found in the disappearance of traditional crafts as the machine replaces the human hand and as labor migrates to the north in ever-increasing numbers in search of high wages and steady jobs. Above all, they are found in the eyes and faces of youth who have come to expect a better future, and the eyes of the old who are bewildered by the disappearance of a lifestyle they thought would last forever.

Reference Notes

1 Thus local sayings such as Al Widaa Sultaama (solitude is beatific) and Al-Widaa Ibada (solitude is prayer) make a virtue of erstwhile necessity

2 Requiring minimal care, this hardy shrub yields continuously, all year long, valuable income to farmers who sell the small leaves in the market. It is estimated that an acre of qat returns approximately six to seven times the income that could be expected from the most lucrative cash crops, without any of the difficulties associated with the cash crops

3 For a detailed discussion of this concept the reader is referred to I. Serageldin “Labor Adaptation in the Oil Exporting Countries” in N. A. Sherbini, ed., Manpower Planning in the Oil Countries (Comm.: 3A1 Press, 1981), pp. 209-227

A farmer in Xingyang county of Henan province by the name of Dian Lui, who was also a building painter by trade, spent all of his off-hours during two years in rehabilitating his cave dwelling and transforming the original cliff cave into a pit-type dwelling. Design concepts stemming both from traditions of the region as well as ingenious improvements took form as he and his wife laboured on their new home. The final dwelling shows distinctive individuality and provides stimulating thoughts for architects. Dian Lui's house is a cave dwelling dug into the northern bluff of a gully running into the Suo River valley, where Xingyang county is located. With a southern orientation the house commands a beautiful view of a vast lake and aqueduct. Thus, the house may be said to have an ideal situation, conforming to the principles of wise integration of building with landscape: back to the hillside and water in front. Originally, Dian's house consisted of three caves. However, the one on the east fell into disrepair over the years and its inner coating began to peel off due to the penetration of rainwater, thereby rendering the cave uninhabitable.

The owner and his wife then decided to repair their house all by themselves. The initial project involved extending the abandoned cave to the back where a squarish pit was subsequently excavated. The abandoned cave would then become the entrance to the sunken court, onto which three new caves opened in order to accommodate the expanding family. As the work progressed new possibilities emerged. The existing two caves with southern exposure could have cross ventilation, since both could have access to the court, and the original doors could be redone up as windows.

Having perceived the benefits of cross ventilation, they decided to create the same conditions in the newly dug cave on the western wall of the pit, initially intended as the kitchen. This was accomplished by an 'off-axis' tunnel to link up with the front yard, which was enlarged by utilising excavated earth from inside. Thus, the inner court is linked up with the enlarged yard for utility purposes. The former then became the centre of domestic life.

In the next phase of construction, the couple built a row of five rooms on the ground level along the eastern periphery by reusing the excavated earth. The row closes the forecourt on the east. Finally, a wall to the south closes the space. Entry to the house is through a gate in this wall.

The couple fully achieved here with their own efforts, their conception of a dwelling to fit their needs and desires without any assistance from outside. They demonstrated themselves to be as competent as any architect. Their concepts materialised into physical form as they scooped out the earth. They were the creators of an architecture without architects. In the handling of spaces, Dian's house can justly take pride in not only having carried on a tradition of cave-building in the loess region, but also having contributed to this through their many innovations.

The excavation of the central pit and the consolidation of forecourt and yard establish a tripartite spatial arrangement. By means of ingenious linkages, the three spaces form a...
coherent sequence while each maintaining distinct functional attributes.

Excavation of the central pit made possible an improvement in living conditions of the two old caves on the wall of the south pit, the opening of a kitchen cave on the west wall of the pit and two inhabitable caves on the north wall. While carefully respecting the traditional disposition of rooms for different uses and the life-styles, the space within the pit court has been maximized in order to accommodate all domestic needs in an orderly way. Two recesses have been carved out of the loess in the pit to provide enclosures for poultry. Tucked away in the corner of the east wall is a niche with covered opening leading to an underground pit where sweet potatoes are stored; it also serves as a shed for tools. These devices clearly show the ingenuity of our builder.

However, the handling of space in the pit court constitutes a departure from tradition. The north and west sides of the pit are bluffs towering to a height of about 9 to 10 meters which act as a buffer against wind and snow in winter. The original bluff on the east side, now reduced to a height of 5 meters, relieves much of the feeling of claustrophobia and also provides a better scale for the entrance gate on this side and thereby serves as an appropriate transition from the forecourt to the pit court. The berm wall on the south is brought down to a height of 8 meters, sufficient to ensure the necessary thickness of soil over the existing two caves on this side. Thus, the pit court can receive better daylight in winter. Bluffs are sheared off a bit at a height of 4.2 meters from pit ground level to provide setback, or berm, along which a brick parapet has been built to prevent earth from falling into the court. The final effect is a reduction in the apparent height of the court, brilliant daylight and a sense of tranquility, there is no sense of claustrophobia, or, as the Chinese say, no feeling of "sitting at the bottom of a well and looking up into the sky ."

With regard to the handling of internal spaces, the use of earth for making furniture produces a textural unity which enhances spaciousness and reduces the amount of excavation to be carried out. And of course, this saves in furniture costs. The traditional practice in this region is to employ earthen kitchen stoves, a bed that is heated from below, called a käng, and which is very widespread, as well as tables, niches for cupboards, and so on. The adept handling of both internal and external spaces of Dian's house is rarely encountered among the traditional cave dwellings in the region, which invariably produce a claustrophobic sensation inside, while a feeling of wilderness pervades outside of the house. Dian manages to obviate these by means of appropriate transition of spaces. He seems to have employed consciously or unconsciously the technique of judicious and subtle contrasts. By devising a subtle progression of spatial sequence by means of transition, directionality, inflection, etc., he succeeds in bringing us from one realm into another throughout the house.

The openness of the terrain reclaimed through excavation on the east and south of the house is first reduced, or contracted, by enclosing walls on these respective sides. The main entrance is given its due prominence while the forecourt wall is set back a distance from the alignment of the utility yard wall. Upon entry into the elongated forecourt flanked on the west by a berm wall of reasonable height and a row of bungalows on the east, the asymmetrical articulation of the gate axis, with a little shift to the west, draws attention to an aperture in the wall where the view is focussed upon delicate cut-outs in red paper in the window. A strong 'pull' in this direction compels one to proceed forward, although the entrance to the pit court — which is the ultimate climax, the final contraction, in the succession of spaces — is not yet visible. The decorated aperture in the wall of the house and the entrance to the pit court are linked by a space covered by a grape trellis and supported by tree trunks. A barrel-vaulted passageway, which leads to the pit court, effectively alters one's path of movement. The transition is masterfully done, with great subtlety.

As one progresses from outside of the main gate to the forecourt, and then squeezes through a narrow passage, one is confronted by a spatial implosion, namely the pit court.
Therefore, as one emerges into the court, the space seems to burst open, to reveal a quality distinctly different from the one just left. Yet, despite the underlying differences, a use of planting in both spaces, the brick architraves of the doorways in the pit court, and the brick plinths of walls in the forecourt provide a unity in detailing. Thus, an environmental unity has been achieved that coexists with diversity in treatment of spaces.

At this apparent conclusion of spatial sequences, one steps into the kitchen, which has a view of the approach axis. An unexpected exit presents itself — the off-axis tunnel at the end of the kitchen — which brings you once again into the open space of nature. Here, in the shade of trees, chickens and ducks picking on the ground, and bees buzzing above, the whole utility yard is teeming with life and presents a highly animated scene.

Such are the principal manifestations of design concepts evolved in the course of making the house. Characteristic of these is their implicit subtlety often embodied in an apparently prosaic form. These environmental qualities justly reflect the simplicity, intimacy, openness and tranquility of cave dwellings, prosaic but never vulgar. They are artifacts built into Nature and they deserve our careful evaluation, and perhaps even emulation. In the course of building Dian gradually identified the functional requirements of his household and duly attributed them to the spaces created. The forecourt, simple and tranquil in character, is reserved for the expanding family; the pit court onto which all cave doors open is secure and intimate, the obvious centre of domestic activities, where various tasks can be carried on outdoors. Sheep and poultry are all kept in their appointed places in the utility yard; latrine and pigsty are grouped together to facilitate the collection of excrement and also to keep the place tidy. Beehives are arranged in a line in the shade of trees. The yard testifies to the industry and frugality of the owner. Compared with the chaos usually seen in the traditional pit-type cave dwellings, Dian's is decidedly a great improvement.
Panoramic view of the front court, entrance (left) and passage to pit court (right)

Drawing P Zhou, G Yang, B Li

Sketch of grape trellis in front court, with free standing buildings at right

Drawing P Zhou, G Yang, B Li

Plan of the cave dwelling.

Drawing P Zhou, G Yang, B Li

KEY
1. Kitchen
2. Rooms for habitation, open at both ends
3. Rooms with a single opening
3a. Off-axis tunnel
4. Pit for potato storage
5. Pig Pen
6. Toilet
7. Curved passageway to a room
8. Chicken pen
9. Dwelling at ground level
10. Grape trellis
11. Front court
12. Pit court
13. Utility yard
With the excavation of the pit, the two old caves were provided with openings at both ends, facilitating ventilation and enhancing the amount of daylight — often lacking in the more traditional types. Dian’s dwelling is not damp during hot summers, although the cave’s temperature is somewhat higher than the traditional cave, where the temperature is usually so low as to verge on discomfort. With better daylighting in the room, occupants do not have to congregate now in the limited space by the window, as it is the custom with occupants of the traditional cave-dwellings.

The most meaningful lesson to be drawn from Dian’s experiences is that it was achieved through self-reliance: the couple worked with their own hands during their off-hours for two years, and without any intervention from outside. There is no heroic adventurism in Dian’s undertaking. It is man’s act of self-preservation against an adverse physical environment. Here, the dictates of Nature play a far more decisive role in the creation of Habitat than in any other human ecosystem. There is no choice in this loess region but “to do it yourself” — to build your own dwelling. With dedication and limited means Dian made a virtue of necessity and built a house of which any architect could be justly proud.

Self-reliance and operating within conventional frameworks are general practice among our peasants in rural areas of China. Dian’s house may be an exemplary case in point but certainly not the only one. We have chosen to present such a case study to this august gathering in the hope that we may derive together some meaningful lessons from our prosaic friend, Mr. Dian.
Photograph of a cave dwelling in Shanxi Province. Note access by a ramp leading down from ground level.

Photo: B. Taylor

Excavation of an additional room in a pit dwelling in Shanxi Province.

Photo: B. Taylor

Traditional Kang bed, heated from beneath, in a cave dwelling, Shanxi.

Photo: C. Little/Aga Khan Awards

Interior of a typical kitchen in a cave dwelling, Shanxi.

Photo: C. Little/Aga Khan Awards
Habitat and Desert: The Case of Cholistan

Kamil Khan Mumtaz

Cholistan, the desert region of Bahawalpur division of the Punjab in Pakistan, extends over some 10,000 square miles. The livelihood of its nomadic population is primarily pastoral. A canal colonization project, originally launched in 1933 but abandoned soon after, has now been re-introduced into the region under the administration of the Cholistan Development Authority. As a result large tracts of the desert are being transformed into agricultural settlements. This paper looks at the impact of canal colonization on the traditional culture, particularly the architecture of this region.

The general background is provided in a description of the physical, socio-economic and political characteristics of the region, the patterns of settlements, administration, the Sutlej Valley Project and the current canal colonization programme of the Cholistan Development Authority.

The paper identifies three types of settlement patterns:
- Temporary settlements of nomads at tobas
- Semi permanent settlements associated with some permanent feature e.g. fort, wells, shrine (case study: Chanan Pir and Dingarh).
- Permanent settlements in the canal colonies (case study: Mandi Yisman).

Land and Climate

The desert of Cholistan extends over roughly 10,000 square miles, and includes two thirds of the old state (now division) of Bahawalpur. It is in fact an extension of the Thar desert, whose western edges are formed by the ancient river called the Hakra in Pakistan and Ghaggar or Ghagra in India. The same Ghaggar or Ghagra in vedic times was the Sarasvati, considered sacred by the Aryans. The rivers Indus and Hakra (Ghaggar) together with their tributaries irrigated a very extensive area, collectively called the “greater Indus Valley”.

Administratively Cholistan is divided between the three districts — Bahawalpur, Rahimyar Khan and Bahawalnagar — of Bahawalpur Division in the Punjab province of Pakistan.

To the north and west are the areas irrigated by the Sutlej (the easternmost of the five rivers of the Punjab) and the Indus. To the east and south, along the border with India, is the desert region of Rajasthan, while across its southwestern boundary lies the desert region of the Province of Sind.

Today the desert region of Bahawalpur, with about five inches of rainfall a year, consists of sand dunes and salt flats. The dunes, or tibbas, are low in the northwestern quarter — the Lesser Cholistan — while in the south, or Greater Cholistan, they can rise to as much as several hundred feet. The salt flats, dhauars, occur among the sand throughout Cholistan. They can stretch for several miles or be as small as a few hundred yards each. The flash storms convert them temporarily into lakes and the run off from them is in places collected in natural depressions or man-made ponds called tobas. The only other source of water for man and beast alike are the wells which are found at a few places in Cholistan.

As in any desert, the climate of Cholistan is extreme. In summer the daytime temperatures rise to around 120° Fahrenheit but the nights are cool and comfortable. In the winter the days are warm and comfortable while the nights are cold. The rains come, if at all, in the monsoon season — from mid July to the end of August — and sometimes in winter. Periodically the rains fail. If they fail for a number of years in succession they take a heavy toll of life. The animal population swells again during years of plentiful rainfall.

As might be expected under these circumstances, the population is nomadic. People move from one water hole (toba) to the next, and when these dry up, to the semi-permanent settlements around the wells; or, in extreme drought, to the permanent settlements at the edge of the desert.

Living at the tobas is in the open, requiring no permanent structures. The toba is generally associated with the family or clan who maintain it and return to it each season. However, a family whose own toba has gone dry may go and camp at another toba which has water. Thus the settlements at the tobas always tend to be temporary.

The semi permanent settlements are usually associated with some permanent features such as a well, a fort or a shrine; and a number of relatively permanent dwellings, but the population is not entirely permanent. Most families who are otherwise based in such settlements (and own permanent dwellings in such settlements), will move with their animals into the desert (rohu) for several months at a time at certain seasons. At other times the
permanent population at such settlements may be joined by nomadic families from the desert.

Permanent settlements are generally restricted to the northern and western edges of the desert where canal colonisation is transforming the land, economy and way of life into the familiar patterns of settled agricultural communities.

A distinctive feature of the Cholistan desert is the relative abundance of vegetation. This consists of a variety of wild grasses and shrubs. In the dry season from February to June this vegetation gradually decreases, but within a few days of a good rainy season the desert is once again softened by shades of green. On this vegetation depends the livelihood of the desert people.

The economy of the desert or rohi is primarily herding and grazing. Camels, cows, sheep and goats are bred for sale, milked or shorn for their wool.

Another important product of the rohi is sajji (carbonate of soda) derived from two wild plants Kangri Khao and Gora Lana which grows in brackish soil.

Settlement

Between 4,000 and 1,000 BC, when the Hakra flowed through it, Cholistan was fertile and populated, playing a pivotal role in the Indus Valley civilization. Among the more than 400 ancient sites identified along the Hakra are those which have recently helped to fill some important gaps in our pre-history.1

The remains of settlements associated with the Cholistan "decorated ware culture" of the beginning of the first and end of the second millennium BC, are usually found in mid-stream in the bed of the Hakra. This means that the Hakra or Ghaggar had already dried up around the first millennium BC. This is generally held to be the period when the Aryans arrived in the Sarasvati valley.

As the Hakra and its tributaries successively changed courses and eventually dried up, the human settlements along its course began to disappear. Recent surveys have shown that the ancient people of this region were constantly being forced by changing circumstances to shift from one site to another. Along the old course of the Hakra is also a series of forts which served as a line of defence against expected attacks over the deserts of the erstwhile Indian States of Rajasthan, Jaisalmer and Bikaner. Many of the forts which still survive were constructed in the 18th century, although several date back to the pre-Muslim era.

In 1739 the title of Nawab was conferred on Sadik Muhammad Khan I by the emperor Nadir Shah, who also granted him a large part of the territory forming Bahawalpur State. The state for many years was a confederation of several petty principalities under the nominal suzerainty of the Nawab until a grandson of Sadik Muhammad Khan succeeded in bringing the tribes together under a single hand.

The Nawabs aided the British against the Sikhs and obtained recognition of independence as a reward through a treaty in 1833. In 1838 they were rewarded with the districts of Sahzakot and Bhang Bara for rendering services to the British army in Afghanistan, and the Nawab was recognised as an absolute ruler by a treaty in the same year. By July 1866 the management of the State was assumed by the British Commissioner of Multan and shortly afterwards by a Political Agent.

The nomadic population today is estimated to be 50,000 with another 20,000 divided equally between semi-permanent and permanent settlements. Sparse as the population is it is divided into a number of tribes and ethnic groups including Muslims and Hindus. Prominent among the Muslim tribes are the Sama, Laar, Sheik, Bohar, Charhua, Daiha, Baluch, Bhatti, Mughal, Panwar, Joo’ya and Langa.

Some of these tribes are located within specific areas. For example the Bhatti inhabit the area around Maujgarh Fort. This family is said to have come from Bikaner, where they worked as brick bakers. They were brought here by the Nawab of Bahawalpur, with the consent of the Raj of Bikaner, when the construction of Maujgarh Fort was started. Thus the Bhattis of Janowali still work as potters. Some of them also have camels and sheep and call themselves the descendants of the folk hero Dulla Bhatti.

The Baluch and Raiputs are not settled in, or confined to, any particular area but move from place to place with their animals in search of water.

Development Projects

The Sutlej Valley Project was launched in 1933 to irrigate the lands of Bahawalpur, including the irrigation of 800,000 to 900,000 acres of Cholistan. But it was abandoned later in the 1930’s after some canals had been dug and a few residential colonies had been constructed, resulting in the displacement or forced departure of the local population.

The area to have been served by the following canals:
- The tail end of the Hakra Branch of the Sadequia Canal (150,000 acres)
- The Desert Branch of the Bahawal Canal (350,000 acres)
- Abbassiya Canal (275,000 acres)
- The tail end of the Sadeq Branch of the Punjab Canal (125,000 acres)

In 1932 several hundred thousand acres had been acquired for colonisation. But as prices of agricultural products fell with the international economic crises, much of the fertile land was abandoned. Subsequently the Anderson committee reduced the flow of canal waters flowing to Bahawalpur while increasing the water of the Bikanar Canal. From the early 1940’s repeated demands were made to resume the work in the abandoned desert regions. Thus in 1946 the Bahawalpur State government approved the resumption of the Abbassiya Canal. As a result in the early 1950’s 150,000 acres were colonised. More recently the Punjab Government has shown some interest in the development of the neglected areas. In 1974 the Prime Minister assured the people of Bahawalpur that the forsaken areas of the Sutlej Valley Project will be supplied water from Turbela provided the link canals have the capacity to take the extra...
flow. Indeed, the system of link canals compensating for the loss of waters in the river system of the Punjab, can be tapped to bring water from Tarbela to the abandoned areas of the Sutlej Valley Project. Already, as an initial step, some of the old canals have been provided with seasonal flow of water. Perennial supply is expected in at least some canals as the next major step.

The responsibility for the development and colonisation of the irrigated areas of Cholistan now rests with the newly formed Cholistan Development Authority. In addition to developing and allocating agricultural land this body also has programmes for the development of livestock. It has reserved 2,000 acres for the promotion of sheep breeding, the management of which has been entrusted to the Livestock Board. Similarly the Forest Department has a “Range Management Scheme” for the development of forests.

For the protection of Cholistan’s wildlife, a national park has been created with an area of 77,000 acres set aside.

Administration

The normal form of transportation of the Rohillas is by camel or on foot. The occasional travellers from the towns use bicycles or motorcycles. Jeeps are restricted to Government Officers. Under a special order private vehicles are not normally permitted to enter Cholistan, except with a specific 24-hour permit issued by the District Commissioner. Being a border area it is patrolled by the Desert Rangers, a para-military force which maintains a string of posts in the area, and are probably the most visible government presence. The function of the Rangers is, however, restricted to policing the border for illegal traffic. Other forms of government such as Revenue Collection, Law and Order, Social Services and Public Works, are practically non-existent.

With the abolition of the grazing tax (trini), the only government revenues from the area are from the production of carbonate of soda (sunit) And this is done through a system of contractors, sub-contractors and sharecroppers which is fairly self-regulating, requiring no government presence in the area itself.

The Khar contract, worth up to Rs. 400,000, is awarded annually to one contractor for the whole of Cholistan. The contractor is usually one of a small clique of wealthy Raisatifs from the big towns. The Khar bushes are gathered by sharecroppers (Kharola) for specific territory and piled in a large circle around a pit and then burned. A liquid juice from the burning plant drops to the bottom of the pit where, on cooling, it solidifies into a grey rock. Half the produce is collected by the contractor and half is kept by the Kharola.

The entire Cholistan is a protected forest and wild life area. Thus, probably the most familiar government presence besides the Rangers is that of the Forest Department. In the past they collected the grazing tax (trini) through the local head men (numbarads) appointed for this purpose. This tax was rather nominal — Rs 1 per camel and Rs 0.50 per sheep annually, and was abolished in 1974. A record of animals is maintained by the Forest Department which issues permits to graze in Cholistan. But this has not been kept for the last two years as the department has run out of permit books.

A project for improvement of grasses started by the department in 1962–63 failed because the untended animals were constantly getting tangled in the barbed wire cordons. The scheme was disbanded in 1970. Now the department mainly works on water conservation schemes, for example the digging of tobas, improvement of wells and demarcation of tracks (katcha roads). The resources of the Forest Department are quite inadequate for the effective patrolling of such a vast area, and poaching and unauthorised hunting are a regular diversion for the rich.

Temporary Settlements

Between migrations, the focus of life for the nomadic tribes and their animals is the muddy pool of rain-water called toba. A toba in the desert is usually considered to belong to the clan who established it. They return to their ancestral tobas every season. Ten or eleven families camping around it with their animals.

Thus, for example, the Soo`fawala and Kaniwala tobas are reserved for the herdsmen of the Punwar clan. Some tobas have a gopa shelter or two, and some even have a few fruit bearing trees. The pride of the Soo`fawala toba are its ber trees with their sweet succulent fruits.

The traditional gopa has a low, circular mud wall with a gap for the entrance. A domical roof of twisted branches rises from this wall to a central post. The jambs at the entrance are slightly raised and three or four stout branches span across to make a lintel. The roof is covered by a thatch of grass. The wall is punctured at three or four points by small square holes for light and ventilation.

The toba itself is a large pond with about two metres high mud banks which are often overgrown with shrubs and a few trees. A gap in the bank permits the rainwater run off from the dhau (salt flat) to flow into the pond. A trench is dug at the water’s edge and the earth used to make a low parapet around to pool. Water from the pond is allowed to flow into the outer trough from which the animals can drink, while the parapet keeps them from fouling the water in the main tank used by people. As the water is depleted the tank diameter is reduced by digging a new trench and parapet. The process continues until all the water is used up.

Information on the status of other tobas and wells is essential to survival in the desert. This information travels by word of mouth. It is the first information exchanged when people meet each other. But also the pattern and movement of clouds, winds and other signs are carefully observed in order to estimate where the rain has fallen.

When the tobas dry, the family must move to another source of water. Normally messages are sent out and permission sought before going to another toba. Before such permission is given, questions are asked about the number and kind of animals, and depending on the level of water, the duration of stay is allowed. There is no payment for the
use of a *toba* other than sharing the work of digging the troughs and making the protective parapets.

The herds and flocks are amazingly disciplined as they are brought to the water. At a shrill whistle a flock of several hundred sheep freezes to a stop and waits for a herd of cows to drink up and move on. At another signal the herd at the water moves away and another takes its place.

The animals graze completely unattended and return by themselves in flocks or herds to the *toba*, each day in the summer or after many as three or four days in winter. Each flock or herd can be recognised by the distinctive sound of their bells, and by the braderi *dangs* or brands.

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**A Semi-permanent Village: Dingarh**

Dingarh was selected as a case for the study of society, culture and built environment in a semi-permanent settlement. The study is here presented in terms of the physical and social structure of the village: that is, the spatial distribution of houses in relation to kinship groups and social stratification: location and role of public and community facilities such as mosques, *tobas*, wells and graveyards, ritual and community activities, particularly those connected with births, marriages and deaths.

The principal house-types are illustrated through two examples from Dingarh and one from a typical *toba* of the region.

About 30 kilometers east of Yasman are the fort, wells, and some 120 houses which make up the settlement of Dingarh in the heart of the Lesser Cholistan.

The houses are scattered across two relatively high (up to 18 feet) sand dunes. Approximately one kilometer to the east are the *tobas*. About 200 meters on the west is the hulk of the old fort and in its shadow, below its northern and western ramparts are the wells. A rough sandy track running east-west passes about 50 meters from the northermost group of houses. Another 50 meters beyond this track are a half dozen burnt-brick structures: the forest Department quarters, dispensary, veterinary dispensary and residential quarters, symbolising the presence of the government. The real presence, however, is limited to the dispensary run by a dispenser and one peon.

The settlement/village itself can be divided into five distinct sectors, corresponding to the five *braderis* (fraternities, clans or tribes) which
make up the community of Dingarh. The largest of these is the Laar braderi with over 50 houses. The second is the Sheikhs, with 25 houses followed by the Dindars with 20 houses, the Panwaars with 9 houses and Qazis with 8.

It is not possible to give a precise count of the population as this varies from season to season. Even households whose home is Dingarh are often dispersed, with some members on the family's agricultural lands in the canal colonies and some with the animals in the rohi, while others remain in Dingarh. A rough estimate of the normal population would be about 500.

The Laars, with about 50 houses in the northern sector, are the largest braderi. Traditionally they own small animals, that is sheep and goats but also own a few large animals such as camels and cows. The Sheikhs is the second largest braderi in terms of numbers, with about half as many households as the Laars. But they own large animals and are considered to be wealthier and, socially speaking, a degree higher than the Laars. The numbardaar has always been from this clan. But since the abolition of the trini grazing tax, the numbardaar has no longer any official function. Nevertheless, Mohammad Ramzan is still called numbardaar.

Dindars, also called Nau-Muslims (new Muslims), are Megwal Hindus who have recently converted to Islam. They are artisans and craftsmen, usually weavers and cobbler. They have about 20 households in the eastern sector and are considered to be at the bottom of the social hierarchy together with the Panwaars.

The Panwaars are also artisans performing a variety of tasks as washermen, cooks, barbers, potters and carpenters. They form a group of about 9 houses on the west.

The central sector of some 8 houses is that of the Qazis, who are supposed to perform the marriage rites but are seldom found in the village, especially since the election of the principal Qazi to the local bodies’ union council, where he has acquired the additional title of “Chairman”.

The nomads who camp at the wells of Dingarh in the dry season belong to the Sirah, Boohar Bheen and Katwal tribes.

Wealth in Cholistan is measured in terms of heads of cattle. Sheikhs and Laars are both referred to as owners of grazing animals, maddaars. Their status in the pastoral community is equivalent to that of the zamindars in the agricultural communities of Punjab and Sind. That is, there is a clear distinction drawn between the maddaars and the artisans and craftsmen or the kaunias as they are called in the Punjab. The word “mua” in Saraiki and Punjabi is used for grazing animals, but literally it means goods or wealth. And some maddaars of Cholistan are indeed wealthy in their own rights. In Dingarh, one Gul Mohammad Sheikh owns 40 female camels (dachis), 300 heads of sheep and 200 cows. Among the Laars, Jam Umar Wadda owns 800 sheep and between 50 to 60 cows. The Boohars who roam the desert and drink from the wells at Dingarh when their tobars go dry, own as much as 600 sheep and 100 goats per family.

Sheep raising is a new trend. They are shorn twice a year, and the wool brings up to Rs. 60 per sheep annually. Young camels (todas) sell for between Rs. 1,000 and Rs 1,500 each.

Mosques

There are three small mosques in Dingarh. One in the southern section of the Sheikhs and two between the northern and central sectors of the Laars and Qazis. The three are similar in size and design, consisting of a single square chamber on the western side of a raised open platform. Two of these chambers are of mud bricks with a single mud-brick dome each, while the third is of burnt brick tiles and has a flat roof. There is no regular congregaion
(jamaat) at any of these mosques, nor any imam to lead the prayers or muezzin to give the call to prayers. Three or four persons do offer their prayers five times a day at each of the mosques, but there is no special congregation on Fridays or even on the two Eid festivals, unless an imam is brought in specially from the town. The ritual sacrifice of animals on Baq’eid is also rare. Though all of the population professes Islam, most are not particular or even informed about its practice or rituals. There is a small local shrine, the Baddal Wala Khanqah, a rather very simple affair with a few colourful flags, but no one seems very clear about who is buried there nor about its maintenance. The main religious day appears to be the gyarwin (eleventh night of the moon). Milk is not curdled on this day but distributed among the people. The same is done on the fourteenth night of the moon (chowldiwin) which is considered a kind of All-Saints day.

Tobas and Wells

Much more significant than the mosques in the life of the community are the tobas and wells. There are two tobas at Dingarh — one for animals and the other for people. The latter has a mud wall with a wicket to keep animals out. These are fairly close to each other and located about a kilometer to the east of the village. A second source of water at Dingarh are the four perennial wells at the foot of the fort. These wells, like the tobas, are each collectively dug and owned by three or four families belonging to a common clan. They are modelled on the toba pattern, with a main reservoir for humans and a lower trough for animals. Like the tobas, the wells may be used by outsiders by prior permission. But unlike the tobas the wells do not require constant repair; thus the families using the well contribute by providing a draught camel for one day each in turn. The water is drawn in a leather bucket tied to one end of a long leather rope which passes over a pulley and is pulled by a camel hitched to the other end. The water in the wells is brackish, and only used when the tobas go dry.

There is a large graveyard to the east of the village. However far they may wander, the clans associated with Dingarh will carry their dead, even a hundred miles, to Dingarh to be buried. The corpse is bathed and wrapped in a white cotton shroud, and placed on a charpai cot. The imam keeps up the recitation from the Koran, while members of the clan come to visit the family. Each visitor puts a veil (dopatta) or sheet over the corpse. The corpse is then carried on the heads of two men to the graveyard to the accompaniment of hymns (naats) Food which is taken with the corpse is given to the potters who have dug the grave. The corpse is let down into the grave and the earth packed with clenched fists, to the accompaniment of verses recited from the Koran. The covering cloths (dopattas and sheets) are all given to the potters.
House Types

A distinct evolution in three stages is discernible in the types of structure employed for domestic architecture: from the traditional circular plan of the gopa shelter, with its domical thatched roof, to the rectangular plan with double-pitched roof and the enlarged rectangular plan with flat roof. However, throughout all these developments, the essential layout of the house remains intact. This comprises a single-family room facing onto an open platform or clear area, the equivalent of the courtyard, but demarcated by a low kerb in place of the screen wall.

Dwellings illustrating the evolution from gopa to flat roof house-type, Nawankot
Source K K. Mumtaz.

The gopa shelter has been described above. The houses of Ghulam Rasul and Jain Umar Wadda in Dingarh are discussed below, as representing the latter two types of construction, found in the more permanent settlements.

Ghulam Rasul’s House. Ghulam Rasul is a Sheikh and a nephew of the numbarkar. He has a brother and two sisters who live with his mother and father in Mithra where the family owns 25 acres (morabba) of agricultural land. In Dingarh, Ghulam Rasul shares the house with his paternal uncle and aunt who have no children. They also have an equal share in the herd of cattle which are tended by Ghulam Rasul and his uncle, while his father and brother look after the uncle’s land in Mithra.
The sizes and orientation of the principal rooms are fairly standard. The rectangular plan with pitched roof is about 3.5 meters by 7 meters (about 12 feet by 24 feet) externally. The flat roof type is slightly larger in plan. In either case the principle rooms always face east with their longer walls along the north-south axis. An entrance in the centre of the eastern wall opens out onto a raised terrace. Ghulam Rasul’s house is no exception. The central ridge (sheheer) is supported by a timber column (tumbah) and a truss, or rather a truss (ghoorhi or adai) formed by two rafters. The eastern wall has a door (dar) while the other three walls have shallow niches (jada) at about 1 metre and a half above the floor. Each wall is perforated by small (3 inches diameter) vent holes arranged in groups of four, at about one metre above the floor. Projected above the niches, and running the full length of the west wall is a shelf (safiyel) on which crockery and utensils are placed.

Against the southern wall are stored bulkier household objects, grain in an earthen bin (kalhoti), a wooden stand (gaharwain) on which are placed a large box (tong) with a lid, and spare bedding. In the northwest corner is a decorated earthen store (bhikare), and in the north eastern corner some half dozen earthen jars (gharas) containing the household supply of water.

On the terrace are a pair of stoves (chulha) in the northwestern corner, protected against the wind and sand by a parapet wall. On the other side of this wall is stacked the firewood (balan) and fodder (chara). The eastern end of the yard is used for activities associated with milking, such as churning the milk for butter and making curd. Beyond the yard to the east, stretched between two pegs, is a rope (tandil) to which are tied the calves while the cows are being milked. Some 10 metres to the south and east is a gopa shelter for animals.

A second room with a flat roof and with its long axis in the east-west direction has recently been added on the south side of the yard. This room could not be studied in detail as the women were working in it plastering the floor and walls. However it was of the flat roof type.

Construction is done generally by the men assisted by a mason (mithi) from the city. However, plastering of roofs, walls and floors is done by women.

Sun-dried bricks of the standard British size (9” x 3” x 4.5”) are used for walls. Columns, beam and rafters in the pitched roof type of construction are all of unsworn local timber. The roofing consists of a thatching of khup grass onto which a mud plaster is applied (gil). A second coat of mud and straw plaster (gaara) is applied to the first, and finished with a third coat (goya or phoosin) of mud and cow-dung. This last is always done by women.

The first mud plastering on the walls (lipat) is done by the mason, but subsequently by the women each year after the rains.

Jum Umar Wadda’s House Jum Umar Wadda is the head of the Laar braderi in Dinkar. He has two sons and a daughter. One son is a shopkeeper in Mandi Yezman, the other cultivates the family’s land at Chak 80. The daughter is married to Umar’s sister’s son who also has land in Chak 80. Umar has two brothers, both herdsmen. Between them they own 800 sheep and 50 to 60 cows. Umar himself is ill with tuberculosis.

Jum Umar Wadda’s house reflects his social status and his relatively progressive urban outlook. (His son, a shopkeeper, is one of the few youthas from Dinkar with a school education) To the principle room in this case has been added another, creating a yard which is twice the width of those in the more modest dwellings. Ancillary rooms are also provided at the northern end of the yard to accommodate a store and a kitchen. All of these rooms are flat roofed. The larger rooms employ sawn timber or steel beams imported from the city. The two living rooms have shuttered windows on either side of the doors facing the yard. The main room has a staircase to the roof. These features represent a strong influence from the urban culture on the settled agricultural areas and are presumably recognised as status symbols. In other respects the disposition and use of spaces is conventional: cooking area to the north of the yard, animals milking to the east. Nevertheless, an oven (tandoor) next to the kitchen and a large grain bin (kalhoti) at the southwestern corner testify to the higher status and wealth of the owner.

KEY
1 Grain storage
2,3 Rooms
4 Water pitchers
5 Storage
6 Kitchen
7 Storage
8 Oven
9 Sleeping perch
10 Animal shelter
11 Milking place
12 Washing place

Umar Wadda’s house, Dinkar.

Source: K.K. Murtaz.
A Permanent Village: Mandi Yazman

On the north-western fringes of the Lesser Cholistan desert is Mandi Yazman, a vivid though deformed illustration of a permanent settlement in the canal colony area — those zones transformed by irrigation and agriculture, as here by the introduction of the Desert Branch Canal.

Yazman is linked to Bahawalpur and the rest of the country through a good, metalled road. From a small trading post it has grown with the canal colonisation programme, into an important administrative and commercial centre. It is a Tehsil headquarters with a Municipal Committee and a number of government departments such as Police, Agriculture Office, Veterinary Hospital, Forest Department, Irrigation Canal Rest House, Food Storage Godowns, Hospital and a Rangers Unit. Around the new grain market is a comprehensive high school for girls and a Government boys high school. Under construction is the latest showpiece, the Dubai Mosque. The main bazaar links the bus station at the centre of the town to the old grain market at the west end. Along the road to Behawalpur is a cinema, an ice factory and a flour mill with the Desert Branch Canal not more than a kilometer to the north of the town. A fine new highway, the “Sharna-e-Rasheed” leads out from the town in the opposite direction to the edge of the desert, some 3 kilometers away.

As an illustration of the extent to which modern technological improvements can influence the design of the built environment, Mandi Yazman is highly instructive, for in this case the transformations have been total and absolute. As the tidal wave of modernisation and industrialisation/mechanisation has driven the desert and its creatures before it, none of the traditional elements of their architecture have survived in its wake.

The people of the old Riasat (state) of Bahawalpur identify themselves not as Punjabis but Riasatis, and the desert people as Rohillas or the people of the Rohi. The population of Yazman included few Rohillas and almost no Riasatis. It is a thoroughly Punjabi town, characterised by standard cement and brick architecture of the Public Works Department or vulgar, small-town facades of any Punjabi market town (mandi). The bizarre “Gulf Islamic” Dubai Mosque, a gift of the Sheikh of Dubai, adds a final touch of incongruity.

The resentment of the local population against the “Punjabisation” of Cholistan must have been expressed strongly to have finally compelled the authorities to adopt a policy of giving first priority to Cholistanis in allocating new agricultural land, and second to landless tenants. As a result of this policy, a number of Rohillas have now been settled in the new agricultural lands. Elements of the architectural and craft traditions of the desert have indeed survived in these frontier lands, where the traditional gup shelter or a fulai weaver’s loom are not uncommon sights in the isolated hamlets at the fringes of the detest.

Conclusions

The canal colonisation programme, typical of several such rural development projects, does not extend to the design and/or construction of buildings, particularly the common rural habitat. Yet it is a rural development programme of no mean proportions, and one that has already transformed, and will continue to transform the rural environment in very real ways.

While many “revolutionary” architectural projects end up making no real impact on the rural environment, this and similar projects which transform the economic base have much deeper, and far reaching, effects on traditional societies and cultures, and ultimately result in often unpredictable and unintended (by the planners) architectural transformations.

Technology Apart from the occasional government buildings the only “imported” technology is to be found in the enterprises of the Sheikh of Abu Dhabi. Normally this imported technology is restricted to the use of kiln burnt bricks, steel and cement applied to standard Public Works Department designs. But the Sheikh has introduced reinforced concrete, diesel pumps, piped water and flushing toilets in his rural barracks and mosques.
No evidence was found of any of these "innovations" having influenced the common habitat of the people. However, a distinct process of evolution was observed throughout Cholistan in the transformation of the rural habitat from the traditional gopa to the flat-roofed rectangular plan. This appears to be the result of "osmosis" rather than "design." Technically, this implies an evolution from mud pisé, available timber and grass thatch construction to standardized, sun-dried, earth brick and cut timber, or rolled steel joists.

The reasons for the employment of the new technologies appears to be a desire, and in the settled areas a need, for more permanence,
and equally a desire to identify with the more "advanced" areas of the Punjab.

There is no imposed planning, administrative or management framework, in which traditional techniques are replaced by modern ones, other than the canal irrigation and land settlement programme itself.

Expertise: The Government and "Abu Dhabi" structures are wholesale importations. The designs, and practically all the materials and skilled labour are brought in from the city. And as noted above there is no cross-fertilization between these and traditional buildings.

There is a vector, however, in the evolutionary process: the travelling, the master-craftsman or mistri. He is brought from the city by the people. He travels alone or with an apprentice in his service. Most of his materials (except sawn timber and steel) and all his labour are locally mobilized. Usually his work team consists of the family for whom he is building, and their neighbours. Most likely he is illiterate and learned his trade from a "master". Occasionally he is a great virtuoso or a specialist.

As a rule, virtuoso or specialist skills such as arched and domed construction and decorative plaster or brick work, are reserved for mosques and tombs, or the palaces of the rulers. In the humbler dwellings decoration is restricted to such furniture as the earthen chest (bhikaree) or grain store (kalioti).

Ideology: The imprint of Islam on the way of living is clearly evident in the customs and rituals associated with marriages, births, and deaths. But as a determinant of the built environment the role of ideology, as conventional religion, is weak. Patterns of settlement, layout of the village and form of the rural habitat are determined more by climatic, economic and social factors than by spiritual ones. A marked exception is the architecture of the mosques and tombs.

In a more general sense, cultural values and social expectations are deeply affected by the transition from the nomadic life of herdsmen to the settled patterns of farming. The "image" of the outside world does become a symbol of progress and advancement but the process is selective and conservative, for only
those forms are adopted which are recognised as conventional in other rural areas.
The rural habitat has so far proved to be curiously immune to the ubiquitous PWD image. Whether the Abu Dhabi image will prove to be equally “invisible” to the eyes of the native builders remains to be seen.

This paper is based on a study conducted by the author under the UNESCO project “Socio Cultural Research on the Relationship Between Architectural Design and the Way of Life of Asian Peoples” Field material for the study was gathered on three visits to the region between February, 1980 and March, 1981. The visits to Cholistan were made possible through the generous assistance and co-operation extended by the District Commissioners Bahawalpur, the Directos General and staff of the Cholistan Development Authority and Nawabzada Falahuddin Abbasi

Reference Notes

1 The decorated brown ware found at these and some other sites has now established that the Harappan civilisation did not come to an abrupt end but continued uninterrupted into the “decorated brown ware” or post-Harrappan culture
2 A large dam on the Indus
3 Administrative Unit below the district
4 New villages (Chaks) in the canal colonies are identified by their official number

Bibliography

Ahmad, Ishtiaq Nazir, Cholistan Desert, Reprint of Pakistan Journal of Science (Vol II), (Lahore, 1959)

Dehavi, Shatah, Al-Zubair (Cholistan Number), Al-Zubair Publications (Bahawalpur, 1978)

Islam, Mazhar-ul, Lok-Punjab, National Institute of Folk & Traditional Heritage (Islamabad, August, 1978)

Khalid, A. K., Bahawalpur Perspective

Research Society of Pakistan (P U Lahore), Extracts from the District & States Gazetteers of the Punjab (Pakizaat) — Vol II, Government of Punjab, (Lahore, May 1977)

Shah, Brig, Nozrat Ali, Sadiqpanah (The History of Bahawalpur State) Maktaba Javed, (Lahore 1959)

Yousaf, Dr. Muhammad “Cholistan — A Strange Live Descent” Pakistan Times (Mag. Sec), Lahore, 8th June, 1979
Pesantrens in Java: Local Institutions and Rural Development

Farokh Afshar

There are reportedly some 17,000 schools that call themselves pesantrens in Java alone. The characteristics common to probably all such institutions are that they comprise teachers known for their knowledge of Islam (kyais) and students (santris), and share the objective of inculcating Islamic principles and ways of life. Pesantrens are thought to be a part of an indigenous teaching tradition going back to early Islamic, some even say pre-Islamic, times.

The smallest types consist of a kyai and a handful of santris, who occasionally meet to read the Koran, either in his house or at the local mosque. Larger pesantrens may be a coeducational, residential school of 3,000 santris with several kyais, trainee teachers (ustads), administrators and support staff, and a curriculum that covers Islamic teaching, a regular secondary education and extracurricular activities such as boy-scouting and community development. Many large pesantrens began primarily as small Koran reading schools. Significant philosophical differences also distinguish pesantrens from one another, in addition to the more obvious structural and functional distinctions.

While pesantrens are located in both urban and rural areas, our concern here is with rural ones of the larger, functionally more diversified category. Such pesantrens seem to have the greatest potential for contributing to the development of habitat. Several such development-oriented pesantrens are undertaking joint projects with government agencies and with non-governmental organisations (NGO) in such fields as rural education and construction.

The primary objective of pesantrens is to teach Islamic principles through the use of both traditional as well as contemporary religious texts. The contents of these texts range from Islamic theology to law and day-to-day individual conduct.

Regular education is offered up to secondary school level similar to that provided in public schools. Community leadership and technical skills are taught through such activities as public speaking and debates, on-the-job training in carpentry, masonry construction, etc., and the management of the school, co-op shop, fish ponds, and farming. After their schooling (6 years secondary in some pesantrens, 12 years of elementary and secondary in others), santris are considered ustads and are expected to teach in the pesantren for a further two years. Ustads are also more actively involved in the management of the pesantrens.

The organizational structure, within which the over 1,000 pesantren members are fed and sheltered and a myriad of activities are performed, is neither as rigid nor as complex as might appear on paper. It is nevertheless a sophisticated and surprisingly progressive structure in its balance between central coordination and delegation of responsibilities. (particularly if we remember we are describing in essence a rural boarding school). The structure can be separated into two basic tiers. The first tier, formalized in the waqaf board of trustees and major committees such as education, consists of the kyai's immediate family, influential village persons as well as some trusted and experienced ustads and santris'.

This upper tier influences and makes the major decisions in the pesantren. Not all of the participants at this level hold official positions on the board.

The second tier consists of elected committees with ustads and santris as members. Each committee is responsible for decision-making and implementation of particular activities in the daily pesantren operations. These include the orientation of incoming santris, landscaping and building maintenance, food services, dormitory and classroom administration, etc. Some of these committees, such as those on education and training, may be headed by an older person from the "upper tier".

The kyai's authority pervades and integrates the whole system in an unobtrusive manner. The delegation of responsibility relieves the kyai of much direct involvement. At the same time, he is regularly consulted or informed, and all major decisions are either made by him or have his approval. Thus although the system is remarkably participatory in the way responsibility in decision-making and implementation is distributed, the kyai maintains overall control.

Not surprisingly, the main participants in the above structure (the kyai and his family, the santris and the village community, at least as represented in the waqaf and main committee) are also the major sources of material and financial support. Firstly, the kyai's own income from farming and/or business activities is donated "in trust" (as waqaf) to the pesantren. Secondly, santris' fees can be an important source of finance. In pesantren Pabelan, for example, they constitute approximately 75 per cent of total income excluding community donations. Thirdly, the village and the supporting community of santri parents and alumni can be called upon periodically for donations in the form of cash, land, materials or labor. The santri's parents and alumni are among those without official positions in the organizational structure, who, nevertheless closely participate in the planning and implementation of pesantren activities.

The actual amounts thus raised can be quite small relative to the number of persons in the pesantren, the range of activities, and the level of physical infrastructure and building. Two factors keep costs and monetary transactions to a minimum. First, all members, from kyai and santris, are willing to live simply and work voluntarily. For instance, ustads who comprise most of the teaching staff perform their duties in return for keep and occasional pocket money: the rest, senior teachers and administrators have sources of income other than the pesantren. Secondly, a maximum use is made of local resources. For example, much of the food comes from the kyai's own land. Similarly, building materials are either freely or inexpensively obtained from the immediate vicinity.

Planning in the pesantren is done on an annual basis. It commences during the Islamic month of fasting (Ramadan) and proceeds thru the subsequent Lebaran, a nationwide holiday period of 7 to 10 days. No classes are held during both periods and most santris go home. The slower, more leisurely pace induced by the fasting and the termination of the regular pesantren activities is conducive to discussion and planning. Being the end of the academic year also, it is an appropriate time to reflect as
KEY
M  Mosque
C  Cemetary
KH  Kyai's house
KPH Kyai's father's house
KGH Kyai's grandfather's house
OG  Office and guest house
GST Grain storing office and storage
GD  Girl's dormitories
BD  Boy's dormitories
WSH Work shop
L  Library
CL  Class room
K  Kitchen
CT  Canteen
PP  Pit privies
W  Wash
SH  Shop
ST  Store
VH  Village houses
GCL  Girls class room
A  Animal pen
P  Pool
Φ  Well
Θ  Water tank
t  Timber construction
b  Bamboo construction
sf  Steel frame

Pesantren Pabelan, site plan.
Drawing: F. Afshar.
well as to plan for the future. Major issues such as curriculum changes, the construction of a new set of classrooms, etc., are handled. Those involved in the discussions are perforce those who remain then in the pesantren = the kyai, his family and closest associates among the ustads and santris, as well as those who cannot afford to leave (poorer santris who earn their keep by working in the pesantren). Relevant persons in the surrounding village are also drawn into these discussions, such as the influential waqaf board members and local builders.

The subsequent 10-day Lebaran period is traditionally one of receiving guests and visiting friends and relatives. For the pesantren, it is a further opportunity to discuss plans and to elicit support from their community of benefactors, particularly those who live some distance away. Alumni and santri’s parents visit the pesantren. Other kyai and well wishers also visit. Some of these people stay for several days, allowing much time for discussion on general matters as well as those pertaining to the pesantren. By the end of this period many major decisions are reached, plans made, and sources of support and implementation procedures established for projects in the coming year.

All of the above usually occurs informally and as a matter of course. Occasionally, plans are made and implemented in a surprisingly thorough fashion. In the next section, both casual and conscious application of the planning and implementation mechanisms discussed here will be illustrated by describing their role in habitat development in each pesantren. However, the major characteristics of Pabelan and An-Nuqoyah pesantren with regard to these mechanisms should be outlined briefly.

Pesantren Pabelan and An-Nuqoyah, with approximately 1,300 and 2,000 members respectively, fall into the category of development-oriented pesantren. They are presented here as typical examples because of their broadly similar planning, financing and implementation mechanisms, although significant differences between the two exist. Such mechanisms are the basis for all pesantren activities in the development of the rural environment.

Pabelan is somewhat a “model” of the development-oriented type of pesantren. It represents the potential of such pesantren rather than the archetype. An-Nuqoyah represents the more traditional and conservative in this category of pesantren. However, their differences are mostly more of degree than of substance. Approximately 60 per cent of An-Nuqoyah’s classroom education draws from religious texts and the rest from standard school textbooks. In Pabelan, the proportions are reversed. An-Nuqoyah has also a much smaller range of extracurricular activities. Structurally, the pesantren is divided into five sub-pesantren each headed by a kyai (except for one which has two kyais). The oldest kyai is the acknowledged head, although decisions on matters of mutual concern are collectively made. Each sub-pesantren is relatively autonomous. The kyai’s exercice more obvious control over the day-to-day running of affairs and the santri committees appear to be less self-governing and active. Male and female santri have little or no interaction.

The sources of income of the two pesantren differ significantly. Santri’s fees form a substantial proportion of Pabelan’s income; in An-Nuqoyah fees are nominal and barely cover stationery costs (Rp 15,000 or US$24.00 compared to Rp 2,000 or US$3.36 per annum, respectively). Pabelan is more successful in receiving development grants from the government and non-government sources. An-Nuqoyah tends to rely more heavily on assistance from santri’s parents and alumni and the surrounding villagers. The reliance partially explains An-Nuqoyah’s very systematic method of mobilizing community support for projects (to be discussed in the next section).

These differences between Pabelan and An-Nuqoyah may be principally attributed to their contrasting locational and historical characteristics. Pabelan is located in the Yogyakarta region of Central Java, a wealthier area with better transport and communication links compared to Madura Island in East Java, a poorer, relatively inaccessible conservative area, where An-Nuqoyah is located. Pabelan was established in 1965 while An-Nuqoyah, established in 1865, is the oldest pesantren in continuous existence in Indonesia. In Pabelan, the kyai, Haman Djaufer, and his main assistant, Habib Chirzin, are recent graduates of Gontor, a pesantren known for its modernizing influence. In An-Nuqoyah, the main progressive force is the youngest and most junior of its six kyais. Pabelan pesantren is thus more innovative, draws upon a wealthier “clientele” of santri (and thus can ask higher fees) and, being more visible and receptive, attracts more assistance from government and non-governmental agencies. These and other differences in planning and implementation are further illustrated by the manner in which each pesantren has improved its rural habitat.

Case-Study: Pabelan, Java

Pesantren Pabelan, in a village of 6,000 inhabitants was established in 1965 by kyai Haman Djaufer, on his return to his village from studying at pesantren Gontor. The physical habitat of pesantren Pabelan then consisted of: the kyai families in three bamboo houses, a mosque and half a hectare of land. This had expanded by 1981 to some 30 buildings (several of which were of permanent materials, brick and steel, etc.) on five hectares of land. In 1965, the pesantren had no paved access, a few wells and pit privies; fifteen years later, much of the area was landscaped. A piped water supply system fed several washing and toilet areas spread throughout the pesantren. Most of these developments were financed and implemented by the pesantren itself with some assistance from government and non-government agencies during the latter years.

Three basic building types, characterized by the technology employed are apparent in the pesantren today, namely: the traditional type with bamboo walls, and bamboo or timber pillars supporting a shingle or tile roof; an intermediate type with timber walls, timber frame and truss supporting a tile roof; and, a modern type with baked brick walls and timber or metal truss supporting a metal or asbestos sheet roofing. All these materials,
except for the metal and asbestos, are locally produced. The types roughly correspond to consecutive phases in the pesantren’s development, each phase marked by an increased capacity to finance and implement construction. What are the characteristics of each phase and how was the pesantren’s construction capacity enhanced?

In the first phase (1965-70) the kyai began by establishing his credibility and reputation. He taught a handful of santris in his house and the mosque. As the numbers increased and particularly with those who came from afar to live in the pesantren, male santris slept in the mosque and female santris lived in the kyai’s house.

Some villagers donated space in their houses to be used as dormitories or classrooms. The kyai, a champion farmer in his own right, taught agricultural skills along with religious teachings. This attracted attendance by farmers from the surrounding areas. Similarly, he arranged for two of his santris who were builders to teach construction skills while the pesantren implemented a modest amount of building and repair (4 dormitories with an area of about 370 square meters). The practice of imparting construction skills while simultaneously improving the habitat was therefore established from the outset. Most of the buildings constructed were of a traditional type. The pesantren was financed largely by the kyai’s agricultural income and some small donations.

By 1970 the kyai and the pesantren were sufficiently well known to attract many more
<table>
<thead>
<tr>
<th>Sleeps On:</th>
<th>Beds</th>
<th>Bamboo Platforms</th>
<th>Bedding</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Dormitories)</td>
<td>Usually on earth floor</td>
<td>Usually on earth floor</td>
<td>On concrete or tile floor</td>
</tr>
<tr>
<td>Floor</td>
<td>Earth</td>
<td></td>
<td>Concrete in situ or tile</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Walls</th>
<th>Bamboo or timber frame with bamboo matting</th>
<th>Timber frame with timber planks (horizontal or vertical)</th>
<th>Brick</th>
</tr>
</thead>
</table>

### Plans and Roof Sections

- Double pitch on rear central country and beam supports
- All laminated joints, or primary supports of cut timber with secondary supports of bamboo
- Either no ceilings or bamboo and lining roofs or flat ceilings

### Verandah

- Some
- None

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Pesantren Pabelan, dormitory and classroom typology

Drawing: F. Afshar.
santris, as well as the active support of the surrounding rural community. For the first time, fees were charged from non-Pabelan santris. Regular donations in cash, materials or labor were elicited from the Pabelan village, partially in lieu of fees which were not charged for santris from the village.

Physical expansion increased during the second phase (1970-74). Dormitories and classroom were constructed in bamboo as well as in timber and, in some cases, reconstructed; that is, they were dismantled on one site and reassembled on another. Since the pesantren was located in the center of the village, the expansion required the relocation of some villagers' houses. The problems such relocation may have posed were eased because one of the wealthier land owners donated a nearby relocation site and pesantren members — santris and builders — undertook the dismantling and reassembling. Eight buildings covering an area of 800 square meters were constructed between 1970 and 1974 at an estimated value of Rp 10 million (US$16,129 in 1980). During the latter part of this period, the pesantren had an adequate regular income to retain a small group of paid workers and builders.

Pesantren activities had begun by 1975 to attract the attention of the government and of non-government bodies, such as the Institute for Economic and Social Research, Education and Information (LP3ES), a Jakarta-based development group.

During the third phase (1975-80) the LP3ES, in collaboration with other government agencies and universities, such as the Bandung

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Pesantren Pabelan, interior of a classroom
Photo: C. Little/Aga Khan Awards

Pesantren Pabelan, new dormitory
Drawing: F. Afshar

Pesantren Pabelan, interior of a classroom.
Photo: C. Little/Aga Khan Awards
Institute of Technology, initiated pesantren workshops to train rural people in both social science and technological skills that were relevant to rural development. Training in building, construction of water supply and roads, landscaping, carpentry and masonry skills were major activities in these workshops. Some of the training was actually undertaken “on-the-job” during physical improvements on the pesantren habitat. The pesantren community hall, some landscaping, and the water supply system were constructed in this manner. The workshops trained a number of santris, pesantren workers, and village people during the first few sessions (1975-77). Some of those trained participated as instructors when training was subsequently conducted in other pesantren. It was clear in 1980, by the number of buildings constructed since 1975, and their level of technology, that Pabelan’s santris and building workers had acquired a high standard of technical skills. That these skills were further enhanced “on-the-job” was evident from the improved quality of buildings constructed between the author’s visits of 1980 and 1981.

The projects constructed during this period demonstrate, in addition to technical skills, broader planning and operational skills of the pesantren. The water supply system was a particular test of the organizational capacity of the pesantren, its ability to coordinate with members of the surrounding community, and to adopt, maintain and extend a technology once it was introduced. The system consisted of a hydraulic ram which pumped water from a river one kilometer away into several bamboo cement reservoirs, from which it was distributed to the various outlets in the pesantren. (A hydraulic ram uses the impact of the water itself to pump it further. It is thus a “free” energy system. Bamboo cement uses the locally available bamboo in place of steel reinforcements. The technologies are thus cost efficient and fully employ rural resources).

The system required the construction of a small diversion of the river bed and the laying of cement pipes through villages and cultivated fields. Constructing the diversion required large numbers of male and female santris working together. The routing of pipes and the timing of laying these had to be negotiated in advance with the farmers. The actual work was done by small teams of santris to minimize disruption or damage of cultivation. The kyai personally supervised every stage of the project. Three or four years after the system’s initial installation, santris and workers were constructing new reservoirs to extend the system.

The building construction grants during this period were, however, a mixed blessing. With them apparently came the pressure to use higher technical standards and therefore more expensive technologies. (For example, brick buildings with metal or asbestos, and sheet roofing cost $65/m² whereas traditional buildings with tile roofs costs $16/m²). A senior assistant to the kyai (Hubib Chirizin) recounted how the kyai argued with one government donor to simplify design and materials in order to lower construction costs. The donor produced in reply an official document for the particular building type wherein were to be found technical standards which he insisted were inviolable. Although only 3 of 4 buildings were constructed through the grants, these absorbed a disproportionate amount of pesantren funds since donor funds had to be matched with pesantren funds. Thus, the pesantren spent a much larger amount in construction during this period than may have been necessary.

Nevertheless, pesantren Pabelan today seems well established, with a regular income from its fee structure, funds through channels to the government and other sources, and a cadre of organizationally and technically skilled members. Its habitat reflects its capacity to utilize and maintain a range of construction technologies, from bamboo to brick and steel, and to combine them in creative ways, such as in bamboo cement. It is thus uniquely placed to aid in the habitat development of its surrounding communities.
Case Study: Pesantren An-Nuqoyah

In 1887 the founder, Syrkwic, a kyai from Kudus, Central Java, came to Guluk-Guluk (population 9,000) to settle and establish a pesantren. A Guluk-Guluk farmer gave the kyai the unused quarters in his house in which to live and teach. Today, An-Nuqoyah pesantren consists of 5 sub-pesantren, each headed by a kyai (one sub-pesantren has a kyai’s compound (which consists of housing for his family, the living quarters and some classrooms for female santris) and an adjoining area of living quarters for male santris. Other classrooms, shops, offices, libraries and mosques are shared by the sub-pesantren. The built-up area and adjacent cultivated land of An-Nuqoyah covers approximately 5 hectares. Unlike pesantren Pabelan, which lies within a densely built-up village, An-Nuqoyah itself forms a hamlet, one of several dispersed hamlets of Guluk-Guluk village.

The historical details are unclear, but one can surmise that the initial expansion of the pesantren occurred on cultivated land either donated or purchased through the founders’ subsequent income from farming and trading. These remain as the principal occupations of his descendants, who are current kyais. The income of the six kyais, along with community donations, constitute the economic base of the pesantren. Unlike Pabelan where fees and, to a lesser extent, government grants are a significant source of pesantren income for construction, An-Nuqoyah’s fees remain nominal — barely enough for such basic items as stationery and textbooks. Community donations financed much physical expansion.

Two distinct building types characterized by their dominant technology exist in the pesantren. pondok (hut) dormitories for the male santris made of bamboo and timber, and the living compounds of the kyais, the classrooms, libraries, co-op shop and offices made of lime-stone blocks. Both materials are locally available as are roof tiles for these building types. Each type, however, has a distinct financing and construction procedure.

For most pondok construction, the kyai provides the land; incoming santris bring building materials from their homes, forage or purchase them from the area. They construct their pondoks either individually or in groups. The parents of the new, younger santris usually accompany them to the pesantren during Lebaran and help to construct these shelters. Otherwise, kyai delegate senior santris to assist in construction. The maintenance and repair of pondoks are the responsibility of the santris.

All limestone block buildings are financed from the kyais’ personal income or from community donations. These buildings are the kyais living compound and public buildings such as the mosques and classrooms. Community donations are only used for public buildings whereas the kyais finance their living compound from their own incomes. Thus the construction rate of the public buildings is an indicator of the rate of increase in community donations over the years. Many of these buildings were constructed over the past five years on sites where previously traditional bamboo and timber buildings stood. These limestone buildings are constructed by Guluk-Guluk builders and some santris who have developed particular expertise in construction. Other santris participate as unskilled labour.

What is remarkable is the amount of recent construction the pesantren has erected without government or non-government assistance. This has resulted from improvement in both the system of generating community assistance and the organization of the construction process.

Previously, during the Lebaran period, the kyais obtained verbal pledges of material and financial support from members for particular construction projects. Projects were then started while attempting to get donors to fulfill their pledges. This system was used to construct one male santris dormitory of limestone block. The construction took over a year, much longer than it should have because of delayed or unfulfilled pledges. The cost was significantly more than anticipated.

For subsequent projects, a more reliable procedure has been adopted. No building project requiring community funding is considered feasible until a group of people volunteer to form a committee to raise funds and oversee implementation. The committee usually consists of some influential and/or
KEY

M  Mosque
KR  Kyai's reception room
KH  Kyai's house
O  Office
CO  Community development office
T WSH  Tailoring work shop
TL WSH  Tile work shop
VH  Village house
BBD  Boys bamboo dormitory

GD  Girls dormitory
BD  Boys dormitory
CL  Class room
K  Kitchen
C SH  Co-op shop
SH  Shop
L  Library
W  Wash and/or W C
FC  Poultry coop

Well and/or wash
Spring
Stone/brick construction
Bamboo/wood construction
Cultivated land
Before '65
'65-'74
'74-'80
'81
Unknown

Pesantren An-Nuqayah, site plan (showing growth periods)
Drawing F Afshar.
wealthy people from the surrounding villages (often a santri's parents or alumni) along with a kyai and some senior santris or ustadz. With the assistance of local builders, this committee prepares a breakdown of the projected labor and material required, their costs and a schedule. The needs and costs are matched with a list of the potential constructors. Each committee member makes a commitment to donate personally a certain amount and raise another set amount. Everything is recorded and prepared during the Lebaran period. In the following month, committee members return to their villages and set up sub-committees to mobilize village resources to aid the project. Construction starts once donations are received or firm commitments have been made. Donations take a number of forms, ranging from bricks provided by an alumni who runs a kiln to a portion of a rice harvest, which is pledged to buy materials.

In return for community aid, the pesantren insures complete accountability. The author was shown a project report for a set of classrooms nearing completion which detailed the complete fund-raising and implementation process. The report included lists of what was promised, by whom and when, what was received and when, dates for initiation and completion of each construction phase, anticipated costs compared to actual costs, etc. All of the input, including the unpaid labour of santris and villagers, were given monetary equivalents so that the amounts donated from all sources were comparable—regardless of the form of the donation. The donors could likewise appreciate the real monetary costs and value of the project for which they had sacrificed.

This surprisingly sophisticated process of mobilizing resources and of accounting is proving effective. An increasing number of buildings have been achieved on this basis. A little over 1000 square metres of limerock buildings were constructed between 1975 and 1980 at approximately $60/m². Both the floor area of permanent materials construction and costs were comparable to those attained in Pabelan for the same period. However, in An-Nuqoyah almost all of the funding came from community sources and very little if any, came from the government. Technologies with higher costs (such as reinforced concrete and steel beams replacing timber frame) as in Pabelan were more apparent here in recent construction.

Most recently, however, timber frame and plywood dormitories of a relatively high technical standard were constructed by santri and builder teams to replace some of the cruder santri-constructed bamboo pondoks. This development suggests an ability and willingness to apply cheaper solutions, while nevertheless upgrading the habitat. It also indicates that sufficient funds are now being generated to be channelled towards the accommodation needs of the male santris.

**Immediate Repercussions**

The pesantren have shown a remarkable capacity in planning and implementation, in enhancing technical skills, and in generating community and governmental resources. This was illustrated in the improvements achieved in their own physical habitats. We might turn then to the question of the influence which such model experiences as the pesantren in Pabelan and An-Nuqoyah may have had upon neighboring rural communities.

One direct repercussion which both pesantrens had upon their immediate surroundings was through rural training programs they operated in collaboration with various government and non-government agencies. As indigenous rural institutions, physically and socio-economically integrated with the surrounding community, they greatly facilitated the program's objectives of increasing the awareness and upgrading social and technical skills of the rural populace. Some of those thus trained in Pabelan now work in the village government office conducting simple surveys and other data collection exercises to help plan for that settlement. Carpenters and builders, etc., trained in these programs also contribute through the private market to habitat improvement of their villages.

In An-Nuqoyah's case, its involvement in habitat improvement outside its own boundaries was directly related to an LP3ES-
sponsored training program which the pesantren hosted in 1978. The program differed markedly from earlier programs, such as those hosted by Pabelan, in that the santris practical training consisted largely of implementing projects for the surrounding villages rather than for the pesantren itself. The kyai most active in community development projects confirmed that since the 1978 program, the pesantren continued to initiate and assist other projects. By 1982, the projects included: pit-privies, improvement of public springs and wells, extension of piped water to villages from springs and hydraulic rams, cement reservoirs; installation of sand-gravel filter systems for water purification; tree-planting, and the utilization of small plots for vegetable gardening.

An-Nuqoyah holds weekly evening meetings during which groups of villagers gather for Koranic study and discussion on matters of general interest. Approximately 15 such groups with 80 members each have been formed, eight of which have been particularly active. The ideas for the project are first canvassed and the organization of construction and supervision set up in these forums. Islamic precepts are drawn upon to persuade villagers of the need for certain projects. (For example, the prescription requiring ablutions before prayers, and the emphasis on cleanliness in general in Islam, proved effective in soliciting villagers' support for the water supply and sanitation projects.) Thus the effectiveness with which the pesantren can draw upon deeply held beliefs to organize institutions, such as the weekly forums, and to give credibility to development projects, underlies much of its unique potential in habitat development.

The collaboration with government and non-government programs also initiated more direct action by both of these pesantrens in upgrading their surrounding rural habitat. The village of Pabelan was one of a number selected in conjunction with a nationwide rural housing program which gave 40 households in the village matching funds to upgrade their houses. The recipients were to set an example for others to follow. The pesantren collaborated with the program in the following task: selecting the households, organizing small groups of 6-8 households to upgrade their dwellings in a mutual aid manner, and assisting these groups in specific technical problems which surfaced during construction. The pesantren members' intimate knowledge of their own village, combined with the technical skills they had acquired, proved valuable in these tasks. Certainly, the recipients' houses generally had a much improved appearance compared to those of non-participants.

It is nonetheless difficult to isolate the exact contributions of the pesantren from those that were inherent in the program. This difficulty applies to both the programs apparent achievements and shortcomings. While many houses had improved facades of brick, enquires were made as to whether it may not have been better to upgrade their facades with cheaper, local materials and use the savings to also improve the health sensitive aspects of the houses, such as kitchen and toilet facilities. According to pesantren residents, brick facades were specifically prescribed by the program and which they were not permitted to alter.

The pesantren's own housing (i.e., not assisted by government) indicates that it would not have proposed such changes in technology or aspects areas of upgrading if they had had more of a say in the program. For instance, the kyai and his family continue to live in traditional bamboo and timber houses but they have upgraded their kitchen and toilet facilities. Similarly the washing and toilet areas of the santris' quarters were redesigned to improve both water and conservation as well as hygiene. Most recently the pesantren constructed a house for one of the poorer village residents using the traditional bamboo and timber. The house serves as a reminder to the community that this technology, while low-cost and thus leaving sufficent funds for other improvements could, nevertheless, be smart in appearance.

Evaluation of Future Impact

Two factors remain to be considered if this particular potential of the pesantren is to be
further realized. Firstly, the pesantrens themselves need to be convinced that it is valid for them to actively assist in improving the habitat of their surrounding communities. Education, specifically Islamic education however defined, and community leadership for its santris remain fundamental objectives of these pesantrens. Pesantren members appear cautious about assuming a more active and deliberate role in development projects, including habitat improvement. One reason is that this role may detract from its fundamental objectives. It may be argued that just as Islamic precepts can effectively contribute to implementing a new water supply system, so in turn the organization and implementation of this system can be an excellent training ground for developing community leadership in santris. The objectives of Islamic education, community leadership and rural habitat improvement should thus reinforce each other.

At present the majority of the graduated santris move to the urban areas and assume teaching positions in the Islamic Universities or Teachers Training Colleges. This is to be expected as a pesantren education equips santris particularly well to become teachers. Their last two years in the pesantren, during which they are considered ustads and teach the lower grades, is in effect a two-year teacher training course. This final practical training period could be expanded to include an alternative option for basic training in relevant rural skills, such as in housing technology. Thus, one problem is the need for some institutional arrangement that would make it possible and attractive for graduating santris to live and work in the rural areas. This assumed greater collaboration is the second major factor to be considered if the pesantrens are to realize their potential in habitat, and indeed rural, development in general.

The residential possibility as well as the range of educational experience and extra curricular activity offered by many pesantrens make them attractive to the wealthier santris as well as the poorer ones. Poorer santris earn their keep by working for their kyai and the pesantren as well as providing services for the wealthier santris. Some amount of cross-subsidising occurs between rich and poor in this
situation. The opportunity to work would not be present if the number of wealthy participants (kyai and/or santri) was not adequate. For the same mechanism to work elsewhere, the institution would need to have credibility and social acceptance, even prestige, to attract the participation of an adequate number of wealthier groups.

The participation of the wealthier groups through the fees paid (as in Pabelan) and the donations made (as in An-Nuqoyah) also helps finance many of the construction projects. The level of material aid thus received implied that, even allowing for a powerful moral imperative to sacrifice, assist and share, there be some resource surplus in cash or kind among a significant number of the participating rural population; or alternatively, a significant surplus among a small number of them. It would be impossible, or at best unjust, for an indigenous institution to tap rural resources from a subsistence area.

The involvement of wealthier groups has already brought us to the set of considerations that concern the pesantren as a whole, as well as its effectiveness in habitat development. Firstly, much depends on the kyai’s capacity to see the pesantren through difficult times. Most kyai are relatively wealthy and, at least in the first instance, can draw upon their own resources to initiate the pesantren and its projects, modest as these might be initially. The respect they command as religious leaders is reinforced by their position as relatively wealthy members of the rural elite. Both these factors aid them in gaining the cooperation and assistance of the surrounding rural community.

In addition to the kyai’s personal influence and resources, the pesantren can draw upon a network of supporting interests both within the village and beyond to aid its projects.

Within the village, the cooperation of the influential and wealthy is elicited by including them in the waqaf Board of Trustees. The santri parents and alumni form another group who typically feel a strong bond of loyalty towards the pesantren and consider it their moral obligation to help in anyway they can.

This support network extends beyond the
village — across geographical and occupational boundaries. Firstly, santri in many pesantren, and certainly in Pabelan and An-Nuquoyah, come from areas all over Java and elsewhere. Thus the parents and alumni association extends correspondingly. Similarly many santri parents and alumni may be prominent people in professional and government service, including members of the provincial and national political elite. All these people are favourably disposed to assist the pesantren as best as they can. Many Kyais all over Java also have an informal but strong bond of mutual support among themselves, often strengthened by family ties.

Finally, non-government and government agencies, increasingly recognizing the pesantren potential as an influential and effective development force, are collaborating with and assisting pesantren.

The Kyais' ability to draw on his own influence and to nurture all these links to solicit support where, when and in what form he needs it, can be critical to the pesantren's survival. The planning system which so carefully elicits the participation of many of the above groups, and in return makes itself so painstakingly accountable to these groups, is thus an essential component of its development strategy. We have seen how this system translates into substantial material support for the pesantren, in general and specific construction projects in particular.

Although a pesantren does not have the official status of a public school, it is still a channel for social advancement. As earlier mentioned santri can assume government jobs, enroll in Islamic universities, and pursue university degrees in other Indonesian universities in such fields as philosophy and literature. Many notable Indonesians from all walks of life came from pesantren. It is thus prestigious to have had such an education.

**Applicability Abroad**

In turning to the issue of whether institutionalized rural development modeled on pesantren experience might be applied in other developing countries, it is perhaps worthwhile reiterating the key factors that underlie the Indonesian achievements.

One might convincingly argue that the pesantren's credentials as an indigenous institution rooted in Javanese tradition provide an authenticity that is readily acceptable to members of surrounding communities, as well as an ongoing stability. A combination of factors gives the pesantren continued relevance in its society, and helps it to effectively perform its functions: these range from ideological and philosophical to the most prosaic and pragmatic.

The most pervasive factor is the ideological appeal that the pesantren has for the many Javanese who are deeply committed to Islam as a religion, and as a way of life. This commitment prompts kyai to invest their life and wealth in pesantren, parents to send their children to the institution, santri to accept simple (sometimes even hardship) living conditions, santri, islads and administrators to work on a voluntary basis and the community to support and aid the pesantren. This commitment also plays an important role in convincing the rural populace of the value of developmental changes as in the case of the water supply projects cited earlier.

Other Muslim countries can thus draw on the same ideological commitment to help initiate or develop similar institutions be they Koranic schools, or madressa. Such a start has been made in several countries. However, as a basic motivator of sacrifice, action and change, an ideological commitment transcends specific religions or even religion as such.

While commitment and motivation are fundamental, it cannot in itself guarantee the longevity of an institution or effectiveness in physical development projects. The pesantren responds pragmatically yet flexibly, to a range of educational, social and economic needs. There is a great shortage of schools in rural Java. For those seeking an education, the 1,700 pesantren offer this opportunity where often no alternative exists. (The Gubuk-Gubuk government, for example, established its first public school only four years ago).

Even where a public school exists, there are a number of factors in addition to the ideological appeal already cited which make the pesantren the preferred alternative. The number and spread of pesantren make them highly accessible. Although many of the pesantren are simply small Koranic schools, it is quite common for santri to enter these and then move rapidly into the larger, more prestigious ones. Movement of santri between the larger pesantren is also common and this is facilitated by the close ties certain pesantren have traditionally with each other.

The opportunity for the low-income santri to obtain an education, food and shelter by working in the pesantren is another important factor. In Java, where exceptionally high rural densities combine with poverty (40 per cent of the rural population is landless), children become a burden to feed rather than an asset to aid in working the land. Thus, an opportunity to earn one's keep and to be educated is most welcome to parents and youth alike, and it is preferable to the more impersonal and uncertain existence as a member of the unemployed urban migrants.

Two strengths of the pesantren movement can also be problematic, especially with regard to expansion and replicability of the institution. Firstly, there is the participation and support of the influential and/or wealthy. The familiar contradiction in rural development projects, construction or otherwise, poses itself. To succeed in implementation one has to have the cooperation, or at the very least, the neutrality of the wealthy and the influential. However, many projects aimed at the poor may harm the interests of the wealthy, or be perceived as doing so by them. In rural Java the differential between rich and poor are not as wide as it is in many other rural regions; thus the problems of poverty may not necessarily be formulated in a context of competing interests. More importantly perhaps, the pesantren may have dealt with this problem by the ideological appeal of its undertakings, and by assisting the poor in ways that do not substantially impinge on the interests of its supporting groups. Some similar formula could emerge in other Third World countries, particularly if the institution limits itself to education and to habitat improvement, which may be less obviously
controversial than other realms of rural development.

Still another dimension to the pesantrens achievements, powerful appeal, and influence might prove problematic elsewhere: namely relations with the government. There is, almost by definition, an ambiguity in relations between a government apparatus and an autonomous or even semi-autonomous indigenous institution. Government agencies are wary of independent centres of influence within their jurisdiction. Conversely, autonomous institutions are wary of being co-opted, or appearing to be mere extensions of the government apparatus, thereby losing some of their credibility as an independent voice in the community. Furthermore, the particular Islamic ideology upon which the pesantrens is based poses additional strains, depending on the attitudes of the specific local government towards it. No indigenous institutions can survive without at least the acquiescence of the government. For the pesantrens — and by implication for similar institutions in other countries — to be more effective in habitat and rural development a more active collaboration will be necessary.

There are three final considerations of the pesantren experience which may ultimately have a bearing on applicability elsewhere. First, few other uses compete with construction projects for the pesantrens resources (fees or donations). The cost of santris' food and incidental expenses are separated from fees. These costs are charged as such (as in Pabelan) or left as the responsibility of santris and parent (as in An-Naqiyah). Others who work for the pesantren (tutors, teachers, administrators and advisors) do so voluntarily and without pay. Pabelan's paid workers spend much time in construction and maintenance activities and resources thus spent can be considered as part of habitat development. Educational materials are few, and these are limited to inexpensive stationery and texts. Therefore, much of the resources raised by the pesantrens can be allocated to habitat development. Such resource allocation is also encouraged by the fact that, for the pesantren, it is a more visible measure of its progress and achievements, and for its supporters, a much
more tangible and gratifying result of their investment. As long as the projects thus constructed are those that meet priority needs (such as improved water supply and waste disposal and alleviation of overcrowding in dormitories and classrooms), this use of the resources is not misplaced.

Second, a strong tradition of gotong-royong, or collective construction based on reciprocal assistance, exists in Java, which the pesanren can draw upon for its projects. This tradition provides the precedent in organizing santri and builders for particular building or large water supply projects. It was also a major factor in implementing the rural housing program in Pabelan and the community development projects in An-Nuqayah.

Third, there is the local availability and a variety of building materials and technologies in Java (to a lesser extent in Madura Island). These are inexpensive and local people have at least a rudimentary familiarity with using most of them. Pabelan’s built environment illustrates this variety of technologies. Self-built dormitories, or pondoks for An-Nuqayah’s santri, illustrate how cheap and simple some of these technologies can be while still providing a basic shelter.

Both collective construction practices and low-cost technologies are fortunately present in many rural regions of the Third World. No single reason can sufficiently explain why many of these are falling into disuse. One likely reason is that the institutional framework within which they thrived has been removed and no alternative has been offered. For example, the large local landowner who in some regions may have financed and organized major rural construction—a village bath, water supply system—now considers it the government’s responsibility. The government, when it can afford to intervene, falls back on more expedient, standardized technical solutions, and its overqualified engineers, neither of which may be relevant to the particular problem. Indigenous institutions such as the pesanren have the capacity to generate the right choices and the best use of the resources. They have had to do so themselves in order to survive and to develop. With assistance and guidance they can help communities to make progress. And in so doing, they will have performed a task at which few governments have succeeded on their own.

Reference Notes

1 Source: Azturahman Wahid, principal advisor on pesanren to the Institute for Economic and Social Research, Education and Information (LPIES)

2 Waqaf is an endowment to an Islamic institution or cause. Pesanren authorities used the endowments become waqaf property. The Kyai in Pabelan has thus donated all this property. At An-Nuqayah, Ktis keep personal and waqaf income separate, although in effect they invest much of their personal income in the pesanren

3 Thus, one of the usuls in Pabelan informed me that several of those most involved in pesanren operations reported the Kyai on a daily basis. The Kyai seem to maintain an almost leisurely pace while the pesanren functions around them like clockwork. A word to an usul assembled a meal or produced a meal in record time and in the most unlikely hours of the day. Similarly santri committees performed functions independent of any external supervision. In Pabelan, a santri’s committee consisting of male and female santri, together interview prospective entrants and their parents, describing the pesanren to them, clashing their expectations, and making arrangements for payment of fees, etc. In An-Nuqayah, however, Kyai’s perform such functions and there is no joint male and female santri committee.

4 No fees are charged to santri from the immediately surrounding villages in Pabelan and An-Nuqayah. Donations in kind or cash are collected however. This form of financing is institutionalized in Islam. Donations to religious or charitable causes—zakat—is one of the five main principles of Islam and is mandatory so long as the donation will not delay debt repayment or cause hardship to the donor’s family.

5 Those and the following figures are estimated values of buildings constructed rather than cash expenditures. The values were obtained by multiplying the square metre cost of a particular shelter type per the total square metre constructed during a given period. Thus they include the imputed value of voluntary labour, recycled and donated materials. Actual cash outlays were given by the main builder in Pabelan (Badrun).

6 According to the list of alumni of pesanren Pabelan, some 90 per cent of the graduating santri moved on to mid-level posts in the ministry of religion or the Islamic universities (in the latter case, via teacher’s training colleges). The rest went into business or farming, a few returning to live and work in their own villages.

7 For example, in Pakistan, the heads of the neighborhood mosques in low-income areas are being considered as “motivators” to initiate and implement physical upgrading in some projects. LPIES in Indo-

8 It is not uncommon for Javanese rural youth to live away from home from their early teens and sometimes earlier. This was stated by several senior pesanren members as well as santri. A low-income farmer in An-Nuqayah stated that his two sons slept in a nearby mosque (since a Kyai starting a pesanren may begin by teaching in a local mosque such youths become a natural first set of santri)

9 The 600 male santri living in Pesanren Pabelan share approximately 1,500 square metres of dormitory space, i.e. 2.5 m²/santri (25 per cent come from the immediate vicinity and sleep at home). In An-Nuqayah, the 1,000 male santri share approximately 3,230 square metres of dormitory space that is 3.2 m²/santri (Approximately 10 per cent of the santri’s come from the immediate vicinity and live at home, a lower percentage since Madura consists of scattered, hamlets less well connected by road transport)
The experience of the socialist villages in Algeria has caught the attention of various observers and researchers. Several theses and articles have already examined the legal, social, cultural and ideological aspects of an achievement of national dimensions (see bibliography at the end of the article). However, a satisfactory evaluation of the results from the point of view of architecture, town planning and regional development, has not yet been made. One cannot say that, on the whole, the interest devoted to architectural problems in the Maghreb measures up to the concern which prompted His Highness the Aga Khan to found an Award for Architecture in the spirit of Islam. We shall see, for example, that the socialist villages demonstrate the fulfillment of the requirements of return on investment, standardized plans and speed in execution of collective housing. The ideological aims are, however, even more significant, and this is why we shall concentrate more on the origins and the socio-political development of this ambitious programme.

We shall begin by recalling the basic facts as we could ascertain them in May, 1981, then give some background information on life in the socialist villages, and finally examine what could be called a total social phenomenon.

**Basic Data**

The socialist villages are one of the concrete outcomes of the Agrarian Revolution launched by President Boumédiène in 1971. The idea of creating 1,000 villages with the objective of regrouping a rural population displaced during the Algerian war was already suggested by the French in 1959. In reviving this idea, Boumédiène wanted "to challenge the colonial past, during which the French colonial regime had planned to create 1000 villages, so-called "villages of the future", with the fixed aim of isolating a revolution of the peasant masses, after its "sorched earth" policy had failed. These villages were in fact concentration centres."

The first village, Ain-Nchala (1971-1972), was built by "the peasants, youth and intellec- tuals". By March 31st, 1977, of the 271 villages registered, 58 were completed, 88 were under construction, 125 had not been started. Only 300 have been built at present, whereas the entire programme was supposed to have been completed in 1980. There are several reasons for this delay, which we shall deal with in the third part of this paper.

The socialist villages, which were at first called Agricultural Villages of the Agrarian Revolution, were technically speaking conceived on an urban pattern. Each village has between 100-200 or 400-700 lodgings; each lodging is able to accommodate an average nuclear family of seven persons (which excludes the traditional extended family). Thus populations vary from 700 persons to 4,900. Neither a private garden, nor a cowshed, nor a farmyard has been provided in spite of the expressed wishes of the future inhabitants. The designers have been both foreign and Algerian, but the interested parties have not been consulted at any stage, from the choice of the site to the layout of each apartment (small kitchen, small rooms, enclosed courtyard with no possibilities for extension...). The people cannot participate in the planning of their own environment in any way. In fact, they are simply integrated into agricultural production units, which themselves are drawn into industrial circuits and an urban life-style.

"Today, hundreds of villages are being built throughout the country. The 'fellahs' will be able to live in new homes after spending their entire lives in slums and in tents, at the mercy of the winter cold and summer heat, drinking water from the swamps and exposing themselves to every possible disease. The aim of the Revolution is to get rid of the archaic structures of society and to create a new society in our countryside where there will no longer be a place for either slums or shanty-town mentality, and where there will be no trace of unhappiness or misery". This means that the infrastructure of the villages has often been out of scale: a large approach road, built at high costs, wide straight streets, geometrically laid out; standard facilities: public baths, grocer's shop, butcher's shop, mosque, bank, post and telephone; running water, gas, electricity. A youth centre, stadium, clinic, town hall, hotel with restaurant, police station market and petrol station are to be found in the largest villages. All of this creates the sort of needs city-dwellers have such as for television, radio, telephone, household appliances, but which rural people, with modest incomes, cannot satisfy. While public benches are even provided, as in the colonial villages, the rural population never think of using them, for psychological and social reasons which I cannot analyse here.

Continuing along technical lines, the villages are very uniform: cement blocks are used indiscriminately, both in the midst of the Sahara (Tamanrasset) and in the north where the climate is milder. The same site plans, the same internal layouts, the same ideological function of integration can be found everywhere. If a mosque, bank or school is aesthetically attractive, one hardly notices. On the other hand, mistakes are easily detected from the moment you approach the village: for example, a "forest" of poles which are taller than any of the buildings, and which one notices all the more because the area around is devoid of vegetation. The choice of sites has not always been dictated by the ecological, climatic, aesthetic or even economic considerations. More thought has been given to imposing the principal ideas of the Agrarian Revolution throughout the land, and this was underlined by President Boumédiène's commitment to inaugurate personally each village and recall the political, social and cultural aims he attributed to the whole enterprise.

**Life in the Villages**

It is very difficult to do research in the villages with all the freedom one desires. A correct sociological inquiry must be directed towards the workers, the women, the children, the old persons, the youngsters... This has been attempted by F. Burgat (see bibliography). Daily life is obviously filled with cultivating the land allotted to the peasants after the nationalization of all property containing over 25 hectares. The political involvement regarding socialist villages renders problematic, if not impossible, a serious study of the adaptation
of these people to their new surroundings, and the actual feelings they have towards the land. In many cases it is still too early to attempt a significant objective evaluation of the program. One cannot help noticing the unwillingness, even the refusal from some of the 'beneficiaries'. Of those who have accepted, not all work the land which does not fully belong to them with the same enthusiasm. There are no peasants in Aurès el-Maya; on the contrary, there are too many in El-Ouidja. This means that the daily life in the villages differs with the cultural and social origins of the inhabitants. Agricultural production has therefore gone through certain difficulties which have not yet been fully overcome. In addition to cultivation of the land, we would like to determine how the experiment is evolving, and especially to see whether integration is being achieved in the towns, or rather in the traditional villages and the countryside, and even, whether a new way of life connected with the specific environment is beginning to develop.

Contact between the departmental administration and the traditional rural dwelling environment has in any case become much easier, more regular than it has ever been. Even though the ‘beneficiaries’ of these new surroundings tend to continue their usual autonomous way of life, the administration is approaching them with remarkable concern. This is evidenced by the social facilities already mentioned and the different kinds of aid proposed so that the neighbouring lands are well-cultivated. They have gone to the extent of refusing to provide private gardens, so as not to distract the workers from the common land. As long as no surveys are made on the daily life of women and children, on men-women relationships in each home, on the distribution of work inside and outside, nothing can be stated about the cultural, moral and sociological impact of the socialist villages. How have changes occurred from the large patriarchal family to the nuclear family, from tribal or regional autonomy to a civic spirit within the national framework, from old kinship patterns to modern matrimonial tactics? These are crucial questions which, when carefully examined, should reveal to what extent the socialist village has become a transforming ground for Algerian society, or merely constitutes a change without a future, of a more decisive page of history taking place elsewhere.

A Total Social Phenomenon

The war of liberation waged by the Algerians for seven years (1954-62) gave rise to a political voluntarism in the hearts of the leaders and the entire population, thereby explaining the particular style of the whole history of the country since independence. The word revolution takes on concrete meaning in everyday life since all the traditional means of obtaining and exercising power, all the social and economic structures, all the regional bases, all the symbolic contents of the collective subconscious are progressively affected by two arbitrary decisions: the priority given to industrializing industry between 1967-1979; the launching of the Agrarian Revolution in 1971 after having initiated in 1962, a self-managed agricultural sector (taken over by management committees of all the wealthy farms left vacant by the departure of the colonial).

It is within this context of voluntaristic politics and the upheavals brought about by the war that the campaign of the 1,000 socialist villages must be situated, in order to judge both the desired effects and the actual results. One of the constant themes in President Boumédiène’s political thought was the destruction of the archaic society, the elimination of the “shanty-town mentality”, and the struggle against “unhappiness” and “misery”. To combat those who were nostalgic for “fundamental Islam”, he used a bold metaphor which struck everyone in Algeria: God did not ask His believers to enter Paradise with an empty stomach!

The model for development implied by this political philosophy unites the productivity of industrial societies, the nationalization of the means of production, the mobilization of all the social forces, the outstanding attention given to workers and the under privileged classes of the population.

The effort undertaken to industrialize production, and to mobilize agricultural workers, accelerated the movement of rural workers towards towns, a tendency which had already begun during the war. The problems created by these movements of population have become all the more serious since demographic pressure has been constantly increasing since the 1950’s. 8 million inhabitants in 1950, almost 20 million today. Far from attempting to curb this growth, the Boumédiène policies have, on the contrary, encouraged it.

From here on we see the problems the socialist villages tried to solve: to contain the influx of rural immigrants to large city centres like Algiers, Oran, Annaba, Constantine ..., to deal with the socio-cultural transition between life in the shanty towns and that of large towns, or even that in traditional villages; to anticipate the social and political threats that slums represent on the edges of vast agglomerations; and hence to counter the notion that independence has aggravated the very social ills vehemently denounced during colonization; to break down tribal solidarity and the mechanisms of alliance and protection in the traditional society (archaizms) to eventually make it possible to build a unified nation under the reign of one state, one culture, with one ideology common to all the citizens. In this way the socialist villages were to become the creation of political awareness in the masses, and for the diffusion of new cultural models (the Arabic language and Islamic ideals).

This helps us understand why the socialist villages are scattered across the entire national territory, why the sites are chosen according to the ideological requirements of the hoped-for integration more than the ecological ones, why the roads, the electricity and water supply are guaranteed almost everywhere regardless of the costs, and why the users have no say in the layout of their environment and cannot influence urban projects and architectural structures by means of inherited, often unique, aesthetic values in local or regional cultures. (Touaregs, Mozabites, Chāwiya, Kabyles, high plateaux, littoral, oasis, Ksour). The entire operation thus rests on one basic assumption which we find in “popular demo-
Pastoral village of El Mahder (wilaya of M'Sila) Algeria 100 dwellings and communal facilities (including mosque, health center, town hall, post office and craft center) H and A El Miniawy, architects Site plan, section and elevation of the communal center, illustrating the use of local materials (stabilised earth) to construct vaulted spaces for living and public activities. This project has been built and is presently inhabited.

Source: Techniques et Architecture, no 329, 3/80

Socialist village Houari Boumedienne near Abdala (Bechar), Algerian A A U. (Atelier d’architecture et d’urbanisme) with Ricardo Bofill, architects Site plan of the village, axonometric drawing of the main plaza with social services grouped around it, and typical plans of houses assembled in groups of eight around smaller plazas Particular emphasis was placed upon creating densities of an urban nature in this project, now completed

Source: Techniques et Architecture, no 329, 3/80
Studies of various plan-types and elevations for dwellings in the Algerian socialist villages of Zelfana, Guerrara and Dahia Benana. There are separate rooms intended for women, for guests and for the family as a whole, arranged around an open courtyard.

Source: Poux and Petitdemange

Village of Zelfana (M'zab), Algeria. Housing and communal facilities as the extension of a peripheral neighbourhood in an existing village. D. and R. Poux and J-C Petitdemange, architects. Site plan of an unusual attempt to give meaningful structure to an already constructed modern complex (center) by filling the vacant open spaces and introducing a variety in house-types and urban spaces. The project is 80% completed.

Source: Poux and Petitdemange.

Village of Dahia Benana (wilaya of Laghouat), Algeria. D. and R. Poux and J-C Petitdemange, architects. Third of a series of villages conceived by the architects, Dahia Benana develops ideas already present at Zelfana and Guerrara: use of house-types composed of independent rooms around a court, grouping of units, and urban structure organized along a main axis or "dorsal column". Marketplace at one pole and mosque at the opposite one, other communal facilities such as a hammam are located along this axis. (Automobiles are permitted only dark-shaded roads on plan.)

Source: Poux and Petitdemange
The Socialist Villages Experiment in Algeria

cracies": it is possible to create a culturally and ideologically homogenous society, an ideal alliance between State and Nation under a varying number of leaders assembled in a Revolutionary Council and all sufficiently enlightened to grasp and satisfy fully and adequately the expectations, hopes and the needs of the "healthy" sectors of the population (as against the deviating or opposing forces: "bourgeois", mercenary persons, reactionaries ...) I am referring here to the citizens' perception of the authorities. The leaders might make successful decisions or fail in their endeavors according to the degree of communication occurring between them and the majority of the population. In order to appreciate the mythological or realistic aspects of this assumption as it relates to the example of the socialist villages, one needs to look at the cultural, historical, sociological, economic facts in the Algerian, and more generally, the Maghrebian society. We have no time to discuss these facts; I would like to emphasize only that they are implied by the setup of socialist villages, and nevertheless, they are not taken into consideration at the initial and decision-making stage of each village. They cannot be taken into consideration even if those in charge wanted to, for these facts are, to this day, inaccessible to the various experts. The tragedy of so-called underdeveloped societies is that they are condemned to a political voluntarism whilst being unaware of the basic facts of their history, the lasting mechanisms which, unknown to them, order their lives. This means, for example, that each region must be considered in its own historical context with its own cultural characteristics as this has been revealed in the recent cultural debate on a national level, in Algeria. Undoubtedly, there is a risk in any political action, which is all the greater when the individual within the group concerned is overlooked. However, in the case of societies like the Algerian one, the need to deal promptly with serious political, economic and cultural gaps forces one to accept in a short space of time, changes made over many centuries particularly in Europe. (I am referring to the processes of secularization, urbanization, democratization, education and social stratification ... in France or in England, for example):

I should like to point out that, in implementing Western knowledge today, even in its original milieu, the social sciences — especially history, sociology, cultural anthropology, social psychology (the study of the collective subconscious) — remain marginal and barely credible, compared with the so-called exact sciences. The mathematics of decision-making, economic science, technological sciences are given priority, and even primacy, in any large-scale project intended to uproot the vital structures of society. Only the weight of ideological "values" compels one to ignore the natural and technical restraints, e.g. to construct a paper factory on a site lacking an adequate water supply. This is true a fortiori if we consider the aesthetic values, the symbolic capital, the rural techniques which only the dispossessed populations can vouch for, plunged as they are in material "misery", labelled "ignorant" and "illiterate" by the "educated" decision-makers, the technocratic planners in ministries and more generally by the "advanced" citizen.

Through the example of socialist villages a socio-cultural dialectics of anthropological significance emerges: I am referring to the structural opposition present at all levels of society, between segregated societies and integrated societies, local charismatic leaders and concentrated secular power, oral tradition and written tradition, popular culture and intellectual culture. For the first time in history, social groups are torn from their autonomous institutions, from their autarchic mode of existence, from their symbolic universe (sacred environment full of ritual objects), from places of pilgrimage and sacrifice, from a projection of the contents of the collective subconscious within inhabited space and in the surrounding area. They enter without any transition, a social, economic and politically rationalized and technicized environment with great unifying, simplifying and centralizing power for the first time. The systems of signs with rich symbolic evocations are replaced by the signs directly referring to concrete objects, quantified values, material relations lacking any mediation by means of symbolic behaviour or sacred rites, as was the case in the traditional world. Anthropologists are again paying attention to the symbolic nature of all relationships of exchange, talents, mutual aid, or conversely the positive realities covered by the codes of honour in traditional Maghrebian society.

The opposing elements that I have just outlined between symbols and signs, values mediated by the codes of honour or of sanctity, and material values directly named and quantified, must not lead to the belief that modern societies are necessarily a degradation of traditional or old-fashioned societies. Nor can it be said that the change from the old-fashioned way of life to that of the socialist villages unquestionably and inevitably spells progress, as President Boumediene's statement suggests. The entire problem lies precisely in our ability to properly decipher the historic significance and the philosophical factors at stake during the change which all contemporary societies go through, in varying degrees: a change from "the archaic" to the modern, from the sacred to the profane, from the symbolic to the geometric and the arithmetical, from the personal to the computerized anonymity. Or, conversely the return to the so-called sacred, symbolic, personal, qualitative. This does not mean that I am either calling nostalgically to restore the past, nor for the submission to the constraints of so-called modernity.

Societies which know hunger, which are deprived of modern security obtained through technology, medicine, scientific culture, speaking through their leaders, say, that they have no time to ponder over philosophical, anthropological and historical questions. They must rapidly house as many families as possible, procure bread, work, education and medical care for everyone. These are gigantic tasks. So, we are brought back to the socialist villages which at least have the advantage, when compared with low-rent housing in cities, of providing homes of reasonable dimensions. As for the established objectives from the beginning by official ideology and the planners themselves, it can already be stated that they will not be attained, because the development strategies in Algeria have been or are being greatly revised.
Reference Notes

1 P Balta, *La Stratégie de Bouneddienne*, p 193

2 Boumedienne, in P Balta, p 194

3 It would be out of place here to recall in the midst of a rapid presentation of the socialist villages, all the social sciences which can offer information and indicate requirements that any project involving the organisation of a national entity, ought to keep in mind.

4 (= The home, the field, the valley, the mountain, the river, the springs: everything is imbued with religious significance and calls for propitiating behaviour).

5 I have proposed a critical analysis of this concept in *L'Islam, hier, demain*, Ed Buchet-Chastel, 1978, pp 120-138
Correa

It seems to me that the separation you mentioned, Professor Arkoun, between what you called the narrow, technological and the bigger ideological, cultural issues is a real one, and has been apparent in our discussions. I think it is one which we must bridge. I thought in Dr Ismail Serageldin’s presentation, there were questions raised which began to bridge this when he spoke about the new technology of building in Yemen. It wasn’t just a new technology, it was really a new life-style which these people have seen and which they are importing. All new technologies really represent a new life-style, therefore a new ideology. Therefore, they are political. When we architects pretend they are not, we are very naive, or we want to be very naive.

Ismail Serageldin

I really would like to ask Prof. Arkoun to expand on two points which he raised in passing, by his description of the Algerian experience in socialist villages. The first of these, which also bears on the question of life-style that Mr Correa mentioned, is that I find the schematic presentation made to have too much of a forced dichotomization. I mean it’s a dichotomy between a traditional society with certain values that are qualitative, and a modern or a secular, quantitative, computerized society. In my estimation, this blurs a great variety that existed in these traditional societies — life-styles from region to region, from one part of the country to another — as well as a great variety that existed in the degree of change which has been introduced in the life-style of each part of the country where this experiment has been occurring. Therefore I wonder to what extent one can clearly speak of a phenomenon, a single phenomenon, of wrenching dislocation or forced change without an adequate transition period, without going down to the particulars of each case, and only then going back up again in scale.

This brings me back to the second point I’d like to ask. At the beginning you mentioned that the ideology was based on a postulate of a myth of a culturally uniform society, but it is indeed based on such a postulate or is it simply that this postulate, in its broader sense, explains what the people have been trying to do in terms of improving the life-styles, in very pragmatic and down-to-earth terms? In trying to provide better housing, bread, and so on, you undoubtedly force a certain uniformity on a large scale, simply by the scale of the problem that you have to tackle. So please, dichotomization: how true would it be? Secondly, in light of that, did we indeed have either a uniform traditional society before, or do we now have a uniform modern society, and hence, why bother with whether it’s a myth or not? Let us architects come down to the business of improving the life-style wherever we find it to the best of our ability.

Arkoun

We can find all levels of evolution in Algerian society, of course. I have called attention only to certain ones in order to analyze the distinction between the so-called popular culture and religion on the one hand, and learned, or written culture and religion on the other. I have done this just to present the scale at which we must consider these problems. Another point is that we, in many Third World societies and especially in Algeria since Independence, are experiencing problems in a very short lapse of time which in other societies were resolved over a very long time. We must look into this time scale, for instance, when peasants who have ancient habits are suddenly moved into a thoroughly new village, built in another place and a different environment. This clash between the old and the new we refer to as déracinement or uprooting, and it is very much a part of contemporary processes of change.

As for the question of ideology, we cannot really say whether it is negative or positive as a factor. I have only indicated that in talking to the population of the socialist villages, it appears that they are reacting against operations forced upon them — whatever the ideological bases.

Mohammed Arkoun

Wang Huabin

After listening to Professor Arkoun’s excellent speech on the socialist village experience in Algeria, I would like to say a few words about rural planning policies in socialist China, where we have adopted the policy of integrating industry with agriculture, and town with country for human settlement. In order to implement this, we have been urged to speed up development of market towns as a national priority.
One may ask, "What is a market town?" It is a site where industrial, commercial, agricultural and residential areas have been integrated into the planned complex. In recent years authorities at the regional and country levels in China have been encouraged to draw up plans for the rational distribution of rural settlements by grouping together villages and hamlets to form socialist communities, thereby preserving arable land. Over 50,000 hamlets where people's communes are located will be developed into market towns. These will serve as locations for various processing industries for agriculture and the necessary accompanying products. At the same time, these market towns will become centers of political and cultural — as well as economic — activity for the surrounding rural areas. Advantages of such a reorganisation include the possibility for promoting the modernisation of agriculture. It provides for a rational use of labor in local production, thereby helping to avoid excessive increases in urban agglomerations while allowing rural inhabitants to take part in both kinds of work, industrial and agricultural. The integration of industry with agriculture paves the way for reducing the differences between city and country life as it exists today, between urban workers and peasants, and between intellectual and manual labor. This will help achieve a new life-style and new civilisation in China.

**Holod**

I am an architectural historian and very much interested, along the same lines, in who provided the building skills in remodeling the rural environment in Algeria. Did the rural population furnish the manpower, or was this simply another "turn-key" operation conceived and built by urban designers and contractors? If the local, rural reserve of building skills was not even used, then clearly there was very little of what we call the process of transferring skills.

Secondly, there is the issue to which Mr Bugnicourt alluded, of the art cultures of architects and planners. There is, after all, an international circuit of which all of the people here are a part, including our Chinese colleagues: we exchange information about how things are done. Taking this into consideration, we can legitimately ask why the Algerian villages were modelled the way they were. If you were to look carefully at the background of the Algerian planners, their type of training, it would reveal quite clearly that the models of Le Corbusier were probably very strong somewhere in the subconscious of the designers, as was also the model of Soviet agro-communities. While Professor Arkoun has laid out for us very nicely the larger cultural oppositions, we must remember that within the culture of architects alone these kinds of dichotomies exist, between operational models and unconscious models.

**Bugnicourt**

In your opinion, Professor Arkoun, what might have been the influence upon the Algerian socialist villages of models like the agro-towns of the Soviet Union? Particularly since, I believe, there were Soviet experts in Algeria at the time. And secondly, did the French architect Le Corbusier's model of a modern rural centre, with cooperative buildings and new houses, have any influence?
China has a vast territory of 9.6 million square KMS, and a large population of one billion people, 80% of which live in the countryside. There are several million settlements spread all over the country. Since the founding of the People's Republic, the government has paid particular attention to improving the living conditions of rural inhabitants, while at the same time restructuring agricultural production. In the past thirty years efforts have been made to help rural inhabitants through the construction of housing, roads, and water supplies, as well as public facilities such as clinics, schools and stores, all of which have brought basic improvements to rural areas. New settlements, complete with buildings for living and production and public utilities have been established in regions where economic development has been more rapid. For instance, all buildings with tiled roofs from the old days in Qidong county of Jiangsu province have been replaced by new ones in brick and tile; in Jiexian county of Shandong province 90% of the brigades have new dwellings; and more than half of the rural inhabitants in Jiading county of Shanghai are living in new multi-storey buildings. Endeavors of this sort have given rural areas a different appearance and have provided rich experience for future development.

Since the widespread rural settlements in China are quite different in terms of natural and economic conditions, as well as living habits and local resources in building materials, development must be adapted to these circumstances. Furthermore, in rural design consideration should be given both to living and to production needs. In order to obtain satisfactory results, attention must be paid not only to ample economic resources and good planning, but also to sound overall policies and well-organized administration. Owing to a readjustment of economic policies in recent years, agricultural production is presently showing very promising prospects, which has lead to "every family storing up building materials, and every village breaking ground for new construction." Improvement of living conditions has become an urgent affair of great importance. Many problems of rural development merit in-depth study, but the following points are put forward for discussion.

Aided projects

In China's present economic situation, inhabitants cannot construct rural dwellings, either individually or collectively, as private property. Many years of experience have proved that only projects which have received outside aid are practical in hastening rural development i.e. in addition to the funds raised by the future inhabitants, aid from the commune in local materials and construction techniques, and aid from the state in the form of controlled materials such as steel, cement and glass must be forthcoming. Such projects have been acceptable to the rural population.

Local building materials

In recent years the building capacity in rural areas has reached between 300 and 500 million square meters per annum. Such a large demand for building materials can only be met through a variety of means and collective support.
efforts. Some experience in this respect has been gained in different localities, such as mobilizing the masses in afforestation projects for timber, in organizing collective production of bricks and tiles, utilizing industrial wastes for building blocks, quarrying of stone in mountainous regions building with adobe and making cave dwellings. Owing to the lack of wood in China, restraint in the use of wood has been emphasized. At the same time, reinforced concrete components have been developed to replace wooden ones. In 1980 alone 520,000 cubic meters of reinforced concrete components were produced in Jiangsu province to meet the demands of some 400,000 families, while 3,000,000 pre-stressed reinforced concrete purlins were manufactured for Anhui province, which economized some 65,000 cubic meters of wood. Precast concrete components will continue to be developed in China.

Land use

China does not have much cultivable land in proportion to her large population: the overall average is less than ½ of a hectare per person, and in some regions it is even less than ¼ of a hectare per person. Control of land use for building construction in rural development has thus become a crucial issue. The Government is preparing regulations concerning use of land in rural areas based upon good results obtained in overall planning, utilization of hilly lots and readjustment of old village sites in some regions on the one hand, and drawing lessons from uncontrolled development in different localities on the other. Emphasis will be upon general lay-outs and building indexes. Research work aimed at good design and promotion of multi-storey buildings is being pursued, so as to fulfill requirements for 'side-line' production. Analysis of old villages has shown that most settlements in the past have been loosely dispersed. Readjustment of settlements in some regions has gained as much as seven hectares of land in a

village. It is hoped that land used for dwellings can be limited to 130 square meters for each family in the southern provinces, and 230 square meters in the northern provinces. If such a plan can be implemented, 70,000 hectares of land would be gained each year.

Comprehensive planning

The Government has detected the influence of uncontrolled large-scale economic developments on vast rural areas, such as the loss of ecological balance, pollution of the environment, decrease of cultivable land, the flow of rural labor to urban areas, and so on. Hence, the general thrust of regional and country planning should be towards rational distribution of settlements of varying scales. Firstly, in towns which serve as political, economic and cultural centers, industrial and 'side-line' production, as well as service occupations, should be established to absorb surplus labour. Secondly, the infrastructures of settlements at various levels should be well provided and organically related to living and production facilities. Thirdly, planning should be adaptable to a particular region, with consideration given to the site and the specific requirements instead of relying upon prevailing stereotypes. Lastly, special attention should be given to the improvement of the existing environment by the removal of harm-
ful enterprises, to the suitable disposal of garbage and sewage, to the protection of water resources, and to precautionary measures against infectious diseases.

New housing design

The designs of traditional housing in rural areas have many drawbacks stemming from historical, social and economic factors. With the increase in physical requirements and intellectual awareness, changes in living habits, as well as the disintegration of large, extended families, old designs for rural dwellings can no longer fulfil today’s needs. The great task lying before Chinese architects and planners is to create innovative designs. Initial improvements in basic design have been made, such as enlarging living spaces, separate quarters for different generations, water supply and disposal of sewage. More efforts should be made in terms of room arrangements, architectural treatment, utility installations and disposition of courtyards. A nationwide competition for rural housing design was held in 1980-1981. The following improvements were incorporated in the various winning designs: increases in the depths of dwellings in order to add more usable interior space and greater flexibility; changes in location of kitchens and the means of cooking and heating, more rational uses of energy; concentration of latrines, biogas tanks and animal sheds to reduce yard areas; use of new structures and modes of construction; special consideration given to resisting natural calamities such as fire, typhoons and earthquakes.

Traditional architectural styles

China is a country with a wide range of geological and climatic conditions and more than fifty nationalities. Traditional rural dwellings of different regions have their own characteristic features. Dwellings, for example, in the provinces south of Changjing have grey tiles, whitewashed walls and curved roof-lines; closed courtyard plans and thick walls predominate on the northern plateaux; there are various picturesque groupings in hilly regions, cave dwellings in the loess areas, and dwellings elevated on pilotes in the south-west. The rational use of local materials, the harmonious combination of architecture with nature, the integration of utility, stability and beauty, all offer the architects a wealth of examples upon which base designs. The legacy of architectural styles, in the context of new functional requirements, should stimulate the work of architects today.

New sources of energy

Seventy-five percent of the energy consumed at present for cooking and heating in rural areas comes from organic matter such as firewood, straw and weeds. This not only causes waste but also, above all, upsets the
ecological balance. Therefore, the search for new sources of energy is an important task. Research and experimentation in this realm has been carried out, with biogas being promoted in many regions. The use of biogas for cooking, lighting and electricity has proved to be successful not only in the southern provinces where there is a mild climate, but also in the cold northern provinces. At the same time, experimental use of solar energy has been implemented in regions with strong sunlight. Other sources of energy such as wind and subterranean heat are also under study. The use of new sources of energy will obviously affect the design of rural dwellings.

**Popularization of planning techniques**

The lack of planning specialists compared with the immensity of the tasks that exist throughout the country means that vigorous measures
must be taken to rectify the situation. In addition to the training of planners in regular technical schools, aid to rural regions could be offered in the form of short-term courses to train planners in the communes and brigades themselves. Such programmes have been adopted in Jiangsu, Shanxi, and Shaanxi provinces with effective results. Because of their understanding of their own local conditions and requirements, the planners thus trained can well play roles in rural development, with assistance and instruction from the specialists. General popularization of fundamental planning knowledge, design and construction theory and techniques is also a strategy not to be overlooked. Articles in newspapers and magazines, publication of popular editions dealing with building knowledge, and books showing recommended housing designs help in the spread of planning and design techniques.

**Demonstration and leadership**

Demonstration projects are more convincing than other means of propaganda in rural development. Experiments have been carried out on a selective basis in many provinces, municipalities and countries to summarize recent experience and to explore new methods. To strengthen the leadership of rural development, the administrative office of
Rural Building Development has been organized under the State Capital Construction Commission to work out relevant policies and regulations, to organize exchanges of information from different regions, and to coordinate different organizations concerned with town planning, technical aid and supply of materials. Corresponding administrative organs are being established at different levels of the provinces (municipality or autonomous region), prefectures and counties.

The modernization of China not only calls for modernized urban areas but also rural ones. Therefore, rural development is an important component of national construction and has been taken seriously by the Government. As China is a developing nation, the living conditions and environments of rural areas tend to be quite backward when compared with those of developed nations. Rural development on a large scale is still constrained by economic resources and physical conditions of the state.

The standards of rural development in China can only be raised step by step. Nevertheless, there is no doubt in our mind that a bright future will be achieved after a period of strenuous effort by the people.
Planning for New Nubia 1960-1980

Mona Serageldin

The Nubian resettlement project is today regarded by a younger generation of architects as the sad legacy of an era concerned almost exclusively with modernization and symbols of modernity, and having little or no appreciation of the inherent esthetic and functional qualities of traditional architecture.

This blanket condemnation is rejected by older professionals who accurately point to the problems and difficulties inherent in projects of this nature. All those who participated in its planning and implementation — architects, sociologists, economists, engineers, and administrators — take great pride in the project, recounting the many obstacles overcome and the achievements performed under extremely difficult field conditions.

The issues involved are very complex, and it is impossible to do justice to an undertaking of this nature by an ex post facto examination of the project area today, particularly when the quality of the physical environment created is of dubious value. I have chosen to concentrate my paper on the process rather than the product, in order to clarify the many considerations that were reflected in the initial plans, the factors that forced changes in the plans, and the constraints that ultimately shaped the environment of New Nubia.

There is a need to understand the magnitude of the problems encountered by public authorities planning and implementing large scale resettlement projects, as well as the special hardships encountered by a population experiencing abrupt economic, social, and cultural dislocation, even under the best restructuring circumstances. Quite apart from intrinsic architectural merit, the physical environment created should be viewed within the context of the total undertaking: the goals and the vision which led to the adoption of specific policies, which in turn influenced the selection of new forms, prototypes, material, and methods, and the rejection or disregard of older ones.

Published reports provide very scanty information regarding the decision making process through which objectives were formulated and projects carried out in the resettlement operation. The analysis presented in this paper draws extensively on information gathered from interviews with senior officials and technicians involved in the project, as well as with Nubian families.

Old Nubia

In November 1959, Egypt and Sudan reached an agreement concerning the use of water provided by a new dam south of Aswan. Construction work on the High Dam began in 1960. In the vast reservoir, Lake Nasser, water was expected to reach a level of 180 meters by 1975, covering 8,000 square kilometers. 500 kilometers of river valley would be flooded, the homeland of 200,000 Egyptian and Sudanese Nubians. Each nation assumed the responsibility of resettling the Nubians living within its political boundaries, by July 1964.

This paper focuses on the resettlement project in Egypt.

Nubia was then a remote, isolated region. The Nile provided the only means of transportation within Nubia and between Nubia and the outside world. Limited agricultural resources had traditionally forced adult males to seek work elsewhere. They went to the urban areas and found employment mostly in service occupations. However, unlike many urban migrants, the move was only temporary. They left their families in their native villages, returned regularly for visits and retired there in their old age. The construction of the first Aswan dam in 1902 and its subsequent heightening in 1912 and 1933 accelerated this trend.

In 1960, Nubia comprised 40 sparsely populated settlements stretching along the Nile over a distance of 320 kilometers. The largest settlement, the district town of Aniba, boasted 914 households and 2.975 resident inhabitants. Each settlement, called nahiya, consisted of several clusters of houses, or naq, quite distance from each other, lying on one or both banks of the river. A village could include up to 30 clusters, and extend over 30 kilometers.

The houses were built of mud and stone around internal courtyards. The high external walls had narrow openings. Facades were plastered with mud, sometimes whitewashed, and decorated with traditional painted designs. Great importance was given to the entrance door, whose size and decoration testified to the status of the owners. Houses were large consisting on the average of five to six covered rooms and one to 2 rooms open to the sky, plus guest accommodations, animal pens and barns. The striking architecture melded features and motifs of pharaonic inspiration with an organization of space reflecting rural and Islamic cultural traditions as well as patterns of incremental growth. With few exceptions house building and decoration were done by the women.

The Nubians consisted of three main clans. The “Kenuz” inhabited 17 northern villages, a distance of 145 kilometers. They spoke a distinctive dialect and were particularly fond of decorating their houses with painted designs.

The “Arabs” lived in the five central settlements, covering a distance of 38 kilometers. They spoke Arabic and most of their migrant workers were employed in Cairo. Their villages lay in the most arid part of Nubia, which accounted for a limited population and traditional occupations with trade rather than

Map of Egypt showing the Nubian region and location of the Aswan Dam
Source M Serageldin.
The 18 southern settlements were inhabited by the “Kushat” or “Vaduga” who spoke a special dialect somewhat related to that of the “Kemuz”. Their dwellings were decorated with characteristic carved reliefs.

In this area, enough land remained above the level of the reservoir water to permit year-round agriculture. Consequently, settlements were more densely populated, and the number and size of resident households were larger than in the North.

At the time of the resettlement the Nubian population of Egypt consisted of 48,000 persons residing in Nubia and 51,000 migrants. Approximately 17,000 households remained based in Nubia with some migrant members, while 8,500 had moved out altogether retaining their vacant houses for occasional visits. Migrant workers sent remittances to support their families while older men kept watch over settlements inhabited by women and children engaged in subsistence agriculture. Every month, the Ministry of Supply sent to Nubia rations of flour, sugar, oil and kerosene. Other goods were sent by migrant family members or obtained from small boats sailing up and down the cataract.

In their villages, the Nubians enjoyed and greatly valued peacefulness, security, privacy, and spacious accommodations. They lacked infrastructure and services, particularly health and educational facilities. It was a deprivation that migrant heads of households were becoming increasingly aware of, through their exposure to the opportunities for upward mobility opened up by education in the urban centers of rapidly developing countries.

The Resettlement Project in Kom Ombo

The Institutional Framework for the Resettlement Program

The resettlement of 70,000 Nubians, one-third of the population of the Aswan governorate at the time, within a three-year period was no small undertaking. At all stages of the project—planning, design, and construction—time emerged as the binding constraint. In the end, it proved the one over-riding consideration, affecting technical, financial, and political decisions. The Joint Committee for Nubian Resettlement was established in April 1961, headed by the Deputy Minister of Social Affairs, with ex-officio members from the Ministries of Agrarian Reform, Public Works, Health, Education, Urban and Rural Affairs, Interior, and Supply.
Kenuz House, Dahmit, Old Nubia.
Photo: A El Fattah Eid.
Plan and section: Survey by Hassan Fathy, Salah Higab and Shoukri Tewfik.

Arab House, Qurta, Old Nubia.
Photo: A El Fattah Eid.
Plan and section: Survey by Hassan Fathy, Salah Higab and Shoukri Tewfik.
Kushaf House, Adindan, Old Nubia
Photo: A. El Fattah Eid.
Plan and section: Survey by Hassan Fathy, Salah Higab and Shoukri Tewfik.

Old Nubia, abandoned houses from which the wood was salvaged
Photo: Al Ahram
The Joint Committee had to work within an administrative structure which attempted to reconcile state control and popular participation through "centralization in planning and decentralization in implementation".

The Joint Committee was authorized to draft new legislation as needed and submit it directly to the President for approval. Program implementation thus proceeded by special presidential decrees.

A complicated administrative organization was created to coordinate activities at the central and local levels. A maze of adjunct and ad hoc committees and subcommittees aggravated problems of joint responsibilities and added to the workload of executive authorities.

The High Dam was the cornerstone of Egypt’s economic development program, which aimed at doubling national income within a decade. The Nubian resettlement project was to be undertaken within the framework of the first Five-Year Plan. The Plan, however, failed to reach its targets for lack of investment funds, as domestic savings, foreign borrowing, and exports all fell short of expected levels. Perennial deficiencies in project financing developed, and shortages of foreign currency became increasingly acute. Despite its priority ranking, the Nubian resettlement project suffered from these funding problems.

**Major Policy Issues**

In January 1960, President Nasser had promised the Nubians a future of happiness and prosperity in the new settlements: "The benefit that will accrue to the Nubians will be great because [the new settlements] will group all the Nubians on the basis of the sound principles needed to build a strong and healthy society."

Translating this promise into an action program, the Joint Committee defined the goals for the resettlement program as follows:

- To comply as much as possible with the wishes of the Nubian people.
- To give fair compensation to the Nubians for their losses.
- To integrate the Nubians into the national social system.
- To provide New Nubia with a sound economic base and adequate community facilities and services.
- To assist the Nubians in adapting to the conditions of their new environment.

To achieve these goals, the Committee decided on the following policies:

- To rely on agriculture as the basic economic sector for New Nubia.
- To promote "rural industries" in order to provide employment to women now relieved from agricultural labor.
- To establish social service centers, form agricultural cooperatives, and create other community development programs.
- To provide in-kind rather than monetary compensation.
- To construct planned communities, rather than aided self-help settlements.

Hilmi El Sayed Moussa, the Director General of the resettlement operation, explained: "The aim was not only to move a population from their homeland; it was also to prepare them for new tasks within the framework of general national action for economic and social advancement."

There are two visions of a better future — the government’s view and the Nubian perspective. Although basically compatible, they did present important divergences, which were aggravated by internal inconsistencies.

The government chose agriculture as the foundation of the economic base of New Nubia, and expanded factories to absorb the sugar cane production from the 35,000 feddans that were ultimately to be reclaimed in the area upon completion of the High Dam.

Despite their assertions to the contrary, past experience should have cautioned the Joint Committee as to the inclination of Nubian men to return to rural living. In 1933, most of those who acquired properties in Asna did not move there; they preferred to keep their jobs in the urban centers, and either contracted with local farmers to work as share croppers or left the land idle altogether.

It was unrealistic to assume that the trend of rural/urban migration that had prevailed in Nubia for generations could ever be reversed. Habits acquired in the long exposure to urban lifestyles had deeply permeated Nubian values. In this respect, the traditional rural appearance of Old Nubia was highly deceiving. Less than one percent of migrant workers, whose remittances provided the real support of Nubian households, were employed in agriculture. That the Nubians had opted for in-kind compensation, in the form of land and houses, was more indicative of the deeply rooted attachment and the longing, shared by all Egyptians, for ownership of a piece of real estate, than of any particular desire to return to the land as
“fellahs”. Furthermore, it was culturally and technically inconceivable that the female population, which had provided the bulk of the labor for subsistence agriculture in Old Nubia, could be mobilized for the intensive cultivation of cash crops in the environment of New Nubia.

A repeat of the 1933 experience was unavoidable. Upper Egyptians eventually provided the labor force for manual work in the new settlements, including farming and construction. Nubian beneficiaries returned to their occupations in the urban areas.

Agricultural land is Egypt’s most valuable resource. That the Nubians preferred to let others farm their land should not be held to detract from the value of a project, that brought 30,000 feddans into cultivation.

The Nubians wanted to be relocated away from existing settlement in the valley, to avoid having “strangers” in their midst. Yet they also desired good transportation links to the neighboring urban centers of Kom Ombo and Aswan, as well as regular educational facilities. It was clear that the perpetuation of the Nubian cultural identity would be at best difficult in the face of increased levels of communication, generalized access to education, constant exposure of women and children to images and ideas propagated by mass media, and new activities promoted by government social programs. The resettlement was bound to create a growing awareness of the Egyptian nation at the expense of the Nubian heritage.

The ambivalent attitudes of the Nubians themselves allowed this issue to remain unresolved. The many dilemmas it raised were never openly discussed. Rather, cumulative decisions based on technical and political considerations were left to settle matters as they may, sometimes counteracting but more often reinforcing integration.

The compensation formula drafted by the Joint Committee gave the Nubians generous terms. Properties in Old Nubia were appraised, and 50 percent of their value was paid in cash to the owners several months before the resettlement. The remaining 50 percent was credited towards the acquisition of property in New Nubia. Each family received title to a house commensurate with family size and an amount of agricultural land, equivalent to their submerged holdings. The minimum plot size was set at one feddan, and the maximum at five, in accordance with the criteria used by the Agrarian Reform. Landless and homeless families were also allocated one feddan and a house.

Charges to be incurred by the Nubians were limited to the construction of houses in the new settlements. The substantial costs of utilities of community facilities — 163 buildings — were borne entirely by the government following a most generous interpretation of national policy regarding land development. Furthermore, the cost of the new houses was to be reimbursed over 40 years with no interest charges. Payments were not due to start until the reclaimed land had yielded its first crop, that is within three years. Nevertheless, many Nubians were dissatisfied. They felt the compensation was inadequate because government appraisers consistently underestimated the true value of their mud houses for which formulas to assess valuation did not exist as in the case of agricultural property. However given the fact that 57 percent of Nubian families were landless and received a minimum plot, the welfare component of the compensation policy should not be overlooked.

Despite the upper limit set on landownership, the compensation entitled the reclamation of 30,000 feddans in Kom Ombo, and an additional 8,000 feddans in Etn. In Kom Ombo, a first phase of 21,000 feddans was to be completed before the relocation in 1964. The second phase had to await the availability of water from the High Dam.

The right to houses in New Nubia was based on the census taken in 1961 by the Ministry of Social Affairs when 16,861 households were counted and surveyed. The publicity surrounding the project had prompted migrant households to return to their vacant houses in Old Nubia in time for the enumeration. Those who failed to do so (about 8,300 families) raised a great deal of fuss and requested houses and land in the resettlement area. Since their conditions was not pressing, they were promised houses in the second stage of the construction and were required to contribute their total compensation towards the acquisition of their new houses.

Since it had been decided that all the Nubians were to be relocated before the completion of the first stage of the High Dam, when the closing of a coffer dam would lead to some flooding in Nubia, the resettlement project was included in the crash program for housing and land reclamation in the Five-Year Plan (1960–65). The crash program involved 200,000 dwelling units and 500,000 feddans, of which the resettlement at Kom Ombo accounted for 17,000 units and 30,000 feddans.

Resettlement, often regarded as a side issue in large-scale dam projects and treated as an unavoidable social cost, became in this case another test of the government’s ability to undertake a project of the magnitude and complexity of the High Dam. The controversies surrounding the High Dam, and the world-wide expressions of concern over Nubia implied that the resettlement operation was bound to receive a great deal of international publicity.

The resettlement agency could not afford the embarrassment of a bad performance. The technical decisions it took were dictated by two imperatives: the need to produce tangible, visible, and acceptable results; and the necessity to beat the clock in doing it.

The selected policies were far more burdensome to the government than alternative cash compensation with serviced house lots. They required more planning, larger outlays, and greater administrative workloads. The Nubians, whose homeland had to be sacrificed for the benefit of the entire nation, generated widespread sympathy in Egypt and abroad. The Joint Committee acquiesced in Nubian demands, irrespective of whether these were really justified. It proceeded to develop programs based on political considerations, until the budget requirement could no longer be met. The total cost of the project rose by a factor of three, from LE 20 million to 30,44, and eventually to 60 million.

However, the approach was never reassessed. Rather, as time and budget constraints set
limits to what could reasonably be achieved, a series of incremental changes were intro-duced, reducing "temporarily" the allocation of land per household, until new budget appropriations would allow the project to be completed as originally planned.

Creating the Physical Setting for New Nubia

To discharge its responsibilities, the Joint Committee had to undertake the following tasks:

- To survey and appraise properties in Old Nubia, and to disburse compensation to Nubian households.
- To establish an outreach program providing information and assistance to the Nubians, and to prepare them for the resettlement operation.
- To build housing, utilities, and community facilities in the resettlement area.
- To reclaim land in New Nubia and install the necessary irrigation systems for perennial cultivation.
- To organize the transfer of Nubians from their old homeland to the resettlement areas in Kom Ombo and Esna.
- To provide assistance and organize community development activities in New Nubia.

Each ministry on the Joint Committee was assigned the tasks that fell within its jurisdiction. Irrigation and major off-site infrastructure were the responsibility of the Ministry of Public Works.

The Ministry of Urban and Rural Affairs was charged with the responsibility of planning, designing, and building the resettlement project. Its tasks were defined as follows:

- To select the location of villages in the resettlement zone.
- To build the housing for Nubians and government employees, and the necessary community facilities.
- To construct the support infrastructure systems: major access roads, streets, water supply and electricity.

Site plan of New Nubia resettlement areas around Kom Ombo

Source M Serageldin
The Site

The site selected for the resettlement was an alluvial plateau on the edge of the Nile valley, 50 kilometers north of Aswan, near the town of Kom Ombo.

Located 10 kilometers away from the Nile, at an elevation varying between 25 and 40 meters, the selected site proved very difficult to develop and improve. Accessibility, water supply, and soil structure emerged as the most pernicious problems plaguing the project and the principal cause of cost overruns.

Given these problems, it is significant to note that the reasons given for the selection were the following:

- The expressed desires of the Nubians to be relocated at a distance from existing settlements and to avoid dispersal
- The suitability of the natural environment, somewhat reminiscent of the features and desertic climate of Old Nubia
- The alluvial soils, which could be reclaimed for cultivation
- The capacity of the site, in terms of size and shape, to accommodate the total Nubian population in separate settlements within a reasonable distance of each other
- The availability of land for future expansion of settlements and agricultural areas, to accommodate 8,500 migrant households in the second stage of the project and to provide for the anticipated natural increase of the Nubian population.

The Ministry sent engineering study teams to Kom Ombo to do preliminary surveys and find immediate solutions to the logistical problems of access and water supply.

The first priority was to lay and pave a road 13 kilometers long, connecting the resettlement site to the city of Kom Ombo.

The second priority was to secure a source of water supply for the site. At first, wells were dug to tap local aquifers, but the yield was far too low to be useful. Consequently, 21 temporary lift pump stations were erected along the Nile to supply non-filtered water for construction work. Potable water for workers and field staff was supplied by another pumping station from the water works at Kom Ombo.

Regional Infrastructure Plan

The transportation network provided for independent connections to the main Upper Egypt Highway and Railway Line at both ends of a ring-road, which linked the villages of New Nubia. The ring-road and the connectors to each village were paved, as were all major roads within each settlement. Telephone communications were also established.

Utilities for New Nubia were planned for a population of 50,000 the estimated resident population during stages 1 and 2.

Electricity was to be supplied from the High Dam through a new high voltage (132 kv) line extending 160 kilometers from Aswan to Esna. Transformer stations at Esna and Kom Ombo would feed the low voltage (33 kv) lines. The resettlement project at Kom Ombo would be served by 42 kilometers of lines and additional transformer stations (33/11 kv) to feed the distribution networks.

Water was to be supplied by a new filtering plant in Kom Ombo. The capacity would at first be limited to 40 liters per second, but would eventually reach 150 liters per second. However, it soon became apparent that due to foreign exchange shortfalls the plant could not be completed by the deadline of October 1963.

Temporary utility systems had to be found. Generators were installed in conjunction with health facilities and police stations, and provided power to houses within their service areas. Smaller mobile generator units were provided to supply electricity to the administrative center, the community facilities, and elsewhere as needed.

Water presented a more difficult problem. The Ministry decided to expand the filtering plant already under construction in the neighboring village of Draw and originally planned to serve the villages in the vicinity. A system of 15 pumping stations, 7 water towers, a 2,000 cubic meters storage tank, and 130 kilometers of force mains and distribution lines (4" to 10" pipes) carried water to New Nubia.

Within each settlement, one water station was provided for every 50 dwelling units. All public buildings had individual connections.

The system was largely operational by March 1963. Subsequently, 5 pump stations were added to increase water pressure.

Soil Conditions: A Persistent Problem

Preliminary borings did not accurately detect the extent of swelling clay deposits common in the Aswan region. It is a type of desert clay which local engineers refer to as buga. The name is probably derived from the medieval geographic name for the region where it is predominant, "And al Buga," which extended from Aswan to the Red Sea, and south in Sudan to just north of Suskin Island. However, the word buga originally referred to the tribe which inhabited the area, and not to its soil.

This particular type of clay is characterized by the following properties: It is as solid as rock when dry. However, when wet it first swells, and then loses its bonding power and disintegrates into a fine powder similar to talcum powder. The effect of the buga on structures can be devastating. During the swelling stage, the upward pressure of the expanding soil can raise the foundation of a two-storey reinforced concrete building and cause major cracks in the structure, rendering it unsafe. As the humidity in the soil increases and the clay disintegrates, the building sinks into the ground and crumbles.

This phenomenon gave rise to the myth of bewitched areas of Dahmit village, where houses were supposedly "swallowed" by the earth. These were zones where construction proceeded without adequate investigation of soil conditions. Ground movements due to swelling clay strata led to the collapse of many houses. An engineering study team sent by the Ministry of Housing in 1968 dealt with the situation by altering the foundations in the rebuilding process. Addition of double reinforcement to footings and the spreading of a deep layer of sand under the foundations stabilized the structure and enabled it to sustain both tension and compression forces.

Another problem was the high salt content of the soil in some areas. When ground water levels rose as a result of irrigation and
domestic water usage, infiltrations and osmotic pressure led to the formation of soft deposits on the ground and on the floors and walls of structures. The situation was particularly bad in the village of Adi Dandar, which was located on the lower elevations. Drainage and seepage from developments on higher ground compounded the problem. Later, the construction of underground drains and the replacement of the top stratum of sand to a depth of 30 centimeters alleviated somewhat the situation.

Soil conditions varied widely over the project site, and adjacent areas showed markedly different structures. To avoid severe problem areas, it was decided that a series of new borings would be taken at the village block level before allowing construction to proceed. As a result of this detailed analysis, major changes had to be made in the original settlement layout. Some villages had to be moved to alternate locations. This was the case of Armita and Aniba. At other villages, where construction had started, areas unfit for building were avoided by relocating the buildings elsewhere in the immediate vicinity or in subsidiary developments. This was the case of Qurta, and the clusters of Qalabsha and Durr. For example, swelling clay at the site selected for Qurta forced the relocation of the village within the boundary of agricultural land. Even then, it was not possible to build more than 130 houses in the area. Consequently, the remaining 404 dwellings were developed at new locations adjacent to Qursha and Aliaqc, which were called Qurta 2 and Qurta 3, multiplying infrastructure requirements and associated costs.

**Layout Plan**

The Ministry of Social Affairs decided that New Nubia should, as much as possible, replicate the physical organization of Old Nuba. The Kenuz were to live in the northern part of the settlement, the Arabs in the central zone, and the Kushaf to the south. Villages in New Nubia were to have the same names at the settlements of Old Nubia. Administrative center, “Nasr City,” located in the central zone, would group community facilities serving the whole of New Nubia. Each village would have a land reserve to accommodate, at the very least, the second phase housing for migrant households, so that they could remain with their kin groups.

The resettlement project covered an area approximately 60 kilometers long and 20 kilometers wide. The villages bordered the reclaimed agricultural land, and were linked by the ring-road connecting New Nubia to the Upper Egypt Highway and Railway Line. The total area to be developed was on the order of 3,000 feddans. Cost efficiency considerations precluded the delivery of social services to 40 dispersed settlements. Smaller villages were aggregated to ensure an acceptable level of utilization of community facilities.

A perpendicular grid pattern for the layout of buildings was adopted. Siting was based on two determinants: the housing prototypes developed by the Ministry architects; and a north-south orientation to ensure the best ventilation of dwellings.

This rigid design approach has been followed since ancient times. The popularity of this approach among government engineers stems from its efficiency. It certainly does not save on infrastructure costs, which, quite to the contrary, tend to increase in proportion to the total length of streets, making clustering a less expensive alternative. No other layout can come close to the expediency provided by the grid pattern in construction work (staying, excavations, laying of utility lines, foundations, etc.).

The drawbacks of this unimaginative layout were compounded by the unfortunate decision to group together houses of the same size. The social ties among old village groups were disrupted by this spatial organization. In particular, elderly widows, to whom one-room units were assigned, found themselves isolated from their relatives. However, the sheer density of the settlement pattern and the case of movement within the settlement implied that kinsmen were never very far away.

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**Key**

1. Mosque
2. Hospital
3. Rural teacher training school
4. Secondary school
5. Primary school
6. Market
7. Supply office
8. Mill
9. Bakery
10. Agricultural cooperative supply center
11. Slaughterhouse
12. Veterinary clinic
13. Agricultural station
14. Pest control station
15. Social center and athletic facilities
16. Political center
17. City council
18. Fire and police station
19. Post/Telephone office
20. Electric station
21. Water station
22. Government employee housing
23. Courthouse site
24. Military housing

**Plan of Nasr City in New Nubia Resettlement project**

*Source: M Serageldin*
Housing Design

Following a study team reconnaissance survey of Old Nubia, model house plans were developed by Ministry architects. At the request of the Ministry of Social Affairs, a model house was built in Aswan in 1961 and Nubian community leaders were invited to inspect it.

Despite its unimaginative architectural design and its questionable suitability to a desert climate, the model won overwhelming approval. This is hardly surprising, since the proposed house was undeniably of a high standard, particularly considering Egypt’s resources at the time. In addition, potential access to utilities and services was greatly valued both by the deprived residents of Old Nubia and by the urban migrants who were becoming accustomed to these conveniences.

Ultimately, four prototypes were offered in New Nubia: one, two, three, and four-room dwelling units with guest reception area, yard, animal pen, kitchen, and latrine. The compensation formula had stipulated that every Nubian household was to receive one house in New Nubia commensurate with size, inclusive of migrant members and irrespective of the number of houses owned in Old Nubia or the number of nuclear families within the house-
hold. Consequently, one-room houses were allocated to one-person households, two-room houses to households of two or three persons, three-room houses to households of four to six persons, and four-room houses to households of more than six persons. To avoid encroachment of agricultural land and to economize on infrastructure, no allowance was made for horizontal expansion. This restriction, which conflicted with the customary settlement patterns of Old Nubia, was a source of bitter complaint.

Allowance was made for vertical expansion and space was provided for a staircase to upper floors. Although only one more floor was permitted, the foundation could support an additional storey.

Despite the generous size of building lots and dwelling components, the houses suffered from obvious design defects that undermined their quality as a living environment. The guest reception areas and the courtyard lacked privacy and shade, and were unusable in a desert climate without the addition of partitions and overhead protection. The absence of storage areas implied unavoidable encroachment on living space in the courtyard and the rooms. However, the most damaging defect lay in the siting of buildings. The alleyway between the houses was far too narrow to permit rooms from the adjacent house to open onto it without undue loss of security and privacy to both houses. Indeed, this was the single most generalized source of complaints.

The reliance on prototypical designs can be attributed to the necessity to use solutions amenable to mass production. Given the scale of the project and the time schedule, it could hardly have been otherwise. The lack of suitability of the housing to the harsh climate is a serious flaw that warrants closer examination.

The construction method was standard load bearing stone walls and reinforced concrete roofs. Summer heat, with temperatures above 40°C and diurnal fluctuations in excess of 25°C, exposes the houses to extremely harsh weather conditions. Yet reinforced concrete slab roofs were chosen for New Nubia, with the result that temperatures inside the houses fluctuated between 25°C and 30°C.

Professionals involved in the decision to use reinforced concrete were aware of this drawback and tried very hard to find an alternative roofing system. Experiments with cement block failed because of the lack of water for on-site pouring and curing of blocks. A vaulted roof system relying on pre-stressed components was tried at Dalmaat. This and other attempts at using prefabricated components failed because these components could not be lain directly over the stone walls, but had to rest on a reinforced concrete tie beam. Additional material and labor required for this solution doubled the cost of the roofing system. The budget did not allow for such prohibitive costs.
The Ministry even investigated some European systems, but found none that could meet the requirements of speed and ease of installment at affordable cost. Furthermore, the growing shortage of foreign exchange put an end to the feasibility of large scale imports of structural components for which substitutes could be found locally. Given the decision to provide complete housing units, there seemed to be no alternative to reinforced concrete slabs in terms of availability of materials and speed of execution. Finally, concrete crews started work on houses which had stood for several months, completed except for the roof, awaiting a solution to this difficult problem.

Attempts at providing an added layer of insulation above the roof had to be abandoned because the single factory could not produce the quantities required for the project.

Whether or not it would have been possible to raise the walls in order to increase the floor to ceiling height is an issue which needs further investigation. Professionals involved in the project feel that it would have added substantially to time and cost. This is undoubtedly true if the additional height was to be built as an afterthought.

The Construction of New Nubia

At the time of the Nubian resettlement project, Aswan was experiencing a rapid rate of industrial and urban expansion. The Five-Year Plan had called for the expansion of established extractive and processing industries and the construction of a huge complex producing nitrate fertilizers. These major projects were, of course, dwarfed by the High Dam, which provided employment for over 50,000 engineers, technicians, and laborers. The laborers engaged in the construction of factories, housing, power plants, and the dam itself were Upper Egyptian Sarids from the Esna-Edfu area, north of Aswan. The wages paid were relatively high, but were partly offset by inflation as the local economy lacked the absorptive capacity to sustain this growth.

Despite strenuous government efforts to provide supplies to the region, and particularly to the priority area of the High Dam, prices continued to rise and shortages of all kinds continued to occur. To forestall shortages in the manpower vitally needed for the High Dam project, the government had authorized payments of substantial premiums and bonuses above prevailing wage and salary rates. The results was accelerated inflation in construction costs and perennial shortages of skilled manpower and building materials elsewhere in the region. Technicians and skilled and semi-skilled workers were in short supply.

With the largest contracting firms engaged in the High Dam, none of the remaining companies had the capacity to take on a project of
Red brick and reinforced concrete house
Replacement Public Housing, Khub Awad, Aswan

Stone and reinforced concrete house
Nubian Resettlement, Aditand, Kom Ombo

Traditional mud brick house
Abel Rish Village, Aswan

Climatic Characteristics of Housing
Source: Ministry of Housing
the magnitude of the Nubian resettlement in Kom Ombo. The Ministry therefore chose to divide Stage 1 work into three phases:
- Phase 1, 11 settlements, to be constructed between May 1962 and March 1963.
- Phase 2, 8 settlements, to be constructed between August 1962 and May 1963.
- Phase 3, 9 settlements, to be constructed between August 1962 and July 1963.

Tender documents were sent to public sector contracting firms. However, the combination of severe logistical problems, harsh field conditions, and stiff penalty clauses for delays prompted contractors to decline to bid on the tender. In the end, the Ministry was compelled to issue work orders requisitioning the services of 12 large firms to undertake the construction of New Nubia.

Even so, the contractors were hard pressed to assemble the workforce needed, a total of 30,000 men, including 3,000 masons. Skilled and semi-skilled workers, foremen, and supervisory personnel had to be brought from Cairo and other major urban centers in Lower Egypt, more often than not withdrawn from active projects elsewhere. The very tight schedule hindered possibilities for systematic, on-the-job training.

Kom Ombo in 1962 was a small city incapable of supporting an additional 30,000 persons. On-site accommodations had to be provided for the work force and arrangements made for regular deliveries of all supplies needed for their sustenance.

The building materials needed for the project provide a good indicator of the overall scale of the operation:

The requirements of the schedule implied that 20,000 tons of materials had to be transported daily from various locations to the site. Regional transportation systems were unable to carry this load. The inadequacy of long haul systems (barges and railroads), used mostly to obtain cement from Cairo, was compounded by the inability of the local transport contractor to keep up with the delivery schedule, despite the 176 trucks specially provided to him by the Ministry for the purposes of the project. A second firm was called upon to assist in this task.
The sheer volume of traffic on the access roads to the construction sites mandated their being surfaced, and forced the Ministry to contract with two firms specializing in road building for the continuous repair and maintenance work needed to keep the road network functional at all times.

To save on transport and foreign exchange, design specifications called for maximum reliance on locally produced materials available in the region, namely sandstone, gravel, sand, lime, and particle board. However, it soon became apparent that the two local mining concerns in the Aswan region did not have a combined capacity to quarry sandstone at the required rate. The Ministry called upon a major industrial company to undertake mechanized quarrying.

In view of the fact that the project involved 12 construction firms, three quarrying companies, and two transport companies, it is not surprising that the Ministry had to mobilize its entire technical capabilities, and assign to the project 62 architects and engineers, in addition to foremen and administrative personnel to supervise construction.

The total cost of the project was first estimated at LE 13.4 million for Stage 1, and LE 4.8 million for Stage 2. An additional funding of LE 2.5 million was requested in 1964 to meet cost over-runs due to the great difficulties encountered.

The Evolution of New Nubia

The Resettlement Operation

A four to five day journey separated Old and New Nubia. 28 barges and boats were assembled by the Joint Committee to transport the Nubians from their villages to Shallal, the Sudanese government provided five additional boats to assist in the move. 10 buses, 10 trucks, 10 trailers, and 90 train wagons lined up for the land journey to the resettlement area in Kom Ombo, a distance of 75 kilometers. The transfer required 158 boat trips, 3,645 truck trips, 1,350 bus trips, and four rail
trips. The transfer of residents and livestock from Old to New Nubia was accomplished rather smoothly, and according to schedule, from October 1963 to June 1964.

Construction of the High Dam was a source of national pride, and the resettlement received the expected fanfare and media coverage. The Minister of Social Affairs came in person to receive the first relocatees — the residents of Dabud.

During the next eight months, 55,690 persons were relocated with their belongings, consisting of 29,300 heads of livestock and 377,400 pieces of luggage — all that could possibly be salvaged from their old homes. Pragmatically, they had sold anything of value that could not be transported, including wooden elements from their houses (lintels, sills, frames, and doors), trees, and some livestock.

Emotional stress, anxiety, fatigue, and disorientation could not completely overcome the Nubians' positive feelings about the move. Young men were excited at the prospect of access to education, better job opportunities, and proximity to urban activities. Young women were hoping for a more normal life pattern, including early marriage, more frequent visits from husbands, and social services for children. No one but the very old felt totally negative.

Mixed feelings also extended to the new urban environment. For the Nubians, accustomed to large, rambling houses, unrestricted horizontal expansion, and wide open spaces around them, the idea of having to move to small attached row houses crowded together in rectilinear blocks was insufferable. Yet there were redeeming features that could not be ignored: Permanency, social infrastructure, and eventual servicing by utilities, particularly electricity, were anxiously awaited.

Despite strenuous efforts, construction in New Nubia could not be completed on time. Priorities had to be established. Most of the houses and schools were ready within a reasonable time span, but many community facilities suffered long delays. Furthermore, the water network was relying on the provisional supply systems, and service in some districts was inadequate. Similarly, the electric power supply, relying on mobile generators, was deficient. Transport delays of four to five hours often meant that relocatees often arrived after dark, and generators had to be moved almost daily from one location to another.

Adjustment to Life in a New Environment

Transitional Hardships. The first year the Nubians spent in their new environment was traumatic. The land reclamation project had fallen behind schedule since 1962. Unexpectedly high soil salinity and even greater difficulties in water supply raised the cost far beyond budget allocations. When the Nubians arrived in June 1964, only 7,000 feddans had been reclaimed. 11,000 feddans were under reclamation and work on 3,000 feddans was programmed to start in 1964. Requests for additional funds to expedite the reclamation process was rejected by the Finance Ministry.

The Joint Committee decided on a minimum size for holdings of one feddan per household, and declared that irrespective of the amount of compensation due, no one would receive more land until everyone had received this bare minimum. One year later, only half the households had received the one of feddan allocation. Fresh produce and fodder were scarce, and the livestock suffered heavy losses.

Compensation payments, travel allowances, and remittances from relatives proved insufficient to support families struggling to survive within an inflated regional economy strained still further by the sudden introduction of nearly 60,000 consumers. Despite government efforts to secure supplies for the relocatees, prices spiralled and shortages occurred. To avoid widespread hardships, the Joint Committee decided to give the Nubians temporary monthly support payments ranging from $5 to $10 per family, a reasonable sum since the annual per capita income in Egypt was around $120.

Problems were further aggravated by the
attitudes of Nubian associations in the urban centers, who insisted on the immediate rights of members of homes in the new settlements. Urban migrants, unsure about the government's intent to carry out the promised Stage 2, crowded the villages, adding to both density and confusion.

The most serious of all hardships was the spread of communicable diseases. Isolated from contact with outsiders in Old Nubia, the Nubians lacked immunity to common "valley" diseases, which took a heavy toll, particularly among infants and elderly.

Adjustments and Socio-Cultural Change A few years after resettlement, the situation had changed drastically. As more land was brought into cultivation every year (the land reclamation project made available 30,000 feddans by 1969), raising animals resumed on a wide scale, with poultry, rabbits, goats, and sheep.

The completion of the community facilities gave the Nubians, for the first time, fully operational schools, markets, and health centers within walking distance from every home. The shift from the provisional to the permanent utility systems provided them with conveniences unknown in Old Nubia. An immediate consequence was a noticeable increase in water consumption which in some instances overloaded the capacity of the drainage system beyond design loads. In time, there may be a change from cesspools to septic tanks.

Despite the high cost involved, house remodeling has been a favorite activity. Most of the jobs undertaken were aimed at increasing the sheltered area. Enclosures were built to separate animal pens from the rest of the courtyard. The use of interior space was rearranged to provide better guest accommodations, rental rooms, or space for small businesses (shops, cafes, and the like).

Labor for building with brick and mortar was recruited from among Sai'dis. However, Nubian women resumed their house maintenance activities by plastering with mud plaster and decorating with paintings and artifacts. Even the traditional benches, mastaba have reappeared in front of some houses. The Kenuz have taken the lead in remodeling and decorating.

Regular bus service between New Nubia, Aswan, and Kom Ombo has provided to the Nubians a degree of accessibility and mobility inconceivable within the confines of their old homeland.

The conveniences of life in New Nubia have given women welcome leisure time, which they use for more frequent visiting and, increasingly, for participation in government-sponsored programs at the handicrafts and social centers.

The combined effect of village layout and house assignment was the creation of new patterns of social relations. Neighbors were no longer necessarily kinsmen. Islamic principles of mutual obligations (rights and responsibilities) between neighbors meant continuous interaction and the formation of ties with neighbors irrespective of family lineage. An urban concept of neighborhood based on residential location and personal affinity was superimposed over the deeply rooted loyalties commanded by kin and clan.

Customs were adjusted to reflect this new level of social relations. Ceremonies were adapted for increased participation and closer residence by reducing length of stay and host responsibility, as well as gifts and services offered by guests.

Drastic reductions in travel time and cost have encouraged frequent visits by urban migrants. A growing number of Nubians have found attractive employment opportunities in the expanding job market of Aswan. With students also able to live at home while attending school, the number of males in residence in New Nubia is now relatively high. Nubians have sought service occupations and civil service positions in Aswan governorate. They have managed to organize themselves and to participate successfully in local politics.
The Commotion over Housing, 1967-68

The emergence of Nubians as an interest group was brought to the forefront of events rather forcefully during the commotion over the adequacy of houses in New Nubia in 1967, and Stage 2 construction of housing for urban migrants in 1977.

In 1967, complaints poured in at the offices of responsible authorities in Aswan, the Aswan governorate, and the Ministry of Housing. The Nubian delegates at the National Assembly were leading the campaign, declaring the houses had serious defects that inflicted hardships on the inhabitants. Certainly, everyone was aware of the problems of the soils, be it swelling clay or excess salinity, and of the heat transfer through the reinforced concrete roofs.

The national mood in the aftermath of the war was somber and there was a general disenchantment with modernization policies of the previous decade. Those questioning the validity of earlier decisions and approaches in New Nubia found receptive audiences among professionals and laymen alike.

The case was not as clear cut as it may seem. It could be argued that the open expressions of dissatisfaction represented the coalescence of a new sense of awareness of Nubia as an integrated community. It could be argued even more convincingly, however, that the timing of the complaints coincided with the end of the grace period granted before reimbursements became due on the outstanding balance for properties in New Nubia (despite the fact that monthly installments would have been on the order of only LE 0.40, or US$0.80). This was accurately perceived by the committee set up by the Ministry of Housing to investigate the matter.

Technical recommendations focused on issues of stabilizing foundations and the like. The major decision taken was to let the Nubians have the houses for free. A ministerial decree ordered the disbursement to the Nubians of the portion of the compensation withheld and credited towards the acquisition of houses (50 percent). This give-away put an end to the commotion. The few complaints filed later were related to structural and other technical problems.
New Nubia, Stage 2, 1969 to Present

The implementation of Stage 2 was delayed by the 1967 war and the economic problems that Egypt faced in its aftermath.

Eligibility was restricted to migrant households who had owned a house in Old Nubia. A special effort was made by the Ministry of Housing, the authority responsible for project implementation, to comply with the requests of the Nubians. After the re-allocation of vacant units in New Nubia, it was found that 6,595 additional houses were needed. The proposed breakdown was 10 percent Prototype A, 10 percent Prototype B, and 80 percent Prototype C. The controversial Prototype D was eliminated. Furthermore, with no time pressure on implementation, it was decided to offer Nubians the option to build their own houses.

Areas were delineated for subdivision. Building plots of 105 square meters (corresponding to Prototype C) were made available to households. To allow for a degree of horizontal expansion, the purchase of more than one plot was authorized. An upward limit of 260 square meters (corresponding to the lot size of Prototype A) was recommended by the Executive Agency for the Resettlement. Priority in land allocations was given to large households.

To economize on infrastructure, the new development areas were kept as close as possible to the existing dwellings in each village. In cases where this was not possible for lack of buildable land reserves, alternative sites were delineated in proximity to the agricultural land allocated to the future inhabitants of the area.

To discourage speculative holding, a time limit of one year for starting construction was set, after which the land plot could be repossessed. People were encouraged to use the government prototypes and not to alter them. Municipal authorities in Nasr City were to supervise building activities. In particular, they were enjoined to require the construction of latrines and cesspools within the courtyard areas and to prohibit the encroachment of cesspools on streets, a widespread violation in urban fringe areas because of ease of access.

for pumping out the contents at regular intervals.

By eliminating Prototype D and offering some possibility for horizontal expansion through the new subdivision program, the Ministry did meet the most pressing Nubian demands, but it did not attempt to experiment with new housing solutions. Municipal authorities in Nasr City felt they lacked adequate funding and staff to enforce building codes and were opposed to the issuance of regulations. Private activities proceeded in an informal manner, altering and adding to existing structures and building new ones.

Government and the Nubians: Emerging Roles in Project Planning, Design, and Implementation

Setting the Criteria for Housing Development

At the outset of the resettlement program, Professor Hassan Fathy had undertaken an architectural survey of Old Nubia. He recommended that each architect be assigned to each naq to live with the people, ascertain their needs, and study their living patterns, the organization of space within their dwellings, and the construction methods they used. Each architect would then be responsible for developing cluster layouts and house designs in the resettlement zone for the inhabitants of the naq to which he was assigned. The government's role would be limited to providing basic infrastructure.

Professor Fathy wanted to assemble a few master masons to train Nubians to build in mud brick. To this end, he proposed setting up a training center in Gurna village, near Luxor 28. The proposed approach offered an ideal solution, in that houses would be related to the needs and lifestyles of inhabitants and admirably suited to the climate. It was estimated that two masons with four assistants would require 45 days, on the average, to build a house.

The Ministry of Housing and Utilities turned down this proposal. The main concern was the lack of control over schedules and the unpredictable nature of results. It was an untenable situation for officials responsible for a technically difficult project with high visibility and important political overtones.

The issue of appropriate housing for Nubians arose again in 1976 and 1977, in relation to the rebuilding of Old Nubia and the construction of additional housing for urban migrants in New Nubia. From 1974 onwards, the Ministry of Housing and Reconstruction was concentrating on the rebuilding of the Suez Canal Zone in the aftermath of the 1973 war. With manpower and budget resources earmarked for the rebuilding programs, there was little inclination to develop new housing prototypes for Nubia. However, New Nubia was no longer in the political limelight and responsible authorities were quite ready to let the Nubians build and rebuild in whatever way they wished to.

Additional Migrant Housing in New Nubia

A study team sponsored by the Ministry of Housing and Reconstruction judged that it would be very difficult to use mud brick as a building material in the Kom Ombo region. The lack of alluvial deposits following the construction of the High Dam meant that the removal of large quantities of mud to manufacture bricks would deprive agricultural land...
of its fertile topsoil. It was recommended that sandstone and fired brick made from desert clay be used instead.

Load bearing construction was praised for economy and insulating properties because of large wall thickness. Project engineers were urged to exercise extreme caution in the selection of building sites, to undertake detailed borings and soil analyses, and to select suitable foundation methods to avoid the recurrence of the embarrassing experience of Dahshut village.

Alternative roofing systems were viewed with mixed feelings. Some felt that the climate control afforded by the traditional vaults and domes justified their use. Others pointed to problems of incompatibility with possibilities of vertical expansion of dwellings, and to anticipated difficulties in obtaining mud and finding masons capable of constructing these roof systems. Qualified master masons were scarce and the price charged for vaults and domes would double the cost of roofs. Instead, they suggested the use of reinforced concrete slabs, properly insulated by the addition of a layer of straw and mud. Other recommendations included narrower secondary roads and smaller, more numerous wall openings, adequately shaded and appropriately oriented.

For their part, the Nubians opted for "modern" housing. Subsequent discussions and negotiations with the Ministry revolved around the issue of size, not kind, of dwelling. The Nubians wanted all houses to be Prototype A, preferably, but were ready to accept Prototype B. Their delegates lobbied relentlessly with central authorities for these changes, and managed to obtain satisfaction.

Planning for the New in Old Nubia

In October 1963, when the Nubians first started to leave their homeland for the resettlement villages in Kom Ombo, they knew they could come back to this area after the level of the water had stabilized in Lake Nasser. This happened in the mid-seventies. Today, it is possible for Nubians to return to

New Nubia, Zawiyah and guest house in one of the villages
Photo: T Swelin

New Nubia, cafeteria, showing the adaptation of traditional decorative motifs to new uses
Photo T Swelin
the shores of Lake Nasser, reclaim and cultivate the alluvial soils on the slopes of kluers and recreate Old Nubia. In 1976, a committee was established by the Governor of Aswan to prepare plans for the development of the Lake Nasser region. It was decided that the re-building should start from the south and proceed to the north. In particular, tourist development around Abu Simbel had attracted population back to the area. This settlement is to provide the nucleus from which development is to spread to the rest of Nubia.

Government plans call for agriculture, fisheries, and food processing industries to provide the economic base of New Old Nubia.

As could be expected, this program appealed most to the Kushaf. Nostalgic elders aroused the enthusiasm of a generation of young Nubians whose recollections of Old Nubia were at best faint childhood memories. Some Nubian leaders requested that the government give them the land and let them rebuild their villages in their traditional way. The government acceded to their demand.

Some clans organized themselves into formal associations and went back to resettle the areas of Assada, Qasal, and Tushki. Land was allocated to the associations which, in turn, proceeded to distribute individual plots to members. Tents provided temporary shelter as these Nubians embarked on an attempt to replicate the past.

Many young people, unable to withstand the rigors of the desert wilderness, have since abandoned homesteading and returned to the urban centers. Others have stayed on. The government is still working on a regional development plan, and at this time detailed projects for new settlements have yet to be designed. It is difficult to conjecture on the eventual character of the habitat of New Old Nubia. But it is also clear that political, economic, and particularly time constraints imposed severe limitations on the technical options open to decision-makers. Two main issues must be addressed. First, what kind of environment should have been offered to the Nubians by the resettlement authorities? Second, what kind of environment do the Nubians themselves really want?

The professionals involved in the project feel that, despite its drawbacks, the environment provided in New Nubia was the best that could be achieved under the circumstances. Given the mandate of the Ministry and in terms of product quality and cost, this assertion can hardly be disputed. However, one cannot avoid wondering whether the need to project an immediate reality justified the time constraints imposed on project implementation. The opening of the coffer dam in May 1964 was going to lead to the immediate flooding of 6,000 feddans only. The gradual flooding of the rest of Old Nubia would take several years. It seems that the schedule could have been relaxed without endangering Nubian lives. With more time to study, analyze, and experiment, many of the technical errors made under pressure could have been averted. Also, one cannot help but ponder over whether oppressive monotony must be the unavoidable result of design for mass production.

At the time of the resettlement, most Nubians were rural in customs and habitat by necessity, and urban in occupation and outlook by choice. It is difficult to assume that they would have wanted to replicate Old Nubia in Kom Ombo, even if it was possible to do so. They were not about to learn building trades and engage in self-help construction, any more than they were about to return to agriculture and reintegrate into the Egyptian rural scene. Today, 16 years later, old values and customs are changing even more rapidly, as Nubians have joined in the massive labor movements in the Middle East, securing jobs in urban centers overseas. New Nubia is no longer a series of villages stretching along a ring-road. More than ever, it resembles the settlements in the fringe areas of large cities: semi-rural in appearance but undergoing rapid urbanization. The new dimensions of rural/urban relationships, involving migration of young families and the channeling of earnings into real estate, is reflected in the sustained demand for migrant housing in Kom Ombo. Old customs are changing and it seems unlikely that change can be redirected towards the maintenance of a rural ethos. The TV antennas sprouting over the houses of New Nubia are a clear indication to the contrary.

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Retrospective on the Nubian Resettlement Experience

Reflecting on the Nubian resettlement project, it is evident that mistakes were made.

Reference Notes

1. 320 kilometers from the Dam to Assada in Egypt, and then another 160 kilometers past the third Cataract to the village of Dal in Sudan
2. The National Charter, 1961, page 52. The system of local government was reformed to introduce partially elected councils, paralleling the hierarchy of appointed executives at every level of administration.
3. The Five-Year Plan for Economic and Social Development of the U.A.R. Cairo, 1960. The stated objectives of the plan were to achieve a balanced and sustained growth at an annual rate of 7 percent and an equitable distribution of income opportunities.
4. In the productive sectors, where investments required a large foreign exchange component, actual growth did not exceed 67 percent of the planned targets. In contrast, the service sectors overshoot their targets; the recorded actual growth was 170 percent.
6. This decision was prompted by the distressing experience of 1933, when Nubians were given monetary compensation for their submerged properties. Government land to be reclaimed at Eisa was made available to them on a lease-purchase basis, but most of them squandered the compensation money on consumer goods.
7. One feddan equals 4,000 square meters
8. In 1959, sales under the Eisa program were suspended, since it was judged that the government's investment in land reclamation was not being put to use.
9. Nubians who had received compensation in 1933 were to be relocated in Eisa, where land had been reclaimed for them. However, 26 percent filed requests to move to Kom Ombo and give up their title to land in Eisa. The government acceded to their request and allocated 214 houses and 445 feddans to them in the resettlement zone.
10. About this same time, in the early to mid-sixties, the Kaptai Dam in Bangladesh and the Volta Dam in Ghana displaced respectively 100,000 and 80,000 persons, without receiving the same attention.
11. The name of the Ministry was shortly thereafter changed to "Housing and Utilities." Later it became
the “Ministry of Housing and Reconstruction” The engineers and architects responsible for project implementation were Hussein Shafey, Head, Project Team; Michel Naguib Raphael, General Director, Kom Ombo; Lewis Atallah, General Director, Cairo; Ibrahim Osman, and Sami Maseoud. The design of settlements and housing prototypes was undertaken by a team in the Ministry’s Planning Office headed by Saleh Nasr Habib.

12. The two railroad stations were called Kalabsha and Ballana.

13. Ibn Hawqal in Kitab Suyay al Arid, Al Istakhri in Kitab al Aqiltim, Yaquat in Mas’um al Buldan, and Maqzish in Alshin al Taqasim, all refer to “arid al bagga,” which is the term for all the tribal areas called “Bagga.” Maqrizi in his Kitab devotes a whole section to the description of this tribe and their lands. The Bagga can still be found in Sudan, in the southern sector of this area. They are somewhat similar to the Bisharis in appearance and speak a dialect different from the Nubians. They live in isolated settlements and avoid contact with other tribes. Nubians who have met some of them say that they are partially Islamized, very fierce, and most frightening to encounter.


16. The first summer after resettlement was marked by unusually hot weather. In some of the worst heat waves, temperatures soared above 30°C. In May 1964, a record 55°C was reached. Nubians, project staff, and workmen suffered great hardships.

17. To the two major sugar refineries at Edfu and Kom Ombo. The district added plants manufacturing paper and allied products, including particle board.

18. Funded by a $77 million plant on the Aswan Dam, producing 1,880 million kilowatts per hour per year since 1960.

19. Numerous housing projects were undertaken by the industrial companies and by the High Dam Ministry, for their technicians and employees. In addition, the government was involved in various urban development projects in Aswan city.

20. Rural in-migrants working as unskilled laborers in the construction sector were most reluctant to return to their villages and remained in the urban centers looking for work on successive projects, or drifting to alternative occupations requiring minimal labor.

21. The small resettlement area at Esna, for Nubians from Tuins and the Aila village who did not petition to be transferred to Kom Ombo, involved housing units during Stage 1 (to be completed by October 1963), and 436 units during Stage 2. Stage 1 contract was awarded to a foreign firm.

22. The use of particle board, manufactured from by-products of the sugar refining process, instead of imported softwoods resulted in the savings of LE 1.5 million in foreign exchange.

23. The amount of stone needed was equivalent of 1.5 times the size of great pyramid.

24. The cattle, which had contracted diseases from Sudan and Ethiopia, had to be destroyed. The sheep and goats, which constituted the bulk of the livestock, were saved.

25. In 1963-64, the Five-Year Plan was falling short of its targets for lack of investment funds. Some of the planned manufacturing projects in the area had to be curtailed, postponed, or cancelled altogether.


27. Compensations varied between $50 and $3,500, and totalled close to LE 7 million, of which LE 3,588,000 had been disbursed in 1963 and 1964.

28. The head master mason would have been ‘Ala‘a al Din Mustafa, the recipient of an Aga Khan Award in Lahore in 1980.

Bibliography

Al Ahram, Cairo, Issues of 1/3661, 1/1661, 1/965, 10/2065, 11/26/65, 12/5/65, and selected issues from 10/63 to 6/64.


Marei, Sayed, U A R Agriculture Enters a New Age, An Interpretive Survey (Cairo, 1960).

Ministry of Housing and Utilities, Public Relations Directorate, Housing Cairo, 1965. (In Arabic).


Acknowledgements

Published reports provide very scanty information regarding the decision making process through which objectives were formulated and projects carried out in the resettlement operation. The analysis presented in this paper draws extensively on information gathered from interviews with senior officials and technicans involved in the project, as well as with Nubian families. I particularly wish to acknowledge my indebtedness to Engineer Michel Naguib Raphael, Member, National Services Council, President of the Republic, and Advisor to the General Organization for Building and Housing Cooperatives, and former Undersecretary of Housing and Deputy Director of the Executive Organization for the Resettlement of Nubians, for sharing with me his unparalleled knowledge of the project and his vast amount of technical reports and studies accumulated during twenty years of continuous involvement. It is not possible to measure the assistance which I have received from officials in the Ministry of Housing and Reconstruction in assembling data, information, and technical material regarding this project. I am also indebted to Mr. Abdel Fatlah Elid, Director General of Art Museums, Ministry of Culture, for giving me access to his invaluable collection of historical photographs of Old Nubia; to Professor Hassan Falisy for his enlightening survey of Old Nubian houses and his commentary on the project; and to Mr. Mohamed Madkour, Director General, Organization and Microfilming Center, Al Ahram, for the documentation of the resettlement operation and photographs of the project in its early stages. Finally, I wish to thank Mr. Tarek Swelim, Lecturer Guide, for his superb photography of New Nubia for the purposes of this paper.
New Nubia Program

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**Nasr City Administrative Center**

- Mosque
- Supply office
- Large market with consumer cooperative
- Bakery
- Primary School
- Intermediate and secondary school
- Rural teacher training school
- Social center and sporting club
- Central hospital (40 beds)
- Fire and police stations
- Post/telephone office
- Agricultural bank supply center
- Agricultural station
- Mill
- Slaughterhouse
- Veterinary station
- City Council
- Political center
- 5 apartment buildings for government employees (total 140 dwelling units)

**New Nubia**

**Building Materials Requirements**

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<thead>
<tr>
<th>Item</th>
<th>Unit</th>
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</tr>
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<tbody>
<tr>
<td>Stone</td>
<td>m³</td>
<td>3,500,000*</td>
</tr>
<tr>
<td>Brick</td>
<td>1,000 units</td>
<td>75,000</td>
</tr>
<tr>
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<table>
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</tr>
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Nubian Resettlement Project

### Housing

<table>
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<tr>
<th>Contractors</th>
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<tbody>
<tr>
<td>Firm 1</td>
<td>Amberkab, Dahmit, Dikka, Kashtamna East and West</td>
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<tr>
<td>Firm 2</td>
<td>Armina</td>
</tr>
<tr>
<td>Firm 3</td>
<td>Qasatal, Tumas, 'Afla</td>
</tr>
<tr>
<td>Firm 4</td>
<td>'Aniba, Masmas</td>
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<tr>
<td>Firm 5</td>
<td>Sayala, Mahraqa, Kalabsha, Abu Hur</td>
</tr>
<tr>
<td>Firm 6</td>
<td>Madiq, 'Alaqi, Qarsha, Qurta 2 and 3</td>
</tr>
<tr>
<td>Firm 7</td>
<td>Adindan 1</td>
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<tr>
<td>Firm 8</td>
<td>Tushki, Abu Sumbul</td>
</tr>
<tr>
<td>Firm 9</td>
<td>Dabudi, Ballana 1, 2 and 3</td>
</tr>
<tr>
<td>Firm 10</td>
<td>Sinqari, Shaterma, Kurusku, Maliki, Riqqa, Abu Handul</td>
</tr>
<tr>
<td>Firm 11</td>
<td>Jinina, Shubak, Ibrim, Jazira</td>
</tr>
<tr>
<td>Firm 12</td>
<td>Wadi al'Arab, Dirr, Tiqala, Qitta, Diwan</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
</tr>
</tbody>
</table>

### Administrative Organization for Nubian Resettlement

![Diagram of the Administrative Organization for Nubian Resettlement](image-url)
Correa

What came out of our discussion was the fact that process and ideology are equally important and absolutely intermingled. In the course of this change process, there is a certain “lead time”, if I may call it that, which is allowed planners. For instance, when we design and build, people then react but it takes some time. This lead time may be shorter when it’s a client for housing than when, let’s say, it is large-scale planning decisions.

One thing disturbs me a bit about our discussion, and this is that we return again and again to the problem of rural housing. This is one realm where we shouldn’t always focus our attention because in many many cases people can do it themselves. We ought to pay attention to other areas since rural development doesn’t just involve housing. There is an old story, quite amusing but also rather ironic, even cruel, about a chap who is seen grumbling under a street lamp. A friend comes by and asks “What’s happened?” The man replies “I’ve parked my car over there and I’ve lost my keys”. So his friend asks: “If you’ve parked the car and lost the keys over there, why don’t you look there?” “But there’s a lamp over there” is the reply. My point is that we keep coming back to the housing question because we think we can find the solution to the house; but that doesn’t seem to me to be the problem we should be looking for.

Lee

In the context of this discussion, I think it is important that we do not separate ideology and process, for when this happens we tend to lose sight of the goals set up by an ideology. Some specific aspects of the Chinese experience since Liberation aid in clarifying this point. This experience has been a long, gradual one, built upon land reform and progressive collectivisation over time; it was not a sudden one-step process. China is an ancient country, with areas already heavily settled, so that after Liberation new towns and market towns were not imposed; they already existed. Some were reorganised and re-planned as communes were founded.

A second aspect worth noting is that the Chinese process is rather different from others: housing is not the first undertaking. As architects and planners we should reflect upon this since we tend to think of giving settlements to people. The Chinese put the economy first; by this they mean production, and raising the standard of living through increased production. Thus, the capability of producing housing comes from within the community and is not simply the result of funds received from the central state — which, by the way, seemed to be the case in both the Algerian and Egyptian examples. In rural areas the communes are seen as self-sufficient units, and they must make investments from their own surplus, although they can and do receive some help from outside. Emphasis is placed first on investment of time and resources into improving production, i.e. irrigation, land reclamation and other kinds of work. Increases in production then lead to development of sanitation, to improved education which leads, in turn, to the surpluses that can be used for new housing. It is in these ways that agriculture is tied to environmental improvement, and a process of decentralised investments in such development is a basic factor of the Chinese system.

Babar Muntaz

I have a question to ask of our Chinese friends concerning the creation of market towns. How has this policy come about, by looking at models employed elsewhere, for example in the Soviet Union? In addition, how will the policy be implemented: by starting off with one or two experimental towns, or by building numerous towns simultaneously all over China?

Cheng Jiugi

China follows the principle: count on one’s own resources — autarky and free initiative. In recent years we have observed very carefully the development of market towns in China itself. Although some people abroad say that a market town should be the nucleus of rural development, it is only one possible conception. We have our own, which reflects real conditions in China. We have of course studied what has happened abroad and retained those experiments which proved applicable.

Feng Hua

One of the questions to which I would like to address myself has to do with the types of houses being built in the Chinese countryside. The construction of housing takes place in several ways, the most important being when the farmer builds himself. In certain regions, nonetheless, the community gets involved, and we have strongly encouraged this method of construction. A number of limitations to this approach have nevertheless appeared over the last few years.

The first of these results from the fact that we were unable to mobilise all the farmers. They were too dependent upon the collectivity. The houses produced were based upon a stereotyped model which did not meet the expectations and needs of rural people. Among other things, the control and maintenance of the dwelling caused problems which have not been solved.
Let me turn now to what has been learned in the field of building construction itself. The model for organising construction which is the most widespread calls upon the individual to execute the work himself while enlisting the community’s assistance. This model has the advantage of coinciding with the needs and wishes of most farmers.

In reality this means that the farmer brings together the capital and the materials, while the collectivity, i.e. the people’s commune or brigade, makes an indispensable contribution in terms of certain materials and the actual construction. Over and above this, the government gives technical assistance.

Thus, the construction of dwelling in China depends upon the individual efforts of rural inhabitants. Statistics are now available which reveal that a farmer, and anticipating his building needs, is able to raise a capital of approximately 100 Yuan a year.

China has 800 million agricultural workers: This figure should give an idea of the scale of problems encountered in construction of rural housing. Experience has taught us that we obtain the best results — in speed of construction and in solving difficulties — through the interaction of the two elements: The collective enthusiasm of the rural population and communal participation. This is the first point I wish to make.

Secondly, Professor Liu Kwang-hua spoke earlier of style in rural architecture. China has an ancient civilisation and farmers like to preserve traditions in housing. We are ready to recognise the fact that we haven’t paid enough attention to this aspect. Now we are proceeding in such a way as to allow a maximum expression of local characteristics, particularly since China is composed of 55 different peoples. Under the circumstances we are inclined to develop rural dwellings that preserve specific local or regional traits. In the last 2 or 3 years our architects and surveyors have made extensive research into rural architectural traditions. Tall buildings are not appreciated at all. Our farmers like to build a court, as Professor Liu already pointed out. So we are taking this into account in our plans and projects.

Our Egyptian colleague, Dr. Mona Serageldin, described for us a little while ago an experience of constructing new villages. That experiment contains important information for us in the realm of building codes as well as the application of plan types.

In the domain of construction materials, China has a number of difficulties. To alleviate these we have strongly encouraged the use of local resources. Take the example of the Loess Plateau in the northwest of China: we have encouraged architectural construction there with earth, similar to the underground houses of local hunters. This problem of materials can only be resolved through use of a variety of methods. During these last few years, the state has itself provided large quantities of materials, particularly wood. This is an important aspect of the Chinese government’s contribution to the building programme.

As for the methods employed by rural workers in constructing their own houses, they called upon their friends and family in the past, or recruited aid. This is a method which has advantages and disadvantages. One of the drawbacks is that labour is extremely costly. For this reason we have encouraged farmers to group together. The people’s communes and brigades organise a team of professional builders who sign a contract with the farmers and assist them in building their houses: the best results have been accomplished in this way.

The gravest problem we are facing is a lack of appropriate plans for dwellings. Numerous houses are still being built according to an identical model. The reason for this is lack of precise plans created ahead of time. We must take note of the problem of repetitiveness, as it is linked on a larger scale, to the problem of environmental planning generally in rural areas.
Introduction

To many developing countries and especially those in Africa, it has become increasingly evident that in spite of the tremendous efforts being made to provide education for their children, they have not been able to meet all of their educational requirements. Since the demand for education nevertheless continues to rise, these countries have had no choice but to try to obtain greater returns for their limited investments. Hence, a search for new approaches to the financing of educational buildings. Such facilities need to be created in Africa by Africans which will be less expensive than the conventional school building and more conducive to the attainment of national educational objectives. African society has a long and valuable tradition of communal actions to which fresh impetus is being given by the vigorous striving for self-reliance observable today throughout the continent.

Although self-reliance efforts in the construction of schools has become an accepted approach for providing educational space, nevertheless, it has not received the necessary technical support to ensure the required quality and imagination. Thus, the opening of new opportunities to African states to tap the non-monetary sectors as a key resource to achieving greater self-reliance in building schools has become the centre of attention.

Furthermore, when we speak here of educational spaces, we are speaking of them as an extension of the dwelling space. The means, materials and available techniques for building them can be similar, given the climatic conditions and norms for comfort prevailing in the same locale. In a wider sense, dwellings, markets, dispensaries, silos and schools constitute educational spaces to the extent that they are places where knowledge is transmitted from person to person. Thus, an educational space corresponds to a liberated dwelling space for it is used by a wider group of individuals than only school-goers.

The issues which lie behind a school building such as the one in Nianing may be summarized as follows:

• reducing the ever increasing capital and recurrent costs of education and in particular the reduction of building and maintenance costs;
• doing away, as far as possible, with the over-reliance on imported building materials and techniques which require high level skills, thus alienating the masses from participating in the educational process and consequently widening the gap between the school and the community it serves;
• the provision of an educational facility that possesses the quality of built-in flexibility and which answers to the demands of curriculum reform and innovative teaching methods;
• the provision of an educational facility that reflects the cultural capacity of the community in utilizing the human and material resources locally available.

Certain basic criteria can be delineated if the goal of self-reliance is to be achieved.

Materials and building technology

1) The materials and techniques to be chosen should contribute towards providing buildings that possess the durability and performance of those ones conventionally built, using cement block walls and reinforced concrete or corrugated iron sheet roofs if they are to be acceptable to the communities.

2) Materials and techniques used in the construction should play the role whereby they contribute directly to socio-economic development. They should provide an alternative to imported materials and give preference to those fabricated from locally available materials in order to generate employment opportunities for local labour.

3) It would be better to avoid the use of materials that work in tension, such as timber and reinforcement steel which are costly and imported. The employment, therefore, of materials working in compression under determined geometrical forms and which permit the provision of spaces of reasonable proportions imply resorting to the possibility of using the arch, the vault and the dome.

Labour

Labour constitutes a basic resource for building which can be found anywhere. Furthermore, the skills of the labour force depend above all on the local architectural practices. Generally speaking, local labour in Senegal is not skilled in modern building techniques and the complicated logistic skills required for them. To make full use of the local human resources, the following conditions need to be fulfilled:

1) building techniques should be sufficiently simple if they are to be mastered by an unskilled and semi-skilled labour force;
2) the scale of the project must correspond to the level of organization within the community;
3) the period during which the construction was to take place should coincide with that when no agricultural activities take place;
4) technical guidance and training-on-site should be provided since they are a crucial element in improving the capacities of the labour force.

Logistics

1) The complexity of supplying building materials to a site is proportional to the number of different types of construction materials utilized, and the efficiency of the transport infrastructure. Materials for conventional modern construction are often not found near the site, whereas those used in traditional vernacular architecture are available.

2) Furthermore, the use of both types of materials requires a two-tier supply structure which will include a central fund for procuring imported materials and a local fund for purchasing materials on site (Likewise, such use of two types of materials will create a need for two types of skills since a good skilled craftsman in the modern sector is not necessarily skilled in traditional building techniques.)
General Background and Ideology

The living conditions in the Sahelian environment have not contributed to promoting the construction of permanent dwellings. Nature imposed frequent population migrations, thereby encouraging temporary dwellings. Apart from a solid artisanal practice and an ancient influence from the East brought about by Islamic and Mediterranean monuments, elements of a traditional architecture were non-existent except in the valleys of the Nile and River Niger, and the areas surrounding them.

It is only in the last 50 to 100 years that such a precarious existence started to slowly give way to an aspiration for more stability around the emerging poles of development.

The modern house is a rectangular one. The walls are usually made of cement blocks with reinforced concrete tie beams at the top and bottom and columns. The roofing is of corrugated iron sheets. Such a house is ill adapted to the climate of the region. The enclosure of the house is in cement blocks.

The traditional hut, the case, is on its way to disappearing in spite of its thermal comfort and low cost. The modern house which requires less maintenance is considered a good investment. The lack of skill in modern construction results in a poor application of modern materials and techniques.

At the same time, with an ever increasing population and already limited resources, materials are becoming scarce, such as timber which is a material that encourages traditional architecture.

With such scarcity of local materials, the way remains open for invasion by corrugated iron sheets, reinforced concrete and hastily made cement blocks which now stand to be the costly symbols of emancipation and prosperity in spite of their poor quality and architectural insignificance.

Under these circumstances, the foundations of an adapted architecture need to be created for which only limited possibilities are available. One should therefore make maximum use of the traditional techniques and expression which need to be rediscovered. Between ill-adapted imported techniques and non-improved traditional techniques as the two extremes, there is a place for an adapted architecture which reintegrates the climatic data and expresses itself through exploiting the best qualities of available local materials and labour.

Human Resources: The Employment Problem

A study conducted in 1974 in the neighbourhoods of Rufisque (second largest town in Senegal) 25 kilometres from Dakar revealed the following:

- In four neighbourhoods surveyed out of a total population of 14,540 the population of working age amounted to 50 percent (i.e. 7270). The active population was found to be 1920, which gives a 30 percent employment rate. However, the official number of unemployed persons is given as 8 percent. If we consider that to be unemployed officially a worker must have a salary and be registered in the Labour Office, we find that most of the people without employment have no fixed salaries;
- The qualified labour force (management executives, high level technicians, middle level technicians, skilled craftsmen, etc.) represents 35.3 percent of the working population. The semi-skilled represents therefore 64.7 percent.

Importance of Traditional Sector Activities

There exists in the urban and semi-urban areas two well defined economic sectors: the modern sector and the traditional one. This dual aspect plays an important role in the employment problem. The modern or formal sector is characterized by capital intensive techniques, high salaries and operations on a large scale.

The second sector which is traditional, informal and non-structured and composed of economic units has the opposite characteristics in having abundant labour (labour intensive), small scale operations, traditional working methods and modest earnings distributed amongst those working in it (production or service labour, individual carriers, street vendors, etc.).

In the context of Senegal, where visible unemployment poses an acute problem, the importance of the traditional sector cannot be overlooked for it contains a considerable labour force which has low productivity and underemployment. In most cases, this sector absorbs 40 percent of the working population (46 percent in Rufisque). One also observes that the job supply in the modern sector has reached its limit of supplying jobs. This can be attributed to the limiting factor of its need for qualified labour. Further, one can say that the traditional sector is often a temporary refuge for workers seeking a permanent salaried job. Its high capacity of absorption reduces the pressure on the urban labour market by ensuring returns (uncertain and modest) to an important part of the labour force.

Principles of Action

To improve employment opportunities in a country like Senegal, one can conclude that:
- the only sector able to meet efficiently and at short notice employment demands is the traditional sector;
- it is particularly desirable to have a large number of minimum investment projects where the labour costs for a product or operation exceed the capital investment for the constant element such as materials;
- employment in the traditional sector does not require a high level of skills;
- as far as the construction market is concerned, a high level of skill should not be required of the labour force and with some training and guidance can improve the quality of the output.

Thus, one of the concerns of the project was to use labour intensive techniques. In this regard attention was given to training manpower on the site by a skilled mason.

The team of architects from BREDA found and hired an experienced but unemployed master mason whom they trained in the
building system by building a first prototype structure in Dakar itself in 1975. With the commissioning of the Agricultural Training Center, the mason agreed to move to Niaining, where he trained a number of local men in the necessary techniques and supervised the totality of the construction which lasted for twelve months. However it should be noted that the availability of the BREDA architects for controlling the quality of execution was a determining factor in the success of the operation. Their participation amounted in all to twenty months of work of an architect for the research, training program, drawing up of plans and supervision.

The Structural Concept of a Prototype

The system proposed and experimented upon by the team is characterized by its short span between parallel bearing walls. The openings in the bearing walls are achieved by means of arched over a span which can extend to eight metres. The short span can be covered in a sense perpendicular to the walls either using traditional materials, a vault or a thin membrane of ferro-cement on condition that the stability of the bearing walls is assured at the central part of the arch. To counteract the horizontal forces on the peripheral walls, buttresses were employed.

Studies were made on the built-in flexibility of the proposed prototype. These were done in a comparative study made on the functional aspects of educational spaces constructed using modern construction techniques and the spaces the proposed structure will provide. It was found that with an arch spanning 6.40 meters and two bays covered with vaults having a span of 2.8 meters space could be provided for 40 pupils with spaces for individual work in the niches. Such spaces would likewise allow for innovative teaching/learning situations such as working in small groups, large groups and for other activities such as drawing, painting, modelling, etc. The space could also serve as a theatre during inclement weather. Further, the possibilities for grouping a number of buildings to form a complex was
Material Resources

The choice of materials or construction technique has both psychological and technical implications. In the first place, it expresses a way of life. In the case under consideration, such choice has to take account of the aspiration for having a durable building, which will enhance the value, and limited financial resources which could lead to an unwise use of the imported and so-called 'modern' materials.

It was therefore found that the use of local materials with simple techniques rather than industrialized ones seemed to present several advantages, of which the following are the most important:

- local materials have undeniable qualities which are sometimes superior to those of modern materials (i.e. thermal qualities which often cannot be matched — at least not for a reasonable cost);
- they are less costly and readily available in the immediate surroundings of the building site;
- their extraction, treatment and use can easily be carried out by a labour force which is abundant and with minimum skills;
- the control of its quality is easy and does not require foreign specialists. When its quality is low it can be considerably improved through simple research.

Bricks

Sand has no cohesion. A binding material must be used to render the soil structure more coherent if it is to resist forces in compression. The granulometry of the sand used is a determining factor in the brick's resistance in compression and the required quantity of the binder. If the grain size is the same, the intergranular cavities will be maximized and larger quantities of the binding material will be required. Further, if the grain size is too large, a rapid erosion of the bricks is likely.

In order to determine the optimum granulometry, compression tests were carried out on 38 cubes having different mixes of sea sand, dune sand and cement. It was found that a mixture containing equal quantities of sea sand and dune sand and 125 kg/m$^2$ of cement (9 percent by volume) had a resistance to compression of 17 kg/cm$^2$.

The production of bricks for Nianing had to be carefully controlled to maintain good quality ones. In order to avoid quick drying which affects the chemical action in the cement, bricks were watered and stacked in the shade. Irregular watering was likewise avoided and bricks were watered during six days, twenty-four hours after coming out of the mould.

Constructions Materials used in Nianing

Sand

The basic building material is earth, the only abundant material around Nianing. Sea sand (grain size 0.2 — 2 mm) and dune sand (grain size < 0.2 mm) are available in abundance. The sea sand was extracted from the higher parts of the seashore which has been washed by rain and thus the salt content is minimal. The dune sand was extracted on the site after excavating the top layers of soil which contain excessive amounts of organic material.

Mortar for the Roofing

The roof vault was made in three successive layers. The first, which represented a thin vault, was of mortar made of a mixture of sea sand and cement (250 kg/m$^3$). The second layer, in order to offset the horizontal stresses in the vault and contribute to its thermic inertia, had a mix of equal quantities of sea sand and dune sand and cement (125 kg/m$^3$). The third and last layer, which is to ensure that the vault is waterproof, is of a mix of equal quantities of sea and dune sand and 375 kg/m$^2$ of cement. To ensure a good bond between the three layers, the vault had to be completed within a week. Fast drying was inhibited by protecting the surface using thin plastic sheets.
Mortar for the Joints

Mortar for the masonry was a mix of sea sand and 250 kg/m$^3$ of cement and this was found to be practical and adequate. To avoid quick drying of the mortar, bricks were soaked in water before they were laid. Masonry was watered once a day during one week. Joints were made with a 2 centimetres shrinkage which was filled with a mortar of a rich mix leaving a joint shrinkage of 3 millimetres. Joints were watered during several days.

Millet Stalks

The millet plant provides, besides the staple food, large quantities of ± 2.0 metres long stalks in the Nianing area. These stalks are used to fence dwelling plots as well as for the construction of huts. Nevertheless large quantities of stalks remain unused. Since they are not a durable material and decompose rapidly, they can be used temporarily and then be discarded. Aware that Senegal has to import all the timber it needs, millet mats were found to serve as shuttering in the construction of the vaults.

Wire Mesh

Although no reinforcement of the vault is required, wire mesh was used to reinforce the vault to ensure security during construction. The first layer of the vault, being a thin vault, such reinforcement was found to be necessary and was to cover a width of one metre centred at the apex. The wire mesh used had 4 centimetre stitches.

Having found that the price is three times that of galvanized wire from which it is made and which can be found in any village shop, the wire mesh was manufactured on site, thus providing an opportunity for employing local labour. Thus, compared to the first experimental prototype, the cost of reinforcement of the vault in Nianing is only 10 per cent of its total cost.

The Notion of Comfort

This aspect was studied from the point of view of the following factors:
- heat and sun radiation;
- humidity during certain periods of the year (rainy season);
- low temperatures during the months December and January;
- violent winds with lashing rain (July to September);
- sand laden winds.

The first three factors of these are closely linked with the notion of thermal comfort which in itself depends on four main environmental conditions which are:
- air temperature;
- humidity;
- air movement;
- radiation.

While air temperature and humidity are difficult to control without mechanical means, by controlling air movement and thermal radiation it is possible to considerably increase the feeling of comfort. This is achieved through the control of openings to attain optimal air movement and better orientation to avoid sun penetration, as well as thermal isolation.

In the case of Nianing, the vaults were studied with a view to increasing their capacity for storing heat during the day (insulation by accumulation) which is a crucial factor since during the bigger part of the day the buildings are occupied.

Climatic Factors

The Micro-Climate of Nianing

Micro-climate is that of the site and its immediate surroundings and as such various factors contribute to it. In the case of Nianing, the presence of the sea influences the climate. The case is especially so during the dry season where the micro-climate, compared to the dry continental climate of the region, is more humid with small diurnal temperature differences and lower maximum temperatures. During the day, from 3:00 p.m. onwards, a cool wind blows from the sea. During the night a hot dusty wind blows from the land to the sea.

Architectural Programme of the School

The Nianing Agricultural Training Centre created by CARITAS-Senegal has a regional character since it receives trainees from all around the area. It was designed to receive 50 full-time trainees for a period of two years, who are sons of peasants in the area. It also receives trainees for short training courses of one month twice a year per group. The full-time courses are from October to May and short training courses take place during the
holidays June to mid-July. From mid-July to end-September the full-time trainees do practical training in the field of grain cultivation.

Based on a study of the training programme content and time allocation, the required spaces were established as follows:
1. Classroom for 40 students
2. Multipurpose hall
3. House for overseers
4. Staff houses
5. 10 dormitories of 4 beds each
6. Dormitories for part-time trainees
7. Kitchen with ancillary service area
8. Library
Sanitary facilities for the administration, teachers and trainees. Evacuation is water borne using septic tank.

Technical Data

The Structural System Used

The system is characterized by short roof spans between bearing walls with arched opening having a span of 7.2 metres in a sense perpendicular to the vaults. The roof spans are of the order of 3.2 metres.

The geometrical forms of the foundations, the bearing walls reinforced by buttresses on the outside of the arches and the vaults have been chosen so that they all work in compression.

The Vault and the Short Spans

By its geometric form, an ideal vault works in compression thus permitting the covering of space with materials working in compression and which are readily available (sand, stone, bricks, etc.) without having to resort to materials working in tension.

The ideal vault does not exist. It is often suggested that the form of a catenary in an inverted sense is ideal. True as this may be such a form offers the resistance to a uniformly distributed load without positive and negative moments, concentrated loads in the vault, wind loads and the fluctuation of the
temperature on the surface of the vault or unequal consolidation of the foundation soil could create positive or negative moments which might result in tension. The form of the vaults at Nianing took that of an arc of a circle as an approximation of the catenary, if the angle of the circle remains small. Since the available materials used had to be supported by shuttering during the construction of the vault, the form of an arc of a circle appeared to be the most practical.

The Vault and its Influence on the Stability of Construction. The choice of the geometric form of the vault determines a total construction system with its span, its bearing walls, its architecture and its thermal qualities. The compressive force in a well conceived vault are of the order of 0.5 — 1 kg/cm². On condition that the walls are sufficiently stable to give the vault a fixed support it can support a charge six times its weight uniformly distributed.

The Rise of the Vault. An increase in the rise of the vault is favourable for the stability of the walls. However, it must be remembered that there is a limit, since a vault with a very large rise needs a larger quantity of materials. In this latter case, the compression forces are low while the wind loads become a determining factor in the case of a thin vault due to the increase in the surface area exposed to such wind.

As such, the Nianing vault was conceived to provide the optimal solution to reducing the force at the point of support and the materials used in its construction.

The Distribution of Loads. For a thin vault, a wire mesh reinforcement is indispensable. One can dispense with such reinforcement by increasing the thickness of the vault starting from the apex and going towards the support. Even if there is a displacement of the line of force because of a concentrated charge, it will still remain within the vault. Further, such distribution of load favourably influences the reaction at the point of support and offers a possibility of creating a thermal inertia.

Testing the Vault for Failure. A failure test showed that the vault could support loads much higher than its dead load. However, most important about the test is that the stability of the bearing walls is a determinant factor of the stability of the entire structure.

The deformation of the vault was less than 5 per cent of the total elastic deformation. The plastic deformation could be seen in well-defined cracks. During testing the vault supported a concentrated load of 400 kg/m² without the occurrence of any visible cracks and without a measurable sag at its apex.

The Arch — The Large Span

The geometric form of the arch permits the provision of a large span using materials working in compression. Such form is also determined by economic factors and construction techniques.

The arch with a plain centering permits having a building of minimum height compared to other types of arches and is therefore more economical. Its execution with a single centre of a circle is the least complicated. However, the stress of the horizontal forces on the foundations are higher than in the case of arches where the ratio between the height and span is higher.

The span of the arch depends on:
- the spaces required;
- the resistance in compression of the materials used in its construction;
the condition of the soil under the foundation.

A span of about 6.0 metres already allows the creation of spaces for various educational activities in a classroom. Up to about 7.5 metres span the stress in compression does not go beyond 10 kg/cm², which is the admissible stress for the materials used.

The bearing capacity of the soil determines the span of the arch. In Nianing, cracks appeared in the crown of large span arches. However, spans of up to about 6.0 metres were achieved where the foundation soil was composed of fine sand without the appearance of significant cracks at the crown.

There are several risks of instability of the arch:
- lateral buckling
- vertical buckling
- rotation or slipping of the foundations.

The solution chosen for the lateral buckling was to reinforce with 38.5 centimetres long bricks laid horizontally all along the length of the bearing wall which decreases springing with a factor of 2.6 on condition that the joints are well filled.

To solve the problem of vertical buckling, buttresses were provided on both sides which decrease the degree of springing by a factor 3.6 if the buttresses have the same thickness as the arch.

The eccentric loads transmitted to the soil by the foundation, as well as their horizontal component can provoke a displacement and a rotation of the foundation. It is necessary to study the admissibility of the arch span for each type of soil. Further, foundations should be conceived in a manner whereby eccentric forces on the foundation are avoided.
For a semi-circular arch, the keystone of the arch poses a special problem. Since the axis of symmetry goes through the keystone, the forces in the latter are horizontal and can only ensure coherence between the arch’s elements. If the shuttering is removed during the construction phase and before posing the vault, the compression centre remains near the centre of gravity of the middle section of the arch and there are no traction forces in the arch. Whereas the compression stresses are highest in the upper extremity and lowest in the lower extremity.

Once the vault is posed on the arch, the vault contributes favourably to the bearing capacity of the arch, thanks to its own rigidity. The compression centre will now move to the centre of gravity of the section comprising both the vault and the arch. The risk here is that tensile stresses might be instigated in the lower part of the arch’s section and cracks may appear.

This cracking can even be more serious if the shuttering is not removed before the vault is posed, since in this case no compression stress will be existing in the arch before such posing.

Cracks which start at the bottom of the centre of the arch and move upwards do not entail the risk of affecting adversely either the bearing function of the arch or the stability of the construction. However, cracking can provoke the risk of bricks coming loose and falling on somebody.

Solutions to Localized Instability

A large keystone, the upper width of which is larger than the lower, makes it impossible for an element to fall down. The width of the keystone should be $\frac{1}{10}$ × the span.

Another solution is the inclusion of the vault to create an expansion joint above the centre of the arch in order to keep the centre of compression near the centre of gravity of the arch.

Roofing can also be done at two levels with a light roofing for the upper and a heavy one for the lower. In such a case, the loading transmitted to the foundation will be almost concentric and its rotation will be minimal. This will reduce the risk of cracking.

A way of ensuring security in case a crack occurs is by doweling with mortar of a rich mix. This will prevent, in the case of two parallel cracks, elements from sliding and falling. Further, to prevent elements from sliding, special bricks with keys can be employed in the construction of the arch.

Bearing Walls and Buttressing

The weight of the vault and that of the wall do not bring about a compression force at the base of the wall in excess of 1 kg/cm².

Meanwhile, compression forces increase considerably because of the horizontal component at the point of support of the vault.

The walls supporting the roof are always built of solid bricks in order to ensure the homogeneity of the wall to create a counter force to
the horizontal ones from the vault. Special attention should be given to the bonding to ensure this. Superposed joints cannot be tolerated in this case. Modular blocks were used which made this possible without having to resort to cutting bricks.

One can increase the stability of the bearing wall in two ways:
- by increasing the thickness of the wall;
- by reinforcing the wall with buttresses.

One notes that increasing the thickness of the wall is costly and has a marginal effect on increasing stability. Also, the bricklaying in a thick wall can prove to be more difficult for masons with limited skills. Therefore, the best way to improve stability is to use buttresses.

In order to obtain optimum stability by means of using buttresses, they must be monolithic with the bearing wall and placed at regular intervals. The upper limit of the distance between two buttresses should be six times the thickness of the wall. The distance between an end buttress to the end of the wall should not exceed two times the thickness of the wall.

These limits were established to answer to the constraints of flexure and shear stresses in the bearing wall.

Foundations

The foundations in Nianing have been designed to ensure a uniform loading on the soil. They are 60 centimetres deep. The first layer is stabilized and well rammed laterite with a minimum thickness of 20 centimetres. It is poured directly in the foundation pit without any blinding. Two courses of masonry are then placed on the top of it which form an integral part of the foundation. The loading of the soil in Nianing was limited to 1 kg/cm² and from the nature of the soil it was found that the angle of internal friction of the soil was 20°. The horizontal component of the support reaction could therefore not go beyond 1/3 of the vertical component.

To avoid settlement of the foundations, the laterite layer was placed directly on the surface of the excavated soil without any sand fill.

Also, every effort was made to ensure the uniform loading of the soil so that differential settlement does not occur.

Stability of the Structure during Construction

While the stability of the peripheral bearing walls is assured using buttresses, that of internal walls is ensured by the symmetry of the roofing vault since the horizontal components of the two adjacent vaults on the wall counteract each other. However, while this is the case on the completion of the building, it is not so during construction.

The possibility of propping the walls to absorb the horizontal forces on them was considered but abandoned since it can be a source of errors and needs close supervision. The procedure was therefore adopted of building vaults in sections.
Waterproofing and Rainstorm Drainage

The tightness of the roof was ensured by a layer of a rich mix of mortar (400 kg/m³ cement).

However, thermal expansion during the day and contraction during the cool hours of the night caused hair cracks in the roof, as well as larger cracks at regular distances where the roof was long. The latter took place in the joint between parts of the vault. For this reason, wire mesh was used to reinforce these joints.

Thus to ensure that the roof was waterproof, the following actions were taken:
* the exposed surface of the vault is painted with lime each year. The lime fills the cracks and expands with humidity closing the cracks. Further, its white colour proved to be advantageous in reflecting the sun’s rays and reducing insolation;
* expansion joints were made to divide the roof in distances up to a maximum of 6.0 metres in order to avoid cracks due to expansion;
* construction joints in the vaults were covered with bitumen felt;
* gargoyles were provided and the slopes leading water to them were increased to ensure a quick evacuation.

Projects after the Nianing Experience

After the experience of the experimental building of Nianing, other buildings were constructed using the short span concept.

Our preoccupation during the architectural conception of these buildings was the provision for stability during construction. During the execution, the supervision by the architects was much less frequent. A silo, a classroom in Nianing Village, a church, and many middle-level vocational training centres were built. However, due to special implications in design and construction, only the silo will be mentioned here.

The Silo — N’Diarao

For better stocking the following considerations were taken into account:
* the need to maintain a constant temperature;
* protection against insect penetration;
* the capacity was to be 200 metric tons;
* the need to use local materials;
* the need for more skilled masons.

Thus the silo of N’Diarao was considered an alternative for a modern silo. It was constructed using the short span concept and all the materials used were working in compression. Sand was extracted from near the site and the masons were from the village where the silo is located.

The silo was designed and constructed to provide the optimum conditions for grain storage which are:
* an average thickness of the roof of 45 centimetres, allowing for a maximum fluctuation of temperature of around 3°C day and night;
* the silo was hermetically closed in order to allow for the generation of methane gas which renders life impossible for rodents. As such the penetration by insects and rats is impossible during the period of storage;
* the silo was protected against humidity through the floor;
* the buttresses of the bearing walls were towards the interior of the silo to allow for a larger storage capacity.

In the construction of the silo, no reinforced concrete was used. This necessitated a design where the pressure on the walls was counterbalanced by the weight of the roof. The technical means employed were:
* the pressure of the grain on the external walls was limited by the adaptation of the height of the roof to the natural slope of the grain, as well as on the flooring sloping upwards towards the outside walls;
* each element of the silo is statically stable, which eliminated the problems of stability during construction;
* with these details and precautionary measures, the villagers were able to execute the project themselves under the supervision of a chief mason who had no previous expe-
rience in this type of construction.

The building costs were 12,000 CFA francs\(^2\) per stored ton. Considering that the value of a stored ton is 36,000 CFA francs and that loss in the traditional silo can amount to as much as 25\%, the N'Diako silo can be amortized within one and a half to two years. Since about 50 per cent of the cost was reinvested as labour costs in the village, the cost of the silo could be considered as 6,000 CFA francs per stored ton.

This detailed presentation of the technology introduced onto the Senegalese building market was intended to reveal the construction techniques and the levels of expertise required for it to be operational. Had time permitted, other factors of equal importance would also have been discussed, such as the way in which architects, masons and trainees interacted and communicated as the building site progressed. The socio-cultural implications of the system and its diverse uses, also merit attention and have been discussed elsewhere\(^3\).

**Reference Notes**

1. See initial study published by the UNESCO regional office for Education, P. Busat (and others), *Flexible Short Span Structure for Low Cost Educational Building* (Beirut, 1973)
2. 50 CFA francs equal 1 French franc

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This text follows the main lines of a joint essay, *Vers une meilleure utilisation des ressources locales en construction, Centre de formation agricole à Ntiring* (UNESCO, 1978) by Oswald Dellicour, Kamal El Jack, Chris Pasata and Paul de Waliek.
A Perspective on Autonomous Building in Senegal

Brian Brace Taylor

In a recent article by Bjorn Hettne entitled "Self-reliance versus Modernization: The Dialectics of Indian and Chinese Development Strategies" the two strategies, self-reliance and modernization are not seen as ideologically incompatible but rather as dialectically interrelated, each having a corrective effect on the other. The building technology, developed in Senegal, and presented here, is an excellent opportunity for evaluating the two approaches, precisely because the technological option was closely tied to larger social and economic issues of development.

According to Hettne, one perspective modernization sees development in the Third World as "necessarily a repetition of the historical experience of contemporary industrialized countries"... "It may be argued", he continues, "that technology is somehow more universal than, for example, a political institution, but we feel nevertheless that the Form and Content of technology is so deeply influenced by a specific culture that a certain technology also implies a certain social structure. Thus, "modernization" will here be used more or less as a synonym of 'Westernization'..."

The other strategy, of self-reliance, is based upon an ideology of localized, progressive change and improvement of existing structures rather than through imitation and ultimately destruction. The stress here is on human potential as opposed to essentially technological means.

The Senegal experience is illuminating because the emphasis was upon an inexpensive building system using locally-produced material and maximum local labour rather than a dependence upon imported materials, machinery and expertise.

Prior to construction of the Agricultural Training Center in Nianing, which proved to be a large-scale application of the system, a prototype structure was erected on an experimental building site in Dakar under the supervision of experts from the local UNESCO (BREDATA) office for educational buildings. This single unit was executed by a Senegal ese mason then unemployed who has been instructed in the building system and who was assisted by local laborers. Several

Interior of classroom, Agricultural Training Centre, Nianing, Senegal
Photo B Taylor

Detail, interior wall showing bricks with decoration incorporated. Light enters through cement block screen at left
Photo C. Little/Aga Khan Awards

Exterior, detail of classroom wall showing relief decoration done by brickmakers, and low seat for sitting out of doors.
Photo B Taylor
Primary school built in Nianing village, using same technique as at the Agricultural Training Centre.
Photo C. Little/Aga Khan Awards

Small church built with the technology introduced by UNESCO
Photo C. Little/Aga Khan Awards

images included here will suffice to illustrate the rudiments of the system, which involved bearing wall construction, with buttressing, sometimes with arched openings, built of sand and cement blocks manufactured on-site. The same blocks were employed as formwork for the arches and then taken away and reused when the wall was completed.

However, the key innovation introduced on the local scene through this prototype was the roofing which consisted of thin, barrel vaults of cement capable of spanning a maximum distance of 3.2 meters. Demonstrations and tests were conducted on site before the vaults were actually constructed in place, using plywood centers and millet stalks as formwork. The prototype was done under the guidance of a largely Western, or Western-trained group of architects, directed by Mr El-Jack, a Sudanese architect employed by UNESCO.

The satisfying results of this experiment, from an economic point of view as well as a social one in having retrained masons, became known to the future client of the Agricultural School, CARTIAS, which is a Western European Catholic assistance organization that had been working in Senegal already for some years and had a rural development station.
about 100 kilometers from Dakar. I wish to underline here the fact that neither the sponsoring institution for the school, nor those who initiated the vault construction system were indigenous to Senegal. This, it may be argued, is a crucial ideological factor in the eventual success or demise of the proposed technology.

At Nianing, the original mason of the prototype unit was hired as chief mason and transferred to the site in order to oversee construction and train new masons in the system. UNESCO agreed to ensure the overall coordination. The programme defined by CARITAS was for a school to accommodate fifty-four resident students from rural villages during two years of agricultural training (basically truck-gardening). One interesting dimension to the endeavor is that initially it was a group of architectural students, from the newly-founded faculty in Dakar where one of the UNESCO experts was teaching at the time, which produced a series of alternative site plans for the Nianing school, based upon the new building system. An amalgam of the best aspects of each yielded the final plan. Had they then been able to follow through the actual construction to the end, it would have been a marvelously integrated pedagogical as well as building effort.

The complex, on the periphery of the village, consists of a teaching block, with main entry, teaching facilities, administration and communal kitchen, student dormitories, separated from the teaching block by a courtyard, and teachers’ housing, for them and their families. A large open hall is the focus of social activities but can be used for instruction or for eating as well.

Construction on the Nianing school began in
June, 1976, with the mason from Dakar and his assistant, and after several months there were six masons who had been trained and twelve laborers. In the beginning, walls were designed brick by brick by the architects in order, among other things, to convey to the masons the required standards of execution since none of the walls were to receive an outer coating of stucco. This no longer proved necessary after the first few buildings and only the basic plans and elevations were drawn thereafter. When construction terminated in July, 1977 some ten masons and twenty laborers were employed. The total cost of the project was 17 million francs CFA, (US$80,000), of which over 60 per cent was spent on labor. (The average cost per square meter according to available figures was 10,000 CFA, or US$47)

The significance of the experience in Nianning may be summarized, at least in the broadest terms, by the following. Techniques developed in utilizing the short-span vault system on a large scale project aided those who initiated it in judging its overall validity. A structural system using materials in compression rather than tension reduced costs by eliminating the need for expensive steel reinforcing and for wood, which is scarce, for formwork. Locally produced rather than imported materials, which includes the cement, were used in the main. Masons could be trained, or re-trained, to utilize the technique, thereby stimulating an alternative to the predominant conventional techniques used in local building, namely reinforced concrete structural framing and cement block infill.

A very encouraging indication of the system's viability was the fact that there was a kind of proliferation of the system, in the form of new commissions for buildings. A primary school classroom was built in Nianning village during construction of the Agricultural Training School. A cooperative grain silo was executed in the even more remote village of Ndiaro, at the request of the local residents. An Intermediate Technical Training School (financed by the World Bank, where one of the original UNESCO consultant architects had important responsibilities) was under construction last year. And, the Duara Koranic school designed and closely supervised by Raoul Schnider in Malika, a village very near Dakar was opened in April, 1980.

However, in each of these instances quality control of the actual execution was ensured, to one degree or another, by architect-technicians. This brings us back to the vital ideological issues of modernization versus self-reliance. It is not at all evident, to my mind, that left on their own, the masons trained in the system would find clients willing to invest in this kind of construction. Nor is it clear that the mason would exercise the same diligence in respecting the norms established by the UNESCO architects once they were no longer present (Walls of 20 centimeters, optimal thickness of the vaults, brick claustras set back from the edge of the vault, etc.) This likelihood, that he would not, raises the criticism of the system being too sophisticated for popular use. A great deal will depend upon the demand for this kind of construction from various levels of society and upon the incentives for the contractor-mason to employ it. Self-reliance in this instance, it seems to me,
will succeed only if the system introduced on the local market can become firmly rooted in the basic local mechanisms that account for the majority of new buildings.

The Daara experience, about which Mr Snelder has volunteered further information during our discussions, provided opportunities for implementing a truly dialectical approach to self-reliance and modernization through greater community involvement (social, religious, and political). Choice of the site, choice of laborers (the mason was, however, initially the same as at Nianing), choice of suppliers, all involved the local population which means their social structure, their specific cultural attitudes, their economic infrastructure came into play to a greater degree than heretofore. Only to the extent that the architect-specialist’s future participation diminishes, as these indigenous mechanisms take over, will self-reliance have occurred. It means, in other words, taking the “assisted” out of “assisted self-help” construction.

It is too optimistic, I believe, to hope that this kind of self-reliance can be instigated effectively by outside international experts alone on a project by project basis, or to imagine that such a technology will take hold spontaneously as a result of several demonstration projects — however convincing to the specialists Decentralization of building technologies into rural areas is also a political issue.

Mr. Abou Diouf, former Prime Minister of Senegal and now President, asked to be kept informed of the Daara project from the beginning and even came himself to inaugurate the school. But awareness must then be transformed into concrete policies which assist in propagating the technological innovation — through building of prestigious institutions, schools, housing, etc. This could be, one imagines, at least one strategy for encouraging the integration of appropriate new tools into common usage.

Another means of disseminating this kind of technical expertise is through decentralized, i.e. rural, training centers in building technology. This would entail a new kind of itinerant architect, who would be sponsored by the State perhaps, but willing to diffuse knowledge of improved building techniques on a regular basis. Is this a future “barefoot builder”?

Nonetheless, real incentives must exist: in terms of cost and in terms of meeting specific demands on the part of the population. The example of the grain silo cited above is a case in point. However, we should inquire of this particular method of building whether in its present form it is within reach economically of the peasantry in Senegal (elsewhere) and whether, ideologically speaking, it can conceivably enter into the peasants’ mental framework of what constitutes “progress”, within a traditional, conservative setting.

Finally, will such products ever carry a symbolic value for rural dwellers, as a commodity for modern consumption once it has already been adopted by the privileged classes of society? And, how fast might this occur in relation to the rapid rises in population and demands for new building? These questions of an ideological nature will recur again and again whenever the issues of introducing technological innovations are at stake.

Reference Notes


2 Hette, p. 21

3 This school was extensively published in Mimar, 1, (Singapore) July, 1981, p. 24–36. Further information, including plans, sections and photographs are included.
Snelder

In the past, a community had a set of techniques and programmes and a language of formal elements that was known to every single member of that community. To put it in a very simple way, one could say that everybody in such a community knew how to make a good building. As a result of exterior influences, that common knowledge of what a building was has been lost. And so one of the main objectives of our building system was to provide again a coherent set of techniques, forms and programmes, not as a finished product but as a start towards a new vitality in the local construction process. A second main objective was to re-integrate the building process into the local economy because the exterior influences brought with them a whole array of techniques, materials and things that were necessarily dependent upon supply from the exterior. Therefore, what we call conventional building in Senegal today really represents a drain on the local economy. We tried to stop that by using lots of local materials, eliminating the reasons for the use of imported materials, in order to reinforce the local economy. Let me give a few figures. A conventional construction employs about 60 percent imported materials, whereas the system you’ve just seen utilises no more than 20 percent.

Dr. Taylor had some doubts about diffusion of the system, and I quite agree. Even the masons who worked with us, some of whom started to build their own houses afterwards, and who were very enthusiastic on our sites about the techniques we introduced, did not use those same techniques for their own buildings. We did some research on this phenomenon, and I think that there was kind of psychological obstacle. The mere fact that the system was introduced by foreigners, who are still associated in their minds with big capital, sets the system apart from their own daily life. This was not for them. If you persist in asking them for a deeper reason, they can’t answer. It’s just that this kind of a project for them is too expensive

However, later it developed that people of a more well-to-do social level started asking

Specifically for the techniques that we had used. You might conclude that we did not reach the segment of population we intended, but I am a bit more optimistic on that score. I found that people are very sensitive to models when used at higher levels of society. It’s quite logical, since people who build something only once in their lifetime (and often not even once) are certainly not inclined to finance experimental buildings with the little funds they have. So, we started to help by offering plans to those people who were able to finance an experimental building. We believe that this may have positive repercussions upon the propagation of this system.

On another level, the government is also getting interested in the system. We have designed public buildings and villages with our system, and this has two advantages. In the first place, we can demonstrate our prototypes; and in the second place, we still only use local labour— which means that the local population is involved on more than one level. This has resulted in quite a number of projects now using the system all over Senegal. Moreover, we have reason to believe that it’s going to be taken out of our hands— which is exactly what we want. But I believe one thing we have not been able to do, and which is very vital to the diffusion of the system, is to communicate information by the media. The approach we advocate cannot really work if we only give technical information to the people who produce the building; those who are the potential clients, the public, must be informed as well.

Cantacuzino

Building appropriately does not necessarily mean building traditionally. The school at Nianing in Senegal had no building tradition on which to base itself. The local people were largely nomadic. A new technique had to be invented therefore, and it made use of sand which happened to be the only indigenous raw material suitable for building. We may criticise the school at Nianing on practical or aesthetic grounds for what it tries to be, but we cannot surely criticise it because it is not built of mud and thatch. It is also a new building type, with quite different requirements from a house. So it surely does not follow (even supposing that the local tradition had been mud and thatch) that the school should have been built in that same tradition.

In her extended background paper Ms. Lee Horne has pointed out that traditional dwellings of rural settlements are not just places where people live, but places where they and their neighbours work, often side by side. Rural people, she says, are food producers whose mode of production is domestic. If this dual function is disrupted by industrial development, for instance where displaced peasants become construction workers, and finally factory workers, the relationship of the houses and the plan of the house itself no longer have a valid basis. To insist on these people living in the same kind of a house for the sake of tradition would make a mockery of the word.

The case of the school at Nianing raises the whole question of outside intervention and the “barefoot” architect. It is obviously impossible to generalise, and in the Nianing case I have little doubt that the intervention was subsidised, even if its effects have not been as great as might have been hoped. Perhaps expectations were a little too high. The ideal must be a combination of government involvement as far as broad policy is concerned and local initiative as far as specific projects are concerned. The so-called “barefoot” architect tends to be acceptable if he is of the community; to come in from outside may well prove self-defeating. At best he should be able to show the way and teach local people the means for continuing work after his departure.
Technology Resources

Renewable Energies and Changing Rural Habitation

Roger Carmignani

Life in the rural world is increasingly affected by the conditions under which basic energy needs are met at the individual, and farm or village level. Rural populations, and in particular the rural poor, are deeply affected by a dual energy crisis, i.e., higher and higher prices for petroleum products and the dramatic depletion of fuelwood supplies and shortage of crop residues and animal wastes at the village level. Basic energy needs for rural populations include thermal energy (essentially for cooking, but also for shelter and water heating and for crop drying), mechanical energy (for water pumping for village needs, pastoral agriculture and irrigation, transport, small handicraft industries, and agricultural machinery) and electrical energy (for lighting and small industries).

This paper first presents, in general terms, the broad aspects of the energy issue in the rural world; second reviews the state-of-the-art with regard to Renewable Energies (RE) technologies and their likely contribution towards meeting rural energy needs; third analyzes three applications of RE technologies of particular relevance to the changing rural habitat, namely the design and introduction of improved wood stoves (an example of a simple, locally-adapted technology requiring individual participation and involving self-help construction with a substantial impact on family energy savings), the establishment of village woodlots (the case for community development and agricultural technology to meet rural energy needs), and the use of passive solar designs and concepts for housing, farms, and village buildings. Fourth, it expands on the impact which RE technologies could have on the rural habitat and the rural life in general. Fifth, it proposes some broad orientation for research and development. Finally, shift the paper offers some conclusions and recommendations for action.

In short, the paper looks at the changing rural habitat (including in the broad sense of the term, rural production systems, farm and rural community organization, housing and community building construction and local environment) from the energy angle, most likely an increasingly dominant factor in achieving comfort, health and increased income in today's rural world. It also concludes that the act of designing and building for the rural poor should increasingly take into account the many local production, organizational, and environmental factors of which energy is a major one. It ventures to suggest the new concept of the "total rural architect," who is first a surveyor of the social and economic/agriculture scene; second, aware of energy issues as they affect rural life and only thirdly a designer and builder always conscious of the need for self help and mass diffusion, when building for the rural poor.
Energy Needs and Issues in the Rural Sector

The traditional energy sources in rural areas, other than products which a rising number of rural poor cannot afford, include first (and most importantly) fuelwood, second, agricultural and crop residues, third, animal and to a certain extent human wastes, and fourth, animal and human power.

The threat of deforestation has led to the “Second Energy Crisis.” The Oil Crisis of the 70’s made world headlines; yet today, for more than one third of the world’s population, the real energy crisis is the daily scramble to find wood to cook dinner, and to obtain warmth in winter. The search for wood, which was once a simple chore, can now take several hours to a full day of labor, as forests recede. About 250-300 workdays per year are required for fuelwood collection, in such countries as Nepal and Tanzania. In Upper Volta, camels, and thousands of cattle, are diverted, from the transportation of agricultural commodities, to carrying wood. The wood itself is basically “where you find it, if you find it.”

Some two billion people (70% of the population of the developing world), depend on biomass in the form of wood, crop residues and animal wastes which are being consumed much faster than they can be renewed — to meet their most basic energy needs of heating and cooking. In Central and North Africa, 65% of energy requirements are met by fuelwood and crop residues; in China and Bangladesh 75%, in Nepal and Tanzania 90%. Forests are decreasing at an alarming rate (loss of some 15 million hectares per year) and the concomitant use of animal manure (dung) as a fuel depletes the soil of valuable nutrients which leads, in turn, to approximately 20 million tons of foregone grain production per year. All of this leads to an ongoing crisis of deterioration and destruction of a fundamental resource base for the poor. The following table shows how people are affected by the fuelwood deficits.

<table>
<thead>
<tr>
<th>Situation</th>
<th>Rural</th>
<th>Urban</th>
<th>Total</th>
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<tr>
<td>Acute Scarcity</td>
<td>100</td>
<td>20</td>
<td>120</td>
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<tr>
<td>Deficit</td>
<td>850</td>
<td>150</td>
<td>1000</td>
</tr>
<tr>
<td>Prospective Deficit</td>
<td>800</td>
<td>200</td>
<td>1000</td>
</tr>
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* Africa, mountain areas of Himalaya, Andean Plateau and others
* People living in urban centers situated in fuelwood deficit areas
* Where deficit will occur by year 2000

Most traditional fuel resources serve many purposes: leaves and twigs for fodder or firewood; trees for fuelwood or building materials; crop residues for animal feed, compost, fuel or soil nutrition; dung for fertilizer, fuel or feedstock. In addition, economic and social factors add to the complexity of the problem. Many fuels do not enter cash markets, and complex exchange relations are involved; regulations (such as the requirement to burn crop residues to control diseases) and local conditions such as fuelwood being unavailable at one place but plentiful at another some distance away, may prevent the poor from essential access to energy resources.

The basic village requirements are heat, light, shaft power and other forms of mechanical power, fertilizers, and communication. Improvements in meeting these basic requirements could come from the following three sources:

- energy source modification/addition, by developing energies not currently available at village level, such as wind, small hydro and solar systems;
- change and improvement in end-use devices, such as improving the efficiency of stoves and bullock carts;
- development of new conversion technologies, such as biogas plants and photovoltaic cells.

The developing countries are at an advantage in developing RE’s resources. They are well endowed with solar radiation and biomass; and RE technologies can be exploited on small-scale and decentralized bases. In addition, much RE equipment is suitable for local manufacture.

The basic RE’s resources include: solar energy, green plant energy, wind energy, and hydraulic energy. These energy resources are usually site specific, and vary greatly according to weather, season, time, and location. Equipment using solar and wind energy does not function in a “permanent” manner and therefore the need for energy storage arises. Also, the functioning of this equipment depends on the intensity of solar radiation and wind speed. Similarly, hydraulic energy — still largely untapped — depends on meteorological conditions. Green energy, including both the calorific energy contained in dry plants, and the chemical energy stored in plants through photosynthesis, is subject to the usual vagaries of nature and how they affect agriculture.

A better understanding and management of rural energy systems is a prerequisite to the successful development and diffusion of RE technologies. The knowledge of energy balances at the farm and village level has to be improved, in order that better analyses of the trade-offs between various forms of energy, and the determination of an optimum mix, can be achieved. In particular, there is a need to develop integrated rural energy systems at the farm and rural community level, able to meet energy requirements by combining in an optimum fashion renewable and conventional feedstocks and technologies. Other major obstacles to diffusion of RE technologies are the weakness of extension services and popular acceptance. Planning, programming, budgeting, and basically moving from laboratory research and field to limited private initiatives, to carefully prepared sector programs and projects are prerequisites to the realization of RE potential in rural areas.

As a dominant factor in rural energy systems, one should recognize that agriculture, which has traditionally been considered as a user of energy, is now becoming a major source of energy in the form of forests, agricultural residues, and specifically-bred crops, thereby presenting the other dilemma of fuel, versus food, crops.
Renewable Energy Technologies

The State of the Art

This section reviews the various RE technologies available today and attempts to evaluate their significance from the point of view of their economic costs and benefits and their impact on the rural life in developing countries. It successively deals with biomass-based technologies, energy conservation and efficiency use, solar technologies, mini hydro power generation, and wind energy. Table 1 provides a Summary List of Renewable Energies, percentages given in brackets are rough estimates of the relative (by 1990) contribution of the various technologies involved to the energy supply from RE sources.

Biomass Based Technologies

Biomass basically includes forest and fuelwood resources, crop and agricultural residues, and animal waste. It merits special consideration because of its importance and versatility; biomass is a prime resource in meeting basic energy requirements of the poor; it is convertible into solid, liquid, and gaseous fuels; and biomass fuels can be produced either on large or small scale and therefore concern both the disseminated and the organized rural sector. Agricultural technology for biomass production is developing fast. It includes biomass production technologies which do not compete with food or cash crops; research on fast growing species of trees for fuelwood production; development of energy oriented crops such as sugarcane, cassava and sweet sorghum; use of vegetable oil as diesel fuel; and improved harvesting and briquetting/pelletizing of agricultural residues.

1) Solid fuel production from biomass basically includes (apart from fuelwood itself) charcoal, wood chips and pellets, and animal dung. Charcoal production and use is one of the most efficient technologies for getting more calories out of wood. Charcoal can be handled and transported more economically than wood and is the most widely used household fuel in urban areas. It also allows a higher efficiency of charcoal stoves. Programs for accelerating charcoal production have been launched in various countries and those introduced in Brazil are leading examples. Charcoal is produced by pyrolisis (i.e., application of heat with insufficient oxygen, essentially obtained by covering wood with a layer of dirt). Various improved technologies which allow higher conversion efficiency have been developed; they include earth kilns of simple or advanced designs and sophisticated automatic retorts or furnaces or portable steel kilns. Chips and Pellets produced through briquetting and pelleting of selected biomass resources (such as wood chips, sawdust, rice husks ...) constitute a fast growing source for solid fuel.

2) Liquid fuel technologies include the production of Ethanol and Methanol as gasoline substitute and vehicle fuel. Ethanol (Ethyl Alcohol or "grain alcohol") can be produced from sugarcane, sugar beets, molasses, and other biomass. The technology is now fully commercial and Brazil has launched a large program of ethanol production to partially replace gasoline in motor vehicle use. Methanol (Methyl Alcohol or "wood alcohol") can be produced by distillation of wood as opposed to the usual synthesis from carbon monoxide and hydrogen (from natural gas or coal). Methanol is not considered to have much potential as a vehicle fuel. It is technically feasible to replace substantial volumes of petroleum with ethanol, but economics vary considerably according to local conditions and type of biomass. Ethanol production is certainly justified in the following circumstances: where large amounts of sugarcane and other biomass are produced at low cost; and where surplus molasses is available. However, these technologies mostly concern the organized rural sector since they involve scale operations.

3) Gas fuels technologies based on biomass are commercially proven and include biogas production through anaerobic decomposition of organic materials (which gives a mixture of gases containing about 55/65% of methane) and the manufacturing of "Producer Gas" by pyrolisis or gasification (i.e., the partial combustion of wood and materials such as saw dust, rice husks and nutsHELLS. Biogas can be mostly used for family or farm lighting and cooking and small diesel engines (stationary or mobile, such as trucks). Producer gas can serve as a fuel to provide energy for process heat, motive power, and electricity generation. Producer gas can also be used in internal combustion engines and appears to be a less expensive alternative to steam plants in specific circumstances, especially in small unit sizes. In rural areas with ample wood supplies, small power plants burning wood either directly or in gasified form might produce electricity more cheaply than diesel plants.

4) Biogas is obtained through a fermentation process in a digester, basically a sealed container filled with water and waste materials. The process by which biogas is produced is complex and involves the action of two types of bacteria. Biogas production is sensitive to temperature, acidity or alkalinity and to the type of feedstocks used. Biogas is usually produced under low pressures (and therefore the distribution network is limited) and is corrosive. With suitable adjustments most appliances made for natural gas and bottled gas can be adapted for use with biogas; they are essentially special types of clay burners and lamps. Biogas can be used to run internal combustion engines without modifications. The sludge remaining in the converter retains with degradation the nitrogen and other nutrients present in wastes, and thus helps resolve the problem of fuel versus fertilizer conflicting uses. Three families of designs have been developed. They can be distinguished by means used to cope with variations in the quantity of gas in storage and the type of construction and material used; they are the floating gas holder type (Indian); the dome type (Chinese); and the bag type. These technologies are shown in Figure 1. China and India both have large-scale biogas programs. The Indian program involved technical assistance and subsidies on construction costs and reportedly resulted in the construction of some 37,000 plants. The program was criticized on the grounds that the benefits from the units initially promoted went to the relatively wealthy families who had the...
cattle, land, and credit needed to build and use them. These units cost Rs. 2,000-3,000 (US$240-360), i.e., several times the average annual income per capita in rural areas and reduced the availability of free dung, so that the program had in fact a negative impact on the real income of the poorest groups. The program is now giving greater emphasis to community-sized plants. In China, biogas was one of the technologies promoted in the “Great Leap Forward” program of 1958-1960, but reportedly was not used on a widespread basis until the 1970’s. Today, over seven million biogas digesters have been built in China. Most of these are family-sized units of 6 to 9 m³. The Chinese designs are simple and well adapted to do-it-yourself construction and require a cash outlay equivalent in Chinese prices to roughly one quarter or one third the average annual per capita rural income. A large part of the credit for the Chinese success with biogas is also due to an intensive extension effort.

Most of the other Asian developing countries have from ten to a few hundred biogas plants in operation. They appear to be very successful in the Republic of Korea (where they are not operated during the winter) as opposed to China which has not apparently mastered low temperature biogas production. There, as in China, the main feedstock is pig manure, which has some technical advantages over cow dung.

While China’s success with biogas digesters undoubtedly owes much to the development of low cost designs, the Chinese experience also serves to underscore the crucial role of the socio-cultural environment and of effective institutions in the dissemination of biogas technology. The Chinese farmers’ traditional concern with maximizing the value of all resources at his disposal, the fact that manures have long been intensively utilized in agriculture and the long standing practice in many areas of collecting night soil in underground tanks, no doubt all helped to create an especially propitious environment for the adoption of the biogas digesters in China. In addition, the rapid dissemination of biogas technology undoubtedly reflects the high degree of organization in the rural sector, in general, and the effectiveness of the country’s extension-type services in disseminating information about biogas digesters and their construction, in particular.

There is clearly a need to broaden the base of experience to assess the impact on biogas economics of the less-costly Chinese designs. A preliminary investigation of the cost of reproducing the Chinese designs in other developing countries, based on the reported material and labor requirements, indicates that the capital cost of a family-sized unit would in many countries be anywhere from 55-75% lower than one constructed on the Indian model. Practical experience with community generators has been very limited (although a few are reported to be operating in Korea and India) but the concept appears to warrant further exploration. The economic case for biogas is likely to be strongest where large digesters are operated as part of commercial scale livestock, dairy, poultry or swine raising operations.

5) Producer Gas is obtained through combustion and pyrolytic gasification of biomasses when wood or other carbonaceous material (straw, nut shells, coal, bark and rice hulls) is heated sufficiently in the presence of moisture and limited amounts of air, the water and carbon will react to form carbon monoxide and hydrogen in a combustible gaseous mixture known as “producer gas.” Producer gas typically has a fuel value about one-sixth that of natural gas. Producer gas can be burned under boilers, and used as fuel in internal combustion engines. It can also be used to fuel vehicles either by using a small, portable generator or by compressing the gas into cylinders. It is produced on a commercial basis from rice hulls, cotton gin trash, saw mill residues, and from wood and coal as well. For example, the SEMRY rice mill in Cameroon will obtain its electricity from diesel engines running on gas produced from rice husks. It has been assessed that this system will be less expensive in terms of both first cost and life-cycle costs than a conventional boiler and steam-turbine system. Another project, a lumber mill and associated township in Guyana, is to get electric power from a similar system operating with saw mill wastes. The cost of the 6MW power station component in the Guyana project was estimated to be competitive.
6) Wood Fueled Power Plants appear economically promising and viable as competitors to diesel where there are adequate firewood supplies which can be assured for the life of the plant, at costs of $15-20 ($75-120 toe). They are, in fact, common practice in saw milling and pulp and paper industries. Wood fueled power plants of 30-55 MW exist, but they would be most competitive in relatively small plant sizes. The optimization of wood fueled power plants involves: plant economies of scale, availability of wood supplies, transport costs and power distribution.

Research in recent years has also been conducted on energy conservation and in particular on efficient end use technologies. Such research covers a large array of fields such as improved wood stoves, more efficient use of energy in transportation in various transport modes and combustion engines, agricultural implements and cultivation, electricity delivery and passive solar design for buildings. The case of improved wood stoves and passive solar designs, and their impact on rural habitat, is dealt with in detail below.

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**Solar Technology, Mini-hydro Power Plants and Windmills**

The technologies discussed in this section are solar water heaters, solar dryers, photovoltaic cells, windmills, and small hydroelectric units. Solar water heaters would replace electricity, wood or coal and bottled gas. Solar dryers, depending on the circumstances, would replace either fuelwood or commercial fuels previously used to dry crops or certain other products such as fish, in order to reduce spoilage and improve the product. The other technologies in this group are all primarily of interest as potentially cheap sources of small amounts of mechanical or electrical power in remote or isolated areas that have a suitable resource base. In some cases, these technologies would be used for traditional tasks such as grinding grain and pumping water and thereby liberate human and animal power resources for other activities. In others, they would be used to provide modern services such as lighting, refrigeration, and telecommunications.

1) **Solar Water Heating** by means of flat-plate collectors is the solar technology that is most ready — technically, economically, and commercially — for widespread application. Water heating is not a major item in any country's energy budget, but it does account for significant amounts of energy in middle income countries. Solar water heaters have been widely used for some time in Australia, Israel and Japan. In developing countries, actual use still seems limited and scattered. The interest in solar heaters is now growing rapidly. Various adapted technologies are being developed and water can be both heated and stored at a cost considerably less than for conventional systems. Solar collectors may also offer an economic means of meeting the need for low and medium temperature process heat in industry. Flat-plate collectors of sophisticated design using specialized materials can produce temperatures in the 90°C range that are sufficient for a variety of industrial processes. Focusing or concentrating collectors are used to obtain temperatures above about 100°C. Solar industrial process heat systems of both the flat-plate and concentrating types are being developed, tested, and demonstrated.

2) **Solar Drying** includes techniques as simple as laying or hanging the material to be dried outdoors. Controlled drying in an enclosed space may be worth the cost for delicate, high-value products such as fruit, tobacco, or fish, where space is a limitation, or where there is too little sun. The use of solar equipment for controlled drying has been demonstrated for meats, fruit, vegetables, grain, tobacco, and timber in a number of countries (e.g., Australia, Brazil, Colombia, India, Syria and the United States). In some cases, the solar drier has a transparent roof and functions as a greenhouse. In others, air is heated in a solar collector and moves by convection to the drying area.

3) **Photovoltaic (PV) cells** convert solar energy directly into electricity. They appear technically well suited for application in many developing countries. The cost of photovoltaic electricity is falling, but is still at levels (of the **Fig 2 Photovoltaic and Thermal Water Pumping**

Source: Roger Carmignani
Fig 3 Windmills Sketch Designs.
Source Roger Carmignani.
order of US$2/kWh) that makes it commercially viable only where relatively small amounts of power are needed in remote locations. The use of photovoltaics to meet larger-scale power needs is being demonstrated by aid agencies in a number of village electrification and irrigation projects in developing countries. Figure 2 presents schematic diagrams for both PV and thermal water pumping.

Most PV cells manufactured today are made from extremely thin slices of high-purity silicon crystals. Cells made with other materials or with amorphous (non-crystalline) silicon may come into wider use in the future. Solar cells are generally rated in terms of “peak” power — the number of watts that can be produced under nearly optimal terrestrial conditions. In such sites it takes an array of about two square meters of photovoltaic cells to produce one kilowatt hour a day, so sizeable arrays are needed to produce even modest amounts of power. As indicated the price of PV equipment is falling. Prices for arrays of PV cells are quoted today in the US$10 per peak watt range and it is generally assumed that the PV array costs will drop in the next few years. However, total system costs are unlikely to fall within the next five years to below about US$10 per peak watt (e.g. US$3 for arrays and US$7 for balance-of-system costs). At this level, PV power would still cost about 50 US cents/kWh in a location providing five peak hour equivalents per day. This might make photovoltaic power competitive for low-lift, small farm irrigation and village water supply pumping requirements in some cases since small conventional generators produce electricity at an estimated cost of 40 to 45 US cents/kWh. However, it appears that PV power is unlikely, at least in the medium term, to be competitive with either conventionally-generated power or other renewable sources for village electrification and large-scale irrigation pumping. As costs are reduced, an expanded role for photovoltaics can be foreseen in specialized low power applications (such as refrigerators in clinics and educational television in village schools) in remote areas.

4) Windmills have been widely used in rural areas and interest in them is reviving. The best established applications historically have been water pumping and grain-grinding, but windmills have also powered sawmills, paper mills, and oil presses. Today windmills exist and are proposed in a wide variety of configurations, sizes, and materials. The wide diversity in designs appears to reflect both the need for different approaches to deal with different wind regimes, fabrication techniques, and applications and the fact that experience has not yet sorted out all the advantages and disadvantages of competing designs. The cost of harnessing wind energy has been estimated at 20 US cents/kWh assuming a 5.5 hour/day operation with winds of 5 meters/second (11 mph) and using locally-manufactured or artisan-built windmills. This type of windmill can compete with conventionally-powered pumps in the same areas if connections to a central electrical grid are not available and pumping heads are low. Winds are not generally as strong in the tropics as they are at higher latitudes, but there are areas where the trade winds or geographic features such as mountains and coast lines produce average winds speeds over five meters/second. Wind-driven electric generators are available commercially in unit sizes up to at least 15 kilowatts rated capacity. Some of these can produce power at costs of 25 to 50 US cents/kWh at low load factors and 5 to 15 US cents/kWh at high load factors in locations with average winds speeds in excess of five meters/second.

5) Small Hydro plants include traditional water wheels and small turbines. Waterwheels have been used for thousands of years, primarily to grind grain and lift water. They have recently attracted some commercial interest in industrial countries and are reportedly available in kit form for roughly US$200 per kilowatt. Where appropriate sites can be found, these cost levels and the simplicity of the technology would make waterwheels a power source to be considered for energy requirements that can be served by a stationary, low-speed power source of 5-10 revolutions per minute. Turbines are generally preferred to waterwheels for electricity production because turbines spin at the much higher rates required by electric generators. “Small hydro” refers to those hydro power units with capacities of no more than several hundred kilowatts, most often 5-50 kW, used to provide electricity to a few users or to individual villages. Turbine systems with capacities of less than 50 kW have been installed in many developing countries; there are reportedly over 80,000 small-scale hydro power systems operating in China. Unit costs of small hydro power projects can be expected to vary widely, depending on the characteristics of the site, the water available, and the distance to, magnitude, and time pattern of the electricity demand. The lowest cost sites are those that can provide large volumes of water and high heads without much investment in civil works. The Intermediate Technology Development Group (UK) has compiled cost estimates for a “model” 40-kW project based on six existing and planned projects in Nepal. The estimated total capital cost is US$1600/kW. While this can be a least-cost solution for village electrification, the cost to consumers per kWh would be very high (18 US cents/kWh) if the electricity is used principally for domestic lighting and the plant is operated at a load factor of only 20 percent. At 55 percent load factor the cost would be about 7 US cents/kWh.

6) Solar Ponds are simply black bottomed ponds about one meter deep in which evaporation is suppressed by imposing a density gradient on the pond so that water is heavier at the bottom than at the top. This is achieved by the dissolution of salt in the pond, with a high concentration at the bottom. The absence of convection allows solar heat, absorbed at the bottom, to be trapped there, whence it can be removed. Temperatures approaching the boiling point can be obtained and 20-30% of the incident solar radiation can be collected at useful temperatures. The pond can be built anywhere where sea-water (or an initial supply of salt) is available and no constructional materials are needed except possibly a lining of the bottom if soil compaction should prove inadequate to seal the pond. Such ponds can be built in almost any size. A pond of 1 sq km area could yield the heat equivalent of 50,000 tons of liquid fuel a year in a sunny climate.
Major applications for the heat collected from solar ponds include operating multistage low-temperature desalination plants, which should provide about four million gallons per day of fresh water from a 1 sq km pond. Solar ponds may also be used to produce high grade (refined) salt from sea water with an estimated annual yield of 40,000 tons per sq km of plant area (almost twice the yield from open pan solar evaporation plants). Electric power may also be produced from solar pond heat using the technology of low temperature geothermal plants. Annual yield, under Mediterranean sunshine conditions, is estimated at about 45 x 10^6 kWh per sq km of pond, approximately equivalent to a 7 MW station. Power costs of 3.4 cents per kWh or less are expected (the cost of power from diesel units of this size is far higher and operation is dependent upon fuel supplies). In particular, heat collected from the pond can serve for so-called "external" combustion or solar engines, which function by using the vaporization of an organic fluid in a sealed circuit; the vapor produced being used to motion an expander or turbine engine before being condensed.

Selected Renewable Energies Technologies

The Case of Improved Wood Stoves, Village Woodlots, and Passive Solar Building Designs

In this Chapter we review three cases of application of RE technologies from three different viewpoints to illustrate the type of issues involved in developing RE's for the rural sector: The case of improved woodstoves for more efficient use of wood resources, where technology is now commercially available but resistance from users is met in dissemination of technology; the case of village woodlots where little technology is involved but community development and organization are required; and the case of passive solar building designs where techniques are generally known but local adaptation of efficient designs for rural areas has not yet been made and awareness of designers is only building up.

Improved Wood Stoves

Presently used wood stoves in many countries include: the traditional "Three Stones Stove" where little heat is transferred to the pot; the "Chula" or "Mud Stove" used in many parts of Asia which is equally inefficient and where smoke escapes around the pots and entrance and a large amount of excess air tends to lower flame temperature; "The Rice Hull Stove," a small oil drum with air vents on side and wood stick on container's floor plus a thick piece of wood placed in center of container touching the wood stick; (after rice hulls and sawdust are poured around the two sticks and packed, the two sticks are carefully removed leaving a tunnel) "The Sawdust Stove" with the same technique as above, but using two bottles, and "The Stove in a Bucket," a galvanized metal bucket fitted with two grates.

Energy losses in these stoves result from: incomplete combustion; heat carried away by combustion gases; losses due to heating stoves; losses to atmosphere and energy used in evaporating excess water from wet wood. Such losses can be minimized through improved stove design, namely: improving combustion efficiency by insulating fire chamber, reflecting part of the heat absorbed by the walls back into the wood, placing pot away from the seat of the fire where the flame is not cooled by the pot's surface, controlling the flow of cold air through various types of drafts and adding secondary air at the end of the flame zone, using the heat transfer from the gas streams by allowing gases to remain longer in contact with the pot and to move in a more turbulent fashion and minimizing heat loss from pots and stove walls by preventing draft flowing around pots, fitting lid tightly and having flat bottom pot rather than round bottom.

Improved wood stoves have been designed to correct heat losses identified above basically by enclosing the fire and controlling the amount of air fed in, which greatly affects the intensity of heat. Several components are common to all improved stoves: a fire chamber with internal combustion benefiting from controlled air entry; flue or chimney to draw water vapor and smoke; an air inlet to allow oxygen to burn; one or more dampers (movable plate) to control draft; baffles (mound or steps moulded into tunnels) to prevent escape of gases allowing them to burn completely and to redirect flow of heat to pots; and satisfactory heat exchangers, most of the time the pots themselves.

Various types of improved wood stoves have been developed recently and are increasingly used. The ITDG stove, developed by the Intermediate Technology Development Group can be used for both cooking and baking; the Ipa stove, has been developed in the Philippines to burn waste and sawdust; the Lorena stove, first introduced in Guatemala, constitutes probably one of the most advanced wood stove technologies and has become very popular in both Guatemala and the Honduras. Such a stove, which can reduce wood consumption by 30-50%, is self or artisan built, can be produced in different sizes or shapes and uses local raw materials for its construction (mostly sand and clay). Its main characteristics and advantages are the following: a long tunnel system which extracts heat from flue gases; a high stove mass stores heat for cooking and baking; a high mass of firebox allows higher temperatures and more complete combustion and pots fit deeply and tightly. Smokeless Chula stoves have been developed with a chimney outlet; this cuts fuelwood use by 40% over an open fire; design and construction methods are now available. The Singer Stove, whose design is very similar to those used in cave dwellings in China. Sawdust Cook Stove can easily be built by converting a square five gallon/twenty liters can. Stove is fueled by packing sawdust into the can around four upright wooden rods which are removed when lighting and during combustion.

Three main issues were encountered with implementation of woodstove projects: Technical, in particular with respect to wrong design and poor field testing and use of wrong materials in construction, inefficiencies in use,
and unforeseen consequences such as increased pests/insects as a result of smokeless stoves; barriers to dissemination as a result of lack of social percutivity of benefits, lack of local leadership and of community participation, lack of extension services, and cooking habits (seated) and users' attitudes (chopping wood); responsibility for dissemination, often under technical Forestry Departments more concerned with large conservation or tree planting projects rather than with community or social forestry issues and introduction of local technologies. A socio-cultural assessment has been made of the introduction of Lorena woodstoves in the severely deforested highlands of western Guatemala. The objective of the introduction of the stove was to encourage a more prudent use of wood for cooking and to alleviate health hazards associated with smoke. The assessment was conducted among Indian families and identified the following advantages/disadvantages of the stove. Among the advantages, ranked in order of importance, were: wood savings, although the problem of deforestation was not perceived at all; reduced smoke in the kitchen; ability to cook in a standing position on an elevated surface allowing for more comfort, greater cleanliness, greater safety for small children; constant availability of hot water; and aesthetic qualities of the stove (women expressed considerable pride in the physical appearance of their stoves).

Disadvantages also ranked in order of importance included inability to provide space heat in the cold highland evenings and early mornings (the stove is built precisely to contain heat rather than to emit it); inflexible nature of the cooking surface, the size and number of pots being limited and the stove remaining fixed.

The success of the Lorena stove in the rural areas of Guatemala and neighbouring countries stems mainly from the fact that it is very responsive to local conditions and needs. However, modification in stove use for space heating purposes indicates that the present stove design could be altered to conform more fully to certain valued traditions which points to the importance of involving users, particularly women, in the design of the stove. In general, it appears essential to teach potential users not only how to build a stove (which is the usual approach) but also how to use it, and check whether modifications in the use of it do not substantially eliminate its benefits. In short there is a need for "quality control" after project execution. The main recommendations drawn from the assessment, for mounting improved wood stoves projects include the following: conduct local surveys (social behaviour, materials, priority villages, ...); pay attention to the choice of design and field testing (prototypes); define carefully, scope, area, timing, financing of project; plan extension services and improve communication with end users; recruit adequate extension workers (role of women); and prepare dissemination campaigns.

**Village Woodlots**

The purpose of village woodlots is to enhance a village's wood fuel resources by growing suitable tree species, using as the inputs resources predominantly available with poor rural populations, such as land, labor, and time. The organization and operating procedures constitute a major feature in village woodlots development. Technical support is needed to select suitable areas for planting, to organize the production and distribution of seedlings and to provide technical advice on establishment and tending. Finally, sharing of produce between villagers is a key issue in the successful development of woodlots projects; usually the concept that wood is no longer a "tree good" is difficult to accept, and, in many instances in countries like India, the poor villagers prefer to continue using dung and agricultural residues as fuel instead of buying fuelwood.

The authority in charge of the project, usually a village organization (e.g., village committee in Korea, panchayat in India, village assembly in Tanzania, etc.) plays a key role in coordinating activities and mobilizing the local population. The land, usually community land or village commons, on which plantations are made most often is land formerly used as waste lands or for grazing. In some cases, private land is used, in which case a certain percentage of the proceeds will go to the landowner. The land selection process is very important from the point of view of the area most suitable for afforestation; and the most acceptable by the population. Families may be displaced, or since woodlots are fenced, some cattle routes are blocked or grazing lands are diminished. Some people may find themselves disadvantaged and feel mistreated, which may have disastrous consequences. The required labor is usually provided by the villagers, either free of charge with the assurance that they will get fuelwood free of charge later on (which needs a strong sense of community, some penal enforcement and a lot of publicity), or paying a salary (which needs adequate budget in the village organization). Frequently work on the plantation has to be done at the same time as crops are harvested, which therefore requires careful planning in order to bring labor from outside.

Several village woodlot programs have been implemented in different countries with variable success, namely, China, Korea, India (Gujarat), Tanzania, Niger, Upper Volta and assessments have been made of these experiences. In China, between 1949 and 1978, the forest area increased by 72 million ha (= 12.7% of land area) through a carefully prepared program involving mass mobilization of rural communities, setting national targets skillfully translated into specific goals for districts, brigades, and communes at the lowest levels. The program was very successful. In Korea, a similar program was introduced and was also very successful. It was launched in 1973 with four principal components: strengthening of the Forest Department and passage of a new forest law; extension and publicity campaign; enforcement of the prohibition measures; national reforestation scheme to create fuelwood plantations in every village. A village forest association was established and linked to district and country unions, and to a National Federation. Government assistance flowed through foresters stationed at the district and county levels. The program had a mixture of voluntary (voluntary decision-making by village associations) and imposed participation (imposed national program). The results were impressive with about 40,000 ha of trees
Fig. 4 Various Wood Stoves Designs
Source VITA Wood Conserving Wood Stoves.
planted every year in about 12,000 villages. In India (State of Gujarat), two systems were launched in 1974, namely the “supervised” village plantations and the “self-help” panchayat plantations, where the Forest Department only provided free seedlings and technical assistance to all persons willing to plant trees. The results were not so successful and only 2,500 supervised, and about 70 self-help panchayat plantations were established (only about 14% the panchayats in Gujarat).

The success of woodlot programs in China and Korea stems from a strong political and organizational framework at the village level coupled with the democratic process of village participation in plan formulation, and strong government commitment to village plantation (free seedlings, budgetary assistance, technical expertise, education of the villagers, enforcement of laws). The key factor to success was the involvement of people concerned. The failure in India, Tanzania, Niger and Upper Volta, is due to the heterogeneity of villages (castes in India, tribal affiliations in Africa) which hinders common action for a non-traditional activity like forestry and to complex land tenure systems and pressure on the land for farming and grazing. The major impact on rural life of village woodlots not only includes the availability of fuelwood in the immediate vicinity of households which reduces time and labor devoted to gathering wood but also reduces the reduction of consumption of dung and agricultural wastes as fuel, which can be used as fertilizers, and the significant environmental benefits resulting from reduced land erosion.

### Passive Solar Designs

#### Basic Concepts

The technology of passive solar designs (PSD) consists of methods for heating and cooling buildings or for heating domestic water in which thermal energy flows by natural means, (i.e., without pumps or fans). PSD therefore include: winter solar gain and summer sunshading and cooling; winter wind protection and summer ventilation; building envelope designs for thermodynamic efficiency through insulation; thermal capacity for time lag heating and radiation cooling; and earth contact for ground temperature heat exchange. Building elements and thermal processes are combined in passive designs.

### Building Elements

- Insulation (resistance to heat flow);
- Glazing (transparent to solar irradiation; trap solar heat);
- Shading (keep sun off buildings and windows);
- Reflectors (increase solar radiation striking a surface);
- Thermal mass (heavy materials in buildings such as concrete, stone, water, adobe, aid storage of thermal energy).

### Thermal Processes

- Radiation (similar to light);
- Convection (air movement resulting from differing temperature);
- Conduction (transfer of thermal energy through materials);
- Air Stratification (warm air rises because it is lighter and more buoyant than cool air; stratified warm air can be transported to other parts of a building or to heat storage);
- Evaporation (energy required to evaporate water reduces air temperature);
- Thermosiphoning (fluids, liquids or air, become lighter and more buoyant when heated).

The basic example of a PSD system is provided by window facing south with a storage wall and night window insulation. Most PSD building techniques such as use of mass inside building, or contact with earth used as a heat sink, are effective for both heating and cooling.

Any PSD system includes the following functions and components a solar collection area, with careful selection of location and orientation; an absorber, generally a hard surface that converts solar radiation into heat and transfers heat to storage mass; a heat storage mass, consisting of dense heavy materials that hold heat and later release it to the interior of the structure; a heat distribution system to release radiant heat to habitable areas through convection flows, and a heat regulation device, usually shading or venting mechanisms to control solar heat admitted, and night time insulation to control heat permitted to escape. The various basic PSD systems can be grouped into four categories: direct gain, indirect gain, isolated gain and earth sheltered structures.

Direct Gain refers to the simple collection of solar radiation through a glazed surface while Indirect Gains refer to both collection and storage of thermal energy for later release. Examples of combined direct: and indirect PSD systems are thermal storage walls, roof pond systems, greenhouses and sycamores. Thermal Storage Wall systems include a south facing window and a dark glazed south wall for collection, storage, and transfer of heat. Air between wall and glass gets heated and circulated by convection controlled by shutters. Heat also conducts through the wall and is transferred to the inside by radiation. The transfer of heat by convection and radiation takes place several hours after the sun's energy strikes the wall. For summer operations, glazing should be removed and wall covered with reflecting insulation during the day and left bare at night; the wall will get cooled during the night and store the heat received from inside during the day. Thermal storage walls, which usually include vent holes at the top and bottom to allow for air circulation, can be made of concrete, adobe, and water (in pipes or drums). Various construction technologies conceived for developing countries are discussed later. **Roof Pond/Skynet System** Systems combining heating and cooling, consist of a water mass on the roof in the form of an open pond, with a transparent plastic cover in the winter and moving insulation above it. Alternately water bags can be used. In the summer, during the day the reflecting insulation keeps the solar heat away from the water, which keeps receiving heat through the roof from the space below, thereby cooling it. In the night the insulation is removed and water,
Fig. 5 Sketch Designs for Passive Solar Systems.

Source: Roger Carmignani
despite cooling the living space below, gets cooled on account of losing heat by evaporation, convection and radiation. Thus the water attains its capacity to cool the living space. In winter, during the day the insulation is removed, allowing the solar energy to be absorbed by the water and black surface of the roof; the living space continues receiving heat through the roof. In the night the insulation is put on the water mass, reducing the heat loss to the outside air. The heat loss to the inside air through the roof keeps the living space warm. Sunspaces (Attached Solarium/Greenhouse) consist of a south thermal space enclosed by glass and attached to a living space. The sunspace receives heat by direct gain, while the living space receives heat by indirect gain, through the thermal storage wall. The sunspace may be used for recreation, or growth of plants. Sun catchers are known and largely-used simple roof configurations which increase the solar collection efficiency of a south facing window while reflecting the summer sun.

In Isolated Gain Systems the building, the collector of solar energy and the storage are isolated and a natural air convective loop is used; water thermosiphoning can also be used. In Earth Sheltered Structures the reduced infiltration of outside air and the additional thermal resistance of the surrounding earth considerably reduces the average thermal load. The addition of earth mass to the thermal mass of the building reduces the fluctuations in the thermal load. Earth sheltered structures provide very efficient PSD systems and are widely used in many cave-type dwellings.

The main items to be taken into account while developing PSD system include: solar position, and particularly information on solar angle since more solar radiation strikes a vertical surface during the heating season (winter) than during the summer; sitting of buildings, (namely lot orientation and size, landscaping, ...); length, width, height ratios of buildings; daylighting; use of movable insulation inserted at night and removed in the morning; use of convective loops and thermosiphoning systems as wall panels to complement south windows; and use of sun-catcher, evaporative air coolers, and earth air tunnels. Examples of Passive Solar Design Systems in Developed Countries.

A number of projects have been executed in developed countries using PSD systems. In the case of St. George School, Wallasey, England, a building with considerable thermal mass, it has operated with nearly no back up since 1962, despite poor winter solar conditions; only windows and vents are used. The Davis House, Albuquerque, New Mexico uses a convective loop air heating collector (air thermosiphoning) in combination with a rockbed which constitutes sufficient storage to carry through two grey winter days. For the Benedictine Monastery Warehouse, Pecos, New Mexico, a combination of direct gain and air thermosiphoning is used. The Unit I of the First Village, Sante Fe, New Mexico, also combined various PSD systems namely Trombe wall and greenhouse. Solar heat is absorbed during the day, by the wall, and works through the wall into living space at night. The average surface temperature of darkened adobe wall can be as high as 100 degrees F on a sunny day. Excess heat from the greenhouse can be circulated and stored in gravel; cool indoor summer temperatures are maintained. The large thermal mass of the house keeps indoor temperatures comfortable in spite of the large day/night fluctuations (35°F) of outdoor temperatures. During most of the winter, internal temperatures are 65°F and peak temperatures during the summer only 76°F.

Examples of Passive Solar Design Systems in Developing Countries.

A project was run by the Save the Children Federation in Makhtar (Central Tunisia) to promote PSD systems for school buildings and other solar applications. Makhtar has a rather severe winter climate with heavy winds, frost, and occasional snow. Virtually none of the lower-income dwellings are heated. Wood is scarce, and other fuels are expensive. Low-cost solar energy applications for heating buildings (particularly schools), providing hot water, and light input for workspaces were therefore developed.

In Abed Sadok and Zouia the system essentially consisted of constructing a south-facing solar wall. The other walls are made of thick field stone and cement mortar, a construction design common to the area; the thickness is about 50 cm and the wall height about 3 m. The solar walls at Abed Sadok and Zouia were constructed in two different ways. For Abed Sadok, 1/3 Trombe wall and 1/3 direct gain was used and for Zouia, 1/3 30 cm-thick Trombe wall, 1/3 metal, to give direct radiant heat and 1/3 direct gain for direct heat and light was used (1/3 direct gain would have caused too much glare).

Vents used in the Trombe wall are hollow bricks. Upper vents have a plastic flap valve which cuts down reverse flow at night. The design also included a roof overhang so as to prevent summer sun input into the buildings. The wall used at Abed Sadok appeared preferable. Tunisians are more familiar with stone construction and the building is warmer during the night. The cost of the solar wall at Abed Sadok is about 350 Tunisian dinars ($890). Since a kerosene stove costs about $300 and the oil to heat it another $200-300 per year, the cost of the solar wall will pay for itself over three years or so. The temperature gain obtained with the solar wall is about 15°F difference with the outside, or 60°F on an average 45°F winter day.

Alternative features were planned for Zouia. It was proposed to orient the school 20° east of south to warm up the building with the morning sun and to moderate the afternoon solar input and to install a louver system which would provide sufficient heat and also maximum light and heat control. Galvanized louveres, 20 cm x 170 cm, were to be hinged so they could be manually controlled to rotate 180°, and glazed with corrugated plastic on the exterior. One side would be painted black and be outward facing, in the cown position. The other side, painted white, would be out in the upward position. Thus, if the louveres were closed with the black side out there would be radiant heat, but no light. If the louveres were closed with the white side out, there would be minimum heat or light. If the louveres were left in a horizontal position (white side up) the
sunlight would be diffused onto the ceiling, and if the louvres were positioned parallel to the rays of the sun, there would be maximum light in the classroom. A shed-type solar greenhouse was built on the south side of a standard Makthar stone dwelling. All sides were covered with two layers of yellow polyethylene (manufactured in Tunisia), including the east and west walls. The south wall of the house was painted black to absorb the heat and three oil barrels filled with water were introduced to balance out the temperature extremes. A duct was built from the greenhouse to the north room to enhance circulation of warm air to the room. The greenhouse helped to heat the house some 8-10°C above outside temperatures, but vegetable growing was not successful because of wide temperature swings. Several design changes were proposed to perfect the greenhouse for growing purposes, namely by insulating the east and west walls of the greenhouse maintaining sufficiently high temperatures and light conditions in winter, and sufficiently low ones in summer, building an insulated overhang to discourage winter heat loss as well as summer overheating and providing adequate venting by increasing size of vents.

Design suggestion for a low-cost solar residence were also made in Makthar, Tunisia. The basic stone structure of the house is much like any other building: 50 cm thick stone walls, 3m high on the south side, with four (double-glazed) windows and one door. The 3.5 m x 7.0 m space could be divided into two rooms. The very simple solar adaptations used were: Trombe-style glazing on the entire south wall, a 1.5 m corrugated iron overhang over the Trombe wall for summer shade, cork insulation in the proof, a low window to the west and a high one to the east to create a through draft, weatherstripping on all openings. The Trombe wall should have provisions for exterior venting during the summer. The solar calculations show the rough design to have a fairly good solar fraction. On the coldest nights of the year, the structure should hold at 56°F, while on average February days it will be a little below 70°F. Excess heat can be vented off at warmer times. It is expected that this house will also be cooler than an average house in the summer. The insulated roof prevents heat intake and the Trombe wall painted in white or covered and shaded during the summer will act as a cooling storage.

Other solar devices for housing were tested in Tunisia in relation to the Save the Children project. Mini-solar ponds, already developed in Nepal, appeared to be by far the cheapest system for water heating. Such ponds may be preferable for commercial use where large quantities of hot water are needed and several long mini ponds can be built. Bach water Heater designed for below-freezing climates consisted of a cylindrical tank (readily available in Tunisia) laid sideways, insulated on the ends, back, and bottom. The top and front are insulated doors that hinge open and have reflective surfaces that augment the solar input to the tank during the day. Single-or double-glazing covers the top and south side of the tank. An important drawback was the need for too much attention required to open the doors every morning and close them at night. Bottom loading, batch water heater was the system finally decided upon. A long, rectangular, horizontal tank is insulated above, on both sides and ends, and is painted black and glazed on the bottom. One stationary and one movable reflector brings sunlight to shine on the bottom of the tank. Minimal heat is lost downwards at night because the air below the tank stratifies with the hottest air being closest to the tank. The main advantage is that the system does not need to be closed or adjusted daily, but some technical problems were encountered with the rectangular water tank.
which was not designed for high pressure. It is therefore recommended to change the design from rectangular to a cylindrical tank and to install a cheap pressure-reduction valve.

The experience with the construction of the passive solar water heater in Makthar was one of the few cases where local artisans (namely young blacksmiths) became actively involved in finding solutions for particular design and manufacturing problems that arose and proved to be quite innovative. They eventually took over the manufacturing of the bottom loading water heaters as a commercial venture. A very brief performance evaluation of the water heater was conducted which indicated a temperature of 157°F the next morning, with inlet water at 75°-81°F and ambient temperature around 100°F at the time the tank was filled.

The combination of a sawtooth clerestory roof and an internal south-facing Trombe wall was used for house heating and lighting. The great day-to-night temperature fluctuations typical of direct gain systems such as clerestories were reduced by the fact that the radiation losses characteristic of a Trombe wall were not lost actually from an interior wall but rather radiated into the living space. One can even increase nighttime heat retention by installing insulated louvres for the clerestory. The main disadvantage was the high cost of the clerestory.

Simple systems for passive cooling and heating and water catchment for a workshop, have also been tested and proved to be economical. The system was applied to a weaving center and involved a sawtooth-type roof, with corrugated iron white cover and reflective insulation roof. The overhang was calculated to allow winter sun and prevent summer sun. A chimney is used for cool air and water transport, down from the roof into the building. The heating function is performed by the suncatcher. The cooling function results from the roof radiator effect of the system, the corrugated iron functioning as a roof radiator, by lowering the temperature of a surface isolated below by radiating heat to the night sky functioning as a heat sink. As a result of air stratification, dense air near the roof surface gets cold and slides down into the chimney.

Proposals were made for the use of PSD systems in buildings to be constructed as part of the Ulia Ulia rural development project in Bolivia: living headquarters for the project staff, model houses for local families, schools and hospitals. The population of the Altiplano depends essentially on non-commercial energy sources of fuel for household needs; dried animal dung is the main source. There is no heating, although temperatures are very low in winter. The climate is generally cold, with marked differences between day and night temperatures (average annual temperature 8°C average winter night temperature 6°C, average summer daytime temperature 28°C). The main design proposals made included: thermal insulation of the buildings by mixing straw with adobe, for wall construction, putting straw under the roof, and installing double-glazed windows; passive designs which consisted of painting the roof and exterior walls of the buildings with a dark color paint, with the exception of one wing of the family house to be used as a natural refrigerator, painting the interior walls with a light color paint, preferably white, installing skylights made of plastic or glass and constructing a veranda and/or greenhouse around three sides (north, east, and west) of the schools; solar water heating where various designs were proposed; and ventilation and rock-bed heat storage: using the "accumulator of heat" function of a bed of rocks placed in an insulated box right under a skylight. Five schools, a house to serve as temporary living headquarters for the project staff and two prototype village-style houses were all built using PSD systems. A temperature gain of 10°C in temperature between the inside and outside of the buildings was achieved.

The main characteristics of the Ulia Ulia PSD project included the following: low cost and replicability; simple technology, well adapted to local conditions; local participation; passive solar technologies were tested progressively and tightly monitored so that necessary changes could be made quickly on designs of new buildings. Lessons can be drawn from the broader experience with PSD Systems in developing countries. It is essential to monitor closely systems' performances and to accumulate data and make economic assessments. It is also important to identify and locate tools and materials that are necessary for the system to be prototyped. A mechanism that will ensure a thorough and orderly transition between a generation of leaders and continuity of projects has to be established. Finally, school building seems ideal for conveying the solar message, since they are social focuses for a community.

Renewable Energy Technologies in Rural Habitat Research and Development

In this section, an attempt is made to summarize the impact which RE technologies could have on rural habitat and, more generally, on the rural community life. A preliminary identification of priority rural energy needs is first made and an analysis of how RE technologies can help meet those needs is then provided. More research work is certainly needed in the field of identifying these needs and adapting technologies to them. The successful introduction of most RE technologies to farms and villages primarily revolves around the concept of extension services and community development viewed from the angle of energy development and savings. Priority rural energy needs with matching RE technologies are listed in the adjoining table.

A desirable orientation for, and classification of, Research and Development focussing on rural energy needs, is provided below. Research on tree growing has, so far, yielded good results in Hawaii on giant iipi-iipi; in Sweden on the willow; and in Australia on the eucalyptus. Breeding programs can be expected to result in growth gains of 10-25%. Pilot trials with introduction of exotic species can yield up to 20 times more biomass than the natural forest they replace. There is therefore a strong case for stepping up: forestry and biomass production (such as shrubs and grasses) research, and research on the use of the leaves of leguminous trees as a source of fodder and fertilizer for small farm systems. Biological research also holds promise for increasing forests productivity.
## Priority Rural Energy Needs and Matching RE Technologies

<table>
<thead>
<tr>
<th>Energy Needs</th>
<th>Matching RE Technologies</th>
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<tbody>
<tr>
<td>Energy-oriented Community Development</td>
<td>• production of biomass and fuelwood (fast growing species);</td>
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<td></td>
<td>• village woodlots;</td>
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<td></td>
<td>• village biogas and wood fueled power plants;</td>
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<tr>
<td>Cooking</td>
<td>• improved wood stoves to obtain more calories from scarce wood and save on transport and</td>
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<td></td>
<td>manpower cost;</td>
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<tr>
<td></td>
<td>• biogas converters;</td>
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<td></td>
<td>• solar oven (not commercially proven);</td>
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<tr>
<td>Village Water Supply</td>
<td>• PV pumps (a breakthrough for isolated areas);</td>
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<td></td>
<td>• Windmills and aero generators;</td>
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<tr>
<td>Pastoral Hydraulics and Irrigation</td>
<td>• dual fuel engines using producer gas (agricultural residues);</td>
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<tr>
<td></td>
<td>• PV and thermodynamic pumps;</td>
</tr>
<tr>
<td></td>
<td>• multi bladed windmills and aero generators;</td>
</tr>
<tr>
<td>Lighting</td>
<td>• PV;</td>
</tr>
<tr>
<td></td>
<td>• biogas;</td>
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<tr>
<td>Crop Drying</td>
<td>• Solar Driers;</td>
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<tr>
<td>Conservation of Agricultural Products</td>
<td>• Solar absorption machines;</td>
</tr>
<tr>
<td>(Refrigeration)</td>
<td></td>
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<tr>
<td>Rural Electrification</td>
<td>• Mini hydropower plants;</td>
</tr>
<tr>
<td></td>
<td>• Aero generators;</td>
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<tr>
<td></td>
<td>• Dual fuel engines;</td>
</tr>
<tr>
<td></td>
<td>• PV and thermodynamic power plants;</td>
</tr>
<tr>
<td>Building and House Heating and Cooling</td>
<td>• Solar collector;</td>
</tr>
<tr>
<td></td>
<td>• Passive solar designs using different systems and materials for house comfort, health</td>
</tr>
<tr>
<td></td>
<td>and education needs;</td>
</tr>
<tr>
<td>Education and Health</td>
<td>• Heating from solar water heaters;</td>
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<tr>
<td></td>
<td>• Electricity supply from PV systems for TV and radio;</td>
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<tr>
<td></td>
<td>• Rural hospital lighting and refrigeration through PV systems and other solar systems;</td>
</tr>
<tr>
<td>Handicraft Industries</td>
<td>• Solar water heater;</td>
</tr>
<tr>
<td></td>
<td>• Biogas and Producer Gas;</td>
</tr>
<tr>
<td></td>
<td>• RE based electricity;</td>
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<tr>
<td>Agro Industries for Rice, Oil, Sugar,</td>
<td>• Valorization of agricultural residues;</td>
</tr>
<tr>
<td>Conservation Industries</td>
<td>• (gasification for dual fuel engines and combustion for steam engines);</td>
</tr>
<tr>
<td>Radio Communications Forest fire</td>
<td>• PV systems and aero generators.</td>
</tr>
<tr>
<td>Surveillance and Meteorology</td>
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</tbody>
</table>

Research on energy crops is becoming increasingly desirable to expand the resource base for ethanol production. It includes accelerated development of known ethanol sources such as sugarcane through collection of genetic materials, testing and establishment of cultivation regimes, cassava and sweet sorghum, and also other crops such as buffalo gourd, carob, tamarind and sagopalm, which can be grown in saline swamps. Hydrocarbon producing crops (oil palm and sunflower) also merit attention; they could become a direct agriculture based source of hydrocarbon.

Research on technologies for conversion and use of RE is also required. Among these technologies for the use of biomass based fuels, more research is needed on: dissemination of fuelwood stoves; straw briquettes and vegetable oil uses; use of biomass to produce heat for industrial purposes and mechanical shaft power namely external and internal combustion engines. With regard to direct solar, wind, small hydro, solar ponds, research and development should concentrate on: reducing costs for water heaters; developing low cost dryers which could help in improving crop quality and reducing post harvest losses; mini solar ponds which constitute promising technology for water heating; small scale wind electric conversion systems that are both cost effective and adaptable for use in remote areas and finally, photovoltaic cells and systems which could become cost competitive for applications requiring small quantities of electricity and remote from the grid. With respect to solar ponds, research could concentrate on both mini and unlimited ponds and control of wind effects on ponds.

Extensive socio-economic research is also needed on processes for development and dissemination of RE technologies, to the rural world. This includes research on extension services adapted to specific technologies; on rural energy systems at the farm level; on the establishment of rural energy balances; and on desirable integrated energy models. The energy concept should be brought into planning of development projects mainly in three stages: assessment of energy resources through life cycle analysis and survey of alternative sources environmental impact analysis; social impact analysis through de-
Table 1  Summary List of Renewable Energies

<table>
<thead>
<tr>
<th>Biomass (40%)</th>
<th>Solid State:</th>
<th>Wood</th>
<th>Charcoal</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Crop residues</td>
<td>Chips</td>
</tr>
<tr>
<td>Forests</td>
<td></td>
<td>Dung</td>
<td>Pellets</td>
</tr>
<tr>
<td>Crop residues</td>
<td></td>
<td>Ethanol</td>
<td></td>
</tr>
<tr>
<td>Animal residues</td>
<td></td>
<td>Methanol</td>
<td></td>
</tr>
<tr>
<td>Liquid State</td>
<td></td>
<td>Biogas</td>
<td></td>
</tr>
<tr>
<td>Gas State:</td>
<td></td>
<td>Manufactured gas</td>
<td></td>
</tr>
</tbody>
</table>

Maxi Hydro (30%)

Conservation (20%)

| Solar (4%)                  | Transportation | Air heating |
|                            | Stoves         |             |
|                            | Agricultural cultivation |         |
|                            | Electricity delivery |       |
|                            | Industrial processes |     |
|                            | Building designs |         |
| Solar (4%)                  | Flat Plates | Water heating |
|                            | Concentrators | Mechanical energy |
|                            | Photovoltaic |             |
|                            | Solar ponds |              |

Mini Hydro (3%)

Geo—Thermal (2%)

Wind Systems (1%)

Percentages given are very rough guesses of percentage use 1990.

Conclusions and Recommendations

The main conclusions drawn from this paper are summarized below:

1) the “Second Energy Crisis” is a prime burden directly affecting the rural life and habitat;

2) RE technologies are unlikely in the near future to contribute in a major way to solving the problem of global energy shortages in the world. Their contribution in aggregate terms will remain extremely modest;

3) however, RE technologies could make a significant contribution towards meeting the rural energy needs, improving living conditions of the rural poor and, in particular, providing energy to isolated areas for which traditional energy costs would be prohibitive. Their impact on the rural habitat could be decisive and they should continue to be developed with that objective in mind;

4) while a number of rural RE technologies have reached maturity, there is a need for local engineering adaptation and optimization of performance;

5) experience today with introduction of RE technologies in the rural world are very scattered, still mostly at the local experimental stage and not yet recognized at the planning and budgeting level. There are three major exceptions: the biogas program in China (with seven million digesters, and affecting some 35 million rural families); the village woodlots in Korea and China; and the sugarcane based Ethanol program in Brazil;

6) the development of RE technologies is a long-range goal, but it is an imperative one to get rural areas today to meet the challenge of the era “after oil”;

7) there is a need to accelerate research on rural energy systems and to develop integrated energy models at the village level serving the priority needs of the rural poor and based on locally adapted RE technologies. In designing these systems due consideration should be given: first to bottom-up planning in order to reflect the needs of the people, as well as the local conditions; and second, the need for aggregation, planning, budgeting and targeting and the central (whether at national or regional) level, to ensure follow up and mass development. The experience of China has largely demonstrated that success in dissemination is only obtained when national and regional goals are properly set;

8) planning of RE technologies could only be carried out satisfactorily if socio and resource endowment studies have been made to allow for proper economic evaluation of priorities and trade-offs;

9) the priorities for RE development, as seen today, are for: afforestation and valorization of agricultural residues; photovoltaic communications and pumping; improved wood stoves dissemination passive solar designs (yet to be fully developed) for community building and houses; rural electrification where RE has a role to play.

Finally, the energy target should increasingly be taken into account in architecture and construction for the poor, namely in using low energy content materials and through mass diffusion of adequately developed passive solar designs. Experiences carried out so far in construction of schools in developing countries has demonstrated that higher school attendance can be obtained in solar heated buildings in remote areas. The architect for the poor should be a “multi-talent” man, capable of surveying the social and economic, mostly agriculture-based, rural scene, aware of energy issues and technologies and always conscious of the need for replicability and mass diffusion, if he wants to help improve the living conditions of the rural poor when building.
Reference Notes

1. If an economic cost of $42/barel is retained for gasoline, ethanol production is competitive if sugar-cane cost is below $14, which is the case of most of the efficient producers.


3. Greater details on research orientation and a listing of promising energy crops, technologies for conversion of biomass into usable fuels, technologies for the use of fuels derived from biomass, major technology development for KE uses, can be found in the World Bank publication on "Mobilizing Renewable Energy Technology in Developing Countries: Strengthening local capabilities and research," World Bank, July, 1981.


6. L. Elmendorf, Case study of Fehovil's program of improved stove diffusion in Honduras, September 18, 1980.

Wind Energy


9. Mobilizing Renewable Energy Technology in Developing Countries: Strengthening local capabilities and research, July 1981.

Sources of Documentation on Renewable Energies Technologies

General Information on Renewables

1. SEMA, Evaluation des energies renouvelables pour le development (2 volumes), Mars 1980.


General Information on Solar Energy


Documentation on Passive Solar Systems


Documentation on Solar Ponds


Documentation on Solar Pumps


Biomass Energy


Fuelwood, Charcoal and Woodstoves

The total energy consumption per year in China is the equivalent of 855 million tons of standard coal. And, 80 per cent of the total rural energy or the equivalent of 250 million tons of standard coal, is consumed as rural domestic fuel. The following is a breakdown of the kinds of domestic fuel employed in rural areas:

- Stalks (from crops)
- Firewood
- Coal and charcoal
- Livestock excrement
- Other fuel (weed, leaves, etc.)

Quite clearly, most present resources for rural energy are biological in origin.

Rural China has a vast area, where peasant dwellings are widely dispersed. Large quantities of energy are required, and today, approximately 70 per cent of the total rural habitat is short of fuel. Most rural districts lack from two to three months' worth of fuel per year, while some individual districts lack from four to five months' worth. Because of such serious shortages of organic fuel, farmers must spend considerable time and effort in collecting wood, grass, roots and stalks from crops, as well as other organic material, in the fields and mountains. This method strips the plant cover from the earth's surface, causing soil erosion from watershed on the slopes, which in turn transforms good cultivable land into sandy terrain. The ecological balance on farm lands is destroyed, thereby working against efforts to improve unfavorable agricultural conditions. Therefore, unless alternative solutions to the problem of organic fuel are found, the modernization of Chinese agriculture will be adversely affected.

More than 90 per cent of all rural energy depends upon some form of biomass energy. The consumption of biomass energy amounts to about 540 million tons, nearly all of which is obtained from direct burning, with very low efficiency (generally below 20 per cent).

When the biomass energy is burnt directly, only a small part of its heat is used, and its fertilizing constituents are not utilized at all. The biomass burnt every year is equivalent to burning 2 million tons of pure nitrogen, which is a great loss to soil fertilization. Therefore, when employing biomass energy, we must try to utilize both its energy component and its nutrient component. Practice has proved that methane production is the most efficient way of biological energy conversion. Human and animal wastes, stems and leaves of all kinds of plant, garbage, and other organic matter are discharged into a methane-generating tank as raw material for fermentation. Not only methane gas, which can be used as fuel, is produced but also most of the nutrient component of plants, the nitrogen, phosphorus, and potassium, is preserved, all of which are high-quality organic fertilizers.

It is estimated that, under present conditions in our country, if half of all human and animal excrement, as well as crop stalks were used to produce methane gas, the output in methane gas would be 68,300 cubic meters a year. In addition to supplementing rural energy production, this can be used to generate power and electricity. Hence, it is apparent that developing methane production is one of the most efficient ways of solving the problem of rural energy needs.

Methane zoning is one of basic procedures in the planned production of energy.

We have already done some preliminary work in this realm. Two kinds of divisions have been worked out. We divided the whole country into several different zones. Each zone has its own special characteristics with regard to methane production. This was done in order to determine the critical aspects and eventual steps to follow in developing methane for different zones.

A. Division according to temperature. Climatic temperature is an important factor affecting the output of methane gas when fermentation is done at atmospheric temperatures. If the fermenting temperature in the methane-generating tank is lower than 10°C, then the fermentation will not take place properly, resulting in low methane output. The temperature of the methane tank is also closely related to the temperature of the earth. Because data is lacking on the earth's temperature at deep levels, we have decided upon a division into zones according to climatic temperature. There are five zones covering the entire country:

1) Zone I: The average monthly temperature is higher than 10°C for 10-12 months.
2) Zone II: The average monthly temperature is higher than 10°C for 8-9 months.
3) Zone III: The average monthly temperature is higher than 10°C for 6-7 months.
4) Zone IV: The average monthly temperature is higher than 10°C for 4-5 months.
5) Zone V: The average monthly temperature is higher than 10°C for less than 4 months.

B. Comprehensive zone divisions: Zoning according to such factors as a shortage of firewood, the resources for producing methane gas, and the economic conditions is called comprehensive division. Taking a county as a geographical unit, and the three above-mentioned aspects as criteria, several different situations have been worked out:

1) Firewood shortage: serious firewood shortage; average firewood shortage.
2) Methane producing resources: rich in resources; average in resources; poor in resources.
3) Economic conditions: rich; average; poor.

Evaluating the three criteria and taking into account the factors of temperature division, we can obtain the order, amount, and scale for reasonable methane development. For example, the average monthly temperature of Guangdong Jiangxi, Hunan, Zhejiang, Sichuan and eleven other provinces in China is above 10°C for more than eight months a year. Among these provinces, Guizhou, Tianjin, Hangzhou, Shanghai and Changsha municipalities have serious shortages of organic fuel in the countryside, but they are rich in methane producing materials and from an economic standpoint. Obviously, these four municipalities will be the focal points for developing methane.

Design of Methane Tanks

Methane production and the use of methane
were developed in China early in the 1930’s. Zhou Peiyuan, the famous scientist of China, built an underground, hydraulic pressure methane tank in Xinying County (Jiangsu province) in 1936 to produce methane for cooking and lighting. In the same year, a methane tank was built in Anhui Town of Shuj County, (Zhejiang province) for the inhabitants to light their lamps. An indoor methane tank in Wuan County (Hebei province), which was built in 1937, still exists in good condition and can be used to produce methane. The history of methane gas use in China is about 40 years old. Since the foundation of New China, the Chinese government has very much emphasize methane development. At the end of 1978, there were seven million methane-generating tanks built in China. Among these, there were 36,000 medium-size tanks. There were 751 small-size methane power stations with a total capacity of 9,234 HP, and 617 small-size methane electric generating stations with a total capacity of 5,060 KW built during the same period. During the five years from 1973 to 1977, there were five million tanks built in Sichuan province alone. This number of tanks provided for 70 per cent of the total agrarian families in 22 counties or municipalities in that province. With the introduction of renewable energies, the accumulation of manures to reclaim soils, and the improvement of rural environmental sanitation, farmers have had more leisure time to study science and agronomy, thereby contributing to modernization of agriculture in China. Methane gas development has helped farmers to solve some of the above problems already.

As those 7 million methane tanks already built are able to supply cooking fuel for 30 million people and 40 million tons of organic fertilizer, the construction of tanks has now passed from the demonstration phase to that of wide applicability, methane gas has become a productive force in the national economy. The whole structure of rural energy in China has been greatly changed by the development of methane gas.

Besides providing microbes with favorable conditions for fermentation, rational design and construction is a crucial factor in producing home-made methane. Design principles include:

1. Methane tanks should be built adjoining latrines and livestock pens so that human and livestock excreta can flow automatically into the tanks. It is thus convenient for men to manage them, good for maintaining the temperature of the tanks, for improving the environmental sanitation, and for raising the amount of gas production.

2. The shapes of methane tanks should be chosen so that they will be favourable to the fermentation of bacteria, rational in terms of bearing forces, of easy construction, and efficient in using materials.

3. A movable lid should be installed in a proper position so that residue can be removed and the remaining gas can be let out. And, it can be used as a safety valve when the gas conduit is blocked up.

4. The pipe for introducing material, which is generally straight, inserted at a slant from the latrine or livestock pen into the fermenting chamber. There should be open ground around the inlet to the pipe so that it will be convenient for preparing the feeding material and for discharging it into the fermenting chamber.

5. The chamber for removing residue should be built in the middle part of the tank in order to draw in the liquid from the middle of the fermenting chamber. It is good for parasites to deposit there. A cover must be put on the top of the chamber for removal of residue to prevent men and livestock from falling into the tank. And it is also helpful in maintaining environmental hygiene. The determination of the volume of the methane tank depends on the amount of methane consumed for cooking and lighting every day. Generally one person consumes about 0.25-0.3 cubic meters of gas a day. The amount of methane produced is influenced by the raw materials used for fermentation, the temperature, and the technological conditions. One cubic meter of liquid material produces around 0.15-0.3 cubic meters of methane per day.

If, for example, we suppose the standard consumption of a man is 0.25 cubic meters per day, a family with four persons will consume 0.25 × 4 = 1.0 cubic-meter/day of methane gas. If the production rate of methane from one cubic meter effective volume is 0.15 cubic meter per day, then the effective volume of the tank should be 0.10 ÷ 0.15 or 6.67 cubic meters. The volume of the liquid material is 85 per cent of the total volume of the hydraulic pressure methane tank. Thus, the volume of the methane tank should be 6.67 ÷ 0.85 or 7.85 cubic meters, or roughly 9 cubic meters.

There are many types of methane tanks. Two types can be categorized according to their positions: one is on the ground, and the other is underground. Another type depends upon the fermentation temperature: high, medium, and low (natural) temperatures. Still others reflect the methods for storing gas: hydraulic pressure, or separate floating cover. In this article, we shall focus especially upon the underground, natural temperature, hydraulic pressure and separate floating cover types of methane tanks.

1) Hydraulic pressure methane-generating-tank: The hydraulic pressure methane-generating-tank (fig. 1) is composed of five units: feeding pipe, fermenting room, gas storing chamber, residue removing chamber, and gas transporting pipe. Material for fermentation is discharged into the fermenting chamber from the feeding pipe. Since the feeding pipe, fermenting chamber and residue removing chamber are connected as a whole, the liquid material in these three are at the same level after the feeding material is fed in. When the gas conduit is closed, the fermenting material is decomposed and methane gas is produced. As the methane gradually increases, it goes up into the gas storing chamber, and the pressure also increases. As a result, the liquid level in the fermenting chamber goes down, while the liquid levels in the feeding pipe and residue removing chamber go up, and the volume of the gas storage chamber thus becomes enlarged. If the gas conduit is open, the methane gas is consumed continuously, and the pressure on the liquid surface of the fermenting chamber decreases. Under atmospheric pressure, the liquid surfaces of the feeding pipe and residue removing chamber go down while the liquid surface of the fermenting chamber goes up, and the volume of the gas storage chamber
decreases correspondingly. In this type of methane generating tank, the gas pressure is regulated through the rise or fall of the connected implements. Thus, the name hydraulic pressure methane-generating tank.

The hydraulic pressure methane-generating tank is the most popular type of tank in our rural areas. The advantages are that its structure is simple, its construction not very difficult, the initial cost is low, and it is easy to use. One drawback still to overcome is that both the fermenting chamber and gas storage chamber are built in the same tank. The pressure in the tank is rather high, and unstable. When methane gas is produced, part of the fermenting raw material is pressed into the water box, so that part of the methane gas cannot be collected, thereby causing a decrease in the production of methane gas. Meanwhile since the methane gas pressure is rather high in the fermenting chamber (usually around 80-100 cm of water-head), gas leakage in the tank body is easily caused and methane gas production drops.

The shapes of methane tank structures depend on the material used in constructing them. At present the materials used are concrete, brick, and stone; hence a round, a spherical or an ellipsoidal shape is often adopted.

2) The structure of round-methane generating tanks (Fig. 1 & Fig. 2) is a rational one, and its carrying capacity is good. The body of this type of tank is spherical; the cover is a spherical segment, and the wall, the cylinder, and the bottom, are reversed spherical segments. Its wall is usually low, about 0.6-1.0 meter high; thus, the fermenting area and gas storage volume are enlarged, which is beneficial to the methane production (raising the production 14-19 per cent). Since the total height is reduced, the depth for excavation is reduced accordingly, and the tank can easily avoid underground water. (Fig. 1 and Fig. 2)

3) The structure of the positive spherical methane tank (Fig. 3) is also simple and rational. It can carry forces evenly. It adapts to external forces from every direction. It occupies little area, needs little material and has low initial cost. Its adaptability is extensive. It can be built in coastal districts, or the districts with a network of waterways and soft soil, or the districts where the underground water level is high. The construction of it is simple, and it is easy to keep it from leaking water and gas. Its shortcomings are that only one kind of material, that is, only mark 150 concrete, and not other fragile materials can be used. It must be cast on site. (Fig. 3)

4) The shape of the ellipsoidal tank (Fig. 4) is quite scientific. The wholeness of the tank is characteristic of it. It forms a balanced system of space. The area of the tank's bottom is large, which aids in raising the amount of gas production and thereby limit the fluctuation of gas pressure to a rather narrow range. This is favourable for the fermentation and the utilization of methane. And, on a large scale, it can overcome the shortcomings of unstable pressure in the hydraulic pressure methane tank. It is suitable for construction on any kind of foundation. It can be made by the assembly of parts, which is helpful in developing standardization and prefabrication. In order to build such a tank, the standard mark of concrete should not be lower than 200.

Let us examine the calculation of the structure in a round methane-generating tank for example. Such a tank is composed of a tank cover, a tank wall and a bottom receptacle.

The structure of the support and basic assumptions for its calculation follow. There are two types of the structure for supporting the spherical segment tank cover. The type shown in the illustration (Fig. 5) is that of a cover supported by a reinforced concrete ring beam. Large methane-generating tanks are usually built in this way. Small methane-generating tanks (Fig. 6) are usually constructed with the support of the cover distributing the forces in a way that the horizontal component of force is transmitted from the ring beam of plain concrete through the ring-shaped supporting pier of gravel concrete (or cement and rocks) sidewise to the foundation. No special measurements are made between the tank wall and the tank cover in
the above-mentioned methods, so there is no bending moment constraint. Therefore, with a uniformly distributed load along the inside and outside axes of the tank, the calculations are done according to the following assumptions.

According to its edge condition, the cover is a spheroidal segment-shaped shell with hinge joints. One should employ non-moment theory to calculate the diametral and circular internal forces of the different parts of the spheroidal shell. The edge structure of the cover shell (or ring beam) has only circular internal forces. The diametral and circular internal forces of the cover shell vary with the proportionality of the height vector and the inner diameter, as well as with the direction of the load. It must be noted that fragile materials should not be used to make tank covers. And since no tensile force should occur on the cover shell, the proportionality of the height vector and the inner diameter must be kept less than 1:4.15.

With regard to cylindrical tank walls, one should assume that both ends of the cylindrical shell are hinge joints, and calculations should be worked out by employing the theory of moment. Calculations for the spheroidal segment shaped tank bottom are the same as those for the tank cover.

At first the values of the internal force under each single load should be worked out, and then add them together. It must be noted that full loading (all kinds of loads work simultaneously) is not necessarily the most disadvantageous combination. For example, the most disadvantageous combination of the tank cover only occurs when the tank is empty. But in normal methane gas production, the result of addition of the internal force values has an effect of unloading, because the direction of the pressure of methane gas is the reverse of that of the vertical external load.

During the period of construction for the tank wall, and before the strength reaches the required mark, a check must be made according to the actual mark. The tamped backfill pre-stressing force (take 200 kg/m² for calculation) is employed as its load.

The period of operation consists of adding the side pressure caused by the ground live load.

**KEY**
1. Fermenting room
2. Gas storing chamber
3. Water storing (feeding) chamber
4. Residue removing chamber

**Fig. 3** Spheroidal methane-generating tank.

**Fig. 4** Ellipsoidal methane-generating tank.

**KEY**
1. Spheroidal segment shaped tank cover
2. Reinforced concrete ring beam
3. Tank wall

**Fig. 5** One of the structures of tank cover support.

**Fig. 6** Another structure of tank cover support.
then the sum of the soil pressures above and under the ground water level, and the static head of the groundwater (when the tank is empty).

A foundation reaction force on the tank bottom is caused by the dead load of the tank body, the covering soil and the live load of the ground.

In order to save construction material and reduce the initial cost, we do not take into account while calculating the internal force of the tank wall, the liquid material pressure and methane gas pressure, nor the condition of no soil around the tank body. Thus it is required that the tank wall be constructed directly against the side of the excavation when built on a site with good quality soil, whereas the soil around the tank wall should be well tamped when built on a site with bad quality soil. The purpose of tamping is that during the operational period of the methane tank, the lateral pressure produced by the material and the methane gas will be absorbed by the soil outside, instead of the wall itself. According to this assumption, if we were to design a round methane tank with a volume of 8 cubic meters, of 2.7 meters in diameter and a wall thickness of 4.5 centimeters, we would use 1.5 cubic meters concrete with No. 150 cement only. Now if we use the traditional method of designing the above tank, not only would we make the wall thickness 8 centimetres, but also we would have to use reinforced concrete. The cost of making a tank would be greatly increased in this way. In our experience, the above assumptions were quite successful in making methane tanks in the Chinese countryside.

5) Separate "floating cover" methane-generating tank. The gas pressure within the hydraulic methane-generating tank varies greatly which easily causes leakage and has an effect on gas production. In order to overcome this disadvantage, the workers of methane production in our country have assimilated the advantages of the floating cover by the Gobur Gas Plant in India, and have successfully made the separate "floating cover" methane-generating tank through experimentation. This type of methane-generating tank is composed of a fermenting chamber, a feeding pipe, an overflow chamber, and a floating cover of the gas storing room (Fig. 7). As can be seen from the illustration, the fermenting room and storing room cover are built separately. This type of methane tank not only maintains the principal characteristics of the hydraulic pressure methane-generating tank, but also draws advantages from the separate gas storage of the "floating cover" methane-generating tank.

It has been proved through practice that the separate "floating cover" methane-generating tank can produce as well as store methane gas under conditions of low pressure and stable pressure. The level of the fermenting liquid remains stable, and its daily production of methane gas can be raised to about 30 per cent more than that of the hydraulic pressure methane-generating tank. Due to the adoption of the separate gas storage device, the volume of feeding material contained in the fermenting room is raised from 85 per cent of the hydraulic pressure methane-generating tank to 95 per cent. Therefore, if the same amount of fermenting material is introduced, the volume of the tank can be reduced about 10 per cent. Since the fermenting liquid will
not be forced into the hydraulic pressure chamber during the gas producing period, the loss of this part of the methane gas is avoided, and the utilization of fermenting raw material is raised. Moreover, since the methane tank is kept under low pressure (about 20 centimetres water head), it is obvious that leakage of the tank body is eliminated considerably. It is advisable to convert unusable (due to leaking) hydraulic pressure methane-generating tanks into separate “floating cover” methane-generating tanks in order to reduce the pressure within the tank to make them work again (Fig 7).

The shapes and the calculation of the structure are as follows:

The fermenting room of the “floating cover’’ tank is the same as that of the hydraulic pressure methane-generating tank. It can be built in a round shape, spheroid shape or ellipsoidal shape. At present, the type of tank that is widespread in Zhejiang province is a kind of round tank which consists of a spheroidal segment tank cover, a cylindrical tank wall and a reversed spheroidal segment tank bottom.

The shape of the floating cover for gas storage is cylindrical. The cover top is a spheroidal segment. The volume of the floating cover is 14 per cent of that of the fermenting room.

The pressure of the gas storage floating cover is calculated as 20 centimetres water head. The gas storage floating cover, a floating body, goes up and down vertically in the liquid in accordance with the changes in gas storage or gas consumption. Therefore, while calculating the weight of the concrete floating cover, we must take the buoyancy into consideration. We assumed that one-half of the floating cover is above the surface of the water.

The calculation for the outer chamber of the floating cover is done under the assumption that it is a cylindrical shell with the upper and free and a jointed hinge at the lower end.

The technology of construction for this type of tank involves several alternatives. One of these consists of the whole body being poured on site. There are two methods for the construction of this structure: one is by excavating the earth and casting a mould on site (Fig. 8); the other is open excavating and casting-on-site. Earth excavation and casting a mould on site is done by taking the earth from the place where the tank wall will be formed (following the design) and smoothing the sides, and then making an earth mould for the tank cover, which is painted with mould release agent; and finally, the concrete of the tank wall and tank cover are rammed continuously. No construction joint gap is needed. When the strength of the concrete reaches 70 per cent, the earth inside the tank is to be removed through the movable cover. The last steps are to pour the tank bottom and ram it well, and to seal the inside of the tank carefully.

Open excavation and casting on site entails the following: according to the designs, after the earth of the place where the methane tank will be built is excavated, the concrete of the tank bottom is poured first, and then the tank wall and tank cover. The tank wall may be cast with an earth mould, but the inner wall is, in general, cast with a moulding board of steel, wood or bricks. All parts of concrete should be rammed continuously, uniformly, symmetrically from bottom upwards to the top to make the ingredients proper. The outer surface of the cover is rolled smoothly by compressing the original concrete repeatedly.

The tank built with blocks is a second possibility. When excavating the pit, the sides of the excavated pit should be kept vertical, without any slope. If the quality of the soil is not very good, enough space must be left while excavation is being done for ramming, each side with a width of no less than 150 millimetres.

When the tank wall is being laid, the inner ends of the blocks should be put together tightly, and the gaps between the outer ends of the blocks should be sealed up with mortar. The lines of block junctions must be strictly horizontal, and the verticals straight. The mortar to be filled into the block joints must be saturated. The key point in the laying of the tank with blocks is that the soil filling at the back of the tank wall must be well rammed. It is necessary that the laying of the block wall and the infilling should be carried on alternately. The water content of the infill soil should be around 20-25 per cent. About 30 per cent of crushed stones and bricks can be mixed into the infill soil. The infill soil should be rammed layer after layer, symmetrically and evenly so that it may work as a band of the tank. It is just like giving the tank wall a prestress, which can unload discharge while the methane tank is working.

In laying the tank cover, the concrete ring beam around the edge should be built first. When the concrete ring beam hardens to a certain degree, the infill must be rammed in time, and the block footing beam must be installed. It is better to employ the method of laying the arch without centering to build the tank cover. The blocks must be of regular shape. During construction, curvature radius rod or string must be used to keep the arch in position. The block joints in the shell should be saturated with mortar, and tightened with flat gravel to keep the whole tank stable. After the body of the shell is completed, a layer of cement paste should be plastered over the shell surface. When the paste shrinks, fill with earth and tamp it well.

The procedure for sealing the methane tank is as follows: Clean the plastered surface and mortar joints. Mend the cracks with cement paste. Then plaster the inside of the tank with cement paste thoroughly once again.

A cement paste of 1:3.5 (by weight) is used for the base coating of the tank cover, the cast in place tank wall above the feeding pipe, and the residue removing pipe. If the tank is built of blocks or bricks, the whole tank wall should be plastered. The base coating is about 5 millimetres thick. A mixture of cement paste of 1:3 is used for the middle coating of only the inner surface of the tank cover. The thickness is about 5 millimetres. Finally, all the inner surface of the tank must be plastered with 5 millimetres thick of cement paste of 1:2.5.

The plastering work must be done continuously. The base coating and middle coating must be pressed compactly. And the surface coating must be pressed flat and smooth without any sand on it after repeated pressing. Then the cement paste (mixed with an aqueous solution of chlorous iron) must be applied twice or three times. The tanks of
higher requirements can be plastered with melted paraffine wax and then baked with a blowtorch so as to let the paraffine liquid permeate the capillaries of the plastered layer. When the tank body is completed, it must be put to the test in order to check whether there is any leakage of gas or water. The test can be done by employing the method of air pressure. The process is as follows: First, the feeding and residue-removing openings, and the movable cover must be sealed with clay, and then the cover is sealed with water. Fix an air pressure meter and turn off the switch of the gas transporting pipe. Fill the tank with air by means of an air pump. When the water column of the air pressure meter reaches 300-400 millimetres, stop filling the air. If the water column goes down to around 20 millimetres after 2-3 hours, the tank can be considered to be qualified.

The Principles for Accommodating Methane Tanks

The building of methane-generating tanks in rural areas not only provides much-needed domestic fuel, but also provides the farmland with excellent high efficient organic fertilizer, and improves the sanitary conditions of the environment. While designing rural housing and plans for villages, designers today have taken biomass energy into account in relation to mountains, water, farmland, forests roads and villages as a whole. Methane tanks should be connected to latrine and animal pens. In general, these should be positioned at the corners of the yard so as to reduce the pollution of the environment. Of course, convenience for feeding raw materials and removing residues must be taken into consideration as well.

The plan of dwelling houses in the Jinma Commune (Sichuan province) is a good example (Fig. 9). A number of the roofs of the one-storey houses can be used for drying crops, and for cooling in the summer. Outside the courtyard of each house, by the road, there is a methan tank attached to the pigsty and latrine inside the courtyard. This is convenient for feeding the tank. The residue-removing opening is located outside the courtyard, which is convenient for carrying the fertilizer to the fields.

As well seen from the three above-mentioned types of dwelling, construction of housing projects in rural neighbourhoods should be arranged in rows facing south. Two rows form a group with their backyards standing side by side. The pigsties, latrines and the methane tanks are positioned between the two yards with a path leading to the fields for sending fertilizer. Straw, firewood or other various household supplies can be stored in the backyard. In order to change the stereotype arrangement of rows, it would be advisable, in the author's opinion, to build a central methane-generating tank with proper pressure. It would unify the gas supply in order to improve the environmental sanitary conditions. And it would also be advisable to combine the advantages of the row-type and courtyard-type housing in order to have more flexibility of arrangement.

Fig. 10 — The plan of the newly built one-storey dwelling-houses of Wangzhong Brigade in Henan Province. Every house is built with two units; every unit is for two households with two rooms for one, and three rooms for the other. Every unit has a courtyard with a latrine and pigsty built together. One or two methane tanks can be built outside each courtyard. Human and animal wastes can be discharged directly into the tank from inside the courtyard.

Fig. 11 — The plan of the two-storey dwelling-houses of Mashie Production Brigade, Hubei Province. Behind each house, there is an inner courtyard with a pigsty and a latrine built against the wall of the yard. Below them is the methane-generating tank. It is very convenient to use and manage the tank.
Conclusion

Although we have obtained considerable experience in the building methane-generating tanks, there remain numerous problems to be investigated. Among these are: the replacing of fragile materials with new ones; the introduction of flexible as opposed to rigid sealers; the standardization of methane-generating tank designs and the prefabrication of constituent parts of these; and, the utilization of solar energy to promote fermentation and thereby increase the production of methane. We earnestly desire exchanges of experience with other specialists in the field of methane production in order that people all over the world may benefit from our joint research.

References

1. Zhang Li-gao, *An Introduction to Agricultural Engineering* (November, 1980, Beijing)
Earthquakes continue to be one of the major natural catastrophes with which humanity, even in modern times, is still trying to find ways and means for coping.

Many professionals from diverse disciplines are currently trying to improve the efficiency of various mechanisms for passive protection. Although this paper generally deals with various measures which are considered helpful in mitigating the lethal and destructive effects of earthquakes, it puts a particular emphasis on proposals of a structural engineering nature, based upon circumstances that prevail in Turkey.

Timber frame structures, stone or adobe constructions are still predominant in rural areas of the world. This is particularly true in the case of Islamic countries of the region that stretches from Central Asia and the sub-continent to North Africa, where a traditional architecture made of earth is an inseparable part of the peasants' daily life. It is an unfortunate coincidence that large parts of this region are under a constant threat of earthquakes; hence, the traditional building techniques on the one hand, and the strong risk of natural disaster on the other, are two aspects of life in such areas which are interrelated.

Some regions of the earth are much more prone to have earthquakes than others. Three main zones may be delineated on the earth's crust according to the intensity of the earthquake. The alpine and transalpine belts form a single zone, the circumcaspian belt is another zone, and the remaining areas of low seismic activity constitute a macro-zone apart. The circumcaspian belt encircles the Pacific Ocean with a series of very close epicentres, while the alpine belt starts to the west of this belt and extends westward with less frequent epicentres along the southern regions of Asia and Europe. The low-seismic macro-zone covers the rest of the world having earthquake-prone areas.

There are different degrees of urbanisation within these earthquake zones. As the percentages of urbanization indicate, a large proportion of the populations of Africa and Asia that lives in earthquake zones are also in rural settings. The ratio of urban to rural in Latin American countries is 50 per cent, while only in those parts of the U.S.A, Japan, and the USSR which fall within earthquake belts does the population density correspond to urban areas. It is clear, therefore, that over a billion people in rural areas of China, and the Muslim world are exposed to the potential ravages of an earthquake.

A large part of the deaths in rural areas, from other than normal causes, can be attributed to earthquakes. International agencies, therefore, that are committed to improving rural living conditions, must concentrate on the problem of developing dwellings resistant to earthquakes.

Map of the world indicating degrees of urbanisation in some of the major earthquake zones

Source: M. Yorulmaz

Map of Turkey, indicating the epicentres of earthquakes with a magnitude greater than 6.9 (Richter) occurring since 1925

Source: M. Yorulmaz.

Turkey is one of those countries which has experienced many strong earthquakes throughout her history. The earthquake belt encompasses 91.4 per cent of Turkey's total area, within which 95 per cent of the population lives. For purposes of scientific analysis, Turkey has been divided into five zones reflecting the different degrees of seismic activity. The most active earthquake regions of Turkey are on the Western Anatolian plateau and along the Northern Anatolian fault. Earthquakes with a magnitude greater than 6.9, that have occurred since 1925 are
shown here. During these tremors alone, approximately 62,000 lives were lost and
350,000 buildings collapsed or were damaged.

Rural Housing

The rural areas in Turkey are defined as areas with less than 10,000 inhabitants. There are
3.9 million dwellings located in these rural areas, housing 62 per cent of the Turkish
population. In addition, the shanty towns around such large cities as Istanbul, Ankara
and Izmir contain some 600,000 houses of a decidedly rural character. Most rural dwellings
are constructed according to traditional building systems and therefore do not reflect
any advanced techniques of structural engineering.

When classified according to their structural materials and systems, rural houses in Turkey
reflect the following statistics: 50 per cent of stone or brick masonry; 24 per cent are of
adobe; 18 per cent are timber framed; 8 per cent mixed construction. Of the total number,
88 per cent are single-storey structures, while the remainder have two stores. The distribu-
tion of these structural types throughout the country, reflecting various geographic,
climatic and economic factors, has been analysed.

Typical damage patterns to different structural systems as a result of earthquakes can be
broadly characterised under the following headings:
1) Damage to heavy masonry buildings due to their brittle character, minimal tension, and
minimal shear strength capacity;
2) Damage due to lack of proper structural joints;
3) Damage due to bad workmanship during construction;
4) Damage due to deterioration over time.

Let us take rural structures, category by category, and describe the kinds of damages that
take place:
1) Adobe houses generally have very poor structural joints between perpendicular walls.
When an earthquake occurs, the walls collapse taking the roof elements with them
and thereby causing most of the casualties. In regions with cold climatic conditions, the
heavy roofs which have been covered with earth for thermal insulation are always a
source of danger.
2) If round stones collected from river beds are used as building material, with mud
mortar as a binder, there is little hope that such structures will resist the effects of an
earthquake. In some cases, these walls are created without binding at the corner joints,
thereby almost eliminating the resistance of the stone masonry construction. This type will
most certainly be destroyed during earthquakes with an intensity of 7 or 8, and severely
damaged at intensities of 5 to 6. If not properly built, such houses generally behave
more poorly than adobe houses.
3) The most frequent structural failure to brick and concrete block masonry buildings is
from shear as a result of diagonal tension. Other failures can be attributed to horizontal
shear or torsion.
4) Timber frame or timber block houses behave better than the above-mentioned
structural systems during earthquakes. Under seismic conditions of moderate intensity,
timber structures often experience damage only to infill walls.

Measures to be undertaken in order to mitigate earthquake damage can be
approached in several ways. Clearly, one of
the most efficient manners is through struct-
tural engineering efforts. However there is
frequently a great disparity between the
measures proposed and actual application, the
causes for which may be political, economical,
technical or socio-cultural. The latter may stem
from a lack of consciousness of danger
due to earthquakes, from a lack of technical
knowledge, or from conservative attitudes
working against the introduction of new
dwellings. Economic reasons may involve
poverty, or simply a dearth of structurally
suitable materials. Finally, there are the diffi-
culties encountered in any effort of technology
transfer. Taken together the above factors
make clear the necessity for structural
engineers to collaborate with professionals
from many other related fields.

Most countries have prepared and put forward
specifications or codes on the design of
buildings intended to resist earthquake forces.
The codes in developing countries have paid
particular attention to problems of design for
rural areas. Perfecting the codes has little
meaning unless we are able to bridge the gap
together in theory and practice. Usually, the
rules and advice laid down are sufficient for
designing rural dwellings which could be
considered safe at least under moderate earth-
quake intensities.

General principles pertaining to all types of
buildings would include:
1) Construction sites should be selected care-
fully. Unstable slopes, loose sand or clay soil
are not suitable for rural habitations.
2) In terms of architectural design, plans for
houses should be as symmetrical as possible in
relation to the orthogonal axes.
3) The joints between different elements of a
structure should be perfect.
4) When materials are not strong in tension
or rigid enough under excessive compres-
sion, timber or steel tie beams should be
provided at vulnerable points.
5) The general quality of workmanship
should be improved.

The following recommendations could be
made for different types of Turkish houses in
order to decrease earthquake damage:

1) For adobe houses additives should be used to increase the strength and durability of adobe. As Turkey has large deposits of gypsum, successful research has been undertaken with this material as an additive for improving adobe bricks. Eventually, a prototype house will be built and tested under earthquake conditions. In order to increase the effectiveness of joints between inner and outer walls, these areas should be reinforced with a strong material acting in tension. Timber tie beams should be provided at the tops and bottoms of windows, heavy roofs should definitely be avoided, implying the necessity for research into alternative solutions. However, they should retain the advantages of the traditional heavy roof and be carefully joined to the supporting walls. Architecturally, the smaller the rooms in a dwelling the better, with walls in designed in both directions.

2) In stone masonry dwellings cut stone rather than round should be used, as well as a good quality mortar. The joints between faces of walls should be well executed. Many of the above-mentioned recommendations for adobe structures apply for those of stone.

3) The Turkish code, like most codes for brick and cement block masonry buildings, sets out rules for design and construction which include: limitations on the number of storeys depending upon the particular earthquake zone; regulations concerning foundations; the inclusion of reinforced concrete tie beams at different levels; thickness of walls; and, specifications for wall openings and for the stabilisation of walls.

4) The integrity and rigidity of timber frames should be improved, with a sufficient number of diagonal stays provided. Light-weight infill material is desirable. Efforts must be made to prevent deterioration of wood.

5) Apart from improving these traditional structural types, entirely new kinds of dwellings could be designed by employing other materials and/or construction techniques. Most of the efforts in this realm in Turkey have been relatively unsuccessful due to the unwillingness of inhabitants to change their ways and to accept a transfer of urban design to urban areas.

Drawings of principal structural systems employed in rural areas of Turkey affected by earthquakes:
a) wood block system, b) timber frame system c) brick masonry

Source: M Yorulmaz
Conclusions

Proper design can improve the earthquake resistance of rural housing considerably even if structural engineering know-how has not been introduced. These improvements depend upon many other factors which lie outside of purely technological developments. Thus, I would like to add a few words in conclusion about design problems as they relate to the use of traditional techniques in earthquake areas.

Ultimately, there is no reason why the aesthetic aspect of all kinds of human habitations should not be taken into consideration. Except for certain forms which have crystallised over time and are deemed beautiful or picturesque by architects, rural housing has not been included in aesthetic theorizing. One of the worst things that might occur in future projects for the rural habitat is a transfer of urban aesthetics into a rural context. I wish to emphasize that design must obey engineering prerequisites above all in areas threatened by earthquakes. This necessitates a modified approach to design.
Chana

I'd like to ask Mr Carmignani about the programmes, and the financial mechanisms, to promote wood fuel plots and agro-forestry projects in Third World countries, and especially as far as the World Bank is concerned.

Carmignani

The concept of creation of wood lots in villages is a concept that has been very successfully developed in China and in Korea, basically using fast-growing species to provide the fuel-wood needs of the village. As far as the organization that you mentioned, the World Bank has been involved in financing a number of forest developments and some village fuel-wood development, and therefore we have some experience in the financing of this type of project; we have a programme for accelerating this type of financing in the future. Our experience with these projects has not always been very good. The reason is that village fuel-wood really is at the center of the concept of community development. It's an entirely different and new approach for many of the communities that have been involved. First of all, the issues are not technical issues. I mean that the species are known, and the way to grow forests is more or less known, but the problems are essentially problems related to local organization, to local authorities, to ownership of land, to common ownership of land, to payment of the labour, and to sharing of the crops. These are really issues that are at the center of the community life in the village. The level of success was extremely high in China and Korea, because of the obvious strong, environmental and organizational framework in these countries, with a strong community stance at the village level.

Babar Muntaz

There are obviously two kinds of energy at stake when we talk about house design: a) the energy consumed in producing component materials, transportation and the totality of the unit once it is finished; b) what we might call "recurrent" energy in any housing scheme, i.e. the energy consumption of heating, lighting, cooking and the rest. The latter are ongoing. Have any analyses been done on the differences between the energy that is used over a limited period and those ongoing costs over the lifetime of a building, which the architect may have more control over in actually designing a house?

Carmignani

What you are asking in terms of our concepts of energy use is that we establish certain benchmarks against which we try to develop technologies, define and compare design alternatives. While I personally have never seen any calculations of construction costs in terms of energy consumption, these would undoubtedly aid our understanding of the factors involved. On the other hand, various laboratories in the USA (e.g. in Los Alamos) have produced statistics on the running costs for houses.

Koenigsberger

The fact that as of 1975 there are 7 million biogas tanks, or "digestors" as you call them, in China is an impressive record. Can you estimate for us how much oil you would need to produce the same amount of energy?

Zhang

In China, the emphasis has been on small-scale digesters primarily intended for household living proposes, such as cooking, hot water, etc.; so, it is difficult to calculate.
Serageldin

With regard to antiseismic design standards, I recently visited the El Asnam region in Algeria devastated by an earthquake. The destroyed buildings we observed had a common feature: they seemed to have collapsed, or literally crumbled, because of very poor quality executive. The concrete crumbled in our hands, and some impurities even appeared in the columns. This raised a question which was subsequently hotly debated: should antiseismic norms indeed be imposed by structural design in rural regions, or would it be better simply to try to encourage the use of lightweight roofing materials—in order to reduce the total number of casualties during an earthquake? Perhaps this is too fatalistic an approach, but it merits discussion.

Anil Agarwal (foreground) and Mufti Yorulmaz.
Photo: C. Little/Aga Khan Awards
Research: Mud as a Traditional Building Material

Anil Agarwal

The problem of shelter in the Third World may not be the most immediate and highest priority problem in the world but it certainly is the most extensive and apparently unsolvable problem.

There is hardly a developing country that is meeting its own housing targets. As towns — especially the metropolises — become stronger magnets of people, more and more people are coming to live in slums and squatter settlements. Between 1950 and 1975, the number of cities with over one million inhabitants rose from 48 to 91 in the developed countries. But in the Third World, the number of such cities nearly quadrupled, from 23 to 90. In these cities, anywhere between 20 to 90 per cent of the people today live in slums, shanty towns and other uncontrolled settlements, and in most cities their proportion is steadily increasing.

What is called 'low-cost housing' remains accessible only to the middle classes, and beyond the purchasing power of the majority. The World Bank estimated that income distribution in cities like Bogota, Mexico City, Madras, Ahmedabad and Nairobi in 1970 was such that 47, 55, 63, 64 and 68 per cent of the total households, respectively, could not afford the cheapest modern house on the market built with modern construction materials (Table 2). It is now widely recognised that the problem of human settlements planning cannot be separated from the overall social and economic context of the society. It is directly related, for instance, to spatial planning and to processes for employment and income generation.

With respect to housing itself, there is a growing realisation that governments ought not to treat housing as a permanent end-product that has to be delivered to the population, but as a process, which is incremental in nature for the majority of the population. The role of the government then is that of an agency which creates basic policy framework and infrastructure in a manner that encourages and supports this process.

<table>
<thead>
<tr>
<th>Country</th>
<th>City</th>
<th>Year</th>
<th>Population of city (millions)</th>
<th>Population in uncontrolled settlements</th>
</tr>
</thead>
<tbody>
<tr>
<td>AFRICA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nigeria</td>
<td>Ibadan</td>
<td>1970</td>
<td>0.74</td>
<td>0.55</td>
</tr>
<tr>
<td>Ethiopia</td>
<td>Addis Ababa</td>
<td>1968</td>
<td>0.74</td>
<td>0.66</td>
</tr>
<tr>
<td>Senegal</td>
<td>Dakar</td>
<td>1969</td>
<td>0.65</td>
<td>0.39</td>
</tr>
<tr>
<td>Somalia</td>
<td>Mogadishu</td>
<td>1967</td>
<td>0.21</td>
<td>0.16</td>
</tr>
<tr>
<td>Tanzania</td>
<td>Dar es Salaam</td>
<td>1967</td>
<td>0.27</td>
<td>0.10</td>
</tr>
<tr>
<td>Morocco</td>
<td>Casablanca</td>
<td>1971</td>
<td>1.45</td>
<td>1.01</td>
</tr>
<tr>
<td>Zambia</td>
<td>Lusaka</td>
<td>1969</td>
<td>0.28</td>
<td>0.13</td>
</tr>
<tr>
<td>Ivory Coast</td>
<td>Abidjan</td>
<td>1964</td>
<td>0.44</td>
<td>0.26</td>
</tr>
<tr>
<td>Cameroon</td>
<td>Douala</td>
<td>1970</td>
<td>0.25</td>
<td>0.20</td>
</tr>
</tbody>
</table>

Source: Global Review of Human Settlements, UN Conference on Human Settlements, Vancouver, 1976, A/CONF. 70/A/1

Table 2: Who can afford low-cost housing?

The table shows the monthly income required to purchase the cheapest complete housing unit then available (including a toilet and other services) in six Third World cities in 1970 (prices in 1970 US dollars). The figures assume that loans are available (usually they are not) and that interest rates are 10%. With interest at 15% (a common figure for 1981) the number of households unable to afford the cheapest 1970 dwelling would rise to 57% in Hong Kong, 61% in Bogota, 66% in Mexico City, 77% in Nairobi and 79% in Ahmedabad and Madras.

<table>
<thead>
<tr>
<th>City</th>
<th>Cost of dwelling ($)</th>
<th>Monthly repayment ($)</th>
<th>Monthly income required ($)</th>
<th>Households unable to afford (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mexico City</td>
<td>3005</td>
<td>28</td>
<td>184</td>
<td>55</td>
</tr>
<tr>
<td>Hong Kong</td>
<td>1670</td>
<td>15</td>
<td>103</td>
<td>35</td>
</tr>
<tr>
<td>Nairobi</td>
<td>2076</td>
<td>19</td>
<td>127</td>
<td>68</td>
</tr>
<tr>
<td>Bogota</td>
<td>1474</td>
<td>14</td>
<td>91</td>
<td>47</td>
</tr>
<tr>
<td>Ahmedabad</td>
<td>616</td>
<td>6</td>
<td>38</td>
<td>64</td>
</tr>
<tr>
<td>Madras</td>
<td>570</td>
<td>5</td>
<td>36</td>
<td>63</td>
</tr>
</tbody>
</table>

Building Materials

Planning in terms of building materials, taking into account the social and economic context of the society, is probably one of the most neglected aspects of human settlements. There has been a wholesale and often inappropriate adoption of Western materials and techniques — even including the large scale importation and use of prefabricated or modular housing units. In the last 20 years many parts of the Islamic world, for instance, have seen increasingly rapid and ill considered destruction of its architectural heritage, often combined with indifference to, or ignorance of Islamic cultural traditions and environmental conditions of the Middle East. But this disregard for traditional architecture and building materials is not restricted to the Islamic world. It is shared by more or less the entire Third World. As President Nyerere of Tanzania said in his 1977 assessment of the Tanzanian economy: “The widespread addiction to cement and tin roofs is a kind of mental paralysis.”

Nearly 50 percent of the world’s population still lives in buildings where mud has been used as a major building material. Given the rate at which purchasing powers are increasing in the Third World, a majority of people in the Third World will in all likelihood continue to live in mud buildings well into the foreseeable future. The rising prices of energy may cause modern building materials to move even further out of reach of the purchasing capabilities of many in the developing world.

Cement, for instance, is an extremely energy-intensive product. Fuel costs make up between one-third and one-half of basic cement production costs. In Denmark, the cement industry accounts for about two percent of the national energy bill, while in Jamaica, imported energy makes up over one half the cost of a locally-produced bag of cement. Rising energy costs also affect cement prices via transport. As cement production is generally centralised in large plants, this means that the price of cement is invariably higher in the rural areas (where purchasing powers are lower) than in the urban areas.

The price of cement in rural Tanzania is often 2-3 times more expensive at the cement factory in Dar es Salaam; and in Indonesia, the price of cement is rarely below US$100 per ton. In various countries of the Third World transportation costs exceed the depot price of cement after a distance of 100-200 miles. Large parts of the rural Third World do not even possess the transportation infrastructure to allow the importing of cement.

National self-reliance in cement production is also not easy to attain. Firstly, the raw materials needed to produce cement may not always be available within the country, and even if they are available, they may be concentrated in one part of the country. Secondly, the current scale of the technological structure for cement production is often inappropriate for many developing countries — especially from the point of view of availability of skilled manpower to erect, operate and maintain large industrial plants. The entire plant has to be imported by most countries. Even in a country like India where skilled manpower exists, it is not easy to install new plants at the rate at which the demand is growing. This leads to a perpetual scarcity of cement. The cost calculations of ambitious housing programmes have frequently been sabotaged by meteoric rises in cement and other building material prices because supply failed to keep pace with the increased demand.

Traditional building materials, on the other hand, offer several advantages. They are cheap. They are readily available. Capital requirements are lower. A house built with traditional building materials can be easily extended as the occupant’s income increases; and, such houses can be built in far greater variety as each householder builds according to his choice, thereby creating a far better social, cultural, and psychological environment than that provided by most low-cost mass housing schemes in the Third World.

That traditional building materials should be given adequate attention, is widely recognised in the literature and lip service is paid to them at many conferences and meetings of experts. But still little is ever done.

To take a quote from the regional paper for West Asia presented to the UN Conference on Science and Technology for Development held in Vienna in August, 1979: “Though there exists a rich heritage in design and construction from Hadramut to Nubia, there is very little concern for these technologies that may be within the reach of the bottom 70 percent of the population of the region. These beautiful structures often decorate travel literature but apparently little engineering attention has been devoted to studying and developing traditional forms.”

Efforts are being made, or have been made in the recent past, in various parts of the world to use and improve mud as a building material. This is not a comprehensive description of all these efforts but some of the high points in the research in this field are mentioned below.

Let me first recount quickly the major defects of mud as a building material. The major disadvantages are:

- It is easily eroded by water.
- It has a low tensile strength which means that roofs are difficult to make with mud (except, of course, in the way that ancient Nubians did with vaults).
- It is susceptible to mechanical damage. Rodents, for instance, can easily make holes in mud walls.
- Mud does not adhere to wood properly, so gaps often develop around wooden doors and windows embedded in mud walls.
- Mud soaks up water and becomes very heavy. Wooden beams supporting a heavy mud roof can begin to sag when it rains.

The effects of water on mud buildings can be greatly reduced by taking a variety of preventive measures according to the local climatic and rainfall conditions in the region. The Building and Road Research Institute at Kumasi, Ghana, has published a series of papers on earth buildings. Table 3 outlines a series of preventive measures against common defects of mud buildings in different climatic and rainfall conditions.

We notice as we study this Table that the general principle is to protect walls and finally the foundations, as the climate becomes wetter and wetter. In very dry regions, such as those of the Middle East, it is not necessary to have overhanging roofs to protect walls from rain. But this does become necessary as we
Table 3  Preventive Measures in Different Climatic Conditions

<table>
<thead>
<tr>
<th>Climatic Conditions</th>
<th>Common Defects</th>
<th>Preventive Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Desert and semi-arid area with annual rainfall</td>
<td>1. Settlement and shrinkage cracks but not extensive</td>
<td>1. Good soil selection — sandy clays or clayey loams or gravely clays</td>
</tr>
<tr>
<td>less than 10 inches</td>
<td>2. Erosion of walls caused by wind laden with sand.</td>
<td>2. Provision of non-erodable rendering such as lean concrete plasters</td>
</tr>
<tr>
<td></td>
<td>3. Mechanical damage</td>
<td>3. Planned layout</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. Improved workmanship</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5. Loans scheme in cash or in kind for preventive measures</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. Dry areas with annual rainfall of 10-30 inches</td>
<td>1. Settlement and shrinkage cracks</td>
<td>1. Good soil selection — sandy clays or clayey loams or graveley clays</td>
</tr>
<tr>
<td></td>
<td>2. Erosion of walls by wind or rain</td>
<td>2. Provision of non-erodable and waterproof rendering such as lean concrete or</td>
</tr>
<tr>
<td></td>
<td>3. Mechanical damage</td>
<td>soil cement plaster</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Planned layout with good drainage facilities.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. Good roofing and long overhanging eaves.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5. Improved workmanship</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6. Loans scheme in cash or in kind for preventive measures</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. Wet areas with rainfall of 30-50 inches.</td>
<td>1. Settlement and shrinkage cracks — very extensive.</td>
<td>1. Good soil selection — sandy clays or clayey loams or graveley clays</td>
</tr>
<tr>
<td></td>
<td>2. Erosion of walls and foundations.</td>
<td>2. Planned layout with good drainage facilities.</td>
</tr>
<tr>
<td></td>
<td>3. Underscouring</td>
<td>3. Concrete aprons and platforms around building</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5. Good roofing, long overhanging eaves or verandas</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6. Provision of waterproof and non-erodable rendering</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7. Improved workmanship</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8. Loan scheme in cash or in kind for preventive measures</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D. Extremely wet areas with rainfall above 50</td>
<td>1. Severe settlement and shrinkage cracks</td>
<td>1. Good soil selection — sand clays or clayey loams or graveley clays</td>
</tr>
<tr>
<td>inches</td>
<td>2. Erosion of walls and foundations.</td>
<td>2. Planned layout with good drainage facilities.</td>
</tr>
<tr>
<td></td>
<td>3. Underscouring</td>
<td>3. Concrete footings, concrete blocks, soil-cement and stones for foundation Where</td>
</tr>
<tr>
<td></td>
<td>4. Mechanical damage</td>
<td>the annual rainfall is 80 inches and above, it is desirable to have foundation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>height extending to at least two feet above ground level</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. Damp roof course</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5. Concrete platforms and aprons around building</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6. Vertical pipes and rain gutters.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7. Verandas with floors designed in such a way as to throw outwards the water</td>
</tr>
<tr>
<td></td>
<td></td>
<td>from driving rains; desirable for areas with frequent driving rains.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8. Good roofing and long overhanging eaves.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9. Provision of waterproof and non-erodable rendering</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10. Loan scheme in cash or in kind for preventive measure</td>
</tr>
</tbody>
</table>

Source:  A.A. Hammond, Prolonging the Life of Earth Buildings in the Tropics  
Kumasi, Ghana, May/June 1973  
Building and Road Research Institute, Current Paper CP/473,
move to regions with higher rainfall. In regions which are extremely wet, it becomes necessary to protect the foundations as well.

In fact, many of these considerations are taken into account in traditional architectural designs. The United Kingdom has a very wet climate and yet it had an extensive tradition of earthen buildings before the era of cement destroyed it. In Cornwall, there is a local saying about cob buildings: "All cob needs is a good hat and good pair of boots," referring to the overhanging roof and the protection of the foundation.

A good selection of soil is very important, particularly as clay tends to expand when wet and to contract when dry, causing cracks. Sand, on the other hand, crumbles easily and erodes when dry. Clayey loams or sandy clays are, therefore, most suitable. It is important to formulate simple techniques by which villagers can find the best soil, or obtain the best mix. In Pondicherry, for instance, certain inmates of the Aurobindo Ashram have encouraged local villagers to build a new village with rammed earth.

For rammed earth construction, a mixture of four parts clay (including loam and silt) and six parts sand (no big gravel) — i.e. less than 50% clay — is good.

They promoted a simple technique to explain to the villagers how to make good soil for construction. This is described as follows:

**Step 1**: Prepare a mixture of earth, containing six parts of sand and four parts of clay; add water (not too much, it should not stick). With two hands form slowly and carefully a symmetrical roll about 20 cm long on the rear side of a spade.

**Step 2**: Take it carefully into your hands, let one end of it project out until it breaks.

**Step 3**: The broken part falls down. If it is between 8-12 cm long, it is suitable for rammed earth.

**Step 4**: If it is more than 12 cm, add more sand.

**Step 5**: If it is less than 8 cm, add more clay.

Finally, certain other elements which seemingly have little to do with housing per se, have to be taken into consideration as they do affect mud houses in particular. Proper leveling of the site and drainage are very important. This is seldom adequately planned in Third World rural settlements. A drainage ditch around many mud settlements would probably do more good than anything else.

If all these factors are adequately taken into account while constructing a mud building, there is little reason to believe that it will not give good service for 50 years or more with little maintenance.

**Soil Stabilisation**

There has been considerable research into soil stabilisation, and three materials have been employed and studied in some detail: cement, bitumen, and lime. Cement-soil research has been conducted by the Portland Cement Association in the USA for many years. It has published manuals for laboratory use and actual construction on highways, irrigation canals and ditches, airfield runway shoulders and sub-bases. It has also published work on the fatigue of cement-soil and design thickness for pavements.

The amount of cement required depends on the clay content of soil. For low-cost housing, the following amount of cement is recommended:

<table>
<thead>
<tr>
<th>Composition of soil</th>
<th>Cemem. required (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand (%)</td>
<td>Clay (%)</td>
</tr>
<tr>
<td>70</td>
<td>30</td>
</tr>
<tr>
<td>60</td>
<td>40</td>
</tr>
<tr>
<td>50</td>
<td>50</td>
</tr>
</tbody>
</table>

Cement-soil structures have been built in various parts of Africa and South America and today cement-soil is being promoted as a building material in several upgrading schemes for slums.

Research on soil-cement in developing countries has focussed on the development of block-making machines. The most important development was the invention of the CINVA Ram in 1950's at CINVA, the Inter-American Housing Centre in Bogota, Colombia. The machine is a simple, hand-operated producer of stabilised earth blocks. It is cheap and portable, and can be easily carried on muleback through difficult terrain. Hundreds of thousands of low-cost dwellings have been built with blocks compacted with the CINVA Ram, and the machine itself is being manufactured locally in many countries, from Ghana to Indonesia. CARE, an American agency, has used it extensively and its largest housing programme using the CINVA Ram was in Bangladesh (then East Pakistan) in 1968. Nearly 20,000 houses were built over 6 or 7 years in the delta region of that country affected by cyclones.

There is still considerable scope for promotion of soil and cement in various parts of the Third World — and one soil-cement enthusiast even visualises an industry comprised of mobile soil-cement rural firms, each using a battery of CINVA Rams.
Asphalt Stabilised Soil

This product was, in fact, first produced as early as 3500 B.C. in Babylonia. The addition of small amounts of asphalt (bitumen) to certain soils to produce a more durable, structurally superior building material has become an important industry in the southern USA during the past 45 years.

Asphalitic cement is mixed with water containing an emulsifying agent (usually soap). The best mixes are:

<table>
<thead>
<tr>
<th>Composition of soil</th>
<th>Asphalt</th>
</tr>
</thead>
<tbody>
<tr>
<td>High sand content</td>
<td>4-6%</td>
</tr>
<tr>
<td>Medium sand content</td>
<td>7-12%</td>
</tr>
<tr>
<td>High clay content</td>
<td>13-20%</td>
</tr>
</tbody>
</table>

Bunker oil and some other petroleum derivatives can also be used to make asphalt-stabilised bricks.

Several factors are responsible for reviving asfadobe technology. Asphalt stabilisation gives the soil greater durability without the need for firing it; greater stress and pressure resistance is obtained while reducing the need for maintenance, and, it renders the soil insect-proof and waterproof. In addition to having greater structural strength than untreated adobe, sundried asfadobe is almost impermeable to moisture and actually may be submerged for extensive periods of time without erosion or loss of its weight-bearing capability. Because of its internal dryness, asfadobe does not host vermin, bacteria or insects and, therefore, is an extremely sanitary medium for domestic use and for construction of stores for agricultural produce.

Again, as a result of its internal dryness, asfadobe acquires excellent thermal qualities; its heat conductivity is less than that of poured concrete, concrete blocks or fired brick. With proper consideration of roofs, floors, doors, windows and other sources of heat loss or gain, asfadobe homes have very desirable heat transfer characteristics. Generally, asfadobe walls maintain heat equilibrium by functioning as heat storage and heat dissipation units and make an excellent medium for the design of passive solar houses.

A pilot project of 200 houses using soil stabilised with bunker oil is currently underway in Khartoum, Sudan and according to its sponsors, the United Nations Centre for Human Settlements, asfadobe bricks and mortar produced as a result of the project were 30 per cent lower in cost than other available building materials. The UNDP has also supported an asfadobe project in Juba, Sudan.

The largest manufacturer of asfadobe is Hans Sumpf Company in California which has a highly automated plant for production of asfadobe bricks. The International Institute of Housing Technology, of the California State University, Fresno, which specialises in research on soil stabilisation techniques, is a leader on asfadobe research. The rising price of oil is forcing the company to study other stabilisers like sulphur and latex.

Lime-stabilised Soil

Lime strengthens the soil by reacting chemically with the clay contained within it. It should be therefore used to stabilise soil with a clay content higher than 30 per cent. However, cement is better suited for stabilisation of sandy soils.

Stabilisation with lime has had less research than stabilisation with cement and bitumen. But bitumen and cement may not be easily available in many developing countries, especially in small towns and villages. An effective and versatile stabiliser which can be produced efficiently on a small scale near the point of use is therefore needed. Lime, although dependent upon chemical reaction with clay minerals for its stabilisation function — and thus is more restricted in its application than Portland cement — broadly fulfils these criteria. Most countries have accessible sources of calcium carbonate (chalk, limestone, coral, etc.) which can be readily decomposed or burned to give quicklime; hydrated or slaked lime is then obtained by addition of water. The whole process can be carried out economically on a small scale.

A recent investigation in Ghana revealed that tropical lateritic soil rich in alumina-containing minerals can be stabilised with lime to increase strength for use in wet conditions and improve durability. Soil not rich in alumina-containing minerals can also be stabilised with lime but should be used with caution, mainly for construction of single-storey dwellings carrying a lightweight roof, and in environments which do not give rise to abnormal loading conditions. It was also found that blocks suitable for single-storey low-cost housing in the tropics can be produced using a simple block press (CINVA ram) but improved performance is obtained by increasing compaction pressure.

In making a good choice at the local level between the various stabilisers, it is important to organise research programmes that evaluate all possible local resources and identify the spectrum of choices available to local builders for different applications. And in the evaluation of these choices, it is also important to consider whether stabilisation is required at all, that is, whether protective detailing would be sufficient, for instance.

There is a fear that interest in the uses of earth as a building material may become an exclusively technocratic interest in stabilisation. There appears to be a strong desire to turn mud into something like cement — regardless of the need to do so. For low-cost housing to remain low-cost, increases in cost must be minimal.

Basic Research Towards the Conservation of Mud Bricks

The International Council of Monuments and Sites (ICOMOS), together with the International Centre for Conservation in Rome, has sponsored three international meetings on mud brick conservation. The first meeting attempted to assess the technical and socio-economic problems involved in conservation and the second identified various research measures. The U.K. Committee of ICOMOS has recently started a major research programme aimed at developing improved con-
servation technologies for structures built in mud brick and related materials. If this programme is successful, it could generate valuable information for development of low cost housing materials as well.

Over the last 20 years, attempts to conserve mud brick monuments have generally failed. These measures were undertaken on a trial and error basis and usually involved spraying of chemicals such as silicones, polyvinyl acetate and bitumens on decaying walls. Incomplete coverage, or a small failure, soon reinduced the decay process and the materials readily peeled off.

The ICOMOS research approach in the United Kingdom is to go back and to analyse and understand in detail the geotechnical and engineering parameters of the decay process in mud structures. In another project, efforts are being made to understand certain microbiological processes that might be taking place in mud walls. Traditionally, a variety of organic materials have been mixed with mud to stabilise it, or used for rendering mud walls water-resistant. For example; in northern Ghana, an extract of boiled banana stems is mixed with lateritic soils; in Upper Volta and northern Ghana, a plant extract locally known as ‘am’ is used as varnish, which colours the walls red; in northern Nigeria, ‘laso’ (an extract from the vince Vitis pallida, locally known as ‘dafara’) and ‘makuba’ (made from the fruit pod of the Locust bean tree) are used for waterproofing mud walls; cow dung mixed with clay is used widely in India; in Sudan, ‘jaloos’ houses are treated with ‘zhiba’, a local waterproofing material made from cow or horse dung; and, straw has been widely mixed with mud since Biblical times, especially in West Asia. In Ethiopia, straw (preferably ‘chikra’, the straw of millet) is used in mixing ‘chikra’ or soil paste.

Research has shown that forces that attract mud particles and hence determine the strength of bricks are governed by the electrical charges on the surface of the particles. These electrical charges can be modified by the both organic or inorganic coatings. Certain microbial products like extracellular polysaccharides are known to bind particles. A Cardiff University team is planning to examine the presence of such microbial products in mud walls, which could arise as a result of the fermentation of the organic materials traditionally added to mud. The team also proposes to encourage the formation of such products by the addition of simple nutrients (starch, molasses, etc.) to see whether the strength of mud bricks is improved. If this research is successful, a cheap and simple technology that is within the capabilities of rural communities could become available.

Direct use of sun-dried bricks is also gaining popularity in many parts of the world. The most celebrated work has been that of Egyptian architect, Hassan Fathy, particularly because of the ingenious ancient techniques that he has revived for making roofs with mud bricks. But the most extensive use of sun-dried bricks for constructing buildings is today taking place in the southwestern United States. It is estimated that about half a million Americans today live in 176,000 adobe homes — 97 percent of which are located in the four contiguous states of New Mexico, Arizona, Texas and California — and probably some 1500 new ones are being built each year. Fifteen years ago only 3 or 4 builders in Albuquerque — the “adobe capital” of the USA — constructed adobe houses. Today, over 20 adobe builders exercise their trade there. This pattern is evident in Santa Fe, Tucson, and other towns throughout the southwestern USA. Ten per cent of the homes built in 1980 in the state of New Mexico, according to one estimate, were made from adobe. However, because of the high labour costs involved, adobe buildings are mainly being constructed either by the poor, who build their own homes, or rich, artistically inclined persons. Adobe houses can virtually become sculptures in their own right.

A major factor in the revival of adobe is the rising cost of energy, which is not only forcing builders to reconsider energy-intensive construction materials, but is also creating a demand for energy-efficient houses. While the steady-state thermal resistivity of adobe is not as great as some high technology construction materials, protagonists of adobe value its ability to store energy and stabilise tempera-
Table 4  Thermal Conductivity of Walling Materials

<table>
<thead>
<tr>
<th>Material</th>
<th>&quot;k&quot;</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rammed Earth</td>
<td>4.7</td>
<td>University of Saskatchewan</td>
</tr>
<tr>
<td>Pressed bricks or blocks</td>
<td>4.7</td>
<td>Assumed</td>
</tr>
<tr>
<td>Adobe Blocks</td>
<td>3.50</td>
<td>University of California</td>
</tr>
<tr>
<td>Adobe — sunried brick</td>
<td>3.58</td>
<td>University of California</td>
</tr>
<tr>
<td>Stabilized adobe brick</td>
<td>4.00</td>
<td>University of California</td>
</tr>
<tr>
<td>Common clay brick</td>
<td>8.00</td>
<td>Building Research Station U.K.</td>
</tr>
<tr>
<td>Limestone</td>
<td>10.60</td>
<td>National Physical Laboratory U.K.</td>
</tr>
<tr>
<td>Dense concrete</td>
<td>7.00</td>
<td>National Physical Laboratory U.K.</td>
</tr>
</tbody>
</table>

Table 5  Over-all Heat Transmittance Coefficient (Air-to-Air) "U"

<table>
<thead>
<tr>
<th>Type of Walls</th>
<th>Over-all Transmittance Coefficient &quot;U&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B Th. U , Sq ft., Nr. Deg F. Temp Diff</td>
</tr>
<tr>
<td></td>
<td>for wall thickness:</td>
</tr>
<tr>
<td></td>
<td>6&quot;</td>
</tr>
<tr>
<td>Pressed Brick or Block</td>
<td>0.41</td>
</tr>
<tr>
<td>Rammed in S itu</td>
<td>0.41</td>
</tr>
<tr>
<td>Adobe Brick or Block</td>
<td>0.34</td>
</tr>
<tr>
<td>Stabilized Adobe</td>
<td>0.38</td>
</tr>
<tr>
<td>Common Brick</td>
<td>0.44</td>
</tr>
<tr>
<td>Concrete (dense)</td>
<td>0.50</td>
</tr>
</tbody>
</table>

Adobe, meanwhile, is already being used extensively in the construction of passive solar houses, whose numbers are growing rapidly in the USA. The enormous demand for energy in the Middle East to cool residences can be partly attributed to the change away from mud structures that is taking place in these countries. In the middle of summer, up to 66 per cent of Kuwait's installed electrical capacity is utilised only for air conditioning. And with a power-generating capacity failing to keep pace with demand, even oil-rich Kuwait is today contemplating energy conservation programmes.

Building for Earthquake Resistance

The susceptibility of mud structures to earthquakes has been widely recorded. The major portion of the housing stock in the seismic zones of the world is made with earth, and the majority of deaths in earthquakes are attributable to collapse of earthen structures. The engineers' response to the problem has been to roundly condemn earthen structures and to encourage a gradual abandonment of such buildings. This response was, among other reasons, conditioned by the belief that grew in the 1950's that the disappearance of earthen housing was only a matter of time. Now, however, realisation is growing once again that earthen structures are here to stay, and that people will continue to build and live in them far into the foreseeable future. There also remains some divided opinion about the susceptibility of constructions in mud brick. Archaeologists and architects report buildings thousands of years old, situated in earthquake areas, that still stand.

The manner by which knowledge about disaster-resistance has evolved is apparently...
responsible for this inconsistency in views and opinions. This knowledge had developed partly from analogy, based on an examination of what types of adobe dwellings fail and why, and partly, from the application of structural design theories originally developed to obtain resistance to disaster forces in industrialised countries where the materials used and the construction practices relate to different technical standards, and supervisory capabilities. Putting these two types of knowledge together and superimposing them on the highly variable, unstandardised, building processes and materials used by local communities in different parts of the world with varying levels or workmanship, has obvious limitations.

The recent International Workshop on Earthen Buildings in Seismic Areas held in Albuquerque (May, 1981) heard about several efforts to improve earthquake resistance. A general consensus was that only those efforts would succeed which aim to bring about simple improvements in the structural system of the building without changing substantially the basic material or forms of construction. (A dangerous trend in certain seismic areas of the world — in Kashmir, for instance — is the slow but steady abandonment of earthquake-resistant forms of traditional architecture and the adoption of less-resistant modern designs in their place).

Eric Carlson has listed a number of common defects found in self-made adobe structures with poor workmanship:

A. Structural Defects:
1. There is no foundation, or it is not deep enough, or it is very poorly made;
2. No consideration has been given to the important function of a foundation as protection of the wall against ground moisture (capillarity);
3. Poor overlapping of the adobe bricks;
4. There is nothing to anchor the structure (tie-beam of adobe clay at least);
5. The distance between columns, wall intersections or other load-bearing members is too great;
6. The area of the openings in the walls (doors and windows) is excessive;
7. The openings are too close to wall intersections or junctions;
8. There are not enough cross-walls to resist the horizontal forces of earthquakes;
9. The roof is too heavy;
10. The roof supports are inadequate;
11. The eaves are not large enough to protect the walls from rain;
12. Elements of the pediment or gable are poorly joined to the rest of the structure;
13. The height from floor to ceiling is too great or the structure is more than one storey high;
14. The lintels are insufficiently embedded in the walls.

B. Defects related to the material used:
1. Use of inappropriate soil, poor proportions of stabilising material and/or excessive water used in fabrication;
2. Improper dimensioning, especially adobe bricks of excessive thickness.

C. Construction Defects:
1. Use of very fresh adobe bricks;
2. Absence of filling in the vertical joints;
3. Poor workmanship in laying the bricks, which is reflected in the poor geometrical quality of the walls (bricks out of line or out of plumb);
4. Building during the rainy season without adequate protection;
5. Very rapid elevation of the wall causing settling in the lower courses.

A variety of simple technologies and educational programmes but not sophisticated structural solutions appear to be the best strategy at the moment to mitigate the effects of these defects. For instance, ring beams can be used to tie the top of the walls together and to prevent tensile cracking from developing at the upper corners. Soil stabilisation together with the use of split cane for reinforcement can also substantially increase resistance to lateral forces. Construction of openings requires special attention — especially their location, size and need for effective reinforcement around them. Some standardisation could also be of help, such as promotion of more symmetrical shapes and establishment of upper limits to length and span of mud walls.

Changes in certain structural elements may, however, be very difficult because of the close relationship they have with various deep-rooted social and cultural practices. To improve the seismic performance of earthen buildings, light-weight roofs, for instance, are being uniformly recommended by engineers. However, the roof is used for a variety of social activities: for sleeping, for drying food. Lightweight roofs will not be socially acceptable in such circumstances.

The Albuquerque workshop may result in a major research programme on earthquake resistance in earthen buildings but it would be unfortunate if the direction is only towards 'hi-tech' adobe — pre-stressed adobe, reinforced poured adobe, etc. — a phrase that was often repeated during the workshop. The key question is how do we acquire greater understanding of the social processes by which communities can be involved in the improvement of their housing stock. The universal experience is that there is considerable community interest in incorporating earthquake-resistant features immediately after a disaster but seldom in pre-disaster or non-disaster situations. It is in social organisation and mobilisation that most learning still needs to be done.

A Future for Mud Housing?

Interest in mud appears to go in cycles. The first major period in this century of interest in earthen structures began in the 1930s and lasted until the early 1950s. During this phase, researchers in developed countries experimented with the material in great detail. Several manuals were published; prestigious journals like The Scientific American reported on the importance of earth as a building material; and, in Britain, an entire village using earth was even built under government auspices. (The village, built in Wiltshire in 1920, still stands today). This interest in earth arose because of the shortage of construction materials created by war, migrations, etc. In developing countries there has been only sporadic experimentation, and more with earthen housing itself. The development of the CINVA Ram is a good example of this effort.
Today we are witnessing another period of revival of interest in earth. This revival is partly due to concerns that have arisen as a result of wholesale destruction of our architectural heritage. It is also because of the scarcity of modern construction materials. Purchasing powers are not keeping pace with the rising costs of modern construction materials; poverty remains a tenacious phenomenon, and increasingly it is being realised that mud structures are here to stay. A third reason now is the spiralling price of energy. The rising cost of energy is not only driving the cost of construction materials up, it is also creating a movement towards energy-efficient structures. Earth is becoming a part of the movement towards passive solar housing.

What then does the future appear to hold for improving earthen housing in the developing world? Purely from a cost point of view, there does not appear to be an enormous advantage in pushing people towards mud buildings, especially those people who get their houses built and have an alternative to build with modern materials. Earth is used mainly in the walls, and as the cost of walls usually does not exceed a quarter of the total cost of a building, the use of mud does not lower costs substantially. There may be an overall cost reduction of 10-15 per cent but this is probably too low an amount to constitute a serious alternative — unless labour is supplied by the house builders themselves, in which case they can also take advantage of the substitution between material and labour costs that the use of earth allows.

The justification for using earth really comes in those circumstances where earth is the only alternative — a situation in which probably the majority of the world still finds itself. In many parts, even traditional construction materials like timber and thatch are reportedly becoming scarce.

Should we then expect a real movement towards earthen buildings in the future — over and above the intellectual romanticism and the artistic fascination with the material that we see today?

From a sociological standpoint, all the forces of exclusion are operating against the material. Firstly, who wants to study or teach about building in earth? There is hardly an architectural school which teaches how to use traditional building materials. Secondly, who wants to allow the building of earthen structures? Most building codes do not allow building in earth. The entire engineering and architectural profession is prejudiced against the material.

In the urban areas, however, the most important factor is the current nature of urban plans. The design of buildings, also like the choice of materials to be used in them, must ultimately have a basis in the urban plan, which itself is a part of the overall social plan. The advantages of using traditional building materials are essentially similar to the advantages of planning for low-rise housing as against high-rise housing:

- An individual can build his own house.
• A low-rise building has a shorter construction period, and involves less capital.
• Low-rise housing can be extended as the occupant’s income increases.
• Low-rise housing has far greater variety, as each household builds according to his choice.
• Multi-storied buildings have to be built with scarce and expensive construction materials, such as cement and steel. Low-rise houses can be built with traditional materials like mud, brick and thatch.

The future of traditional building materials in urban areas will be intertwined with the importance that housing planners attach to low-rise housing. As governments tend to encourage schemes for slum upgradation, the advantages of low-rise housing will come to be regarded as outweighing their disadvantages. And in such schemes, traditional building materials will certainly obtain, however grudging, a role to play.

But finally, we have to ask who wants to live in earthen buildings? Here too, unfortunately, the answer is: very few. Earth is today regarded as a low-status material. Housing is not the first priority of a poor family on its ascending scale of perceived needs — at least in the tropics. Higher priorities are food, job, water, and sometimes even education. Until these are obtained, just about any shelter is acceptable. Improvements in housing conditions become an immediate need only after all these basic needs have been met; in other words, only after a poor family has moved several runs up on the socio-economic ladder. But by then it has also acquired enough notions of status and it then generally wants a house built with modern materials instead of simply an improved earthen house. Usually at this point, the family is still not able to afford a high-quality modern house. But for reasons of status, it still decides to move into a modern house even if it is sub-standard and ill-constructed. In fact, this phenomenon can be seen in operation all across the rural Third World today — especially in those areas where new agricultural practices are today generating increased agricultural incomes, and are generating a demand for better housing.

Mud as a component of low-cost housing, especially rural housing, is caught up in this social web. Extricating it is going to be very difficult, unless a mechanism can be found by which status can be bestowed on earth. This would probably call for a revolution in attitudinal changes, which one cannot see coming even far into the foreseeable future — though clearly all those interested in housing of, and by, the poor must strive for it. Ironically, there is just a very, very remote, but distinct chance that the rich may bestow status on earth by incorporating it as an energy-efficient material in their palatial solar houses.

Bibliography


Housing, World Bank, 1975


Rural India Village Houses in Rammed Earth, Popposwamy, Dienste in Ubersee, Stuttgart, 1979

Construction Standards and Methods Appropriate for Simple Building Needs, UNDP, Interregional Project No INT/77/021/A/01/42, June 1979


Lime-Stabilised Soil Building Blocks, J. B. Load, Building Research and Practice, March/April, 1979

Built in Earth, ICOMOS (Mud Brick Research Programme), London

The Extent of Adobe Use in the United States, Harold Gerbracht and Gerald May, The University of New Mexico, Albuquerque, Mimeo.

Is adobe energy-efficient?, Researchers take a close look, Energy Source, December 1980, published by New Mexico Energy Institute, University of New Mexico

Simplicity in Adobe, David Godolphin, Solar Age, June 1981


Earthen Buildings in Seismic Areas of India, Jai Krishna and Brijeesh Chandra, ibid

Social and Cultural Aspects of Earthquake Resistant Adobe Housing Program, David Oakley, ibid

Earthquake Resistant Construction of Earthen Housing, A.S. Arya and T. Boem, ibid


"Third World Housing: Space as a Resource", Charles M Correa, Ekistics 242, January 1976
Concluding Remarks

Some Remarks on Environmental Appreciation

Dogan Kuban

Interest in rural architecture among architectural theorists is relatively recent. Current debates in architectural circles avoid rural architecture, and the history of architecture has stressed value systems of the dominant elite and has developed theories based primarily on great architecture rather than the rural or vernacular. But, because rural architecture is so widespread, and because it represents and embodies spiritual as well as physical qualities, any sincere effort to improve the human environment must take it into account.

In rural architecture one can observe traditional forms and building techniques as well as a close relationship between social behavior and physical form. Unfortunately, most architects have been concerned solely with formal aspects of indigenous architecture. Field trips in Islamic countries and seminars have shown us that monumental expression, urban esthetics, and religious symbolism are not sufficient to form the basis for environmental answers in the Muslim world. We, therefore, developed an appreciation of the indigenous urban and rural environments.

Even though many Muslim countries are undergoing rapid urbanization, most are still primarily peasant societies. Urban and rural life styles and house forms are much more similar in Muslim societies than in the west. A monumental architectural tradition is much less conspicuous. And even the concepts of urban society and structure are western intellectual constructions which do not help to explain either the contemporary or the historic Islamic city. Finally, even the urban-rural distinctions current in much of the literature is not particularly helpful in describing or explaining differences between city and village in Muslim countries.

The modern rural world is no longer isolated from the urban world. Friends and relations, mass communication, government programs all convey to rural dwellers information about the urban world. Even if living conditions in some places resemble those of the Middle Ages, expectations do not. Economic, political and military considerations prevent governments from ignoring even the most remote portions of their countries. The rural world, thus, has a new importance. But the communication of information has tended to be in a single direction: the peasant learns about the outside world from the different media, while the so-called specialists know relatively little still about the rural environment. A means of fruitful interchange has to be found between peasants and specialists of urban origin.

In many Muslim-countries, traditional building techniques have proven the only way to bring decent dwelling standards to the rural or semi-rural population. Building-systems developed primarily for urban applications have proven too expensive and inappropriate to local building skills. However, there is considerable promise in techniques which improve upon traditional building systems. While these techniques must vary according to
local circumstances, some ideas seem likely to be widely applicable. The use of stucco in the making of mud brick is one example for countries with abundant gypsum. As a matter of fact, mud brick is often the most common and cheapest of materials. Studies of it have been made and the results used in constructed projects. As one example, an Aga Khan award was given in 1980 to a health center in Mali, largely constructed out of mud brick, but with improvements of reinforced concrete and other materials.

Less study has been made of wood and stone, but, to cite only one example, Jan Myrdal in his Report from a Chinese Village describes stone vaulted dwellings covered by a thick layer of loess clay which, together with the cave dwellings, constitute the main building systems of Liu Ling in Yenan. It provides great solidity and insulation against cold and heat. Similar traditions exist in many Islamic countries, yet formal solutions should not necessarily be accepted a priori as a basis for replicability in other circumstances. Potential applicability does not entail replicability, which must be left to the vicissitudes of national life.

For the more spiritual aspects of rural architecture, the idea of an aesthetic of anonymous form may prove to be extremely exciting and provocative. But the appellation "anonymous", used commonly to refer to an architecture without pedigree as compared with the great stylistic traditions usually featured in architectural histories, should be used with some caution. More than functional, rural architecture represents very long building and cultural traditions. A door with sliding panels or simple wooden lock system may have a very long lineage, and may express values and sensibilities of simple but genuine peoples.

There is a correspondence between certain formal preferences and the human mind and body. We cannot ignore rural building traditions because they are isolated from urban cultures. Does it matter whether rural architecture is a simplified version of urban architecture or entirely independent? For there is little doubt that formal properties of rural houses are no less instructive about the nature of aesthetic feeling than the great monuments. As in anthropological studies, simple relationships may inform us more about the nature of process than the more complex.

While the social and economic dimensions of housing for the poor and for peasants have been emphasized in former seminars by Soedjatmoko, Nahbud ul Haq, John Turner and others, we must come to terms with the question of image. We would like to see an image of a physical world which would create an appropriate milieu for Muslims. Since more than half of the Muslim population is rural, what level of knowledge and sensibility can be addressed? At least we should provide for very real differences of housing types and environments, and strive to avoid homogeneity. But we cannot ignore the image of environments toward which rural peoples themselves strive. And what can we do if their aspirations are toward distorted images of modern architecture, inappropriate climatically and other ways? It is difficult to reach the consciousness of the illiterate or the partly literate if not through examples. In the urban milieu we base our hopes on the efforts of an enlightened elite. But in the villages?

In Islamic societies, officially sponsored activities do reach the rural areas. Here the government's role may be accepted, as John Turner says, "to ensure equitable access to resources which local communities and people cannot provide for themselves." The Award's role should therefore be the widest possible circulation of ideas developed in these seminars among government officials and others who do intervene in rural regions.

Through efforts of government and in an atmosphere of total communication, rural and urban worlds are nevertheless becoming progressively integrated at many levels: economic, political, but also physical. For many people, living conditions in cities are similar to those in villages. The Kampung project, awarded in the 1981 Aga Khan awards for architecture, cannot be labelled urban or rural, yet is a major accomplishment in the solution of the problem of rapid urbanization.

While one can still discern great differences in behavior between peasants and urbanites, these differences are diminishing; the peasants are gaining a stronger political foothold in their countries; and urban and rural areas are becoming more and more integrated. Guided by lessons from the rural environment, our formal concerns in both urban and non-urban areas will be replaced by considerations such as energy food, labor intensive production and new forms of social organization.

A Nubian proverb, cited by Zen, says: "The water wheel is like a mosque and those who serve it are like those who serve the mosque". In the edge of life fighting for survival, religious and cultural symbols may be replaced by economic ones. These considerations should eventually influence our whole approach toward physical form. In the context of the rural habitat, a program of action to be valid must be concentrated primarily on the fulfillment of material demands of the rural population. As in the Nubian proverb, the act itself gains spiritual dimension.

Reference Notes

1 Rapaport, Amos, House Form and Culture (Englewood Cliffs, N J 1969)
3 As an example we may cite Sudan where 80% of the population live in rural areas. See, Sudan Shelter Assessment, Agency for International Development, Washington, D C November 1978, p 56
4 Yona Friedman already called the baidonilles as bidonvillages. For other useful hints see his 'L'architecure de Subur' (Paris, 1978)
6 Turner, John, F C, Housing by People (New York, 1976), p XIV. His book, although more on city's problems than the villages, still brings out numerous useful observations
7 On the integrating force of the urban-industrial complex see, Pearse, Andrew, "Metropolis and Peasant: The expansion of the Urban-Industrial Complex and the changing Rural Structure", in Shatin, Theodore, and Peasants' and Peasant Societies (Penguin, Harroadworth, 1971), pp 69-80; see also Redfield, Robert and Singer, Hilton B, 'City and Countryside: The cultural Independence', idem, p 337-365
I. SERAGELDIN

It is a daunting challenge you have posed: to sum up these many hours of prismatic, intense deliberation in under five minutes .... I will nevertheless try to do so.

I would like to group my remarks under six distinct, yet interconnected, headings that I believe reflect the main themes of this seminar.

1) Should the rural habitat change (or be changed)?

Clearly Yes: The deprivation and misery of the rural habitat documented in countless statistics (of which we were eloquently reminded by HH The Aga Khan at the outset of these proceedings) clearly belies the mythical, romantic vision of an idyllic existence worthy of preservation. The basic needs of rural inhabitants (including the right to have a voice in the decisions affecting their lives) must be raised at least to the minimum level of decency that others have come to take for granted. From there, it appears to me, that the desirable direction of change is clear, as are its determinants. Change in the rural habitat is to be sought and found first in the provision of basic services (education and health, etc.) and utilities (water, electricity), and only secondly in the physical expression of the built habitat.

2) The rural habitat must be viewed in context.

The rural environment does not exist in a vacuum, distinct from the people who inhabit it or the larger regional or national whole of which it is a part. Hence, it is important to understand:

- the demographic characteristics of inhabitants;
- their socioeconomic characteristics;
- the political, organizational and institutional aspects of their society; as well as
- their cultural-ideological frame of reference.

There are also trends to be recognized and dealt with, such as:

- rural/urban migration;
- inter-regional migration;
- changing labor force characteristic;
- changing family roles, etc.

Furthermore, all this must be viewed in the bigger context of history, geography (climate and ecology), demography, and ideology. Without this setting, the evaluation of a specific project in terms of its "intrinsic" or "abstract" qualities means little. It may even be deceiving.

3) Technology.

Technology is neither a panacea nor a rampaging evil. Although it holds promise, it often acts indirectly — affecting lifestyles which in turn reflect upon habitat rather than immediately impacting on the habitat itself.

More serious thought is certainly needed in this area. Such thought should also remain cognizant that the introduction and application of technology is inexorably intertwined with economic factors in terms of feasibility vs. viability.

4) Decision-making.

Who decides what for whom is an important question. There are many actors: users with their preferences, ultimate clients, local elites, national (political) authorities as well as outside experts. All of their roles and interests need to be articulated, for a coherent, realistic understanding of the interplay of forces that affect the final decisions. Because the rural environment, unlike the urban context with which we are more familiar, is diffused and dispersed, lacking in horizontal as well as vertical channels of communications, the necessity of a broad commitment is even more important than in other areas of endeavor. Hence, the essence of success in intervening to change the rural habitat requires a political will and a clear vision coupled with effective leadership and organization.

5) Innovations and interventions.

For innovation to take hold, it must be introduced in a manner that does not run counter to the realities of socio-cultural and economic constraints. But innovation is not an end in itself. The success of any intervention must be measured by the totality of its impacts (both desired and undesired); and by its potential replicability. Interventions must be weighed against the likelihood of success in the face of prevailing trends (not conditions).

This requires a dynamic perspective, not static pictures of "before" and "after".

6) The Role of the Architect/Planner.

This role needs to be redefined: First, a degree of humility is needed about the amount of knowledge or the relevance of the expertise which we bring to the task. Second, there is, by definition, a fundamental built-in interventionist bias in architects and planners. This should be checked, to make sure that we intervene: (i) in areas where we bring special competence, (where we enjoy a comparative advantage); (ii) at the right scale; (iii) with correct appreciation of context and trends; and (iv) in collaboration with local forces.

In this quest for both relevance and effectiveness, the architect has to function as teacher, as catalyst for change, as preserver of heritage, as champion of cultural continuity through change, as introducer of new technology, as advocate of design in its purest sense, amidst a climate insensitive to, or impatient with, all these functions. It is a tall order. I hope we are up to this challenge.

Babar Munirzad

I'd like to limit my comments just to one aspect of the things that we have been talking about, and that is technology. In so many of the cases we saw presented in the last couple of days, we found that traditional architecture and traditional technology were being replaced by inappropriate technology and that this was leading, as it was pointed out, towards inappropriate architecture. There has been the talk of the needs for appropriate technology. However, I'd like to suggest that we should say appropriate, not as an adjective describing the particular technology, but rather as a verb describing what is done to a technology. If we observe what the people and the cultures all around the world have been doing, we see that they are indeed appropriating, that is taking over, technology. I would like to suggest that there are some kinds of technology that are more easily, or more often, appropriated by people than others. For a technology to be more liable to be appropriated it must have the following three characteristics called the three "5's" of appropriate technology, that is: they must be
repayable, reliable and reusable. By repayable, I mean that they should be within the available resources so that they can be afforded by the persons who are taking it over, or by a community that is going to appropriate it. This means obviously not only the material resources, but also the social, cultural resources as well. Secondly, when I say reliable, I mean that they must have built-in redundancies; that is, should there be a minor change or alteration made to this technology, then it should still be usable. It must have a higher tolerance level. Finally, it should be reusable; that is it should have a built-in potential that allows it to be used in different situations. If it has these three, then I suggest that it will be appropriate.

When we compare what has happened to one of the roofing products that modern technology has evolved, the corrugated iron sheet, which works and which has been widely appropriated, with one of the technologies that was shown yesterday from Senegal, mud and cement vaulting, we can assess which of these is more likely to be appropriated. In terms of repayableness, we find that both of them are possible within the available resources of some people, and indeed in the case of the corrugated iron sheet, whenever somebody has been able to afford it, even if that’s the only manufactured item, they went out and bought a corrugated iron sheet. In the case of the Senegal vault, I am told it is within people’s means, within their resources. So far it seems to be only within the means of the elite. If you look at the reliableness, although the corrugated iron sheet has been designed to be put onto timber with a certain spacing and certain kind of fixing, you find that it has a built-in robustness that allows it to span much wider distance. You even find people in different villages just holding it down with stones, and it still works. If you look at the vault, I have a feeling that it is not reliable in that sense, because the shape of it and the thickness of it is such that any minor change will mean that the thing will collapse. And thirdly, in terms of reuseableness, the corrugated iron sheets could again be used not just for roofs, but also for walls, for doors, for windows, for shutters, and in a number of situations, such as forming downspouts for water and the like. If you look at the vault, I suspect that it is not usable in any other situation; it’s just strictly for the particular situation for which it was designed. I suspect that those are the kinds of considerations which will mean that the vault is not going to be as widely appropriated as, for example, the corrugated iron sheet.

If we are concerned about what kinds of technologies are taken over by people, then I urge that we begin to develop technologies that have these characteristics. If architects are designing, I would ask a further “r” policy that the technology must have: it must be responsible. That is, it must respond to and demonstrate a respect for the cultural values of the people.

Makiya

Mr. Chairman, I still feel, towards the end of this seminar, that there is a confusion on the following issues: confusion on the meaning of tradition and continuity, and also confusion about technology. Have we succeeded in defining what we mean by rural habitation in terms of a future environment?

A phrase from one of our Chinese speakers struck me: “learning from the people”. This meant a lot to me because it reminded me of what we were trying to do some years ago by studying dwellings in the marsh areas in Iraq. The only way was to go and to live there, study there. Only then did I feel one had the right to intervene. We could learn much about technology that a textbook could never give us, nor a manual of details, in order to design something in the marsh areas of Iraq. We had to force our students to go there, live and study there before daring to make a shelter there.

However, my understanding of tradition goes much deeper than technology. Our relation to tradition is not only our relation to man but also to God. I still have a responsibility as a traditional man to understand continuity as a responsibility to God. This aids me in evaluating my work and other people’s work. Islamic ideology teaches me a scale of reference. Whether I am dealing with rural habitat, or urban, or anywhere on the planet, I must have human scale.

Mohammed Makiya

Photo: C. Little/Aga Khan Awards.
Afshar

There are two basic concerns I would like to propose which should be given special consideration in the coming Aga Khan Awards. In spelling them out, I would like to set them within the context of the present conference and the issues that have been raised. I think that one useful way to approach this whole question of rural housing, its improvement, and the sorts of impact an architect might have, is to see how architecture can contribute to general rural development objectives. There is, for example, the raising of rural incomes, the provision of gainful employment, and helping to orient income distribution towards the poorer sections of the rural population. This is one objective. Another is to enhance the political and social organizational capacities and opportunities of rural people so that they can better implement their own needs and aspirations.

Now I think that the sort of decisions that architects are in a position to take whether it be the speeches they make, the designs they conceive or whatever, these can have very immediate repercussions on the above-mentioned objectives. I'll give you a very simplified example of two technological alternatives, the use of steel or brick in a building. In most countries, if you decide on steel you are talking about one or two industrial complexes in rather centralized locations, which will benefit a particular region should the demand for that particular commodity be increased. When one prescribes steel, even reinforcing rods, in a construction, it is the people in those regions whose incomes you are enhancing. Bricks, on the other hand, are a material whose manufacture is more decentralized, more locally based. We should not, however, talk only about creating employment and assisting distribution of income towards the poorer sections, since one could easily imagine a local brick industry which is monopolized by a local rural elite. One should really go a little bit further, to try to discern what type of industry (small scale, perhaps even cooperatives) could be developed in the interest of rural populations who are without land or who are unemployed with regard to enhancing local organizations, the Algerian approach is one option which amounts to saying that if there are 'x' number of units to build, you use contractors to build them. Alternatively, the primary objective could be to improve the capacity of the local people to do it themselves. Therefore one devises a construction project which can be a very useful training tool for increasing a capacity for decision-making, organizational and technical skills. In some ways this turns upside down a conventional approach to architecture; the architectural product becomes secondary whereas the objectives of income generation, employment, income distribution and enhancement of local organisational capacity become the primary objective. The architectural product becomes the vehicle for achieving it. It is a new challenge for architects, because in addition to design and technical skills, we must try to develop certain skills that until now have been considered the domain of the social scientist decide. In order to learn from the people, we ought to go a step further. If we really want to appreciate, to be sympathetic to, the aspirations and the ideals of our people, we not only have to learn but be one of them. There is a very, very big gap between us. I, for one, think I should call myself a member of an elite. I find myself obviously quite different from people who are, I confess, my compatriots. I feel quite a difference because of the background, and the lifestyle I have; it's so difficult really to understand our people.

Now we know, I think that we have no right, as it were, to speak in place of the people, nor to act on their behalf. This is what we have been taught all these recent years. To be one of our people, is very hard. I can tell you this much, it's a very hard experience. I feel that although I am now this age, I think I still have a hard way to go yet, just to be one of us, in the midst of my own people. It's not easy at all.

Now I really take my hat off to Dr. Taylor and Mr. El Jack, the speakers of the first papers.

Chen Zhanxiang

In the three papers we heard this morning, I had the genuine impression that we as architects had raised the question of the role we have to play in this changing society. The first paper on the Senegal experience impressed me enormously, for I said to myself: here is a real example of what architects ought to do.

Many speakers have referred, in a way, to the architect's appeal to tradition in building monuments, or to an individualistic expression in architecture. I feel that architects now are in a difficult time. Our role in society is entirely different from the architect's role in the past. We must step down from our pedestal and stop seeing ourselves as some kind of arbitrator of fate. It's about time we stepped down and began to learn from the masses. Now this is not an easy process. I've been learning from the masses for the last 20 years. I don't think I can cheat them much. You see, as much as we like to intervene in the environment, the fact is that the environment is inspired by people, and it is the people with whom we must consult in the end. They have the right to decide.
because I feel Mr. El Jack really took a great interest in solving the problems, the reality of a particular country's circumstances. He tried hard to solve the problem of spanning a space, and ultimately worked out a solution that is indigenous to local conditions, and also worked out a very careful economic solution. You see, this is very important, so significant. For instance, last year our Architectural Society of China has taken an interest in this rural architecture that is the kin to the cave-dwellings, about which my colleague gave a paper a little while ago. We've began to take interest in what appears to some of my colleagues to be a rather primitive form of dwelling. But in these conditions found in China, this is the only rational solution to our problems. At present there are more architects among us who are gradually becoming interested in these types of conditions. I think we ought to learn from the speakers of all three papers that with their kind of commitment and responsibility to a community, to a society, we will learn from them how to work out a better solution in the interest of those people living in that particular sort of environment. It's pretty hard. We know very well we can have better dwellings other than these caves, but this is one solution.
Concluding Remarks

His Highness the Aga Khan

Mr. President, ladies and gentlemen,

The seminar on the changing rural habitat organised by the Aga Khan Award for Architecture is coming to an end, and I would like before anything else to thank the President and the members of the Architectural Society of China for their courtesy, their hospitality, their generosity and the warmth of their welcome. It has been for all of us a unique experience and I know that in the days ahead this experience will be continued and be enlarged, and we owe a great debt of gratitude to the Architectural Society of China.

I would also like to take this occasion to thank all the men and women who participated in organising this seminar. I know that it has taken hard work, time, thought, commitment and I can imagine the difficulties of assembling this number of people, not only in Peking but all the way up to Kashgar where this has never been done before, and again I would like to express my very warm gratitude to everyone who has made this possible.

The case papers that were presented were of a remarkably high standard, and I would like to thank all those who have taken time and given thought to presenting these papers because it was their work which has made this debate so fruitful; and I hope that in the future seminars this is a procedure that we will be able to continue because I think it is extremely informative and constructive.

The debate has been interesting and I believe that all of us have learned from it, and in concluding the seminar I thought I might try to highlight some of the important themes that have come out of the last three days of discussion. I think for all of us this has been a first occasion to discuss in an interdisciplinary manner, with a multiplicity of inputs, the problems of the changing rural habitat. It is an international conference which has been drawn from the experience of a number of countries, and I hope that this process of international debate, of exchange of thought and of learning, will be repeated and be continued in various forums. I think we have learned a lot of questions but I don’t think we have found many answers. I suspect that what this seminar has done is to have highlighted seven or eight fundamental issues which all of us would agree are of prime importance for the future of the rural habitat. Perhaps the first issue is the absence of communication between those who live in the rural areas and those who work for its betterment. What I mean by communications is the ability of the rural population to express itself in a clear manner to the people who are planning the development of the rural areas, to participate fully in the processes which contribute to the development programme of the rural areas, and then having a chance to evaluate the response that these developments produce. I think this may well be due to the nature of rural society. It is more widely spread; it is less vocal in many cases, and it is more difficult for urban technocrats to penetrate the thought processes, the responses of rural society than if you are building for programmes in an urban development. I think it is also true that international planners and architects communicate more easily amongst themselves than they do with the urban population as a whole. So maybe the first challenge, if I can call it that, which deserves further thought and reflection is how to establish better communications between the rural societies that are of concern to us, and those who are involved in planning the development of the future of these societies.

I think that the second theme which is important is the theme of modernity versus traditionalism. Our Chinese delegates, and delegates from other parts of the world, have all emphasized the diversity of the rural populations for which we are working, the different reactions of these to modernity, and many of us have questions as to the speed with which, and the totality in which, the rural habitat can or should be transformed.

A third theme, I think, is the one of making the rural habitat a desirable place in which to live. Here I return to the question of what the rural populations consider desirable and I have a feeling that their definition of desirability may be somewhat different from the definition of desirability within an urban context. I would think this is an area in which greater exchange of information could be extremely helpful.

A fourth theme of concern must be the one of cost. Of the projects that we saw, I think very few actually were completed within an outcome cost which was the one which was originally forecast, and one may "fluff" the figures but I don’t think that anyone really would shy away from the reality of the fact that it is exceptionally difficult to build low-cost housing in rural areas in an efficient manner.

A fifth theme which is of concern to all of us here, is the diversity of the populations for which one is building. I am thinking of the desirability of enabling those populations to express, through the modernization of rural society, their own customs, their own traditions, their own habits, their own necessities. I was struck by the examples of Sana’a, the example of Nubia, the example of Chitrakal that we saw at the last seminar where people tend to give their habitat old or new, in the countryside those traditional elements of design of personal touches which is theirs. It is important that that opportunity should be left to the rural societies and not simply pushed away by the process of modernization.

Two other themes are highly relevant, one of which came out very clearly during this seminar, and this was the interface between technology, expertise and ideology. These are three elements which are key elements in the modernization or improvement of the rural habitat, but I think it is quite clear that they are interfaced, and it would be risky to deal with one without appropriate consideration of the other. And the last theme is the architect. This is the sixth seminar that we have held, and at every seminar the architect’s role has been modified, changed, perhaps even tortured. It is a little bit like putting that goes around a child’s school and every child who gets hold of this putty makes a different animal out of this putty. But I think in no seminar has the role of the architect been expanded as it has been in this seminar. I think it is interesting to note that probably in dealing with the rural habitat, the architects themselves will have to take cognizance, will have to accept the fact that the criteria for designing and planning for the rural habitat are totally different from the traditional criteria of designing for urban buildings.
Those then are some of the themes which I felt were predominant in this seminar. If I may say so, I think they remain challenges for most of us; and rather than having to find solutions, if these challenges are at least better perceived, better understood, then one could hope that this seminar will have contributed to the establishment of wider bases, for the future transformations of the rural habitat.

I would like to close this seminar by repeating the Award's and my very sincere gratitude to the Architectural Society of China, and to express to them my personal hope that this will not be the last time that they will be associated with such seminars, and that they will accept to send representatives to future seminars when we will be discussing, of course, other subjects, but in which we will look forward to their participation and to learning from them continuously. I wish you good health, happiness and thank you for three interesting days.