# MIMAR

Architecture in Development



MIMAR 37 · DECEMBER 1990
BUILDINGS FOR HIGHER EDUCATION AND RESEARCH · DISASTERS

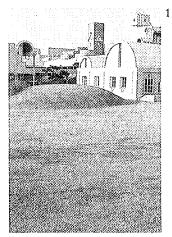
# MIMAR

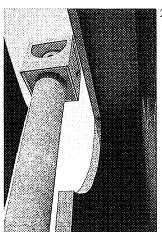
### Architecture in Development

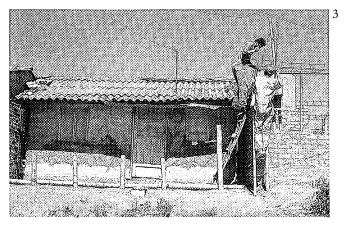
NUMBER 37 · DECEMBER 1990

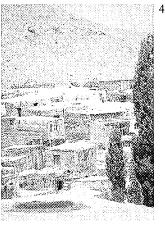
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#### POINT OF VIEW

In the first article of a new series in MIMAR, Mohammed Arkoun sets the scene for our theme and gives his views on the nature and purpose of higher education and research in the developing world.

t is difficult to generalize about higher education and research in the developing world. Countries have different cultural traditions, different political regimes and economic resources. Zaire, Chad, Senegal and The Philippines cannot be compared to Saudi Arabia, Morocco, Turkey and Algeria. Algeria had one university when it became independent in July 1962; now, there are more than 15 universities. Riyadh has the most sophisticated laboratories in its universities. By contrast, Cairo is still unable to enlarge and modernize its already old universities, overburdened by thousands of students.

Material resources are, as everywhere, a key element in meeting the enormous demands of higher education and research. But wealthy countries like Saudi Arabia, Libya, Algeria (before the recent crisis) the Iraq, highlight a more important factor in the evolution of higher education and research in all developing countries: namely the enormous historical gap between 'The West' and 'The Third World'. This gap has been widening since the late 1960s. Let us consider some possible explanations for this decisive aspect of the contemporary history of third world societies.

#### The Western Model

Janet Abu-Lughod has recently published a provocative book entitled: Before European Hegemony: The World System A.D. 1250-1350, (1989). The ideas presented in this book are reinforced by two other monographs by Georges Makdisi: The Rise of Colleges: Institutions of Learning in Islam and the West, EUP 1987; and The Rise of Humanism in Classical Islam and the Christian West, EUP 1990. The thesis of these three books can be summarized by saying that before European hegemony, there was from the eighth to the twelfth century an Arabic-Islamic hegemony in the whole Mediterranean area, especially in the field of higher education and research.

Makdisi develops the controversial contention that colleges and universities in Europe after the thirteenth century have been influenced by the models established in Muslim cities like Rayy, Isfahan, Baghdad, Damascus, Cairo, Fas, Córdoba and Toledo. There was a rich humanist movement in the classical age of Islam, influenced by Monotheist legacy, Greek thought and science, Iranian culture and religions and Indian elements.

All contemporary Muslim societies which represent a large number among third world countries, share the aspiration to restore Islamic hegemony and go back to the Islamic model, because this is the only way to break free from the 'Western Model', as it is now called. Non-Muslim countries in the third world also develop this position about the 'Western Model': they want to preserve, restore and return to their own cultural traditions. This opposition between the West and all third world countries is well known in international organizations; it is a recurrent ideological theme which has strong historical roots and strategic purposes on the Western side. The ongoing tensions inside UNESCO demonstrate clearly the impact of these issues.

The West has been overused as a political and ideological concept in the context of the wars of liberation from colonial domination. Today, the West includes Japan, America and the old European powers. The term should be used to describe the 'seven richest countries' as opposed to the 'poor countries'. In discussing higher education and research we should take as our starting point the Mediterranean area. This was the common cultural space where Islam, Christianity, Judaism, Greek, Roman and Byzantine cultures shaped the mentality of all peoples living in the cities until the fourteenth century.

Then Europe started to move towards a secularized culture and thought, imposing a new intellectual regime on the theological systems prevailing in Jewish, Christian and Muslim areas during The Middle Ages.

European hegemony has been intellectual since the sixteenth century, before becoming industrial and technological. Luther, Calvin, Descartes, Spinoza, Leibniz, Galileo and Newton made a revolutionary impact on all fields of thinking, including religion. Islamic thought deeply involved in the same intellectual issues up until the thirteenth century, was cut off from the new revolution in Europe where the great movement known as modernity began. The Anfklaming 'Enlightenment' in the eighteenth century further developed this modernity with two major revolutions: the political rupture in which monarchic regimes based on religious legitimacy were replaced by the sovereignty of people; the rise of capitalism and industry which became the basis of the colonial domination and the present hegemony of the West.

In this long, complex process, the phenomenon of 'developing countries' became apparent at the end of the 1950s, when the colonized countries became 'independent' and asked for economic and cultural help from developed colonial countries. Expressions like 'third world', 'underdeveloped', 'developing', or 'poor' countries were created by the capitalist hegemony model to attract satellite nations into its control.

Developments in all fields — cultural, social, economic, political — have been inspired by specialists trained in the West. That is why the universities, institutes, high schools and laboratories created in 'developing countries' are still dependent on their models in The West. The problem here is not to reject or even to avoid these models, but rather to find adequate answers to specific needs in each country. The conflicts which led to the rise of Khomeini in Iran, the present crisis in the Gulf and many other civil wars in the world, are linked to the failure of these Western models applied without a critical adaptation to the local context in so many different countries.

#### Satellized cultures

I do not use the expression 'satellized cultures' in the current ideological opposition to the 'imperialist' domination of the West; I aim rather to emphasize two important points:

Firstly, Western intellectual, scientific and technological models are unavoidable; they represent the highest standards existing today, and, consequently, the reference point for any research which aims to criticize or to improve upon them. As far as the hard sciences are concerned - mathematics, physics, chemistry, biology, astronomy - higher education in developing countries is limited only by material and financial constraints. Here, the dependence on Western universities and scientific environment will probably continue for many years. We know that every discipline is advancing rapidly with new discoveries being made, and the application of new technology. This evolution is difficult to follow in developing countries not only because of the lack of resources, but also because of the difficulties associated with translating scientific discourses into traditional languages. Arab countries are handicapped by the fact that the majority of professors and researchers are trained in Western languages.

The purpose of education in this domain has been, up to now, the spread of a scientific culture, without the objective of challenging the most advanced centres and institutions in the West. The example of Japan is admired, envied, but not emulated anywhere in the third world except in some parts of Asia like South Korea. An important point here is that third world countries have been excluded from sharing some secrets in the fields of technology, biology, atomic physics and chemistry. There has been heated debate about the atomic bombs possessed by India, Pakistan and Iraq. Economic considerations are mixed

#### POINT OF VIEW

with problems of security to force developing countries to remain dependent on the West. Algeria, when it first became politically independent, tried to break this cycle, by opting to develop a heavy industry, with the capacity to challenge European industry. It has been a dangerous dream for which Algeria has paid a very high price in the past ten years.

The second point when we talk about satellized cultures has even more negative consequences than the first one: its concerns the cultural identity of each country endeavouring to become a modern nation. The purpose of higher education as it is proclaimed by the states and understood by the people is to recover the 'national personality' obliterated by 'colonial domination'. The official programmes insist on the necessity of restoring and modernizing the national language, the cultural legacy and the historical glory as represented by monuments, religious buildings, literature, music and other crafts activities.

Arab countries particularly, are mobilized by these objectives, used as slogans in all official declarations, texts of meetings, conferences and international services. Classical heritage of Arabic civilization the Turath - has become one of the most dominant themes in contemporary Arabic discourse. Islam as a more widely shared theme is added to and mixed with Arabic, Indian, Turkish and Urdu civilizations to attribute meaning and purpose to education at all levels. Books used in primary and high schools are conceived and written to fulfil these purposes.

In analysing all the literature generated by the political struggle against the Western model, we discover how, in fact, higher education and research is weak, far from scientific norms and irrelevant to the officially declared purposes. Why is this? Where is the impact of the Western Model on this aspect of national life?

Third world countries since the late sixties have shared three common features: they have, as we said, weak economies; they face rapid population growth; they are subject to authoritarian, not to say totalitarian, regimes. The pressure of these three

factors caused in each country the deterioration of 'popular culture' under the impact of the so-called agrarian revolution or reform; the pressing demands of the younger generation; the collective move from the rural areas to the large cities, generating the predictable urban disorder, not to say disaster. Popular culture is replaced by *populist* mélange with fragments of the broken cultural systems evident in rural areas as well as in the cities.

The responsibility of the political regimes – whatever their ideological and economic options – has not been evaluated with all the necessary information and objectivity. It can be stated nevertheless that they did not encourage democratic experiences,

they did not praise the function of intellectuals, they relied rather on the police, the army and the Party to impose decisions inspired by foreign experts. In the process, they neglected references to the political and social sciences applied to the critical study of the new societies emerging in the new international environment.

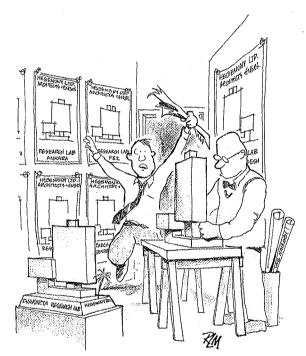
In this context, five disciplines must take priority over all the others — history, linguistics, sociology, anthropology and architecture. These are precisely the disciplines that are absent in higher education and research; history is taught of course, but in such a strong ideological context that it leads to the opposite result from an objective analysis of the past. This is particularly true of the history of the formative and classical period of Islam, which is used as a mythological reference in the fundamentalist discourse.

Linguistics is not yet catered for in all its branches and is not

applied to a critical evaluation of all types of texts - religious, theological, philosophical, literary and historical. Sociology and anthropology can help to eliminate the damaging use of ideological constructions for political purposes. Third world societies are manipulated more now than at any stage in their history, because political and social sciences do not fulfil the same function as they do in Western societies. This is the key issue to be considered and resolved in a new programme for higher education and research.

Since we are examining these problems in MIMAR, we must stress again the importance of architecture as a field of education and research combining not only the practice of the mentioned disciplines, but many other skills and sciences: artistic creativity and technological knowledge. Architecture is a totalizing discipline, because it requires artistic gifts and abilities, as well as a wide multidisciplinary training. This ideal conception of the role of architecture is far from the current dominating practice in schools of architecture. Pragmatic, economic solutions and technical devices prevail over theoretical views in the urban fabric and architectural design

produced during the last 30 years in third world societies. This situation is compounded by the deficiencies in higher education and research as discussed earlier in this article. I urge all responsible directors of the schools of architecture in developing countries to *rethink* the programmes, the methods and the epistemological framework in architectural and urban education and research. Few schools have yet enlarged their methods and programmes to form a multi-disciplinary training and practice.



"TROUBLE, KARL! THE COPY MACHINE JUST ATE SINGAPORE!"



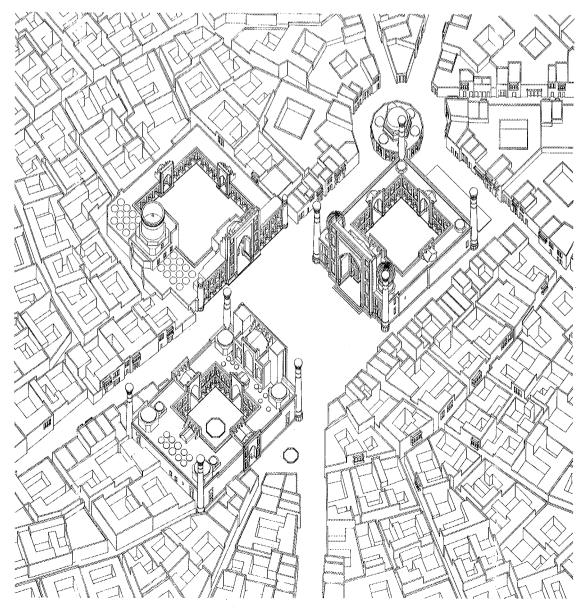
### IMAGES OF SAMARKAND

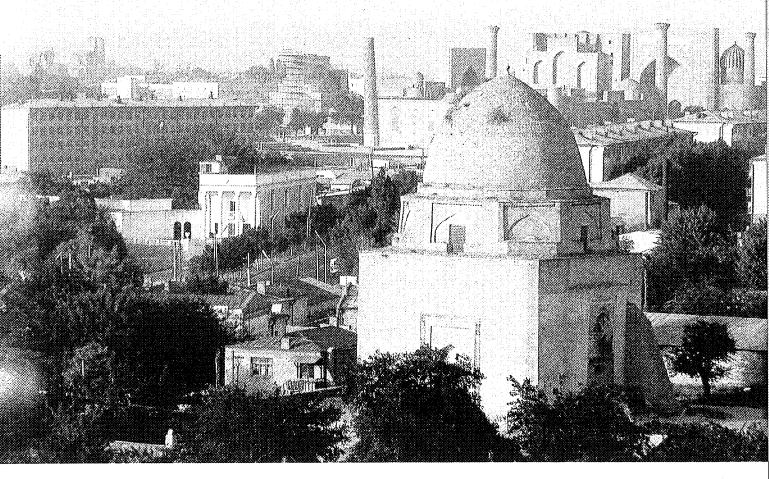
Klaus Herdeg first visited Samarkand, Uzbekistan in 1975 to gather research material for his book, Formal Structure in Islamic Architecture of Iran and Turkistan. He returned in the Summer of 1989 in order to see what changes 14 years had wrought and to show his New York architecture students some of the most important sites in central Asia. Here he gives an annotated, kaleidoscope view of past and present images of a thriving city, whose complex history and adaptation to modern urbanization have left a lasting imprint.

amarkand has the distinction of having been at a 'crossroads in history' several times. It was part of Cyrus' Persian Empire, conquered by Alexander the Great, and subsequently governed by the Seleucids, the Parthians and their successor Persians, the Sassanids, who were in turn conquered by the Arabs. A few hundred years later, Genghis Khan sacked Samarkand, Bukhara and Kiva, on his

push westward in 1216. Timur (Tamerlane) took possession of Samarkand in 1370 and it became the chief economic and cultural centre of central Asia, and the capital for what was to become an enormous empire for the Timurid dynasty. At the end of the fifteenth century, the Uzbeks began to establish their various principalities, called Khanates, in this region. The Russian Czars Peter the Great and Nicholas I tried in vain to

conquer the region in the early 1700s and the mid 1800s, respectively. Finally, Samarkand fell into Russian hands in 1866-68. By 1888 a spur of the Trans-Siberian railway had already reached this important outpost, giving rise to a burgeoning Russian city to the west of what the Baedeker guide book of 1914 calls the 'native' city. The Soviet State was the natural successor to the Imperial Russian state.





Left: Axonometric, hypothetical reconstruction of Registan Square, perhaps close to what it looked like in Timurid times, although there were earlier versions of the buildings standing on the other sites. The three major buildings are (except for the Ulugh Beg madrasa) increasingly independent from the city fabric: Tillya-Kari. The madrasa is completely engaged in the fabric so that its facade becomes part of a continuous street. Ulugh Beg Madrasa is engaged only on the western side, and Shir-Dor Madrasa, completely disengaged and, therefore, perceived as an object-building. The 12-sided bazaar building is at the intersection of most entry routes to the city. (From the author's book Formal Structure In Islamic Architecture of Iran and Turkistan Rizzoli International, New York, Autumn 1990.)

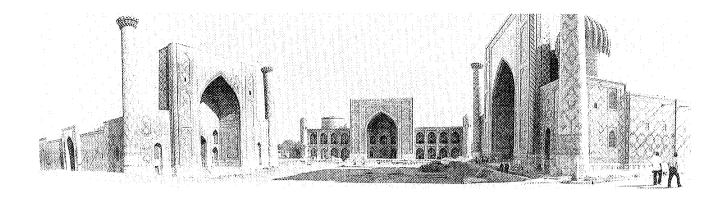
Top: North-east view along the road leading to Registan Square, where, in this 1975 photo, the construction of the new dome on the Tillya-Kari Mosque is clearly visible.

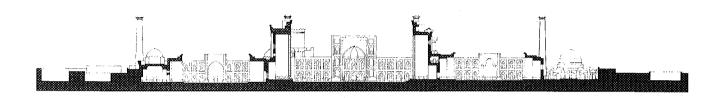
The most striking characteristic of this view is the bizarre juxtaposition of buildings from the Timurid, Czarist Russian and Soviet periods. Between Timurid foreground — the tomb of a fourteenth century mystic — and background from Bibi-Chanum Mosque to Registan complex, a neo-classical gem demands our eye's attention, next to rather large and mundane Soviet blocks. The traditional, largely private, urban fabric out of which once public monuments grew, seems to be swept aside.

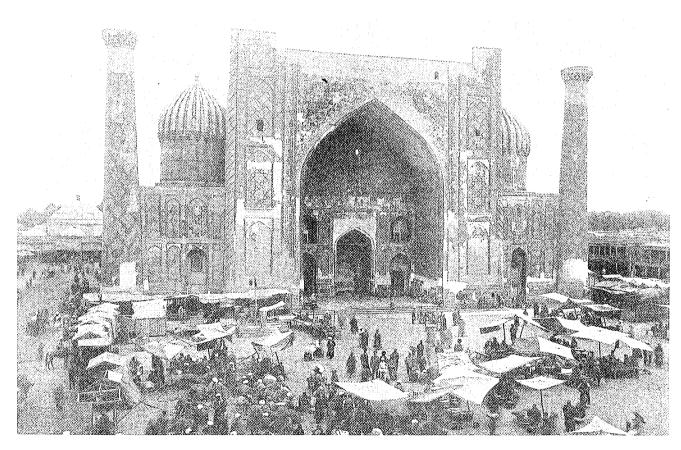


Above: A reconstructed plan of a time between the fifteenth-century Timurids and the eighteenth-century Uzbeks. The main gates with the road curving at the Registan towards the bazaar, the citadel, the Gur Enir Mausoleum, the Registan and the Bibi Chanum Mosque are all clearly recognizable within the city walls. Outside the walls to the north-east is the Shah-i-

Zindeh street of tombs and to the southeast the Ishratkhana Mausoleum and the Abd-i-Darun complex. One should imagine the late nineteenth-century Russian city being laid out with broad, tree-shaded avenues, west of the old city walls. None of the fabled gardens of Samarkand are shown because, as yet, nobody knows where they were.



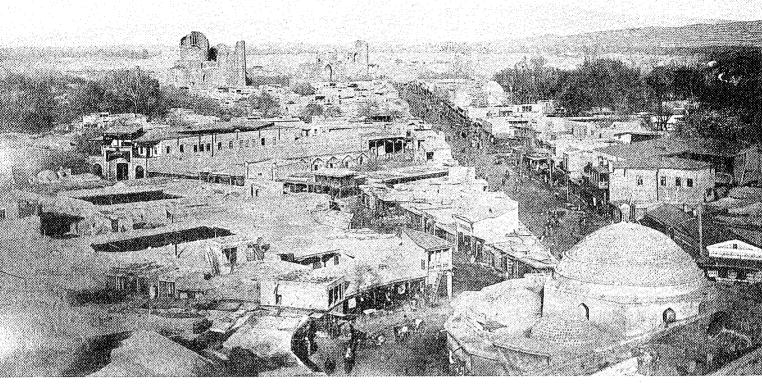


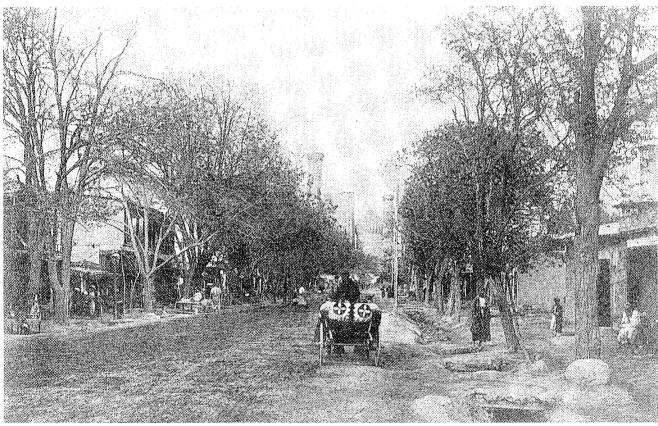


Top: Panorama looking into Registan Square. To the left the Ulugh Beg Madrasa, to the right the Shir Dor Madrasa and straight ahead the Tillya-Kari Madrasa. On the roof of the latter, a drum is visible over the mosque part. The outer dome was built by the Soviet authorities.

Centre: Registan, east-west section, through Ulugh Beg Madrasa (early fifteenth-century) and Shir Dor Madrasa (early seventeenth-century) looking at Tillya-Kari Madrasa (midseventeenth century).

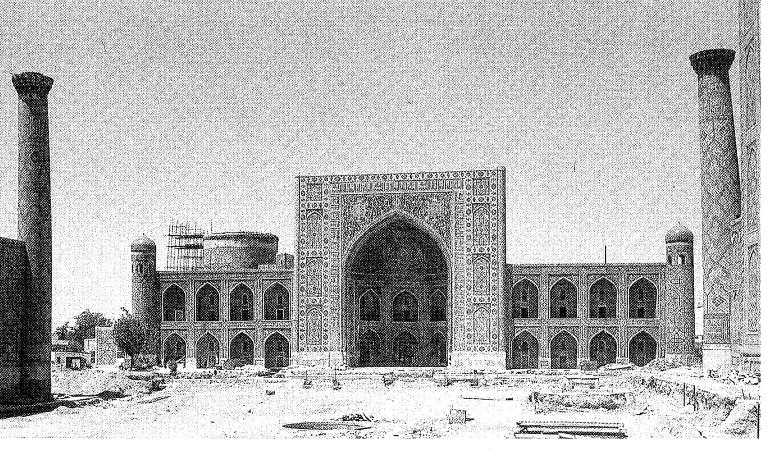
Above: Late nineteenth-century view into the Registan looking towards Shir Dor Madrasa. A market animates the space while some of the old fabric of the city can be seen on either side of the madrasa.

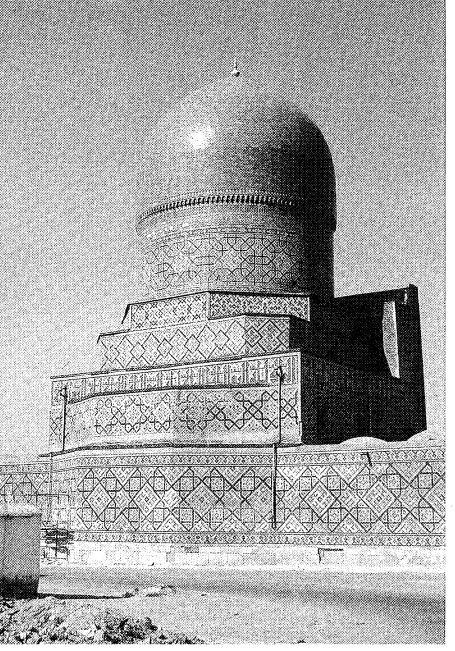


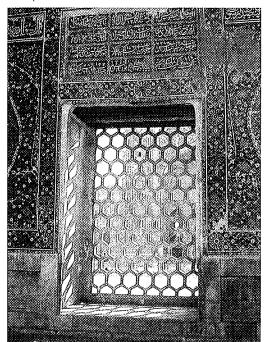


Top: Late nineteenth-century view from the Registan northwards past the bazaar district to the ruins of Bibi Chanum Mosque (begun in 1399) by Timur. Beyond is the Zeravshan Valley which meets the desert. The domed structure in the foreground is a 12-sided bazaar building, which in Timurid times may have been integral with the city fabric.

Above: Late nineteenth-century view north-eastwards, down to the Registan. The width of the street suggests a considerable broadening since Timur's time.





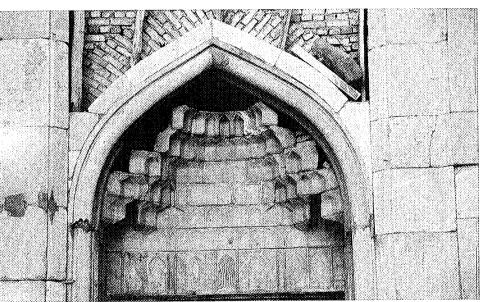


Top: A view of Registan Square, 1975.

Left: Tillya-Kari Madrasa, Registan (1989), with recently constructed dome over the mosque section of Madrasa.

Above: Traditionally, the entrance to a mosque is never direct. In this example there is a screen door in the centre of the main façade which allows one to see in, but not enter. The screen in evening light appears fully as part of the surface in which it lies. The emphasis is on the lightfilled interior of the court. In morning light the opposite is seen, as the screen becomes an object in itself. This perception is emphasized by its shadow looming toward the viewer (1989).



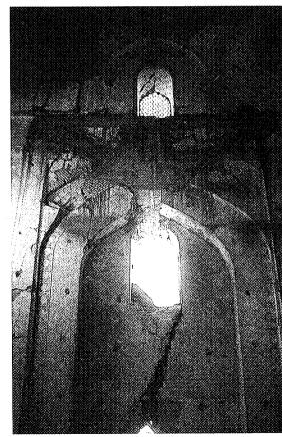


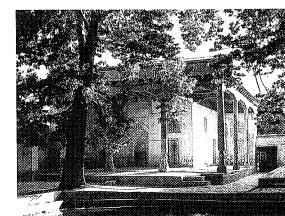
Top: View of the Bibi Chanum complex from the north-east (1975). Banners, signs and a rickety-looking overpass have formed a contemporary yet typical central Asian equilibrium with the imposing ruins behind them. If the authorities can realize their dream, one of the largest mosques in the world will have all its domes recapped, as well as the gigantic centre gateway, minarets and all, reassembled. They are well on the way. There is enough heavily reinforced concrete that a new building the size of the opera house or a new hotel could be built with the same material. And then, when Bibi Chanum has been resurrected, what purpose will it serve?

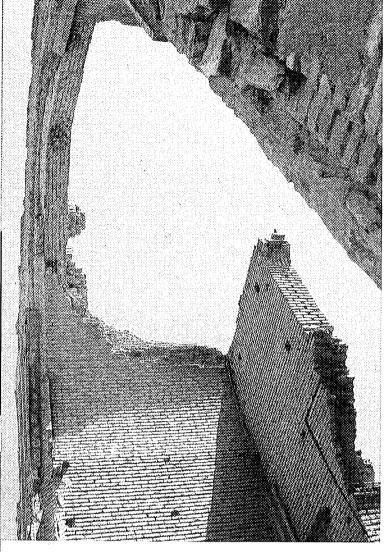
Above: Bibi Chanum Mosque, showing progress of the re-insertion of muqarnas vaulting (1989).

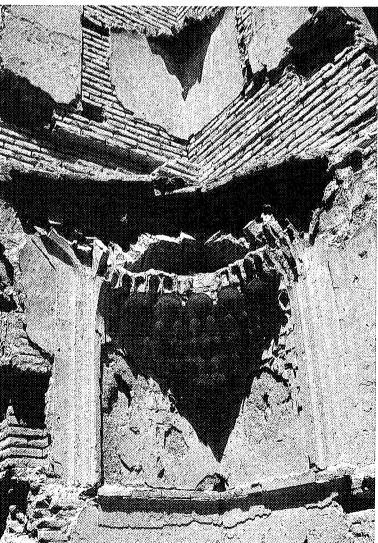
Right: Bibi Chanum Mosque (domed space in front of mihrab) looking towards the entrance (1989). Even with new concrete 'muscles', the job is far from done.

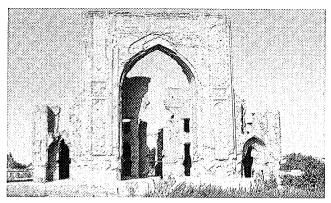
Below right: Abd-i-Darun, Khanaka, mosque and mausoleum. A type of building complex often found in Central Asia, combining piety and utility. The piety is obvious from the mausoleum and the mosque; the utility is in the private rooms for travellers arranged in an L-shape around the deep pool which in turn makes for a pleasant climate by encouraging trees to grow. Since it is not used for its intended purpose any longer, it has become a 'secret' place for young lovers to meet. Admittedly this is not a peach orchard whose quality Claviho, ambassador to Timur's court, wrote about with amazement; this view (1975) of a quiet spot is as close as we can come to experiencing a fifteenth-century Samarkand garden. Samarkand peaches were prized highly in the commone took th

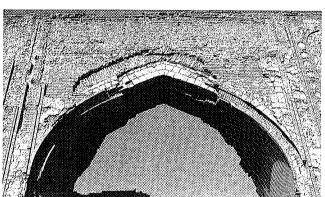












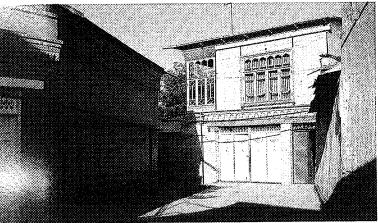
Top/above: The Ishratkhana mausoleum: general view and detail of main iwan (1975). The building is often praised, not so much because it became the final resting place for so many women of the Timurid dynasty in the fifteenth century, but because, in Soviet terminology, "it is one of the most refined works of Central Asian craftsmanship...". Supposedly for this reason the same Soviet source continues: "Restoration work at Ishratkhana began in 1980 and the time will soon come for the mausoleum to rise in its initial grandeur."

Above left: View of the same iwan 14 years later. Time and harsh climate are literally chipping away at the old ruin. Ruins are always photogenic precisely because they are a fragment of a gestalt, which different eyes and minds can imagine to be whole again in different ways, depending on their scientific training to extrapolate from given clues or their intuitive ability.

Left: Ishratkhana mausoleum. This view (1989) of an internal fragment tells us a great deal about fifteenth-century construction methods: the principle of interdependence. In this case the way the bricks are interlocked — those one would not see in the finished building. Even the squinch muqarnas helps to hold the outermost skin in place.

Facing page, top: One of countless lanes giving access to the many areas of continuous housing fabric (1989). Here we are in the vicinity of Gur Emir, Timur and Ulugh Beg's mausoleum. Here and there a building beyond the corridor-like walls will show itself. Natural gas and water is available to every house.



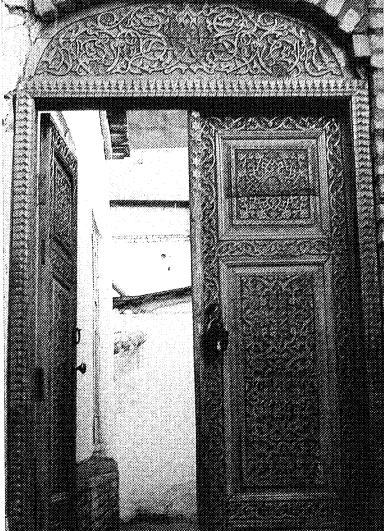


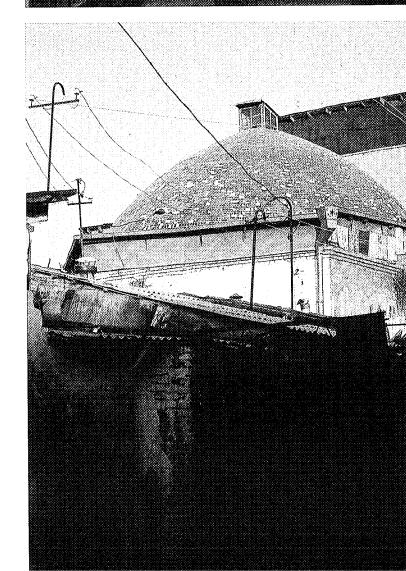
Above: A house along a typical Samarkand alley which was obviously brand new in 1989 when the shot was taken. The owner takes great pride, as evidenced by the fancy woodwork, the decorative brickwork, and a garage door leading into the courtyard inside. This owner even has a telephone. Obviously religious taboos are not ruling the public side of the building, but then they rarely did. Balconies overlooking the street were always quite common.

Above right/Right: In another part of town, to the east of the market street leading down to Bibi Chanum, there is nothing but traditional city fabric, for private and public use (1989). Cheek to jowl we found a Jewish neighbourhood, for us undistinguishable from their Moslem counterparts, had it not been for a clue we picked up on a city map displayed in the hotel. As vague as the map was, we found the centre of this ancient community: a handsome synagogue with a discreet flat dome sitting on a hexagonal base which, in turn, gives way to a perfect cube in the interior. Between the embedded house of worship and the alley was a small court, half covered for large family functions. Everything was tidy and repaired where necessary. The municipality even affixed a public plaque near to the door announcing that this place is officially under its protection. In this case at least the city fabric of houses with continuous outside walls is conducive to civic harmony.

PHOTOGRAPHS AND DRAWINGS BY THE AUTHOR

KLAUS HERDEG IS PROFESSOR AT THE GRADUATE SCHOOL OF ARCHITECTURE, PLANNING AND PRESERVATION, COLUMBIA UNIVERSITY, NEW YORK.







## THE INDIRA GANDHI INSTITUTE OF DEVELOPMENT RESEARCH

#### BOMBAY

Ranjit Sabikhi

#### **Project Data**

Location: Goregoan, Bombay Architect: Uttam C. Jain Sponsor: The Reserve Bank of India Client: The Government of India Consultants: Sharad R. Shah (Structural Engineers) M/S Tech (Consultants Services) Kishore D. Pradhan (Landscape) R.L. Parmar (Approvals) Suri & Suri (Acoustics) Uttam C. Jain (Interiors of Auditorium and Seminar Rooms) Professor Salve (Main Door Muralist) Unik Engineering Services (Electrical) Site Area: 14 acres Cost: Rs. 80 million

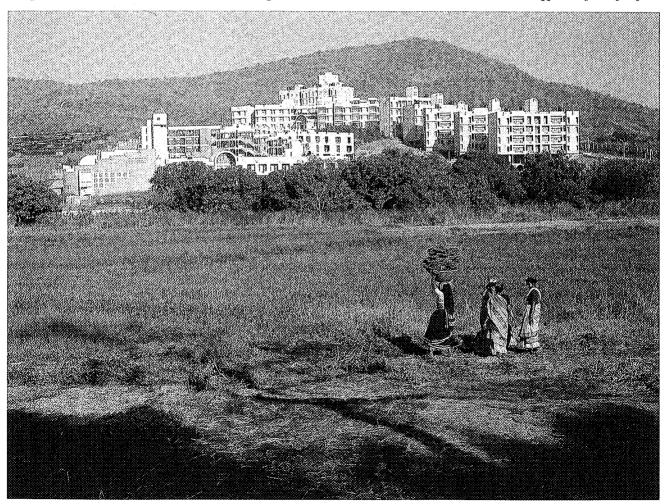
Completion: December 1987

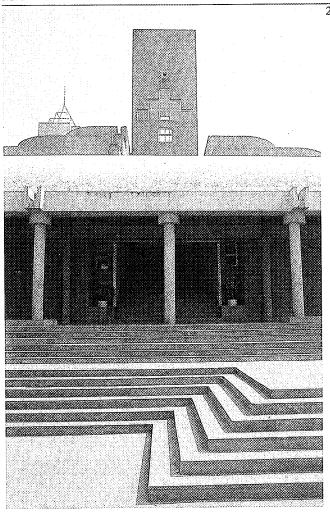
ituated on a hillside on the outskirts of Bombay, the Indira Gandhi Institute of Development Research is an impressive complex. It is flanked on one side by a large shanty town settlement - an indigenous collection of self-help squatter huts - and on the other sides by the Borivili National Park - a sizeable nature reserve. The complex was commissioned and built in a short time-span and therefore reflects considerable spontaneity and freshness. For Indian architect Uttam Jain it is a culmination of ideas that he has been exploring over the years and the project provided an excellent opportunity to apply them on a reasonable scale and to produce a strong and well-articulated statement.

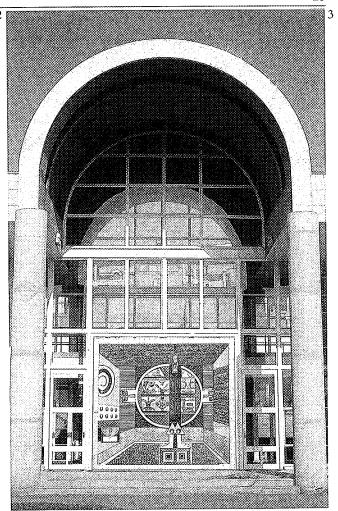
While the form is clear and easily readable, it is the layers of meaning that lend subtlety and interest to the complex.

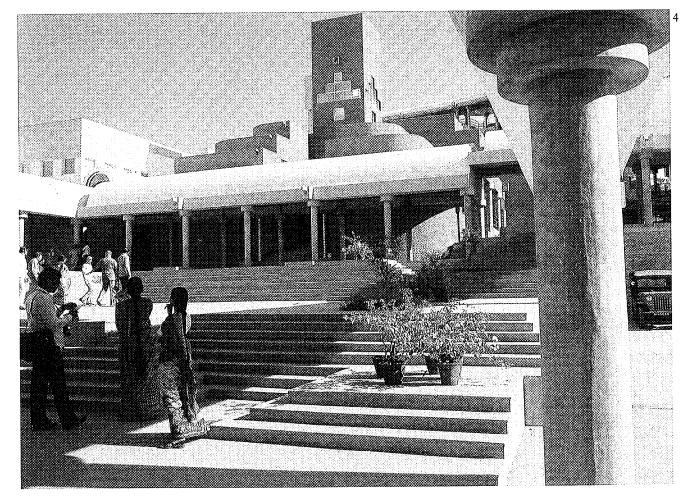
- 1. View of the Institute campus from the west, set in the green rolling acres of Goregoan a suburb of Bombay.
- 2. The seminar rooms, rising above the steps of the plaza, evoke Mount Meru.
- 3. The entrance, conceived as the 'City Gate'. The mural, based on a theme of man's potential for self-development, sets the mood for the building.

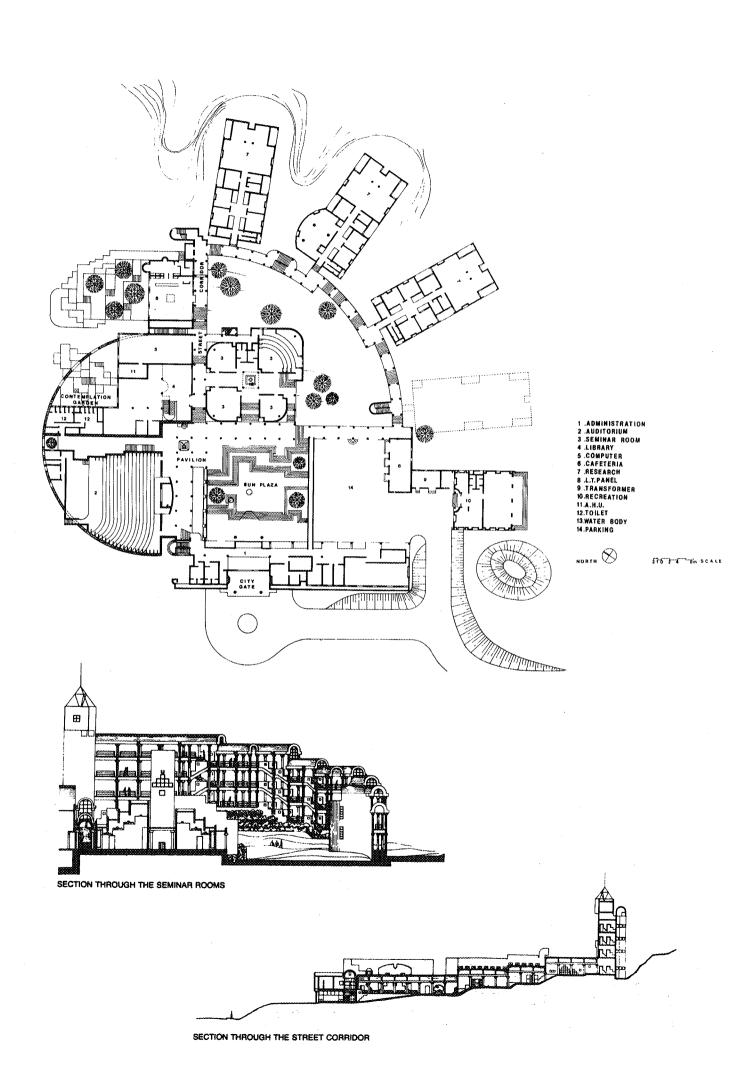
4. The sunlit central plaza. The steps are intended to echo the stepped river fronts of Gujarat.











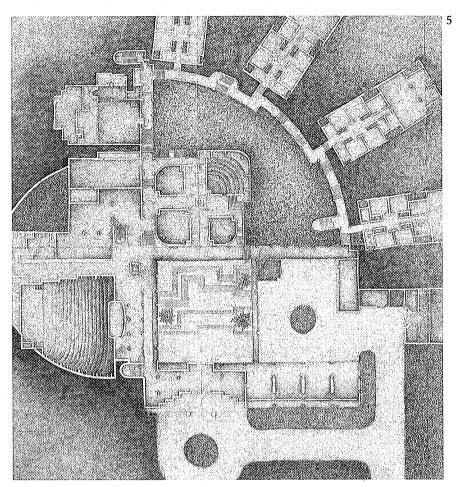
5. & 6. Floor plans coloured as miniature paintings by Uttam Jain. The design layout echoes the configuration of navagraha or 'nine building masses', referred to in the tenets of city planning in ancient India.

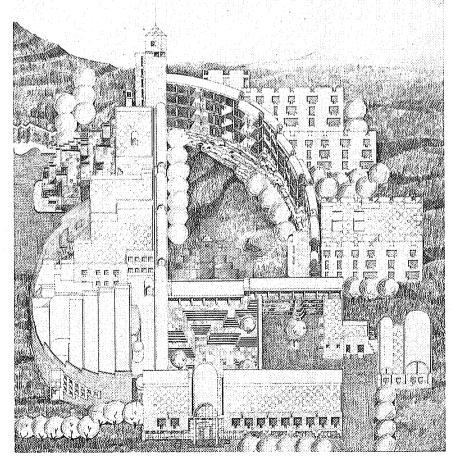
People may read the complex in various ways and interpret it in their own terms. Uttam Jain himself talks of symbolism and the complex as a city with its city gate, its 'sun-soaked plaza' and its network of sequentially-linked spaces leading from light-filled areas to semidark and dark private spaces. He refers also to the use of water recalling Mughal monuments, the flights of steps resembling the stepped wells of Gujarat, and to the section of seminar rooms as a model of the cosmic Mount Meru significant in Jainism, Buddhism and Hinduism. This intellectual posturing, however, tends to obscure and detract from the simple delight of a wellintegrated complex superbly related to the steep topography of its site.

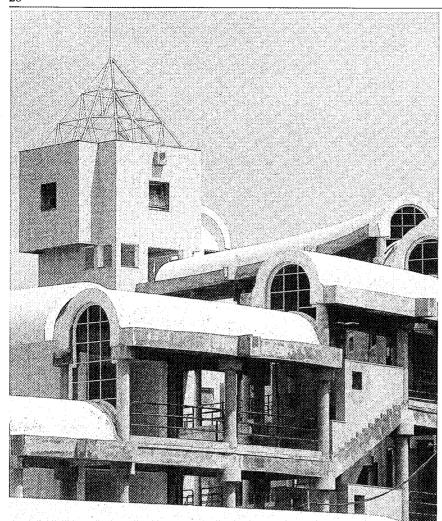
The institution complex is entered via an administration building that is completely transparent at lower level, establishing direct contact with the stepped plaza beyond. The entrance is further emphasized by a giant glazed arch set within a barrel vault with a ceremonial entrance door surmounted by a mural reminiscent of Le Corbusier's monumental door to the Assembly building at Chandigarh. The entrance lobby itself is a vast sunlit glazed space with all the administration facilities accommodated in offices at the second floor level. Immediately in front is the sandstonepaved, open-to-sky, stepped plaza. This is a masterful handling of levels which, despite recalling traditional temple tanks, has resulted in the most attractive space in the whole complex. All the academic facilities of the Institute are organized concentrically around this central open space.

The sequence of movement goes clockwise up the slope of the hill from the entrance hall to the auditorium and then further up to the cluster of seminar rooms placed at the very heart of the complex. Further up, on the left, are the library, the computer building and the cafeteria with the passage terminating at the top of the hill beside the lift tower. From this point, a system of quarter-circle passages on different levels connects to the three separate research blocks which span out in radial fashion. The passages connect with the seminar rooms and a link in the form of a bridge defines the fourth side of the central plaza, connecting with the administration block at second floor level.

The formal organization of the academic complex revolves around the



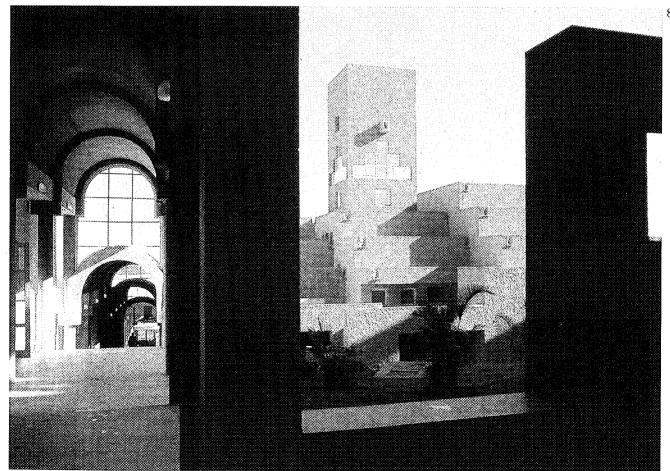




7. Terraced passages connect different segments of the campus and allow unrestricted view and breezes.

8. A 'street corridor' with barrel vaulted roof, looking west.

9. The main auditorium. The ceiling carries a series of jumbo-sized wooden arches, echoing the elemental form of the Buddhist Chaitya Caves.





central space in the middle of the arrangement of seminar rooms - a space defined by the skylight tower above a small square water fountain. This tower, at the centre of the seminar complex which Uttam Jain refers to as the model of Mount Meru, is the pivot around which the entire complex is organized. It serves as the axis mundi or cosmic pillar around which the world revolves. It is not only the geometric centre of the organizing order; it is also symbolically the heart of the entire complex. It is essentially a simple square tower lit by windows from all the four sides above, highlighting a structural cross that seems to be suspended in the empty space within. The tower itself holds an ambiguous position as the central feature at the heart of the complex. It is largely subdued by the lift tower, located to one side at a higher point of the site which is the more dominant element. The duality of the two vertical features is partially resolved by placing an open pyramidical steel structure with a central vertical spire above the lift tower, thus defining its pre-eminence.

The form of the auditorium, the library and the computer centre, is defined externally by a semi-circular stone wall that echoes the arch of the quarter-circle passages connecting the research blocks. Landscaped spaces adjoining the library penetrate the curved wall and visually connect it with space beyond.

A system of barrel vaults provides a dominant image that is characteristic of this project. A massive barrel vault defines the entrance to the institute and another flanks the administration complex covering the access passage to the offices. A further system of barrel vaults is stepped up the hill and curves along the corridors at several levels linking the research blocks. The form of the barrel vaults recalls the rock-cut Chaitya Caves of Buddhist architecture. The form of the columns with their circular capitals and arched beams provides a definitive image to the complex.

The form of the buildings themselves with their many different external treatments is rich and varied, but despite the strong central order which pervades the complex, the architect's penchant for post-modernist effects tends to distract. The fragmented facades and the conglomeration of materials tend to both deconstruct and destroy the abiding overall image. The walls, covered with glazed tiles, rough plastered stucco in

different colours, and made of Malad stone – while recalling Jain's earlier works in Rajasthan – do not successfully hold together and tend to break down the strongly integrated fabric of the complex.

The same tendency to fragmentation is also evident in the planning and organization of the various residential blocks and hostel units. The residential buildings, by their sheer bulk, dominate the hillside and overshadow the central complex, while having no real relationship with it. These buildings do not have the same clarity of expression; nor do they really seem an integral part of the Institute complex.

The central complex of the Institute, however, has about it a rare vibrancy as well as a casual spontaneity that makes it particularly impressive.

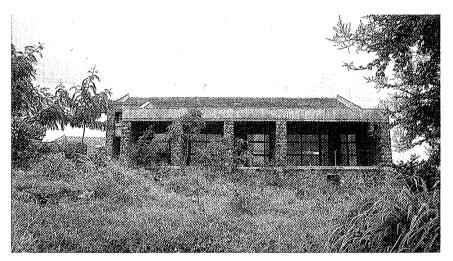
#### PHOTOGRAPHS BY UTTAM JAIN

RANJIT SABIKHI RECEIVED A BARCH. AND MASTERS IN CIVIC DESIGN FROM LIVERPOOL UNIVERSITY, UK IN 1959. HE TAUGHT FOR 16 YEARS AT THE S.P.A., NEW DELHI, WHERE HE WAS HEAD OF THE DEPARTMENT OF URBAN DESIGN. HE HAS HIS OWN PRACTICE IN NEW DELHI AND IS ACTIVE IN NATIONAL AND INTERNATIONAL ARCHITECTURAL JOURNALISM.

## THE CENTRE FOR DEVELOPMENT STUDIES AND ACTIVITIES

#### POONA

Christopher C. Benninger



#### Project Data

Location: Poona, India.

Architect: Christopher C. Benninger. Architectural Team: Manisha Boradkar, Rajiv Vishwas Rao, Madhav Joshi, Gautam Balsekar, Nikita Oak.

Prime Contractors: Dinshaw and Dinshaw. Structural Engineers: C. E. Godse and Associates.

Electrical Contractors: Maintain. Fenestration: Jogo Engineers.

Covered Area: 743.5 sq.m. (existing); 720.3 sq.m. (planned).

The Centre for Development Studies and

Activities was founded in 1976 by Christopher Benninger and his wife and colleague, Aneeta Gokhale, with Barbara Ward as the Founder Patron. Through the medium of the Delos Group, Margaret Mead, Buckminster Fuller, Arnold Toynby and others contributed to formulating the founding principles of the Centre, which instigates and analyses development work throughout India, Bhutan, Sri Lanka and Nepal. An autonomous centre for advanced studies of Poona University, sponsored by the Indian Council of Social Science Research, it carries out research and advisory functions for community groups, development authorities, financial institutions, the UNO and the ministries of national governments. A two-year postgraduate programme in development planning and management, sponsored by the CDSA, is based on the campus, and attended by students

from Africa, America, Asia and Europe.

ith Independence, India became free, and the pace of transformation hastened. Urbanization, industrialization, and the introduction of high technology all placed new pressures on a growing, multi-racial, multi-linguistic nation. Pandit Nehru pondered a new society with the new purposes of secularism, planned progress, and constitutional rights. As architectural artefacts reflect the intentions of each era, so research institutions emerged in the subcontinent, reflecting the intentions of this new society, whose purpose is symbolized more by a question mark, than by an exclamation. If previous societies were characterized by a sure direction towards a vision of the future. India is characterized by a search, and a re-search for what it is, and what it wants to be.

The Centre for Development Studies and Activities (CDSA), Poona, is one such expression of this great quest. Rather than a laboratory of experimentation, it is a place of exploration and reflection on the great laboratory that is India. The villages, towns and regions are a complex socioeconomic context, from which the Institute gathers information, analyses it, and attempts to improve the emerging development scenario. Most of the Centre's work is field-based, and action-orientated. The campus is a place of retreat, analysis, debate, intellectual

 View up the hillock towards the eastfacing elevation of the Institute for Rural Development.

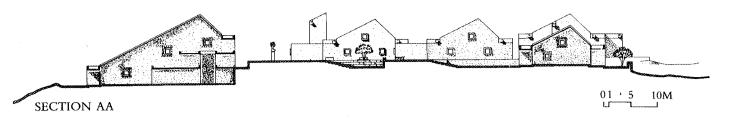
proposition; and for the preparation of proposals for action.

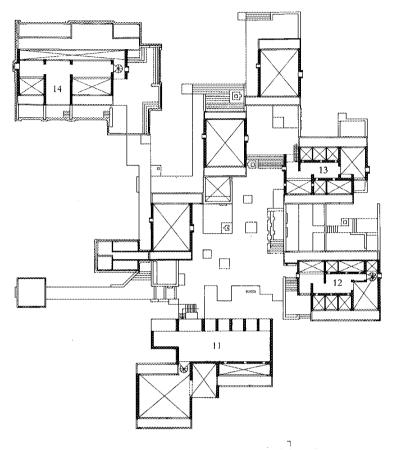
Unlike cultural artefacts of the past, which reflected a Utopia, or a slice of paradise, the environment at the CDSA campus is an enclave which represents just one possible arrangement. But it is not a passive reflection; it is an intended response, which expresses the concepts of sustainable environment through its forest and orchard, planted on its one-time wasteland site; in the water harvesting of the hillside; in the use of local materials; and in the crafting of structures by local artisans.

The Centre is located on the periphery of Poona, an industrial and educational centre in western India with about two million inhabitants. The climate of Poona, about 200 metres above sea level, is mild the year round, except for a hot period in April. During the rest of the year it is either rainy, during May to September, or balmy, from October to March. A great deal of the life of the Institute therefore takes place out-of-doors, or under semi-enclosed spaces. The campus sits on a terrace, along the fall of a hill, where the slopes of India's Western Ghat Mountains meet the great plains of the Deccan Plateau. Such a location provides vistas up into the mountains, or down a valley to the city.

A fabric of build has emerged from the assemblage of three generic elements. Stone, which has been cleared off the land, where terraces are planted with orchards, forms a strong pattern of east-west parallel walls. They shade the interiors from the southern sun, and are punctured by framed views into the bucolic valley below. Reflecting the ancient terraces of the region, the walls provide a clear structure to the fabric.

The north-south enclosing elements are of transparent sliding panels, shaded by large verandahs. These screens can be adjusted in individual spaces to regulate the breeze; hence there are no electric fans in the complex. They also provide





#### MEZZANINE FLOOR

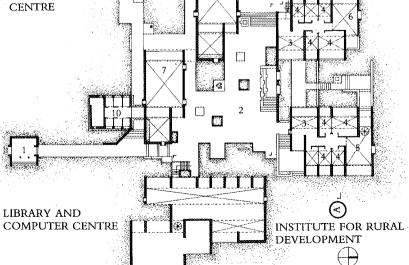
- 1 ENTRANCE
- 2 ACADEMIC QUADRANGLE
- 3 OFFICE
- 4 STUDY

SCHOOL FOR DEVELOPMENT

PLANNING

- 5 SEMINAR
- 6 DIRECTOR
- 7 CLASS ROOM
- 8 DINING ROOM
- 9 KITCHEN
- 10 WET CORE
- 11 COMPUTER LABORATORY
- 12 STUDIO
- 13 ADMINISTRATION
- 14 RECREATION





SEMINAR

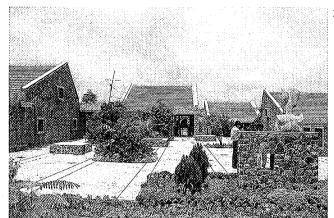
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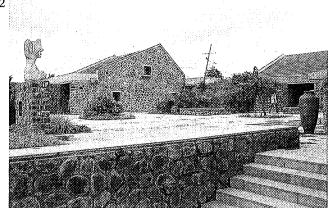
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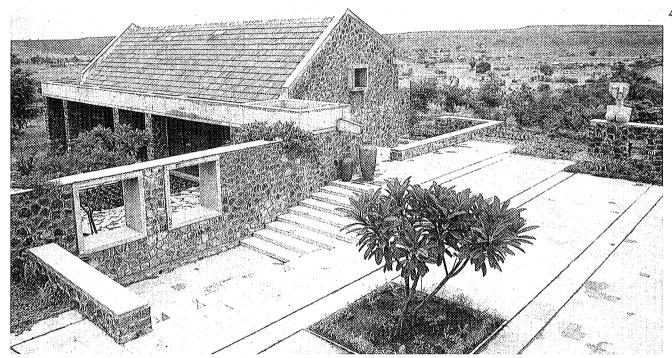
**GROUND FLOOR** 

32 MIMAR 37

#### BUILDINGS FOR HIGHER EDUCATION AND RESEARCH







energy-free lighting during the day.

The third element is that of tile roofs, which slope more steeply towards the west, from whence strong winds blow, bearing the heavy monsoon rains off the Arabian sea. Facing east, they slope more gently against the delicate morning sun. This asymmetry, which is used throughout the fabric, reflects the thoughtful mind which is always wondering. The three elements are held together by a system of courts, or chowks, stone stairs and paved pathways. Staggered steps, sitting blocks, or ottas and lotus ponds all reflect local forms of space moulding, common in the village squares, mosque courtyards, and temples of this mountainous region.

All of the elements are patterned into a language in which functional spaces can be conceived of as nouns, and visual-spatial links become the verbs, connecting the whole into various graphic ideas, which change their tone of meaning with the variable light of day, and the transforming colours of the seasons.

2. The academic quadrangle is arranged around a podium. (This view is looking towards the west.)

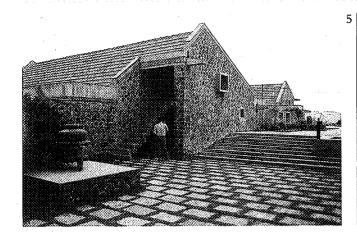
3. A view from the entrance forecourt of the Institute for Rural Development across a podium towards the classroom.

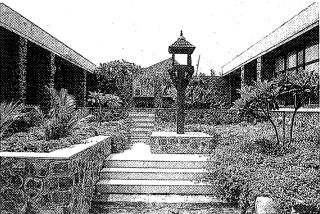
4. Kund-like steps demarcate, and create an informal place to sit. (This view is looking towards the east.)

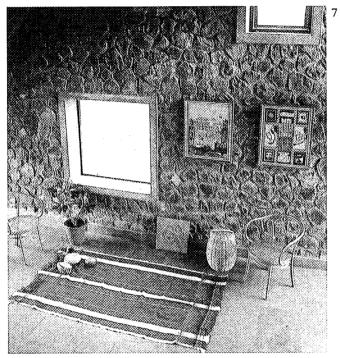
Every institution has two contradictory aspects: its rituals and its aspirations. The rituals bring order into an architectural expression, but they can also be negative influences, in that they foster bureaucracy and stifle aspiration. So, as a counterpoint to order, there must also be mystical elements, which invoke the spirit and call out to it to be free. At the Centre, a number of devices make an entreaty to the habitués to stop 'seeing', and to 'be'. A wall which encloses, which defines, is unexpectedly interrupted by an opening, revealing the sky, clouds, hills,

villages, and the city beyond. There is a kind of rhythm between that which is sure, and that which is fleeting. The presence of pattern, of proportion, and of texture provide a constant sense of consistency, but then there are no boundaries. Just when one feels one is enclosed by nurturing roofs, one realizes it was a prelude to an invitation to the mind, to look out, away from one's self, and to contemplate the cosmos. These physical devices, which link the day-today work of the Centre to the spiritual, evoke the ideology of the institution, which calls upon each member to think freely, but also to make some contribution to his context, his society. Rather than a tight lattice of order, which holds things together, the lattice is used as a pattern out of which individual perogatives emerge. Some platforms are created ostencibly for an ancient brass pot to sit on, or as a base for an antique bird feeder. But these mechanisms are in fact used to attract the mind away from the core of the institute, where daily tasks, and the details of work,

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could overpower one's creative energies.

The internal spaces are closely linked with the external ones, beyond transparent screens, through verandahs, extended porches, and platforms. Under the tile, polished teak ceilings radiate a warm sense of shelter, and their slopes focus spaces inward, while the wandering eye steals distant illusions. Seminar rooms, studios, and entrance halls are double-storeyed, the upper portion often merging into a mezzanine, or higher floor space. Glass fenestration allows views through other structures, and an openness prevails. One can see what activities are taking place, yet one can claim authority over one's own privacy. This openness reveals the deep-rooted meaning of the Institute, in which the liberated mind searches for the resolution of specific problems, often through team-work, or through the exchange of ideas.

The landscaping, furniture, interiors, structures and much of the artwork, have been created by the Institute's own members. Thus, the research/action concerns

5. View across the lower court to the entrance of the School for Development Planning. An ancient brass pot acts as a focal point, around which spaces re-orient as the eye moves.

6. View between the School of Development Planning and the Institute for Habitat and Environment, towards the 'illusionary' windows into the podium. In the centre is the bird-feeder or chabutra.

7. The Director's meeting area, from the balcony in the mezzanine floor.

of the Institute range from the design of very small artefacts required in everyday life (like drawer handles, or light switches), to regional plans, and national policies which temper macro- development.

The Centre houses a major collection of Rajput and Mogul miniature paintings, silk screens by Balakrishna Doshi, ancient bronze statues, and concrete reliefs by Christopher Benninger. A statue presides over the main podium, sculptured by the famous Indian artist Piraji Sagara. Its body

represents what is nurturing, and its eyes, looking up to the sky, represent the search for wisdom. People at the Institute call it 'Karuna', which means in Sanskrit 'wisdom tempered by compassion', which is the guiding spirit of the Centre.

Construction, which began in 1988, is ongoing, and in the near future the library and computer centre will be initiated.

PHOTOGRAPHS BY NIKITA OAK

CHRISTOPHER C. BENNINGER STUDIED ARCHITECTURE AT THE UNIVERSITY OF FLORIDA AND AT HARVARD UNIVERSITY, AND THEN STUDIED URBAN AND SOCIAL POLICY AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY. HE TAUGHT AT THE SCHOOL OF ARCHITECTURE (AHMEDABAD), AND LATER AT HARVARD (1969-71), AND HE INITIATED THE SCHOOL OF PLANNING AT AHMEDABAD WITH BALAKRISHNA DOSHI (1971). HE ACTS AS AN ADVISOR TO DEVELOPMENT AGENCIES, SUCH AS UNCHS (HABITAT), THE WORLD BANK, THE ASIAN DEVELOPMENT BANK, UNFAO, AND UNICEF.

# ISLAMIC CENTRE FOR TECHNICAL AND VOCATIONAL TRAINING AND RESEARCH

#### DHAKA

Abu H. Imamuddin

Project Data

Location: 30 km north of Dhaka. Client: The Organization of the Islamic Conference.

Architectural Design: Mehmet Doruk Pamir & Ercüment Gümrük Associates STYDUI 14, Ankara, Turkey.

Project Manager: Gültekin Aktuna. Infrastructural and Engineering Design: HES Engineering Consultants Ltd. Ankara, Turkey. Shaheedullah Associates Ltd., Dhaka (working drawings for Mosque). Specification and Tender Documents: Development and Design Consultants Ltd, Dhaka.

Project Engineer: Azharul Haque. Contractors: Nirman International Ltd. and National Construction Co. Ltd. Omarsons Bangladesh Ltd. Site Area: 125,457 Square metres

Building Area: 33,300 Square metres (358500 sq.ft).

Cost: US \$ 11 million. Completion: 1987.

(31 Acres).

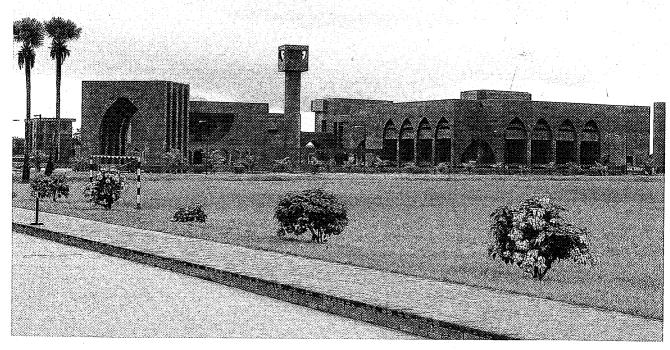
he Islamic Centre for Technical and Vocational Training and Research (ICTVTR), Dhaka, Bangladesh, began its academic programme in 1985. The Centre developed as a subsidiary organ of the Organization of the Islamic Conference (OIC), with the primary objective of upgrading mid-level manpower by improving technical know-how and promoting research for the general well-being of the people in the Islamic world. The project was funded by the joint contributions of OIC member countries. The teaching staff, students and trainees are also recruited from the member countries.

The centre consists of three departments: The Department of Mechanical and Chemical Engineering, the Department of Electrical and Electronic Engineering and The Department of Instructor Training and General Studies. Its enrolment capacity is 480. The academic programme ranges from short courses to higher diplomas.

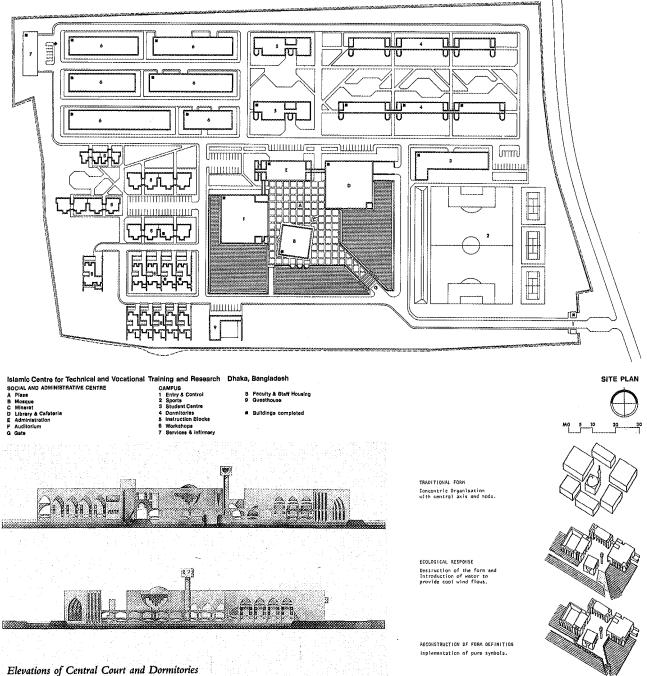
The ICTVTR Campus is located to the west of Dhaka-Mymemsingh Highway. From the playing field there is a panoramic view of the entire complex an ensemble of medium-rise structures built with reddish-brown brick in a tranquil sub-urban setting, with its ceremonial entrance gate, the Gate of the Five Fundamentals, in the foreground. The campus is, however, not yet complete. A number of student dormitories, one instruction block, a student centre and gymnasium, a faculty club and much of the faculty residences which were a part of the master plan will be built in the next phases. Yet in its present state the campus looks complete, by virtue of the planning of construction phases starting with those buildings in the centre and moving towards those on the periphery.

The complex has a strong architectural

1. View of the campus from the road, showing the entrance.



**JORUK PAMIR** 

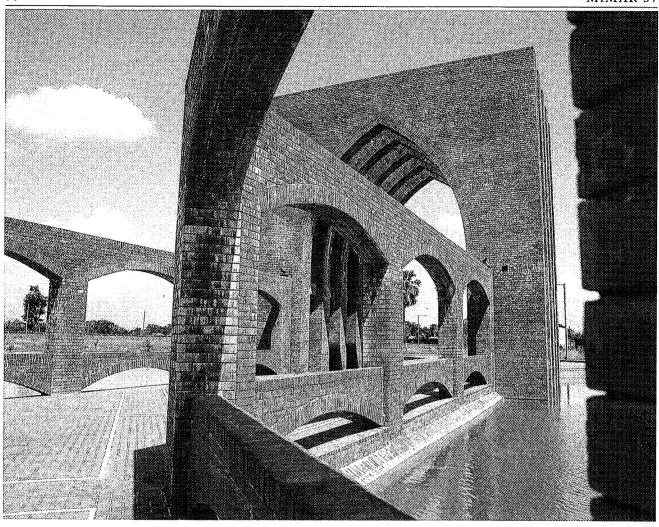


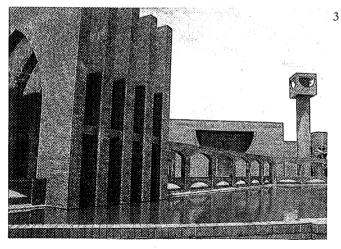
order derived from the Külliye of Turkish Ottoman architecture, in which structures for collective activities are clustered around a spiritual node. The plan generates from a central court which is commonly found both in Muslim civic architecture and in local tradition. The court is developed as the central core of the campus, around which are arranged the administrative building with 465 square metres of exhibition space of the north, an auditorium with a capacity of 500 on the west, a cafeteria-cum-library on the east and a freestanding mosque on the south, positioned at an odd angle to the other buildings and facing the qibla. The cubic volume of the mosque, with its 21 metre-high minaret, is the only

isolated entity which acts as a focal point, while the other three buildings are connected to one another. The court is defined by a delicate arcade on the south and east, beyond which there is a pool of water surrounding its three sides. The pool acts as a climate modifier and a reflecting surface and also serves the symbolic purpose of spiritual purification for those who pass through the ceremonial gate towards the mosque. There are three other pedestrian gates to the court. The Gate of Knowledge connects the instructional blocks and the dormitories; the Gate of Learning links the workshops and the Gate of Instruction connects the faculty residences. Vehicular circulation is around

the central zone. Roadways also link the instructional block on the north with the student's dormitories and workshops. Housing for the faculty members is arranged to the south-west of the campus, - an appropriate distance from buildings for student activities - and it is approached by a separate road from the ceremonial gate.

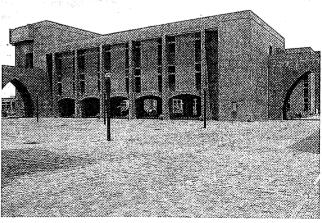
As an international centre, the campus receives students from diverse geographical areas and socio-cultural backgrounds. Moreover, ages of students and trainees vary widely, between 16 and 50 years. Religion is their only common bond. The architectural order and discipline underlying the design of the campus has a great psychological impact

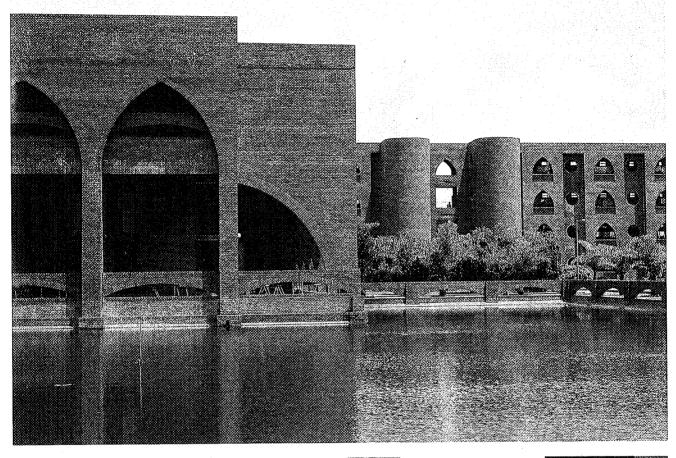




- 2. Colonnade. Water in moats reflects and acts as a microclimatic coolant for breezes.
- 3. The ceremonial entrance to the campus the Gate of the Five Fundamentals, with the mosque behind.
- 4. The northern facade of the hostel blocks
   in complete opposition in its treatment
  of openings to the southern facade (6).
- 5. The stark rigidity of the central court, with the Gate of Knowledge on the rights and the Gate of Learning on the left.



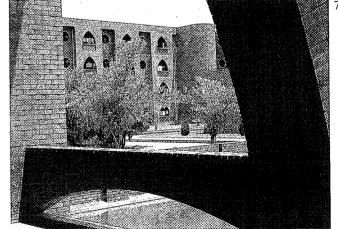


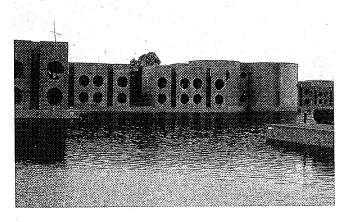


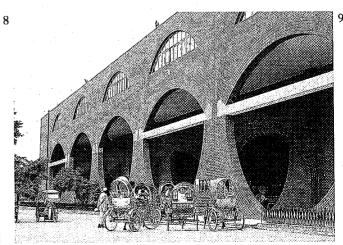
6. The reflecting moat and, beyond, the southern facade of the hostel blocks.

#### 7. Detail of the arched buttressing.

8 and 9. The use of exposed brick and circular openings in the ICTVTR is evocative of Louis I Kahn's Sher-e-Bangla Nagar, Dhaka (left) and his Cardiac Hospital, Dhaka (right).







upon the students. The formal nature of the campus is viewed by one senior member of the faculty as a physical manifestation of the discipline in Islamic lifestyle and living, which has helped to regulate campus life and bring social order to the students and trainees.

Students take pride in the architectural design and generally find the campus homely and secure. They refer to the water body and the green areas of the campus as the most attractive parts. However, the stark, formal central court and the forecourt of the mosque remain uninviting to them and those are the spaces that are less well used. Criticism can be broadly classified into two categories - inadequate climatic adaptation and inappropriate organization of internal spaces. The first problem is indeed very serious in some places and easily adaptable solutions are hard to find; the second problem emerged from communication gaps at the programme level which affected the socio-functional inadequacies. General opinion is that the designers, being non-locals, were not fully aware of the prevailing climatic problems and social context of space use.

Despite some of the limitations and constraints, the ICTVTR project reflects the deep sensitivity of the architects and their respect for local technology,

materials and scale. The project is one of the few designs in Bangladesh that evokes a deeper meaning and understanding of architecture. In the formulation of the concept, the architects appear to have been open to a wide range of ideas and influences of local, regional, Islamic, modern and traditional designs, and applied them according to their own creative will. The organization around a courtyard, the reflecting pool, the decorative arches and the space - defining arcade, together with the rationalized and streamlined forms and openings, generated an architecture which appears formal yet is informal in organization; monumental yet humane in volume; regional yet universal in pattern; and traditional yet modern in ambience. The mastery with which these polarities have been reconciled into a unified whole, creating an environment of variety and diversity within a given order, is the particular strength of this design.

The ICTVTR project is, indeed, unique in many ways, and yet it has qualities

10. A view of the faculty housing.

Opposite: The mosque. Despite its prominent location, it is not treated as an overpowering monument, but a genial structure.

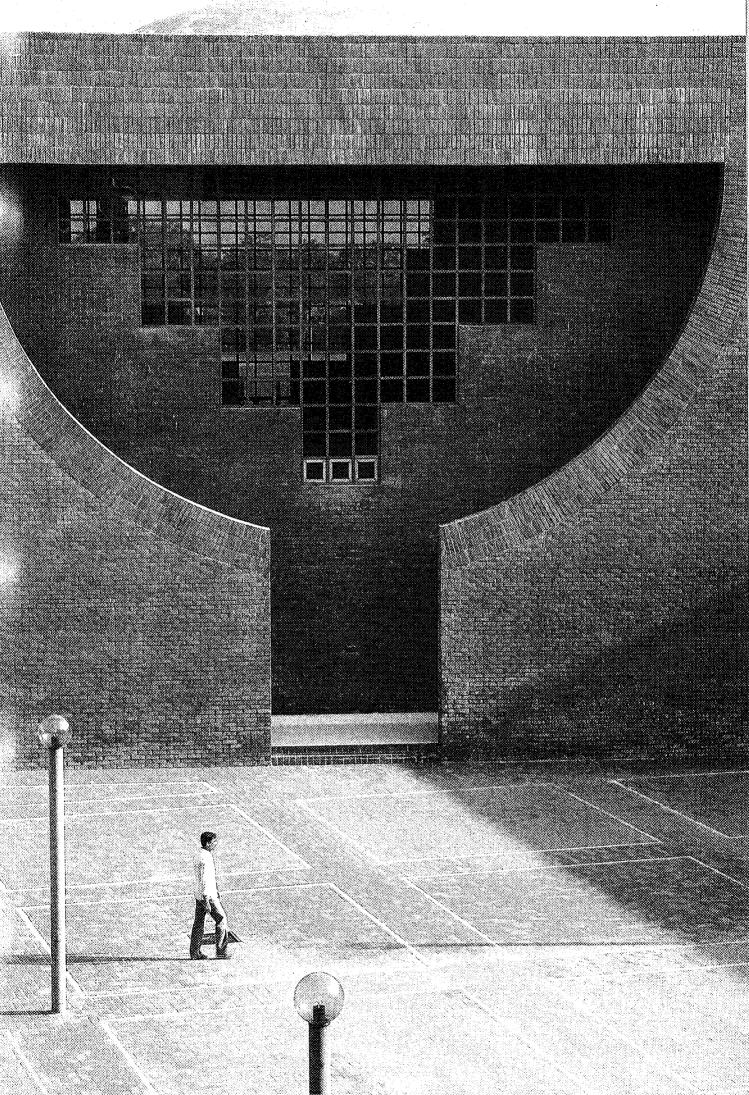
comparable with Louis I. Kahn's Capitol Complex at Sher-e-Bangla Nagar, Dhaka. The large scale, exclusive use of exposed brick structures and circular openings in brick suggest Kahn's immediate influence. The relationship is, however, much more fundamental. Centralized grouping of the prime functions in dominant building masses, isolating them with a water body like a moat, placing the mosque at an odd angle in plan, creating a double-layered façade and using semi-circular and circular forms in brick, are some of the striking similarities. Nevertheless, they do not merely represent an array of ideas for morphological characteristics; embedded in them is a strong philosophy, shared by both architects, of building civic architecture and developing institutions with a human scale.

Architects in Bangladesh see this project as a strong contribution to the contemporary architecture of the country. Its intellectual and philosophical basis will continue to inspire further studies, analysis and interpretations.

PHOTOGRAPHS BY THE AUTHOR EXCEPT WHERE OTHERWISE STATED.

ABU H. IMAMUDDIN IS PROFESSOR OF ARCHITECTURE AT THE BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA.





## LAHORE UNIVERSITY OF MANAGEMENT SCIENCES

#### Murlidhar Dawani

#### Project Data

Client: The National Management

Architects: Habib Fida Ali, Husnain Lotia, Ali Naqvi, Mansoor Ghanchi Structural Consultants: Progressive Consultants, Lahore.

Electrical Consultants: M. Ayub and Associates, Karachi.

Mechanical Consultants: A. Saadat and Company, Karachi.

Phase I: Academic Block, Student Housing (3 blocks).

Site Area: 60 acres.

Academic Block Area: 150,000 sq. ft. Student Housing Area:

13,156 x 3 floor = 39,468 sq. ft. 39,468 x 3 block = 118,404 sq. ft. Cost: Rupees 150 million = US\$ 6.50 million.

Completion: Phase I: Academic block, Student housing (3 blocks): 1992.

he Lahore University of Management Sciences, a privately funded and run University devoted to Management and Business Administration is currently located in rented premises in Gulberg, a residential but increasingly commerical suburb of Lahore. To fulfil their aims in establishing a centre of excellence rivalling the finest in the world, the University acquired a parcel of land of some 60 acres on the outskirts of the city.

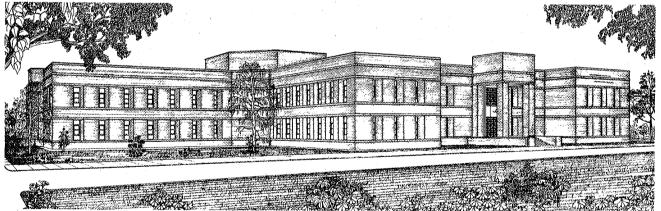
The plot of land has been divided roughly into three major parallel sectors. The central sector is the teaching area, with the Graduate School of Business Administration in the first phase to be built now, and space for future faculties all around it. To one side is the student housing, and on the other, housing for faculty and staff.

Construction will begin in December

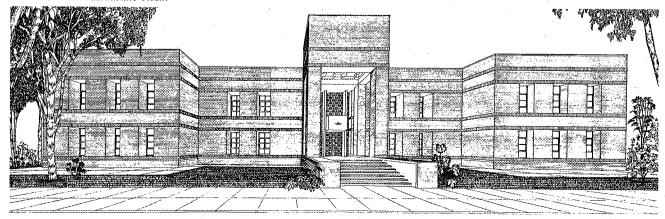
1990. The first phase of development includes the Graduate School of Business Administration and the Executive Development Centre, which offers intensive short duration specialized courses for business executives and working professionals.

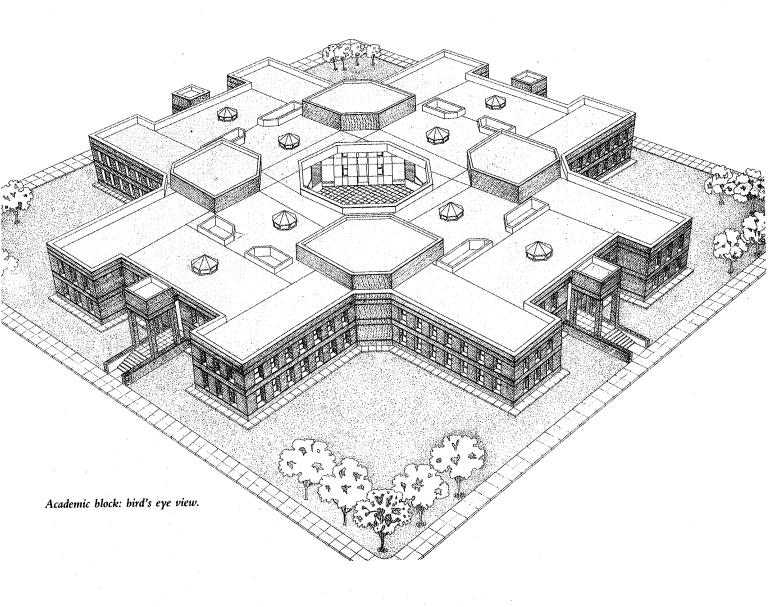
The GSBA is located in a large two-storeyed 150,000 square foot building. Cruciform in shape, this building comprises the business school featuring lecture halls, discussion rooms, faculty offices, cafeteria, as well as the university's administrative areas. These areas, separated according to function, are in four wings grouped around a central courtyard. Housing blocks for some 200 students will also be built in the first phase. A typical block, two and three storeys, consists of single rooms arranged around courtyards.

All the buildings are planned as low rise



Above & below: Academic block.





low slung structures, to offer the minimum visual bulk to the flat green landscape of tilled fields around. Reinforced concrete frames clad totally in locally available brick, coupled with the varying heights of the different buildings, will evoke, it is expected, images of the rural landscape of closely massed red brick forms rising out of a brilliant green, billiard-table-flat base, so typical to the rural scene of the Punjab.

Habib Fida Ali

pakistan is to acknowledge and appreciate prevailing modern ideas, while exploring the notion of regionalism and vernacular tradition. The majority of buildings in Pakistan lack character and continuity with the past, and are not appropriate to the local society and culture. Among professionals there is

a serious intent to embark on traditional vocabularies and at the same time reflect current modernity.

Habib Fida Ali's University of Management Sciences in Lahore is a significant step forward in the development of an architectural vocabulary characterized by local tradition and conscious of its modernity. A devotee of the Le Corbusier brand of architecture for over 20 years, Habib Fida Ali has finally discovered his roots. The recent influence of architects such as Luis Barragan of Mexico and Geoffrey Bawa of Sri Lanka, and his experience as a member of the Aga Khan master jury in 1983, have changed his ideas about architectural theory. The new project uses a blend of western technology and local materials and tradition.

The influence of regionalism in architecture, which is an increasingly important issue in developing countries,

is a natural response to western hegemony. It is part of a broader movement towards greater cultural awareness. In this context the modernist values of Habib Fida Ali are a good influence. Habib Fida Ali studied at the Architectural Association in London. He returned to Pakistan in 1963 after practising for a few years in London and joined the architectural firm of William Parry and Associates. In 1965 he established his own office. Until the midseventies his work was limited largely to higher income houses, interior designs, and relatively small-scale commercial projects.

Habib Fida Ali's first big opportunity came in 1975 when, after winning a limited competition, he was asked to design the head office for Pakistan Burmah Shell. The result was met with acclaim, and the building proved a turning point in his professional career.

Through this he identified a distinctive style. Fair-faced concrete façades, broken up by panels and grooves and windows, created substantial and monumental effects and were executed with excellent workmanship, fine detailing and a strong sense of proportion. This building became a hallmark of Pakistan's contemporary architecture and led Habib Fida Ali to design other large building projects, such as the National Bank Building in Quetta, the 120-room extension of Hotel Midway House at Karachi Airport, and a 13-storey Sui Gas head office in Lahore. He continued the style he set in the PBS building, characterized by a bold and clear expression of structure, and a deep understanding of modern materials, function and aesthetics.

Habib Fida Ali was commissioned in 1982 to design the University of Management Sciences, a prestigious institution consisting of an academic block, executive development centre,

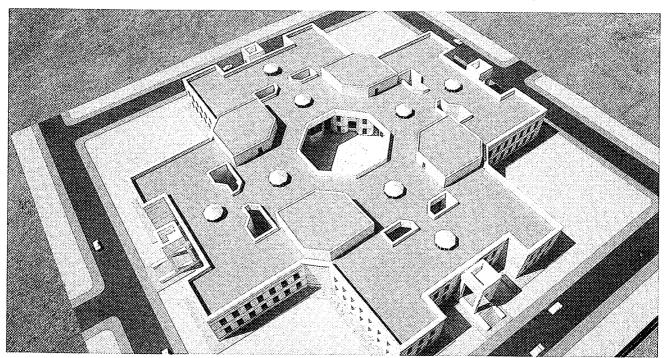
student housing, faculty housing, staff housing and a mosque to be built on a 67 acre site in the centre of Lahore. Here he had an opportunity to put into practice his fascination with the architectural tradition of the sub-continent.

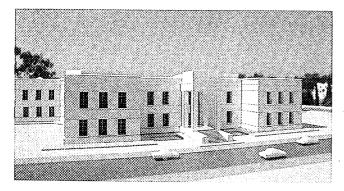
After winning the commission, he went to study the top management schools in different countries; not only to see the architecture but also to appreciate methods of teaching and the way in which they function. This helped him immensely in designing the University. He states, "The requirements for a management school were very specific; for example, classrooms, discussion rooms, the library, computer centre, reprographic centre, and the faculty and management area. Instead of separating them, which was very common, I have set them into one specific building. I wanted to have integration not only of the elements, which I have achieved through very strong form, but of the students and

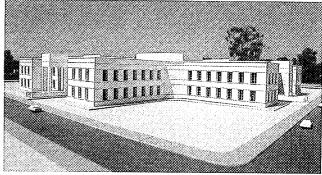
the faculty. This will create a pleasant and vigorous academic atmosphere and would be practical and functional too, as most of the spaces will be air-conditioned."

The handling of spaces, which divide the functions into four parts under the same roof, and the integration of open and partially covered courtyards, is excellent. They are not only the transitional spaces between air-conditioned and non airconditioned areas, but also a source of natural light and air in the building. The separation and incorporation of students. faculty, management, visitors and their activities is considered and accomplished beautifully. This is a current architectural expression that accommodates the prerequisites of modern life and enhances the cultural authenticity of the traditional environment of Lahore.

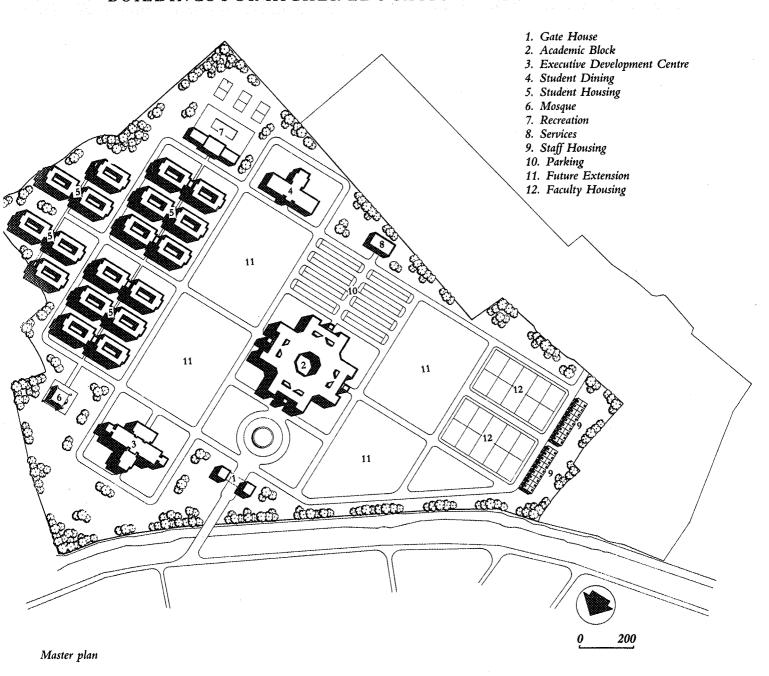
Habib Fida Ali, trained in the modernist tradition, has attempted to reflect historical tradition in a modern idiom. He has moved away from the PBS brand of







Three views of the model for the acedemic block, showing the cruciform shape formed by the four academic areas, grouped around a central courtyard, and the tall porticos.



international architecture and has come closer to home. The University of Management Sciences provides all the facilities required in a modern educational building. Yet, traditionally inspired elements such as form, courtyards, materials, and detailing have been carefully amalgamated to the design, which has captured the spirit of vernacular architecture and combined it with the present-day style.

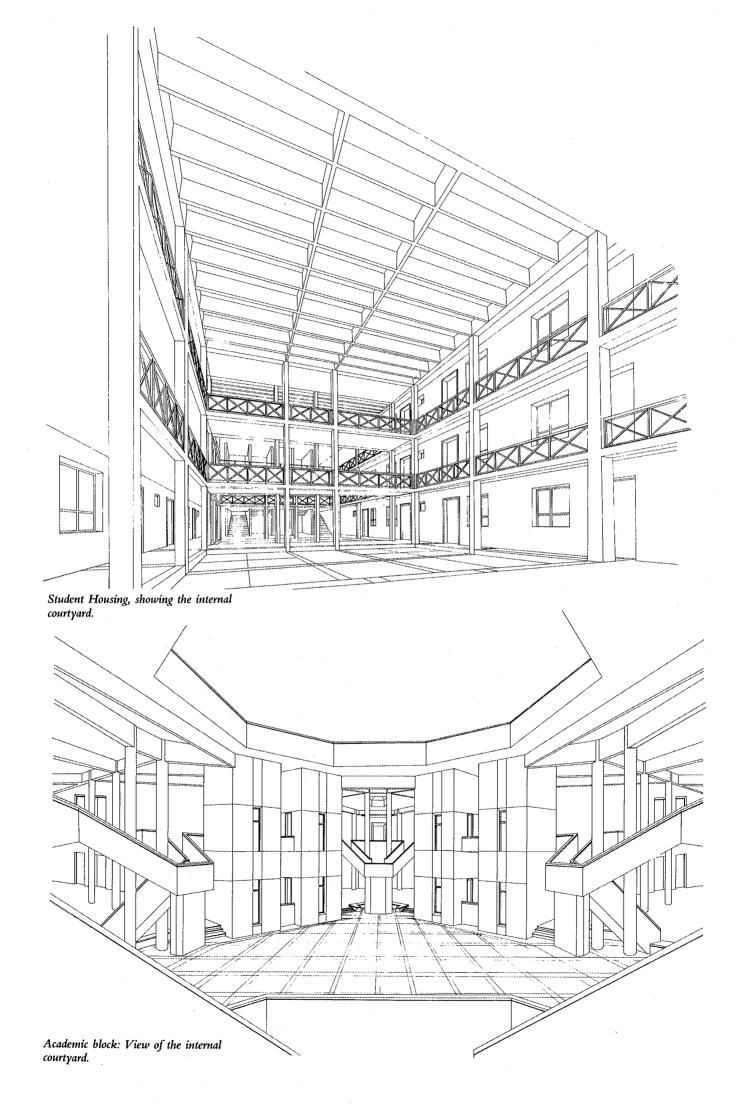
The school is essentially a cluster of semi-independent blocks assembled around the central courtyard. In developing an anomalous site, an axially-based layout has been followed, which has helped to regulate the site in a formal manner. It appears that the fundamental concept for the master plan has been the orientation of the mosque, which faces west. The business school is the largest

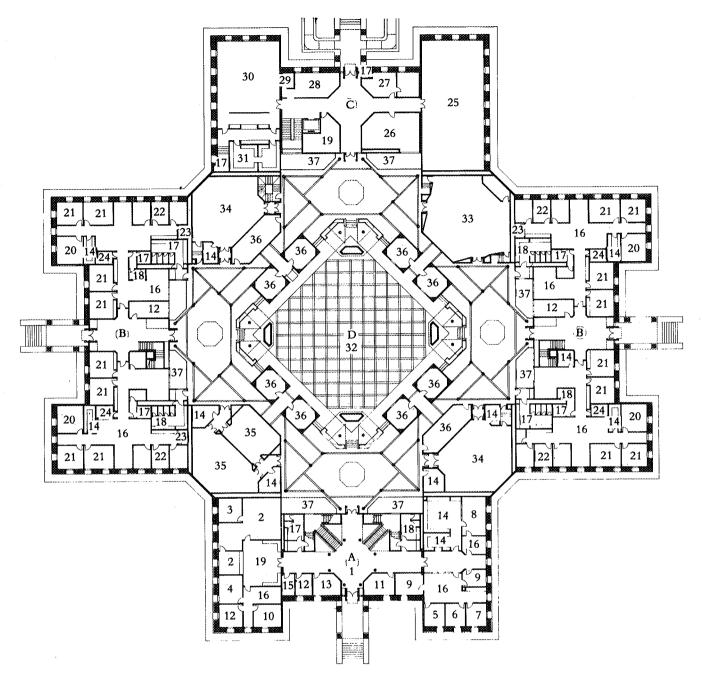
block and occupies a central location in the master plan.

Habib Fida Ali has designed this building seeking a built environment as an outcome of the culture, tradition and the physical, social, and economical resources of a society. A sympathy with the character of this region is expressed through traditional geometry following a strict symmetry. Here, for the first time in his work, Habib Fida Ali has not applied his theory that form should follow function.

This is a symmetrical form expressing the discipline and geometry in planning which further symbolizes the walled city's image and its four gates in four wings. The scale of Moghul architecture is respected by keeping the height of the buildings to two storeys. Since Lahore is a city of gardens, special consideration has been given to the outer and internal landscape. Covered, semi-covered, and open spaces with little ornamentation, are weaved around artistically in traditional brick, displaying greenery and water. This creates an agreeable social and intellectual environment, providing a pleasant atmosphere for informal gatherings and activities. The ingenuity of the design is that it fulfils function, environmental needs and academic goals and creates an uncomplicated environment with a new image without disguising the past.

MURLIDHAR DAWANI GRADUATED FROM DAWOOD COLLEGE OF ENGINEERING & TECHNOLOGY, KARACHI, IN 1986 AS AN ARCHITECT AND STARTED HIS CAREER AS A CONSULTANT. IN 1989 HE JOINED THE FACULTY OF DAWOOD COLLEGE. HE HAS CONTRIBUTED TO SEVERAL JOURNALS AND MAGAZINES IN THE COUNTRY.





#### Ground floor plan

#### A ADMINISTRATION BLOCK

- 1. Main Foyer
- 2. Accounts
- 3. Accounts Manager
- 4. Administration
- 5. Alumni Relation
- 6. Student Affairs
- 7. Placement Officer
- 8. External Relation Manager
- 9. Interview
- 10. Spare
- 11. Reception
- 12. Office
- 13. Telephone
- 14. Record/Staff
- 15. Battery Room
- 16. Secretary
- 17. Gents Toilet
- 18. Ladies Toilet
- 19. Lounge

#### B FACULTY WING

- 12. Office
- 14. Record/Store
- 16. Secretary
- 17. Gents Toilet
- 18. Ladies Toilet
- 20. Senior Faculty Office
- 21. Faculty Office
- 22. Research Cell
- 23. Copier
- 24. Pantry

#### C STUDENT CENTRE

- 17. Toilet
- 19. Lounge
- 25. Reprographic Centre
- 26. Archive
- 27. First Aid
- 28. Prayer Hall
- 29. Ablution
- 30. Dining
- 31. Kitchen

#### D CENTRAL COURT

- 14. Store
- 32. Central Forum
- 33. Auditorium
- 34. Main Lecture Hall
- 35. Mid Size Lecture Hall
- 36. Discussion Room
- 37. Open Court

### SULTAN QABOOS UNIVERSITY

#### OMAN

YRM International

#### Project Data

Location: Al Khwad, The Sultanate of Oman.

Client: The Government of Oman. Turnkey Contractor: Cementation International.

Architects/Building Services Engineering/ Interior Design: YRM International. Structural and Civil Engineering: Trafalgar House Engineering Services.

Landscape Consultants: Brian Clouston International, with Robert Adams.

Quantity Surveyor and Cost Consultant: D G Jones and Partners, Muscat, Oman. Acoustic Engineers: Sandy Brown Associates.

Site Area: 11 sq km Cost: £225m Completion: 1986.

he Sultanate of Oman lies to the south west of the Gulf of Oman, on the shores of the Arabian Sea, with Saudi Arabia, the United Arab Emirates, and South Yemen to the west. Since 1970 the Sultanate has been ruled by H M Sultan Qaboos Bin Said, who has taken his country into the twentieth century in little more than a decade. Educational facilities and health care have been strong priorities

in his government's five year plans. Facilities for education are seen not only as a means of increasing levels of literacy and technical competence, but also in fostering a greater sense of nationhood among Omani youth. The Sultan Qaboos University - the national university is intended to effect a comparable transformation at university level, making a significant contribution to the intellectual and cultural life of Oman and the Gulf, and helping to prevent the drain of Arab students to universities in the West. It is conceived as a world class technical university founded on both Omani and Islamic cultural and social traditions.

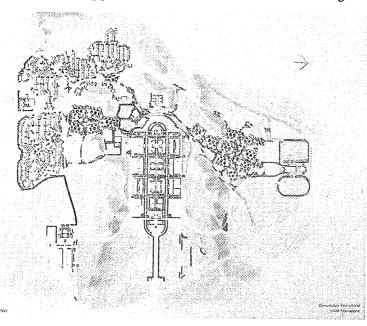
The nature of the project, requiring design and construction in a time span of only four years, demanded the type of contract arrangement in which the turnkey contractors would lead a multidisciplinary team in designing, constructing and equipping the project from inception to completion. In 1981, the Government of Oman approached Cementation International to become the turnkey contractors, and gave them six months in which to prepare a master plan for the proposed university. Cementation International, the overseas building and

civil engineering arm of the Trafalgar House Group, have been responsible for over 20 international hotels, bridges, housing developments, schools and industrial complexes.

Cementation International rapidly appointed YRM International, one of the few British practices able to provide planning, architectural, building services, engineering and interior design services under one roof. The company - the division of YRM Partnership Limited that handles overseas work - had already collaborated with Cementation International on a large medical project in Iran, and has experience both in the Middle East and in large educational projects including Warwick University in Britain, major facilities at Liverpool, Oxford and Cambridge and the master plan for the University of Ibadan, Nigeria.

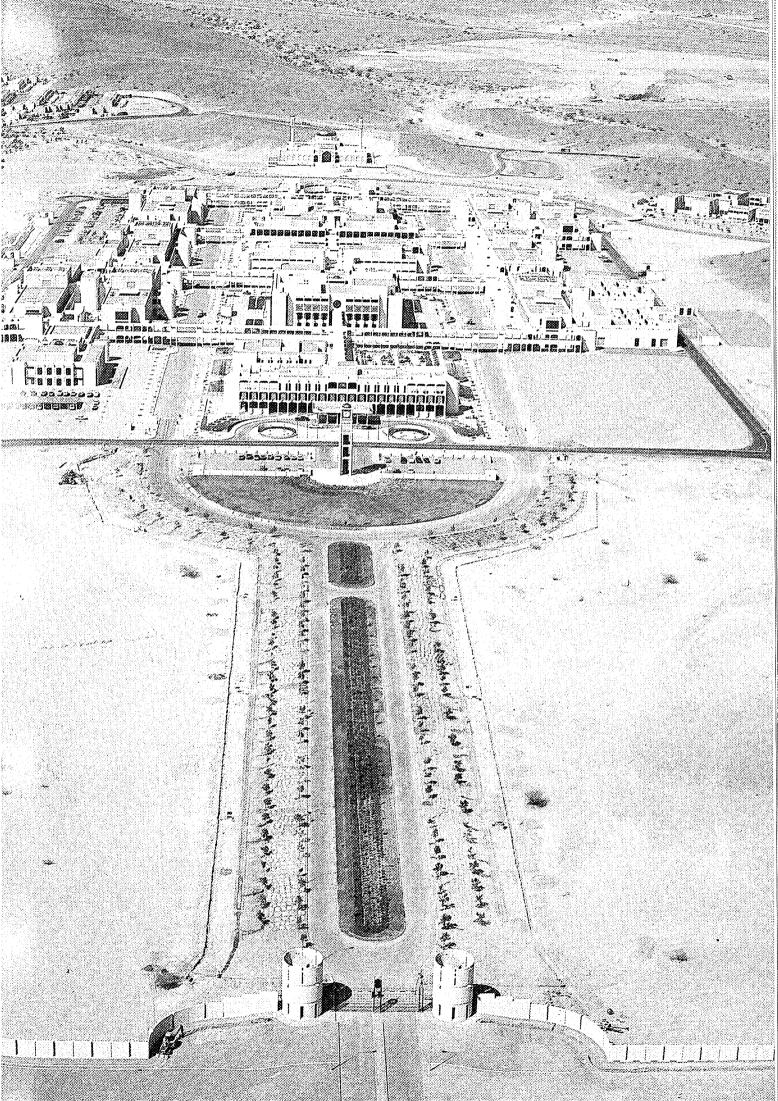
The briefing for and supervision of the project was the responsibility of the University Project Office, whose executive consisted of a Foundation Committee under the chairmanship of the Minister of Education and Youth Affairs, HEE Yahya Mahfoudh Al Manthri, with H E Sheik Amir Ali Ameir as Secretary General. These two key figures in Omani public affairs appointed a team of 1 academics from Oman, Britain, America and Egypt. The Foundation Committee's brief was for a campus university that would accommodate around 5,000 students, as part of a total campus population of around 10,000 people. A total of 250,000 square metres of university buildings was immediately required, including all common facilities and provision for the five academic disciplines as well as staff and segregated student accommodation, and allow for future expansion in a possible second phase of development.

Staff housing and student residences, being the quickest to design, came first, followed by the infrastructure of the university as a whole, the support facilities



#### 1. Master plan.

2. The university, from the air.



## BUILDINGS FOR HIGHER EDUCATION AND RESEARCH

and the central areas, which included the five faculty buildings and common facilities such as the library and the mosque. Furniture, fittings and equipment was the last package to be developed.

#### The Site

The chosen site was a shallow desert valley of rocky volcanic soil, bounded to the east and west by small wadis, and by gentle hills to the north and south. Here there was the potential to create a memorable environment for teaching or study — a place where modern university buildings might be imaginatively integrated into their natural surroundings.

The site lies 40 minutes' drive from the capital Muscat, with the lofty Jabal Alchbar mountains rising in the distance to the south, and a glimpse of the Gulf of Oman to the north. The land, of which only about a quarter was to be used for the campus, formed an irregular rectangle enclosed by four roads. Two access routes to the university complex could easily be created, and water, gas and electricity were present at a reasonable distance.

The relationship between the buildings and the local topography was of primary importance to the designers. The site suggested a logic for the layout of the university which was both elegant and functional. As the direction of the bowl valley gave the exact line to Mecca, some of the university buildings could be symbolically aligned along its centre, with the remainder sweeping away up the hillsides.

A close examination of the natural features revealed that it would be possible to place the academic nucleus of the university along the length of the valley. The mosque was positioned at a slightly higher level at the western end of the principle axis — detached from the academic area, but linked to it by paved footpaths across the lower ground between.

The surrounding natural valleys gave the designers the opportunity to separate the staff housing and student residences from the central spine of academic buildings without totally cutting them off. It also made it possible to arrange the residential areas more informally, setting them in the landscape and thus creating a sense of privacy and seclusion appropriate to their role on the campus. It was clearly logical to place the accommodation within easy walking distance of the academic area but away from the busy entrance to the university. Therefore the staff housing, with its own central amenity area, lies to the west and south of the site - further from the university than the more compact student accommodation which is situated to the north and to the south.

By the same reasoning, recreation and other ancillary facilities, as well as the service and support zone, could be restricted to the perimeter of the complex. The amphitheatre was cut into a fold of the hillside near the entrance to the university where it was highly visible and where large numbers of visitors could easily gather.

The site allowed YRM to design both for the university's present needs, and for potential future ones. The design plan provided for a linear growth pattern in the major common academic facilities, extending along the deep east-west axis of the central area, and for lateral expansion in some of the faculty buildings which flanked them.

YRM's response to the demands of designing a development of this complexity on a virgin site was influenced by the physical characteristics of the area, the climate, Omani traditions and culture, and the rigorous demands of the building programme.

The Oman climate is harsh, and for much of the year the heat and sun are unrelenting. The buildings are placed so that their main openings are on the north and south faces, avoiding the entry of direct sun and, in the case of the housing, allowing breezes to flow through the rooms during the cooler months. Positioning also takes account of the danger of flooding during one of Oman's dramatic rainstorms, and the comprehensive system of drainage channels is treated as a significant feature. The channels have been carefully designed: some are up to three metres deep and lined with stone pitching; others are very shallow and serve a double function - also acting as pedestrian routes.

YRM International's response to Omani and general Arabic traditions and culture is shown in the frequent use of courtyards, small windows and gargoyles throughout the campus, and in the provision of separate pedestrian routes for male and female students. The predominant Omani architectural feature in the academic area is a flat arch supported on cruciform concrete columns. For the mosque, however, a three-centred arch form has been adopted.

The massive requirement to construct 250,000 square metres of buildings of various forms and degrees of complexity in four years also affected construction. Building systems had to be specially developed and involved the repeated use of sophisticated steel shutters and forms. As a result it was possible to erect the reinforced concrete structures with considerable speed over the site, consequently allowing the time-consuming activities of finishing and servicing the buildings to begin as early as possible.

The Central Academic Area & Mosque The Central Academic Area is the heart of the University. It comprises the five colleges and their shared facilities.

The colleges occupy the north and south edges of the Central Area, flanking the central spine of the common facilities. This part of the campus is bound together by a two-level walkway system, which passes between, and sometimes through, the buildings, providing segregated access to both colleges and common facilities.

The colleges are similar in construction, but each is given its own identity by form and colour. Balustrades to access galleries are painted white; behind them the walls of the colleges themselves are clad in beige-coloured tiles. The buildings are painted off-white with dark bronze aluminium window frames and main doors.

The buildings housing the common facilities are richer in form than those for the colleges, as befits their role in the life of the university. The first of these grander structures – the administration building – is seen as one approaches through the main gate along the formal tree-lined avenue. Approached by ramped drives, it affords views under and through the building to the landscaped courts.

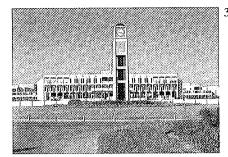
The Indian sandstone-clad university clock tower rises from a stepped stone base on the lawn in front of the administration building. Five bells sound the Westminster chimes and were cast at the Whitechapel Bell Foundry in London. The specially commissioned clock has four illuminated faces, with hands and subdivisions detailed in black and gold leaf.

Moving westwards along the central avenue, the next building is the Faculty Club – which has dining and recreation facilities for faculty members and residential accommodation for visiting academics. The club faces across an open landscaped court to an elegantly designed sun-dial.

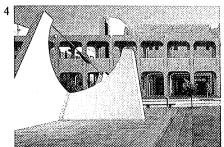
Further west lies the library. It is an impressive three-storey building traversed by the two-level pedestrian route. A double height colonnade on all four sides of the square structure carries its upper floor, which is façed in red sandstone, with large circular stained-glass windows on the east and west facades. Pedestrians using the route through the building pass into a spectacular three-storey void at its centre, which has been treated in a formal sculptural way to dramatic effect.

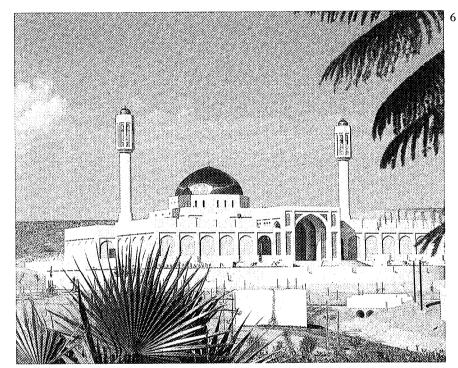
Beyond the library are the common teaching buildings, providing 108 classrooms in four three-storey wings placed symmetrically around the central walkway. Access from these wings to the classrooms is by screened galleries similar to those found in the college buildings, though here the inner walls are clad in

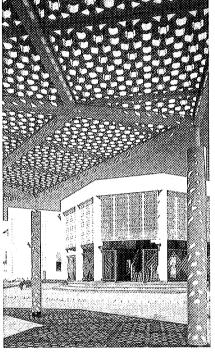
# BUILDINGS FOR HIGHER EDUCATION AND RESEARCH











3. The clock tower, with the administrative building behind.4. The university library.5. A sun-dial, with faculty buildings behind.6. The mosque.7. Student residences.

dark brown tiles. The classroom blocks enclose two courtyards in which sits a further block containing four 150-seat lecture theatres and the single 450-seat theatre. The latter is octagonal in plan, with curved raked seating.

Further west again is the conference and cultural centre — complex of four buildings all approached from a common central point. These buildings, like the lecture theatres, are clad in pale pink dholpur sandstone from India. The conference hall is a ground-level space with a clear roof span of 25 metres and, as in the larger lecture theatre, the concrete ribs forming the structure of its roof are clearly expressed, with infil panels of decorative fibrous plaster.

Students' needs are catered for in the student centre which concludes the spine of academic buildings to the east. Its north and south sides face into a landscaped garden, and its eastern end is semi-circular and opens up on its central axis to give marvellous views of the mosque.

The mosque, set against a backdrop of low hills, with its twin minarets and huge dome, can be seen glinting in the sun from afar. It is clad in pink Indian sandstone, with more blue, turquoise and gold tiles and topped with polished gold metal to complement the clocktower at the opposite end of the central area's eastwest axis.

#### Accommodation

The staff housing resembles, from the air, a string of beads that has been allowed to settle into the contours of the land a few hundred metres west of the main university complex, with the larger community buildings (the family recreation centre and shops) as the focus in the middle. This apparently casual grouping of the houses enables small, local spaces with a domestic feel to be created within the housing area. Similarly, each home has a front and rear courtyard providing secluded and well shaded gardens for each household. These houses have been carefully designed to cope with the problems of climate. All face north/ south to minimize unwanted sunshine. Decorative sunscreens and slatted pergolas over a car space provide design features as well as valuable shade.

There are 570 houses in all, the largest being nine two-storey detached villas for senior academic staff, located on the base of a hillside. Next come a group of three different types of two-storey courtyard houses for other academic staff with either two or three bedrooms. These houses are arranged in short terraces — some straight and some staggered. Finally, located close to the support facilities there is accommodation for technical and maintenance staff in six two-storey buildings, with four one-bedroomed flats grouped to form a unit on each floor.

The student residences are grouped like the staff housing, in a comparatively free and informal way, and each group responds to the character of the land around it. A variety of different enclosed and semi-enclosed external spaces has been created by a combination of the use of architecture and landscaping; the aim being to differentiate the halls, and encourage some friendly scholastic and social competition — much as a collegiate university does. Each residential building is self-contained, with its own enclosed courtyards, providing quiet contemplative gardens with water features.



# LEARNING FROM DISASTERS

# Yasemin Aysan

Natural disasters have claimed the lives of over three million people over the past two decades. As the first year of the International Decade for Natural Disaster Reduction draws to a close, Yasemin Aysan looks at natural disasters in the developing world and asks what lessons might be learned by architects and builders in reducing their catastrophic impact on the most vulnerable communities.

In the six hundredth year of Noah's life, in the second month, the seventeenth day of the month, the same day were all the fountains of the great deep broken up, and the windows of heaven were opened. And the rain was upon the earth forty days and forty nights. In the selfsame day entered Noah, ... the sons of Noah, and Noah's wife, and the three wives of his sons with him, into the ark ... And the waters prevailed, and were increased greatly upon the earth; and the ark went upon the face of the waters.

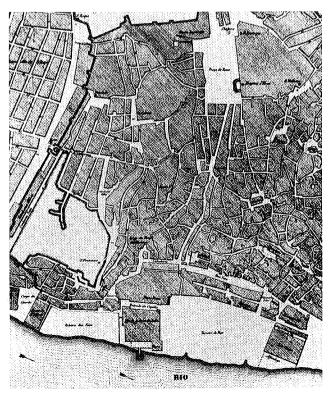
the historical evidence indicates that calamities and disasters have disrupted the lives of people and societies for centuries. Though detailed description of many of these events are fragmentary and slender, major disasters such as the eruption of Vesuvius (AD 79) described by the Roman historian Pliny, the great fire of London (1666), and the earthquakes of Taxila near Islamabad (AD 25), Istanbul (1509), Lisbon (1755), San Francisco (1906) and Tokyo (1923) are relatively well-known due to the scale of damage and loss of life. It can be argued that many of these events became the catalyst for new architectural and urban forms. Archaeological discoveries in Taxila indicated houses rebuilt after the earthquake with very deep foundations; the London building acts restricted wooden

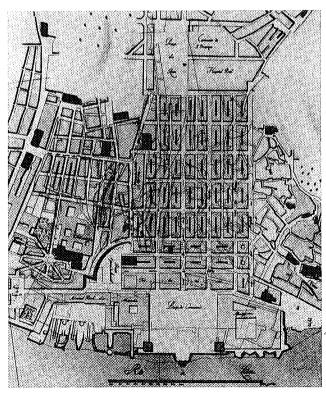
houses being built on narrow streets and introduced regulations for party walls in terrace houses. The most grandiose rebuilding schemes changed the centre of Lisbon from irregular narrow streets into large boulevards and squares. The reconstruction following such catastrophes also provided the medium for training of builders in implementing safe construction techniques. Following the 1509 earthquake in Istanbul, which destroyed over a thousand houses, 109 mosques, many caravanserais, medreses, baths, fortifications and large sections of Topkapi palace, the Sultan mobilized a large workforce of 66,000 labourers and 3.000 master craftsmen together with 11,000 assistants. Historians state that the transition from masonry to wood frame construction in Istanbul was a result of this earthquake1. Three centuries later,

the fires induced by the earthquake of 1855 in Bursa enforced the separation of houses and, this time, the use of masonry instead of timber frames for buildings where possible.

Many of the natural disasters of the twentieth century are much the same as those that have afflicted human kind since our beginnings. Earthquakes, floods, fires, volcanic eruptions and hurricanes continue to threaten lives and properties despite the experiences of centuries of calamities and post-disaster measures. The recent earthquakes in Iran, Armenia and Mexico; the floods in Andhra Pradesh and Bangladesh; hurricanes in the Caribbean

1. Lisbon before the 1755 earthquake and 30 years after, rebuilt on the lines of boulevards and squares. (Source: National Archives in Lisbon.)





- 2. Many engineered buildings, designed after Le Corbusier's 'construction on pilotis' principle collapsed after the 1980 El-Asnam earthquake in Algeria. Photo: Fatiha Haddar.
- 3. Poorly constructed concrete framed blocks of flats suffered damage during the Mexico earthquake of 1985.

resulted in human and economic losses far exceeding the impact of historical catastrophes. The unsettling question then is: Are these natural hazards increasing in numbers?

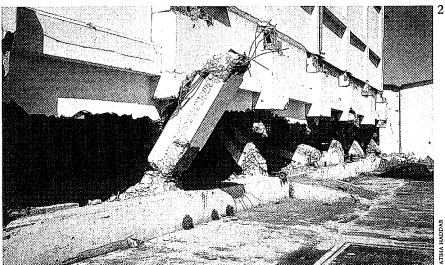
The most recent survey of disaster statistics clearly demonstrates that the average number of geologic, atmospheric and hydrologic disasters per year has not increased significantly<sup>2</sup>. There is not evidence, as yet, for a 'greenhouse effect' induced rise in sea level in the coastal regions of Bangladesh, or any indication of radical change in rainfall characteristics for Calcutta in the last 150 years which might have caused an increase in the severity of Ganges floods<sup>3</sup>. There is also no published evidence for a recent increase in the magnitude of floods or in sediment loads on the Ganges-Brahmaputra floodplains that can be attributed to the widespread assumption about Himalayan environmental degradation<sup>4</sup>. However, these are rightly held concerns and environmental impact studies certainly need to be undertaken to monitor the possible increase of future risks.

The answer to that unsettling question is more complex than it might appear. Reviews of the world situation indicate that while the number of disasters may not be increasing markedly, the catastrophic impact of these events in terms of loss of life is accelerating in developing countries (table 1). Increased vulnerability to disasters in the developing world is related not only to limited economic resources but also physical, socio-economic and ethnographic changes that have been taking place in these countries. In recent decades, there has been rapid population growth throughout the developing nations at an average growth of two to three per cent annually. This factor alone contributes to

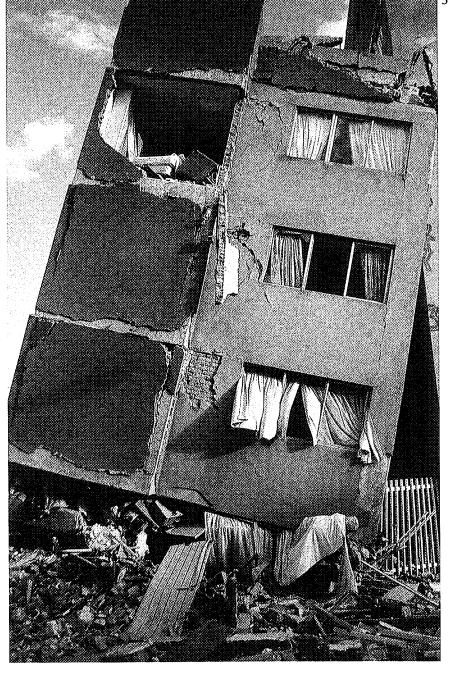
Table 1

Region	Deaths Per Million
North America	31.5
Europe	38.57
Central America/Caribbe	an 918.16
South America	341.33
Asia	376.28
Africa (excluding drough	nts) 117.05
Australia/Oceania	323.5

(Based on data from Thompson 1982: 14-16).











the expansion of settlements onto floodprone land or hurricane-prone coasts. The population of active river flood plain in Bangladesh is thought to exceed one million and at least a further one million people inhabit similar insecure habitats in Meghna estuary, where people are also exposed to the hazards of tropical cyclones and storm surges. Clearly, it would be impractical in land-hungry Bangladesh to prevent people from occupying such unstable yet fertile land; much less to resettle such numbers in a less disaster-prone location.

While population growth puts at risk a higher number of people in both rural and urban areas, the rate of urbanization that has been occurring in developing countries presents a more complex problem of demographic and physical change. With the exception of cities like London, New York and Tokyo, the

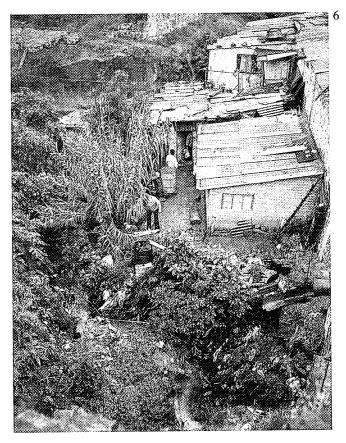
4. The historic centre of Popoyan, Colombia, after the 1983 earthquake. Timber rot, lack of maintenance and structural interventions to the buildings were the main causes of heavy damage.

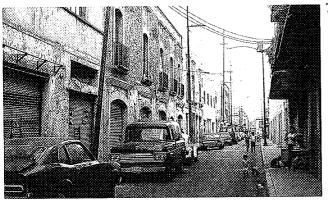
5. The historic centre of Popoyan after reconstruction. The post-earthquake rebuilding of the city was used as an opportunity to train the builders and the public in safe reconstruction.

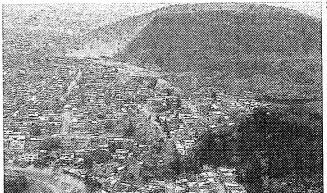
majority of cities with a population over five million are today in developing nations. It is crucial to recognize that fires have not been a major catastrophe in London since 1666, and the recent earthquake of Loma-Prieta in San Francisco took only over 100 lives. However, in cities like Istanbul and Bursa, once carefully-devised urban patterns and architectural details represent today only

a fraction of the built environment swamped by uncontrolled urban development and seismically inappropriate building forms. Urban planning by the Ottomans could never have foreseen or attenuated the massive changes that many Turkish cities have undergone in the last 30 years.

Strictly enforced building codes and zoning laws may help to reduce disaster risk for developing countries, but the planners and local authorities in these nations are under constant pressure to increase densities so as to accommodate ever increasing urban populations. Besides, quality control is poor, codes are difficult to enforce; the new risks introduced by imported technologies and architectural forms are not well understood by the professionals. During the 1980 El-Asnam earthquake in Algeria, the widely practised stylistic trend of







'construction on pilotis', which followed from one of Le Corbusier's five principles, proved to be the wrong 'principle' in seismic zones. Failure of critical function buildings such as hospitals, due to inappropriate designs and poor quality construction puts professional ethics into question. During the hurricane of 1988 in Jamaica 80 per cent of hospital capacity was badly damaged; in the 1985 Mexico earthquake, 28 per cent of the much-needed bed capacity was lost by total collapse of five hospitals and severe damage of 22 hospitals.<sup>5</sup>

The risk due to urban disasters is not confined to new buildings. In the majority of developing countries historic centres once occupied by high income groups are now turned into multiple occupancy, high density tenements for low-income groups. Often with absentee landlords

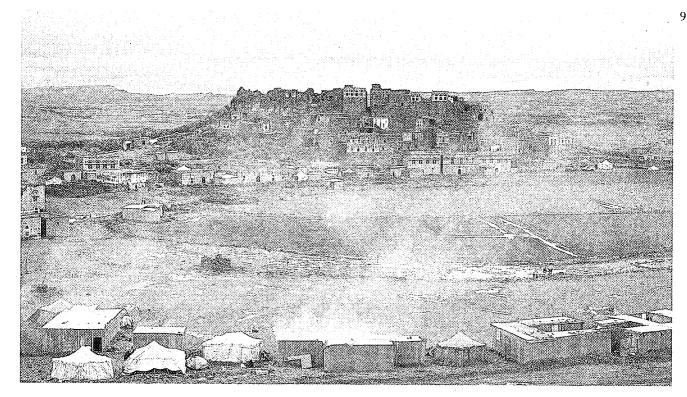
6. and 7. Squatter housing in Mexico City. Landslides and flash floods are common disasters.

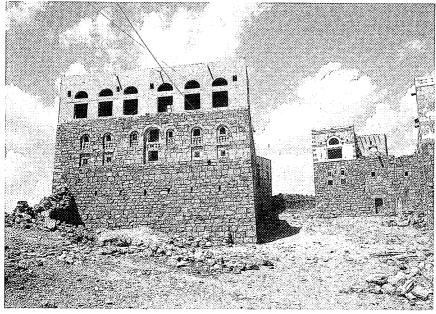
8. The Historic Centre of Mexico City. Lack of building maintenance and high density occupancy resulted in heavy collapse and high casualties.

and low rental revenues, such buildings receive little or no maintenance. Their structural resistance is often further weakened by repeated disasters, damage followed by centuries of cosmetic repair, and haphazard modifications to the buildings. The Popoyan earthquake of 1983 in Colombia devastated the Colonial Centre of the city which was built four centuries ago, taking into account the seismic risk. Similarly, the 1985 earthquake of Mexico City hit hardest the historic centre, damaging culturally

valuable buildings occupied by large, low-income families. Damage in both cities is repaired with the incorporation of seismic safety measures and upgrading of living standards. The inhabitants are provided with public awareness programmes and given skills to safeguard the future maintenance of historical buildings. However, in many disaster-prone countries of the developing world, the interest, if any, in protecting cultural and architectural heritage against natural calamities still targets only monuments and 'important' building.<sup>5</sup>

Above all, perhaps the most vulnerable population in developing nations are the inhabitants of small dwellings; the informal houses and the non-engineered buildings in cities, towns and villages. Where the most basic shelter needs are not met by the authorities, the poor and the urban migrants are forced to occupy





9 The town of Mangadah after the 1982 earthquake in the Yemen Arab Republic. Loss of traditional building skills, lack of maintenance and scarcity of timber were among the factors for building collapse.

10. Rural buildings in the Yemen Arab Republic. New building materials such as concrete in many developing countries are replacing the traditional ones. The risks induced by them are yet to be tested.

high-risk sites such as ravines, river floodplains and steep slopes. They are outside any building or zoning regulations and live in dangerous structures. In Guayaquil, Lima, Caracas and Rio de Janeiro it is the shanty towns that are in the path of landslides. The rural materials and skills are no longer applicable to the urban conditions and safer building materials either are too expensive or their behaviour in earthquakes, floods and hurricanes is not well understood.

The scarcity and cost of traditional building materials and the loss of fine buildings skills is a problem also faced in many rural areas. As the recent earthquake

in Iran and many others in Turkey and Pakistan proved, well-constructed and maintained timber-framed buildings often perform better than other structures.6 However, environmental degradation and population explosion force people to look for alternative material such as concrete, breeze blocks and iron sheeting. New materials require new construction skills which are often acquired 'on the job' without necessarily understanding the fundamental safety principles. In Bangladesh, the increased use of roofing sheets to replace traditional thatching materials and bamboo when not properly attached to the structure was a major source of casualties during recent

cyclones and tornadoes. In Iran, the quickly erected steel-frame buildings collapsed due to the failure of simple spot welds and heavy masonry infill.

Projects such as OXFAM's Builders Training Programme after the 1982 earthquake in the Yemen Arab Republic, the post-disaster housing schemes in the aftermath of the 1987 Ecuador earthquake and the 1988 floods in Bangladesh, are attempts to improve the hazard-resistance of traditional buildings by promoting traditional skills. However, 'urbanization of the mind'; the values attached to modernity and the rising aspirations in some rural parts of the developing world, may resist the idea of returning to tradition.

11. The village of Aksaklar in western Turkey. New building materials such as concrete are used alongside traditional ones in most earthquake-prone parts of Turkey.

12. After the earthquake in the Yemen Arab Republic many houses were quickly repaired or rebuilt without much improvement of the traditional techniques. OXFAM's Builders Training Programme targeted the village builders.

At a recent conference in Oxford Polytechnic *Disasters and the Small Dwelling*, attended by Non-Governmental Organizations (NGOs) and researchers from 19 different countries, understanding the social, cultural and physical dynamics of this shift was identified as the key to successful future risk mitigation programmes.

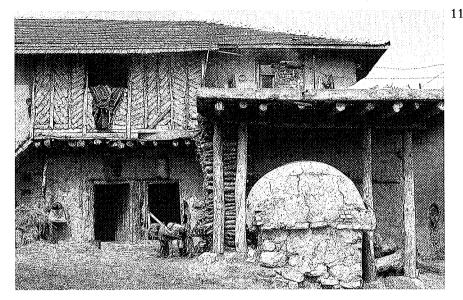
At the onset of the International Decade for Natural Disaster Reduction (IDNDR), declared by the United Nations and supported by 93 countries, architects, planners, and educational institutions in developing countries have a unique opportunity: to become aware of the increasing disaster vulnerability of communities and the means to reduce risks – and thereby save lives and protect property.

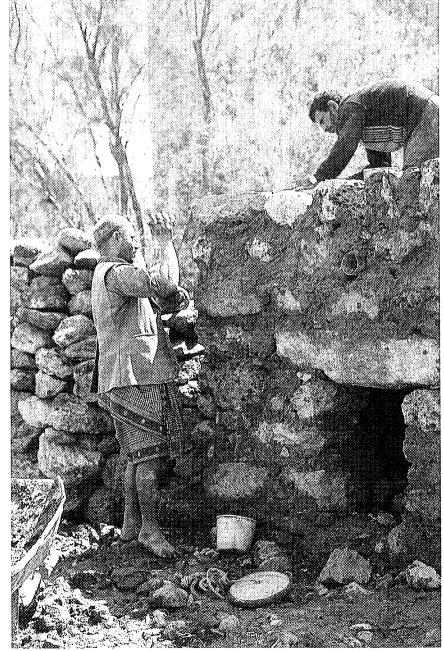
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- 5. Aysan, Y., et. al., Mitigation of Urban Seismic Risk: Actions to Reduce the Impact of Earthquakes on Highly Vulnerable Areas of Mexico City, Report of Bilateral Technical Cooperation Project between the Governments of Mexico and United Kingdom, 1989.
- 6. Aysan, Y., and Oliver, P., Housing and Culture: A Guide for Future Policy Making on Housing in Seismic Areas, Oxford Polytechnic, for Overseas Development Administration, 1987.

PHOTOGRAPHS BY THE AUTHOR UNLESS OTHER-WISE STATED.

DR. YASEMIN FATMA AYSAN TRAINED AS AN ARCHITECT AT THE MIDDLE EAST TECHNICAL UNIVERSITY IN TURKEY. SHE IS NOW DIRECTOR OF THE DISASTER MANAGEMENT CENTRE, OXFORD POLYTECHNIC, WHERE SHE ALSO TEACHES IN THE SCHOOL OF ARCHITECTURE.





# THE IRAN EARTHQUAKE

Four of the 20 highest fatality earthquakes this century have been in Iran, but the earthquake that hit Manjil in June 1990 far exceeded previous disasters both in the death toll and the scale of destruction. Here we report on the findings of two UNDRO missions in the impact of the tragedy on buildings in rural areas, and the priorities for reconstruction.

western Iran on 21 June 1990 was the sixth most lethal in the world this century and the largest ever in Iran. The official death toll announced on 27 June was 36,898, and an estimated 60,000 were injured. The losses were greater because the earthquake struck at 31 minutes past midnight local time, when most people were asleep.

Destruction to buildings and property was on an unprecedented scale. Four towns with a combined population of 50,000 were devastated and an area of 30,000 square kilometres was affected. A total of 1,600 villages were damaged; in some village areas, 60–90 per cent of the houses collapsed.

The earthquake occurred in a valley between two mountain ranges, one of which borders the south-western margin of the Caspian Sea. The zone of destruction included the three towns of Manjil, Rudbar and Lowshan – all in Gilan Province. Manjil took most of the impact of the earthquake, but the effect was just as devastating to Lowshan, which is one of the fastest industrializing areas in Iran, growing at 11 per cent a year. The majority of the buildings in the towns were damaged beyond repair. But 83 per cent of the houses destroyed and most of

the losses were in the thousand or so neighbouring villages, where most of the affected population live.

The provinces hit by the earthquake — Gilan and Zanjan — are distinct in climate, culture and buildings. Gilan, located towards the Coast of the Caspian Sea, is densely populated, temperate in climate, and well-cultivated with rice, wheat and tea plantations. The traditional building type in this area is two-storey timber framed construction with wattle and daub infill on a masonry plinth. Their pitched roofs are of clay tiles, thatch, corrugated iron sheeting and corrugated cement fibre

1. Map of Iran showing the area worst affected by the earthquake.

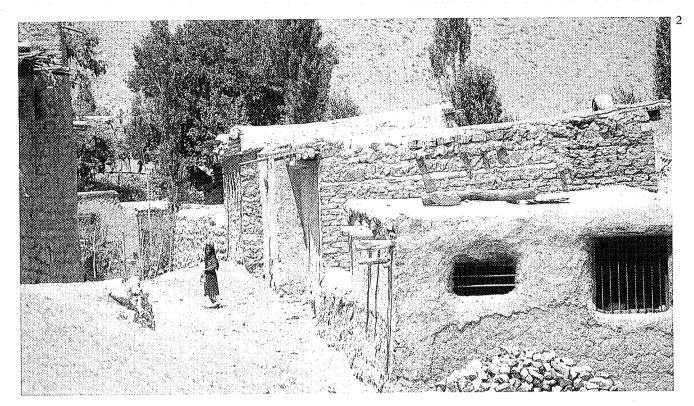


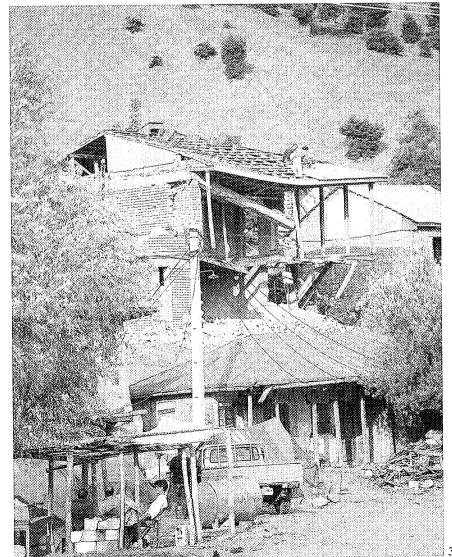
sheeting. Modern housing is mainly of similar form, using steel framing members and fired brick masonry with cement mortar. Modern roofs are pitched, of timber construction, covered by corrugated iron or asbestos cement sheeting.

In the mountainous area of Zanjan one of the poorest provinces of Iran - the landscape is dramatically different. It is relatively sparsely populated; villages are located about 30 square kilometres apart in sheltered positions in the valleys or south-facing hillsides, around springs, in pockets of irrigated land in an otherwise barren landscape. The traditional housing in the region is single storey, of rubble or adobe masonry, with flat roofs made from compacted earth and rush matting. Some of the older traditional rubble masonry houses also have horizontal timbers near the top of the walls, to add strength to the unsupported masonry. Modern housing in the area is mainly fired brick with horizontal reinforced concrete ringbeams.

The Government of Iran announced that a Master Plan for reconstruction would be prepared before the end of September 1990, and asked for all international aid to be channelled through the United Nations Development Programme and for a small international







2. Houses in the mountain villages of Zanjan are typically of rubble or adobe masonry, with flat roofs. Regular maintenance has reduced the buildings' vulnerability.

3. Modern non-engineered house in Gilan. Timber and masonry houses such as this one stood up reasonably well.

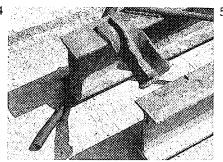
team of consultants to be appointed by the United Nations Office of Disaster Relief (UNDRO) to assist the national authorities in devising a reconstruction strategy.

The first mission by UNDRO took place from 22 June to 6 July. It reported¹ that in the towns of the worst affected area, where buildings were mainly one or two storey brick masonry on steel frames, collapse resulted primarily from rupture of poorly welded connections in the steel frame, and from the heavy weight of the ceilings, especially roof masonry. The mission also reported that mud and reed roofs in the village houses had offered very low resistance to the earthquake.

The Reconstruction Programme Formulation Mission from UNDRO went out to Iran on 28 July 1990. This second UNDRO mission, consisting of a six-man team of advisors<sup>2</sup> and led by Dr Andrew Coburn, a director of Cambridge Architectural Research Ltd., set out to investigate more fully the technical impact of the earthquake and make recommendations for reconstruction, focusing on housing.<sup>3</sup>

As a framework for assessing the performance of the different types of dwelling, the team distinguished not 3 between rural and urban housing but





4. Non-engineered steel framed buildings, like this one in Lowshan, suffered collapse as a result of the failure of poorly welded joints.

5. Detail of spot welding of I-beams, which led to failure of non-engineered steel frames.

between engineered and non-engineered buildings. Non-engineered housing may be of steel frame or mud construction, and constitutes a very large proportion of the building stock in both towns and villages. It is typically built by the Mimar (master builder) or Bano (village builder) under contract to a household, who also provide much of the labour. In the epicentral region, around 75 - 80 per cent of these non-engineered buildings suffered collapse (ie more than half of the primary bearing members of the roof were dislodged) while most of the other buildings suffered from partial destruction or heavy damage.

The team highlighted the rapid proliferation throughout the towns and many rural areas of the country (and particularly in Gilan) of steel framed buildings. Several of these were nonengineered buildings, whose frames were held together by simple spot welding. While steel elements are expensive, they are used because they can be erected quickly (a two-storey frame can be erected in two days), and they require a low level of skills. The problem of the failure of the welds had been exacerbated by the construction of floors by jackarches: shallow arches of fired brick masonry with steel joists about a metre apart. When the welds failed, the masonry fell into the structure. The Mission also noted, however, that some of the simple welded frames remained standing even in the severest conditions at the epicentre; it appears that these structures are less likely to suffer total collapse than other building types.

Problems of construction were also identified in non-engineered reinforced concrete framed buildings with weak mixtures of concrete steel often poorly arranged within the concrete and columns and undersized.

In unreinforced masonry structures -

including those of adobe, rubble stone masonry in mud mortar and unreinforced fired brick in cement mortar — the variation in the strength of materials and quality of construction, affected how they fared in the earthquake. In several cases, damage was found to relate to weaknesses such as cracks and other defects present before the earthquake. A major problem identified by the team was structural separation between load-bearing and non-loadbearing masonry walls, which had in several cases led to collapse of the roof.

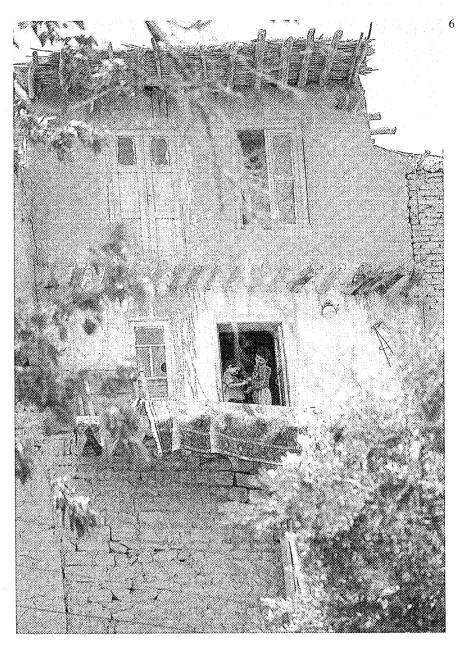
The minority of buildings in the affected region which have horizontal reinforced concrete ringbeams, performed substantially better than other masonry, but, again, were sometimes prone to weaknesses of materials and construction. Some intact ringbeams also showed a disparity between the strength of the ringbeam itself and poor brickwork below it.

The team found that both old and recent timber framed buildings, seen in many of the villages in Gilan in the valleys down to the Caspian Sea, fared well compared with other structures. Very few of these timber framed houses were badly damaged in the earthquake. Composite structures of masonry on the ground floor and a timber framed upper floor often showed more damage to the masonry than the timber. The few collapses seen were mainly where the ground on which the structures were built had fallen away, bringing the structure down with it. Scarcity of timber would prohibit its extensive use in reconstruction; but the Mission Report advises that where structural timber is available, it should be encouraged.

Andrew Coburn, Team Leader, emphasizes that the problem is not lack of adequate seismic building codes, but the fact that very few of the buildings were constructed to the code requirements. The priority, as he sees it, is in making improvements in the quality of building construction without stifling the building production of much-needed new housing. Even more important, he stresses, is mitigation of future losses in the region, by establishing a building process of stronger structures, for the next generation of building.

The reconstruction programme is divided into an urgent first phase to provide temporary winter shelter, for completion before the end of 1990, and a second phase for completion by the onset of winter 1992.

The main reconstruction activities will be co-ordinated by the Housing Foundation in Iran – a highly competent operational organization, with almost a decade of experience working on the war



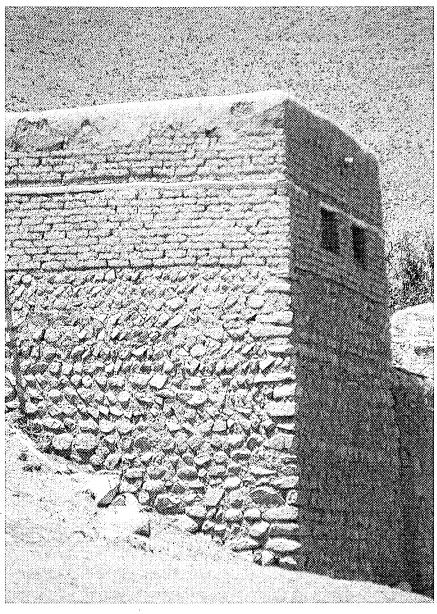
6. A traditional village house in Zanjan. Timber, which adds stability, is now scarce and therefore not commonly used in mountain villages.

reconstruction. As Akbar Zargar, advisor to the Foundation, points out, eight years of war has also created a strong community network (organized through the mosques), through which the local population are involved in the building task.

The Housing Foundation have already provided each family with the emergency provision of a tent, and are providing thousands of pre-fabricated structures as emergency measures. The objectives of the Housing Foundation for the reconstruction programme include maximum participation of the affected population and reliance on locally available raw materials for the production of the construction materials. The

Housing Foundation's Reconstruction Programme also states that the technology of converting raw materials into the final product must not be complex, so as to make possible their preparation by local inhabitants; that the choice of materials must take into account economical considerations and that the production of these materials must not have a detrimental effect upon the environment.

The United Nations Expert Mission are currently making recommendations on suitable materials for short and long-term building. In the short term, the advisors have recommended that the emergency housing for the winter take the form of one or two rooms built by the house-holders on the site of their previous house to form the core of an eventual reconstructed dwelling — or a store-room which can later be used alongside it. They also emphasize the short-term need for expansion of the existing small-scale





7. A well crafted village house of rubble stone masonry. The stones are neatly wedged together and smaller stones are used towards the top.

8. Detail of the horizontal timber reinforcement in a masonry wall – a traditional way of increasing stability.

Opposite: A master mason begins reconstruction of a house in Zanjan.

concrete block production for building winter shelter.

Recommendations by the UNDRO mission for the long-term reconstruction include the training of village builders by master craftsmen from the region, in techniques of good quality masonry and concrete making, using rural technology. The proposed goal is to train 2,000 builders in 18 months. The team also recommend that the UN and the Housing Foundation work together in appointing resident Iranian architects who would be responsible for the town reconstruction.

Coburn stresses that the biggest bottleneck in reconstruction will be supply of materials. There is a severe shortage of building materials nationwide. The UNDRO mission anticipates the exploration of appropriate materials of domestic origin, such as reinforced fired brick masonry, lightweight concrete blocks and stabilized soil.

The reconstruction in Iran takes place against the back-drop of an expanding population (growing at around 2.3 per cent) – which is also currently receiving an influx of 30,000 former prisoners of war from Iraq. However, as Coburn points out, the technical capabilities of Iranian national institutions is high, building research is of international standard; and there is an impressive spirit of cooperation and enterprise among the people, who are already actively involved in rebuilding their homes and their lives.

#### Notes

- Report on UNDRO Mission, 22 June 6 July J. Tomblin and O. Almgren, August 1990.
- 2. The mission team consisted of the following: Dr Andrew Coburn, Team Leader, University of Cambridge, UK; Professor Jakim Petrovski, Skopje University, Yugoslavia; Dr Danilo Ristic, Skopje University, Yugoslavia; Dr Ignacio Armillas, United Nations Centre for Human Settlements (UNCHS — Habitat); Dr Niels Biering, United Nations Industrial Development Organization (UNDRO); Giovanni Verese, Office of United Nations Disaster Relief Coordinator (UNDRO).
- Reported in the Mission Report and Technical Review of the Impact of the Earthquake of 21 June. A.W. Coburn, J. Petrovski, D. Ristic, I. Armillas, N. Biering, September 1990.

PHOTOGRAPHS BY ANDREW COBURN TEXT BY EDITORS



# EARTHQUAKES AND Traditional asian buildings

John Beynon

John Beynon has had substantial experience in developing disaster resistant buildings, encouraging local architects to provide ideas and skills. Here, he suggests the simple measures that can be taken to improve the earthquake resistance of traditional architecture in Asia – particularly school buildings.

or earthquake resistant design it is traditional Japanese architecture that is often cited as a perfect response, with its light-weight, inter-connected yet flexible wooden structures. For thermal comfort in arid zones, the thick-walled and thick-roofed masonry structures of central Asia are given high marks by the specialists in tropical design. What is less written about is the inherent danger of fire in buildings of wood and paper and of structural collapse in unbonded traditional masonry buildings.

School buildings have a special role in any community as the place where the next generation is shaped. When tragedy strikes it is only natural that communities want to be sure that their children's lives are safe. This leads to giving a special priority to building school structures that can resist earthquakes. A natural spin-off is that these buildings, with their large rooms, sanitary installations and running water, are easily converted into refuges or field hospitals.

When disaster strikes, countries send out appeals for emergency assistance. While Unesco is neither a relief agency The Christian College of the Philippines is a private secondary level institution in the city of San José some 150 kilometres north of Manila. It was created in the late 1960s to provide a low-cost education to some of the poorer children in the area. The owner had constructed the buildings on a limited site and expanded the capacity

as funds became available.

Given the land restrictions, the expansion was vertical, beginning with two floors and eventually growing to six. Construction began before the unified building code with antiseismic measures had been adopted. Costs were kept low which meant outdated building techniques were

used. Stop and go building procedures built in structural discontinuities.

RECIPE FOR DISASTER

The earthquake of 17 July 1990 struck at 5.04 pm, when children were still in school. It reduced this structure to a pile of five concrete floor slabs and the roof resting on top of the ground floor columns which remained intact. In all, 124 children died - it was one of the worst individual tragedies of an earthquake that claimed more than 1,600 lives. The press issued incensed articles. A major inquiry is underway to determine if the fault rests with the owner, the designers or the builders. A technical inspection before the earthquake would have easily detected this "disaster waiting to happen".

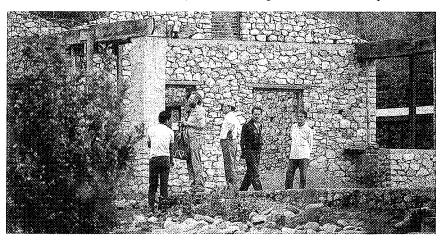
nor a financing agency, it is extremely concerned about the hardships people suffer in these disasters. Unesco's main contributions are to help with the provision of technical advice on how to avoid future disasters. The materials in this article are drawn from the results of those experiences.

# An approach to saving lives

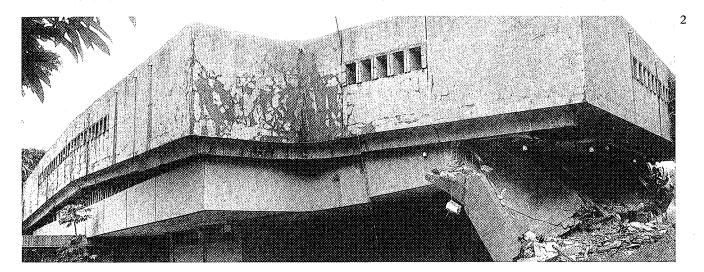
An engineer who visited the 1988 earthquake in Armenia has been quoted as saying "earthquakes don't kill, buildings do". In fact, earthquakes are a

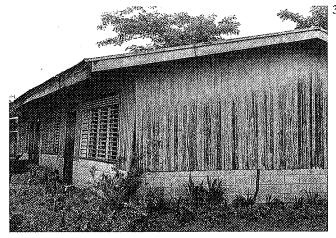
natural phenomenon that trigger off manmade disasters. It is, consequently, within man's power to reduce — if not virtually eliminate — fatalities due to earthquakes. Since most school buildings are in the public domain, a ready-made infrastructure of public authorities which can take direct responsibility is already in place.

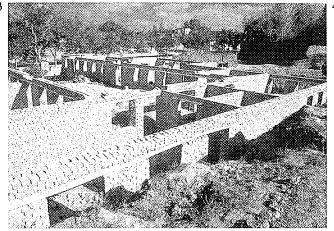
The twentieth century has brought about a clearer understanding of why earthquakes happen and where they are likely to occur. The well-known Professor Richter has produced a global map showing where shallow earthquakes occur. Active tectonic plates are being carefully mapped and scientists in earthquake affected countries are developing more detailed maps with fault lines and earthquake zones of different intensities.



1. Nepal: In remote areas of Far Western Nepal a school can be from one to seven days' walk from the nearest road. Materials are usually portered on people's backs. In these areas there is little choice but to use timber members for earthquake reinforcement. Ring-beams are placed at lintel level. Examples of wood reinforcement can be found in buildings 100 years old.







Thanks to the mass media, citizens are increasingly made aware of the fact that the Richter scale exists to indicate the magnitude of an earthquake. Less well known is the Medredev Sponhever Karnik (MSK) Intensity Scale which describes the types of damage sustained in a local area. Table 1 gives an approximate idea of the interrelation between these two scales.

It should be clarified that the intensity of the earthquake can vary from one locality to the next, depending on soil conditions and other factors. In recent earthquakes in the USSR, USA, Mexico and Philippines, the greatest damage to buildings occurred to those constructed on unstable soils some distance from the quake centres.

To design buildings that can perform well in earthquakes requires an elementary understanding of what earthquakes do to buildings.

An earthquake is basically a wave moving across land. The effects on buildings are usually that the foundations tend to move sideways out from under the buildings and that the ground drops out from under the building. It is fairly easy to imagine how this wave could affect a rigid structure or one that does not have well-bonded joints.

2. Philippines: Even the best engineers may not be able to find satisfactory structural solutions to meet unreasonable architectural demands. This university library building was designed with excessive cantilevers and an intermediate floor with unsupported columns.

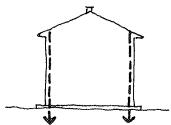
3. Philippines: Classrooms built with plans developed in foreign countries sometimes fail to take into account local situations. The thousands of 'Marcos type' primary school classroom buildings have concrete block walls that are unattached to the structure. These walls simply fall over when the buildings accelerate horizontally in earthquakes.

4. Afghanistan: Traditional structures of stone and brick need to be tied together with ring-beams. Where transportation permits the delivery of steel and cement, buildings can be constructed with a concrete beam around the perimeter of the building, forming a continuous lintel. Where timber is more easily available than steel and cement, wood members are used with care taken that the pieces are adequately connected to enable the whole beam to act in tension.

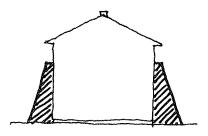
Table 1. Earthquake magnitude and intensity			
	Maximum		Felt
Magnitude	Intensity	.Effect	Radius
(Richter Scale)	(MSK Scale)	(MSK)	(Km)
4.0 - 4.9	IV - V	Largely observed - Awakening	50
5.0 - 5.9	VI – VII	Frightening - Buildings damaged	110
6.0 - 6.9	VII – VIII	Buildings damaged - Some buildings	
		destroyed	200
7.0 - 7.9	IX - X	General damage of buildings - General	
		destruction of buildings	400
8.0 - 8.7	XI – XII	General Destruction - Landscape changes	800
(Source: Earthqua	kes, Don de Nevi	i, Celestial Arts, Calif., May 1977, p.102)	

The solution to compensating for these forces resulting from the acceleration movement generated by the earthquakes is, of course, the application of basic laws of physics. External forces must be compensated by equal and opposite forces coming from the strength of the building itself. Furthermore, as the force is the product of acceleration and mass, it follows that the heavier are the upper parts of a structure, the more internal strength will be required.

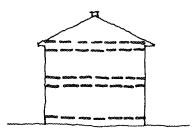
When dealing with the modest scale buildings relying on traditional materials and skills, there are several crucial elements that need to be achieved.



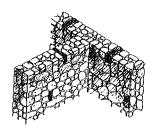
Vertical tension members need to be introduced bringing forces from the roof rafters down to the foundations.



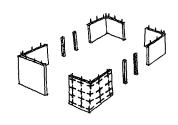
Buttresses can be used to help push the walls together.



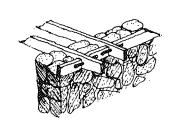
Tension members may be added at grade, lintel and plate levels to tie walls together so that they move in unison.



Thick masonry walls need through elements to ensure that both faces oscillate in unison.



Select internal or external walls may be specially strengthened to prevent the building from shearing apart when the lower part tries to move out from under the upper part.



Make sure that all connections are integrated with neighbouring components and do not rely only on gravity to keep elements in place.

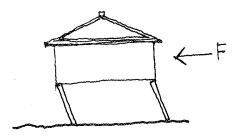


Keep building sizes small, and regularly shaped so that they will act in unison when a wave passes under.

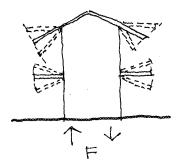


Create a 'crumple' link between segments of large or irregular buildings so that the structures will not hammer one another when they oscillate in different directions and frequencies.

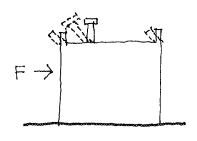
There is an equally basic list of things not to do:



Don't leave columns unsupported and unbraced. Particularly at the lower levels of a building.



Don't use excessive cantilevers.

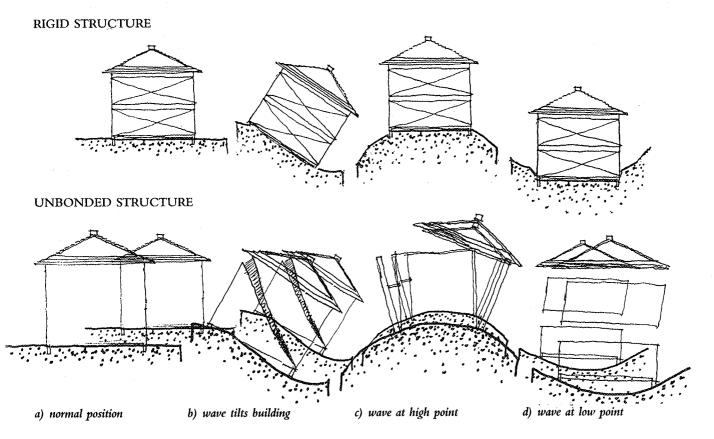


Don't count on gravity to keep in place such things as chimneys and parapet walls.

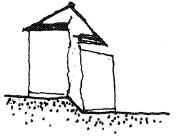
Don't assume the builder always knows best. Supervise to make sure:

- enough cement is used in concrete
- not too much water is used in concrete
- that there are no air pockets in structural elements – particularly where reinforcement rods are close together.
- that mortar is placed in the vertical joints of masonry walls.

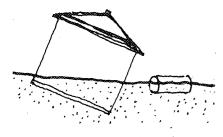
These pointers are, of course, intended only as a general guideline for the simplest and most routine situations where small buildings are located on bedrock or well compacted soils. The problems created by fault lines and unstable soils that undergo



liquefaction are so great that only the most sophisticated earthquake engineering can guarantee a building's survival. Imagine designing for these conditions:



Along fault lines the earth comes apart and changes location vertically or horizontally.



When liquefaction occurs the earth acts as a liquid into which heavy objects sink and buoyant objects (such as underground storage tanks) float to the surface.

The easiest solution is to build somewhere else.

## **Building details**

Unesco (Bangkok) has published a handbook¹ for use by designers and builders that will enable them to design small one or two storied educational buildings that can resist earthquakes. It also presents earthquake zone maps for countries in the Asia and Pacific region. The suggestions are such that they propose ways to achieve required strength without fundamentally violating the basic design concepts of traditional structures.

The easiest and most elementary advice is to create triangles, the uniquely stable geometric shape, within structures. Securely attached diagonal bracing is the way in which the more functional rectilinear building shapes can be transformed into triangles. Obvious and inexpensive as diagonal bracing is, it is usually missing in traditional structures. Diagonal bracings in bamboo structures may be held in place with lashlings or through inter-locking slots and pegs.

The second point to investigate is that of structural continuity — both vertically and horizontally. Small metal connectors are increasingly available that can be simply introduced between elements of wood.

Steel reinforcement bars protected with

1 Arya A.S., Protection of educational buildings against earthquakes, a manual for designers and builders. Bangkok, UNESCO, 1987. 67 pages (Educational Building Report 13). a minimum five centimetres of concrete are a small element easily embedded into thick masonry walls of rubble, stone or brick. Professor Arya makes a number of suggestions on how vertical reinforcement can replace a half brick or part of the random rubble thrown in between facing stones.

Integrating 'ring-beams' into traditional structures is also easily done.

Wooden plates can be stiffened and joined longitudinally, most easily by using two planks nailed or dowelled together with offset joints and diagonal corner bracing.

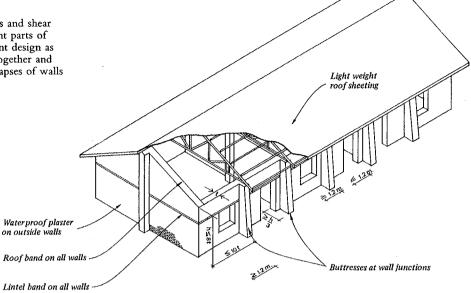
Brick, block or stone masonry can provide its own framework for inserting the required steel and concrete or alternatively an RC beam can replace a course of masonry.

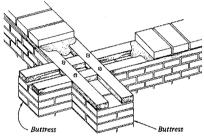
The most challenging situation, perhaps, is where steel is not available and one is obliged to reinforce masonry structures with wooden timbers. This is feasible — indeed long timber segments have been used in the Arabian peninsula to reinforce thick walls of mud and masonry. Professor Arya suggests that timbers be inter-connected to ensure longitudinal continuity and overlapped at the corners to provide bracing.

If existing buildings need to be reinforced and insertion of a ring-beam is not feasible, then the addition of an external buttress or constructing an internal shear wall can provide reinforcement.

#### 1 BUTTRESSES

External buttresses and shear walls are important parts of earthquake resistant design as they push walls together and help to avoid collapses of walls and roofs.

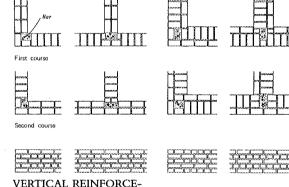


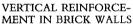


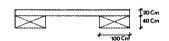
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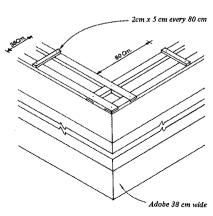
# 2 BELTING

Building walls need to be strapped together. Ring beams are best located at floor, lintel and wall plate levels. Any material that has tensile strength can be used.





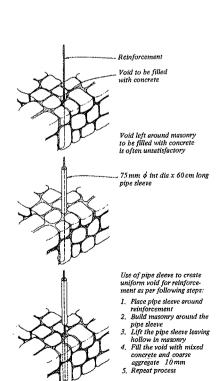




DETAIL OF A WOODEN BAND

# 3 STRUCTURAL CONTINUITY

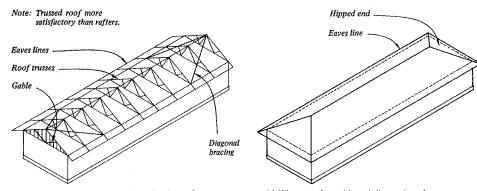
Designers should imagine what would happen if the building was hung upside down. Anything that would fall off is vulnerable to being displaced in an earthquake. The footings should be tied to the base plate which should be tied to the walls which should be tied to the top plate which should be tied to the rafter. If the various elements have tensile strength, connectors at critical junctions can provide structural continuity. Alternatively steel bars can be embedded into the vertical structure.



VERTICAL REINFORCE-MENT IN RUBBLE STONE MASONRY

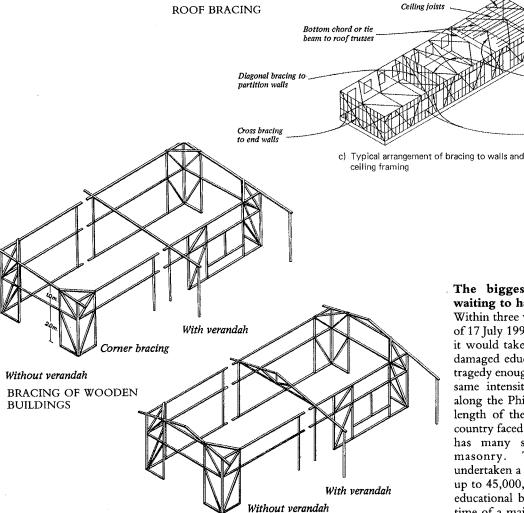
#### 4 TRIANGLES

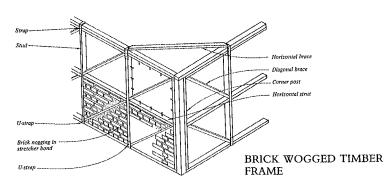
Adding reinforcements that sub-divide structures into a scries of triangles, in horizontal and vertical planes alike, is the easiest way to make a building volume rigid.



Angle ties

 a) Diagonal bracing to end bays in plane of top cords of roof trusses or rafters b) Where roofs are hipped diagonal roof bracing is not needed.





# The biggest challenge: disasters waiting to happen

Diagonal bracing to all bays at ceiling level

Nogging use heavier section as lintels

over door and window openings

Within three weeks after the earthquake of 17 July 1990 the Philippines estimated it would take \$56 million to repair the damaged educational structures. This is tragedy enough, but an earthquake of the same intensity could occur anywhere along the Philippine fault that runs the length of the country. China, another country faced with frequent earthquakes, has many schools of sub-standard masonry. The government has undertaken a survey and concluded that up to 45,000,000 square metres of their educational buildings will be unsafe in time of a major earthquake.

The challenge, therefore is much greater than to incorporate earthquake resistance in the new educational buildings. Countries and communities must also get on with the inglorious task of reinforcing existing ones.

AMERICAN ARCHITECT JOHN BEYNON IS A GRADUATE OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY, USA. HE IS PRINCIPAL ARCHITECT AT UNESCO'S REGIONAL OFFICE IN BANGKOK AND IS INVOLVED IN DESIGNING SCHOOLS IN ASIA THAT WILL STAND UP TO CYCLONES, FLOODS AND EARTHQUAKES.

# TYPHOON RESISTANT BUILDING IN VIETNAM

John Norton Guillaume Chantry Nguyen Si Vien

Each year typhoons sweep across the central and northern coastal plains of Vietnam, leaving a trail of death, destruction and loss of crops. In the aftermath, the population mobilizes to rehabilitate their region. Scarce resources of materials and money are consumed. Much damage could be reduced, and far less effort, materials and money consumed, if preventive steps were taken to make buildings stronger against typhoons.

This article describes a programme started in January 1989 in the provinces of Quang Binh, Quang Tri and Thua Thien (BTT zone)<sup>1</sup>, aimed at reducing typhoon damage by raising awareness about the need to protect buildings and about techniques to achieve this. The BTT programme was initiated on request from the Vietnam Government by UNCHS Habitat, and designed and implemented by Development Workshop (DW), Group de Recherche et d'Echanges Technologiques (GRET), the Institute of Building Design (IBD) in Hué and the Institute of Housing and Public Building Design (IHPBD) in Hanoi.

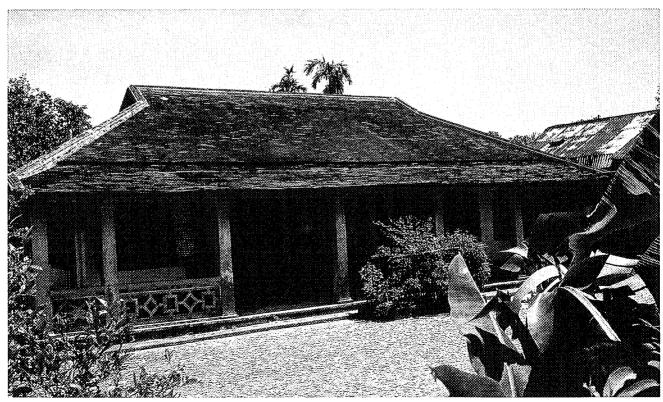
ost buildings in BTT zone are small dwellings with adjoining structures for kitchens, selling, workshops and animal sheds. Public buildings - with the exception of a few major ones - use forms and methods similar to those used in the smaller domestic building, and, for storm resistance, present similar strengths and weaknesses. Most buildings can be considered primarily in terms of a supporting framework holding up the roof. The walls are usually light-weight, often contributing little to the structure. One can identify three main families of construction: the traditional buildings; buildings with a mixture of materials and techniques - the 'transition' house evolving towards the 'modern' dwelling; and the local public buildings in the districts of each province. The latter two are both characterized by poor detailing and poor quality; since they increasingly represent the building stock of the area,

they are the major concern for typoon resistant construction.

Traditional buildings — whether on the scale of the region's palaces, tombs and temples, or that of the house — exhibit quite consistent characteristics: a framed structure with many substantial heavy wooden posts and short span beams, held together by finely-executed mortise and tenon joints. The roof, often with hipped ends, is an integral part of this framing. Between the structural elements, the infill walls use various materials, from wattle and daub to fired brick or timber. On tiled roofs it is common to see exposed masonry ribs which help hold down the covering.

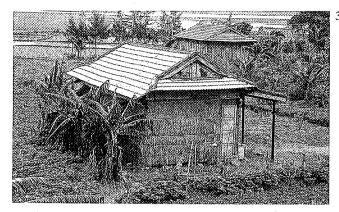
1. Opposite: Bao! Cyclone! Launching the public information campaign in Thua Thien Province, the IBID core team prepared a special poster.

2. Solid and smoothly shaped traditional housing resists against typhoons.

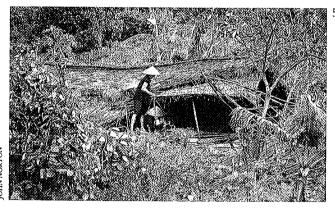


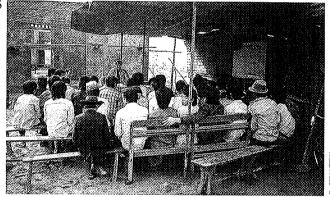
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The combination of good jointing, small structural units and large timbers gives traditional buildings structural integrity and stiffness: these make them very able to resist typhoons.

Today, the increasing scarcity of timber has pushed up costs, making the construction of a traditional house very expensive. Nevertheless, one still finds the traditional beautifully executed timber frame used in new houses and regarded as a status symbol. Sadly, the quality of walls and roof covering is not always of similar standard, and this is just one example of the second category of houses and public building in the area: the 'transition' building.

# Contemporary habitat: the 'transition' building

A wider variety of materials and techniques are employed today than in the past; some are hybrid forms of traditional building; others are the result of attempts to apply new techniques and new materials such as reinforced concrete: often without the necessary skill or the money to get it right. The poor depend on using straw, leaves, branches and bamboos. Construction of most houses is a protracted process; with the difficulties of acquiring materials, various elements that make up the building are often linked together in a haphazard manner, influenced more by what is available at the time than by what might best protect and secure the investment that is being made. These buildings are characterized

3. Contemporary 'transition' houses on the coastal planes – weakened against typhoons by a mixture of materials and techniques.

4. A small typhoon destroyed this thin concrete block walled house near Da-Nang; the roof just blew off. Better design at little extra cost could have saved the building.

5. Poorer houses of thatch and bamboo collapse easily, but are quickly repaired.

6. A training session on a demonstration building works site: local technicians and builders learn to understand the problems and to become advisers to help the public.

7. Opposite: A poster prepared by the participants — the ten key points of typhoon resistant construction. Some 10,000 copies have been put up in Thua Thien Province.

by the weakness of the joints between elements, which thus easily fail; and by the increasing lightness and lack of rigidity in the structure, offering less resistance to high wind pressures. Everyone would like a version of the 'modern house', which, once complete, offers quite good typhoon-resistance: but in the meantime the step-by-step investment made in materials such as tiles, bricks and cement is at high risk from frequent typhoons. This is exacerbated by poor workmanship.

## Public buildings

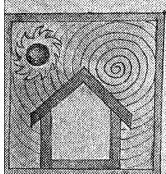
Public buildings, although designed by technicians, are similarly vulnerable to storms. The same weaknesses in detailing and execution are compounded by the design of the buildings: a trend towards high un-triangulated structures, the use of gable end walls with little rigidity and large verandahs where the roof is greatly exposed to uplift. Typhoon Irving in 1989 highlighted this problem, with the collapse of hospitals and schools in the Thanh Hoa province.<sup>2</sup>

#### Costs

Construction is not cheap. At 1989 prices,<sup>3</sup> a thatch and bamboo frame structure cost 50,000 Dong per square metre; a brick and tile roof structure 200,000 Dong per square metre, and a reinforced concrete structure with concrete roof some 300,000 Dong per square metre. Comparing this to the monthly wage of local engineers – in the order of 45,000 Dong per month – gives an idea of the magnitude of the investment. The affordability of housing is a worse problem for farmers and fishermen, with an average family revenue of 40,000 Dong and often less.

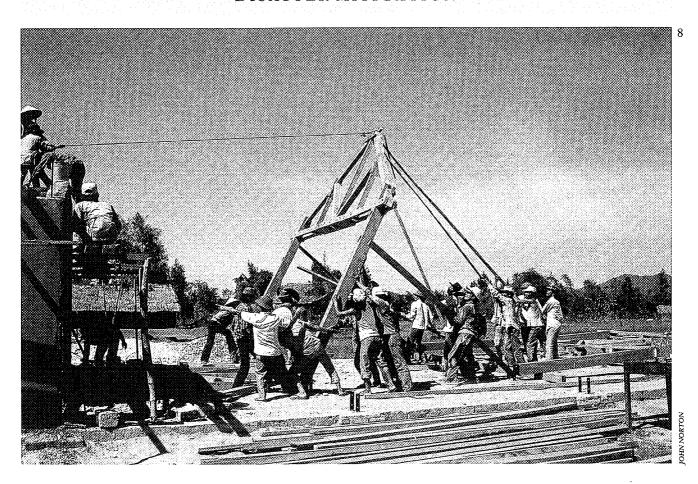
# Typhoon damage and cost: prevention or recovery?

Typhoons of varying intensisty hit the Vietnam coast: those with small intensity which come every year, where damage should be limited; medium, so-called 'ten year typhoons' causing far more major



# MÜMBÜRÜKTINET MI XAY BUNG NHÀ CHÓM G65666





8. Loc Dien primary school – the first demonstration building. Programme participants raising the main roof frames and columns.

damage; and massive '100 year typhoons' which cause major devastation. The effect of typhoon winds for all but the frailest structure is progressive: in a medium typhoon, bamboo and thatch shelters collapse rapidly under the initial buffeting of the wind. Damage to more substantial buildings comes in a sequence of events, where elements are weakened or loosened by pressure and suction: the tiles lift on the eaves and ridges, the entire roof blows away, followed by collapse of the roof frame. Walls are either flattened or carried off, depending on the structure. Rapidly, 70 or 80 per cent of the building can be razed to the ground; 40 to 50 per cent of the materials are lost beyond recovery.

Against this cost and loss, comprehensive surveys carried out by BTT programme participants during 1989 and 1990 show that an extra construction investment of ten per cent (on more solid buildings) to 30 per cent (on thatch and bamboo shelters) would make most buildings able to resist small and medium scale typhoons, the latter seeming to occur more frequently than every ten years. It has thus been a major task of the BTT programme to persuade people to spend time and money on

preventive action in order to secure their investment in the 'transition' building.

#### Who builds and how?

Houses in the BTT zone are usually built by local builders, employed somehow even in the simplest construction. The family helps with the work. Local materials are used for the most part. Usually little or no attention is paid to typhoon resistant construction details and there are no regulations. When a typhoon arrives, last minute measures are taken to stop the tiles blowing off, or the walls collapsing. By this time it is often too late.

Public buildings, designed by provincial and district technicians who carefully follow rules for reinforced concrete design, have habitually had little attention paid to typhoon resistant detailing and form. The local building brigades and contractors who do the construction have little contact with the designer, and pay even less attention to quality control. This sad sate of affairs has too often become the accepted norm.

After a typhoon, the population and the province mobilizes in a major effort to reconstruct, but the quality of work that contributed to the collapse of the building beforehand is now repeated: at the next typhoon the building will be just as much at risk. Thus, the cost of recovery is compounded by its repetitive nature.

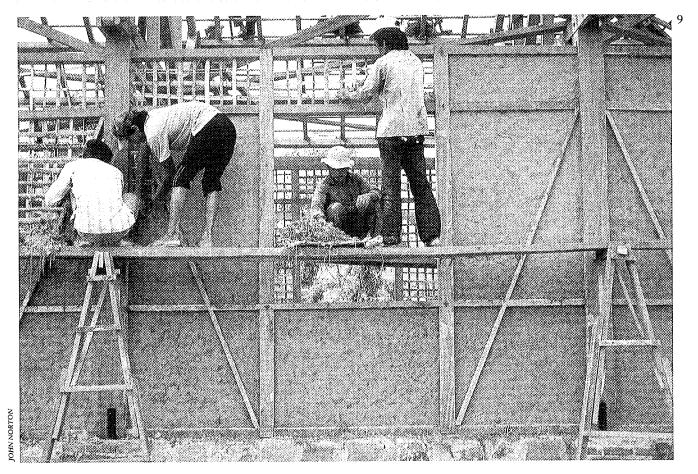
# A programme to create a local capacity

The UN-funded BTT programme followed the massive 1985 typhoons which devastated BTT zone, leaving 875 people dead, 49,000 houses destroyed and 230,000 damaged, 2,600 classrooms destroyed, and six hospitals and 250 health centres damaged.

Implemented by sub-contractors Development Workshop/GRET, the programme's objectives were clear from the outset:

- rather than develop regulations which would impossible to apply, the programme should instill, through training, a local capacity to raise awareness about the need for preventive action against typhoon damage to buildings, and develop a local capacity to show people what can be done to make homes and public buildings stronger.
- The programme should put in place a plan of action at provincial, district and commune level to guide people in how reduce the effect of typhoons on buildings;
- The programme should support these activities by helping the organization of the local services who would in future maintain the plan of action.

In implementing these objectives, one of DW/GRET's local partners, the IBD Hué, has, increasingly, taken a leading role in maintaining the programme.



9. Plastering the walls. Diagonal bracing has been introduced into the framed structure.

#### How to achieve a local capacity

The programme focussed on three levels of activity:

- short (one and two-day) seminars, to raise the awareness of possible actions for typhoon resistant building amongst decision makers and 'politicians' (essential for the long-term continuation of the programme);
- two to three-week training programmes for technicians and builders from the provincial towns, the districts and communes;
- district and province-wide public information programmes to carry the message of the programme to the population.

Developing the organizational as well as the technical skills of the technicians and builders in each province has formed the backbone of the programme. Each provincial seminar has involved the participants in theoretical and practical work: conducting village level surveys to find out the weak points of local construction, how local buildings can be made to resist typhoons, and with which locally available resources; exploring ways in which this information can be transferred to the popultaion: and detailing the extra costs involved. The

participants produced technical dossiers for each aspect, and used the media they felt was best suited to inform the public: posters, poetry, radio and video materials, including a short film.<sup>4</sup>

Central to the programme has been the proposal by DW/GRET, (and the subsequent refinement by the participants) of 'ten key principles of typhoon resistant construction': principles which can be adapted to suit local realities rather than those which cannot be applied by the population: use topography to shelter your building; keep the building form simple, with minimum obstruction to the wind; pitch the roof between 30° and 45° to lower wind suction; avoid large overhangs, and separate the verandah from the house; tie the whole structure firmly together; use diagonal bracing; fix down the roof covering; balance the size of openings; if you can, make sure that all openings can be closed; plant wind breaks.

During each seminar, the participants also designed, and subsequently constructed, a public building. These buildings — a primary school, a health centre and a library — have provided the opportunity to demonstrate the application of the 'ten key principles'. They have given first hand experience to local builders and technicians, particularly with respect to quality control on the building site. These demonstration

buildings have played an important role in making the public aware of the programme and its message.

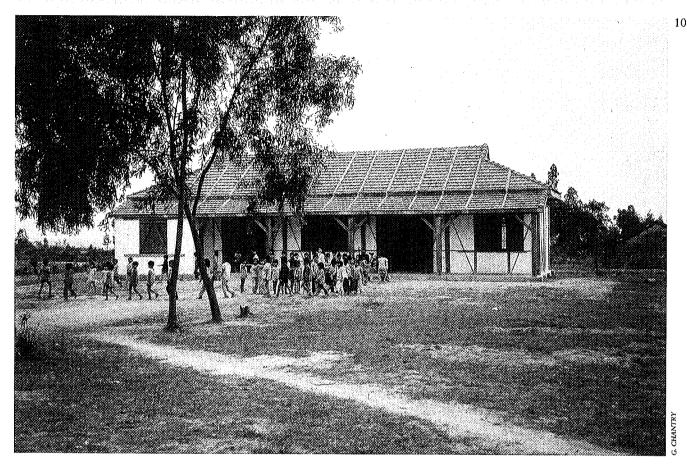
In the course of the seminars, IBD Hué staff have been trained to take over from DW/GRET the role of organization and training, and out of this IBD, Hué has constituted a core Typhoon Resistant Construction Unit: the 'IBID Core Team'.

#### How to get the message to the public?

The most fundamental action in the programme has been to inform the population about the need to protect their buildings, about the ways that this can be done, and who can help them - the builders and technicians trained in the programme. Following an encouraging trial campaign in January 1990, a major campaign was launched in Thua Thien Province in April 1990, reaching some 500,000 people in communes affected by typhoons. The campaign activities have been multiple and rich. In Hué, newspapers ran full page articles prepared by the IBID Core Team. The team toured the province to lecture, and appeared on local TV with provincial leaders to carry the message further. Local radio announced the programme and the times of showings for the video, which was seen by several hundreds of people prior to main feature films. Locally, photography and drawing exhibitions

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## DISASTER MITIGATION



10. The Loc Dien primary school, the vertical ribs on the roof are a traditional method of holding tiles down.

showing action against natural calamities were organized, and in the schools competitions were held for poetry and drawing about the Campaign for Typhoon Resistance Building. Throughout the province, the Women's Union, The Youth Union and the Farmer's Union organized public gatherings on the same theme. Over 2,500 large posters were shown in gathering places, markets, bus stations and cafés all over the province. On the Provincial Day of Disaster Preparedness, 26th April, youth brigades paraded the streets of each district with specially prepared banners, and radio and TV stations ran special programmes. This campaign met with great enthusiasm and several districts prolonged activities into a second month.

#### A plan of action in place

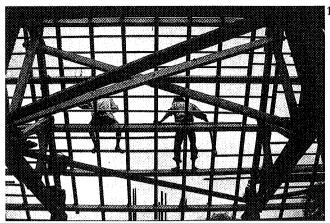
Developing from the seminars, and embodied in the first public information campaigns, was a plan to ensure the spread and application of typhoon resistant building techniques, first in the provinces of the programme, and gradually to other provinces, ultimately becoming a national programme. Its execution brings together three levels of action. At province level, the Building Institutes constitute the Typhoon Resistant Construction Unit. The Unit organizes the programme, prepares training and information materials, trains district technicians, and constantly evaluates and improves the programme. At district level, local technicians now trained in typhoon resistant construction techniques, become the local public advisers, helping families and training local builders. They also advise on how the core teams should improve the programme. At the commune level, the local mason and carpenter, once trained, through involvement in domestic building activities provides practical advice in house design and materials.

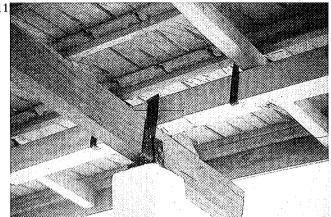
In the plan's application, the experience of 1990 has also shown the important role to be played by local institutions in information dissemination, education, and political decision: mobilizing resources of people and money - and complementing the skills of the core teams.

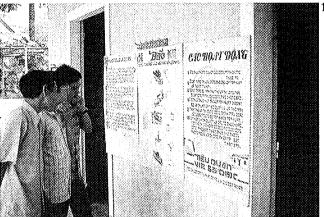
The impact of the BTT programme is, so far, very positive: the constitution of specially trained teams, a process of training technicians and builders which has been tried and tested, and the development of an excellent local knowledge of 'what is possible'. Linked to the experience of the public information campaigns, this represents a real capacity to identify applicable

12

#### DISASTER MITIGATION









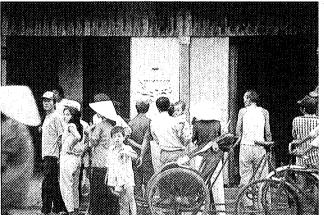
11. Work on the roof frame, strengthened by horizontal and vertical timber bracing.

12. Metal straps link the roof elements: great attention has been paid to improving the small details that tie whole buildings together.

13. The public information campaigns: villagers reading posters and poetry sheets about the ten key points of typhoon resistant building techniques.

14. Villagers gather with interest round the 'ten key principles' poster.

techniques, evaluate them and assure their dissemination. Nevertheless, after two years of action, the programme must still confront some major issues. It is clear that for many families who live in the frail thatch, branch and bamboo structures, there is still almost no chance that their home will resist a typhoon: the extra cost is prohibitive. It is realistic to envisage the improvement of 'transition' buildings, to resist, at least, a medium 'ten year' typhoon; but there is still insufficient protection against the massive '100 year' typhoons, frequent in recent years, which destroy essential public infrastructure as much as private homes. The economic situation of the country and the people imposes severe limitations on what can, in reality, be achieved.



For the individual family, the notion of spending extra scarce resources on protection against a typhoon that may not hit your home remains hard to accept: child vaccination against disease is becoming accepted; 'vaccinating' your home against typhoon damage still needs much promotion and active demonstration of the benefits it brings. These remain the tasks for the years ahead.

#### Notes

- 1.Until July 1989, these three provinces were known as Binh Tri Thien Province. Quang Binh has a population of 646,000; Quang Tri 458,000; and Thua Thien 891,000 (1989 figures).
- $2. Thanh\, Hoa\, province, just to the north of the\, BTT$ provinces, was hit by a major typhoon in October 1989. DW & GRET were called in to provide rehabilitation assistance, and at their instigation involved the Vietnamese institutes of IBD Hué and IHPBD Hanoi
- 3.One US\$ = 4500 Dong in 1989.
- 4. We Build our New House a story about a young family who follow the advice of properly trained local builders and technicians: their new home resists when the typhoon arrives.

JOHN NORTON IS A DIRECTOR OF DEVELOPMENT WORKSHOP (EUROPE OFFICE: BP13, 82110 LAUZERTE, FRANCE); NGUYENSI VIEN IS DIRECTOR OF THE IBD DESIGN, 24B LY THUONG KIET, HUÉ CITY, THUA THIE-HUÉ PROVINCE, VIETNAM: **GUILLAUME CHANTREY IS A MEMBER OF** THE HABITAT CO-ORDINATION TEAM, GRET, 213 RUE LA FAYETTE, 75010 PARIS, FRANCE.



# FLOOD ADAPTIVE HOUSING IN BANGLADESH

# Peter Duby

Architectural designer Peter Duby was a volunteer for the Red Cross from August 1988 to December 1989 with the task of developing disaster relief housing for the handicapped and landless in Bangladesh, following the 1988 floods. Here he describes his experience in developing a model for houses with better flood resistance for the most vulnerable of the population.

magine, if you will, a billiard table. Flat. Bangladesh is so flat that the Gangetic dolphin not only swims up the rivers of the country, but swims out the other side too; leaving the country at a distance of 400 kilometres from the sea, but at an elevation of just 17 metres above sea-level. The country is watered (flooded would be more appropriate) by three great rivers, the Ganges, the Brahmaputra and the Meghna, which combine to form the largest delta in the world, with a freshwater outflow second only to the mighty Amazon.

Bangladesh lies at the apex of the Bay of Bengal, one of the most fecund of all bodies for giving rise to cyclonic storms. In August 1988 the rise in water in the Ganges, resulting from a late monsoon over northern India, coincided with the rise in water in the Brahmaputra, following an early snow melt in Tibet; and, combined with a spring tide and one of these onshore cyclonic storms, resulted in unprecedented floods. Over sixty per cent of the country was inundated.

With a population approaching 120,000,000 in an area of 143,998 square kilometres, and with a per capita average income amongst the lowest in the world, the country has to rely on intensive cereal agriculture; thus even fairly small upsets to the delicate balance of the routine rapidly deteriorate into major disasters.

The short history of this country is beset with calamity. Created by the stroke of a civil servant's pen in the early years of this century while dividing the unruly province of Bengal into West and East, and with its boundaries confirmed by the creation of the Islamic state of Pakistan at the partition of India in 1947, it took a bloody civil war to win independence

in 1971. Almost immediately, the infant state was crippled by the devastating famine of 1974, and into this situation poured large amounts of foreign aid, establishing a pattern of dependency that exists to this day; foreign aid is responsible for over 75 per cent of the GNP.

Because the land is so flat, the flooding in Bangladesh is seldom very deep and the water does not rush with great speed. The image of the billiard table, but with a pail of water spilt on it, may suffice. This may mean that fewer lives are lost through drowning than might be expected, but it does not reduce the damage caused by the rising waters. It was estimated by the International Red Cross that beside the quarter million or so, families that had been added to the two million families already homeless in Bangladesh, another million homes had been severely damaged by the 1988 floods.

1. During the flooding the local people take to the rooftops, setting up complete communities on any available flat roof—in this case on the local mosque.



In November 1988, a cyclone struck the southeast of the country and resulted in an estimated 5,000 deaths, besides wreaking havoc in several districts. Finally, on 29 April, 1989 the area of Manikganj-Saturia was struck by what was quickly labelled a tornado, but actually appeared to be a hurricane or typhoon. Besides inflicting injury and death, the storm demolished or severely damaged thousands of houses. By the time of this third disaster, the Red Cross, working through the local body, the Bangladesh Red Crescent Society, had in hand a detailed operation for the building of 10,000 houses. This was by no means the only relief housing programme; other Non-Governmental Organizations such as Oxfam, Christian Aid and Enfant du Monde were considering rehabilitation programmes and the local Grameen Bank had its own project of housing loans for the rural poor but the Red Cross programme was designed specifically to reach the handicapped and landless among the poorest sector of the population.

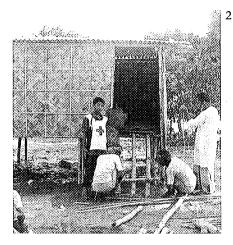
The Red Cross houses were developed by the writer, and based on materials and techniques employed while constructing, in conjunction with a local 'bamboo builder', a temporary clinic on the roof of a flooded clinic that serves one of the most densely populated slums in Dhaka. As part of the background research, more than a dozen designs for disaster relief houses, by both local NGOs and international aid organizations, were assessed and costed to a common baseline.

The average house appeared to be a single room of about 6 x 3 metres, with

walls of woven bamboo matting and a pitched roof of corrugated iron sheeting, which is locally rolled but from imported steel sheet. Details varied between the different designs, some having welded steel tube frames and others having precast concrete frames; but all shared a common feature in that the floor consisted of a platform which had to be provided by the beneficiary, built of the local clay about 300mm above the natural ground.

This clay platform, of course, becomes waterlogged and during flooding is liable to return to the natural state: mud! It was felt, by the Red Crescent medical advisers, that sleeping on cold, and possibly damp, clay floors was responsible for various rheumatic ailments suffered by great numbers of the population. It was decided that the houses should have some form of raised flooring. However, Bangladesh is now alarmingly deforested and timber is therefore an unaffordable luxury. The answer was to raise the whole house on stilts, to avoid minor flooding; and to make the floor of bamboo. This then was the starting point of the design. One of the early criticisms of this design was that the Bangladeshi women, many of whom wear bourka of Moslem purdah, would not climb the ladder to a house on stilts. The local people were asked to comment on this aspect of our first sample houses, and the comment was that as long as the floor platform was below the eye-level of the average man, no impropriety would be construed.

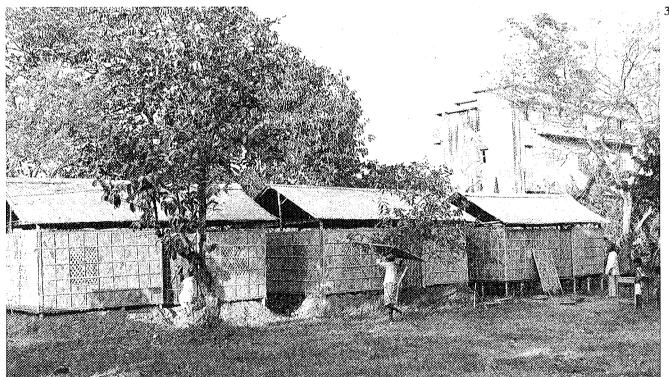
A further consideration in the development of the house was that many



2. The construction of the first sample Red Cross house, which took place during the floods of 1988, while the water was at its highest. The raised floor, the mouli bera walls and the mono-pitch roof can be seen.

3. Three sample houses built in the compound of the Bangladesh Red Crescent in Dhaka. These sample houses contain various elements that were under consideration. The house on the right is built on stilts, as used in the relief housing programme, but those houses also had a corrugated iron roof, as can be seen on the house in the centre of the picture.

of them would be built for landless people on the strength of a witnessed agreement of temporary occupation by the landowner. Landowners were known to rescind on these agreements and install their family members in houses built for



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## DISASTER MITIGATION

the less privileged. The house was therefore designed to be collapsible, and could be transported on a pedal rickshaw and re-erected by the beneficiary or his friends.

A costing exercise revealed that each house would be supplied and built for just over US\$ 110; making the Red Cross house the cheapest of all the house designs available for comparison. The house could, and would, be donated, free of any input from the beneficiary; a factor that meant that, for the first time, even the crippled and disabled homeless could be reached. Furthermore, enough roof sheeting for two houses could be carried, together with the building crew, in a local country boat; the bamboo, all still in its raw state, was tied in bundles and towed along behind the boat like a barge; allowing the Red Crescent to build houses in locations accessible only by boat.

The actual construction begins by sinking the ten main poles into the ground. For these pillars the base of the cane of a variety of bamboo known for its thick wall and great strength, called 'borak', is used. First coated with old motor oil (obtained from the bus rank), these columns become both the stilt and the framing for the walls, so it is to these that the cross- and edgebeams for both floor and roof are attached. All joints are lashed, using coir or jute twine — a traditional fixing.

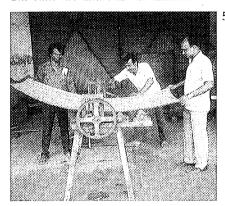
The woven bamboo matting for the walls, known as 'mouli bera' (from mouli, a variety of thin-walled bamboo that grows with a fairly constant diameter over most of its length, and bera, matting) is made up on site. First the mouli is split once along the length and opened out and flattened, forming long even strips about 100mm wide. These strips are then split in their thickness, creating two types of strip; the hard outer skin, known as 'pit', which contains the highest concentration of silica and is the most weather-resistant, and the softer, more pithy inner section known as 'book', and suitable only for internal use. Each wall is tailor-made of a single panel of bera framed with thin strips of borak, and lifted into place and fixed. To form the floor, a series of borak poles were split into four and lashed into place; this base was covered by a layer of mouli bera and finished with a soft grass or palm frond matting. Each beneficiary was advised that limewashing the stilts and underside of the floor would decrease the chance of attack by insects.

In the earliest versions of the house, a mono-pitch roof was used, but this did not allow for air circulation beneath the corrugated iron sheeting; so a pitched roof was adopted. After the wind storm at Manikganj-Saturia in April 1989, when I had been one of the first outsiders on the scene, with our Red Crescent medical



4. A very graphic display of the force of the wind storm of April 1989; note that the corrugated iron sheeting has been bent around the tree against the corrugations.

5. The first example of the machine for curving corrugated iron sheeting developed from scratch by Md. Hafizul Hassan, who can be seen on the right of the picture. The other two men built the machine.



teams just two days after the event; it had been noted that a great deal of the injuries had been caused by flying corrugated iron roof sheeting torn from the buildings and sweeping through the air like flying scythes. This led to a study of the aerodynamic qualities of the sheet and resulted in the recommendation that the sheet be curved on a gentle arc to ensure that in a high wind free sheets would fall to the ground. As the manufacturers were unable to curve their sheet, the matter was discussed with a local engineer and put to a remarkable man, Md. Hafizul Hassan, senior engineer at the Mirpur Agricultural

4 Workshop and Training School, who designed a machine on no better information than a hazy memory of having seen such a machine in Africa, He had two ex-students build the machine. turning the shaped rollers by hand, from an old ship's propeller shaft, and produced sample sheets. These curved sheets proved (as expected) to be inherently stable structurally; and were capable of spanning from wall to wall, eliminating the need for a roof structure, thereby effecting a saving of almost 20 per cent per house on our base costs. Unfortunately the modification was not adopted; had it been, 20 per cent more houses might have been built.

Further thought into the problem of flying roof sheeting led to consideration of the failure of the structure; when the roof sheeting was torn off by the wind to become a deadly object. The standard method of fixing the roof sheet was by means of the conventional roofing screw developed to hold corrugated sheeting to timber purlins. Because of the lack of available timber, the local people are forced to use bamboo strips in place of timber purlins. Bamboo shrinks laterally as it dries, and many roofing screws can be extracted with little more than finger pressure. An alternative fixing was designed, using a simple principle found elsewhere; a fixing which would have reduced still further the cost of each house, and ensured that, in the event of high wind, the roofsheet would remain attached to the house. But there was no local interest in this alternative fixing; the Bangladeshi industrialists were reluctant to venture capital on untried products whose cost benefit had not been proven.

By the end of 1989, as my agreement with the Red Cross came to an end, I began to see the long-term benefits of the housing. I was taken to see a house that had been built in a particularly poverty-stricken slum for a handicapped widow with three children, on a minute piece of land belonging to a man who supported his family with seasonal work as a goatherder. This new establishment had meant that two of her children, six and eight years old, could now find regular employment — in part payment for which they were being taught to read.

#### PHOTOGRAPHS BY THE AUTHOR

PETER JON DUBY, A FRENCH CITIZEN, WAS BORN AND BROUGHT UP IN AFRICA, AND HAS SPENT MOST OF HIS WORKING LIFE IN THE DEVELOPING WORLD. HE IS CURRENTLY ASSISTING SKAT, THE SWISS CENTRE FOR APPROPRIATE TECHNOLOGY, IN A STUDY TO IDENTIFY PROMISING BUILDING MATERIALS AND TECHNOLOGIES IN BANGLADESH. WHEN IN LONDON, HE WORKS AS A CONSULTANT TO CHAPMAN TAYLOR PARTNERS.