NEW TOWN HOUSING AND PLANNING

FOR BURMA

Submitted in partial fulfillment
of the requirements for the degree
of Master in Architecture at The
Massachusetts Institute of Technology.

May 13, 1957

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Dear Dean Belluschi:

In partial fulfillment of the requirements for the degree of Master in Architecture, I submit the following thesis entitled "New Town Housing and Planning for Burma."

Sincerely yours,

William D. Warner

To my wife, Cynthia for her encouragement, help, and her willingness.

To Geoffrey and Jonathan for ??????

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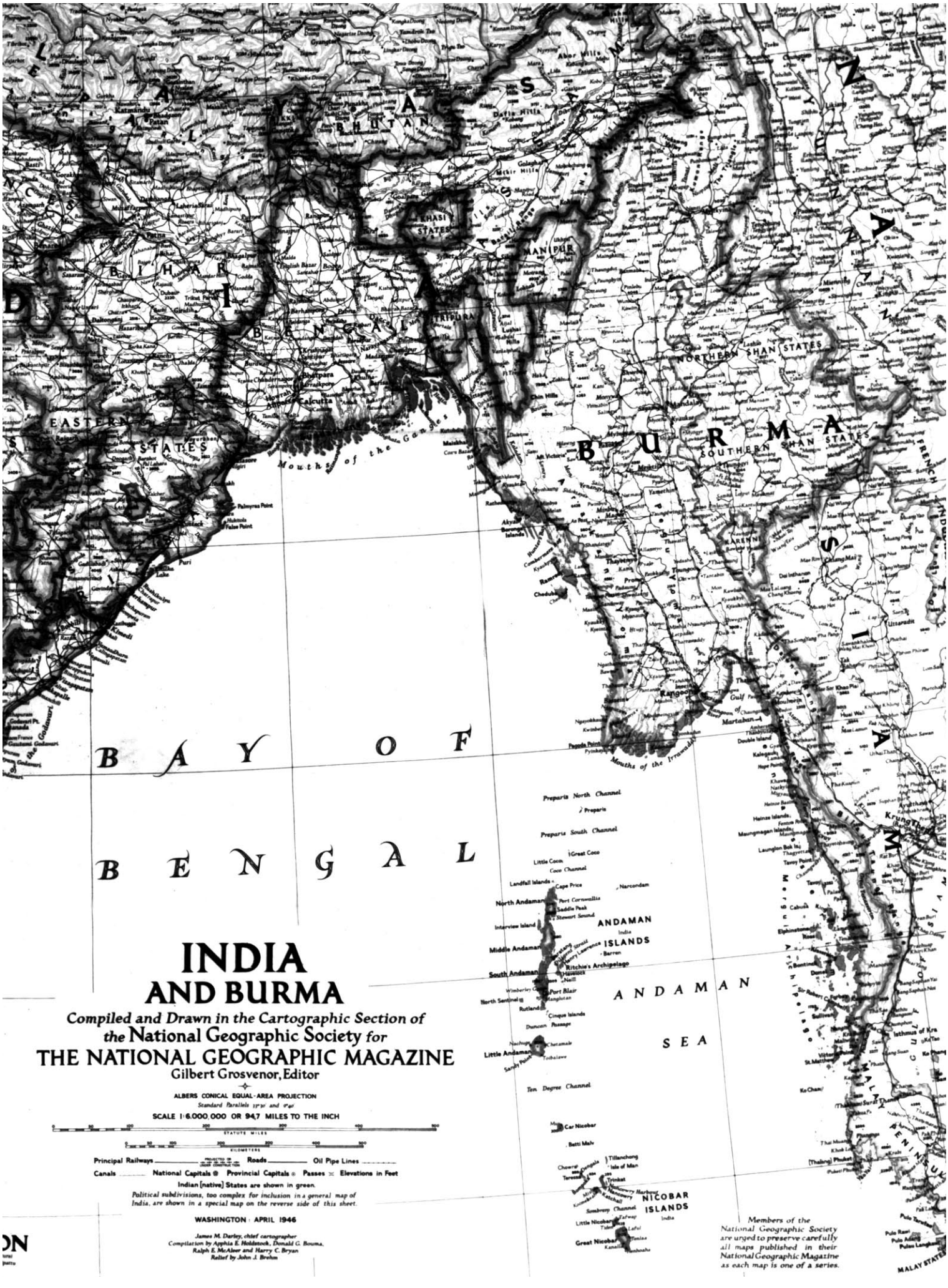
BACKGROUND AND INTRODUCTION TO BURMA

The success of a program for design of a new town depends on the knowledge and collaboration of a team of experts using the tools of a myriad of disciplines. To give meaning at a basic level to the whole process however it is necessary to understand the people in their roles as humans, as individuals, and as members of families and communities. It is particularly important in this case for two reasons: one, because the economy, education, tradition, in short, the whole culture is different from ours. Two, because a town is being planned instantaneously by a small group of men instead of evolving over a great length of time as the result of thousands of careful decisions from the entire community of citizens.

Physical

Burma is a land rich in forests and fertile land, netted with many rivers and their associated benefits of cheap transportation and hydro-electric potential, yet it is relatively under-populated particularly in comparison with its neighbors India, China, and Pakistan. An interesting comparison can be made with Great Britain which has three times the population in only one-third the land area.

In certain respects the country can be thought of as being split into two regions: the river valley and delta region of the south, and the highlands and plateaus principally of the north. Different climates and ways of life accompany this division. The fertile lands of the south and the hot, humid climate have been factors in establishing a vast rice growing belt which has been settled mostly by the Burmese. The upland areas have a warm-dry climate with a more varied but less rich agriculture and are peopled with a variety of ethnic groups.


INDIA
AND BURMA
Compiled and Drawn in the Cartographic Section of
the National Geographic Society for
THE NATIONAL GEOGRAPHIC MAGAZINE
Gilbert Grosvenor, Editor
ALBERS CONICAL EQUAL-AREA PROJECTION
Standard Parallels 37°30′ and 67°30′
SCALE 1:6,000,000 OR 94.7 MILES TO THE INCH
STATUTE MILES
KILOMETERS
Principal Railways
Roads
Oil Pipe Lines
Canals
National Capitals
Provincial Capitals
Passes
Elevations in Feet
Indian [native] States are shown in green.
Political subdivisions, too complex for inclusion in a general map of India, are shown in a special map on the reverse side of this sheet.
WASHINGTON: APRIL 1946
James M. Darley, chief cartographer
Compilation by Apphia E. Holdstock, Donald G. Bouma, Ralph E. McAbee and Harry C. Bryan
Relief by John J. Brehm
Members of the National Geographic Society are urged to preserve carefully all maps published in their National Geographic Magazine as each map is one of a series.
BAY OF BENGAL
ANDAMAN SEA
ANDAMAN ISLANDS
NICOBAR ISLANDS
BHUTAN
KHASI STATES
MANIPUR
TRIPURA
NORTHERN SHAN STATES
SOUTHERN SHAN STATES
EASTERN STATES
BURMA
Mouths of the Ganges
Mouths of the Irrawaddy
Calcutta
Rangoon
Mandalay
Chiang Mai
Martaban
Gulf of Martaban
Preparis North Channel
Preparis
Preparis South Channel
Great Coco
Little Coco
Coco Channel
Landfall Islands
Cape Price
Narcondam
North Andaman
Port Cornwallis
Saddle Peak
Stewart Sound
Interview Island
Middle Andaman
Barren
Ritchie's Archipelago
South Andaman
Neill
Wimberley
Port Blair
North Sentinel
Rutland
Cinque Islands
Duncan Passage
Little Andaman
Ten Degree Channel
Car Nicobar
Batti Malv
Tillanchong
Isle of Man
Trinkat
Kamorta
Katchall
Sombrero Channel
Little Nicobar
Tafwap
Tuhet
Lafol
Great Nicobar
Kanaidao
Chowra
Teresa
Palmyras Point
False Point
Puri
Chittagong
Akyab
Ramree
Chedubaw
Mergui
Tavoy
Moulmein
Thaton
Pagoda Point
Double Island
Kalegauk
Hope Point
Heinze Islands
Maungmagan Islands
Launglon Bok Inj
Tavoy Point
Kyaukpyu
Kyaukphyu
Ramree
Cheduba
Isthmus of Kra
Ko Chang
Pulo Rawi
Pulo Adang
Pulo Langkawi
MALAY STATES

Great mangrove forests rim stretches of the tidal lands. Small fishing villages are scattered about like knots in a net of tributaries that shift through the delta country of the Irrawaddy and Salween rivers. Parallel to the rivers long ridges run north and terminate in the plateaus and mountains which form the boundaries with China, Pakistan, and India.

Historical and Cultural

Like many of the countries in this part of the world Burma has a mixture of over one hundred ethnic groups within its population.[1] The following table lists major groups.[2]

Burmese	13	millions
Karens	3	
Shans	1	
Indians	.8	
Chinese	.3	
Others	.4	

The Karens and the Shans have been the longest in the area yet they are in the minority and have not been as active in developing the new Burma as the Burmese are. These people for the most part have lived in the less fruitful upland regions of the country either by choice or because of conflicts with the Burmese. The Burmese stock originated in Tibet and China and they settled in the country sometime before the ninth century. They occupied the delta and valley regions of the Irrawaddy River where they developed a rich culture and adopted Buddhism as their religion. For centuries their economy was a simple one primarily based on rice and fish. The religious simplicity of the people's needs and the ease with which the country-side allowed them to be fulfilled contributed to cultural attitudes about work and savings.

Commercial contacts with the outside began with the Portugese during the sixteenth century and were followed by regular trading with the Dutch, French, and finally with the British who occupied the country during the first half of the eighteenth century. During these centuries the great upswing of economic life had several implications: The introduction of a money economy, the formation of new kinds of jobs associated with commerce, industrial production and shipping, and the production of goods (teak, rice, oil, minerals) in excess of consumption to provide a basis for trade or colonial export.

The Burmese did not as a whole participate in this new phase of economic life; instead large numbers of Indian and Chinese immigrants entered the country to take up jobs as clerks, laborers, and storekeepers to such an extent that by 1900 they constituted two-thirds of the population of the six large urban centers of Burma.[3.] Two reasons have been given as possible answers to this unusual situation. The first involves the British colonial policy where the British felt that they could best rule by dividing the people and allowing minority elements such as the Indians and Chinese to assume considerable economic and administrative power. However this is not entirely true, for the immigration of these people started much before the British had colonized the area.

The second reason concerns traditional Burmese culture. This reason has some validity; namely that cultural attitudes caused the Burmese to hesitate to take up these new jobs and opportunities; hence the vacuum was filled by the Indians and Chinese.[4.] The agricultural sufficiency plus Buddhism produced a framework in which spare time was spent at religious festivities and dances rather than for increased production as a means of trading power. Similarly, any savings were given for religious purposes

instead of for expansion of production or for acquiring material goods.

Associated with the growth of nationalism there has been a marked change in these attitudes as is evident in the mushrooming of urban areas and in the present surge of industrial and economical activity throughout the country. Four important foctors have shaken the political and cultural structure of the people from a village-autonomous system into a modern twentieth century democratic state. These are first, the British imposing of a central judicial and administrative system upon the century-old village headman system. Second, a unifying desire to be rid of the British. Third, World War II with the Japanese occupation and vast destruction received from both sides (Burma suffered devestation second only to Japan.) and fourth and perhaps most important, the growth of technology with its itergrating influence on communication and transportation.

Religion

Traditionally the monastary has been the focus of Burmese village life. Buddhism was looked to for educational and social needs as well as purely religious ones. All males were expected to join monastaries for a certain period of training. Education centered on observing religious practices rather than for practical use in outside life.

The importance of the monastary has greatly diminished in the last generation especially in the urban areas. Public education has supplanted its teaching functions and the monastary has not modernized its teaching program to compete as has the parochial school in the West. Commercial entertainment and growth of social organizations has to a

degree replaced many of its social functions.

As mentioned before, monetary wealth was discouraged by religious values. Depending on the resources of an individual he was expected to donate anything from food for the village monks to the cost of the construction of a pagoda. Charity was institutionally rather than socially directed and was more a way of increasing self-evaluation than benefiting society.

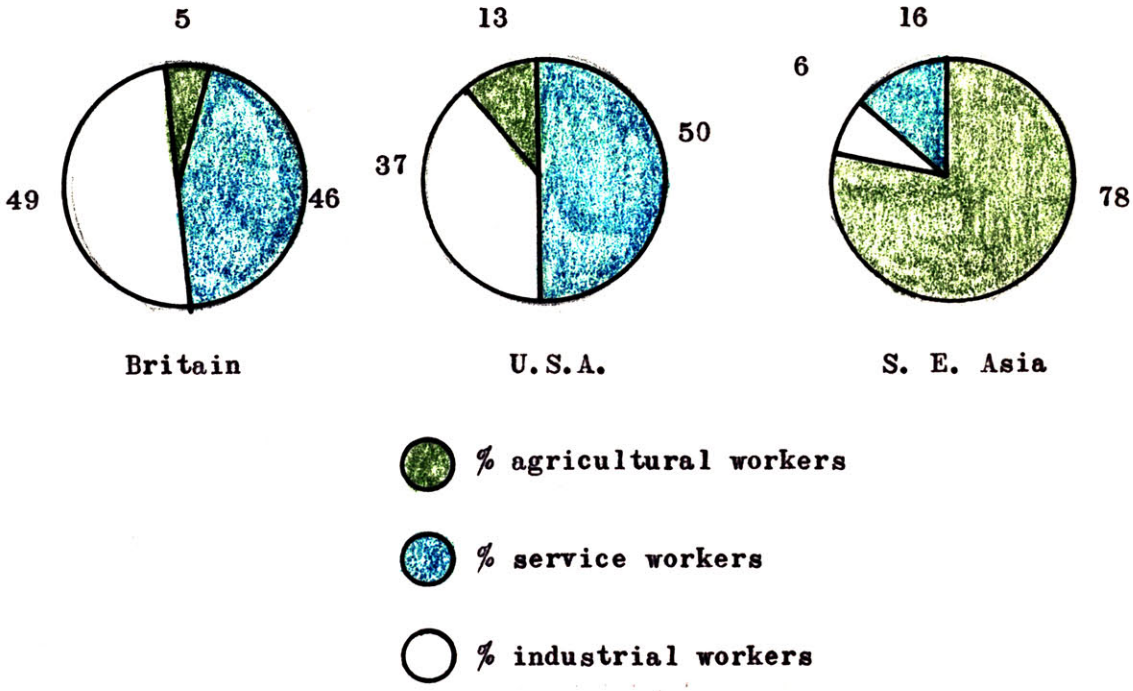
Two aspects of religious thought which are still strongly held in belief are the relationships a person has with the "nats" and his balance of merits with respect to his "kan". The "nats" are ever lurking invisible mischief makers and must be appeased to prevent their evil acts. Such precautions constitute a large complex system of rituals including such proceedures as wearing a yellow string around the left wrist or sprinkling hallowed water about the house depending on which "nat" is to be intercepted.[5.] A man after insuring himself against drowning by acting out the proper ceremony with deference to a "water-safety" "nat" proceeded to bind his wrists and legs and instructed his friends to drop him into the middle of the river which they did, and as a result he drowned. The observers felt that the man had somehow offended the "nats." Today though this kind of thinking could not occur in the urban areas, it might well still happen in the distant rural villages.

The other important religious idea is that of increasing one's "kan". The "kan" is a kind of eternal bank balance of an individual's personality with regard to evil and meritorious deeds. The "kan" in the idea of incarnation is transferred from one life to another. A poor record in one life may cause one to become a vile frog in the next. A "kan" is increased particularly by observing religious

traditions and donating to the church generously.[6.]

The Economy

Burma's economy can be described as an agrarian economy, but it is one which is in transition to industrialization. An idea of the progress it must make can be seen from a comparison of the charts below showing the allocation of labor force.



Rice and timber are the most important "products" in Burma's economy. With them she feeds and houses her people and exports the rest to maintain a foreign balance of payments which she needs so desperately to purchase items abroad necessary for the capital expansion program. Rice accounts for two-thirds[7.] of all crops and 80%[8.] of the country's exports. Other crops include groundnuts, pulses (types of legumes), sesamum (used in making fats and oleomargerine), millet (a kind of cereal), maize, cotton, tobacco, sugar cane, fruits, and other vegetables. Ohly about fifty percent of the suitable land is cultivated.[9.]

About half of Burma is covered with forests containing about seventy-five percent [10.] of the world's supply of teak. One fourth of the lumber annually produced is teak, most of which is exported. The journey of logs to the mill or to export shipping locations is a long one. Elephants haul the logs to a stream into which they are dropped to make the trip at the mercy of the currents. Some logs take years to arrive at their destination, others never get there. This industry is gradually becoming more mechanized.

Oil is another source of wealth in Burma, but more intensive development of the facilities destroyed during World War II are necessary before it will reach pre-war production levels.

The government is desperately trying to increase the ratio of imports for capital development and reduce those for immediate consumption. For example, over half of 1953's imports were building materials.[11.] The government realizes this and is placing a primary emphasis on the construction of building material industries. It presently has facilities for manufacturing part of the requirements for steel, cement, mill products, bricks and tile, glass, concrete blocks, and has planned for expansion and addition.

The government partly with the help of United States technical assistance and of a large consultation firm, Knappen, Tippetts, Abbett, McCarthy, Engineers has launched a three phase fifteen year industrial development program involving over forty five large projects.[12] These will be built primarily in the industrial centers of Akyab, Myingyan, and Rangoon. The pharmaceutical, burlap, and spinning industries on this particular site are a part of this economic development program.

Rangoon and Urban Burma

I have previously mentioned that a cultural split exists because of a geographcal division between the upland regions and the valley lands. An equally important cultural difference lies between the people of the cities and those of the rural regions, The cities have been largely influenced by the West and particularly by Britain to such an extent that Rangoon has more in common with London, Rome, and New York than it does with the villages on the upper reaches of the Irrawaddy River. This split between the lives of the villagers and the city dwellers has made itself felt on national levels and there exists some bad feelings for the government which is believed to be too firmly controlled by the educated people of Rangoon. [13.]

Only about 8% [14.] of the people live in cities of over 10,000 population, but this number is rising more rapidly than it did in the cities in the United States during the great influx from the farm lands. This tide of urban migration is causing squatter and permanent slum problems which have never before been known in the West. Calcutta and Singapore and other Asian cities have districts where the density has reached over 1,000 people per acre. Some families occupy rooms with no outside light access; others less fortunate take shelter under stairways or other semi-covered areas.

There are few large cities in Burma. Mandalay is the central city in upper Burma. Akyab and Mymgyan are towns of some industrial importance, but these three cities are small in comparison with Rangoon, the nation's capital. Rangoon is the combined New York and New Orleans of Burma. As a port it handles 85% of all foreign trade and 44% of the costal commerce. [15.] It serves as the terminus for the

river traffic of the Irrawaddy and the delta systems. The population now stands close to 800,000.[16] and is rising rapidly. This influx is occurring at a faster rate than housing accommodations can be built and consequently several communities of squatters have been formed, though many of these people are being housed temporarily in settlements by the government.

Education

The Burmese have always had a rather high rate of literacy owing to the tradition of young males entering the monastary for a period of learning. Such education has been limited however. Though the young men received instruction in reading, writing, and religion they were not instructed in technical, scientific, and social matters. In modern Burma the monastaries are playing much less of a role than previously. The government is now engaged in a program of building schools and training teachers as rapidly as possible to make education through high school compulsory. The chart below gives an indication of ground to be covered before this goal can be realized.

	Age 5-10	Age 10-15
Attending		100,000
Kindergarten	200,000	
Primary grades	180,000	
Monastary	200,000	
Not attending	1,670,000	1,900,000
Total	2,250,000	2,000,000

School Attendance For All Burma, 1951 [17]

Other phases of the educational program include large scale adult education, vocational training centers to

raise the supply of skilled workers, and high school systems offering the student a choice of technical, university, or agricultural training. University training is publicly financed and facilities are primarily centered at the University of Rangoon with its affiliated colleges in Mandalay.

Health

The public health situation in Burma follows a pattern similar to other nations in this part of the world. Some telling statistics follow: [18.]

1. The average life expectancy is one half that of the United States.
2. 20% of the infants die before the age of one year.
3. 50% of the children die before the age of ten years.
4. The most prevalent diseases are malaria, tuberculosis, and venereal disease.

The gap is slowly being closed as hospitals and clinics are being built. More doctors are being trained and the public is becoming more aware of modern medical and health methods and concepts.

Housing

Housing and its related activities have been administratively coordinated under the National Housing and Town and Country Planning Board. In addition to its housing and planning functions the board is engaged in materials research, materials production planning, financial aid for low income groups, and providing services to private home builders. The government housing program got under way in 1952 with an initial budget of 5% of the government income. [19.] The ten year program goal is 240,000 non-basha (permanent) types of homes to

be built by 1962.[20] The housing problem is largely urban since villagers are able to build relatively spacious quarters with local materials doing the labor themselves with the help of a few neighbors.

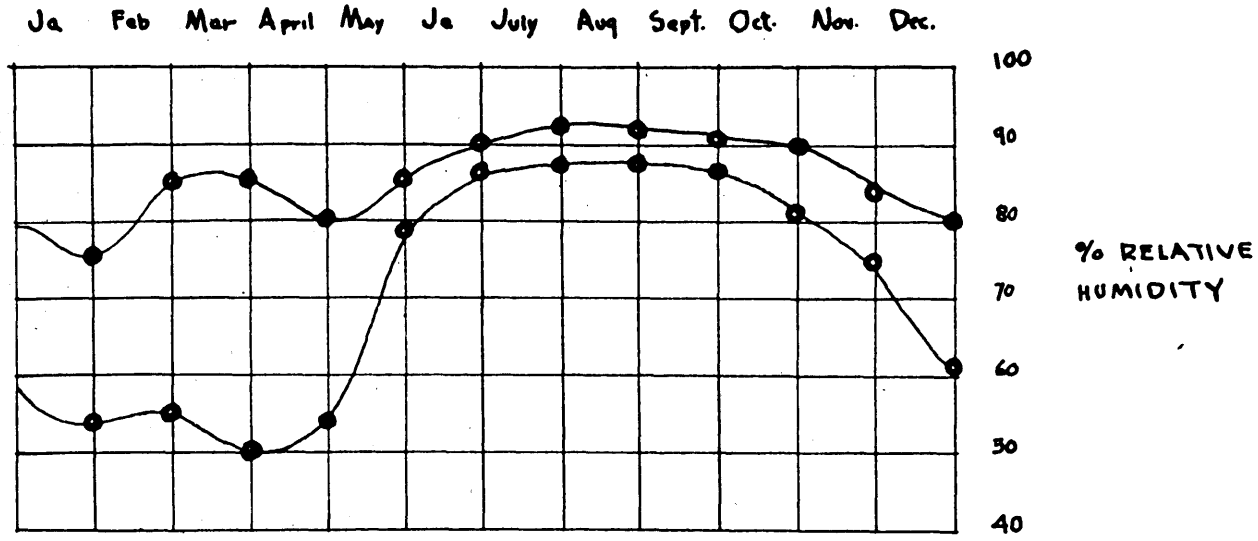
DATA FOR DESIGN

Climate

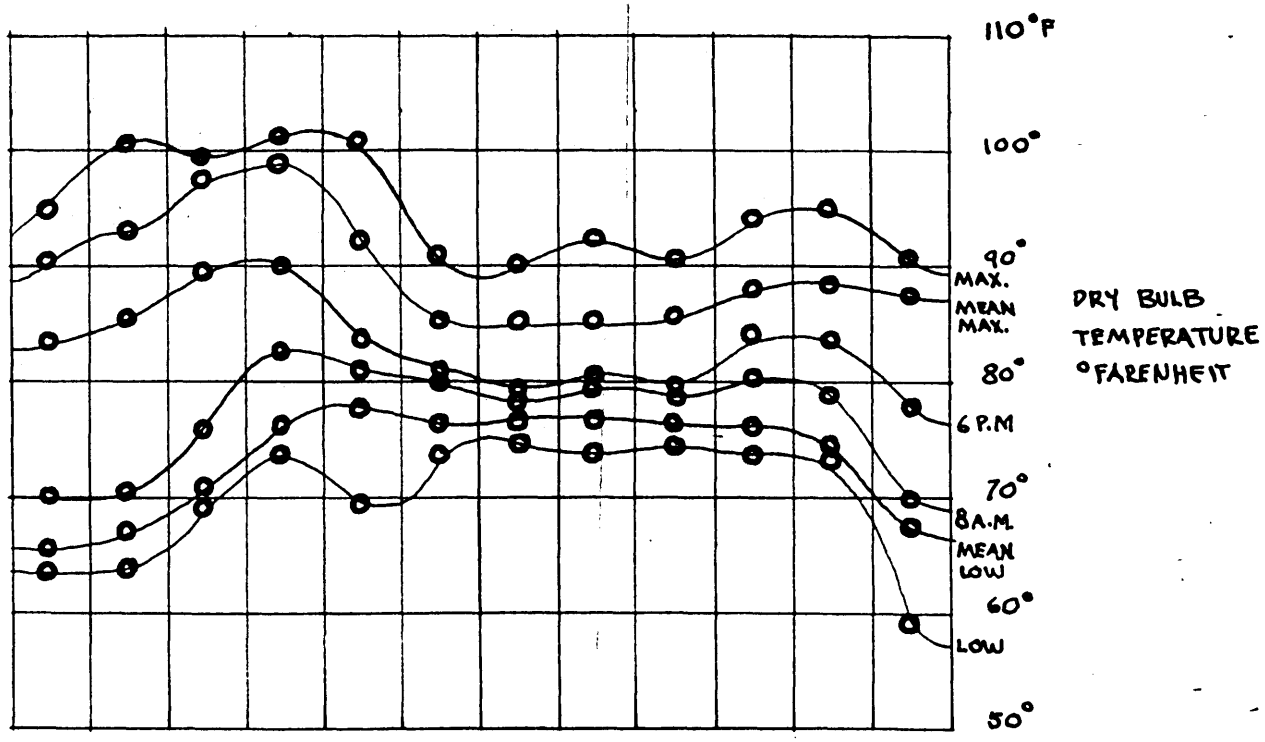
Description: Most of Burma is within the world's tropical climate belt where the weather conditions are hot and humid. The year has three seasons: the hot period from March to mid-May or early June when even by nine A.M. ...."the heat throbs down on one's head with a steady, rhythmic thumping, like blows from an enormous bolster.".. [21.] ...."and glare from the sky, buildings, and vegetation makes ones eyes ache and sends a weariness through one's bones." [22.] The monsoons follow with four and one half months of rain when it...."rains for as much as thirty-eight hours at a stretch, sometimes pouring down in such cataracts that one thought the whole ocean must by now have been sucked up into the clouds, and inside the rattling on the roof became maddening after a few hours." [23.] The delightful "cool" season completes the cycle with its period from November through February. This is the season when...."the rain tailed off, the fields dried up, the paddy ripened, and the children played hopscotch with gonyin seeds and flew kites in the cool winds. The sun circled low in the sky, and the nights and early mornings were cold, with white mists that poured through the valleys like the steam of enormous kettles." [24.]

A complete record of the climate in the Rangoon area appears on the following charts. This information will be employed later in arriving at an architectural design which will give maximum protection from the elements.

Climate and man: Two questions must be answered in reference to climate: First, how does man react as his



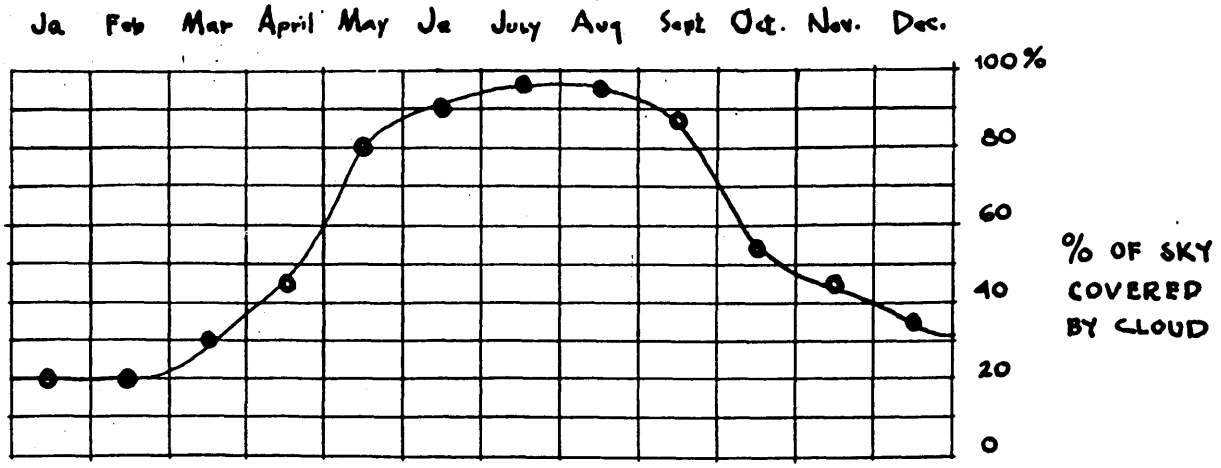
RELATIVE HUMIDITY



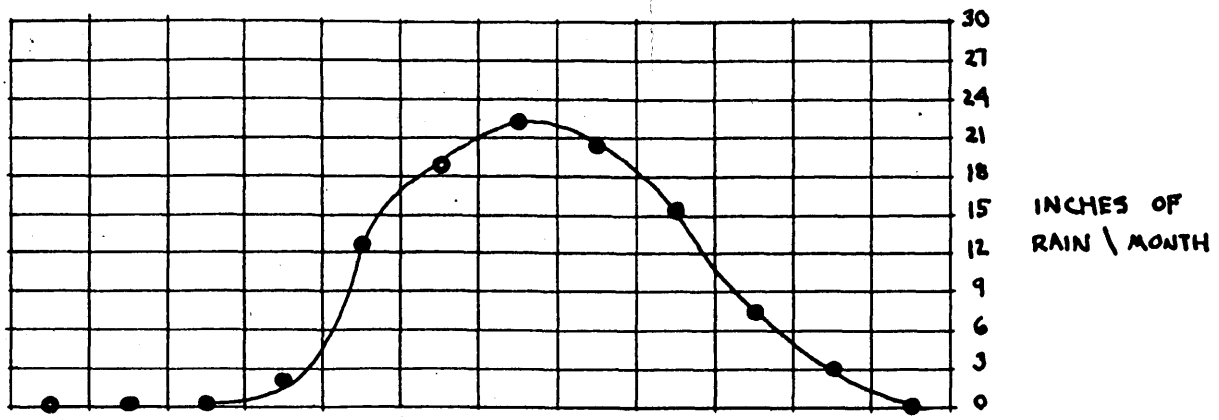
TEMPERATURE

CLIMATE CONDITIONS RANGOON, BURMA*

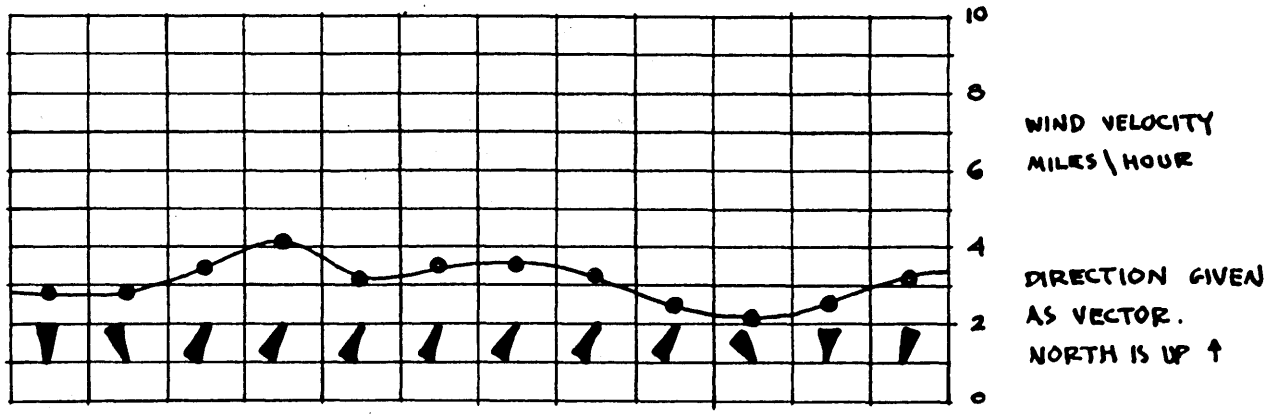
* BURMA MONTHLY WEATHER REVIEW 1939
METEOROLOGICAL DEPT., GOV. OF BURMA



CLOUDS



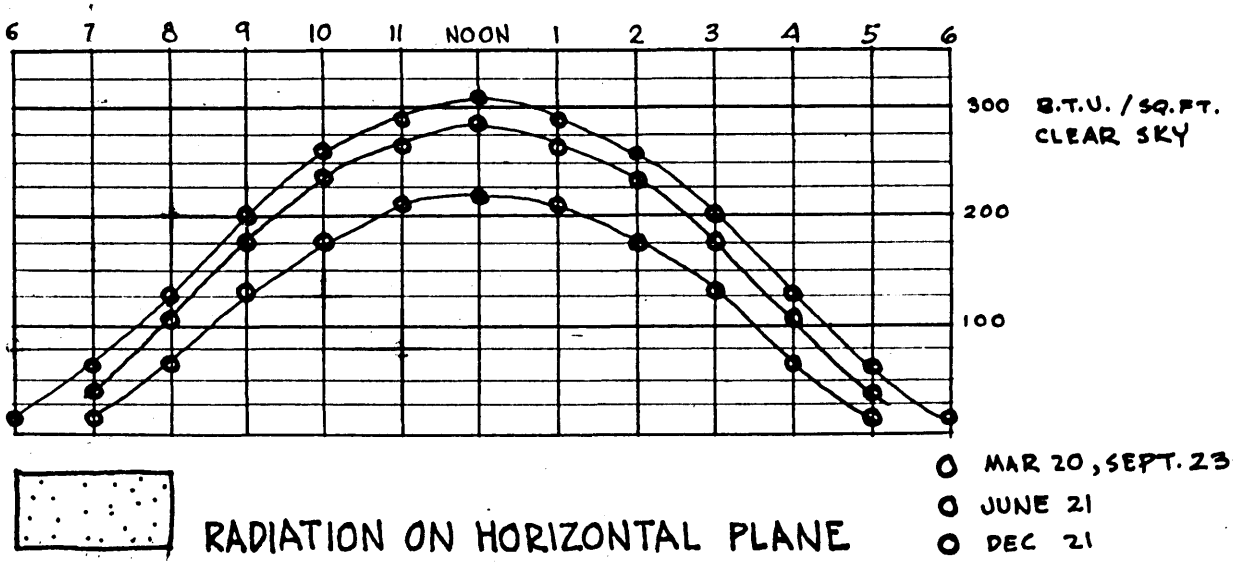
RAIN



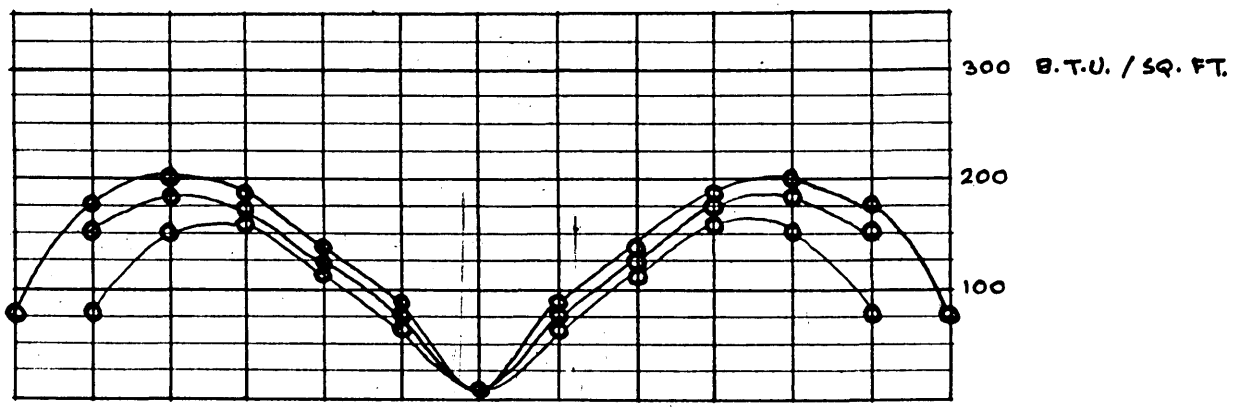
WIND

CLIMATE CONDITIONS RANGOON, BURMA*

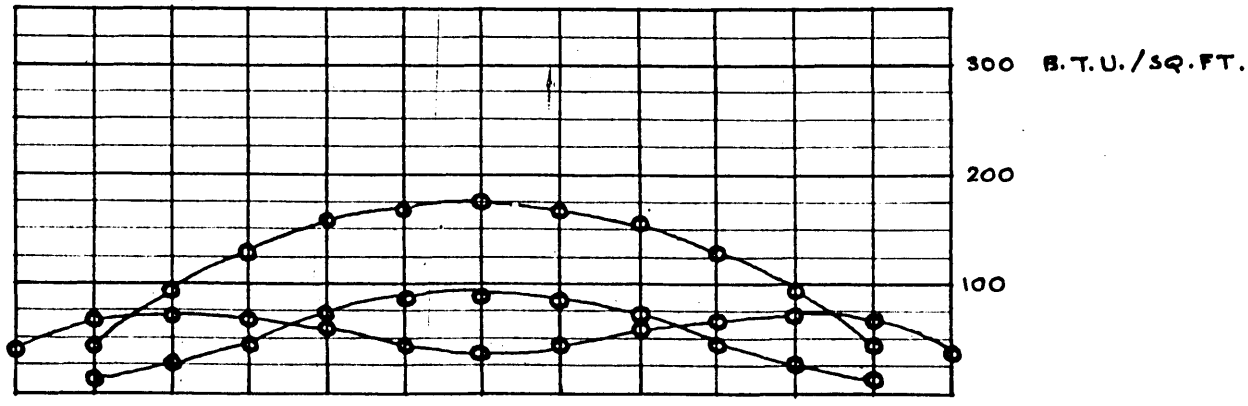
* BURMA MONTLY WEATHER REVIEW 1939
METEOROLOGICAL DEPT., GOV. OF BURMA



RADIATION ON HORIZONTAL PLANE



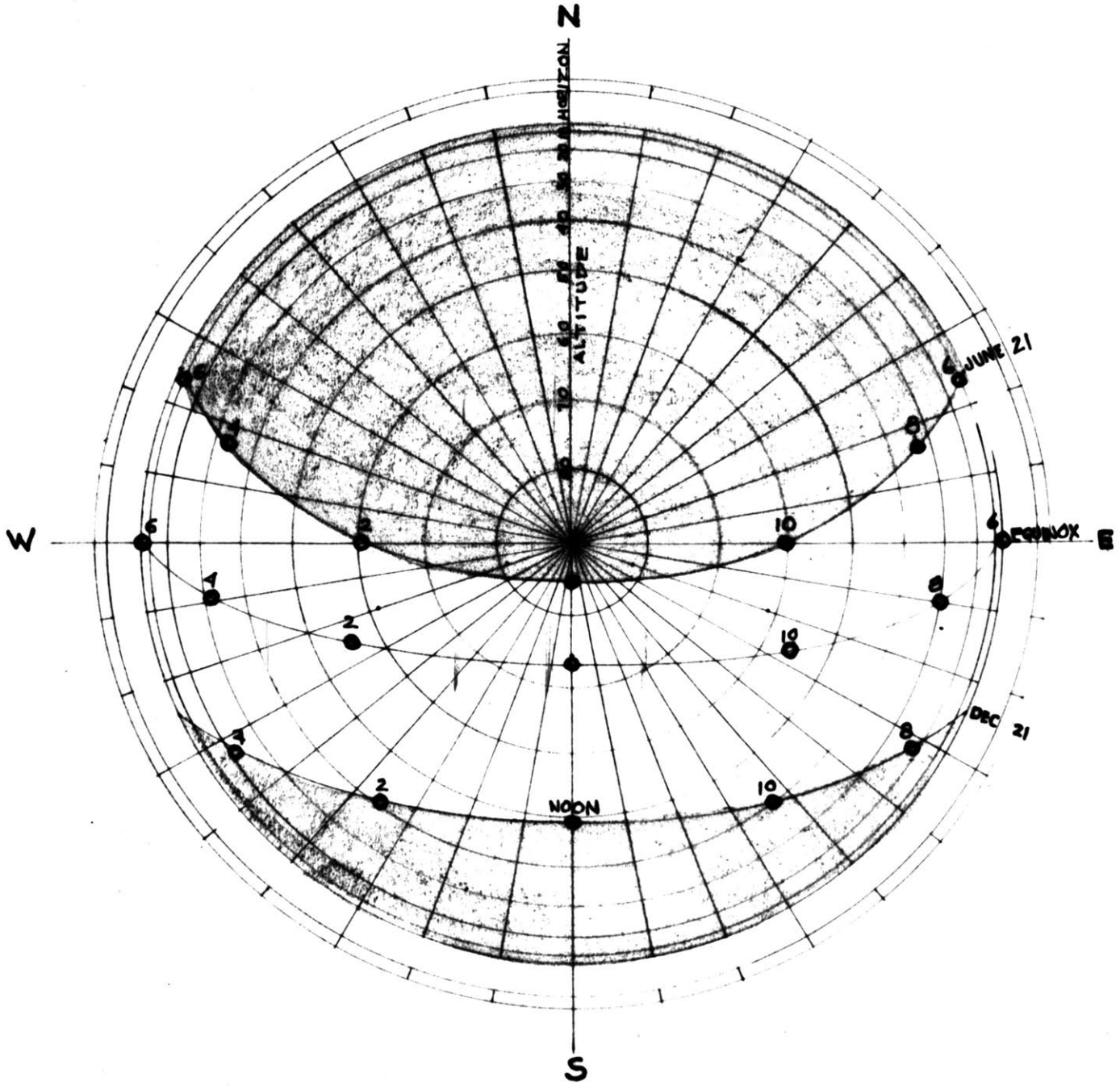
RADIATION ON VERTICAL PLANE



RADIATION ON VERTICAL PLANE

SOLAR RADIATION : RANGOON, BURMA*

*"HOT WEATHER HOUSING"
— DOUGLAS H.K. LEE



SUN PATH ON PROJECTED SKY VAULT : RANGOON, BURMA

immediate climate changes? Second, what criteria should be used in arriving at an ideal micro-climate within the dwelling?

Man must keep heat gained and heat lost in balance so that his body temperature in F remains $\pm$ 1½ degrees. The factors involved in such a balance are given in the table below.[25]

Body gains BTU's/hour		Body losses BTU's/hour
1. Body heat:	290 minimum 350 seated, sewing 1700 max. running hard	1. radiation - to air to surface
2. Radiant energy: from sun	320 max. R. sun, clear sky 350 max. R. sun, some clouds 50=15% R. sun, clear sky, sun shaded 80=25% R. sun=max. ground glare	2. Conduction to air to surfaces
3. Conduction Air objects		3. Evaporation of perspiration

Not only does the body contain an extremely sensitive temperature control mechanisim but also an equally responsive method of increasing heat loss. As the temperature increases, the surface blood vessels dilate and the heart circulates blood at a faster rate; both actions facilitate cooling. If however, the temperature rises too high, the blood directed to surface areas for cooling becomes disproportionate to that directed to the brain and the resulting shortage will cause first nausea and then lead to actual fainting and heat stroke.

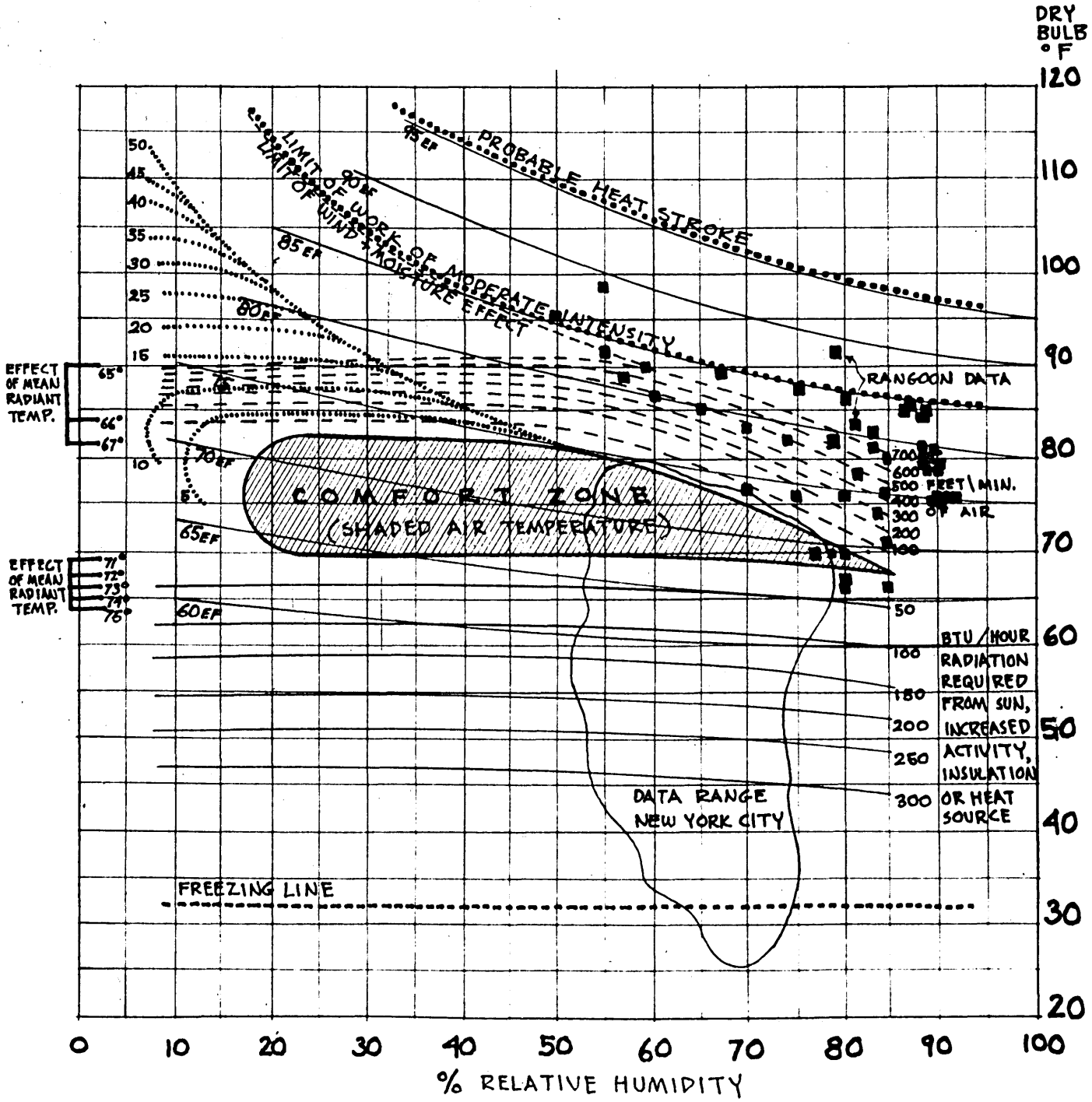
Though the comfort zone for people in the tropics is considered to be a few degrees higher than for inhabitants of the temperate zones, there still exists a very large temperature differential which must be overcome. That this is important to do has been confirmed by scientists who point out the "debilitating effects in hot climates of heat-stress and a generally lowered metabolic activity that seriously interferes with body comfort and work efficiency". [26.] A second important climate problem is that of keeping evening temperature in hot, humid climate low enough so that sleep is possible, which means below 85 degrees Farenheit effective temperature in 50 ft./minute of air movement. This is important since inhabitants of these climates can work efficiently and live healthfully under daytime conditions of temperature stress somewhat above the physiologic comfort level if they are fortified by sufficient sleep. The Olgyay brothers in their extensive research into climate compared several surveys to arrive at a criteria which unfortunately may be limited in application here since the subjects in the surveys all lived in the temperate zone. Their criteria for a comfort zone was defined by 70 degrees Farenheit to 82 degrees Farenheit with 30 to 70% relative humidity. [27.] The zone is applicable for lightly clothed persons of the temperate zone doing light work under still air conditions. The zone may have to be lowered a few degrees for the English and Scandanavians and raised for tropical inhabitants. More research is necessary to establish just how much.

Man's thermal comfort can be affected by several interrelated factors: radiation, air temperature, air movement, and vapor pressure(an indication of relative humidity.) It is possible within certain limits to extend the comfort

zone by adjusting these variables even though conditions are "out of" the comfort zone. Water introduced into the air can lower its temperature with a maximum effect at a minimum relative humidity. Air movement can cool the body by evaporation at the skin with a maximum effect as the humidity increases. Psychologically this is limited at about 300 feet per minute above which the breeze is definately annoying. The following chart shows the comfort zone [28.] as part of the range of climate conditions and to what extent it can be changed by varying controllable factors. Lines of equal temperature sensation (effective temperature) are related on the chart to dry-bulb temperature and per-cent of relative humidity. This chart becomes meaningfull when the climate data for Rangoon is superimposed. Now it can be seen just how much cooling, shading, and air movement is needed. (The data for New York is shown for a comparison.) A second chart can be drawn from this which relates these needs to any hour of any day of the year. It is this information which can be directly related to the design and orientation of the dwelling.

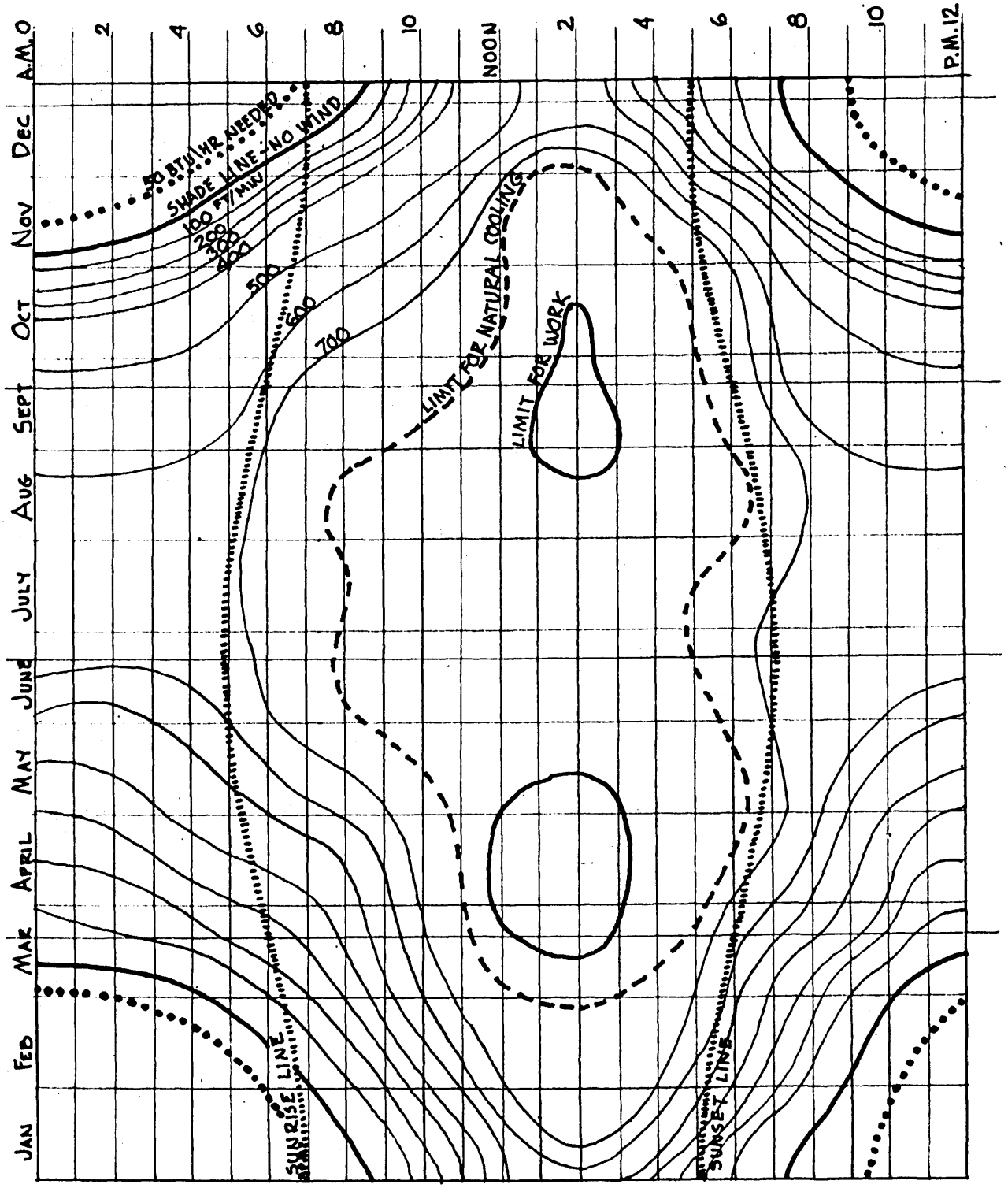
Climate and Materials: In simple cultures the home seems to grow out of its environment like a kind of plant , so attuned is it to the conditions of nature. It seems almost ironic that after years of high level research we do not yet have the answers to the problem of shelter which these people have come by through the long processes of their tradition. They could use materials instinctively while we must painfully examine and compare them.

It is not sufficient that only the inside of a dwelling be protected from direct sunlight. Surfaces exposed to the room should be radiating as little heat as possible. This can be controlled in two ways: first, by keeping



BIOCLIMATICAL CHART*

* "METHODS FOR APPLYING CLIMATOLOGICAL DATA IN DWELLING DESIGN, SITE SELECTION, AND PLANNING."
—M.I.T. — OLGYAY + OLGYAY



CLIMATE DESIGN NEED CHART*

SHOWING AMOUNT AND KIND OF CONTROL FOR ENTIRE YEAR

* COMPILED BY THE AUTHOR FOR RANGOON - BASED ON METHOD DEVELOPED BY THE OLGYAY BROTHERS.

the walls in shade by using wide roof over hangs, louvers, and trees, and shading the roof by using double construction or shade trees; and second, by using surface materials which will maintain low rates of thermal radiation by having good reflective and insulating properties.

There are two basic aspects of insulation: one, the rate of conductivity, and two, the rate of thermal difusity. (a measure of the heat capacity of a material) Rate of heat flow through a material already having a steady state temperature gradient is measured by CONDUCTIVITY. Rate of heat flow to bring the material up to a steady state temperature gradient is measured by THERMAL DIFFUSIVITY.

	Conductivity	Diffusivity
Wood	.0003	.0018
Marble	.007	.0119
Water	.0015	.0015
Dry Clay	.002	.0035
Steel	.11	.1282
Air	.00006	.2000

The above table [29.] shows that air while being an excellent insulator has little heat capacity. The situation is the reverse for steel. In the hot-dry climates of the tropics the problem is to find a material somewhere in between having such a low rate of diffusity as to enable heat to store up during the day (when the temperatures reach 110 - 120 F.) without reaching steady state conditions before night falls and the air temperature drops. The instinctive use of these relationships is evident in the massive stone and earth houses of the arid regions. The walls of these houses have been designed so that the inside temperature

finally reaches a maximum when the air temperature is minimum. The table below shows how this time lag varies among materials.[30.]

Type and thickness of structure	Time lag in hours
Roof - 1 in. wood and layer of dark waterproofing	1
Roof - 4 in. reinforced clay tile - waterproofing	2¼
Roof - 6 in. concrete and waterproofing and slag	5
Roof - 8 in. concrete and waterproofing and slag	6
Walls - wood siding and sheathing and studs and plaster	2
Walls - 13 inches of brick plastered	12

In hot-humid climates the night temperatures do not drop very much because of the heat in the moisture laden air and abundent vegetation. This is an essential difference between the two climates and the architectural implications are strikingly different. In the one, heating is welcome at night, while in the other it is not. It is better then, to use light materials and airy structures which depend on shading, reflection and ventilation rather than massive insulating materials. In fact if heavy walls are used they should be shaded in order not to radiate as a heat source. The following is a list of materials showing heat reflectivity.[31.]

Material	Color, Finish or Condition	Reflection Coefficient
Slates	silver grey	0.21
	dark grey (smooth)	0.11
Clay tiles	machine made - red	0.38
Concrete tiles	uncolored	0.35
	brown	0.15
	black	0.09
Asbestos cement	white	0.58
	after 12 mos. exposure in Westminster	0.29
	red	0.31

Material	Color, Finish or Condition	Reflection Coefficient
Galvanized Iron	new	0.36
	very dirty	0.08
	whitewashed	0.78
Copper	polished	0.82
	tarnished by exposure	0.36
Lead sheeting	old	0.21
Bituminous felt		0.12
	with aluminum surface	0.60
Asphalt	new	0.09
weather	weathered	0.18
Mortar Screed		0.27
Steel Sheet	vitreous enamelled	
	white	0.57
	green	0.24
	dark red	0.19
Bricks	gault - cream	0.64
	Stock - lt. fawn	0.44
	Stafford - blue	0.11

Materials exposed to solar radiation have yet another aspect which demands investigation; namely their temperature distribution. The temperature of the room side of the material by conduction will heat up the adjacent air mass which by convection and conduction will raise the air temperature in the room, depending on the amount of ventilation. A few instances of this phenomenon are shown below.[32.] The sky is clear, the air temperature is only 80 F. yet the materials are raised to very high temperatures. The necessity for double roof construction with vented air space, or a roof with insulation combined with high reflectivity becomes apparent.

Material	Outside surface T. in °F.	Inside surface T. in °F.	Time lag
2" concrete	121°	115°	1½ hrs.
4" concrete	104°	98°	2½ hrs.
8" concrete	101°	84°	5 hrs.

Another study shows the recording of temperatures of materials directly on the ground.[33]

Material	Temperature F.
Air	X
Grassy ground	X + 4
Gravel	X +13
Earth	X +18
Sand	X +18
Tar	X +35

This indicates that paved areas ought to be shaded or minimized if near the house.

We have talked about the influence of materials on the micro-climate. Now a word must be said about the effect of the climate on materials in hot-humid regions.[34]

Material	Problems	Advantages
ferrous metals and zinc	high rate of corrosion unless very open and free of ground	
Aluminum		does not corrode high reflectivity is waterproof
copper		does not corrode
concrete and cement	danger of premature cement hydration susceptible to intense blackening caused by weathering	easy transportability of material durability
steel reinforcement	susceptibility to corrosion requires careful construction	
asbestos cement		durability waterproof

Material	Problems	Advantages
earth and stabilized earth	susceptibility to termite and water erosion unless stabilized height limited to 3 stories because of strength	durability if stabilized makes use of local materials
wood	susceptibility to insects and fungi can be solved by detailing and chemicals	easy to renew durability, especially of certain types
thatch	deterioration considerable after 1½ yrs. harbors vermin	easy to renew good insulation properties
bamboo	in mature state will deteriorate after 3-5 yrs.	if washed of sugars and treated with copper or lead salt dip, will last for many years.
paint	deteriorates rapidly	
bituminous materials	blisters and creeps unless treated with reflective paint	good for timber protection

Climate and Design Principles: By analyzing and correlating the data with respect to the problem of providing man with the optimum climate, both outside of and within his home, it is possible to arrive at a series of general principles. These are outlined below and pertain primarily to hot-humid conditions.

Solar Radiation Protection:

Orient building parallel to the path of sun to minimize radiation on walls.

Shade roof, walls, and openings by using planting and/or structural methods.

Reduce glare from hazy skies through openings by using screens or louvers.

Use exterior surfaces having high reflectivity.

Use light-weight type of insulation roof.

Shade or minimize paved areas near buildings because of high reflectivity.

Walkways should be narrow and shaded with trees or by buildings.

Minimize Miscellaneous Heat Sources:

Use light weight materials or shade massive materials to air temperature.

Bathroom shower vapor and kitchen steam should vent easily to outside.

Reduce Human Heat Output:

Ease of maintenance
Efficient circulation
Efficient plan
Minimize stair climbing.

Increase Air Movement

Orient long dimensions of building toward wind.

Avoid dead air pockets in plan and section.

Select upland or hillside sites.

A sloping roof is more easily cooled by a breeze than a flat one.

Facilitate air movement by arranging series of shaded and open spaces in juxtaposition in such a way as to cause pressure differentials. This is important for days when the breeze is not stirring.

Shade trees should be used with care that air paths are not obstructed.

Vent roofs to prevent pockets of warm air from building up maximum wall openings for cross-ventilation.

Furniture and storage units should be of web type and as open as possible.

The Rain

Slope roof to carry off water as fast as possible.

Roof run-off to gravel beds at ground is preferred to gutters which may provide conditions for mosquito breeding.

Raise building for drying out floors and structure.

Provide sheltered outdoor space (under raised portion) for clothes drying during monsoons.

Walk ways and immediate yard to be raised on plinth for tolerable conditions during periods of heavy rain.

Evaporation

If air passes over water and evaporation takes place, the air will be cooled but the water content will be increased. The body will lose heat to this air by conduction, but will lose it at a lower rate to the more humid air.[35] However, the net effect will always result in cooling as long as the air circulation is not reduced. Water screens, pools, and water on the roof are effective cooling devices in both hot-humid and hot-dry climates though markedly more so in the latter.

Building Technology

Materials: The determinates in selection of materials include climate, availability, and economy. Availability and economy for a country like Burma are closely related, for unavailable materials must be imported at great cost from Europe or Japan. Since Burma's rate of industrialization depends somewhat on the speed with which she can build up basic industries imported piece by piece from abroad; it is essential that imports for consumption be minimized. In 1953 for example, 56% of her imports were building materials.[36] A large housing program could be considered a drain on the effort to import machinery, construction equipment, and other capital expansion goods. This housing design will be based on using as much local material as possible.

Traditionally bamboo and wood have accounted for the vast majority of house construction as is indicated in the survey below taken in 1950.[37]

House Type	No. of Dwelling Units	%
Bamboo	2,000,000	50
Mixed timber and Bamboo	1,400,000	35
All timber	560,000	14
Brick or concrete	40,000	1
Total	4,000,000	100

Rural dwellings account for most of the bamboo construction. These houses are usually raised several feet off the ground with a basha (thatch type) roof and walls of woven grass.

Other materials are available however, and it would be good to examine them all.

Wood

Burma is rich in timber resources having over 250 potentially useful species. 75% of the world's teak supply is held by Burma. The three biggest categories for wood use are fuel, house construction, and exporting. The various species of timber are divided according to durability. Pyinkado(iron-wood) and teak are the most durable, being resistant to termites and fungi. Gurjan, a little less durable and less expensive, is widely used for construction. 30% of the annual cuttings are used for house construction. Wood processing plants are already built or are being planned for the near future. These include:

- Saw-mills - for structural and yard lumber
- Woodwork plants - for door frames and windows
- Plywood and veneer plants - for doors, panels and partitions
- Furniture factories - for making basic furniture and storage cabinets.
- Wall board plants
- Wood treatment facilities - Penta - WR for protection against decay and insects.

Cement and Concrete

Cement producing facilities are being expanded but not fast enough to eliminate the need for importing one-half of the cement used in Burma. Large amounts of these materials are going primarily into the construction of dams, highways, and other engineering projects. The widespread use of concrete is limited by the shortage of cement and good agregates.[38] Rangoon is in the center of a large alluvial delta area and is therefore entirely devoid of the proper aggregates for ordinary concrete. Some aggregate is shipped from limestone deposits near Moulmein or from granite deposits near Mokpalin,

but only at some expense. However, the clays of the region can be worked and burned in a rotary kiln to make an aggregate for light weight concrete. The procurement of proper sand is also a problem since that which is in the area is all of a grade too fine for concrete.

Concrete Block and Precast Concrete

At present there is one concrete block plant in Rangoon and it produces a block which just competes with brick in cost. A factory for precasting concrete roof tile, pipe, planks, and small building units is either under construction or is in the advanced planning stages.

Asbestos Cement

An asbestos cement plant is at present under consideration and it will be equipped to manufacture corrugated and flat sheets for roofing and siding and also pipe for water supply. Such pipe can withstand considerable pressure and does not corrode as metal would in this climate.

Plaster

Lime plaster has traditionally been widely used inside and out, usually in conjunction with brick construction.

Clay Products

The clays of the region produce good quality brick and tile. A factory built in 1955 has been producing 8 million brick and 6 million roof tiles per year [39.] and will expand shortly to include clay drainage, coping, and wall tiles. This production will not meet all the demands; in fact the housing board feels that 70 to 80% of the new housing will have to be of other less permanent materials.

Steel

Burma's first steel rolling mill was built in 1956 and has a production rate of 16,000 [40.] long tons per year

which is far below current demands. Its coking coal comes from India and the raw material comes not from ore but from scrap. Since the variety of items such a mill could produce is naturally limited, the government decided to produce a few basic materials from which a variety of products could be formed. These basic products include:

- light structural shapes up to 6 inches
- bars
- rod from which reinforcing and bolts can be made
- sheet
- wire from which screws, nails, fencing, and reinforcing mat can be made

Steel is perhaps the most critical material for the country's growth and unfortunately it is very expensive to import and is in short supply. Its use should be minimized in housing.

Earth Construction

Earth is one of man's most ancient building materials. Until recently it has been used largely it hot-dry climates because of its poor resistance to weather and termites. Several methods have been evolved for using earth as a construction material.

> The Indians of south western parts of the United States made the mud into blocks which were dried before building with them.
>
> From Japan to the Cameroons houses are still being built of wattle construction in which the walls are formed by applying mud to a woven latticework of bamboo poles and strips.[41]
>
> In West Africa the cob method is widely used in which moist balls of earth are pounded into 12 " courses and then allowed to dry in place.[42]
>
> Another method is used by the French.[43] It consists of tamping the earth into a wood form. This process is known as rammed earth.

The weathering problems in the past have been only partly solved by applying rendering coats to the surface and

by protecting the wall surface as much as possible by overhanging roofs.

During the past fifteen or twenty years much progress has been made in stabilizing the earth by adding cement, lime, or pozzolanas. Depending on the quality of the soil, more or less stabilizing additives are used; an average ratio being 1 part cement to 18 parts soil. It has been confirmed that this type of construction is suitable for hot-humid climates by Maxwell Fry.[44.] This has been based on the excellent condition of stabilized earth houses built in the Gold Coast ten years ago.

The crushing strength of stabilized earth blocks laid in a $1\frac{1}{2}' \times 1\frac{1}{2}' \times 6'$ pier varied from 43 p.s.i. for hand-made blocks to 121 p.s.i. for those made by machine.[45.] These values though low compared with most building materials, are quite adequate for residential buildings of this type.

Stabilized earth is relatively termite-resistant but can be further protected by adding a string course of 6:1 concrete at the floor level, or by running a concrete floor slab clear through the wall, or by bedding the floor level course of blocks in 3/4" of cement mortar. In the Gold Coast where these precautions have been taken there has been no penetration by termites.

If desired the walls can be finished on the inside with a coat of weak (1:12) cement render; and on the outside with a 1:16 cement plaster or merely a few coats of lime-wash.[46.]

Economically the argument is strong for the use of stabi-

lized earth for several reasons.

- In a country where the cost of materials is high, earth is an excellent choice since it is usually available at the site.
- Very little cement is consumed since the ratio varies from 1:14 to 1:20.
- The material is manufactured on the site and erected easily by unskilled laborers.

In Africa [47.] and Ceylon [48.] where cost comparisons have been made, earth construction is cheaper than other materials in this order: stabilized earth, brick, concrete block, and concrete.

Bamboo

An important material in Burma's economy is bamboo. The use of bamboo in house construction is more than five times that of timber. There are over 20 species of bamboo in Burma, [49.] the largest growing up to 30 feet with a diameter of 5½ inches. [50.] Usually a bamboo house must be repaired every 3 or 4 years because of infestation or deterioration; however, if it is first washed free of natural sugars and then emersed in a copper or lead salt solution it should last for many years. [51.]

Bamboo itself is so versatile that all of the parts of a house may be constructed of it. However it does have limitations:

- It cannot be pierced or notched for connections without being weakened, but must be bound with wire or vine, thus sacrificing some rigidity.
- Its tubular section is more suited for column or rod loading than beam loading.
- Even though treated, there is always danger of rotting where it is used close to the ground.

- It may develop cracks after a certain period of exposure to rain and sun cycles.

Bamboo has some remarkable structural properties, particularly that of tensile strength which has been observed to be as high as 34,000 p.s.i. [52.] Listed below are some properties of bamboo which must be carefully considered before using as a design basis since the species of bamboo number in the hundreds and have different characteristics. [53.]

Compressive strength		8,800 p.s.i.
" "	allowable	2,200 p.s.i.
Tensile strength	(with joints)	20,000 p.s.i.
" "	allowable	4,000 p.s.i.
Shearing stress		2,000 p.s.i.
Modulus of elasticity		2,300,000 p.s.i.

With respect to the previous data it appears that bamboo can be used in several ways for housing construction:

- reinforcing for concrete beams of short span where deflection is not a consideration
- reinforcing for stabilized earth piers and walls
- truss members in which the tubular section of bamboo can work efficiently in receiving only axial forces
- panel material for louvers, sun shades, walls, and shutters
- secondary structural members

Construction Techniques: At the present time Burmese construction practice lacks the degree of mechanization that we are used to taking for granted in our design process. The design and selection of materials should be in cognizance with the fact that most materials will be unloaded, lifted, worked on, and assembled primarily by hand.

A considerable expansion of the supply of skilled labor is now necessary for the demand created by the government's national construction program. Artisan training centers were established as early as 1948 to increase the supply of skilled workers and also to teach new methods of construction.

The Burmese have developed great skill in working with bamboo, wood, and brick as is evident from the hundreds of intricate and monumental pagodas and monastaries which dot the countryside. One of the most impressive of these structures is the gold leaved Shwedagon Pagoda in Rangoon which rises 325 feet above its platform.[54.]

The housing board has already built several thousand units of modern reinforced concrete frame housing. Factories, schools, and clinics representing the latest equipment and structural systems are being constructed without difficulty by Burmese, local Chinese, and Indian workers.

In the housing design in this thesis where full advantage is not being taken of these modern techniques and materials it is for reasons of economy and employing as much unskilled labor as possible.

Typical Family of Rangoon

The Family and its Pattern of Daily Life: The word typical is a little misleading for the Burmese of Rangoon at this particular period of its history when it is growing and changing so rapidly. Certain traits are however typical for the Burmese culture.[55.] Family loyalties run high and successful family members often contribute to their poor relatives even though they might be distantly related. It would be unthinkable to send an aged

grandparent to an institution. Instead it is customary for elder members of the family to rotate their visits to the homes of all their children. Often a newly married couple lives with the bride's parents until independent quarters can be established. Marriages are quite simple affairs. Divorces are granted merely by mutual consent; but the divorce rate is low. Love and understanding are emphasized in child up-bringing and reprimands are mild, and physical punishment is rarely resorted to. An age hierarchy of children usually exists within a family in which the eldest child has certain privileges.

There has been little written in detail about the typical Rangoon family; but a study has recently been conducted of a family type which is becoming more numerous; namely the refugee family from the rural regions. K.G. Orr reported for the United States Educational Foundation in Burma [56.] on on a fisherman and his family who came from Pathwe, a village on one of the numerous tributaries of the Irrawaddy River which winds through the delta region. The insurrection against the government by the Communists in 1949 involved the fisherman's village and caused him to flee with his family to Rangoon where he found quarters in a refugee camp.

Though he had been no wealthier than most in his village, he had lived in a wooden house with 1,500 square feet of floor space. There he had been a member in a cooperative which operated an "In" (a river fish trap) and sold the fish to processors who took it by boat to the market in Rangoon.

When he arrived in the city he went through a period of mixed frustration and partial adjustment to the new values

or confusion of values in the city. His first job was as a laborer for a Chinese contractor who was building a spinning and weaving factory. Most of the laborers were Indians and only three others were Burmese. His daughters had to find jobs; one in a cigar factory and the other in a spinning factory.

The Burmese have two meals during the day; one at 7:30 A.M. and the other at 5:00P.M. Many evenings are spent at home with an occasional guest dropping in for tea and conversation. Occasionally the people go out to see the "Pwe", a drama ranging anywhere from burlesque to religion usually held in an open square and lasting into the "wee" hours of the morning. Marketing at the bazaar is an important part of the woman's social life. These trips are made daily since the average family does not own a refrigerator and the food would not keep in such a climate.

Furniture and Clothing: Furniture is minimal; this being in part a reflection of the Burmese simple way of life, and in part due to their low income. The furniture of the refugee family consisted of low stools, tables, boxes, baskets and mats. There were no beds or chairs. A more complete description of their furniture is tabulated below:

- 5 stools only 4 inches high
- 3 round tables 2', 3', and 4' 9" in diameter and all about 1' high
- 1 stool used as a chessboard 4 or 5 times a month
- 2 cupboards $4\frac{1}{2}$' x $3\frac{1}{2}$' x $1\frac{1}{2}$'; one for clothes, the other for crockery
- 1 basket for the woman's clothing (many Burmese do not believe that men's and women's clothing should be stored together)
- mats for sleeping 6' x $3\frac{1}{2}$' with pillows (sleeping on raised beds is an urban custom for those who can afford it)

- rectangular insect nets suspended over sleeping areas are lowered at night and tucked under the mats.

kitchen ware:

- 2 earthenware pots 7" diameter
- 1 " curry pot 8" diameter
- 1 " tea pot
- 3 " storage jars
- 1 " mortar and pestle
- 4 aluminum pots
- several storage tins
- cooking spoons and knives (the Burmese custom is to eat with the fingers), bowls and cups
- 2 or 3 wicker baskets (often these are filled with fruit and set out in the yard to dry in the sun)
- cooking is done on masonry open stoves which use wood or charcoal as fuel

Clothing is also very simple, for the climate requires very little.[57] Most of the items of clothing are stored by folding in cabinets and a few are hung in a closet. Below is a list of clothing for the typical Burmese family.[58]

Man

- 8 longyi (brightly colored skirts)
- 4-8 shirts
- 2-4 vests
- 1 or 2 jackets
- 1 or 2 gaung baungs (head bands)
- 6 handkerchiefs
- 2-4 underclothes
- 4 shoulder bags
- 1 umbrella
- 1 bamboo hat
- 1 razor
- 1 comb
- 2 pr. sandals
- 1 pr. wooden clogs (per month)
- 2 towels
- a few items of jewelery

Item	Wife	Grand-mother	2 oldest daughters	2 youngest daughters
longyi	4-8	3-5	6-18	
jackets	3-5	3-4	3-6	
frocks				6-8
bodices	3-5	3-5		
underclothes	4-6	4-6	4-6	4-6
leather sandals	1	1	2	2
wooden sandals	1	1	2	2
scarf	2	2		
jewelery	2	2	4	4
sandal-wood face powder sticks	1	1	2	2
comb	1	1	2	
stone slab for making face powder	1	1	2	2
parasols	1	1	1	1
umbrella	1			
hair oil				

Standard of Living: The average income in Burma is lower than in the western countries, but is higher than in many of her neighboring countries. The distribution of 1954 monthly income for families in Rangoon is tabulated below. 59.

% of families	Monthly Kyats	Income U.S. dollars
13	0-120	0-25
30	120-199	25-42
22	200-299	42-63
21	300-499	63-106
14	500+	106+

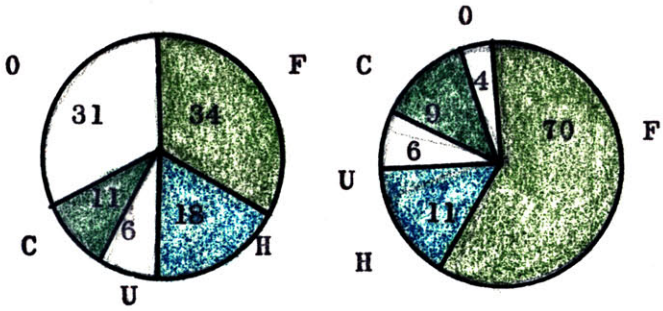
In 1951 austerity income was 102 Kyats per month. This meant that skilled laborers earning 100-150 Kyats were

just above the austerity living level and unskilled laborers earning 50-100 Kyats were actually below this level. How a typical Burmese laborer's family spends its 1951 monthly income is described below:[60.]

Cat Category	Particular Item	Quantity	Monthly Cost in Kyats	
FOOD	rice	65#	17	
	pulse	4#	1	
	oil(sesamum)	6#	9	
	fresh fish	14#	15	
	dried fish	2#	4	
	ngapi	3#	2	
	pork	7#	9	
	salt	4#	.5	
	tamarind	2#	.5	
	onions	6#	3	
	chillies	3#	2	
	vegetables	....	7	
				70
FUEL & LIGHT	firewood	110 splits	4	
	oil	4 gal.	2	
				6
CLOTH	cotton lonkyi	1.25 yds.	4	
	grey shirting	1.25 yds.	1	
	twill khaki	.75 yds.	3	
	longcloth	.75 yds	2	
				10
MISC.	soap	6 cakes	1.5	
	tobacco, cheroots	....	2.5	
				4
RENT				12
			TOTAL COST	102

A comparison between the way a Burmese and an American laborer's family spends its income shows that the disposable income above food and shelter is very small for the Burmese family. The implication of this is that it will be many years before the average family will have

a radio, refrigerator, automobile, and other consumer goods.



U.S. Laborer's Family

Burma Laborer's Family

F....food
H....housing
O....other
C....clothing
U....utilities, fuel

Population Characteristics

Family Size: The average family has about 4.8 people as compared with 3.5 people for the United States. This information is necessary for determining the distribution of dwelling types in the community. Family size distribution is shown below. [61.]

# persons	1	2	3	4	5	6	7	8	9+
% of families	1.6	14.4	16.8	17.3	14.1	11.2	7.9	6.0	10.7

Age Distribution: Information on the age distribution is useful in determining the size and number of schools and other community facilities. No information was available for Rangoon age distribution, but since the Union of Burma has a high rate of infant mortality and an average longevity of one-half that of the United States, its age curve is bell shaped and similar enough to other tropical nations so that one of their charts could be used as an approximation. On the following page the curve for Venezuela is shown. 62.

Building Economics and Housing Standards

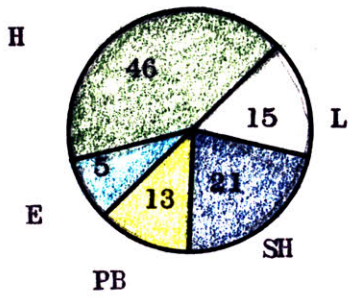
Building Economics: The housing problem is so universal in urban Asia that several international organizations have been formed to deal with it. The United Nations estimates that over 150 million people are living in "sub-human" and sub-standard dwellings.[63] The economic feats to be accomplished are colossal:

- The number of dwelling units to be constructed is very large.
- The allowable subsidy available from tight over-burdened government budgets is small.
- The income and hence the rent paying ability of the people who will live in the housing is small.
- The secondary costs are great for such things as community facilities, streets and services, and expansion of the materials industry.

A major decision for most governments to make is the balance to strike between healthy occupancy standards on the one hand and economic realities on the other; since larger houses mean fewer houses. Such a decision should not be based on floor area as the sole indicator of cost, but rather on the entire project cost. It

would seem that the most effective way to achieve the maximum economic efficiency in a housing program would be first; to coordinate all parts of the process from building materials up to city planning techniques, and second; to examine individually and collectively the costs of each component of the entire process.

Below are percentage cost break-downs compiled by Otto H. Koenigsberger on the basis of his experience with community development in India and Burma.[64.]



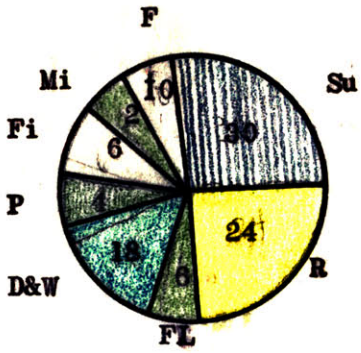
H....houses
L....land: acquisition development water, drainage

SH...shops, small workshops, service, cinemas, restaurants, etc.

PB...public buildings (school hospitals, administration, post office, police) parks, playgrounds, etc.

E....electric installations, street lighting

Cost Relationship of Elements Within the Community



F.....foundations and earth-work

Su.....superstructure:walls, partitions, sills, lintels, etc.

R.....roof

Fl.....interior floors

D&W....doors, windows, louvers

P.....painting, finishing

Fi.....fittings and sanitary installations

Mi.....small miscellaneous items

Cost Relationship Between
Elements of House Construction

Cost Relationship Between Labor and Materials [65]

Labor	Materials	Region
50%	50%	United Kingdom
45%	55%	U.S.A.
75%	25%	tropics

From the above analysis some conclusions can be reached concerning ways of reducing building costs:

- Since the proportion of labor to the total cost is very high; significant savings could be realized by using self-help labor as much as possible.

- The reduction of one element of house construction cost (using a concrete shell for a roof for example) is not going to be a panacea for housing the masses. The roof accounts for 24% of the cost of the house, but only 11% of the cost to the community; and if the new roof affects a 30% saving over an old type the

total saving is 30% x 11% or 3.3%. Importing prefabricated shells is not going to solve the housing problem for similar reasons.

- Significant cost reduction can only be achieved by paring down on all components. One way to do this is to use a system of modular coordination both in construction and material production.

Dwelling Area and Occupancy Standards: Burma's housing board has not yet developed specific area standards; but is still experimenting and building up experience. In one of the large housing developments at Kanbe the floor areas ranged from 350 to 500 square feet. [66.]

There seems to be no international agreement as to detailed housing standards for the tropical regions of the world except for a general consensus that the average family household should have a minimum of: [67.]

kitchen
bath and toilet
storage
2 separate rooms

The government of India adopted these standards in 1950 but had to rescind them when it realized that progress would be too slow. [68.] It was discovered that many of these units were actually being occupied by two families, so pressing is the demand for shelter.

A realistic set of housing standards can only be determined by analyzing the economy, economic planning programs, and other conditions of a particular country. For the purpose of this thesis a preliminary set of area standards will be formulated by comparing published data for housing developments and programs of similarly situated countries. Values for selected countries are shown on the following page:

Size of D.U.	Total D.U. area sq.ft. by countries			
			69.	70.
Rooms including kitchen	Puerto Rico	Singapore	Bantu	Philippines
1	180			
2	270			
3	360	340	404	265
4	450	550	577	370
5	540			500
6	630			640
7+	810			750

TOWN PLAN FOR THAMAING, AN INDUSTRIAL NEW TOWN

Thamaing and its Origin

Thamaing is to be built from scratch in open country about ten miles to the north of Rangoon. It is being planned for an initial population of 40,000 (8,800 families). Most of these people will work in the nearby light industrial area now under construction. When completed it will contain manufacturing facilities for pharmaceuticals, cloth, and jute processing. The agricultural institute and research station adjoins the industrial property, and presumably many of its employees and staff will move into Thamaing.

The National Housing and Town and Country Planning Board feels that some of the problems of housing and congestion in Rangoon can be partly alleviated by locating new industry beyond the peripheral fringe of Rangoon. Thamaing is one of several new towns being built under this program.

The Site and its Setting

Surroundings: To the north-west Thamaing is separated from the industrial district by a railroad and the Pome Road which runs from Rangoon to Mandalay. Along the west boundary of the industrial site a tributary of the Irrawaddy River flows south parallel to the road. The river is important to the town as it permits passage of ships which supply material to the industry, and it allows river boats to carry people and commodities to and from Thamaing. To the north and east is open country sparsely populated by a few villages and farms. To the south lie the fringes of Rangoon's suburbs. A pleasant lake touches the site at the south. It is about a mile and a half long and its southern shore is rimmed by the campus of The University of Rangoon.

Topography: The land slopes gently up from the river to a ridge 70 feet high about a mile and a half to the east. The average slope is only one or two per-cent; some areas are flat, but near the top of the ridge the slope increases to five per-cent.

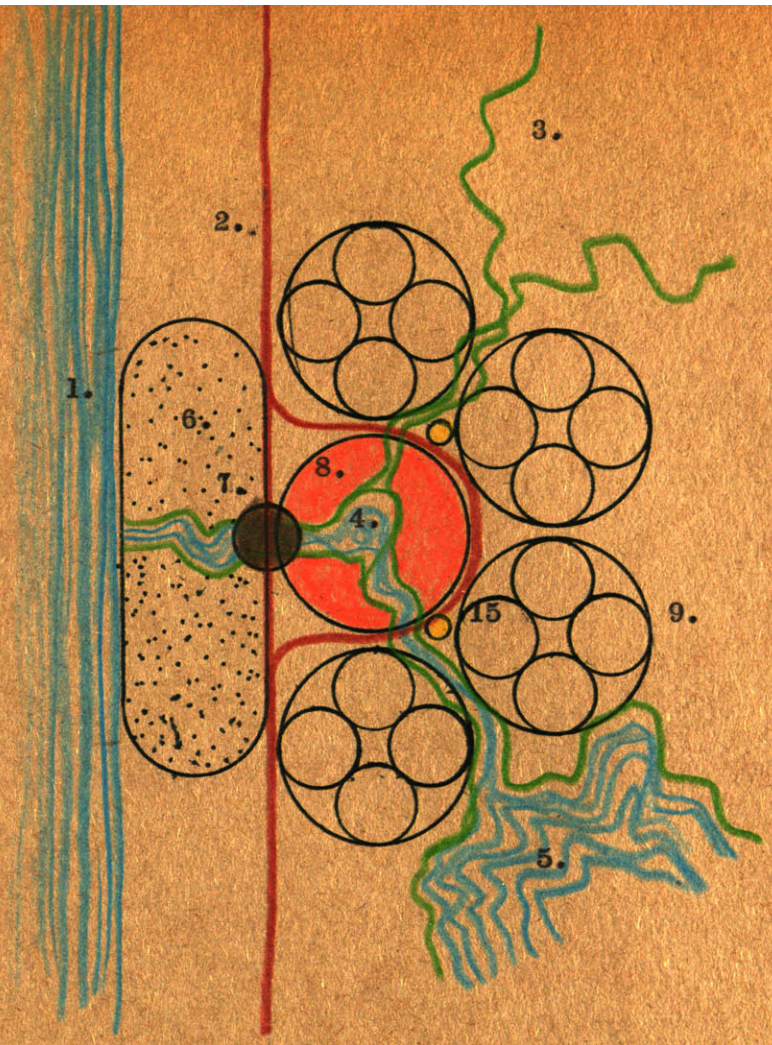
Water Table and Flood Waters: Detailed information was not available for this study. It is assumed that because of the high rainfall streams would carry ground water from the area to the river. During heavy rains the ground would be saturated and therefore it is advisable to raise many of the principal routes of circulation as is the tradition in the regions of the country visited by the monsoons. Innundation from the river is not to be considered a threat since the industrial site occurs directly along its banks.

Trees and Other Vegetation: There are both open and tree covered areas on the site. The tree types are numerous... there are bamboo thickets, clumps of palm, and rows of great flowering Banyan lining some of the roads. It should not be difficult to find the right kind of tree or plant for any landscaping problem.

Organization of the Plan

The plan should be guided by general goals and conditions which intimately reflect the Burmese "way of life". A diagram of the plan is shown below together with a list of goals and conditions which have shaped it.

Residential Density and Scale: Tropical communities have traditionally been densely populated for three reasons: one, closely related buildings shaded eachother as well as the walk-ways between them; two, since everyone was



1. RIVER
2. POME ROAD
3. OPEN COUNTRY
4. PEDESTRIAN WAY + PARKS
5. LAKE
6. INDUSTRY
7. TRANSPORTATION CENTER
8. TOWN CENTER
9. COMMUNITY
10. NEIGHBORHOOD
11. SUB-NEIGHBORHOOD
12. COURT
13. ELEMENTARY SCHOOL
14. MIDDLE SCHOOL
15. HIGH SCHOOL
16. COMMUNITY CENTER

DIAGRAM OF THE TOWN PLAN

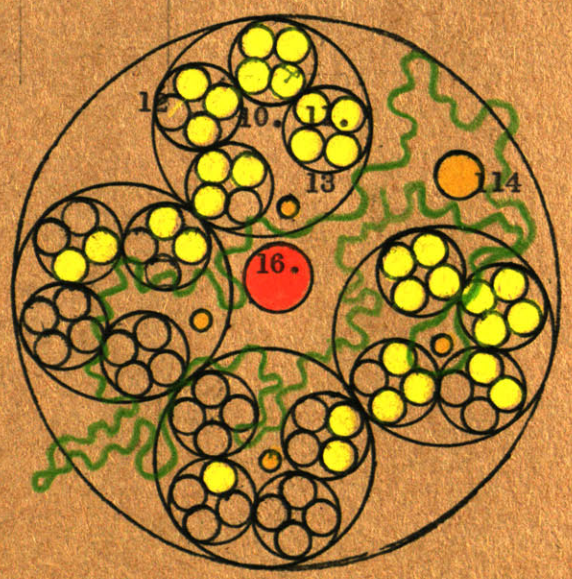


DIAGRAM OF A TYPICAL COMMUNITY

a pedestrian, dense development required a minimum of walking; and three, tight little communities were easy to protect from marauders. Some density standards have been advanced for community development in these areas, but they should be regarded as approximations only and used as a tool for analysis rather than for design. A gross density excluding industry of 40 persons per acre 71. has been suggested for Thamaing. This is a little more than twice the density in most United States, automobile oriented cities.

Sequence of Areas: Even within great cities which appear to be sprawling masses of buildings and streets, the people have somehow satisfied their natural needs for a variety of socially oriented areas, from the front steps.... where a few mothers can talk while watching the very young children....to the city center....where a great variety of specialized shopping and service facilities exist. This town will have a succession of areas organized in the following manner:

The COURT with about 34 families, has one or two small enclosed areas where mothers can chat and pre-school children may safely play. The COURT is given social and physical unity by being raised slightly on a plinth so that circulation can be relatively dry during the rainy season.

The SUB-NEIGHBORHOOD having from 3 to 5 courts focusing around an open space for recreation. In it live about 137 families.

The NEIGHBORHOOD having 4 sub-neighborhoods and centered around a twelve-room elementary school, with vehicle-free access from all homes. A neighborhood

would contain 550 families which would have about 440 children of elementary school age, as can be observed from the age distribution curve.

The COMMUNITY made up of 4 neighborhoods and having a population of 2,200 families or 10,000 people. The community population has been determined by keeping all homes within walking distance of the center and serving the people with a middle school.

The TOWN of 8,800 families (40,000 people) will be comprised of 4 such communities.

Recreation and Open Space: For reasons of unity and economy a green belt will connect the industry, transportation center, town center, and communities. This will be used mutually for pedestrian circulation and recreation. Some of the schools will be located on it and a dual-purpose will be served by the mutual use of their grounds.

Circulation: Though some have bicycles, none of these families will have automobiles. In 1951 [72.] only 21,000 vehicles of all types existed in the entire country. If one half of them were cars this means that one car exists for every four-hundred families, and it is difficult to say when the automobile will be an average family posession. For this reason traffic except for emergency service will not be provided for within the neighborhoods. The basic circulation plan should not be made obsolete by the increased use of vehicles since they will have peripheral access to all neighborhoods.

There will be a transportation center in the central town from which one may board boat, train, or bus. A small

transportation depot will be located in each community where one may take a bus or rent a horse drawn carriage. A system of well shaded foot paths will connect the communities with eachother and with the town.

Community Facilities: These facilities will become more extensive as the community unit increases. They are fully described elsewhere.

Orientation: Fortunately the best solar orientation very nearly coincides with that determined by the prevailing breeze; therefore all buildings will be oriented toward the south and south-west. An attempt will be made to keep exterior spaces small in order that they may be easily shaded and not become sources of heat and glare.

Residential Program

Approach: Millions of Asian families must live, cook, eat, and sleep in the same room. The implications of this overcrowding are clear: older brothers and sisters sleep together, the sexual life of the parents must be awkward and inhibited from lack of privacy, and the number of functions that can go on harmoniously in one room is indeed limited.

In the "Pyidawtha" (new Burma) which the people are working for, new conditions of life will have their architectural implications, and it would be inconsistent to design for "old life" habits. The older children will need privacy in which to do their homework. Adult education and other programs will gradually expand the use of leisure evenings by the adults to include reading and entertaining which should be carried on without disturbing sleeping children.

On the basis of the above I have decided to provide separate spaces for the adults and the children. The space

for adult sleeping will also be used for dining and living functions. The size of the children's area will vary with the number of children. The partitioning off of this area will be left to the occupant.

Space Standards: For the purpose of preliminary planning, average dwelling unit sizes are determined partly by comparison with values of other similarly situated countries (see page) and partly by adhering to good dwelling design practice. I hope that slightly larger than average dwelling units can be justified by using a construction system of pre-cast and pre-cut parts which can be assembled on a twelve foot module for a variety of dwelling sizes. In this program a room is defined as a 12' x 12' area of floor space. It was decided on as the basic unit because it provided the right amount of space for:

- a core containing kitchen and bath
- a living-eating-sleeping room
- sleeping space for 2 people (including circulation and storage)

By these standards a 4 room house would have

kitchen-bath core	1@ 12x12 =	144
living-sleeping room	1@ 12x12 =	144
sleeping area for children	2@ 12x12 =	288
		576 sq. ft.

In comparison with other country's standards for the equivalent 4 room house (see page) this area seems realistic.

Country	Area sq. ft.
Philippines	370
Puerto Rico	450
Indonesia [73.]	550
Singapore	550
THAMAING	576
Bantu, So. Africa	577
Average	512

Distribution of units by Number of Rooms and Family Size: From the data in previous sections it is possible now to determine the entire housing schedule as shown below:

% families	family size	number of rooms: utility core	living sleep	child. sleep	total	area sq.ft.	A	B
14	2	1	1	....	2	288	144	151
17	3	1	1	1	3	432	144	114
18	4	1	1	1	3	432	108	85
15	5	1	1	2	4	576	115	65
11	6	1	1	2	4	576	96	60
8	7	1	1	3	5	720	103	68
6	8	1	1	3	5	720	90	60
4	9	1½	1½	3	6	864	96	...
4	10	1½	1½	3	6	864	86	...
1	11	1½	1½	4	7	1008	98	...
2	12+	1½	1½	4	7	1008	85	...

$A = \frac{\text{area}}{\text{person}}$

$B = \frac{\text{area}}{\text{person}}$ (Rangoon survey) [74.]

Building Types: Instead of splitting up the housing into the usual building types; namely semi-detatched, row, walk-ups, etc., it was decided to use the same construction system and vary the height at required points. This had some advantages:

The building system is simplified.

A variation is possible in the vertical dimension in what would usually be row houses of the same height.

Small apartments near family dwellings make it possible for grandparents to live close by.

Community Facilities

Unfortunately a program of such facilities was not available for Thamaing and there has not been enough experience to know exactly

what should be provided. George Reed sreported on a community built in Rangoon, part of which was left vacant so that the people could innagurate their own facilities according to their needs.[75] The program of facilities listed here is a composite of coverage of facilities for similar housing developments in this part of the world.

	Facilities in Each Area		
Category	Town Center	Community Center	Neighborhood
Administration	government fire protect. police sta. court	offices police station volunteer firemen	
Health	small hospital	clinic child welfare maternity center	doctors offices
Education	vocational high school university high school artisan training school adult education	middle school adult education	elementary school nursery school
Recreation	water sports stadium gymnasium tennis courts soccer fields swim. pool chinlon park, playfield	tennis courts swimming pool chinlon parks, playground	playground chinlon
Social - Cultural	cinemas theater for "Pwe" youth organization library exhibits open square	reading room auditorium outdoor "Pwe" youth organization exhibits open square	

Category	Facilities in Each Area		
	Town Center	Community Center	Neighborhood
Religion	pagodas monastary	pagoda monastary	shrines
Business	lodging house shops bazaar offices	shops bazaar home industry	shops
Transportation	bus terminal train station river boat warf animal and carriage depot	bus station animal and carriage depot	bus stops

ARCHITECTURAL DESIGN

Goals

To achieve a variety of spaces and visual experiences by subtle and simple means , and yet retain an underlying unity throughout. This has been sensitively and naturally done in the adobe villages of the south western United States, the Mediterranean villages; particularly in Greece and Italy, riverside stilt villages in Burma, and in nineteenth century Boston's Beacon Hill. A design goal of unrelated variation seems questionable if judged in comparison with the monotony of slight variation which occurs mile after mile in many American suburbs.

To allow for individual expression by leaving certain aspects of the dwelling such as sunshades, partitions, screens, and planting for the tenant to supply.

The design should grow like a plant out of a balanced synthesis of all the design conditions, particularly those of climate and economy.

To create an environment which is based on an understanding of the Burmese pattern of life and culture.

Construction

Since the ground creates problems of moisture, fungi, and termites, the dwellings will span between masonry piers and walls 12 feet apart. These masonry fins are to be pointing into the breeze to minimize air obstruction. To minimize foundation work, stairs and grill frames will also be supported by the walls. The floor system is to be plank and beam to minimize construction depth. The roof is a double surface system for shading and venting purposes, separated by trusses

which span 24 feet. The utility core unit containing the kitchen and bathroom will be assembled from precast concrete and vitreous tile inserts for sinks. Interior partitions where required will be suspended from the roof construction. The outside walls will be made of a system of interchangeable, light weight bamboo and wood screens, louvers, and panels to meet the various demands of the climate.

Materials

The materials are all chosen on the basis of economy, suitability for use and climate, and availability.

Foundations - concrete, serve to discourage termites

Load bearing piers - bamboo, reinforced stabilized rammed earth or light weight concrete

Party wall panels - stabilized earth blocks

Floor beams - pre-cast, bamboo reinforced concrete

Stairs, paving stones, core unit floor, stove, plumbing fixtures, shower stall - pre-cast concrete.

Floors - 2" termite resistant wood

Interior partitions, exterior wall panels and louvers - wood and bamboo.

Rain shedding roof - corrugated asbestos

Roof shading panels - bamboo

Roof trusses - bamboo and wood

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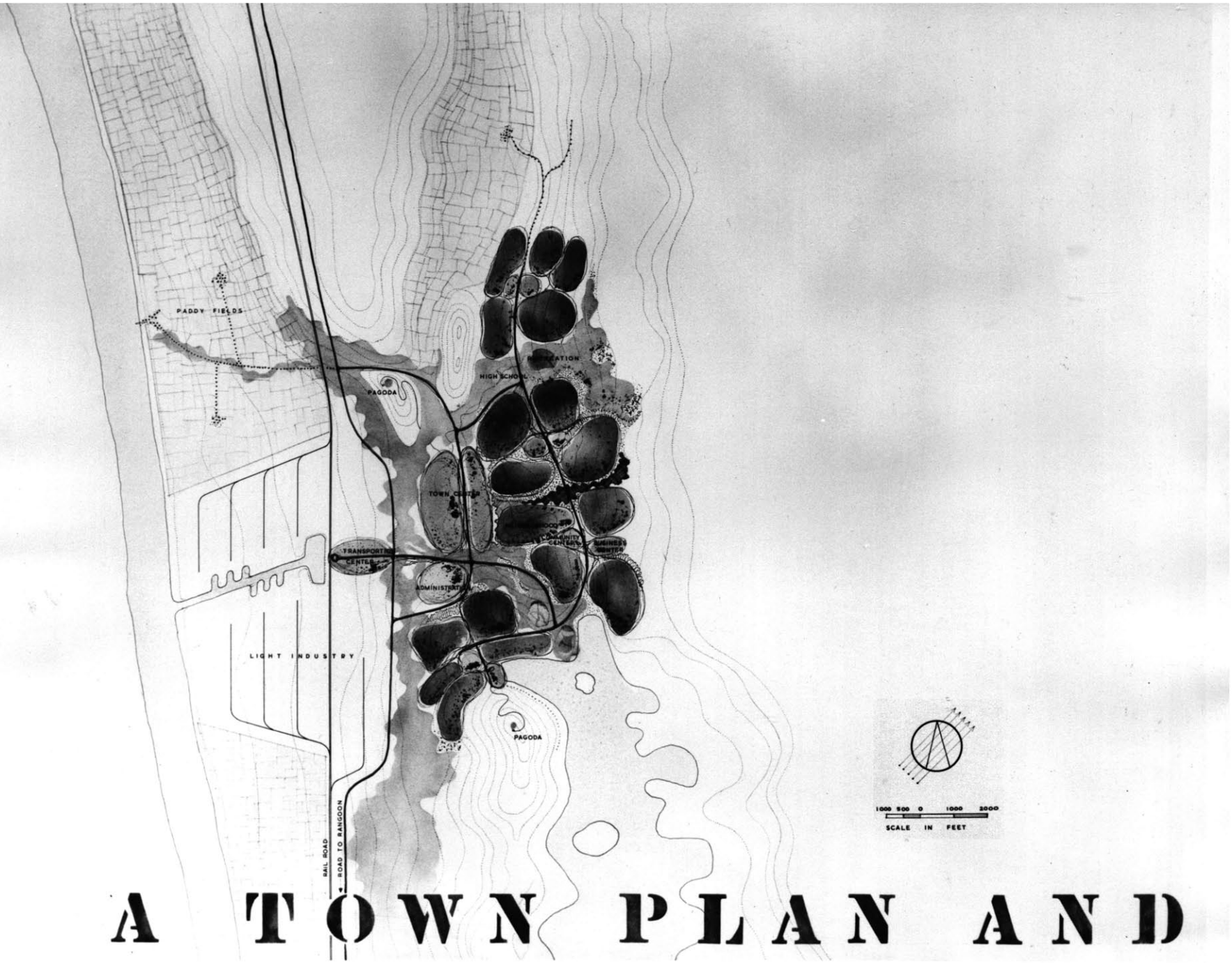

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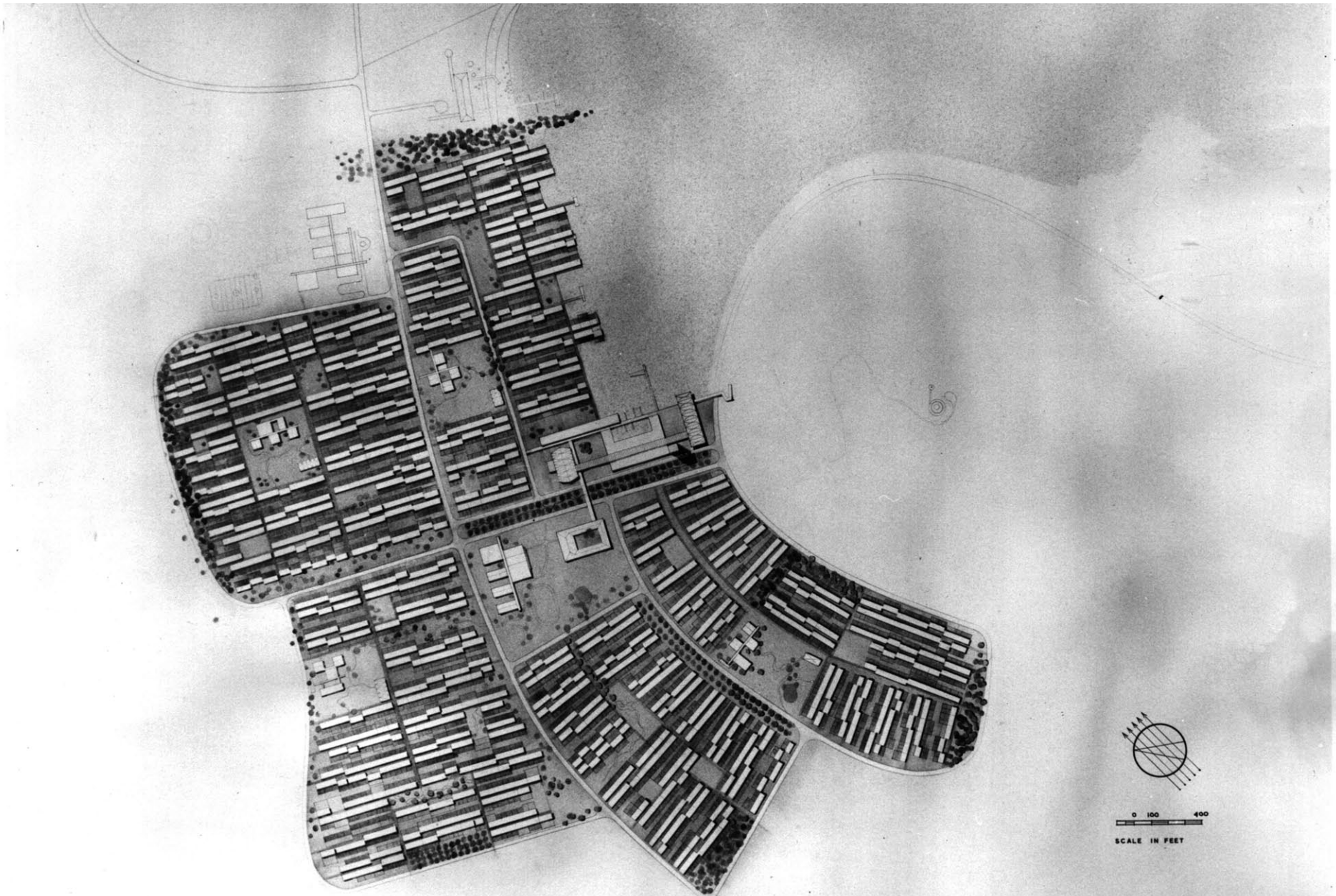

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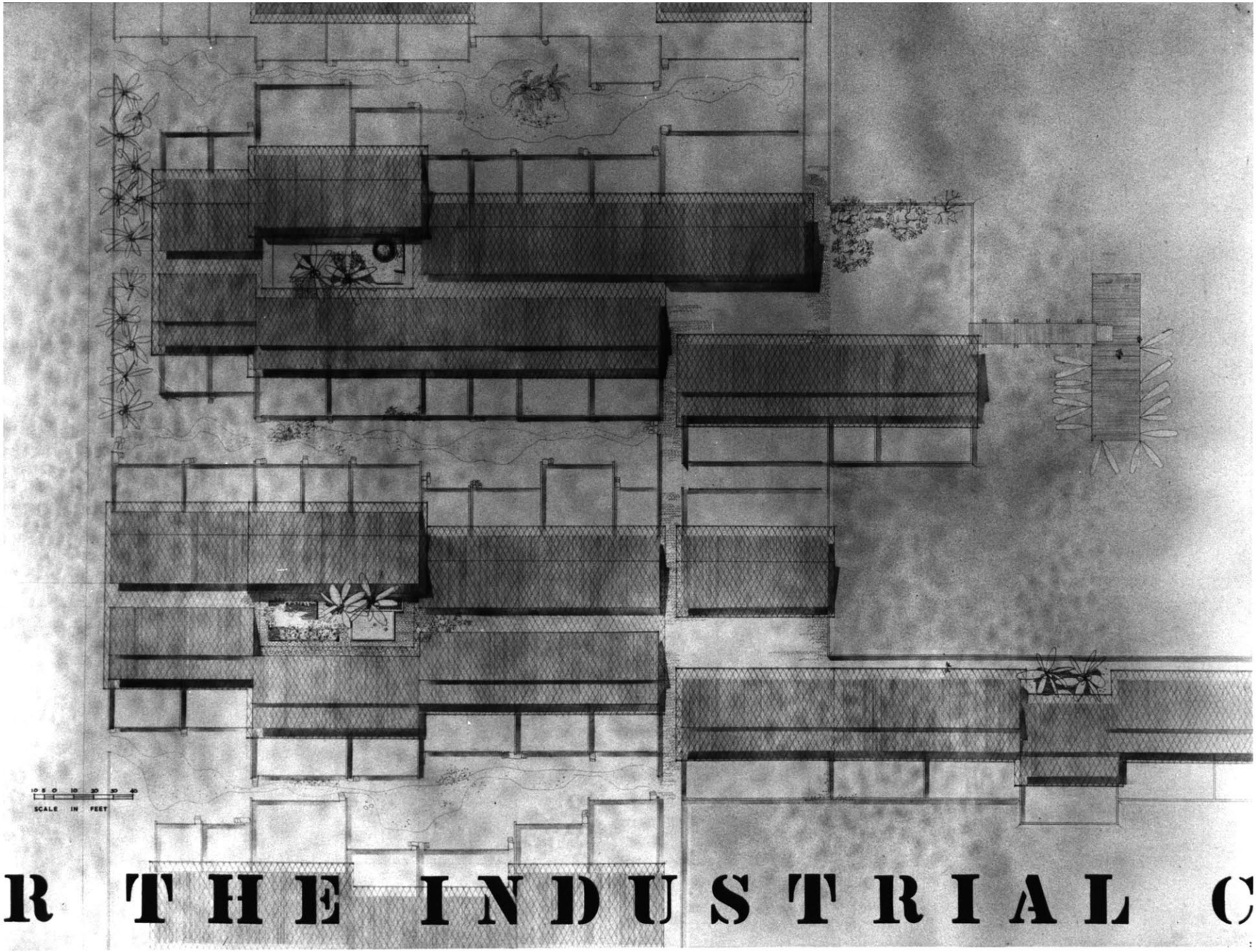

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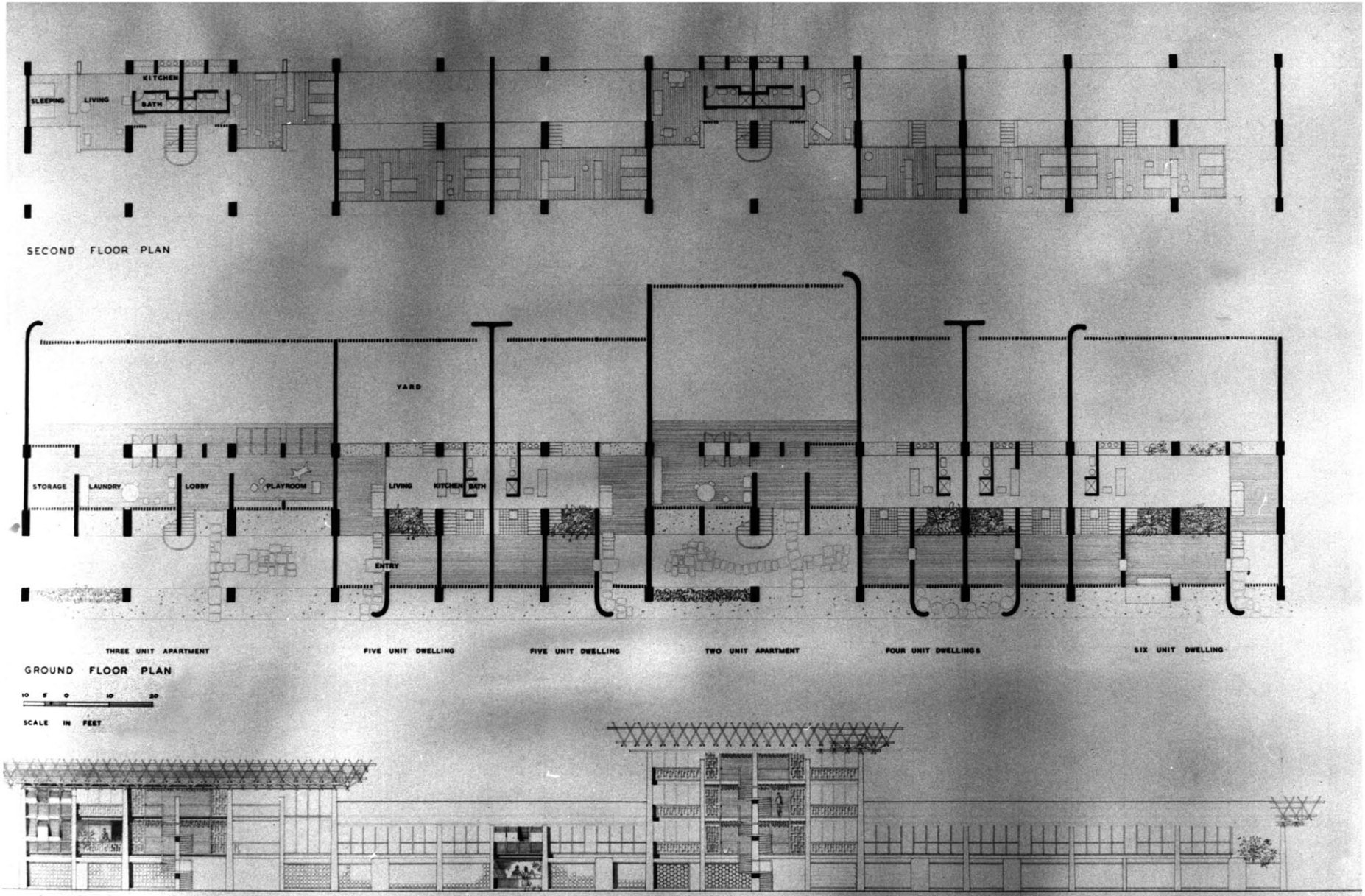

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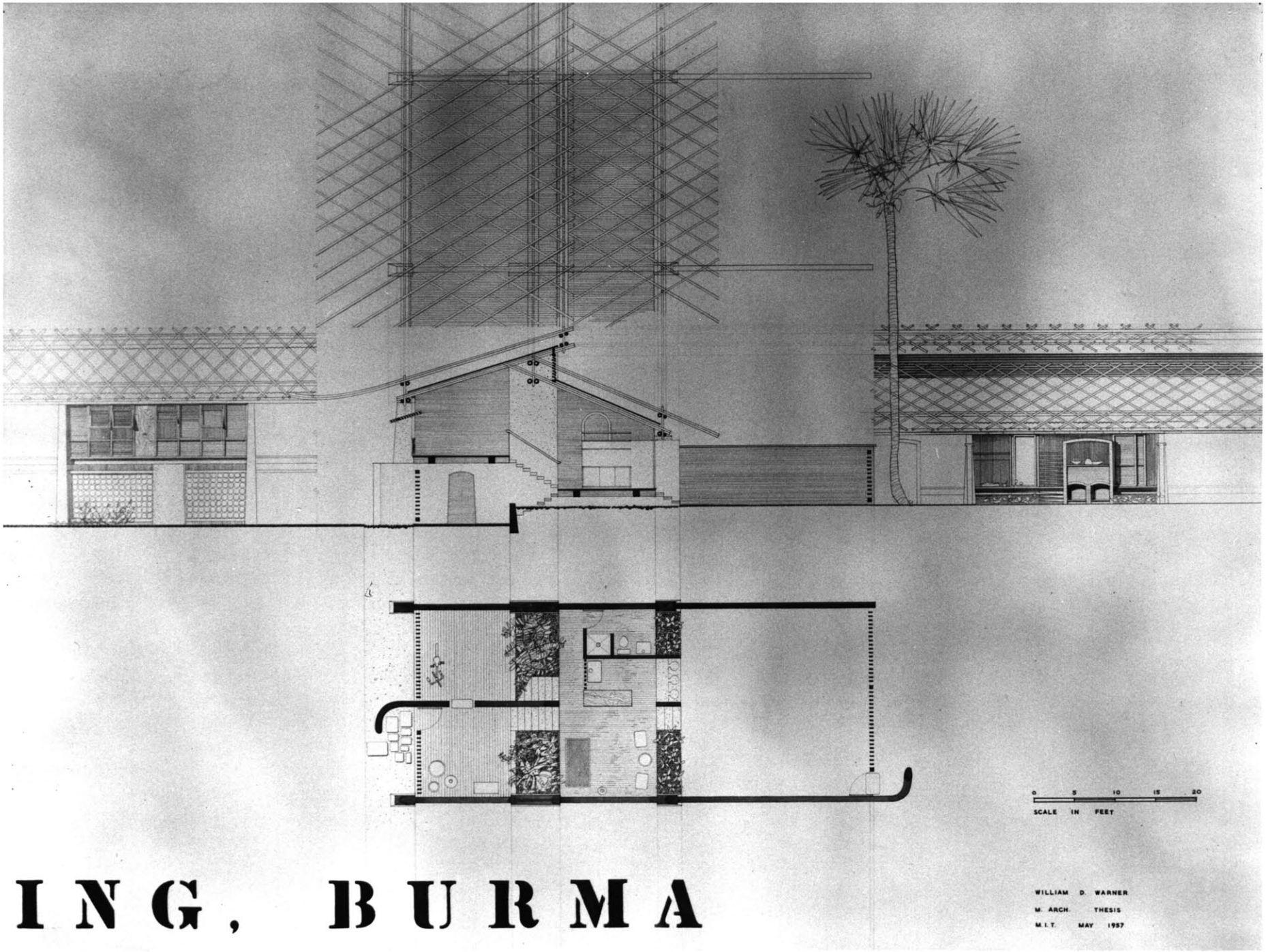
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SCALE IN FEET
WILLIAM D. WARNER
M. ARCH. THESIS
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