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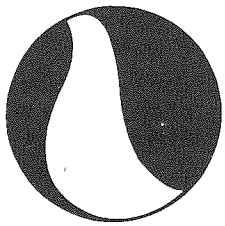
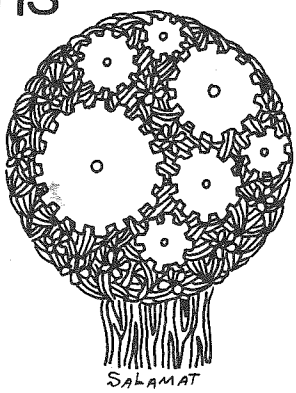


inappropriate technology-appropriate solutions



This issue of *Communications and Development Review* and the next deal with two expressions of what is at heart a single theme: the unparalleled domination of western science and technology in the twentieth century. The next issue will deal with the evolution of scientific rationality into the single mode of western rationality, and increasingly into an ideological mode of discourse which erases the possibility for any other kinds of discourse.

This issue takes up the topic of technology, the concrete way in which man's image of and relationship to nature is expressed in reality.

Technology is as inseparable from man as is society, and as old. It is part of our contemporary hubris that we label as 'primitive' those cultures which did not develop the tools *we* now consider vital for our existence (the wheel and metal tools, for instance) while overlooking the advanced astronomy, mathematics and architectural engineering that such 'primitives' possessed.

Yet from a period roughly centered on 1750, the world was propelled with a quantum leap into a radically new era: that of industrial technology.

From the beginning there were dissenters. In Britain, the Luddites tried to smash the very machines they felt were encroaching on their lives. The romantic poets asked with Blake if such 'dark, satanic mills,' were really Jerusalem, the Promised Land? And in Europe, there was Marx, describing man's increasing slavery to and alienation from the machine, arguing that the cause was the relation between capitalist and proletarian. His was essentially an optimistic evaluation of industrial technology as a potentially liberating force if used in the correct, socialist, way.

That very assumption is increasingly under attack. Technology is not neutral. Far from the simple development of new tools to solve concrete problems, industrial technology has brought new sets of human relationships, new values, a whole new industrial culture. Berger has pointed out a number of ways in which everyday consciousness is altered by technological production; these include componentiality, mechanisticity, the separability of means and ends, and the separability of work from private life.[1] Technological culture has become the bedrock, on which capitalist or traditional socialist values seem to have little impact.

Contemporary analysts of technology can be classified into three groups.[2] One is the New Utopians, Robert Boguslaw's description, who believe in the potential of new technologies, such as cybernetics or laserology for increasing man's control over the environment. This group includes Norbert Weiner, and Buckminister Fuller who advocates "a comprehensive anticipatory design science" as "a way of making life on earth a general success for all men".[3] The desirability of a pre-planned environment over a spontaneous human one is taken for granted, and such technological values as efficiency, precision, and organization are reinforced. What is utopia for some may seem quite the opposite for others.

The second group are the "Media is the Message" people, Harold Innis and Marshall McLuhan. They assume that the most important technologies are those that convey information, which should be considered in terms of how each medium shapes and influences information, and thus ultimately, the culture. Media are seen as organic extensions of man, unfolding in an inevitable process. The problem with such a position is how to distinguish what is a medium and what not, in the sense that almost any new item may cause a rearrangement of the environment and bring to light hitherto neglected parts of it. Also, if this process is indeed 'organic' then how can we account for the terrible lack of 'sync'

The Institute for Research and Planning in Science and Education of Iran recently organized a Seminar in Tehran on Appropriate Technology for RCD countries. The following three papers were presented at this Seminar, although the article by the Development Workshop has been substantially rewritten by them for publication here.

the potentials of indigenous building technologies

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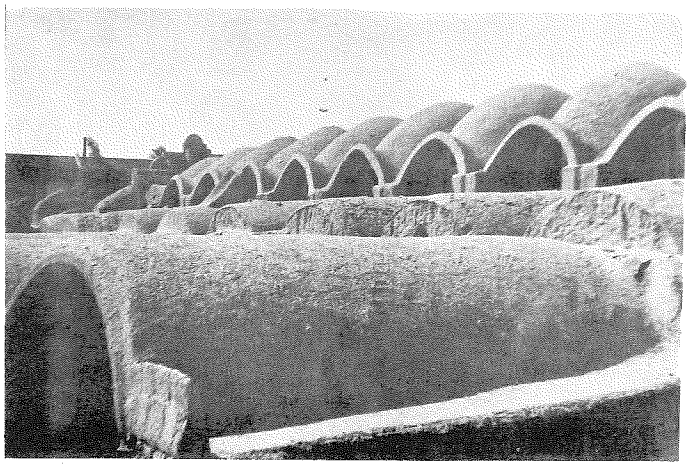
This paper presents the view that to develop an appropriate technology Third World countries should first thoroughly study, develop and share their indigenous technologies. This paper concentrates on indigenous building technologies to make this point.

1. The Case for Indigenous Building Technologies

Indigenous planning and building methods have been neglected in most Third World countries. Yet these countries still have some highly developed indigenous technologies evident in their villages and traditional city quarters. The architecture of these indigenous settlements has evolved over thousands of years and reflect their countries' accumulated expertise on how to build cheaply and appropriately to the local social, cultural, economic and environmental conditions. Squatter settlements are often one of the few areas which drew from this experience. Furthermore, the majority of people live in the villages, traditional city quarters and squatter settlements. Thus the approach to developing an appropriate technology is through first understanding and improving the indigenous technologies being used in these settlements.

The irony is that Third World countries are importing methods that are being seriously questioned in the countries of origin. For example, high-rise becomes a major feature in many Third World countries at a time when the West is beginning to realise the damaging social effects of high-rise living, the high energy requirements and the costs to keep them even minimally comfortable and functioning.

Meanwhile, the indigenous courtyard house with its many energy-saving devices, providing a climatically comfortable and quiet atmosphere (increasingly important in noisy and polluted cities) is in fact being ignored. The potentials for achieving high densities using the courtyard house form as illustrated in Third World cities' older quarters is also ignored (high densities are one of the most often quoted defences of high-rise).



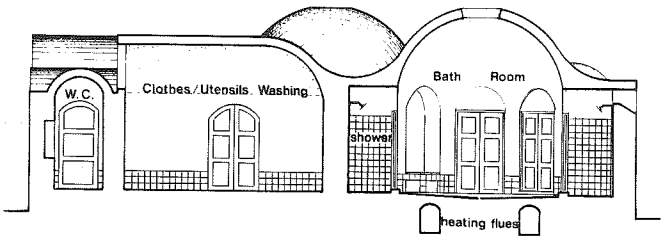
Old city centres such as those in Isfahan, Cairo and Delhi are examples that have much to teach us and should be studied from a number of aspects. In aesthetic terms: the sense of scale and proportion, vistas, and the juxtaposition of open and closed spaces; in climatically functional terms: the shaded streets, orientation according to the sun's angle, and the beneficial air-movement generated by the street layout; in terms of traffic control: the use of a rational hierarchy ranging from major vehicular thoroughfares to residential pedestrian access and the above mentioned ability to achieve high densities with low-rise. Again it is ironic that while many Third World planners seem oblivious to such practical lessons offered by their indigenous methods, Western planners are implementing similar principles in their work. The fact that some Third World countries may not have an urban tradition does not exclude the possibility that lessons could be learned from a neighbouring country with similar environmental, social or economic conditions, and which does have an urban tradition.

In general it can also be said that in a world of dwindling energy resources, indigenous technologies, not least indigenous building technologies, show us energy saving methods on a variety of levels, from materials such as mud-brick to elements such as the wind-catch. Unfortunately, the recent interest in indigenous building has more often "inspired" formalistic mimicry, expressed in arched facade treatments and concrete vaults rather than serious assessment and application.

2. Indigenous Building in Regional Development

A common situation in Third World countries is one of burgeoning, increasingly unmanageable major cities drawing labour from the rural areas, undercutting the agricultural food base and creating imbalances between a few large cities and the rural areas. National Development Plans should place more emphasis on the development of the rural areas, their villages and service towns, leading as far as possible to self-reliant regional groupings.

On the construction aspects, in most official rural development projects the physical services and infrastructural networks are planned in centralised offices by people who have little knowledge of the socio-environmental conditions of the field area. If the project is on a national scale, often the same building designs are applied to all the regions. This approach results in the buildings being alien to their environment, and almost invariably reduces their effectiveness and usability. Furthermore, since the designs are usually implemented by city-based contractors, a considerable proportion of the building investment is absorbed by them and the city materials merchants, and not by the local community. The



local population is left with a structure which they cannot easily repair and maintain themselves nor use as a model for their own houses, since the structure is too expensive and technically complicated.

An effective strategy for meeting shelter needs requires a much more comprehensive, integrated and grass-roots effort.

Locally based teams working within regional development projects should act on the following closely inter-related levels:

1. Research Experimentation and Development work on local building resources – materials, technologies and skills.
2. Training of local builders to develop a cadre capable of implementing most building projects independent of extra-regional professionals and contractors.
3. Stimulation of local building materials industries such as quality controlled mud-brick yards, and brick and lime industries, to make regions largely self-sufficient in materials.
4. Construction of essential buildings such as schools, clinics, houses and village baths in a way that demonstrates the use of indigenous technologies, and training local builders during the construction.
5. Plan for the growth of the major settlements of the region, demonstrating how settlements can grow in continuity with their indigenous settlement pattern, as well as develop traditional planning methods.

The one fundamental principle underlying these proposals is that the local people, such as the local builders, are often both the best sources of information and the most effective implementors. The extra-regional cadres can best act as temporary catalysts. The authors have been involved in implementing this policy within the Selseleh Integrated Development Project in Luristan, Iran.

3. Mud-Brick Vault and Dome Technology

INTRODUCTION:

Here mud-brick vault and dome technology is being presented as an indigenous technology with particular potential in low-cost housing for developing and sharing between Third World countries. The mud-brick vault and dome system evolved centuries ago in countries like Iran. Their invention came about largely out of necessity in hot-dry semi-arid regions where roof spanning materials such as timber and reeds became more and more scarce as populations grew. Although mud-brick building reached an extremely sophisticated level, in public and domestic architecture alike, it has in more recent times been neglected in favour of building methods from the West which are automatically assumed to be superior. Interest in mud-brick developed again in the late 40's and 50's and can be seen in the work of Hassan Fathy in his New Gourna village in Upper Egypt, and in research on alternatives to cement carried out by building stations, particularly in India.

The need to seriously evaluate the potentials of such indigenous technologies has never been more evident than today, with the world wide crisis caused by the over-exploitation of energy and resources. Local timber reserves are being depleted in many countries by ambitious building programmes, and more and more the building industry becomes dependent on expensive imported or manufactured materials and components. Reinforced concrete roofing for instance puts the price of housing well above what the majority can afford and the accompanying technology outside of what the owner-builder can handle.

The less expensive corrugated iron roof produces interior environments which are excessively hot. Our own research bears this out. For example, in many rural areas concrete and steel are being brought in at exhorbitant prices and the owner-house builder is finding it more and more difficult to provide housing for himself. In many such areas there exists local mud-brick building industries. Walls are built of mud-brick and in the past the roof structure was usually timber. There exists a potential for the upgrading of the traditional mud-

brick building industry in the introduction of vault and dome roof technology and the improvement of the mud-brick itself.

Structural Performance :

Sun-dried mud-brick has been used most commonly for load bearing structures. The brick itself has strength in compression but not in bending or tension. The vault and dome are responses to this. The traditional vault follows a geometry similar to an inverted catenary. The catenary is the pure tension curve that a chain or rope takes when it is allowed to hang free, suspended by its ends. Thus an inverted catenary-shaped vault or mud-brick is always in compression and is one of the most efficient forms possible.

Vaulting in the European tradition involves the laying of the masonry over a wooden supporting formwork which is later removed when the vault is dry. The Middle-Eastern vault construction method does not require supporting formwork, whether one is using fired or sun-dried brick. In the case of the latter the particular adhesiveness between the mud-brick and the mudmortar is additionally useful. There are a wide variety of vault and dome types, both in shape and construction method. A common type is a vault which is built so that courses of brick are sloped and lean into the end wall which supports the vault while it is being built. Vaults that we built could be stood on immediately after being constructed. Domes, at their simplest, are semi-circular, the geometry and the slope and placement of the bricks being determined by a string with one end anchored at the centre of the circle, and the other end tracing out the arc of the dome. The dome, like the vault, is built without any supporting formwork.

Climatic Performance :

When looking at the climatic performance of buildings made of mud-brick and those made of concrete the advantages of the former are obvious. Mud-brick's high resistance to heat flow and the thickness of a mud-brick building's walls ensure that interiors of houses are insulated from extremes of heat and cold. Similar structures of concrete tend to heat up excessively due to solar radiation and will require extra expensive mechanical air conditioning to achieve comfortable conditions within.

Vehicle for Training Skilled Builders :

Mud-brick through history has shown itself to be an excellent tool for exploring and learning about structural principles of building. Because the material can only take compressive forces the built forms reflect the structure directly; there are no hidden stresses. The very cheapness encourages experimentation and the small size of the unit, the brick, allows for a core of skilled builders or a building co-operative to deal with the more complicated problems of building, such as roofing or large public building. Investment in local materials and expertise means that money spent on building remains in the local area rather than passing to a city-based contractor, or being lost abroad.

Mud-brick vault and dome technology is a case of an indigenous building method which has potential for development. This is not to say that advanced and intermediate technologies do not have an important role to play in Third World countries, but indigenous technologies have been the most neglected. Much pressing work has to be done. The trend in many countries, even where a strong vault and dome roofing tradition exists, is to put all the investment for new building into western capital-intensive methods. As a result, highly skilled traditional masons find no market for their trade. New apprentices are not being trained. Before such skills are lost they must be reassessed and developed. The shortcomings of such indigenous materials and methods must be analysed and improvements suggested in the light of modern research. For example, improvements can be made in the mud-brick's strength properties and, more importantly, in its resistance to water damage, abrasion and insects. These improvements must be fed directly back into the indigenous industries.

Finally, the feasibility for the use of vault and dome roofing should be explored in developing countries where the environmental and economic conditions are appropriate and modern roofing techniques are proving too expensive.

Indigenous Building Workshop

The following case study is offered as an example of how indigenous building technologies can be developed and taught through research and training workshops with village builders.

The local builders in villages and small towns are

traditionally responsible for most of the construction, both public and private.These builders are both a valuable source of experience on indigenous building methods and also an appropriate channel for the introduction of improved indigenous building techniques.

A workshop for upgrading the skills of rural builders was organised by the Development Workshop in conjunction with the Selseleh Integrated Development Project in the spring of 1977. The workshop was carried out in Yazd in south central Iran, an area of advanced indigenous building techniques. Builders from villages in Luristan province, Iran, participated in the two month programme. They were involved in experimenting with improvements to their local materials and building technologies. Experience was shared between workshop participants, who included village builders, architects and master builders from other regions of Iran. Solutions to village settlement problems were arrived at through discussion, then tested in the field.

There were two closely inter-related aims; firstly, to develop indigenous building methods through the pooled knowledge and participation of the village builders; secondly, to train these builders in practical and organisational skills so that they were equipped to meet most rural shelter needs without dependance on city based contractors, engineers and building materials.

Methodology :

The workshop methodology adopted was: learning through discussion, through practice and through experimentation.

For example, discussion on building methods, design, and drawing principles was introduced by asking each participant to draw their own house and discuss its advantages and disadvantages. From these discussions village housing and detailed building problems were identified and drawing skills were developed.

Each aspect of building construction, from different types of soils and foundations to walls and roofs were discussed in turn. On each subject the participants contributed their experiences and optimum solutions were agreed upon. Each building solution was tried out in practice in a yard set aside for such testing. At the same time, experiments were carried out on local materials like timber, stone and mud brick. Soils were tested using simple sedimentation techniques that could be mastered by any local builder. Stabilisers for mud brick and renders for improving earth walls against rain and wind weathering were developed for local soil types.

In the evening, literacy classes were conducted for the largely illiterate village builders. The workshop demonstrated the importance of basic literacy to the builders by relating it to their work. By gearing a literacy programme directly to the problems of reading plans and keeping their own building records, builders developed a keen interest in becoming literate.

Subjects Covered:

1. Problems and potentials of Indigenous Building and general village development:
   - problems of rural underdevelopment
   - potentials for small-scale village industrialisation using local resources
   - rural shelter and village settlement problems
   - the role of the village builder as a development cadre
2. Basic Design Principles:
   - site planning and orientation
   - relationship of spaces and elements within a building
3. Reading drawings and laying out buildings
4. Foundations:
   - for differing soil and site conditions
   - differing building requirements
5. Walls:
   Mud, mud-brick, fired-brick, stone, and mud-brick and fired-brick combinations. For each type of wall the costs, structural, physical and climatic properties were compared. Builders learned the best methods for compacting mud, making mud-brick, fired-brick, types of mortar, required wall thicknesses, brick laying methods, etc.
6. Timber Roofs:
   Timber roof types in Iran and other countries, new alternative timber roof types and timber trusses. Through construction and experimentation each type was evaluated.
   Vault and Dome Roofs:
   The most widely applicable vault and dome types were selected. Builders learned how to construct these types, the variations of wall thicknesses according to roof span, arch construction, roof span to vault and dome curve ratios, the physical, structural and climatic properties of vault and dome.

Finally, the aim of the workshop was to develop an educational methodology that barely literate builders could use to educate themselves and improve their indigenous methods. This methodology, based on problem identification and problem solving by sharing knowledge through the processes of discussion, practise and experimentation, proved successful within the workshop.

Conclusions

In conclusion we make the following proposals.

1. Third World countries should set up Regional Development Projects that deal with the problem of meeting local shelter needs in the comprehensive and integrated way outlined in Part 2 of the paper. In this way, not only would local building technologies be developed and applied but also the criteria for their selection would be made on a grass-roots level.
2. A programme should be implemented for Research and Development of Mud-Brick, Vault and Dome Technology for application in both the countries of origin and in other Third World countries.
3. Indigenous Building Workshops should be held with the participation of builders and professionals from different Third World countries, who have knowledge of their indigenous technologies so that this knowledge can be shared between these countries.

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