O.T. - CMU. Ultra Low Cost Refugee Housing & Symposium.

Item 1 - Goals

Item 2. a. Emergency shelter program.

b. Grant Proposal.

~~Item 3 Symposium Prospectus~~

4. Course Description

~~Item 4 O.T. Criteria, Prospectus Development Plan~~

Item 6 Bamboo Details

Item 7. Mockups of O.T. Designs. (Frames only)

Item 8. O.T. Prototypes in Guatemala

9. Prospectus Growing out of Work in Progress to Develop Emergency Shelter Systems

10. Grant Proposal: Construction of Emergency Shelters

303/1E

UT-CMU Ultra low-cost Refugee Housing & Symposium

FREDERICK C. CUNY & ASSOCIATES

INTERTECT

Item 1

U.T. Goals

INTERTECT COPY

Research Plan

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This research plan is being coordinated with a similar effort by a working party at Carnegie-Mellon.

Management Plan

The Emergency Shelters Group is divided into four teams.

1. Global Survey - A "cultural impact" team which is working to compile and evaluate data on world cultures, climatic conditions, soil types, negotiation and other pertinent information.

2. Technological Survey - This team is taking a critical look at existing building systems in use throughout the world both for relief structures and those employing only materials found on or near the site location.

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4. Materials - A working party that is surveying and developing materials that will work in rapid construction environments.

Each of these ~~items~~ teams interacts on all levels with each of the other groups.

The work of these groups will result in the following:

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   b. General availability
   c. Ease of transport
   d. Uses in field
   e. Ease of construction/degree of sophistication required
   f. Geographic/climatic limitations

3. A Socio-Cultural Index of housing types, patterns, constraints, etc., for world-wide reference. The report will show with illustrations existing housing types in disaster-prone areas and outline in detail problems likely to be encountered in housing and related areas in these regions.

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5. Produce prototype ultra-low-cost refugee housing units or systems and illustrated working reports.

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Ongoing Programs

The four reports that will be the result of our research (1. a housing systems report, 2. a bibliography, 3. a socio-cultural directory, 4. a possible disasters index) will be the basis for further research at U.T.

Periodic reports on new developments will be issued as research progresses.

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1. A symposium on emergency housing systems
2. Interdisciplinary programs at U.T.
3. Establishment of a training center for relief personnel
4. Publication of a mimeograph series on emergency shelters
5. Inter-University research programs
6. Development of a publishing center for relief/emergency shelters material

Key Personnel

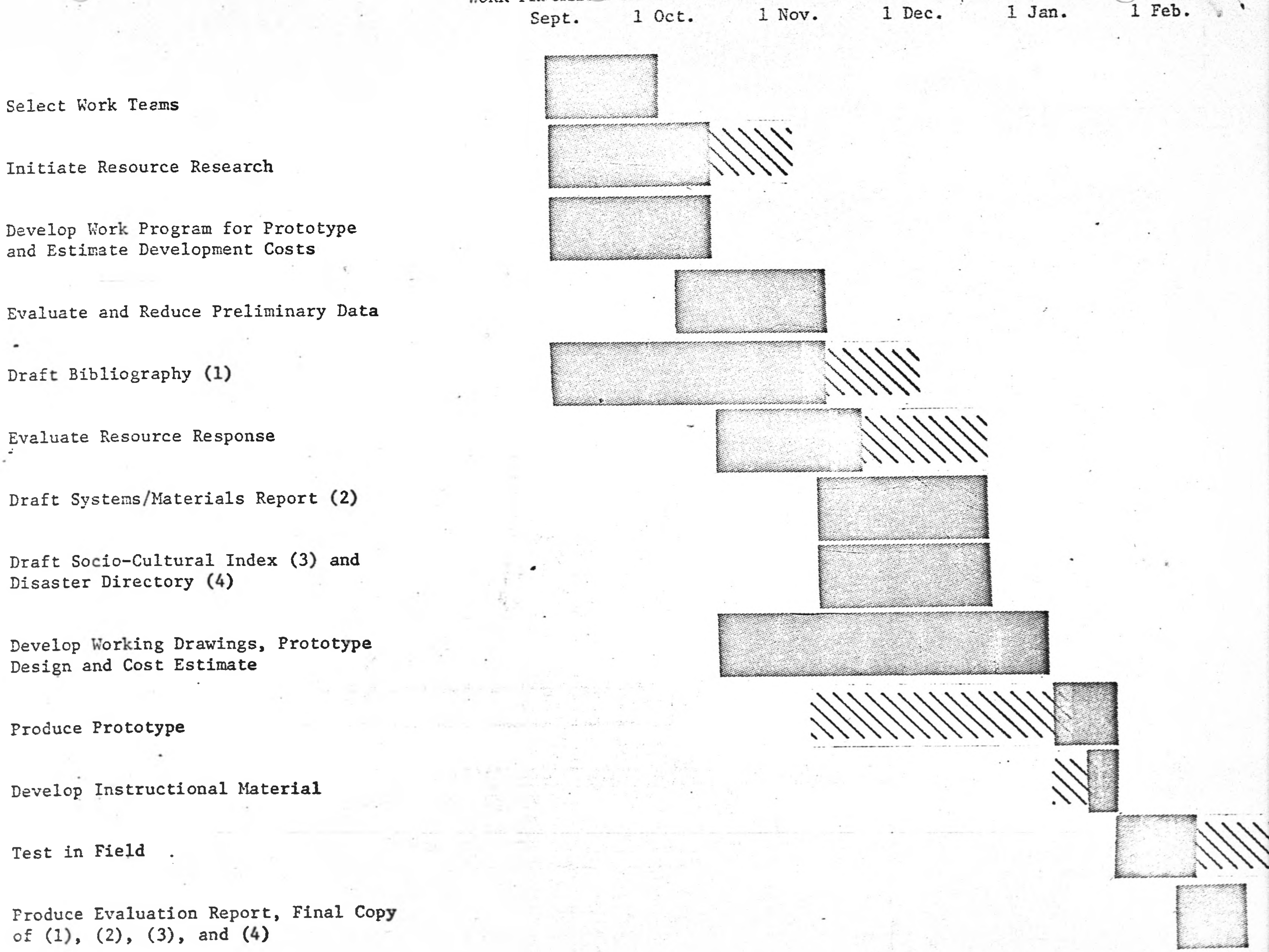
Professor Wolf Hilbertz of the University of Texas, School of Architecture, is overall program coordinator for the project. Assisting him are Geoffrey Wright and Richard Trimble.

The research is being coordinated with the program at Carnegie-Mellon University by Professor Volker Harkopf of CMU.

Consultant for the project is Frederick C. Cuny of INTERTECT in Dallas, Texas.

Fri - 19th 12:00 meeting

WORK PROGRAM MILESTONES



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SOME PROT. TO PROMOTE
INSTRUCTIONAL MATE

SUGGESTED OUTLINE FOR CULTURAL INDEX (3)

(See Accompanying Map)

A. Region

B. Nations in Region

C. Relief

D. Climate

E. Types of Transportation

F. Population Characteristics

1. Urban - Rural
2. Familial Make-up
3. Average Family Size
4. Living Patterns
5. Religion

G. Housing Patterns

1. Size of Structures
2. General Layouts
3. Materials Used
4. Preferred Colors
5. Cultural Restraints
6. Adaptability to New Designs
7. Types of Supportive Systems Required
8. Adaptability to High Density Environments

H. Materials Available

1. Soils
2. Organic Materials
3. Synthetic Materials in use
4. Costs of Construction
5. Availability of Skilled Labor

I. Comments

1. Materials which could make units more efficient
2. Systems currently in use which could be used in relief operations
3. Systems currently in use which should not be used in relief operations

SUGGESTED OUTLINE FOR POSSIBLE DISASTER DIRECTORY (4)

Country ____________________ Location ______________

Physical Data

- Area
- Relief
- Climate
- Mean Annual Rainfall
- Soils
- Types of Transportation & Availability
- Physical Problems

Demographic Data

- Population
- Density
- Birth Rate
- Urban - Rural Ratio
- Per Capita Income
- Average Family Size
- Literacy
- Languages/Dialects
- Ethnic/Racial/Tribal Groups
- Religions

Governmental Data

- Type of Government
- Disaster Agencies
- Sphere of Influence
- International Organizations

Health Data

- Prevalent Diseases
- Possible Diseases
- Doctor/Inhabitant Ratio

Possible Disasters

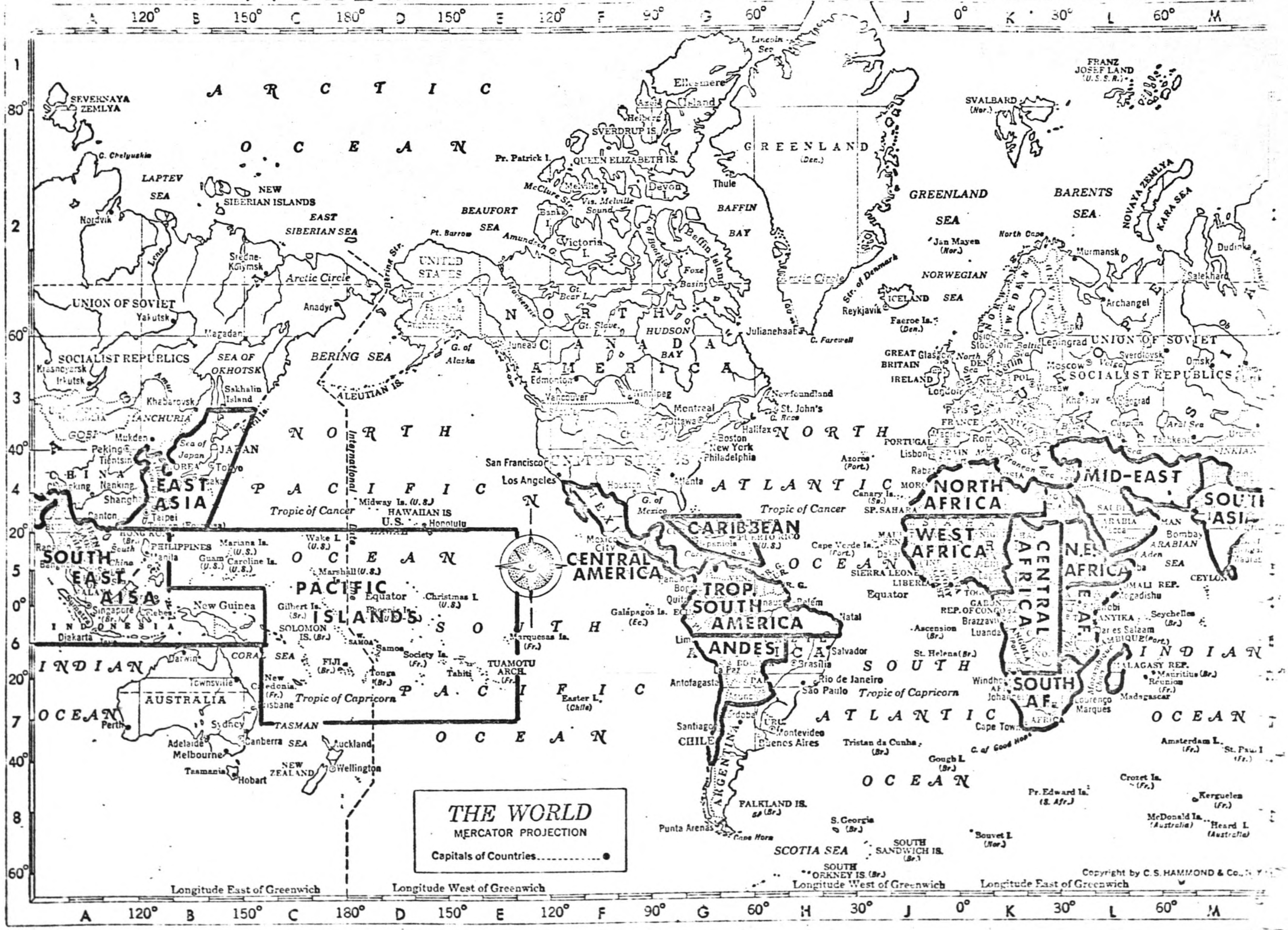
- Natural Disasters/Probability Index
- Man-Made Disasters
- Ability of Government to Respond
- Degree of Expatriate Assistance Needed
- Nations that can be Expected to Assist
- Cultural Restraints to Relief Operations

Yr.? SCALE 1-10

Comments

Biblog.

3rd World DISASTER-PRONE AREAS



ITEMS TO BE COVERED IN FIELD OPERATIONS GUIDEBOOK

I. Medical facilities
   A. Field medical warehouses
   B. Medical stores
   C. Clinics
      1. Out-patient clinics
      2. Special service clinics (children's, etc.)

II. Preventative health procedures
   A. Basic field sanitation (flyproofing, etc.)
   B. Medical staff requirements and utilization

III. Environmental planning and improvements
   A. Field sanitation
   B. Housing and shelter
   C. Drainage
   D. Water supply
   E. Sewage disposal and facilities
   F. Waste disposal, solid and liquid
   G. Lighting and power
   H. Removal of the dead
   I. Camp planning techniques
   J. Utilization of complex materials and equipment

IV. Distribution of supplies and relief goods
   A. General procedures and facilities
      1. Storage in the field
      2. Distribution in the field
      3. Inventories
      4. Requisitions
   B. Food handling and distribution
   C. Clothing and distribution
   D. Household and supplementary goods (blankets, utensils)

V. Resources management
   A. Materials handling
   B. Monetary control
   C. Personnel
   D. Communications
   E. Liaison with local organizations
   F. Transport
      1. Surface
      2. Air
      3. Sea and other waterbourne
   G. Establishment of field operations center
   H. Data Gathering (Disaster Intelligence)
   I. Organizing

Item 2

1. Emergency Shelter Program
2. Grant Proposal

THE UNIVERSITY OF TEXAS AT AUSTIN
AUSTIN, TEXAS 78712

School of Architecture

Emergency Shelter Program

Arc. 355/380

November 6, 1973

INTERNATIONAL NEEDS

The number of refugees in the world today is well in the millions and is increasing daily. Civil disturbances in Bangladesh in 1971 drove an estimated 12 million people into India as refugees and caused millions of others to flee their homes. Earthquakes in Mexico this summer claimed the homes of thousands as did similar earthquakes in Nicaragua last year. As of 1971 over 3 1/2 million people had fled or been evacuated from areas of conflict in Viet Nam and the refugees in Laos and Cambodia account for several million more.

The threat of natural disasters (earthquakes, hurricanes, draughts) is forever with us and they somehow seem to occur most often in the most highly populated areas of the globe. These regions also tend to have, along with their other difficulties, unstable governments and not enough capital to deal with disasters when they do come.

Concerning this situation and the technological expertise now available in the world, C. P. Snow in his 1959 Rede Lecture at Cambridge University states:

> "Since the gap between the rich countries and the poor can be removed, it will be. If we are shortsighted, inept, incapable either of good-will or enlightened self interest, then it may be removed to the accompaniment of war and starvation: but removed it will be. The questions are, how, and by whom."*

Although many international relief organizations deal with health and food services, surprisingly few can deal with the acute housing need. One main reason for this is that no one has successfully solved the difficult problem of providing adequate housing which fits the extremely low budgets available.

* C. P. Snow, The Two Cultures, and A Second Look. Cambridge University Press, 1969, page 46.

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TECHNICAL SURVEY OUTLINE

I. Organization of Survey...by Materials
  A. Four Main Categories
    1. Roof frame
    2. Roofing materials
    3. Walls, foundation, flooring
    4. Other (e.g., polyurethane foam)

  B. Within Each Category...Specific Data
    1. Material/and bibliography
    2. Structures using this material
    3. Details of joints
    4. Limitations (if known)
    5. Suggested improvements (if any)

  C. List of Materials to be Included in Survey

Bamboo		Thatch	Polyethylene
Earth		Reeds	Polyurethane
Rammed		Sand Bags	Rubber
Adobe		Canvas	Metal Scrap
Stabilized		Burlap	Shellac
Sod		Stone	55 Gallon Drums
Brick Pressed		Brick	Sewer Pipe
Earth Stabilizers		Hemp Rope	
Dung	Sand	Nylon Cord	
Lime	Asphalt	Glue	
Straw	Bhusa	Wire	
Molasses	Hair	Fiberglass	

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Country ______________________ Location _______________

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- Relief
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Comments

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Item 3

UT Symposium Prospectus

10 October 1973

MEMORANDUM

TO: P. Arumi, S. Black, J. Bowman, P. Coltman, A. DeLong, A. Derman, D. Fisk, P. Fisk, J. Gallery, R. Mather, R. Parkins, A. Schaller and F. Cuny-Intertect, T. Jannuzi-Asian Studies, R. Owens-Anthropology
BOB COPELAND, ROGER RAU - PHILOSOPHY

FROM: W. Hilbertz

SUBJECT: Proposed Symposium on Emergency Shelters and Possible Development of an Interdisciplinary Emergency Shelter Program.

As a result of the role of the emergency shelter group the possibility to develop ongoing programs in this and related fields has arisen. Specifically, these items are:

1. The development of a program of study in emergency housing. This program could eventually expand into "Housing for the Third World".

2. The initiation of a symposium on this subject to be held next spring at U.T.

Dean Burnette has requested that interested faculty members meet with him to discuss possibilities and individual committments. This meeting will take place 19 October at 12:00 noon in ARC 102.

Prior to this we would like to meet to discuss the attached material and explore the best approaches. This first meeting will be held 18 October at 12:00 noon in the Faculty Dining Room, second floor U.T. Union.

Please call me at your leisure for more information.

Attached:
Preliminary symposium outline.
Ongoing programs.

Item 4

~~UF Curricula, Projects~~
~~Development Plan~~
Course Description

August 29, 1973

COURSE DESCRIPTION

1. Course Name and Number:

   Emergency Shelter Systems
   Arc. 355/380, Unique No. ...
   3 Hours Credit

2. Instructor:

   Wolf Hilbertz

3. Meeting Time and Place:

   T, Th 9 - 12
   Room t.b.a.

4. Format:

   Design Construction and
   Testing Laboratory

5. Description of General Intentions:

   1. Recently, some students and this instructor were contacted by Fred Cuny from "Intertect", a limited-profit-co-op of professionals in the design field who provide specialized engineering and planning services to international relief organizations in disasters and emergency situations.

      "Intertect" urgently needs practical approaches to providing effective shelter. Our group agreed to develop an ultra low cost shelter system for them. "Intertect" will assist in securing developmental aid, travel funds and a site in Bangladesh.

   2. It is intended to design, build and test a mechanical shelter generator which structures indigenous materials.

      Testing of both generator and structure(s) will hopefully take place in Bangladesh. Several students will take the equipment there and build and evaluate.

6. Description of Content:

   1. Study of existing emergency shelters. Critical Evaluation.

   2. Study of existing building techniques using indigenous materials.

   3. Study of existing and proposed morphogenetic hardware. Critical evaluation.

   4. Design of emergency shelter building system.

5. Construction of generator.

6. Testing of generator and shelter in a real situation.

7. Evaluation of results.

7. Grading:

According to commitment and vigor.

8. Resources:

1. We hope to secure funds from international relief organization and some minor monetary aid from U.T.

2. Tools, devices and materials in the S.P.L. at Balcones Research Center.

9. Reading Suggestions:

1. Cuny, F., Intertec Folder and Papers, available from Wolf Hilbertz.

2. Moorcraft, C., Building with Stabilized Earth, Architectural Design, January, 1973.

3. Building Research Station. Building in cob and pise de terre: a collection of noted from various sources on the construction of earth walls. H.M.S.O., 1922.

4. Commonwealth Experimental Station. Earth-wall construction: pise or rammed earth, adobe or puddled earth, stabilized earth. Sydney, Australia, 1952. Bulletin No. 5.

5. Croome R. Pise de Terre Construction, Report to Cromer U.D.C., "The Builder", January 30, 1920.

6. Ellis-Williams, Clough and Eastwick-Field, John and Elizabeth. Building in Cob, Pise and Stabilized Earth. London, Country Life, 1919. 3rd ed., 1947.

7. United States Department of Agriculture. Building with adobe and stabilized earth blocks. Washington, D. C., U.S.A., December, 1965.

8. United States Government Printing Office.
Publication PB188918. Earth for Homes: Ideas and Methods Exchange.
Publication PB179327. Handbook for Building Homes of Earth.
Southwick, Marcia. Build with adobe. Chicago, Sage Books, 1965.

9. Hereford, M. W., Weaving with marram grass."Country life", June 21, 1956.

10. Dodds, L.V., Straw Thatch as a building Material. National Builder, October, 1929.

11. Jarret, G., Growing wheat reed for thatching. "Country Life". January 28, 1960.

12. McClure, F.A., Bamboo as a building material. Peace Corps. Tech. Resources Division. Washington, D. C. 20525. Peace Corps., 1969.

13. Raborn, J.M., Shelterbelts and windbreaks. London, Faber, 1965.

14. Crampton, Charles., Canework. Leicester, Dryad Press, 19th ed., 1966.

15. Davey, Norman, A History of Building Materials, Phoenix House, London, 1961, pp. 19-25.

16. Dumbleton, M.J., Investigations to Assess the Potentialities of Lime for Soil Stabilization in the United Kingdom, Road Research Technical Paper No. 64, H.M.S.O., London, 1962.

17. Kern, Ken, The Owner-Built Home, published by the author, Sierra Route, Oakhurst, Calif. 93644, U.S.A. (The relevant chapters on rammed earth and earth block construction were reprinted in "Mother Earth News", Nos. 9 and 10).

18. Kirkham, How to Build Your Own Home of Earth, Oklahoma A & M, Stillwater, Oklahoma, November, 1946.

19. Merrill, The Rammed Earth House, Harper, New York, 1947.

20. Middleton, G.F., Build Your Own House of Earth, Angus and Robertson, Sydney, Australia, 1953.

21. Nebauer, L.W., Adobe Construction Methods, Agricultural Publishers, University of California.

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23. Sherwood, P.T., The Effect of Soil Organic Matter on the Settling of Soil-Cement Mixtures, Road Research Technical Paper No. 61, H.M.S.O., London, 1962.

24. Southwick, Marcia, Build With Adobe, Sage Books, Chicago, 1965.

25. Szczelkun, Stefan, Survival Scrapbook 1. Shelter, Unicorn, Bookshop, Brighton, 1972.

26. Thomas, D. W., Small-Scale Manufacture of Burned Building Bricks, WITA, New York.

27. UN, A Manual of Stabilized Soil Construction for Housing, UN sales no. 58.11.h4.

28. U.S. Dept. of Commerce, A Handbook for Building Homes of Earth, NTIS, Springfield, Va. 22151, U.S.A.

29. Webb, Culliers & Stutterheim, The Properties of Compatted Soil and Soil-Cement Mixtures for Use in Building, National Building Research Institute, South Africa, March, 1950.

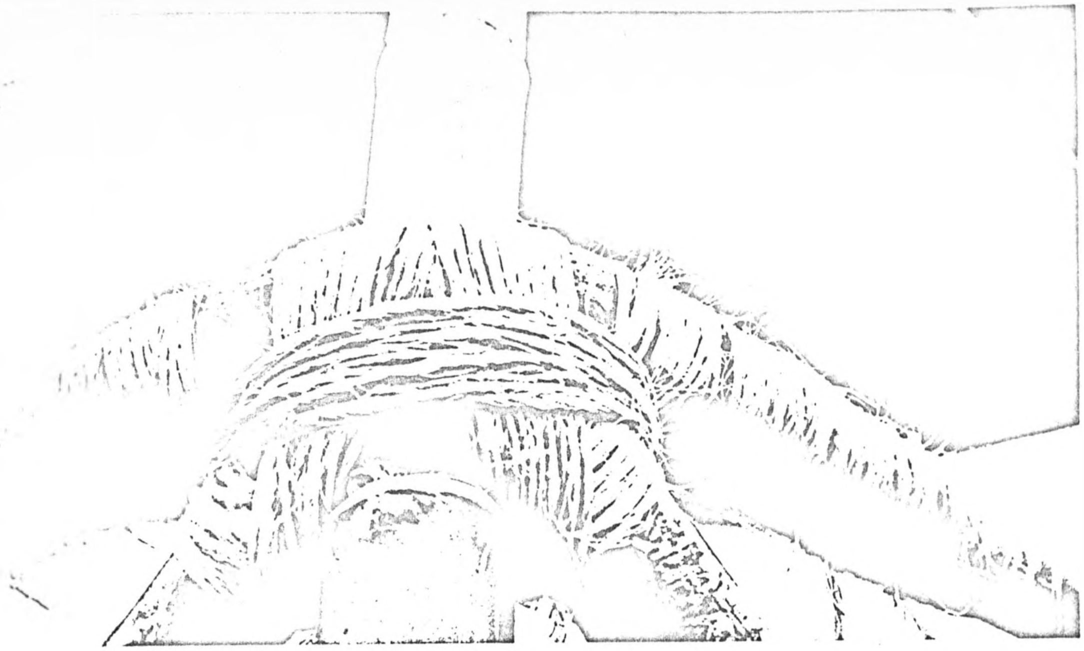
30. Williams-Ellis, C. & Eastwickfield, J. & E., Building in Cob Pise and Stabilized Earth, Country Life Publishers, London, 2nd edition, 1947.

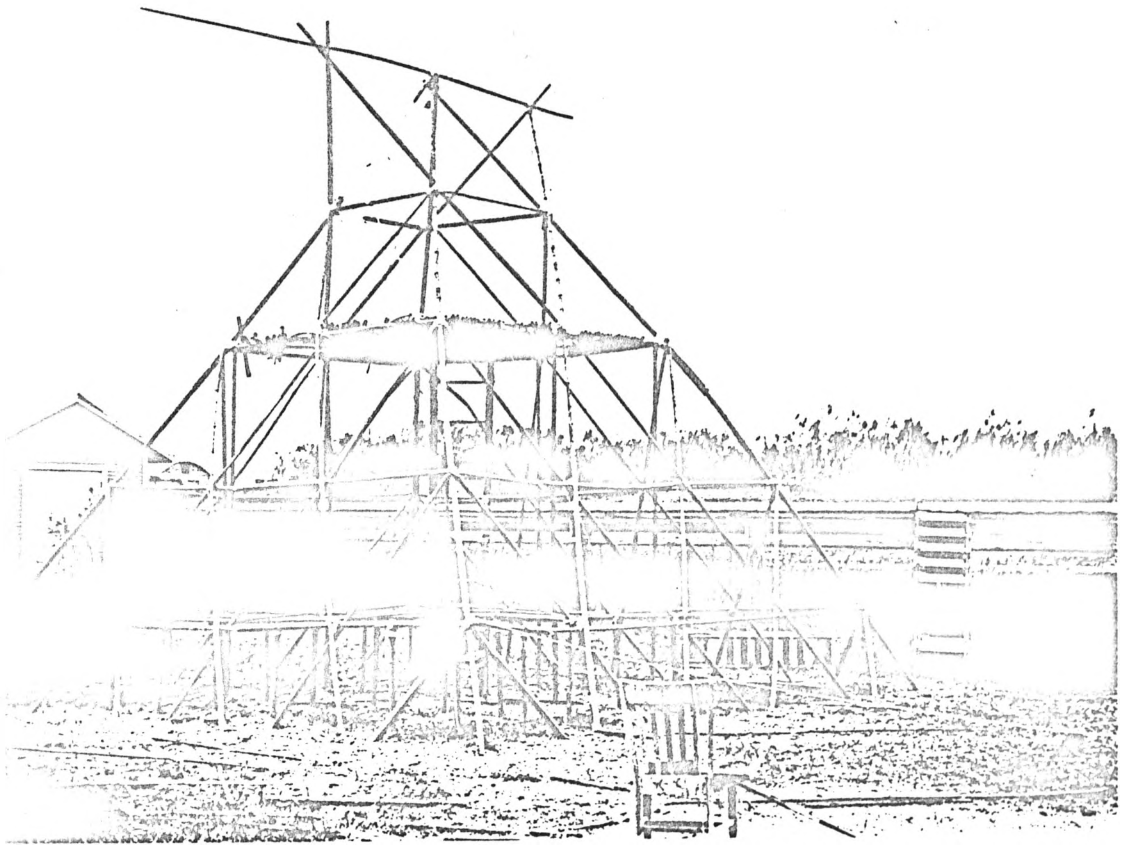
THE UNIVERSITY OF TEXAS AT AUSTIN
AUSTIN, TEXAS 78712

School of Architecture

A PROSPECTUS GROWING OUT OF WORK IN PROGRESS TO DEVELOP EMERGENCY SHELTER SYSTEMS

November 6, 1973





A PROSPECTUS GROWING OUT OF WORK IN PROGRESS TO DEVELOP EMERGENCY SHELTER SYSTEMS

SCHOOL OF ARCHITECTURE & PLANNING, U/T AUSTIN

INTRODUCTION

An interdisciplinary working party has been formed at the University of Texas to develop new approaches to the problems of housing refugees. The team is made up primarily of faculty and students from the School of Architecture with additional members from the center of Asian Studies and the Department of Anthropology. The project is being coordinated with a similar and complimentary project at Carnegie-Mellon University.

EXISTING PROGRAMS

"Emergency Shelters" (Hilbertz) explores the following areas:

1. The cultural and geophysical characteristics of disaster-prone areas.
2. Existing emergency housing techniques and systems.
3. Proposed emergency shelter systems; design and evaluation.

Several full-scale prototypes using bamboo and stabilized as well as rammed earth techniques are being constructed and tested at Balcones Research Center at the University of Texas at Austin.

"Structural Systems" (Bowman) is an introductory course, analyzing a wide range of structural systems and their resulting force systems. Such systems include those using native indigenous materials.

"The Steady State Environment" (Mather) treats the entire region of Texas as a steady-state environment passing through a seventy-five year succession of development states. Drawing on Mather's experience in Iraq in the early sixties as part of an AID funded faculty team and as part of the HUD funded Austin Oaks Low Income Housing Demonstration in the late sixties, the course attacks man-environment problems by means of a set of conceptual tools developed for this work. Some of this effort has dealt with modeling the disaster/relief situation.

"City Planning" (Coltman). While no specific work in the field of emergency shelters is being done at present in Professor Coltman's own educational program, his background includes twelve years in specialized work related to low income community development, self help, direct building and rural housing in South Africa, Zambia, and Swaziland.

Professor Coltman also was recently a visiting lecturer at the University of Manitoba where he participated in an "emergency shelter" project in which third year environmental studies students were required to construct shelters in three different environments with only local materials.

"Low-Technology Applications" (Fisk) - This course is concerned with research, experimentation, and working examples of the following:

1. Indigenous building methods and materials amenable to individual and small group construction: concerns focus on reversible and or renewable resources.
2. (Small scale domestic) Energy and utility systems using available natural forces in the focus of sun, wind, and biological energies.
3. Information access means for individual user design and building.

TARGET AREA

The problems of housing refugees occur world-wide and the working party realizes it is impossible to design one structure which can be adapted to all emergencies. However, environmental similarities can be found in many areas of the world which enables the team to concentrate on responding to disaster "types."

In the initial research, the team has narrowed its focus to responding to those disasters which occur in developing nations generally between the tropics of cancer and capricorn. Specifically, the research will center on tropical areas, especially those in which bamboo is generally available. This environment assumes high rainfall with accompanying flooding, high winds, and difficult terrain features. It also assumes a low technology society and a general unavailability of sophisticated equipment. It should be stressed that the development of response to this environment does not preclude the adaptation of the techniques and methodology of the project to other situations or areas.

APPROACH

The team has categorized the problems of relief in the third world into two areas. The first is <u>emergency response</u>, the immediate provision of aid for maintaining human life. This includes food, medicines, and temporary shelter. The second area is defined as <u>change response</u>, the introduction of international aid and expertise combined with local resources to implement and evaluate certain outcomes stemming from the emergency. The team has concentrated its efforts in developing prototypes for emergency response but has designed the program so that evolutionary units may be constructed with regard to the second.

In developing prototypes which can be utilized in emergency response, design constraints have been adopted. These can be categorized thus:

1. Technological - The overall structure must be adpatable to areas in which only limited technology is available. Thus the structure must rely on indigenous materials, local skills, and unsophisticated techniques. The specific design constraints are:

   a) The unit must be able to be built without more than one day initial instructions.
   b) The process must be adaptable to mass construction techniques (i.e. assembly lines).
   c) The units produced must be 90% reliant on local materials. (at least).

2. Cultural- Both the prototypes and the building process must be adaptable to local cultural patterns. Specifically the form must be suitable to the culture and the process must utilize local craftsmen and tools.

3. Environmental - The prototypes must be able to withstand a hostile climate environment. Specifically, the unit must be able to withstand steady winds of 140 mph, normal flooding to 2 1/2 feet with escape areas for 8 foot flood levels.

4. Cost - The prototypes must be economically feasible. Unit costs are not assigned but a range of costs is utilized based on the number of occupants per dwelling unit. The cost of a single family unit must be under $50. However, no more than 10% of the total cost may be for the import of non-local materials.

The key constraint is the at least 90% reliance on locally available materials. However, the team will attempt to increase this reliance to the ultimate 100% in the on-going test program.

TEST PROGRAM

The University of Texas Test Program deals with three areas of concern:

1. the technology of joining structural members(primarily bamboo joined with hemp, jute, or sisal)
2. roof systems (bamboo trusses covered with canvas, polyethylene, thatch or other indigenous materials)
3. wall systems (stabilized earth, polyethylene, canvas, thatch or other indigenous materials).

Based on research, several types of structures have evolved employing the structural characteristics of triangulation, stabilized earth, lattice shells, tension structures, and double-curved structures.

The testing of a structure is carried out in three phases:

1. A given structure is drawn, then models are built at a small scale in labs at ehe University of Texas School of Architecture and preliminary testing is carried out. The structures are then built to full scale at Balcones Research Center. These prototypes are tested for wind loading, load bearing capabilities, and use adaptability and efficiency. This phase of the testing will be completed by December 22, 1973.
2. The prototype will be field tested in a tropical environment. Testing there will include such considerations as organization of labor, construction time, location and transportation of materials and emvironmental compatibility. This phase will be complete by January 15, 1974.
3. A trip to the actual country of potential use to gather information, make limited tests, and establish a framework for emergency response would be undertaken, the knowledge gained would then be used to refine the proposal and test structures and to prepare for an emergency response.
4. To build several units in an actual refugee situation and evaluate their performance. Feedback will be sought from those people erecting the structures, members of relief organizations, and where possible, by the inhabitants of the structures. The feedback from the evaluation will be input into the design of new housing types and construction systems.

MATERIALS BUDGET

20 Bags Cement @ $1.90 each	$ 38.00
10 Bags Lime (Type Al) @ $3.50 each	35.00
30 Gallons Asphalt @ $1.00 each	30.00
6 Loads of Dirt, Sand @ $20.00 each	120.00
10 Sheets of 1/2 Plywood @ $12.00 each	120.00
5 Sheets 3/4 Plywood @ $16.00 each	80.00
Various Steel Profiles	25.00
2,500 Ft. Hemp Rope @ $0.03 per foot	75.00
Various Pulleys	20.00
Various Gears	20.00
Bolts, Nuts, Screws, Nails	20.00
Wire, Solder, Tape, Paint	25.00
Welding Equipment:	
Acetylene	25.00
Oxygen	14.00
Rods	9.00
Propane	8.00
Misc. Hand Tools	50.00
Sub Total	$714.00

Photographic:

10 ROlls 35mm B&W (Plus X)	$10.00
42 Rolls 120mm B&W @ $.90 each	3.60
2 Rolls H. S. Ect. @ $3.00 each	6.00
Processing H.S.E. @ $3.50 each	7.00
10 8X10 Prints @ $2.25 each	22.50
Sub Total	$49.10
TOTAL	$763.10

PUBLICATION EXPENSES

50 Copies of a 70 page report are currently envisioned approximately 20% of the report will be illustrated by B&W photos & 30% by graphs and drawing illustrations

15 halftones @ $1.00 each	$150.00
20 metal plates @ $2.00 each	40.00
70 plastic masters @ $.90 each	63.00
Press work	90.00
Paper changes	20.00
Colating	7.00
Binding	4.00
Binding Labor	50.00
TOTAL	$424.00

MISCELLANEOUS EXPENSES

Water Proof Shipping Tubes @ $1.00	$20.00
Documentation	
Secretarial Typing @ $.50/page	15.00
Copying @ $.05/page (600 copies)	30.00
TOTAL	$65.00

TRAVEL BUDGET

Round trip for 10 members of working party Austin-Site-Austin

Austin- New York	
Air (200 each round trip)	$2000.00
Per Diem @ 10 each/day	100.00

New York- Dacca	
Air (900 each round trip)	9,000.00
Per Diem (2 days @ 10 each)	200.00
Dacca- Site	
Air ($50.00 each round trip)	500.00
TOTAL	$11,800.00

SUBSISTENCE

10 days at $5.00 each	$ 500.00
Incidental expenses (indication, etc.)	100.00
TOTAL	$ 600.00

SUM TOTAL	$13,654.10

PARTICIPANTS

School of Architecture:

Faculty: John Bowman, M.S.
Peter Coltman, Dipl. TP.; MS in CRP
Asher Derman, Cand. PhD
Daria Fisk, M. Arch.
Pliny Fisk, M. Arch.
Wolf Hilbertz, M. Arch.
Robert Mather, M. Arch.

Students: James Amoretti
Gabriel Baez
Charles Bellomy
Henrique Carrizales
John Corbin
Milosav Cekic
Noel Cruz
David Davidson
Ferida Haratunian
Deborah Higgs
Robert Ikel
Murray Libersat
Aise Mahmood
Jaime Mota
Charles Phillips
Chester Slimp
Eugene Smith
Robert Swaffer
Regan Terrier
Richard Trimble
Ray Truitt
Ray Villasana
Warren Wurzburg
Geoffrey Wright

Center for Asian Studies:

Faculty: Tomasson Jannuzi, Ph.D., Director

Department of Anthropology:

Faculty: Ray Owens, Ph.D.

Consultants: Frederick C. Cuny, Intertect, Dallas, Texas
James Parkey, A.I.A., Dallas, Texas

TIME SCHEDULE

Select Work Teams

Initiate Resource Research

Develop Work Program for Prototype
And Estimate Development Costs

Evaluate and Reduce Preliminary Data

Draft Bibliography

Evaluate Resource Response

Draft Systems/Materials Report

Draft Socio/Cultural Index

Develop Working Drawings, Prototype
Design and Cost Estimate

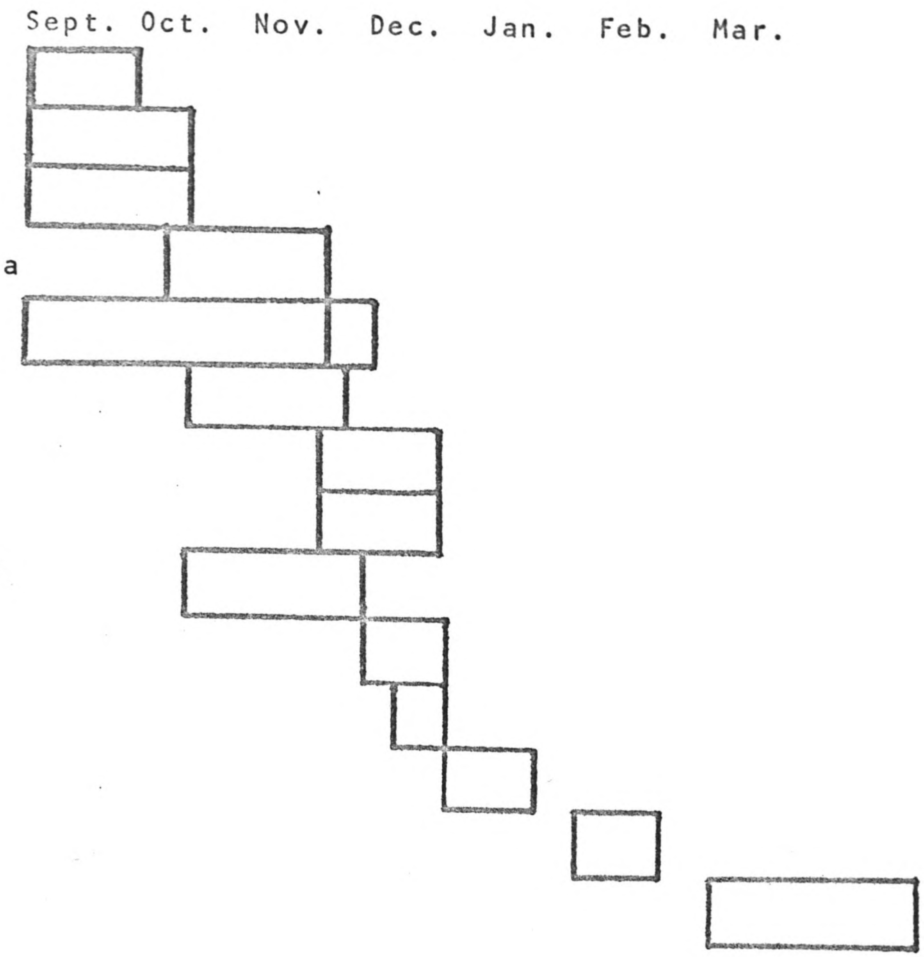
Produce Prototype

Develop Instructional Material

Initial Field Test

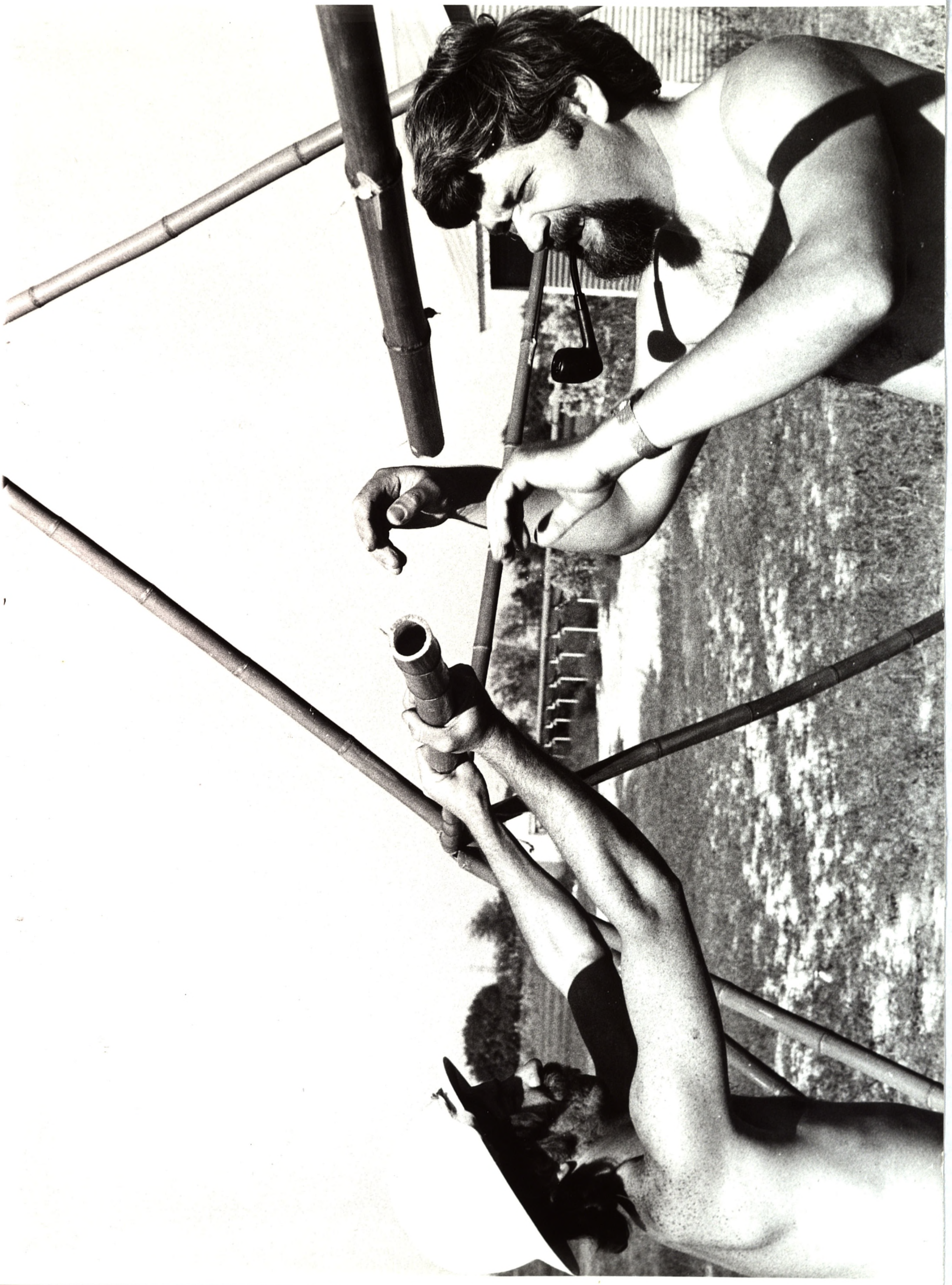
Situation Field Test

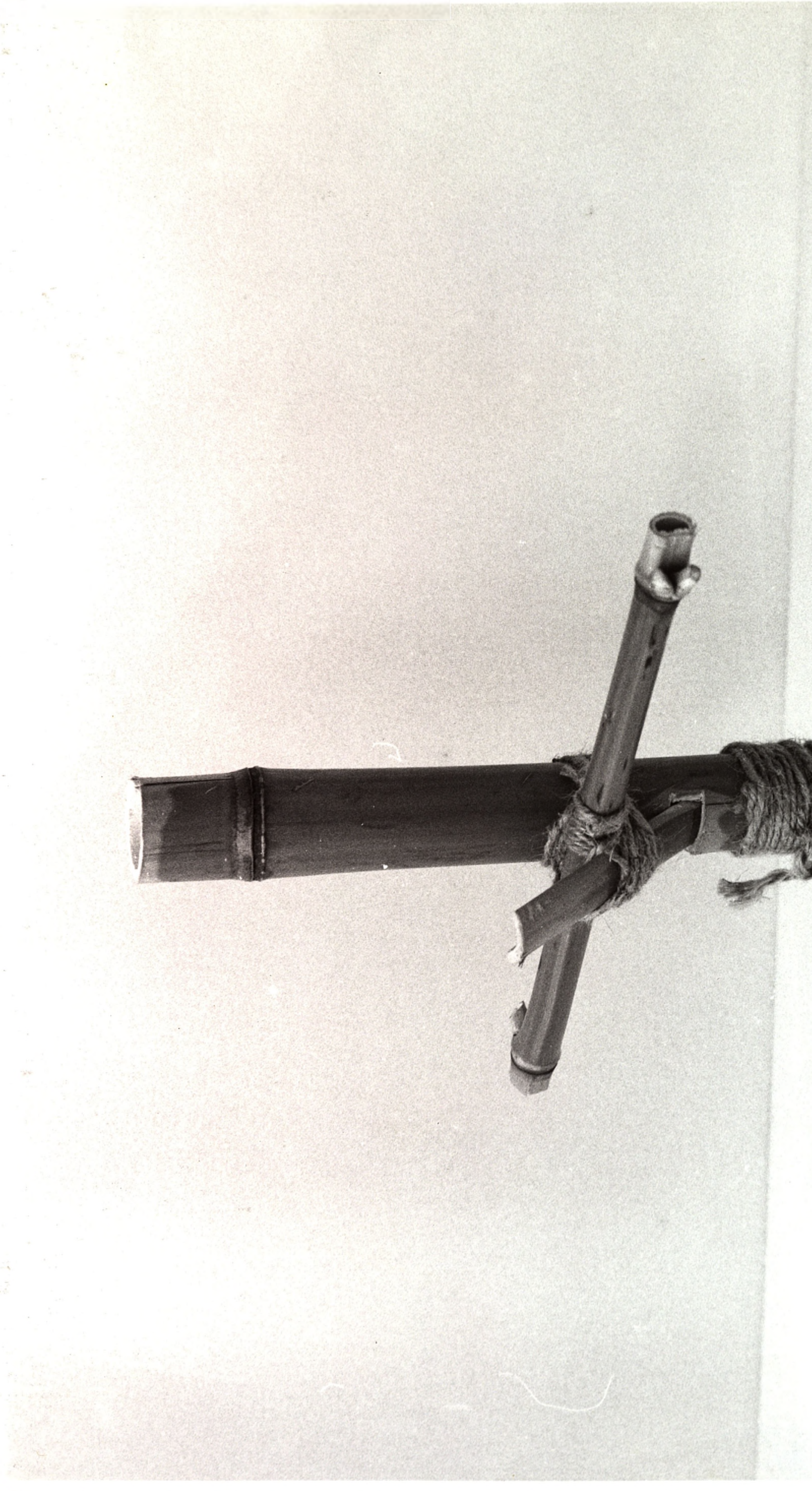
Requests

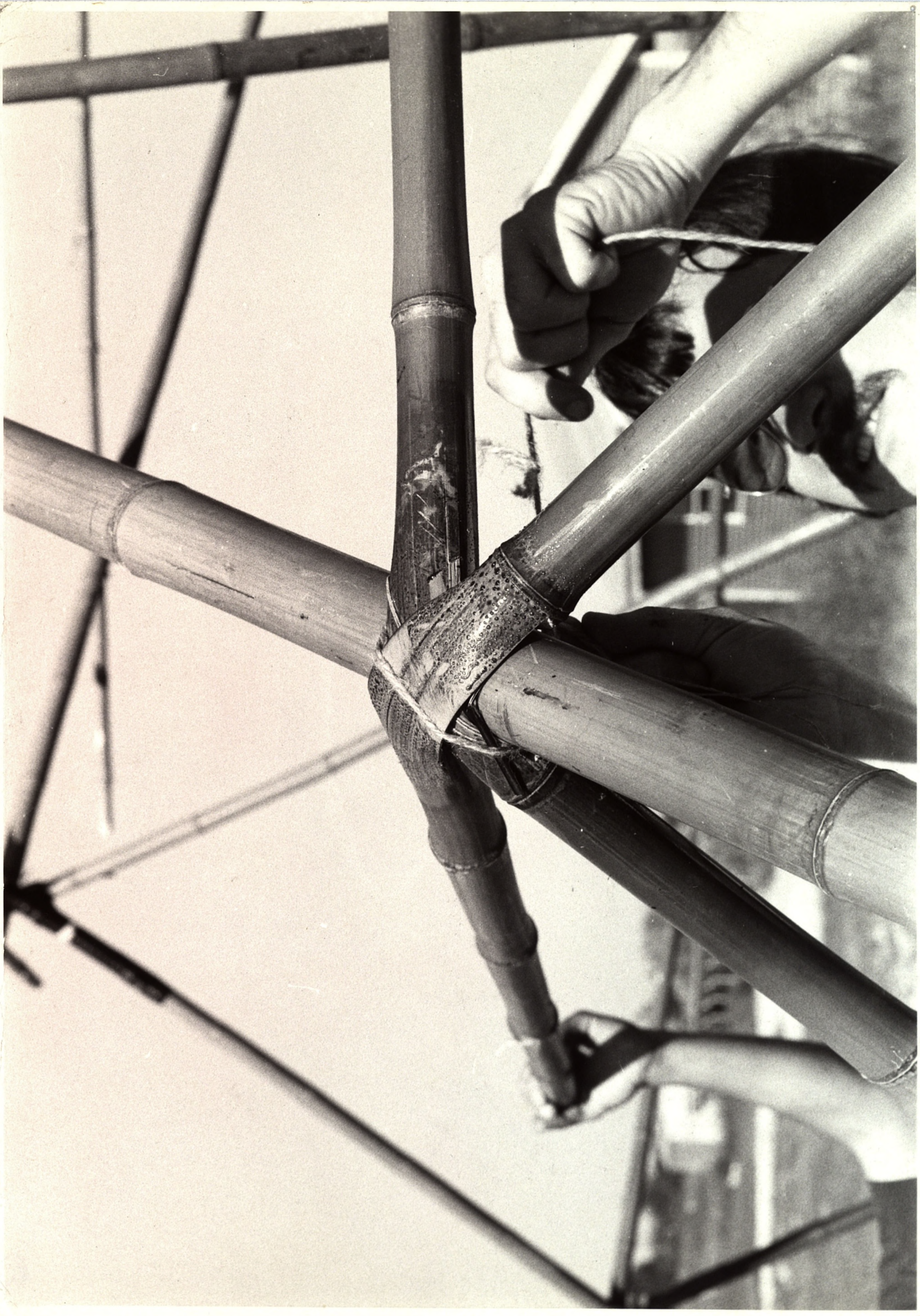


Item 6

Bamboo
Details

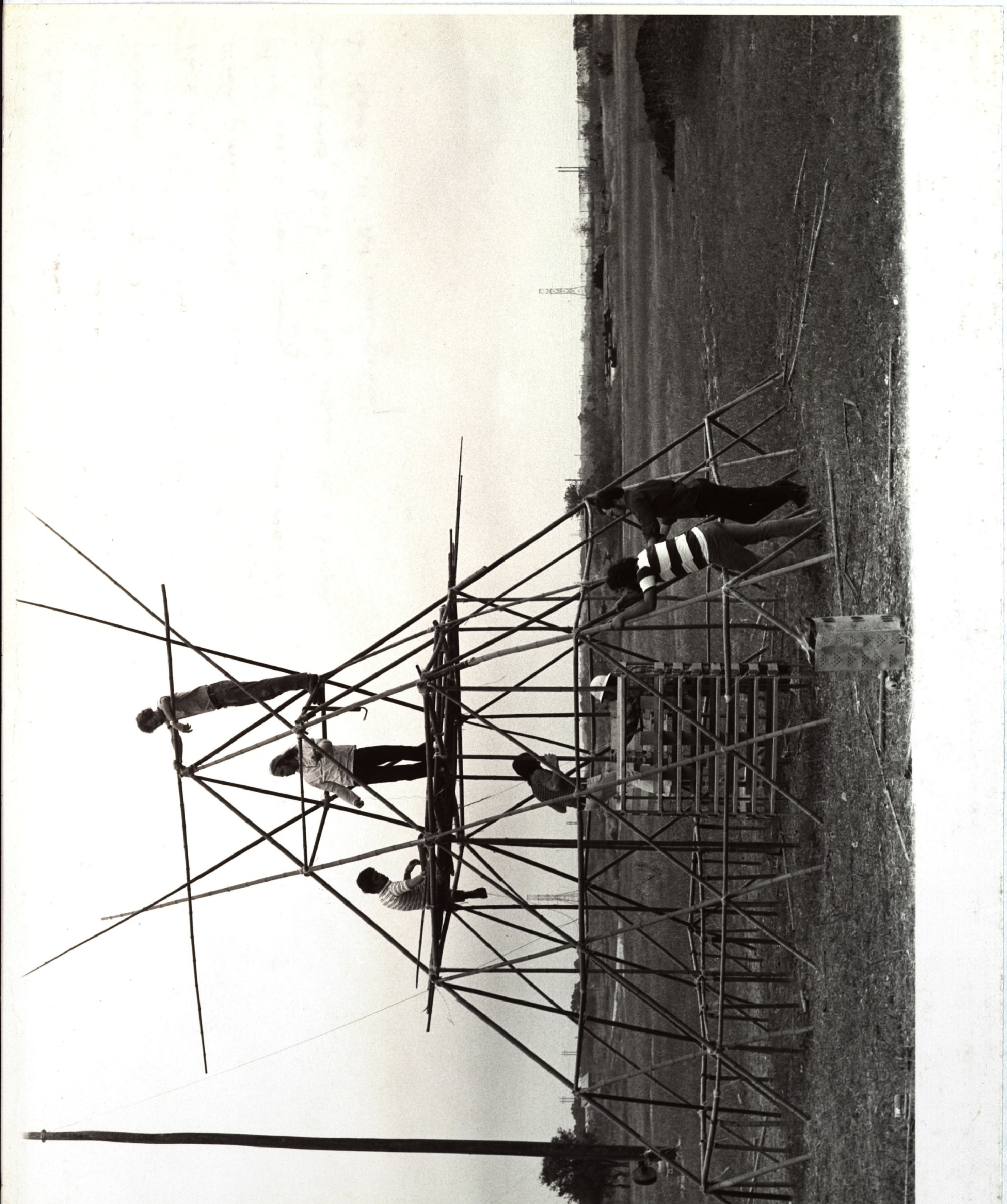


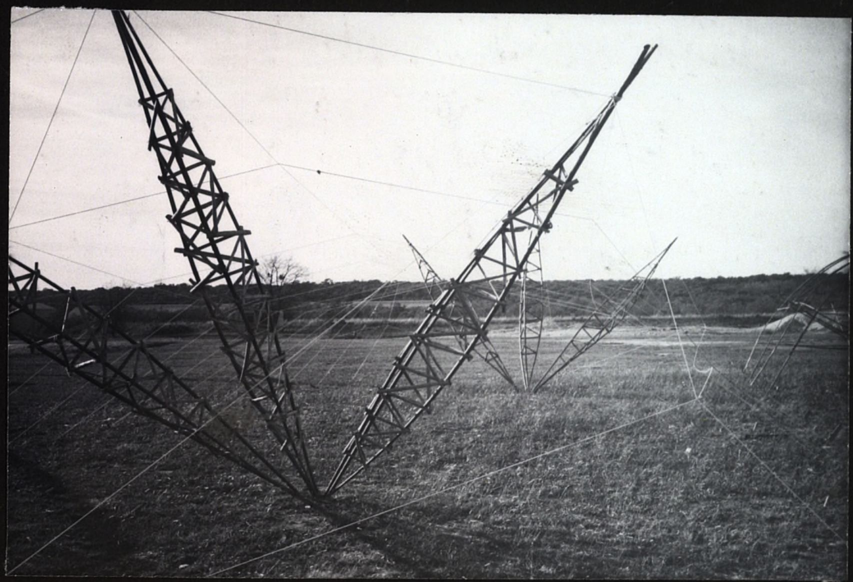


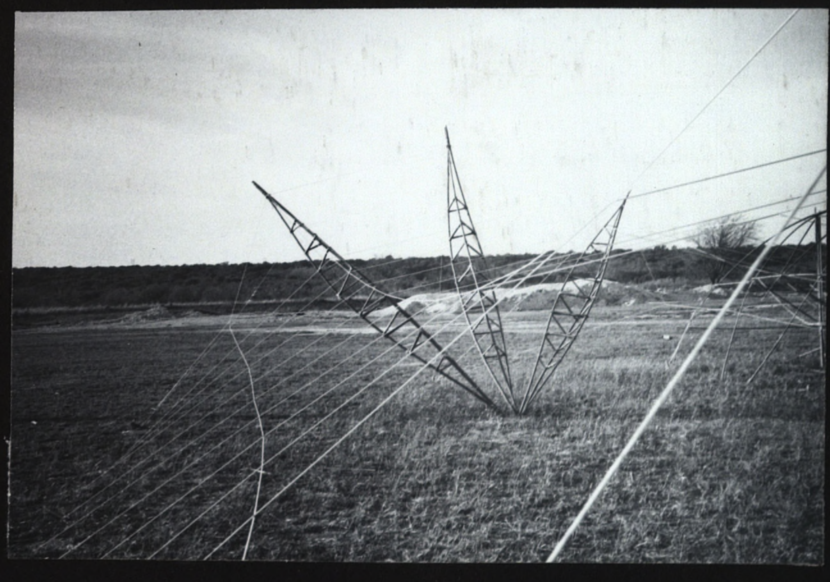


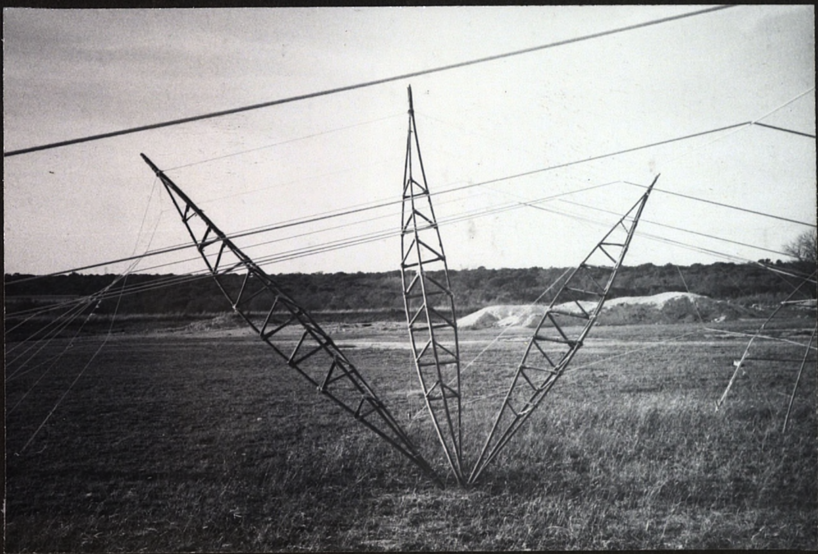
Item 7

Mock-ups of
UT Designs
(Frames only)









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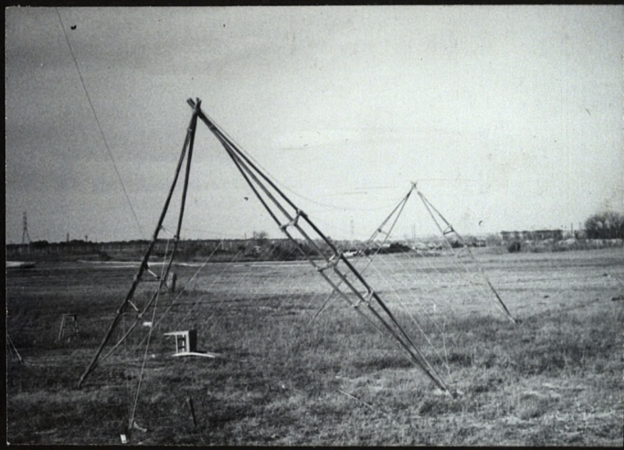
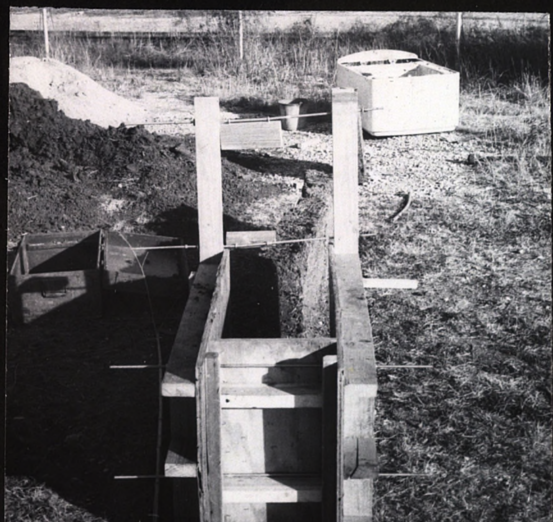
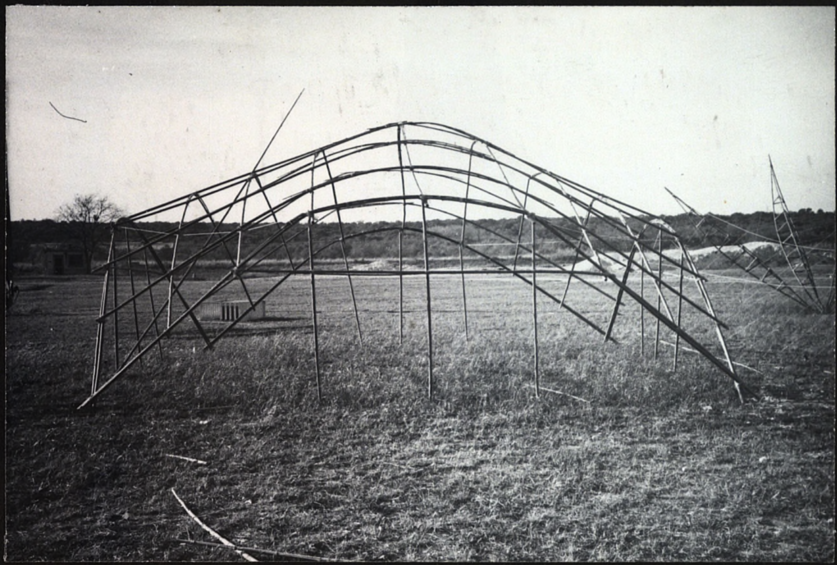
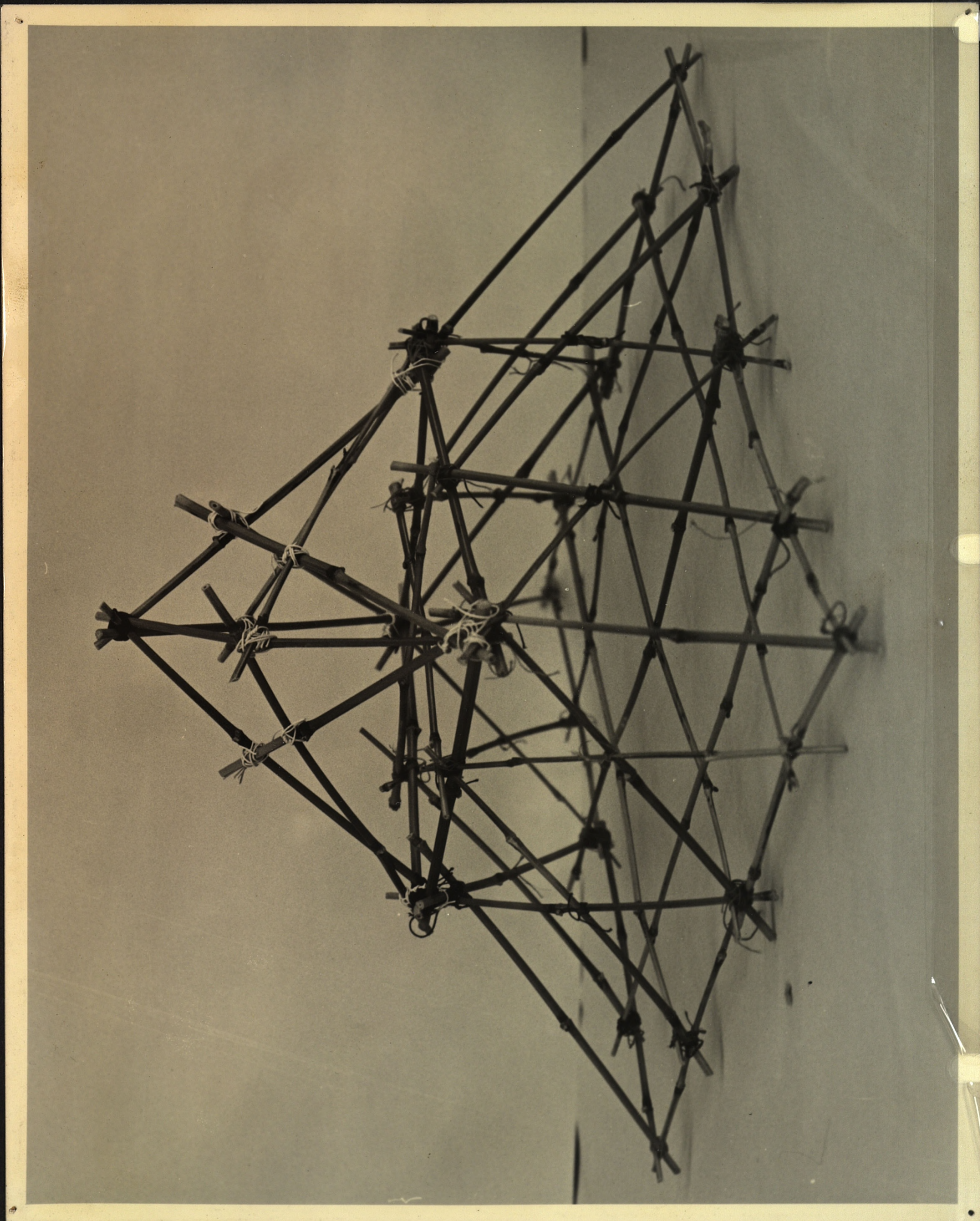


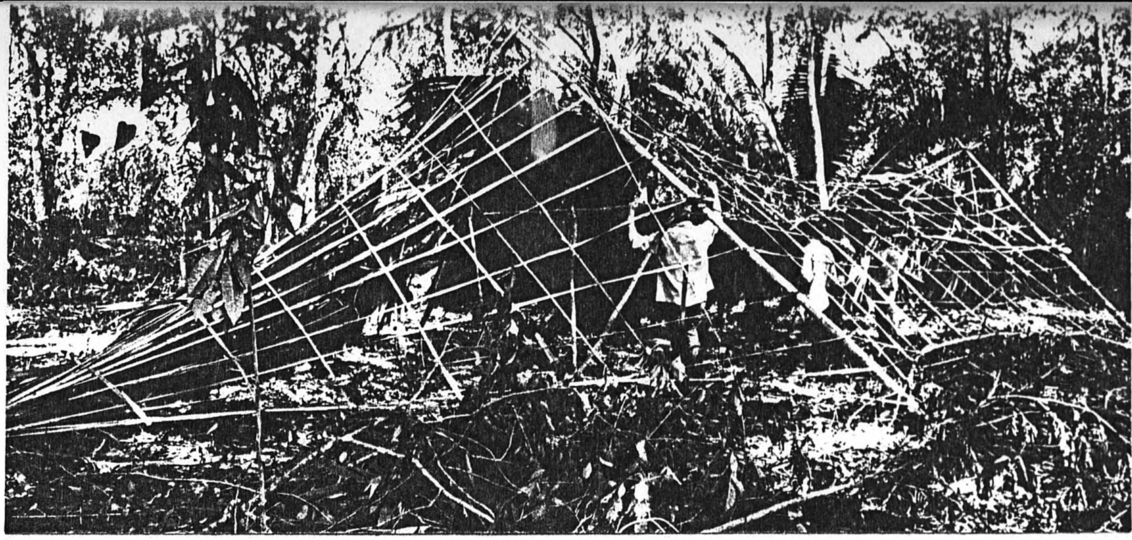






ITEM 8

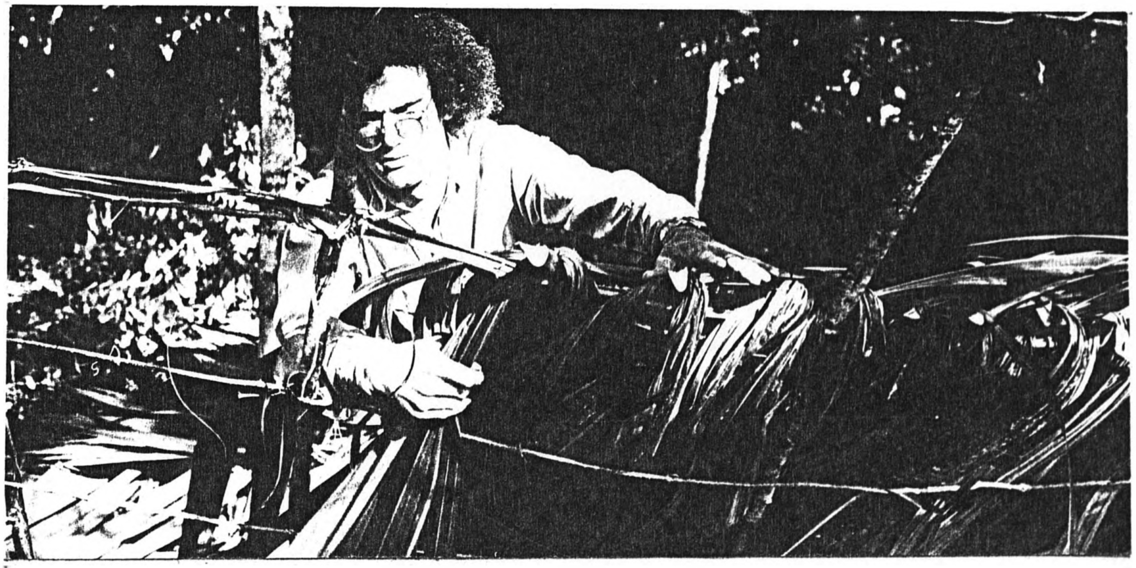
UT Prototypes in Guatemala



Report of Activities

Emergency Shelters Group

University of Texas School of Architecture



Prepared by

Geoffrey Wright

Photographic Work by

Jalaire Craver
and
Timothy Tynan

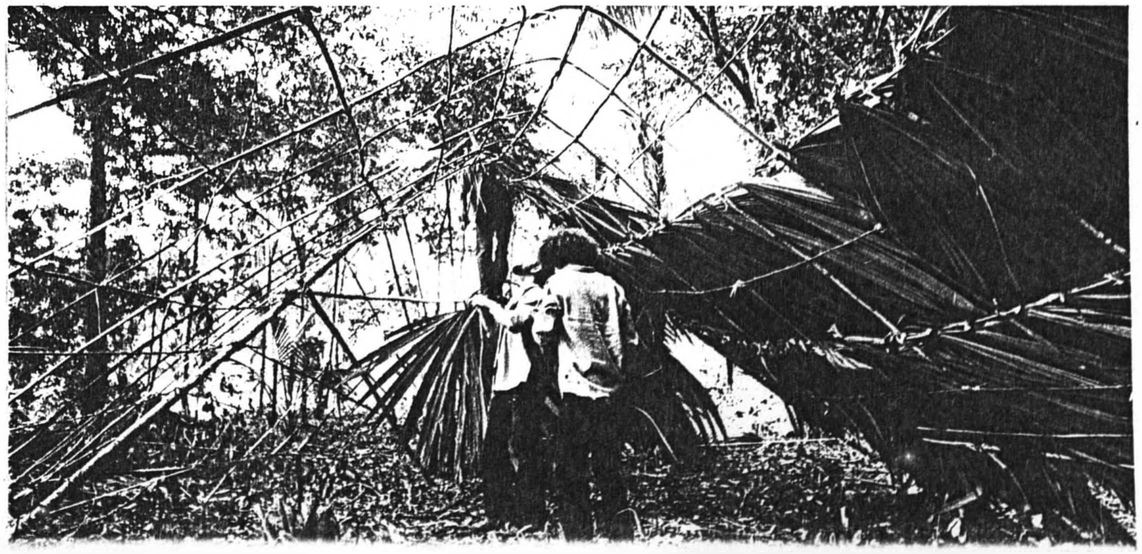


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Table of Contents

Introduction

An interdisciplinary working party at the University of Texas has been working since September 1973 to develop new approaches to the problems of housing refugees. The team is made up primarily of faculty and students from the School of Architecture with consultants from Intertect, a Dallas-based international relief cooperative, and the Center of Asian Studies and the Department of Anthropology at UT. The project is being coordinated with a similar and complementary project at Carnegie-Mellon University.

Existing Programs

"Emergency Shelters" (Hilbertz) explores the following areas:

1. Cultural and geophysical characteristics of disaster-prone areas.
2. Existing emergency housing techniques and systems.
3. Proposed emergency shelter systems; design and evaluation.

Several full-scale prototypes made of bamboo have been constructed at the Symbiotic Processes Laboratory (Hilbertz, Director) at Balcones Research Center of the University of Texas. The group also experimented with rammed and stabilized earth.

The prototypes were also constructed in actual tropical conditions at the Emergency Shelters Workshop (January 1-12, 1974) in Peten, Guatemala.

"Low-Technology Applications" (Fisk) is concerned with research, experimentation, and working examples of the following:

1. Indigenous building methods and materials amenable to individual and small group construction (focus on reversible and/or renewable resources).
2. Small-scale domestic energy and utility systems using the available natural forces of sun wind and biological energies.
3. Information access means for individual user design and building.

"Structural Systems" (Bowman) is an introductory course, analyzing a wide range of structural systems and their inherent forces. Such systems include those using non-industrialized indigenous materials.

"The Steady State Enviroment" (Mather) treats the entire region of Texas as a steady-state environment passing through a seventy-five year succession of development states. Drawing on Mather's experience in Iraq in the early sixties as part of an AID funded faculty team and as part of the HUD funded Austin Oaks Low Income Housing Demonstration in the late sixties, the course attacks man-environment problems by means of a set of conceptual tools developed for this work. Some of this effort has dealt with modeling the disaster/relief situation.

"City Planning" (Coltman). While no specific work in the field of emergency shelters is being done at present in Professor Coltman's courses, his background includes twelve years in specialized work related to low income community development, self help direct building, and rural housing in South Africa, Zambia, and Swaziland.

Professor Coltman also was recently a visiting lecturer at the University of Manitoba where he participated in an emergency shelter project in which third year environmental studies students were required to construct shelters in three different environments using only local materials.

Target Area

The problems of housing refugees occur world-wide and the working party realizes that it is impossible to design one structure which can be adapted to all environments. However, environmental similarities can be found in many areas of the world which enables the team to concentrate on responding to disaster types.

The team is geared to respond to those disasters which occur in developing nations between the tropics of Cancer and Capricorn. In general, the research has centered on tropical areas, especially those in which bamboo is indigenous. This environment assumes high rainfall with accompanying floods and high winds. It also assumes a low technology society and a general unavailability of sophistocated equipment.

Specifically, the research has been aimed at Bangladesh. It should be stressed that the development of response to this environment does not preclude the adaption of the techniques and methodology of the project to other situations or areas.

Approach

The team has categorized the problems of relief in the third world into two areas. The first is emergency response, the immediate provision of aid for maintaining human life. This includes foods, medicines, and temporary shelter. The second area, change response, deals with longer term developmental response which combines international expertise with local resources.

The team has concentrated its efforts in developing prototypes for emergency response but has designed them with an eye to longer term development.

In developing prototypes which can be utilized in emergency response, design constraints have been adopted. These can be categorized thus:

1. Technological - The overall structure must be adaptable to areas in which only limited technology is available. Thus the structure must rely on indigenous materials, local skills, and unsophistocated techniques. The specific design constraints are:

   a) The unit must be able to be built without more than one day of initial instructions.
   b) The process must be adaptable to mass construction techniques (e.g. assembly lines).
   c) The units must be at least 90% reliant on local materials.

2. Cultural - Both the prototypes and the building process must be adaptable to local culture patterns. Specifically, the form must be suitable to the culture, and the process must utilize local craftsmen and tools.

3. Environmental - The prototypes must be able to withstand a hostile climate environment. Specifically, the unit must be able to withstand winds up to 140 mph and flooding to $2\frac{1}{2}$ feet.

4. Economical - The prototypes must be economically feasible. Unit costs are not assigned, but a range of costs is utilized based on the number of occupants per dwelling unit. The cost of a single family unit must be under $50. However, no more than 10% of the total cost may be for the import of non-local materials.

The key constraint is the at least 90% reliance on locally available materials. However the team will attempt to increase this reliance to the ultimate 100% in the on-going test program.

Evolved Prototypes, Balcones Research Center

As a result of research into the technology, culture, and climate of the tropical developing nations, the following prototype structures and systems were developed at the Symbiotic Processes Laboratory at Balcones Research Center:

1. Triangulated Structure - The basic unit for this system is a triangulated pyramid. For a detailed explanation of this system see section 8.1.

2. Lattice Shell - This structure is the result of springing a two-dimensional bamboo grid into a vaulted or domed space. Because of the varying pitch of the roof, a combination thatch and fabric or plastic covering is necessary. The floor can be either a bamboo platform or built-up stabilized earth.

3. "A"-Support Tension Structure - A tensioned web supported by two A-shaped pylons. See section 8.2 for further explanation.

4. "W"-Support Tension Structure - Based on the same principles as the preceding structure, the six-pylon version is capable of handling larger loads and thus larger spans. Instead of forming an "A" at either end, these pylons are pinned at a common point. The detailing is the same as that of the preceeding structure.

5. Elevated Ellipsoid - From square horizontal bamboo grids supported by columns of bundled bamboo, extended roof rafters and floor joists are sprung toward one another until they meet forming convex exterior walls. The floor is a bamboo platform and the roof is a combination of thatch and fabric or plastic similar to the lattice shell.

6. Rammed Earth Structure - Employing slip-formed walls of rammed earth and a bamboo truss roof system, this structural type has the ability to be extruded continuosly to any length desired. Here too, the floor can be made of a raised bamboo platform or built-up earth.

Based on the prototypes built, the structural systems which seemed to have the most promise were the triangulated structure, the lattice shell, and the tension structures. These structures, which have a large floor area to surface area ratio, allow refugee camp coordinators to easily walk through them to inspect conditions periodically because of their linear shapes. This is an essential feature to any refugee building type.

The space generated by the elevated ellipsoid was inefficient because of the curved floor and convex walls. Also the amount of roof that required a fabric or canvas covering (because of the low pitch) indicated a prohibitive expenditure when compared to the amount of resulting usable space.

Problems with rammed earth are 1) that the soil must be of a certain composition to stabilize properly when rammed and 2) the exertion necessary to stabilize soil by ramming was considered to be prohibitively taxing for tropical climates.

Further Prototypes, Emergency Shelters Workshop
Peten, Guatemala January 1-12, 1974

To further test the prototypes the working party felt that a tropical environment field test including such considerations as organization of labor, construction time, location and transportation of materials, and environmental compatability was necessary. A site was located in the jungle near Flores, Guatemala where indigenous materials and labor were available. Bamboo, however, is not indigenous to the area, so the group used saplings and other small trees which were available and generated the necessary new connection details on site.

The following structures were built at the workshop:

1. <u>Triangulated Structure</u> - One unit of the expandable triangulated system was built and thatched in $1\frac{1}{2}$ days by seven local laborers and a supervisor from the working party. Although the first structure took $1\frac{1}{2}$ days, once the laborers had become familiar with the system, production could increase rapidly for three reasons:

   a) Parts could be mass produced.

   b) At least three of the seven laborers could supervise construction of further units which would, in turn, generate more supervisors, and so on.

   c) Thatching, which was the biggest time consumer, would be minimized as the system grows and the surface area to volume ratio is diminished.

   Further, we found that in this particular environment, while structural material was plentiful, thatch material, although available, was not abundant in the immediate vicinity and a great deal of time was devoted to gathering the necessary fronds.

   The importance of ventilation in a thatched structure also became immediately apparent. As a result, designs have been altered to insure more ventilation space at the bottom underneath the floor and through more window openings at various places along the upper portion of the structure.

   The construction of this system is explained later in the report.

2. <u>Lattice Shell</u> - The lattice shell has more problems inherent in it than either of the other two structures built. For this reason further pursuit of developing this building type for emergency shelter has been abandoned.

   Problems include inadequate roof pitch for thatch (thus the need to employ canvas, polyethylene, or other expensive imported materials), the necessity of specialized materials for the structure (i.e. strong, lightweight, regular in cross-section), and a shape which will tend to blow away in high winds.

   Basically the structure is a sprung square grid of bamboo which forms a domed shape by compression of the corners inward so that the middle springs up. No known indigenous building material is flexible enough to arch on a small scale structure so that the roof pitch is greater than 45 degrees, the minimum pitch required for thatching. The only available building material in Guatemala, corroza, is neither radially symmetrical in cross-section nor hollow; thus it fails when flexed. The resulting shape also is not ideal aerodynamically.

square grid sprung

Lattice Shell

3. Tension Structure - The tension structure was the quickest and most elegant structure built. Provided adequate materials were available, this structure could be completed by four people in one day. Its two biggest drawbacks are 1) flooring problems and 2) cable material availability, but neither seems to be an insurmountable problem.

To keep a dry floor, care must be taken either to build on high ground or to incorporate a freestanding bamboo floor system in the event that no high ground is available. In most tropical areas some sort of indigenous rope is made which can serve for the cables (hemp, jute, sisal, etc.). However, if no local rope is available, vines can be substituted. (The working party used vejuco, a local vine, in Guatemala.) In the event that neither local rope nor vine is available, the cost of importing rope compared to the amount of area one is able to cover using this system is favorable.

This structure produces a large open space in contrast to the expanded triangulated structure which is a series of smaller compartments. The construction of the tension structure is explained in a following section.

Proposed Test Program, Bangladesh

The UT Emergency Shelter Working Party proposes to test the developed prototypes in an actual refugee situation in Bangladesh. The group feels that only in such a situation can the problems of unknown language, culture, and environment and their effects on organization of labor, location and transportation of materials, and dissemination of construction techniques be fully explored. This knowledge is essential both for further adapting the structures to tropical developing nations and preparing the necessary construction documents in such a way that they will be valuable to people who will actually build refugee housing.

The group proposes that six members travel to Bangladesh for ten days. The team will divide itself into two groups of three. The first group will devote itself to construction of the expanded triangulated system, whereas the second group will concentrate on the tension structure. At the end of the period the project will be evaluated by means of questionaires filled out by occupants, refugee workers, and working party members. The results will be incorporated into further designs and will serve to generate alternate structures if necessary. They will also be published and distributed to interested parties.

Time Schedule

Day	Activity
1	Arrive and survey camp site if necessary.
2	Further survey. Locate and transport materials. Organize first construction crews.
3	Begin construction and adaption of building types for local use.
4	Continue construction. Evaluation of laborers.
5	First structures completed. Reorganization of laborers. System evaluated and adapted for mass production.
6	Continued construction and adaption.
7	Continued construction and adaption.
8	Continued construction and adaption.
9	Questionaires distributed and data collected.
10	Pack and leave.

Budget

Materials:

5000 ft. hemp rope @ $0.03/ft.	$ 150.00
Bamboo, various lengths and sections	200.00
Thatch material	100.00
Photographic:	
10 rolls 35mm ectachrome @ $3.00 ea.	30.00
10 rolls 35mm plus-x @ $1.00 ea.	10.00
Processing ectachrome @ $3.80 per roll	38.00
Developing plus-x @ $1.00 per roll	10.00
20 8x10 B&W prints @ $2.25 ea.	45.00
Sub Total	$ 583.00

Publication:

100 copies of a 50 page report are currently envisioned. Approximately 20% of the report will be illustrated by photos and 20% more by graphs and drawn illustrations.

Typing, 50 pp. @ $0.50 per page	$ 25.00
20 halftones @ $8.00 ea.	160.00
Printing, 50 pp., 100 copies ea. @ $2.25 per page	112.50
Binding, 100 copies @ $0.75 per copy	75.00
Sub Total	$ 372.50

Travel:

Round trip for six members of the working party; Austin to Site and back. (Prices as of March 20, 1974, subject to change.)

Austin to New York	
Air - 6 coach fares @ $234.00 ea., round trip	$1404.00
Per Diem - $10.00 ea. per day, one day each way	120.00
New York to Dacca, Bangladesh	
Air - 6 coach fares @ $759.00 ea., round trip	4554.00
Per Diem - $10.00 ea. per day, two days each way	240.00
Dacca to Site	
Air - 6 fares @ $50.00 ea., round trip	300.00
Sub Total	$6618.00

Subsistence:

10 days @ $10.00 per person per day	$ 300.00
Incidental expenses (medication, etc.)	100.00
Sub Total	$ 400.00

TOTAL	$7973.50

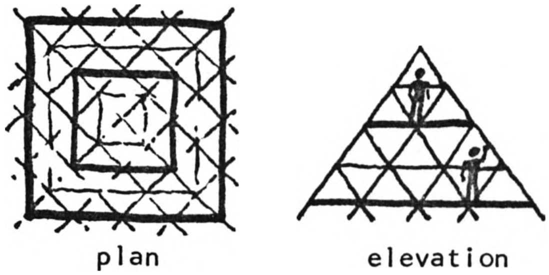
Members of the Team:

Wolf H. Hilbertz, Lecturer in Architecture, University of Texas
Werkarchitekt HBK Berlin, 1965
M.Arch. University of Michigan, 1967
Frederick C. Cuny, PIC, C.E., Intertect, Dallas
John Corbin, 5th year student in architecture, University of Texas
Robert Swaffar, Graduate student in architecture, University of Texas
Regan Terrier, 5th year student in architecture, University of Texas
Geoffrey Wright, B.Arch., University of Texas, 1973

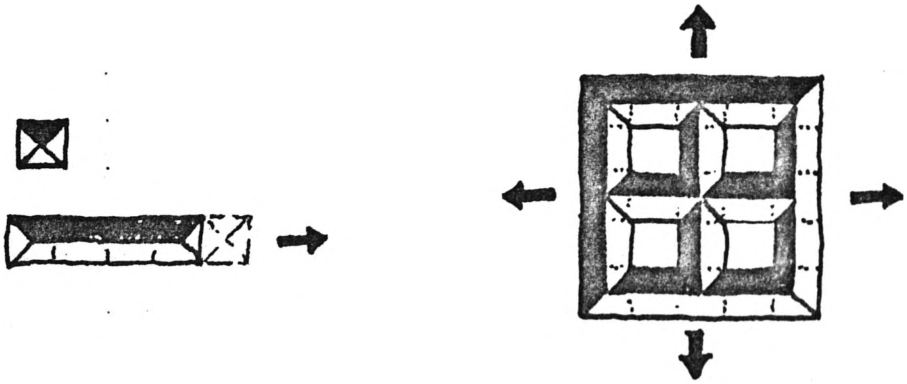
Construction of Prototypes

Triangulated Structure:

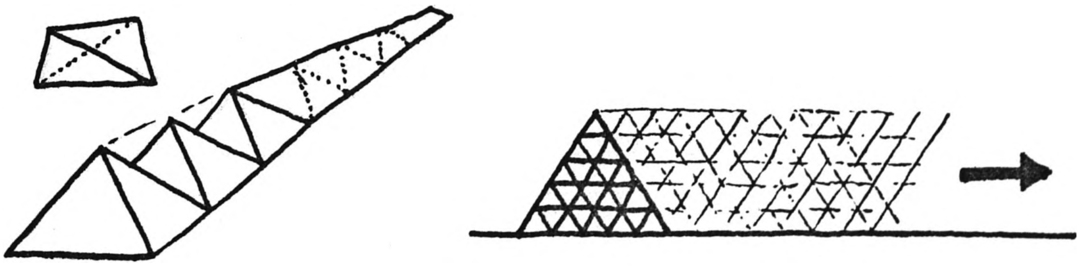
The basic unit of this system is a two story square pyramid with triangulated surfaces.



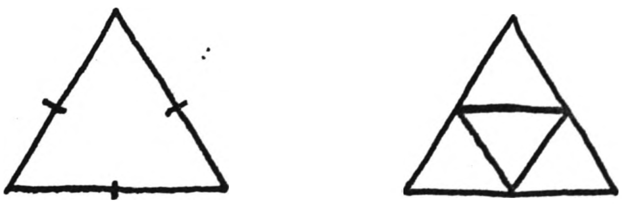
This module can be repeated so that the system can expand linearly or in two directions.



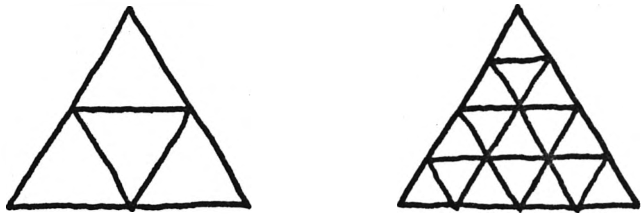
The expanded unit can be thought of either as a sequence of pyramids juxtaposed and joined with large tetrahedrons or as a figure whose sides are parallelograms which have the potential to grow indefinately.



The basic strength giving principle of this structural type is triangulation. The triangle is the strongest of basic polygons. Trianqulation is the process whereby a given triangle is divided into four smaller similar triangles by joining the midpoints of its sides.



Each of the four generated triangles can be further subdivided giving the structure further strength.



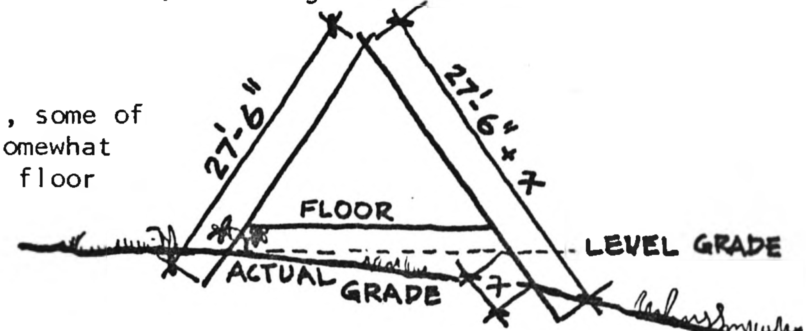
From this principle the structural configuration was derived.

Construction of the Basic Unit:

To construct an individual unit, start by digging four holes 2'-6" deep in a 25'-0" square plan. You can be sure that the plan is square by checking that the diagonals are of equal length. Fill the holes 6" with rocks or concrete if available.

Now find four sturdy members about 27'-6" long each and about four to six inches in diameter.

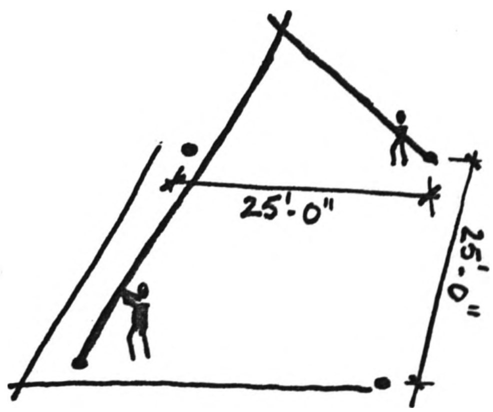
If the ground is not level, some of the poles may have to be somewhat longer to maintain a level floor system.



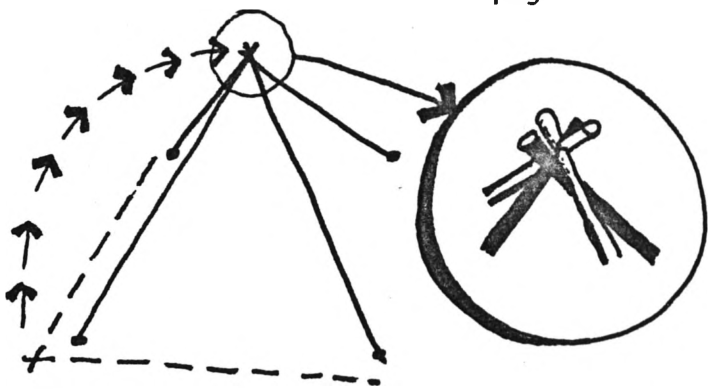
Next, take one pair of poles which will be diagonally opposite one another in plan and notch them within six inches of their thin ends half through their diameters so that they interlock snuggly at 90 degrees and tie them firmly together.

Do this with the other pair also.

Now you are ready to position one joined pair by placing its free ends into diagonally opposite holes.



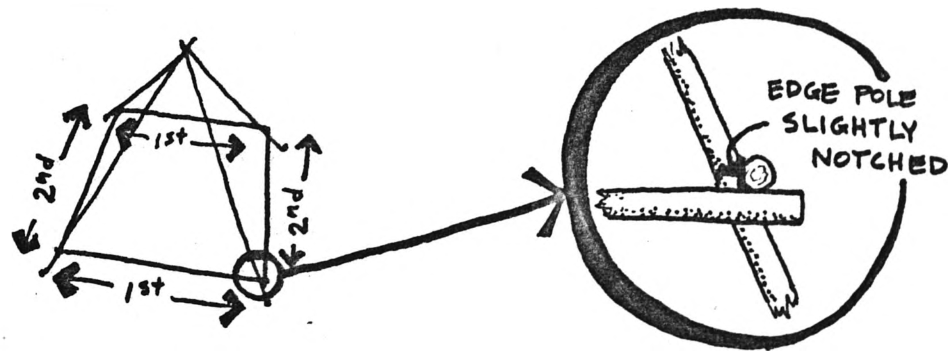
Next, swing the other pair of poles upward and rest it on top of the first pair, placing the free ends in the other two diagonally opposite holes and fill in all holes.



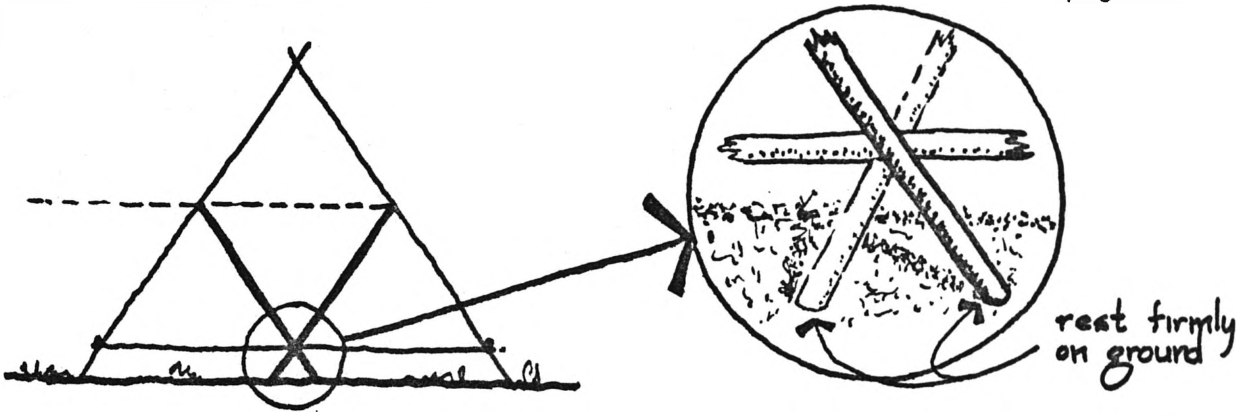
This is the basic structure from which the entire pyramid derives, so make sure it is regular, vertical, and firm.

The next step is to add the first horizontal members to create the first triangles. Find four stout poles about 22'-0" or a little longer and four to six inches in diameter and tie them horizontally accross two opposite sides of the pyramid about three feet above level grade on the outside of the edge poles. Place the thick end of one pole across from the thin end of the other and make the top sides of these poles as level as possible as they will support the floor. It may be necessary to notch the edge poles slightly so that they will accept the load without slippage.

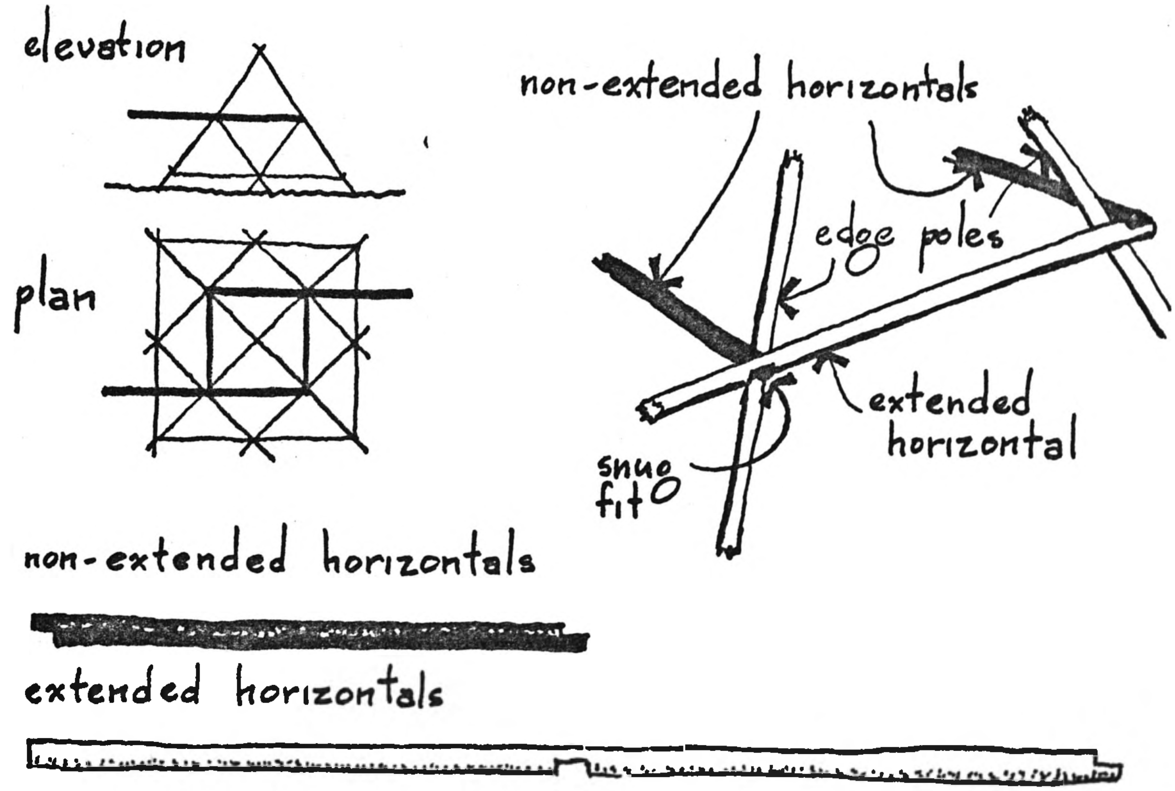
Now add the other two poles to the other two sides of the pyramid, resting them on the first horizontals, and tie all horizontals firmly to one another and to the edge poles.



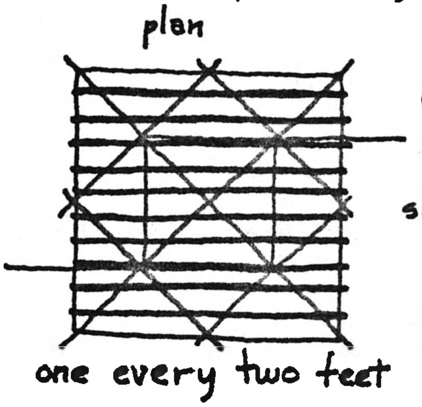
You now have the first major equilateral triangles which give the structure its strength. The next step is to triangulate each of the four major triangles into four smaller triangles each, extending the diagonal members so that they rest firmly on the ground. To maintain regularity, be sure that all poles which slant from upper right to lower left pass inside the main horizontals and all those which slant from upper left to lower right pass outside. Follow this convention for all subsequent diagonals added. Wherever any members cross tie them firmly together.

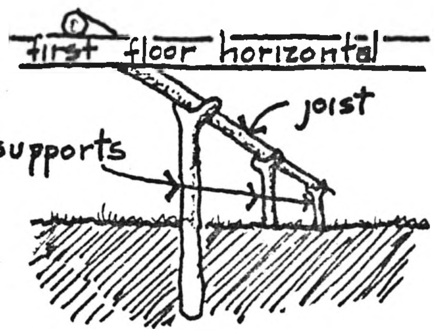


The second set of horizontals added are the main supports for the second floor, so their tops must all be level. To do this they must be notched as were the first two pairs of poles. Also two horizontals on opposite sides must be extended out beyond the edge poles so that they are twice as long as those on the sides perpendicular to them. These extended poles will be the ridges of roof overhangs for the two portals.



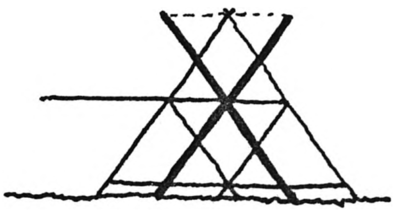
The first floor joists can now be put into place while the sides are still relatively open. To do this take ten fairly stout poles about 22'-0" long or a little longer and space them all in the same direction every two feet on the ground inside the pyramid. Support the joists with forks so that they rest on the lower pair of the first-floor horizontals. If working with bamboo, use stout members and use a heat bent connection for attaching the supports to the joists. The supports should be about five feet long so that they can be sunk into the ground and should be spaced approximately every three feet along a joist. You need not have supports under the main horizontals as they will be supported by triangulating diagonals. For a level floor it is important that the tops of the joists be as level as possible.



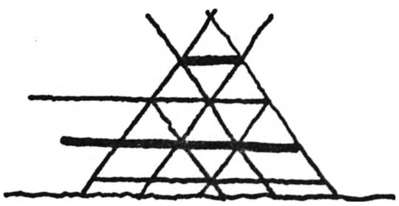


If the joists are thick, you can get by with fewer horizontals. Likewise, if the flooring material is thick, you can use fewer joists.

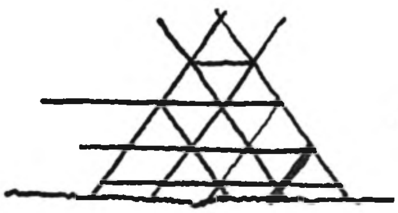
Once the joists are completed, the two opposite sides without doors should be triangulated thus:



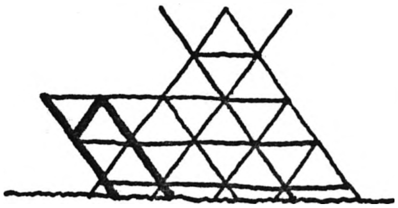
First, to each side add two more long diagonals, one in each direction, bisecting adjacent sides of the four smaller equilateral triangles and extending beyond the edge poles to an equal elevation with the tip of the pyramid. A piece will later connect these with the tip. Make sure these diagonals also rest firmly on the ground and are lashed to all other poles which they cross.



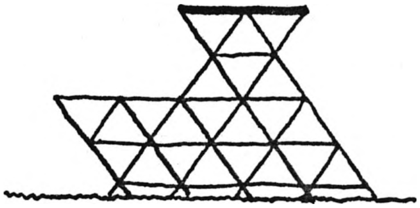
Next, add two more horizontals to further triangulate, extending the lower one past the edge pole on the end adjacent to the door about six feet to help form the portal overhang.



Now add one more small diagonal from upper right to lower left and rest it firmly on the ground.



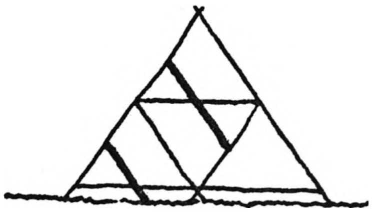
Add two more diagonals which are lashed to the extended second floor horizontal at upper left and set firmly at the ground at lower right. Then add a small one slanting the other way to finish off the outside of the portal overhang.



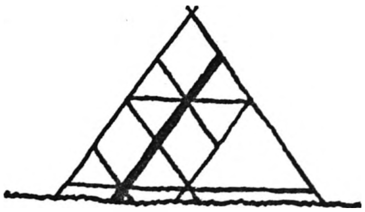
If the structure is strong enough to support a man's weight at this point, add the topmost horizontal. If not, add it immediately after the other two sides with doors have been triangulated.

Note: As these secondary diagonals and horizontals are not under much stress, they need not be as stout as the edge poles or preceeding horizontals or diagonals. It is vital that they be securely tied at all crossings and that the diagonals rest firmly on the ground.

Now triangulate the remaining two sides which contain the doors:

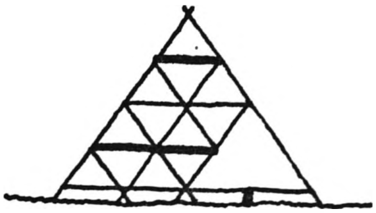


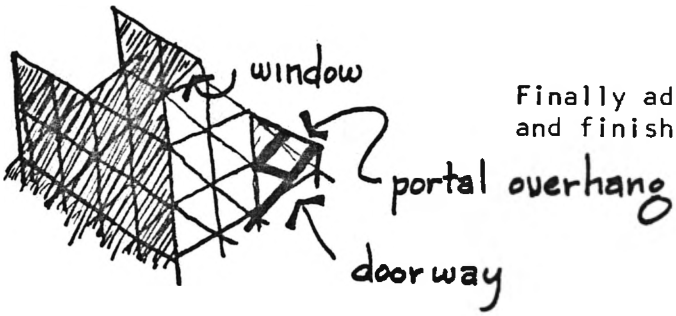
First add two diagonals which slant from upper left to lower right and bisect the sides of the existing triangles. End the upper one at the secondary diagonal so that it does not block the doorway triangle.



Then add one long diagonal which slants the other way.

Add two more horizontals to finish the triangulation, ending the lower one so that it will not block the doorway, and place a support under the center of the threshold.



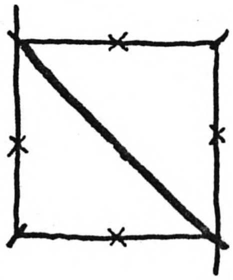


Finally add two diagonals and a horizontal and finish out the roof overhang.

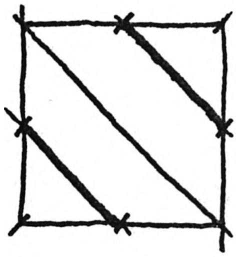
At this point the exterior structure is complete and the only remaining things are to install a ladder, finish the floors, and thatch the structure.

The runners of the ladder serve to support the second floor, so they must be constructed together.

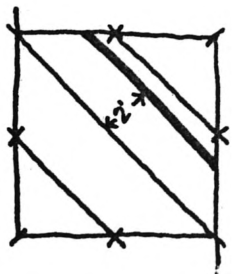
Second-Floor Plans



First, place a strong wood member diagonally accross the second floor opening, from portal to portal.

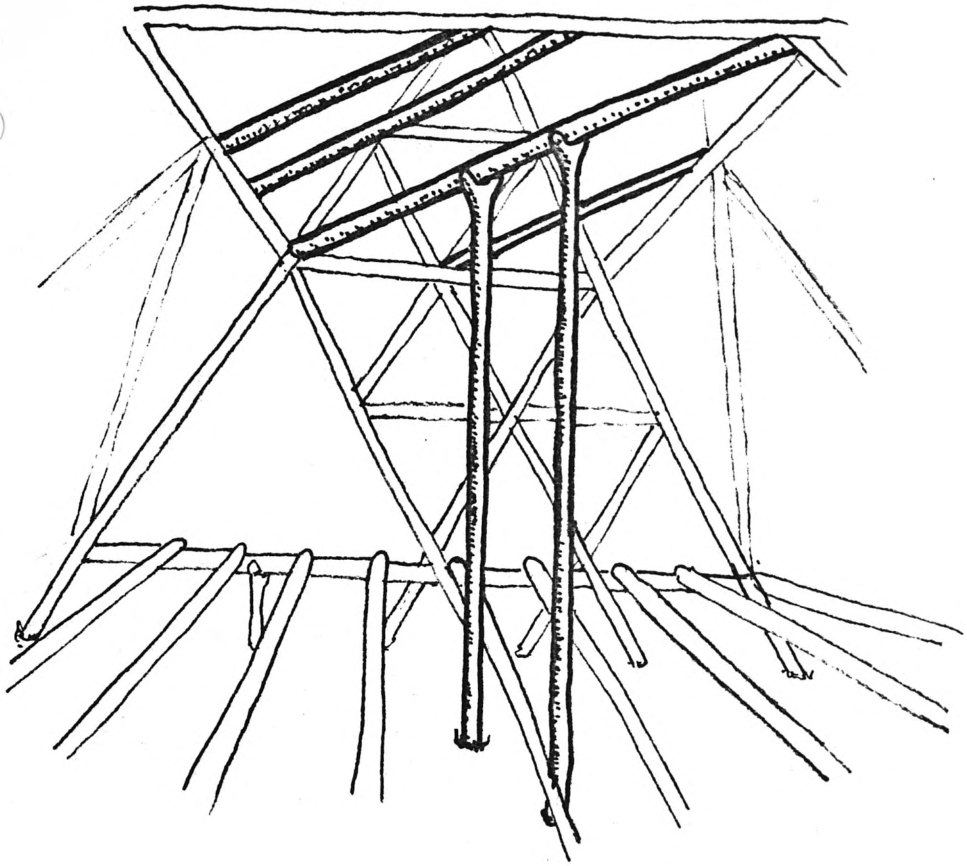


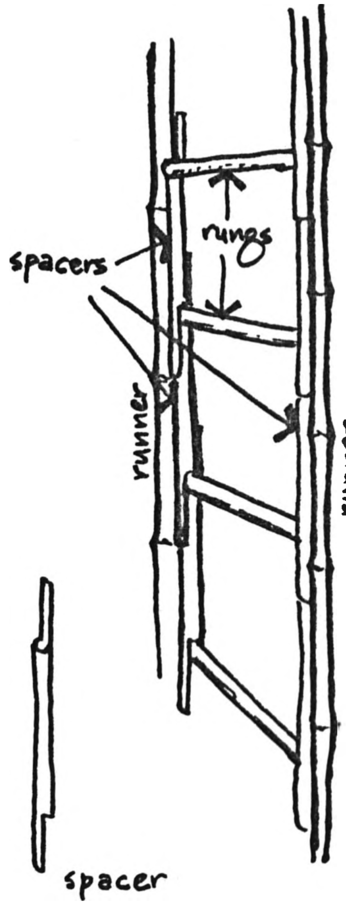
Next, add two more horizontals diagonally in the same direction which bisect adjacent sides of the square.



Then add one more member, two feet to one side of the origional long diagonal. This member will act as the outside edge of the ladder hatch.

Now the first runner of the ladder can be positioned. It should be placed directly under the center of the pyramid so that it supports the longest of the second floor supports. Sink it into the ground some two feet to assure that it is solid. The other runner should be positioned in the same manner two feet to one side also under the main diagonal. If using wood, these runners should have forked tops to accept the load of the second floor. If using bamboo, make a heat bent joint and tie them securely.

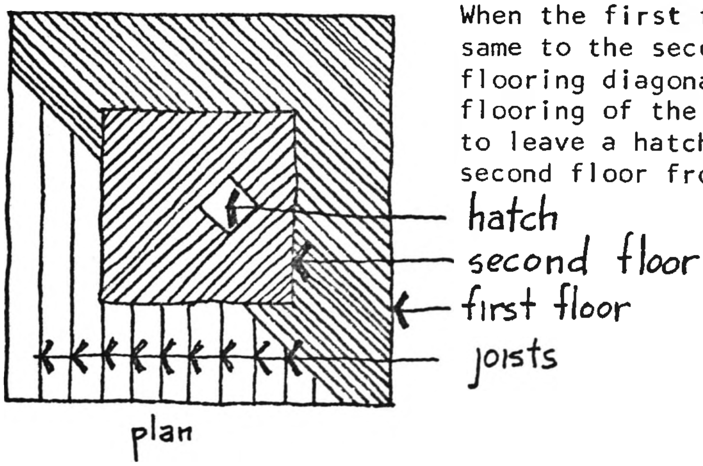




Now the rungs can be added by notching the runners and tying on the rungs, if using wood, or by adding short bamboo spacers and tying spacers, rungs, and runners firmly together.

When the ladder is built, start putting in the flooring on the first floor. Use split logs, planks, small trees, or split or whole bamboo. Lay the flooring diagonally in the same direction as the diagonal second floor brace which the ladder supports. This triangulates the floor and helps the structure resist wind forces. Tie each flooring member firmly to each of the joists as well as to the main horizontals which define the edge of the floor.

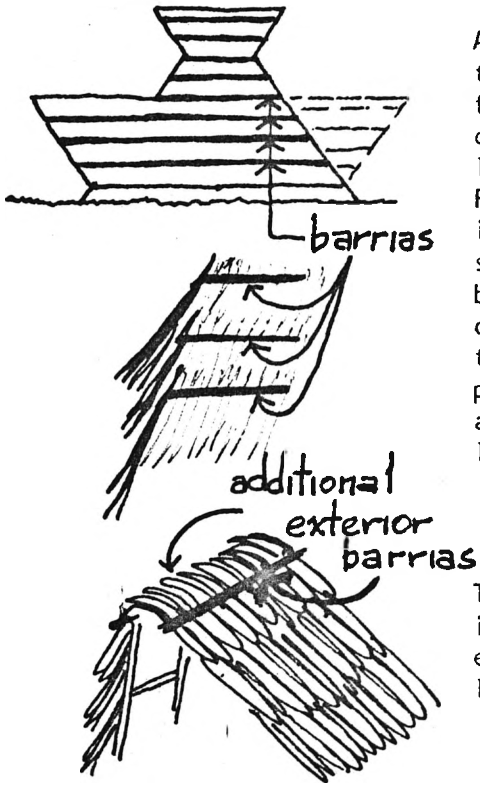
When the first floor is finished, do the same to the second floor, but place the flooring diagonally, perpendicular to the flooring of the first floor. Also, be sure to leave a hatch through which to enter the second floor from the ladder.



The structure is now complete and all that remains to be done is to trim off all unneeded projecting members and to thatch it.

Thatching:

To support the thatch material one uses small horizontal members (Sp. barrias) tied to the exterior of the structure and spaced approximately every three feet vertically, depending on the length of the thatching. The barrias should be placed on all sides except, of course, the two hooded window openings at the top and the doors. Both sides of the door overhangs should receive barrias. Tie the barrias firmly to to the structure as the thatch material in quantity is quite heavy.



A variety of material can be used for thatch, the best of which is probably palm fronds. To thatch, one should start by covering the bottom first as the upper layer must overlap the lower as in shingles. For tropical climates adequate ventilation is a necessity, so the thatch material should not extend all the way to the ground, but the space under the floor should be open so that the floor can breathe. The thatch material should be closely spaced to prevent rain leakage. The closer together and thicker it is, the longer the roof will last.

To cover the ridge of the portal overhangs, it may be necessary to add additional exterior barrias to hold down the uppermost layer of fronds.

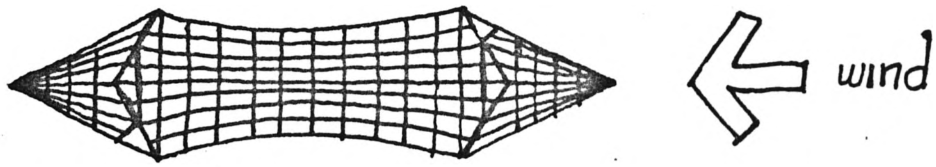
Once the thatch is all in place the single unit is complete and ready for occupancy. From the experience gained from constructing the basic unit, the construction of the expanded structure can be extrapolated, and many short cuts not included here for the sake of clarity of explanation can be incorporated.

Further explanation of the thatching process can be found in the section on Guatemalan materials.

Tension Structure:

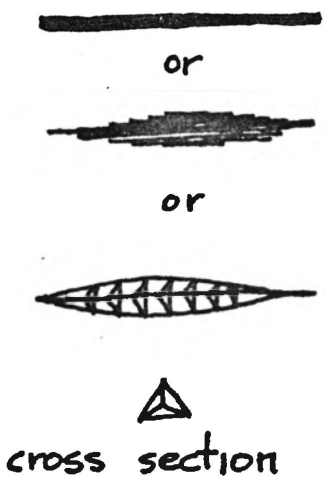
The tension is the most elegant of the structures built and the quickest to construct. Large areas can be spanned if necessary, allowing the refugee camp staff clear access to monitor the conditions of the refugees. This type of structure is not expandable, but the large span capabilities reduce the need for expandability. In addition to thatch, only two types of members are necessary for the structure: 1) the poles which support the web and which are subject almost entirely to compression forces, and 2) the web or netting which can be made of any linear material strong in tension (rope, steel cable, vine, etc.) because they are subject only to tension forces.

The structure should be oriented so that its end faces the prevailing winds.



Construction:

The compression members must be stout as they must withstand large compressive loads especially in the case of large spans under heavy wind loading. First choose four stout poles about 16'-0" long.



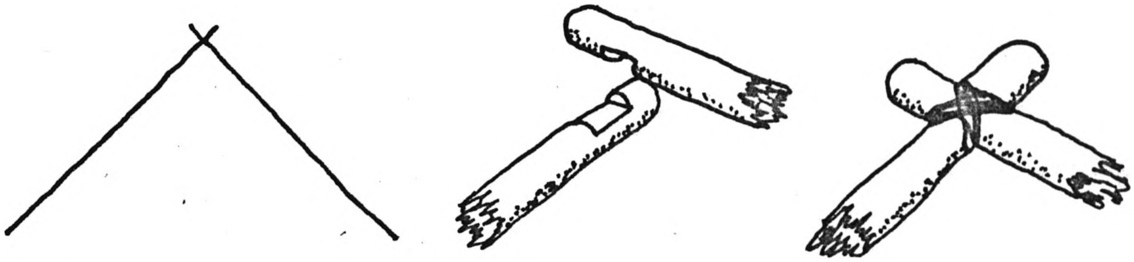
(Note: The structure described here is a small one, but larger spans can be obtained if strong enough cable is available. In such cases, increase dimensions proportionally.)

If thick poles are not available, thinner ones can be bound together so that they are thickest in the middle.

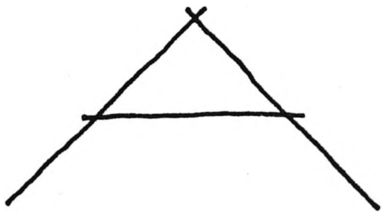
Another possibility (especially in cases employing bamboo) is to tie three pieces together to form a banana- or pod-shaped member, triangular in cross section.

The members need to be thickest in the middle because tendency toward failure due to bending is most likely in the center when compressive forces are applied.

Once the four main poles are ready, they should be lashed firmly together in pairs at right angles. In the case of wooden poles, they can be notched at the ends to insure a firm connection.

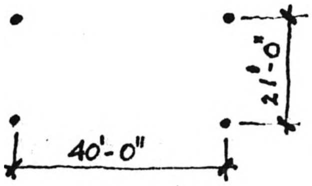


Next, take two ten-foot poles which needn't be as stout as the matched pairs, and tie one across each of the pairs forming "A" shapes. The bottoms of the legs should now be about 21'-0" apart.



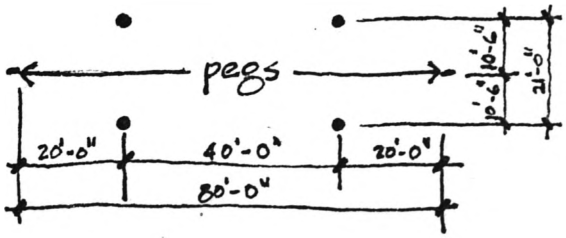
The main supports for the structure are now complete.

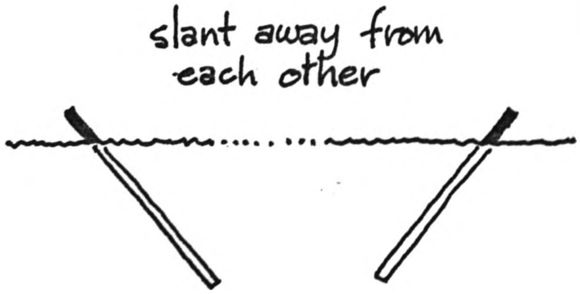
As the supports will be in compression, there is no need to sink them far into the ground. So dig four holes six to four inches deep in a rectangular plan 21'-0" by 40'-0".



If the ground is soft, dig a little deeper and fill the holes with rocks or concrete if available to form a pad.

The next step is to drive two long pegs (4'-0") into the ground about twenty feet beyond the ends of the plan. These pegs must be extremely secure as the tension of the entire structure depends on them. If either one should accidently pull out of the ground, the entire structure would collapse.

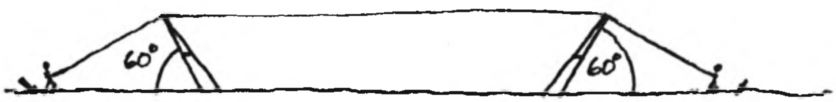




These pegs should lean back away from each other about 45 degrees, should stick out of the ground about one foot, and should penetrate the ground at least three feet.

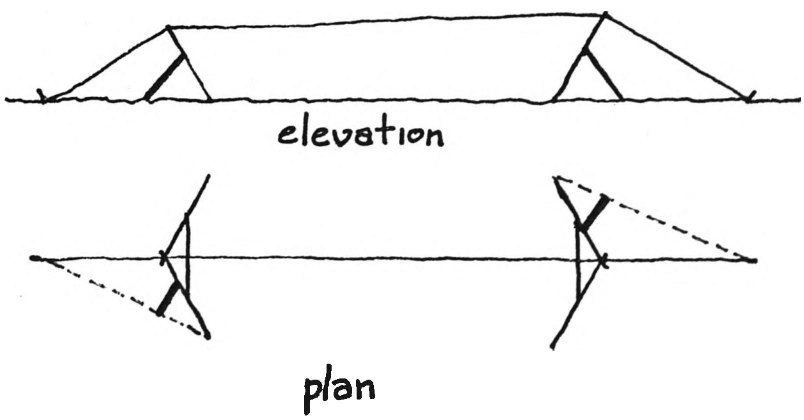
You are now ready to stand up the two A-frames which will support the cables. The two A's should now be lying on the ground with their legs in the foundation holes and their tips pointing toward the pegs.

The main cable must be strong in tension (1" hemp, jute, or sisal; 3/8" marine rope, nylon minimum). Loop the main cable around the top of one A, allowing about 20'-0" of free rope toward the peg. Run the cable to the top of the other A and loop around it also, standing the two A's up as you go so that they each lean out toward the pegs at 60 degrees to the ground.



Once the two frames are leaning at the proper angle, pull the rope tight and tie the ends to the pegs.

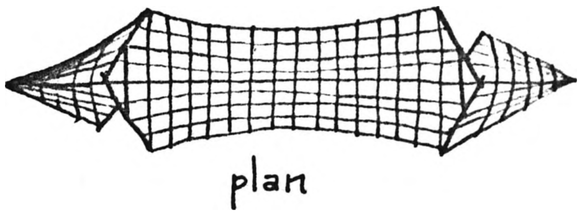
Diagonally opposite in plan, lash two stout poles to the A-frames and sink the other ends at least two feet into the ground in line from the legs of the A's to the pegs, forming triangular openings for the doors.



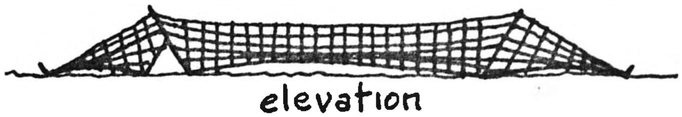
Now add additional longitudinal cables along the length of the structure spaced every 2'-6" along the sides of the A's. The cables should run from one peg, loop around the near A, run across to the far A, loop around it, and back to the other peg. To avoid vertical slipping, notch the A's slightly wherever the cables cross them. When you come to a door opening, tie the cable off at each side of the door frame so that the doorway remains free. A cable which runs at the ground level is also necessary as it will serve to anchor the transverse cables.

These cables, as well as the transverse cables, need not be as strong as the main cable. As cables are added, be sure to maintain the proper angle of the frames to the ground. Also retighten all cables to equal tension once they are all in place.

To further increase tension, transverse cables perpendicular to all preceeding cables must be added every three feet along the length of the structure. Tie one end of the transverse cable to the bottom longitudinal cable on one side and throw the free end over the peak of the roof. Tighten them to equal tension as you go and tie the free ends to the bottom longitudinal cable on the other side.



The addition of the transverse cables will cause the other cables to bow in, both in plan and in elevation. When all transverse cables are in place they should all be retightened to equal tension.

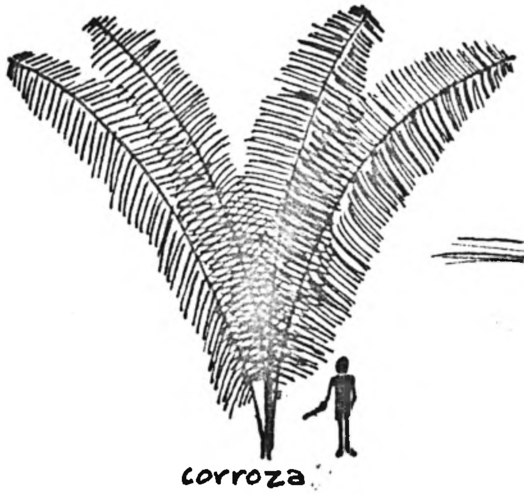


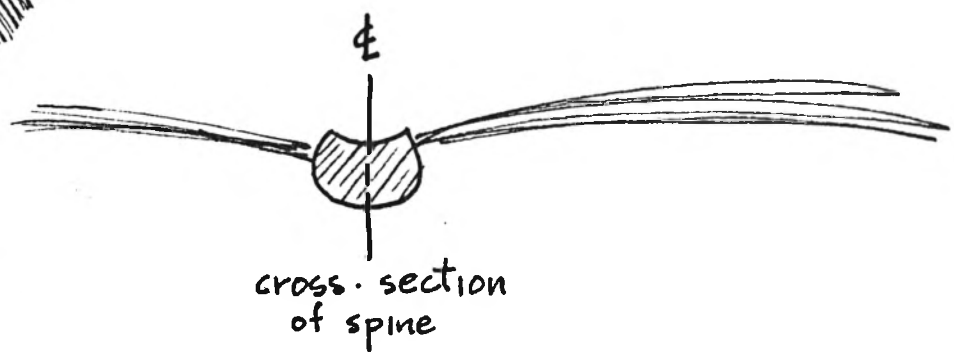
Where the transverse cables cross the longitudinal cables tie them together with small pieces of string or bark.

The structure is now ready to be thatched. Simply use the longitudinal cables to attach the thatch material. This additional weight will provide the final tensioning. Once the structure is thatched, it is ready for occupancy.

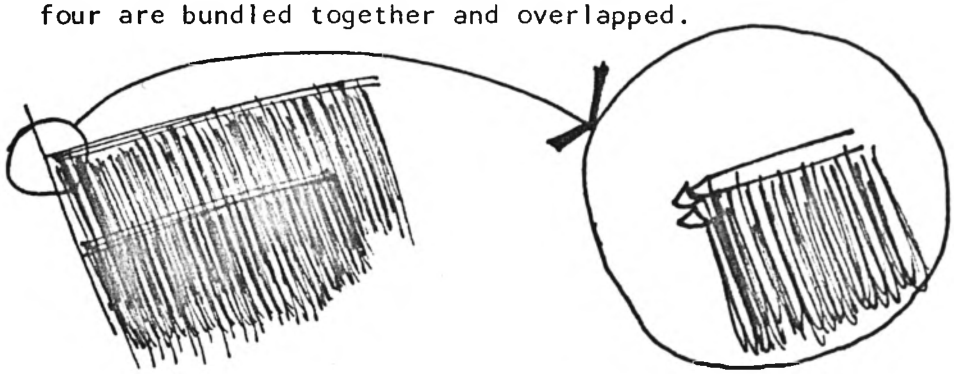
Indigenous Materials: Guatemala

corroza - tall palm fronds which spring in clusters directly from the ground, or in some cases, in old plants, from up on a pineapple-like stalk. These plants have a sturdy central spine from which leaves radiate in a plane configuration. These spines grow up to thirty-five feet in length with the leaves up to $3\frac{1}{2}$ feet on either side of the spine.

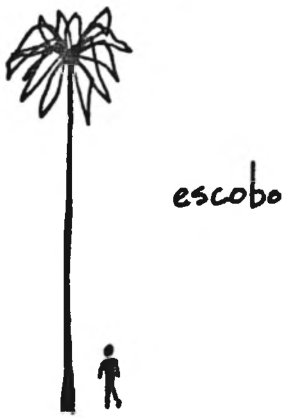




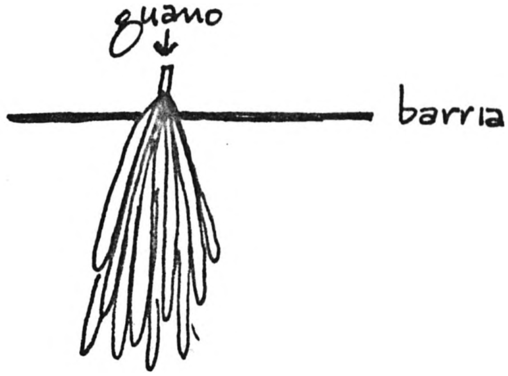
To thatch, these plants are split down the center, then three or four are bundled together and overlapped.



escobo - a tall thin spiny palm which grows very straight. This tree has whitish green bark and $\frac{1}{4}$" to 2" spines which can be extremely painful. The diameter of the tree averages about $3\frac{1}{2}$" for a twenty-five foot tree. Its wood is strong and dense and its leaves resemble guano and can be used for thatch.



<u>guano</u> - a palm frond with leaves grown from a central point. This is the best type of thatch material to be found in Guatemala. To thatch, some of the leaves are tucked under and some over the <u>barrias</u> (small sticks or stringers). The closer together the guano, the better the thatch.



Thatch is rated for the number of years it will last. Three layers of guano close together will last ten years.

These fronds grow in clusters from the ground, much like <u>corroza</u>, up to ten feet tall.

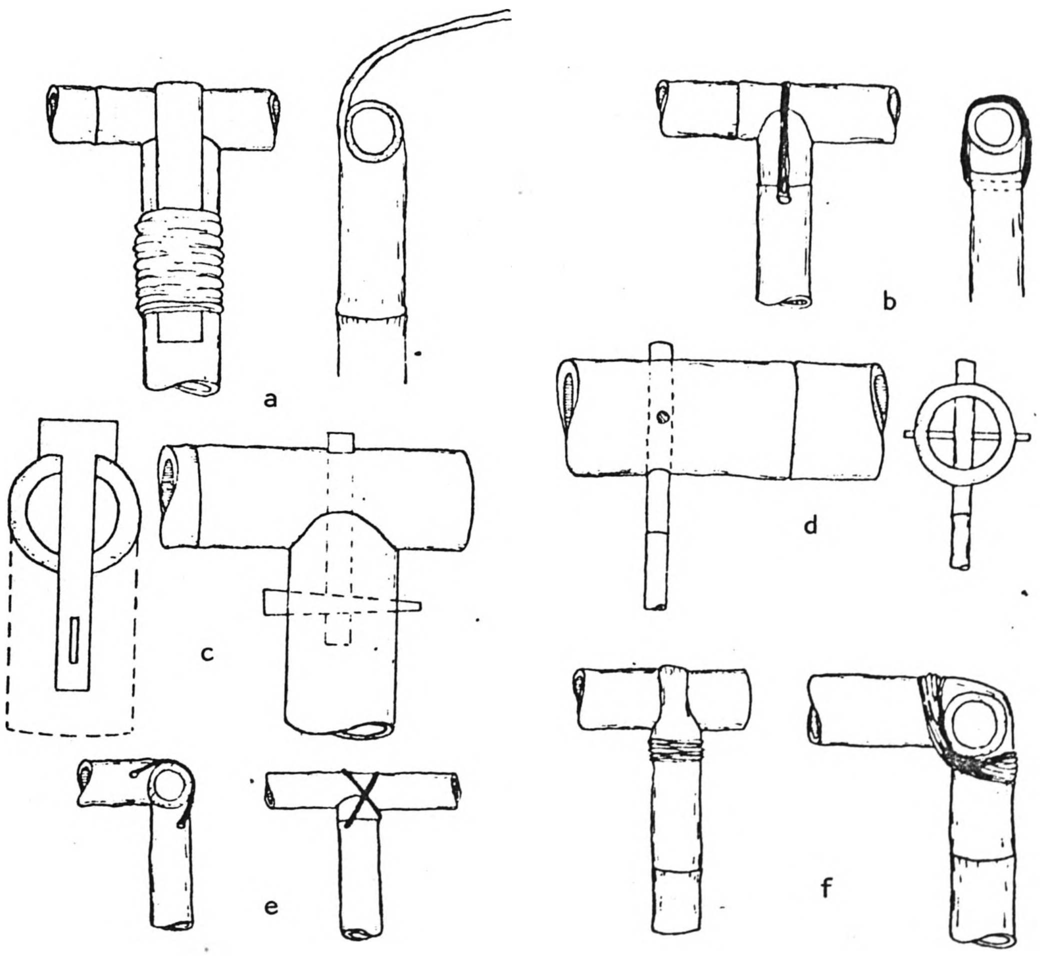
<u>majahua</u> - the inner bark of a thin brown-barked tree by the same name. This extremely strong bark is especially good for tying when cut into thin strips.

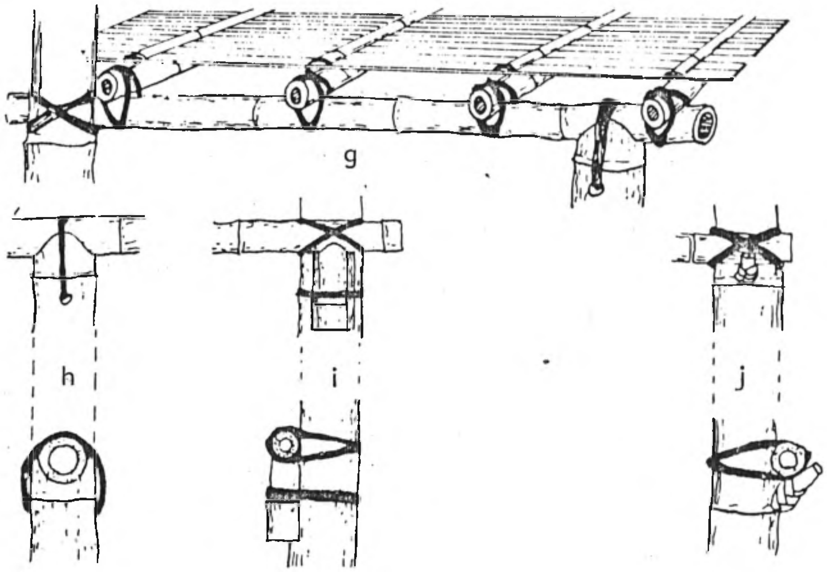
<u>vejuco</u> - a long fibrous vine with nodes every eight inches to two feet. This grey/brown green vine is very strong when living. Its skin is sometimes slightly pebbled and its green leaves are four to five inches long growing out of the nodes on tendrils. This all-purpose vine forks and branches out as it grows. It varies from 1/8" to 2" in diameter and the larger ones can be split lengthwise to use it to tie with. To loosen up the fibers before using it to tie (logs, etc. together) twist the vine. In addition to tying, this vine makes very good cable for such uses as the tension structure.

Bamboo Joining Techniques

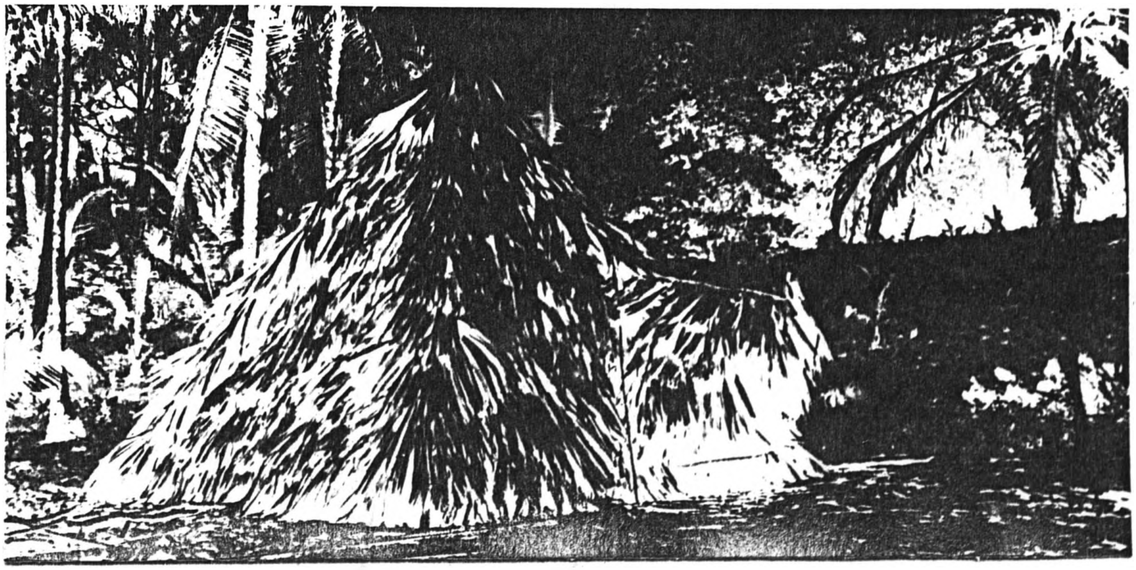
Because it is cylindrical, hollow, and lightweight, bamboo adapts itself excellently to all kinds of joining techniques. The joints need not rely on simple cutting and fitting because by application of heat, bamboo can be bent so that it loses memory of its previous shape. Submersion in water is probably the best way to permanently bend bamboo, but it can be bent by simply sticking it in the fire.

Following are several joining techniques reprinted from the United Nations handbook on The Use of Bamboo and Reeds in Building Construction, New York, 1972, pp. 63,64. The working party has found this book to be an excellent reference. Pay special attention to joint "a", a heat bent butt joint, as the working party has found this to be the most useful universal joining technique.





g. Fitting and securing bamboo boards to floor
h. Saddle joint
i. Use of inset block to support horizontal load-bearing element
j. Use of stem of branch at node of post to support horizontal load-bearing element (McClure)



Prospectus Growing Out of Work in Progress . . .

Grant Proposal:
Construction of
Emergency Shelters

THE UNIVERSITY OF TEXAS AT AUSTIN
AUSTIN, TEXAS 78712

School of Architecture

Grant Proposal:

<u>Construction of Emergency Shelters</u>

Arc. 355/380

School of Architecture

October 25, 1973

INTERNATIONAL NEEDS

The number of refugees in the world today is well in the millions and is increasing daily. Civil disturbances in Bangladesh in 1971 drove an estimated 12 million people into India as refugees and caused millions of others to flee their homes. Earthquakes in Mexico this summer claimed the homes of thousands as did similar earthquakes in Nicaragua last year. As of 1971 over 3 1/2 million people had fled or been evacuated from areas of conflict in Viet Nam and the refugees in Laos and Cambodia account for several million more.

The threat of natural disasters (earthquakes, hurricanes, draughts) is forever with us and they somehow seem to occur most often in the most highly populated areas of the globe. These regions also tend to have, along with their other difficulties, unstable governments and not enough capital to deal with disasters when they do come.

Concerning this situation and the technological expertise now available in the world, C. P. Snow in his 1959 Rede Lecture at Cambridge University states:

> "Since the gap between the rich countries and the poor can be removed, it will be. If we are shortsighted, inept, incapable either of good-will or enlightened self interest, then it may be removed to the accompaniment of war and starvation: but removed it will be. The questions are, how, and by whom."*

Although many international relief organizations deal with health and food services, surprisingly few can deal with the acute housing need. One main reason for this is that no one has successfully solved the difficult problem of providing adequate housing which fits the extremely low budgets available.

* C. P. Snow, The Two Cultures, and A Second Look. Cambridge University Press, 1969, page 46.

Research Plan

The Emergency Shelter Group is researching and applying existing and new technology for refugees within the cultural context. While realizing that cheap, quick shelter must relieve the highest priority, shelter which does not fit the culture is useless.

Initially, the group is compiling a catalogue of environments based on a worldwide survey of cultures, climatic conditions, geography, soil types and existing technologies. The objective is to publish this in a flexible format which can be updated with data gained from testing and evaluation of prototypes in actual site conditions. Based on this program, the group will be building and field testing prototypes with indepth evaluations feeding back data which will then be incorporated in the Intertect Relief Operations guidebook.

The first prototypes will be employed in an actual refugee situation this winter with the complete reports being incorporated for the publication by early next spring.

Based on the positive responses of other departments in the University System the School of Architecture is considering instituting an Interdisciplinary studies group and including the emergency shelters as a regular course in the architecture curriculum.

In addition the Emergency Shelters Group will be publishing a monthly report on our progress listing the results and progress of the various activities and other related endeavors pertaining to emergency shelters.

This research plan is being coordinated with a similar effort by a working party at Carnegie-Mellon.

Management Plan

The Emergency Shelters Group is divided into four teams.

I. Global Survey - A "cultural impact" team which is working to compile and evaluate data on world cultures, climatic conditions, soil types, negotiation and other pertinent information.

II. Technological Survey - This team is taking a critical look at existing building systems in use throughout the world both for relief structures and those employing only materials found on or near the site location.

III. Specific Technologies - The team working to develop prototype technologies and building systems for emergency situations.

IV. Materials - A working party that is surveying and developing materials that will work in rapid construction environments.

Each of these teams interacts on all levels with each of the other groups.

The work of these groups will result in the following:

I. A bibliography on housing and shelter systems currently in use and on systems which might be adapted to relief operations. A brief description will accompany each source listed.

II. A report on existing housing systems and materials used in relief/disaster operations for housing, shelter, warehouses,.medical facilities, etc. Report will include:

a. Costs of materials
b. General availability
c. Ease of transport
d. Uses in field
e. Ease of construction/degree of sophistication required
f. Geographic/climatic limitations

III. A Socio-Cultural Index of housing types, patterns, constraints, etc., for worldwide reference. The report will show with illustrations existing housing types in disaster-prone areas and outline in detail problems likely to be encountered in housing and related areas in these regions.

IV. A Disaster Directory, listing each nation in the third world and the types of disasters which it could be expected to face, an evaluation of housing problems which might be encountered and a cross-reference to the Socio-Cultural Index.

V. Produce prototype ultra-low-cost refugee housing units or systems and illustrated working reports.

VI. Initiate an ongoing research program in Emergency Shelter Systems.

Ongoing Programs

The four reports that will be the result of our research, (1. a housing systems report, 2. a bibliography, 3. a socio-cultural directory, 4. a possible disasters index), will be the basis for further research at U.T.

Periodic reports on new developments will be issued as research progresses.

Other ongoing projects may include:

a. A symposium on emergency housing systems
b. Interdisciplinary programs at U.T.
c. Establishment of a training center for relief personnel
d. Publication of a mimeograph series on emergency shelters
e. Inter-University research programs
f. Development of a publishing center for relief/emergency shelters material

Key Personnel

Professor Wolf Hilbertz of the University of Texas, School of Architecture, is overall program coordinator for the project. Assisting him are Geoffrey Wright, Richard Trimble, Bob Swaffar and Murray Libersat.

The research is being coordinated with the program at Carnegie-Mellon University by Professor Volker Hartkopf of CMU.

Consultant for the project is Frederick C. Cuny of INTERTECT in Dallas, Texas

Other participants are as follows:

- Sami Angawi
- James C. Amoretti
- Gabriel A. Baez
- Charles R. Bellomy
- E. Carrizales, III
- John Holmes Corbin
- David Davidson
- Ferida Harutunian
- Deborah Jean Higgs
- Robert Garth Ikel
- Charles Phillips
- Chester Arthur Slimp
- Regan Douglas Terrier
- Ray Villasana
- Lannie Lynn Wagner
- Warren S. Wurzburg, Jr.

TECHNICAL SURVEY OUTLINE

I. Organization of Survey...by Materials
   - A. Four Main Categories
     1. Roof frame
     2. Roofing materials
     3. Walls, foundation, flooring
     4. Other (e.g., polyurethane foam)
   - B. Within Each Category...Specific Data
     1. Material/and bibliography
     2. Structures using this material
     3. Details of joints
     4. Limitations (if known)
     5. Suggested improvements (if any)
   - C. List of Materials to be Included in Survey

Bamboo		Thatch	Polyethylene
Earth		Reeds	Polyurethane
Rammed		Sand Bags	Rubber
Adobe		Canvas	Metal Scrap
Stabilized		Burlap	Shellac
Sod		Stone	55 Gallon Drums
Brick Pressed		Brick	Sewer Pipe
Earth Stabilizers		Hemp Rope	
Dung	Sand	Nylon Cord	
Lime	Asphalt	Glue	
Straw	Bhusa	Wire	
Molasses	Hair	Fiberglass	

BUDGET

Materials:

Canvas	
20 Bags Cement @ $1.90 each	$ 38.00
10 Bags Lime (Type A1) @ $3.50 each	35.00
30 Gallons Asphalt @ $1.00 each	30.00
6 Loads of Dirt, Sand @ $20.00 each	120.00
10 Sheets of 1/2 Plywood @ $12.00 each	120.00
5 Sheets of 3/4 Plywood @ $16.00 each	80.00
Various Steel Profiles	25.00
2500 Ft. Hemp Rope @ $ .03 per foot	75.00
Various Pulleys	20.00
Various Gears	20.00
Bolts, Nuts, Screws, Nails	20.00
Wire, Solder, Tape, Paint	25.00
Welding Equipment:	
Acetylene	25.00
Oxygen	14.00
Rods	9.00
Propane	8.00

Documentation:

Secretarial Typing @ $ .50 per page	15.00
Copying @ $ .05 per page (20 copies)	30.00

Photographic:

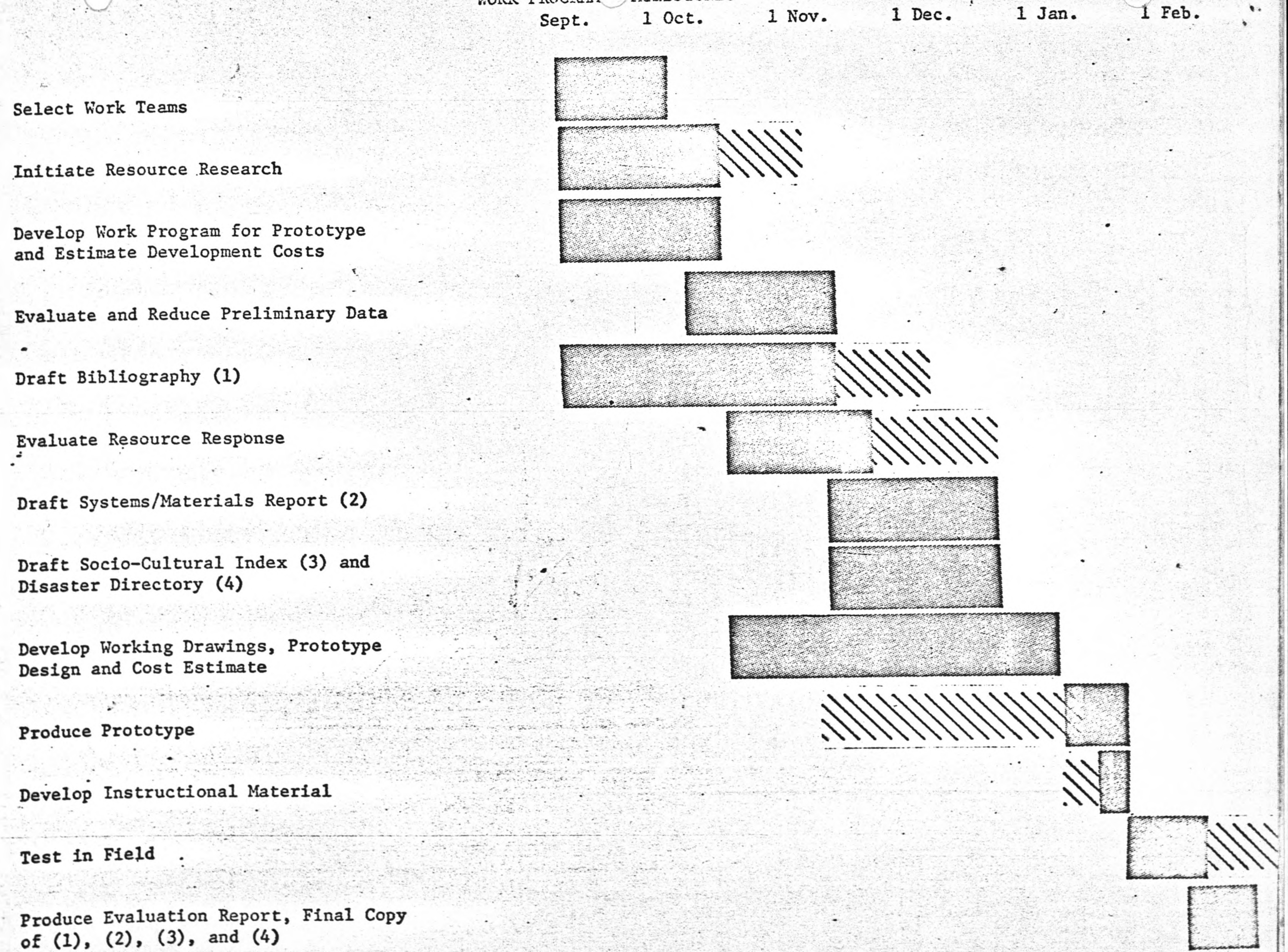
10 Rolls 35mm B&W (Plus X)	10.00
42 Rolls 120mm B&W @ $ .90 each	3.60
2 Rolls H.S. Ect. @ $3.00 each	6.00
Processing H.S.E. @ $3.50 each	7.00
10 8X10 Prints @ $2.25 each	22.50

Transportation:

Transportation to Louisiana for Bamboo 860 miles (round trip) @ $ .09 per mile	77.40
6 X 14' Tandum Trailor @ $8.50 per day	25.50
Transportation Expenses for Consultants	175.00

TOTAL: **$1036.00**

WORK PROGRAM MILESTONES



SUGGESTED OUTLINE FOR POSSIBLE DISASTER DIRECTORY (4)

Country ______________________ Location ______________

Physical Data

- Area
- Relief
- Climate
- Mean Annual Rainfall
- Soils
- Types of Transportation & Availability
- Physical Problems

Demographic Data

- Population
- Density
- Birth Rate
- Urban - Rural Ratio
- Per Capita Income
- Average Family Size
- Literacy
- Languages/Dialects
- Ethnic/Racial/Tribal Groups
- Religions

Governmental Data

- Type of Government
- Disaster Agencies
- Sphere of Influence
- International Organizations

Health Data

- Prevalent Diseases
- Possible Diseases
- Doctor/Inhabitant Ratio

Possible Disasters

- Natural Disasters/Probability Index
- Man-Made Disasters
- Ability of Government to Respond
- Degree of Expatriate Assistance Needed
- Nations that can be Expected to Assist
- Cultural Restraints to Relief Operations

Comments

SUGGESTED OUTLINE FOR CULTURAL INDEX (3)

(See Accompanying Map)

A. Region

B. Nations in Region

C. Relief

D. Climate

E. Types of Transportation

F. Population Characteristics

   1. Urban - Rural
   2. Familial Make-up
   3. Average Family Size
   4. Living Patterns
   5. Religion

G. Housing Patterns

   1. Size of Structures
   2. General Layouts
   3. Materials Used
   4. Preferred Colors
   5. Cultural Restraints
   6. Adaptability to New Designs
   7. Types of Supportive Systems Required
   8. Adaptability to High Density Environments

H. Materials Available

   1. Soils
   2. Organic Materials
   3. Synthetic Materials in use
   4. Costs of Construction
   5. Availability of Skilled Labor

I. Comments

   1. Materials which could make units more efficient
   2. Systems currently in use which could be used in relief operations
   3. Systems currently in use which should not be used in relief operations

3rd World DISASTER-PRONE AREAS