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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

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INDUSTRIAL CONSTRUCTION IN DEVELOPING COUNTRIES

Report of an Expert Group Meeting

Vienna, 20-26 November 1974

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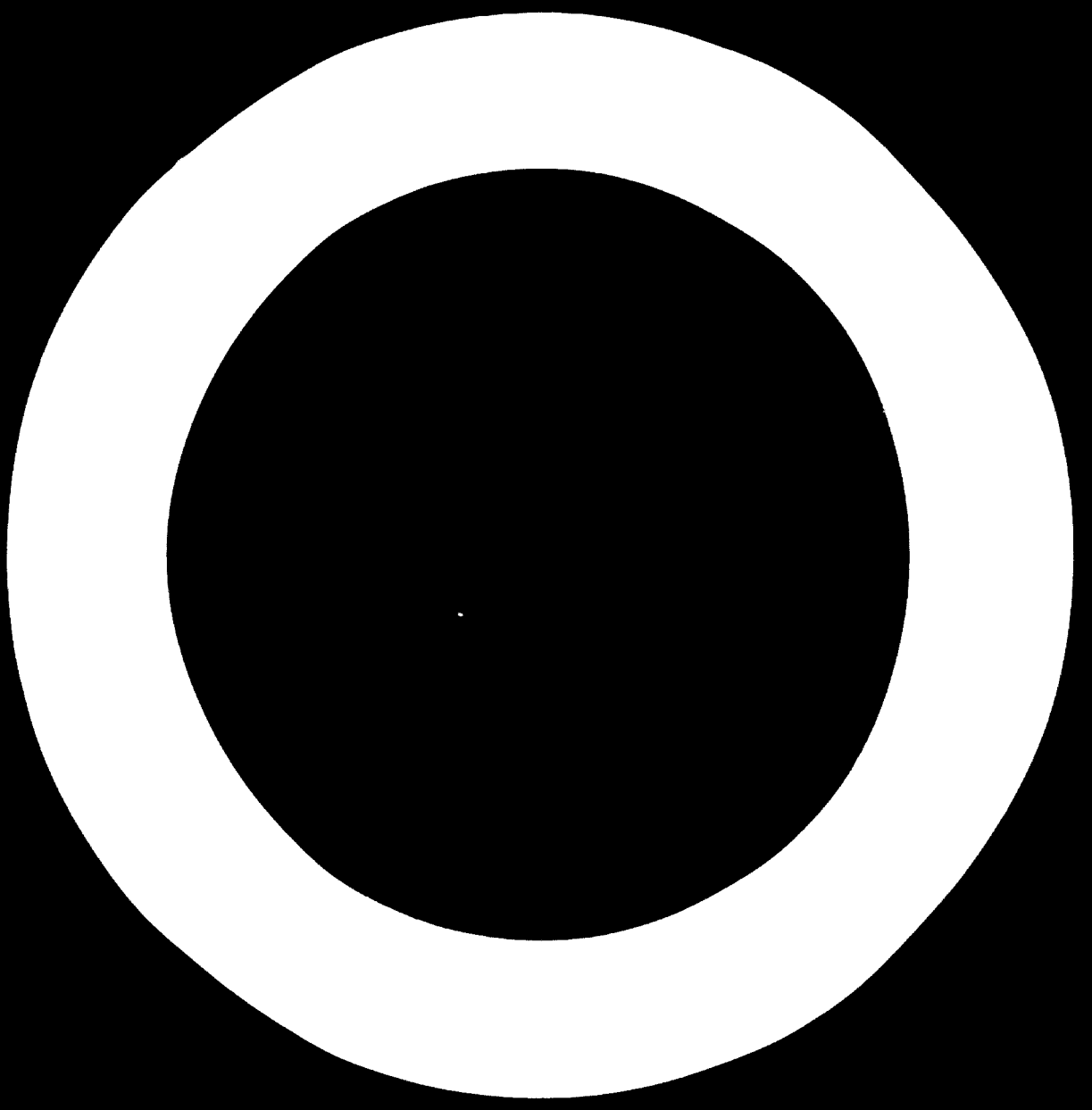

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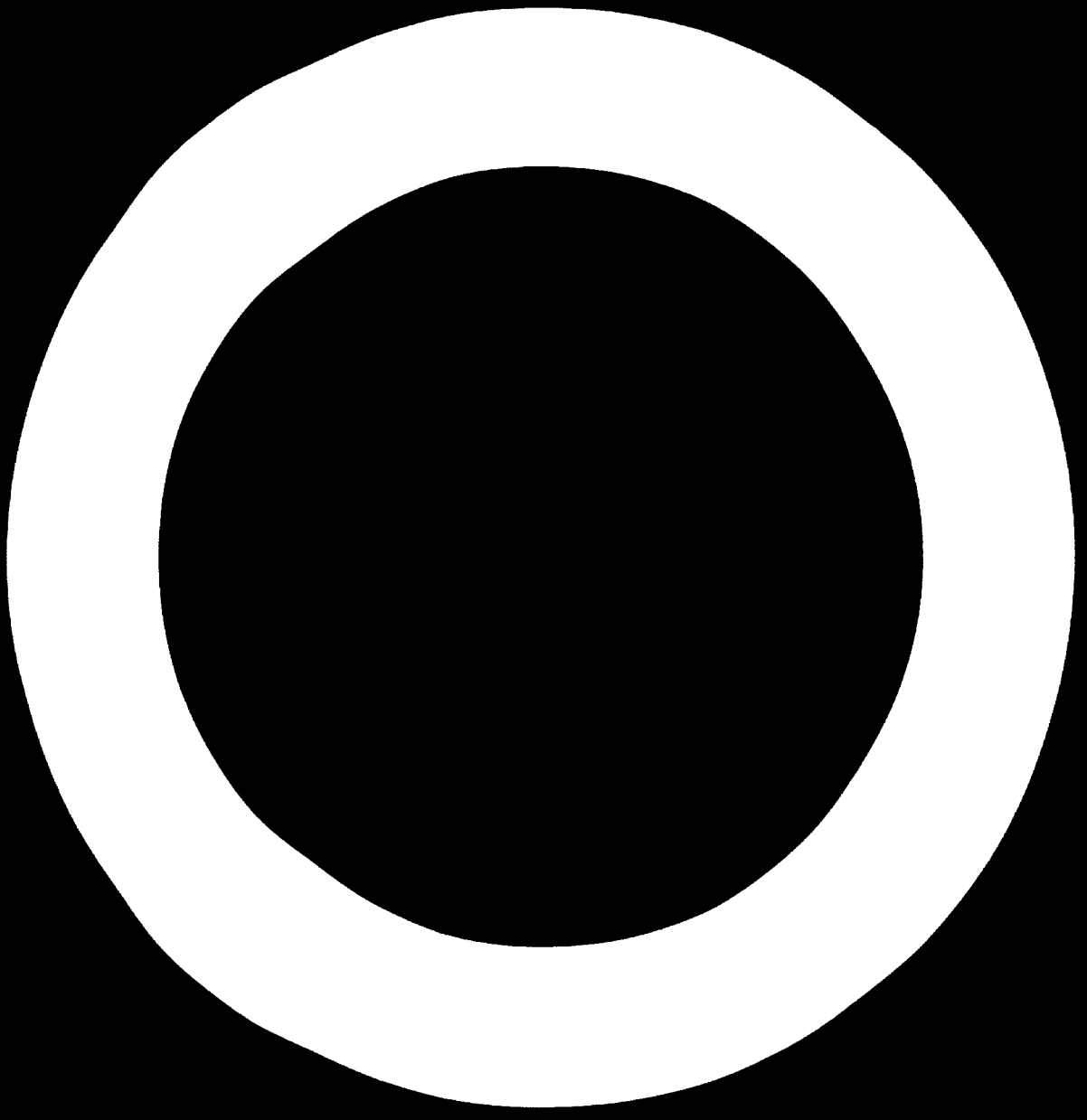


INTRODUCTION

1. The Expert Group Meeting on Industrial Construction in Developing Countries was held in Vienna from 20 to 26 November 1974. It was organized by the United Nations Industrial Development Organization (UNIDO).

2. The purpose of the Meeting was to discuss and define the problems to be overcome in establishing and encouraging the development of effective and appropriate industrial construction activity as a basis of industrialization in developing countries.

3. The Meeting recommended certain courses of action that would contribute towards easing the constraints on the growth of factory building.

4. Industrial construction is a component of the entire construction activity. The main problems of the construction industry in developing countries were discussed at an Expert Group Meeting held under the auspices of UNIDO at Vienna in October/November 1973. (See ID/WG.142/21.) The Meeting on which this report is based was a follow-up to the earlier Meeting.

5. The group of experts dealt with the over-all aspects of development of a country together with other considerations that must be kept in mind while formulating policies for the industrial construction sector. The activities of this sector may range from the rationalization of conventional construction techniques to a mechanical processing procedure and assembly operations.

6. The issues dealt with related to standardization, construction components, selection, utilization and maintenance of equipment and improvement of techniques in large prefabrication plants.

7. Priority areas for construction firms and contractors in developing countries were also discussed. The important aspects of project surveys, project engineering, specifications, deficiencies in tendering, contract financing, construction management, quality control and labour relations were highlighted. Stress was laid on construction firms receiving better technical and managerial training in all fields of industrial construction.

8. The Expert Group elaborated a number of specific recommendations with [illegible] programmes [illegible] action that the countries themselves could initiate to [illegible] [illegible] [illegible].

9. Stress was placed on mutual co-operation and co-ordination among western countries in initiating institutional and technological change in industrial construction in developing countries.

10. The Meeting was attended by 12 experts from 9 countries, observers and representatives of the Economic Commission for Europe (ECE) and of UNIDO. The officers of the Meeting were: E.H.A. Hardy (UNIDO), Director; E.E. Jonjić and V.A. Avramenko (UNIDO), Joint Secretaries; A. Raghuttama Rao (India), Chairman; E. Csorba (Hungary), Vice-Chairman; and D.H.J. Miles (United Kingdom of Great Britain and Northern Ireland), Rapporteur.

11. Papers relating to each of the agenda items appear as chapters I-X of this report. The Meeting was split up into two working groups, each of which considered different agenda items; the groups then presented their conclusions to a plenary session.

CONCLUSIONS AND RECOMMENDATIONS

14. The following conclusions were made on the discussions of the two working groups of the Meeting:

(a) Industrial construction is a specific component part of the entire construction activity in a country or region;

(b) Each industrial project comprises two main components: construction work and equipment;

(c) The proportion of these two parts is different and depends on the character of the project and the stage of economic development;

(d) The average proportion of the total costs of the project of construction work to the installation of equipment in industrial buildings is 60 to 40 per cent;

(e) The cost of mounting operations, including the costs of equipment of industrial projects, tends to grow in the process of economic development in each country;

(f) Industrial dwellings, taking into account their functional purpose, are significantly different from other types of construction industry end-products;

(g) The main industrial processes require heavy structures of industrial dwellings, which are usually built of such strong materials as steel and concrete;

(h) The rather heavy technological equipment and structural components of industrial dwellings require special cranes and other construction equipment for installation and assembly operations;

(i) Some elements of factory buildings as well as some structures of industrial complexes can be built of local building materials using conventional construction methods;

(j) Industrial construction design is usually divided into two stages: technological project and construction design. The technological part of industrial project design is sometimes complicated and creates functional requirements for the dwellings;

(i) On the other hand, the wide application in industrial construction of identical prefabricated elements for different types of dwellings requires the typification of industrial buildings on the basis of modular [illegible].

(j) Development of industrial construction requires the rational combination of the use of main elements of industrial buildings such as columns, beams, trusses and roofs manufactured both on-site and at the factory.

(k) Development of industrial construction requires for the production of bulky elements of factory buildings such materials as cement, rolling steel, glass, bitumen and others.

(l) The assembly operations of prefabricated elements like beams, floors and trusses, needed for the construction of factory buildings as well as for mounting heavy technological equipment, require the use of high-capacity cranes, cranes and special tools or construction sites;

(m) The transport of large structural elements from the factory producing prefabricated components to the construction site is only possible with big trucks and special vehicles;

(n) [illegible] will in regions that do not have enough developed [illegible];

(o) In order to meet the energy requirements of the factory buildings in such a region, it is necessary to have [illegible];

(p) Such studies usually cover all work on the erection of the plant or factory, beginning with the drilling needed for geological survey and ending with final operations.

13. The Expert Group recommended that developing countries should:

(a) Make special examination of local raw materials deposits needed for the production of the main kinds of building materials;

(b) Elaborate the prospective programme of building materials industries development, taking into account the overall target of general economic development of the country;

(c) Organize government support for construction firms dealing with industrial construction;

(d) Protect, on a cooperative basis, the mass production of building materials, elements and components as well as construction machines and equipment, including their repairs;

(e) Develop industrial construction design with wide use of the experience already accumulated in developed and developing countries with large application of typified projects for industrial dwellings.

14. The Expert Group recommended the UNIDO should:

(a) Organize assistance to the developing countries at their request in the implementation of proposed programmes (see annexes II-IV, Programmes I-III);

(b) Collect systematically experience on the development of the industrial industrial construction sector in developing and developed countries;

(c) Increase the dissemination of information on the development of industrial construction which could be used as guidlines in developing countries;

(d) Organize a large exchange of experience among developing countries on industrial construction problems through seminars, joint consultations, meetings and others;

(e) Extend the UNIDO training programme for professionals dealing with industrial construction.

I. COMPLEXITY OF INDUSTRIAL CONSTRUCTION ACTIVITY

13. Any organisation that has to formulate a policy for implementing the development of the industrial construction sector must appreciate and analyse the complexity of this activity in formulating long-term as well as short-term strategies and planning. The following are some main considerations:

(a) Industrial construction covers such a vast area that almost all activities of a society have some bearing on it. Industrial construction not only includes the building of small factories but also large industrial projects. It also covers the maintenance and repair of previous works;

(b) Agencies range from self-employed workers building their small workshops to large construction firms or government agencies carrying out national projects in the industrial construction sector;

(c) Components range from ordinary soil to the most sophisticated man-made materials;

(d) Labour covers the ordinary unskilled workers employed in factory construction right up to highly skilled operators and servicemen working on sophisticated equipment;

(e) Management ranges from a "one-man" managing work in a small factory to a well-established construction firm dealing with the management of a major industrial project;

(f) Design ranges from a self-designed factory to intricate civil engineering designs of nuclear power stations or other large industrial projects;

(g) Equipment ranges from simple hand tools and buckets to the most sophisticated construction equipment;

(h) Financing embraces an owner's self-financing his own factory to the complicated financial arrangements for a national industrial project;

(i) Methods range from fully labour-intensive to fully mechanized;

(j) Tendering and contracting is another area of conflicting interests and is complicated since many parties are involved with different interests and approaches;

(k) Standards and specifications for construction materials and components, tools, plant and equipment, and for different items of work vary with the agency handling the construction;

(l) Development of industrial construction activity depends on other sectors and industries. On the other hand the status of those sectors has a bearing on this branch of the economy;

(m) Labour laws must take into consideration the complications of the industry, its seasonal nature, its varying work volume, the closure of labour activity as soon as the structure is finished, the mobility of labour, the system of task work and the system of contracting;

(n) The organization or methods required for new construction work are different from maintenance and repair of old structures;

(o) Activity is often carried out in a country by many agencies, private and public, many government departments, municipal bodies etc. with their own vested interests, standards and methods;

16. Keeping these complexities of industrial construction in view, it may be worth consideration to form a team of experts who would be assigned to analyse and establish a policy consistent with the socio-economic factors and other construction existing in the country to identify the following:

(a) The present status and prospects for development of the industrial construction industry;

(b) The material inputs with special reference to local production and also with reference to imports;

(c) The building techniques adopted and the construction equipment, machinery and tools being used to determine whether any automation or mechanization of operations could be made to improve the quality of end-products. (This effort should be consistent with the technology available locally and also should aim at reducing import expenditures for the building industry);

(b) The technical skill and power existing and what will be needed in the future for industrialization, before formulating the training programme

(c) The areas that need improvement within the regions considered for industrial construction in terms of road transport, auxiliary services etc.

17. A plan of action for the countries concerned and UNIDO is suggested in the programme outlined in annexes II-IV.

II. CONSTRUCTION DESIGN AND TECHNOLOGY

18. Design is vital in ensuring that industrial structures shall be appropriate to local needs. In many developing countries most of the local architects, civil engineers and quantity surveyors have received at least a part of their training overseas, and consequently face a heavier task than their counterparts in industrialized countries in adapting their methods and techniques to local needs and conditions. It is not surprising therefore, that in a large number of developing countries, designs are based on overseas practice and modified to correspond to local conditions. This process of modification to suit local conditions is often made more difficult by the lack of local standards, codes of practice and published information.

19. It it is at the design stage that a major contribution to cost saving could be made. Even a highly skilled contractor using advanced construction techniques cannot produce a truly suitable and economical structure if the fundamental design is not appropriate to the needs of the eventual user.

20. Thus, the designer's skills should embrace traditional as well as modern materials, local skills as well as advanced techniques and local socio-economic habits and conditions. The best results are likely to be obtained by designers with a sound knowledge of modern flexibility to adapt these to local needs. This required range of skills is only likely to be achieved if constructive thought is given to the continuing training and education of local professional talent so that knowledge can be regularly updated. National building research organizations, universities and other training institutions have a part to play in this process, but UNIDO could also have a key co-ordinating role by providing the necessary external advice and expertise and ensuring that experience and innovation is shared and disseminated. A Plan of Action for UNIDO is suggested in Programme II (annex III).

21. The pool of professional design skills is one of the most valuable national resources, and in many developing countries these skills are particularly scarce. In these circumstances, the tendency to design a "bespoke product" to suit each individual client is perhaps a little extravagant, and more consideration should be given to the potential advantages of standardization and modular co-ordination. A further

stimulus to standardization is the need for versatility as industrial needs change. As Kriukov pointed out at the 1973 UNIDO Expert Group Meeting on the Construction Industry in Developing Countries:

> "A characteristic feature of modern industry is the increasing improvement of its technological processes, the creation of new kinds of equipment of every type, the elaboration of highly sophisticated assembly line procedures and the manufacture of more and more product lines. All this has an effect on the buildings and facilities that are to be planned. Shorter lead-times for technological processes coupled with the availability of equipment of constantly increasing efficiency require the design of new, versatile types of buildings and institutions in which the need for reconstruction will be held to a minimum."

While the pace of change is unlikely to be so great in most developing countries, the need for versatility and adaptability remains. Whatever future population trends may be, it is certain that most developing countries will have to cope with steady increases in their populations of working age for the next 10 to 20 years. Assuming that these countries appreciate the scale of the problem and consciously pursue a policy of work creation, the need for additional work places could be very large. It would be surprising if this growth of additional work places were not matched by a variation in patterns and types of work, so that factories, warehouses, workshops and other industrial buildings will have to be regularly adapted. To the present priorities of low initial cost and speed of erection it would therefore be wise to add their versatility.

22. It is important to remember the one feature that cannot be made adaptable (except in the case of mobile buildings) - the site. As most permanent buildings are designed to last at least 40 to 60 years, it is vital that new industries and factories should be sited strategically in relation to planned national, regional and local development. This will probably be achieved more successfully with a network of small local industrial units than by concentrating development on a small number of large trading estates.

23. Productivity in building can be increased by the manufacture of components off the site, and in many developed countries building techniques have already followed this trend, beginning with simple small components and progressing to larger elements through assembling of components. Brick windows and doors are examples of components which at an early stage have progressed from manufacture on site to the workshop or factory.

24. Reducing work on site to an assembly process of manufactured components permits the employment of a higher proportion of unskilled labour and reduces the level of skill required of the skilled operative.

25. The transfer of the manufacture of components to the factory introduces the need for standardization both in component size and performance. Limitation of size and performance is essential for the following reasons:

(a) It simplifies manufacture;
(b) It provides market continuity;
(c) It eases ordering, scheduling storage and costing.

It is vital that the sizes of components should be co-ordinated so that the components can be used together as an "open system" of building. To quote the simple example of traditional building, window sizes should be a multiple of brick sizes.

26. Co-ordination of size of building products and components is also important to allow scope for further rationalization and industrialization of the building process, since many components may be used more generally in the construction industry.

Open systems

27. Industrial building consists basically of two major elements:
(a) The shell or main production area;
(b) Ancillary accommodation (stores, sanitary, welfare offices).

28. The production area must be capable of housing a wide range of industrial use and must enable change from one use to another by addition, subtraction or substitution. The building envelope for the production area requires an open form of structure and large spans compared to building types such as housing. The structural system, particularly the means of spanning the roof, is of primary concern.

29. An "open system" for industrial building would, therefore, be based on establishing the performance and dimensional requirements for a structural frame designed to allow the use of a traditional or indigenous type for the external envelope and internal divisions. To develop an "open system" for industrial building, the following steps need to be taken:

(a) Quantify available resources:

Materials; local and importable
Labour resources and craft skills
Level of management resources
Quality of building organizations, supervision,
Quality control
Staffing needs;

(b) Establish performance and user requirements.

30. With the exception of special types of industrial processes requiring the building envelope to be closely tailored to the machinery and process housed, a large number of industrial processes can be accommodated in building envelopes of standard type and structural bay dimension. To establish performance and user requirements, a methodology can be developed. For performance standards of the components, this could take the form of a check list based on the work of ISO. The check list would include such items as wind loading, daylighting, glare, insulation, condensation, rainwater and iron protection. Guide standards could be established for each of these performance requirements, but since many may need to be related to local conditions (e.g. climatic conditions) expert help and assistance from UNIDO would be needed in the country concerned.

31. Similarly, user requirements to establish bay width of structure, access, type and form of ancilliary accommodation could be formulated in the same way. Again guidance standards for some could be recommended providing that the industrial process to be housed in the building envelope was based on a technology acquired from developed countries and planning or spatial requirements would, therefore, be at least similar.

III. DIMENSIONAL CO-ORDINATION, STANDARDIZATION AND TYPIFICATION

Dimensional co-ordination and standardization

32. The prerequisites of industrialisation are dimensional or modular co-ordination and standardization. A number of national and international organizations, as well as ISO (International Standards Organization), deal with standardization, but very often the standards in building and construction vary from one agency to another, even in one country. In countries without official standardization, different foreign standards are used from job to job.

33. It seems that the best way to enforce standardization is by ensuring that the Government as the major client of the local building industry gives a positive lead.

34. A complete standardization in building and construction should include:

(a) Building materials;

(b) Building components including prefabricated elements;

(c) Industrial products used in building construction;

(d) Design criteria and methods of calculating foundations, structural safety against static and dynamic loads, earthquake engineering, building installations, concrete, steel and timber construction;

(e) Physical properties of building such as sound and thermal insulation, humidity control, water-proofing and fire resistance;

(f) Methods and procedures for testing building materials, components and prefabricated elements used in building construction;

(g) Methods and procedures of quality control during construction and regular maintenance of completed work.

35. The task of standardization is a permanent one, but a relatively small number of standards may bring large benefits, both technical and economical.

36. The beginning of standardization work in regard to the industrialization of construction should include:

(a) some basic rules on dimensional or modular co-ordination;

(b) Analysis of basic building materials including burnt-clay products, cement blocks, stone and aggregates, timber, lime, cement and steel reinforcement;

(c) Design criteria for foundations, structures, concrete and timber construction;

(d) Site safety and welfare.

37. If it is not possible to make local standards, the adoption of recognized international or foreign standards, eventually with some corrections corresponding to local circumstances, is an acceptable procedure.

38. The process of making standards usually encompasses:

(a) Making a survey of the properties from materials or products produced country-wide which will be standardized;

(b) Getting acquainted with international or recognised foreign standards;

(c) Drafting proposals of standards;

(d) Country-wide discussion about the proposed draft between producers, designers, research and construction people;

(e) Drafting the definitive text;

(f) Adopting the standard.

The organisation concerned with making standards should have an advisory body for the purpose of planning and supervising the activities of standardisation. The adoption of a standard should be done by a not too large expert group formed from qualified representatives from among producers, designers, research and construction people.

40. The drafting of the proposal for a standard may be done by an expert working group that is fairly small in size.

41. Professional engineers, producers and contractors associations should be fully involved in all bodies concerned with the planning, making and adoption of standards.

Typification

42. In industrial building it is possible to design and construct (with typified elements) a reasonably large set of different structures.

43. The technical document stating the forms, dimensions and properties of typified prefabricated building elements or components is the catalogue.

44. For example, a catalogue for prefabricated industrial concrete structures should contain:

(a) The general principles of design, production and storage of elements as well as the construction (assembling) of buildings;

(b) The systematization of spans, lengths and heights which could be achieved in the building;

(c) Drawings of typical sections of the building showing possibilities of combining individual sections to produce larger building units;

(d) Detailed drawings and specifications of various typified elements including columns, beams, frames, roof and cladding elements;

(e) Detailed drawings of joints and connections;

(f) Detailed drawings and specifications for building components such as windows, doors and dividing walls;

(g) Detailed drawings and instructions for the finishing of the building (floors, waterproofing, painting etc.);

(h) Detailed drawings and specifications for the installation of plumbing, electricity, ventilation and other services.

46. For the local conditions in which the production is expected to be run, this catalogue should be followed by a production technology proposal including suggestions for the use of suitable plant to erect the structure.

46. This catalogue might lead to the production of a prospectus showing the elementary possibilities of such a typified system. This prospectus could incorporate parts of the catalogue but should not be accepted as a catalogue.

47. In many countries there is a wide variety of industrialised building systems. Some of them could, with proper adaptation, be used in other countries. Direct transplantation without direct adaptation usually leads to very serious complications, often combined with substantial economic losses for the buyer.

IV. CONSTRUCTION COMPONENTS AND MATERIALS

48. Two thirds of the population of developing countries live in the tropical zone. Developing efforts should thus be concentrated on materials and conceptions suitable in this zone. (If the hot zone is also included, the study will cover almost all the people living in developing countries).

49. In Africa, for example, about 60 per cent (in some States as much as 80 per cent) of the building materials are imported.

50. In choosing building materials, priority should be given to those locally available. The natural resources of the country should be capitalised, instead of importing expensive foreign substitutes.

51. In most developing countries, there is a lack or scarcity of local steel and cement manufacturing facilities which are needed for the factory building in the first place. The limited stock of rolled steel and sheet metal are needed in other fields. Construction industry has to reckon with rolled bars of lower quality. Meanwhile, should cement production stay below a suitable level, in most countries there is enough raw material to raise the output.

52. The insufficiency of timber for the construction industry is world-wide and increasing. The international market price of lumber rises constantly; this is one of the factors leading to prefabrication.

53. Whereas reinforced concrete is the principal material for load-bearing structures of industrial dwellings (frames, columns, beams, roof slabs), traditional and newly developed local building materials should be considered for other parts of the building, such as external non-bearing walls, partitions and floors. Stabilised clay, laterite, industrial and agricultural wastes are to be mentioned.

54. The small-scale production of main building materials such as cement, rolled steel, glass and some others is uneconomical.

55. Developing countries should increase the manufacture of these building materials more profitably, co-operating in their production on a subregional basis.

56. To optimise the investment in foreign building products, these should help to increase the quality or increase the length of life of domestic building materials (i.e. good aluminium roofing protects the

structure, arsenic salt treatment to improve the resistance of wood, as arsenic is almost free etc.).

57. A survey of the locally available building materials should be undertaken by governments. This could be carried out by one of the departments of administration (e.g. Ministry of Industry or Public Works, Major Projects Administration, Ministry of Planning etc.). Data on both technical and financial aspects should be collected and analysed.

58. A survey of the resources hitherto not sufficiently utilised for the production of building materials should be undertaken, possibly by some government department already existing (geological and mineralogical services), or by one that could be organised. The assistance of the United Nations could be requested.

59. The trend in developed countries in industrial fabrication of building materials has been to produce units with ever-increasing production capacity. This implies high demands on the infrastructure and logistic co-ordination, not to mention the most important point; that there must be a demand for the product.

60. Most developing countries have a capacity for research and development work on local building materials in their technical faculties, technological institutes, technical schools, research and development centres etc. Some of these institutions have recently been established, quite often with bilateral or international aid. Research work should be a part of their activity, and topics should be chosen in accordance with the development plans of the country, on the basis of experience already gained in developed countries.

61. Traditional building materials (bricks etc.) will prevail for a considerable time in industrial construction. However, the use of light prefabricated reinforced construction components (beams, lintels, doors and window frames) in connexion with traditional masonry can accelerate and facilitate the development of this sector.

V. MAINTENANCE OF INDUSTRIAL STRUCTURE

62. Even though new construction forms a major quantum, the upkeep and maintenance of existing structures is important in the over-all economy and development of a country. Maintenance techniques and the materials used for maintenance are often quite different from those used in normal construction. The maintenance personnel have to be all-rounders to understand the implications and make the maintenance work economical and effective. The training of personnel, methods employed, material used, scheduling and programming maintenance all need great planning and training. The experience of various countries in such special cases of repairs will be of great value.

63. For many developing countries where industries possess rather new dwellings, the problem of their maintenance does not yet exist. However, developing countries should be ready to solve this problem.

64. More often the developing countries have to reconstruct existing industrial buildings to meet the requirements of greater production or changes in technological processes. In this case the construction has specific features since contractors must build at the factories.

VI. CONSTRUCTION PLANT AND EQUIPMENT

65. In most countries industrialisation or mechanisation of construction comes about through the introduction of imported equipment. There are any number of different makes and capacities of plants that have been introduced in developing countries from abroad through aid or loans. Each make or type of different technological development needs different spare parts, lubricants etc. The availability and utilisation of equipment is thus poor. Even new equipment is seen idling for want of imported spares involving heavy foreign exchange. Of late, many developing countries have become self-sufficient in construction equipment, except possibly for some sophisticated and special equipment which is cheaper to import than to manufacture locally. A developing country that intends to manufacture its own construction equipment progressively should select only equipment which can be fully utilised or for which there is a ready outside market and for which technology could be easily developed.

66. Many developed countries which may have undergone this exercise will benefit by exchanging their experiences. A developing country could evolve the most suitable plant and exchange it with a neighbouring country in the region. This would help build up expertise and make large-scale production possible, economical and worthwhile.

67. For the mechanisation of industrial construction, the high capacity earth-moving machines and mounting truck-cranes are most important.

68. Particular attention should be given to the special vehicles for the transportation of heavy structural elements of industrial buildings.

VII. IMPLEMENTATION AND CONSTRUCTION OF INDUSTRIAL PROJECTS

69. If it is accepted that the designer has a key function in the transfer of construction technology, it must also be noted that the implementation of this technology depends on the skills and experience of the contracting sector. Unfortunately, the indigenous construction firms in developing countries often find it difficult to recruit sufficiently high-level manpower to match their growing responsibilities. Among the specialized functions required within a firm of building and civil engineering contractors are:

- Estimating
- Planning and programming
- Purchasing
- Plant management
- Site supervision
- Personnel management
- Preparation of interim and final accounts
- Accounting and financial control
- Office organization

70. A large international contractor would arrange for these various functions to be carried out by separate departments manned by experienced specialists. But the smaller local contractor must rely on his own resources to a much greater extent, and is often insufficiently experienced even to appreciate and evaluate the worth of external specialist services.

71. A further factor is the enormous range of size and type of construction agency, making the co-ordination and organization of the industry a particularly difficult task.

72. Assistance to the participants should be available in written form and in the form of experts/consultants. It is suggested that the functions of each participant be identified and serve as a basis for the organization of the information and expert/consultant services.

The participants involved in the implementation and construction of industrial projects are:

Client
Designer
Financing agency
Regulating agency
Building supplier

73. The following is an outline of their functions.

I. Owner/Client

A. Determines requirements for the project

1. Definition (statement of project objectives)
2. Scope (determination of things to be included)
3. Time constraints (phasings as well as deadlines)
4. Priorities (functional and political)
5. Standards of construction (degree of austerity)

B. Determines value/worth of industrial construction to his organizational objectives

C. Selects design(er)

1. Designer's experience in similar work
2. Sensitivity to local conditions
   (a) Available building standards
   (b) Available building materials/methods
   (c) Available building trades and level of skill
   (d) Social/cultural sensitivities
3. Current work load
4. Probability of meeting required design completion date
5. Method of evaluating potential designers
6. Designer's assessment of producing a design that can be built for budget

D. Selects site

1. Industrial constraints
2. Construction constraints

(a) Design related

(i) Access to water, power/fuel, waste disposal

(ii) Topographical features (growth, wind, drainage)

(iii) Sub-surface characteristics, soil conditions, water table, rock

(iv) Flood potential or other natural disaster

(v) Access to transportation system/network

(b) Construction related

(i) Availability of materials, labour, site access; water table and drainage during construction

(ii) Available finances

(iii) Available equipment (pumps, trucks, cranes)

E. Arranges for financial assistance for industrial complex

1. Prepares financial statement

(a) Current

(b) Project

2. Determines period payment on "loan" principle

3. Establishes terms of financial assistance

(a) Duration

(b) Interest

4. Identifies sources of financial assistance

(a) Foreign investment

(b) Sale of paper in foreign/domestic security market

(c) International bank

(d) Foreign/domestic government

(e) UNDP/AGIDO

5. Applies for loan

6. Obtains insurance on physical plant of industrial complex

(a) Gets appraisal of property replacement value

(b) Identifies sources of insurance

(c) Makes application for insurance

F. Approves work of designer

1. Establishes points for review of design
2. Determines criteria by which review will be made
3. Reviews the design
4. Recommends required changes
5. Approves work

G. Accepts work of constructor

1. Determines inspection frequency
2. Establishes criteria for inspection
3. Makes periodic inspection
4. Analyses test results
5. Accepts/rejects work

II. Designer

A. Determines the user's functional requirements

1. User/client/owner states his requirements in terms of potential qualities
   (a) Processes to be housed (storage, assembly, manufacturing process)
   (b) Qualitative/quantitative requirements
      (i) Room temperature
      (ii) Requirements for utilities (noise, vibration, light)
      (iii) Interrelationship of material flow, information flow, human traffic patterns

2. Translates the user's functional requirements into design requirements
   (a) Establishes each space type
   (b) Determines the required spatial dimensions
   (c) Conducts spatial proximity analysis and locates each space type in complex of facilities
   (d) Determines amount and location of services (power, water, air flow, heat/ventilation)

B. Component design/material selection

1. Identifies the type of constraints listed in I.B.2. above, i.e., construction constraints
2. Determines impact on material selection and dimensioning of components

(a) Impact of constraints on physical properties of materials and components

(i) Length, width, thickness

(ii) Weight

(b) Interaction between material properties and component design and level of construction technology

3. Decides on prefabrication/industrialization

(a) Determines modular co-ordination standardization

(b) Available materials

(c) Available skill/equipment/on site erection

(d) On-site vs. off-site fabrication

(e) Transportation facilities capability

(i) Mobile equipment

(ii) Roadway (train, automotive, barge) constraints

(f) Type of joint required on site

4. Interprets locally applicable regulatory standards (codes)

(a) Building design codes

(b) Safety code

(i) Occupational/health standards for occupants of industrial complex

(ii) Use of materials that have safe procedures for their placement in the facility

(c) Environmental impact

(i) In the design (sees that industrial processes have an acceptable impact on the environment)

(ii) In the construction of the facility (selects materials and components that have an acceptable impact on the environment while in the course of construction)

(d) Translates the locally applicable codes into construction specifications

(i) Control of construction processes

(ii) Establishes a basis for quality assurance and therefore quality control

(e) Impact on design

5. Advises the owner/client on status of design

(a) Per cent complete

(b) Estimated cost of construction of industrial complex

III. Financial sector

A. Solicits projects for financing
   1. Determines acceptable threshold
   2. Identifies types of industries that are acceptable
   3. Identifies acceptable geographical/economic/political/social systems that are acceptable
   4. Identifies potential owner/clients

B. Solicits investment sources
   1. Determines value of investment acceptable (interest)
   2. Identifies sources of investment capital
      (i) Other financial institutions
      (ii) Private investors
      (iii) National governments
      (iv) International agencies
   3. Establishes acceptable limits of constraints on investment capital
      (i) Duration
      (ii) Interest
      (iii) Minimum amounts
      (iv) To whom it may be lent

C. Investment control
   1. Establishes limits (constraints) on investments
   2. Monitors time payments from those who have made loans
      (i) Principal
      (ii) Interest

IV. Regulating agencies

A. Establish qualitative standards for industrial facilities
   1. Safety } occupational
   2. Health }
   3. Environmental impact
      (i) Air effluent
      (ii) Water effluent
      (iii) Impaction terrain (drainage etc.)
   4. Testing

B. Establish quantitative standards for individual construction
   1. Material quality, minimum acceptable values of physical properties

2. Methods of testing based on
   (i) Time constraints
   (ii) Educational/skill qualifications of personnel required to perform test
   (iii) Construction methods, standards of workmanship

C. Establish testing laboratories
   1. On-site testing programmes
   2. Material/product certification

D. Develop authority to enforce adherence to regulations, codes, specifications

E. Establish component modularity, standardization and dimensional co-ordination

V. Building suppliers

A. Identify standardized elements/units of measure
   1. Aggregates
   2. Thin building materials
   3. Structural elements (sizes, dimension, shapes, properties)
      (a) Beams
      (b) Columns
      (c) Panels
   4. Architectural elements
      (a) Doors/door panels
      (b) Windows/window panels/frames
      (c) Claddings
      (d) Partitions
   5. Technical structures

B. Determine demand for products
   1. Short-term/project
   2. Long-term, 2-3 years
   3. Determine intermediate storage requirements

C. Establish delivery system for materials from source to site
   1. Determine the scheme of transportation
   2. Identify modes of transportation available

D. Establish marketing information distribution system

1. Determine categories/groups of materials
2. Establish format for information
3. Determine characteristics/properties of materials and/or components that require distribution
4. Establish means of certifying information
5. Determine frequency of periodic update of information and its certification

VIII. TECHNOLOGY OF THE CONSTRUCTION OF LARGE INDUSTRIAL PLANTS AND PREFABRICATED INDUSTRIAL STRUCTURES

74. Characteristic features of the industrialisation of construction are:

(a) The wide use of standardized prefabricated elements and components, industrially produced at plants;

(b) The full mechanisation of all construction processes on site using automation;

(c) The introduction of construction techniques, advanced technology and line methods in the organisation of construction work and assembly operations.

75. In the first stage of development of construction as an industry, all the operations concerned with the treatment of materials and the manufacture of structures and elements of buildings, such as floors, roofs, partitions, stairs, windows and doors are manufactured on construction sites. When construction is carried out by industrial methods, most bulky elements are manufactured at specialised industrial plants using mechanisation and automation for the main production processes. The construction site is then an assembly place for the mounting of ready-made elements with the extensive use of high-capacity cranes and other high-productive machinery.

76. Industrialisation of the construction may reduce the influence of climatic conditions on the work.

77. The main requirements needed for the industrialisation of construction are:

(a) The wide development of prefabrication;

(b) Unification and typification of buildings and dwellings;

(c) Mechanisation and automation of construction work;

(d) Introduction of progressive technology and advanced methods of organisation of construction firms.

78. The development of mass production of prefabrication elements and the progress in the development of prefabrication construction itself depends significantly on the degree of typification and unification of buildings. The wide application of typified projects, unified elements and components opens the possibility of introducing industrial methods of construction. The industrialisation of construction is closely linked with full mechanisation and automation of construction works and assembly operations.

79. Mechanization and automation change the character of construction work and create the conditions for the growth of labour productivity and the reduction of construction time.

80. Industrialization in construction requires the specialisation of construction firms and enterprises. In specialized firms ..e builders can better use the modern high-capacity machines and equipment. Development of industrialization in the construction sector requires the introduction of modern technology and advanced methods of organisation of construction processes. Implementation of any construction project calls for the detailed elaboration of appropriate technology and the programming of the construction before work on-site begins.

81. The growth in production of prefabricated elements permits their use in all types of construction. In recent times, prefabricated reinforced concrete elements were not used for the construction of such industrial projects as blast furnaces, coking plants, foundries and long-span bridges.

82. Precast concrete is now successfully used even in mining, replacing the traditional wood structures underground and bricks in pit-head buildings.

83. There are good prospects for the use of concrete blocks, panels and other elements in agricultural construction. The application of reinforced concrete sleepers and tunnel liningscan have a major economic effect on transport construction.

84. Development of the production of prefabricated reinforced concrete elements has two stages. At the early stage the production of the elements is organised on construction sites with wide use of manual labour. At a later stage, production of prefabricated reinforced concrete elements and components can be concentrated at specialized plants.

85. The trend in development of different kinds of prefabrication production in developing countries starts at the lowest level and goes through intermediate stages with various combinations of proportions (on-site production and plant production) until it eventually reaches the uppermost level. The mass production of prefabrications requires the specialisation of plants permitting the introduction of mechanisation and automation of most operations.

86. For reasons of economy, the minimum production capacity of prefabrication plants for industrial construction should be no less than 60,000 to 90,000 m^2 a year.

87. In this connexion, the economical approach sometimes requires the establishment of bilateral and multilateral co-operation among developing countries in the field of production, construction of building materials and components on the basis of interregional projects.

88. Particular attention should be paid to the design of prefabricated elements. The experience gained in the application of prefabrication shows that the further development of such elements follows the following main trends:

(a) Enlargement of elements with relative reduction of their weight;

(b) Unification;

(c) Improvement of quality.

89. The use of high-capacity cranes on construction sites makes it possible to raise the dimensions of elements significantly. There is a trend that weight of components for assembly operations on site, especially in industrial building, increases from year to year.

90. In this connexion the working papers of the international symposium of thin plates and sandwich panels in the building industry, conducted by the International Council for Building Research Studies and Documentation (CIB) in Linz, Austria, from 4 to 7 June 1973, in whose work UNIDO has assisted, might be considered by developing countries in the development of prefabrication.

91. The further performance of prefabrications will lead to the larger application of light structures based on aluminium, plastics and other modern materials. It should be recognised that the application of such modern materials as plastics makes it possible to increase considerably the factory readiness of prefabrications and to reduce substantially the labour-intensive operations on construction sites.

92. The growth of the fleet of construction machines and their modifications is very important for the further development of mechanization in construction.

93. The development of the application of technology to construction requires that the performance of construction machines and equipment conform with changes in construction technology.

94. With the rapid development of the application of prefabrications on construction sites, the weight of mounting elements tends to increase, requiring cranes as the main equipment for assembly operations.

95. Particular attention should be paid to the introduction of advanced methods of management in construction with the application of some types of accounting techniques for automatic control and the provision of working documents.

96. An increase in the mechanisation of construction processes is ensured not only by the application of high-capacity machines and equipment, but also by the better use of available techniques.

97. The effectiveness of using construction techniques depends on the proper combination of sets of needed machines and equipment, specialisation and construction work, the availability of repair shops for the right technical exploitation of machines, and skilled technicians.

IX. TRANSFER OF CONSTRUCTION KNOWLEDGE

98. In many developing countries there are no construction firms or contractors who are capable of industrial construction. Many firms or contractors are real-estate speculators rather than contractors. Most firms are family-owned or one-man enterprises. There are no business organizations, and no technical personnel is employed or encouraged. The smaller firms in developing countries need the know-how for construction techniques and management.

99. The guidelines for transfer of know-how could be concerned with how to develop a proper attitude in industrial construction towards the aims of business, how to secure business, how to shape the future, how to build good relationships with subcontractors, clients, owners, government, labour, financial institutes etc.

100. Construction is a business that must be pursued primarily through proper bidding. Thus, bidding for work needs careful study in terms of the contract, site investigation, quantity survey, pricing, work planning, manpower, plant and equipment organization, turn-out efficiencies, productivity, financing etc.

101. Since construction is work executed through written contracts, the type of contract - its implications, general conditions, special conditions, obligations on the part of the owner and the contractor, arbitration and other connected clauses, escalation etc. - needs careful attention. As most of the developed countries have passed through different stages of contracting and contract conditions and have arrived at current practice after much experience and legal battles, the developing countries should be given guidance so that the pitfalls may not be repeated and time wasted.

102. Once the bid is accepted and work is secured the next area of activity is the organization of work. In this phase, such matters as job-planning, organizing different stages of construction, subcontracting, recruiting labour and deciding whether to buy a machine or hire it need examination. The reporting, costing, financing, relationship with the owner's supervision etc. are other areas in which past experience will be of great help in the proper execution of the work and in profits.

103. It should be noted that transfer of know-how between developing countries may be as valuable as, perhaps more valuable than, transfer from developed countries. The criterion in each case is whether one country can contribute expertise to the other. If the level of development of the two countries is similar, the transfer of expertise will be facilitated. To achieve this goal, the following steps should be undertaken:

(a) A directory of suitable contractors in industrial and developing countries should be compiled and published. The capacity and experience of each contractor should be described and the names of references should be included;

(b) A list of countries wishing to engage contractors for projects leading to transfer of know-how should also be compiled. The types of project likely to be undertaken should be described and some indication given of the amount of work likely to be assigned to foreign contractors within the next five years;

(c) Guidance should be given on the ways in which contracts should be undertaken. Such guidance should include advice on the contract provisions ensuring that local nationals shall be fully involved in the project;

(d) The local nationals who will be involved should receive guidance on which processes to observe and on how to ensure their genuine participation in the work. Short training courses could augment and reinforce the learning process.

(e) The provisions of the contract should allow organizations rendering assistance to make a case study of the operation of the contract for use in drawing up future projects.

104. It should be noted that the general method for the transfer of know-how, which is outlined in this section, can be adopted in situations in which foreign contractors have not been appointed. Training as described in programme II (annex III) will then apply.

Directory of contractors

105. The cost of producing a directory of contractors could be quite small if each country were asked to produce its own list. Opposite the name of each contractor the following information should be shown:

(a) Name of organization, address, telephone number, telex;

(b) Name of man to contact or his function (e.g. marketing director);

(c) Annual turnover in last five years in a single prescribed currency;

(d) Type of project undertaken;

(e) Nature of services offered, e.g. design and build, build only, management contracting;

(f) Location of offices outside the country of the head office;

(g) Brief description of three foreign contracts completed in the last 10 years;

(h) Names and addresses of three client organizations to whom reference may be made.

List of agencies within developing countries

106. This list should provide guidance for contractors as to which agencies in developing countries may place work suitable for their operations. The information on each agency should therefore include the following:

(a) Address of the office, telephone and telex numbers and the name or designation of the person to whom inquiries should be sent in the first instance;

(b) Approximate indication of what contracts may be let to foreign contractors in the next five years. This should include an indication of the type of work and its likely cost;

(c) Whether contracts are likely to be let for design and build, build only or for construction management only;

(d) Any restrictions on the nature of the contractor's method of working, e.g. that a foreign company would have to establish a partnership with a local company and that this partnership would enter into the contract for the work;

(e) Any limitations on the purchase of materials or equipment, e.g. that cement must be purchased from a specified country or manufacturer;

(f) Any limitations on the repatriation of profit.

107. Before compiling this list, it would be useful to discuss its format with reputable foreign contractors currently working in developing countries. The more carefully the information is compiled, the fewer will be the abortive attempts to establish suitable contracts.

Guidance to promising entrepreneurs

108. A review should be undertaken of projects in which UNIDO has recently been involved. The achievements of these projects should be compared rigorously with the original objectives, and any failings should be noted. The reasons for any failings observed should be diagnosed.

109. The foregoing review should be used as the basis for compiling a set of guidelines for developing countries on their use of foreign contractors. Such guidelines should include draft forms of contracts incorporating specific requirements for the responsible parties. Contracting should take two forms, namely direct employment of individuals and the engagement of local subcontractors.

110. The pitfalls involved in the engagement of foreign contractors should be itemized and explained. Guidance should be given on the planning and control of the work of the client to provide the

possibility of efficient working by the contractor. The client should be encouraged to seek advice on whether his own programming and control is adequate and the sources of such advice should be indicated (e.g. United Nations agencies and private consultants). Where the control arrangements are judged inadequate, the client should be advised either to engage a consultant to make good the shortcoming or to allow the foreign contractor to include the client's activities and decision-timing within his own plan of work. It should be emphasized that failure to respond to the subsequent expediting (based on the detailed programme of work) would jeopardize the outcome of the project both in regard to time and cost.

111. Where package deal contracts are adopted (e.g. the combination of design and construction) the evaluation of alternative contractors presents difficulties. Moreover, the contractual conditions offered by the contractor may be weighted unreasonably in his own favour. Again the client should be encouraged to seek advice.

112. The use of management contracts should be explained and their adoption encouraged in suitable circumstances.

[illegible] guidance for individual local nationals

113. Know-how will be transferred through local nationals. It is essential therefore that they be informed about the main points to watch and assimilate. There a document (or alternative documents) should be compiled setting out key points. These would include

(a) The ways by which the contractor decides on his construction methods

(b) The development of the construction method in detail;

(c) Processing all the stages and key events in the contract, including the procurement of materials;

(d) The programming of the project, the monitoring of work against the programme and the distribution of control reports;

(e) The ways by which the contractor ensures that the participants, including the client, respond to the control reports;

(f) The nature of the subcontracts, the selection and appointment of subcontractors and the way in which their work is controlled;

(g) The w[illegible] estimates and cost [illegible] re[illegible]

(h) The way [illegible] taken when adverse variances are revealed.

(Note: [illegible] control [illegible] in industrial countries is [illegible] control systems are very simple and the local national [illegible] these simple systems and to participate in their [illegible].)

114. Where practical, the learning process of the local national should be reinforced by [illegible] on-the-job training. Where funds permit, [illegible] assignments for a suitable expert should be arranged. The task would be to examine the existing situation and discuss his findings with the local national in the presence of a representative of the foreign contractor. It may be, for example, that the client's decision-making is not being expedited, but for reasons of diplomacy the pressure for action cannot be intensified. The local national should be made aware that this is an undesirable situation that should be avoided if possible on future projects.

115. A less expensive means of reinforcing the learning process would take the form of regional group discussions attended by the local nationals from several projects and led by an appointed expert. Such discussions should be seeded by brief papers setting out the main principles to be observed. The appointed expert should have the opportunity of studying the main aspects of each project, if only vicariously, to ensure that his introductory comments shall be relevant to the problems being encountered.

Observation of projects

116. While recognizing that UNIDO resources are limited in comparison with the total problem, every effort should be made to monitor projects undertaken on the basis advocated above. When on-the-job training is adopted along the lines suggested, the expert assigned should report his findings to UNIDO to supplement the case material. Failures should be identified and their reasons diagnosed.

117. Where regional group discussions are held, the expert leading the discussions should seek to identify the problems being experienced by the local nationals. The report of his findings should be submitted to UNIDO.

118. Developing countries can learn from other developing countries and from industrial countries. Joint involvement in a project can be an effective means of transferring know-how. Developing countries should be provided with names of suitable foreign contractors and with detailed guidance on the selection and appointment of a suitable company.

119. Guidance should also be given to the individuals from the developing countries to ensure that they shall profit from their involvement. Their learning process should be reinforced by in-plant training or problem-solving seminars. Key information on projects undertaken as suggested should be fed back to UNIDO for future reference.

X. PREFABRICATION OF INDUSTRIAL CONSTRUCTION

120. The trend in industrial building as in other types must inevitably be towards prefabrication of some or all of the components. Although a system of prefabrication may consist of only the structural frame and roof, it has to fit together with other building components which may not be part of the system of prefabrication. It is important, therefore, that a clear distinction be made between materials and components. A building component may be defined as a building material that has been processed to form a unit of finished size and shape. Bricks, blocks, windows, doors are therefore examples of prefabricated components. Clay, cement, lime are aggregate examples of building materials.

121. The ranges of standard components produced for other building categories are needed in considering the requirements of industrial building. In some cases the design and performance requirements may be wholly different; in others, the same components might be used.

122. Programmes to provide technical assistance and training for prefabrication are offered by UNIDO and are included here as annexes II - IV. Those programmes respond to the use of prefabrication in industrial construction.

Annex I

LIST OF PARTICIPANTS

Experts

Name and title	Address
E. CSORBA Consultant	Hungarian Institute for Building Science Pentafák 71 1502 Budapest Hungary
A. FLAŠAR Consultant	Institut za ispitivanje materijala SRS Bulevar Vojvode Mišića 43 11000 Beograd Yugoslavia
B.J. KUIPERS Consultant	Chief, Project Systems Branch Construction Engineering Research Laboratory Champaign, Illinois U.S.A.
J. LICHNER Consultant	Ministry of Building of the Slovak Socialist Republic Bratislava Czechoslovakia
A. LIEBERMAN Engineer	Polservice, Foreign Trade Enterprise Ul. Szpitalna 5 P.O.Box 335 00-950 Warszawa Poland
T. LIEBERT Director	Polservice, Foreign Trade Enterprise Ul. Szpitalna 5 P.O.Box 335 00-950 Warszawa Poland
A. LINDLE Civil Engineer	Franz Josefs Kai 31 1010 Vienna I Austria

D. MILES Consultant	Intermediate Technology Development Group Ltd. Parnell House 25 Wilton Road London SW1V 1JS United Kingdom
R.C. PURDEN Chief Executive, Architectural Division	NBA The National Building Agency NBA House, 7 Arundel Street London WC2R 3DE United Kingdom
A. NAGANTUSHANA RAU Deputy General Manager	The Hindustan Construction Co. Ltd. Construction House Walchand Hirachand Marg Ballard Estate Bombay 400 038 India
Y. TANOUT Consultant	40 avenue de Bellevue 92340 Bourg-la-Reine France
G. TRIMBLE Professor	University of Technology Loughborough, Leicestershire LE11 3TU United Kingdom

Observers

J. SOKOLSKI Consultant	Polservice, Foreign Trade Enterprise Ul. Szpitalna 5 P.O.Box 335 00-950 Warsaw Poland
A. TELIDAKIS Consultant	Economic Commission for Europe Environment and Housing Division Palais des Nations CH-1211 Geneva 10 Switzerland

UNIDO participants

H.H.A. HAMDY Director of the Meeting	Chief, Industrial Construction Unit Industrial Technology Division
M.M. JANJIĆ Industrial Development Officer	Industrial Construction Unit Industrial Technology Division
V.A.AVRAMENKO Industrial Development Officer	Industrial Construction Unit Industrial Technology Division

Annex II

PROGRAMME I

Identifying the present state of construction in developing countries

Subject

In order to provide effective technical assistance in the industrialization of the construction sector it is necessary to examine the present status and trends in the development of industry in the country.

Aims

To achieve this, UNIDO could assign a team of experts consisting at the least of an economist, a civil engineer, a mechanical engineer (construction tools and plant), a building materials engineer and an expert in construction management and training.

Any other specialists might be included in this team in each particular case if required. The team should be assigned to analyse and establish, consistent with socio-economic and other considerations prevalent in the country, the possibilities for construction activity.

Description of programme

The following main topics should be considered:

1. Definition of the present status of the production of building materials and components and the presence of raw materials available for the production of building materials and components. This work should consist of the following:

   (a) Collection of all information available on the subject from literature and previous surveys, if any;

   (b) Preparation of a programme for surveying the country by region if the territory is large enough;

   (c) Geological survey of raw materials hitherto not utilized for construction purposes, especially for the production of such main building materials as cement, lime, glass, gypsum. This survey should also gather the data on available raw materials used as aggregates for concrete and construction mortars.

2. Study of the present status and prospects for the development of the industrial construction sector, which should cover:

(a) A complete register of main companies dealing with industrial construction with the number of employed technical staff and workers; available construction equipment and machines and volume of work done in the last year; and proposals for the establishment of the most effective set-up of construction firms;

(b) Guidelines for the development of local industries whose end-products are used in the construction sector;

(c) Proposals for the improvement of financial rules in order to protect industrial project implementation.

3. Identification and specification of fields in which lateral assistance is needed and the estimated volume of assistance that may be necessary, including:

(a) The state of implementation of national plans for the development of the industrial construction sector;

(b) Proposals on the adaptation of these plans in accordance with over-all national plans of development;

(c) Estimation of needed resources for the implementation of the construction programmes and proposals, how to accumulate and use them with maximum result.

In each particular case other specific topics can be added.

Annex III

PROGRAMME II

Training construction specialists from developing countries

Objectives

The main purpose of this programme is to make it possible for professionals from developing countries to become familiar with the main principles of organization of the construction sector as well as new techniques and equipment used in modern construction.

The participants will have an opportunity to assess the advantages of different building systems and their applicability to local conditions. The training programme as a separate component exists in almost all technical assistance projects. However, training concerning particular tasks can be organized as an independent programme.

Description

All the possible training programmes concerning the construction sector of the economy can be combined in the three following groups:

1. Training of the decision makers and top-ranking officials of ministries, banking and planning institutions dealing with construction activity. Duration of such programme can be from two weeks to three months and would cover the following subjects:

(a) Main principles of organization of the construction sector in a country;

(b) Methodology of the formulation of the construction programme;

(c) Programme of training personnel for construction;

(d) Accounting of resources needed for the construction programme;

(e) Investment promotion for the construction sector.

2. Training professionals from research institutes, consultant firms and design teams. Duration of this programme can be from one to three months and would cover the following main topics:

(a) Organization of research work in the construction sector;

(b) Progress in laboratory-testing processes;

(c) Consultant services in construction;

(d) Standardisation and modular co-ordination in construction;

(e) Low-cost construction systems and their application in industrial buildings;

(f) Transfer of new construction technology;

(g) Construction economy.

3. Training of professionals including young engineers from construction companies and enterprises manufacturing building materials. Duration of the programme can be from one to six months, covering the following main aspects:

(a) Structural firms and specific character of the construction companies;

(b) Contracting systems;

(c) Organisation of the construction processes and building materials production;

(d) Management in construction;

(e) Mechanisation of the main construction work;

(f) Cost control and operation of contract;

(g) Organisation of training for skilled workers;

(h) Production and use of prefabricated elements of dwellings;

(i) Economic analyses of construction activity.

Types of training

The training described for three categories of specialists can be organised as: (a) individual programmes or (b) group training.

An individual programme is usually organised in a single developed country. The programme may include work and visits to the several government institutions, companies and research organisations dealing with specific problems which form the subject matter of the training.

Group training may be represented as follows:

(a) Workshop training (minimum 25 to 30 people);

(b) Seminar (minimum of 25 people);

(c) Expert group meeting (approximately 10-15 experts);

(d) In-plant or in-site training (approximately 20 persons);

(e) Joint consultation (minimum of 20 persons);

(f) Training school (more than 20 persons).

Each type of training can be organized either in developed or developing countries.

For the elaboration and implementation of the training programme it is necessary to send a request to UNIDO specifying the following main information:

(a) Number of professionals to be trained;

(b) Professional level;

(c) Working language;

(d) Duty station (preferred country);

(e) Main topics for the training;

(f) Proposed visits to firms, companies and construction sites;

(g) Duration of programme.

Annex IV

[illegible]

Technical assistance projects for the development of industrial construction

Objectives

UNIDO can provide technical assistance to the developing countries in setting up local construction firms and national companies producing prefabricated elements for buildings, building materials and components.

It is possible to improve the production capacity of projects on the establishment of new enterprises and plants or on the reconstruction or/and reorganization of existing ones. These projects may also be executed as pilot demonstration plants.

Description

Each technical assistance project executed by UNIDO to help the developing countries in the development of industrial construction could cover the following stages:

1. Feasibility study with determination of:
   (a) Existing needs;
   (b) Available resources;
   (c) Needed investments;
   (d) Development of substructure;
   (e) Corresponding methods and techniques;
   (f) Production structure;
   (g) Needed operating areas and production space;
   (h) Production facilities (type and size).

This part of the project requires approximately six months' work of a team of experts comprising a civil engineer, an industrial economist and a technologist on each specific branch of the industry.

2. Setting up pilot plants for the following stages:
   (a) Establishment of design criteria and construction techniques;
   (b) Production of design and production drawings, including costing data;

(c) Ordering material, scheduling delivery and stock piling;
(d) Arranging component supply, including manufacturing arrangements;
(e) Construction;
(f) Training programme;
(g) Feedback and improvement.

Duration of the second phase of the project depends on its character and volume. Practically, the phase lasts a minimum of 12 months. For the follow-up of tasks of the second phase of the project, the team of experts usually has to include civil and structural engineers, designers, technologists and managers as well as architects and specialists to organize the training.

3. Review of effectiveness of a project consisting of:

(a) Data collection requirements during project operations;
(b) Evaluation of results;
(c) Preparation of proposals for the improvement of project implementation;
(d) Preparation of proposals for further extension of projects on the basis of new requests, if any;
(e) Dissemination to other developing countries of experience and results gained in the process of execution of the project.

The phase of project implementation usually takes six months. The team of experts for the review should consist of construction economists, technologists and specialists in the field of data processing.

4. Centres for industrial construction in developing countries, with the main objectives of giving the host country or predetermined geographical region advisory services to support industrial construction in that country or region.

Scope of services for centre

Since the centre would be located in one developing country or would be designed to serve several countries in a region, the scope and therefore the organisation of the [illegible] offer. This implies that UNIDO would need a method of scaling the organisation of the centre to fit the particular scope of functions required. The need for scaling down the possible functions is brought about by the differing social/economic/political environment of the developing country or region.

Organisation of the centre

Similar to scope, the organisation of the centre would be highly dependent on the conditions surrounding the establishment of the centre, i.e., the particular form of the construction industry and the social/political/economic environment of the country or region to be served by the centre. Furthermore, the organisation would also depend on the scope and range of [illegible] provided by the particular centre. Thus, it would be important to be able to relate organisation to scope and scope to the environmental influences or else a general model of the centre could be constructed and tailored to fit the particular needs of each situation, thus reducing the total UNIDO effort required to establish these centres. However, this approach does greatly increase the UNIDO effort at the beginning of the implementation programme. It is safe to say that the centre should be functionally organised in two primary divisions: (a) technical/professional disciplines and (b) administrative services and support; the latter would support the activities of the former. It is further proposed that the technical/professional disciplines be organised according to the functions of those they would be servicing. This is suggested since the technical and scientific training of the participants as well as their experience is often along paths similar to other participants of the same functional category and dissimilar to participants of one of the other categories. The organisation of the administrative services and support would be typical of groups of this type in other organisations and would be highly dependent on the range of services provided by the technical/professional disciplines of the centre.

Location of the centre

UNIDO has two tasks related to the location of each centre. First, the geographical boundaries of the territory to be serviced by each centre must be determined. Secondly, the specific location of the centre must be decided within the geographical territory being serviced. In setting the geographical boundaries, UNIDO must consider such factors as homogeneity within the industrial construction to be serviced by the centre, social/political/economic similarities within the territorial boundary, similarity of problems to be addressed, over-all efficiency of the system of centres located throughout the developing countries and available financial support. The location of the centre within the region to be served would depend on: proximity to dependable air and ground transportation, availability of communication systems (telephone, telegraph, mail etc.), proximity to centre of projected construction activity in the region, availability of support services such as office supply service, copying and printing service, and availability of sufficient quarters for the centre and housing for the staff.

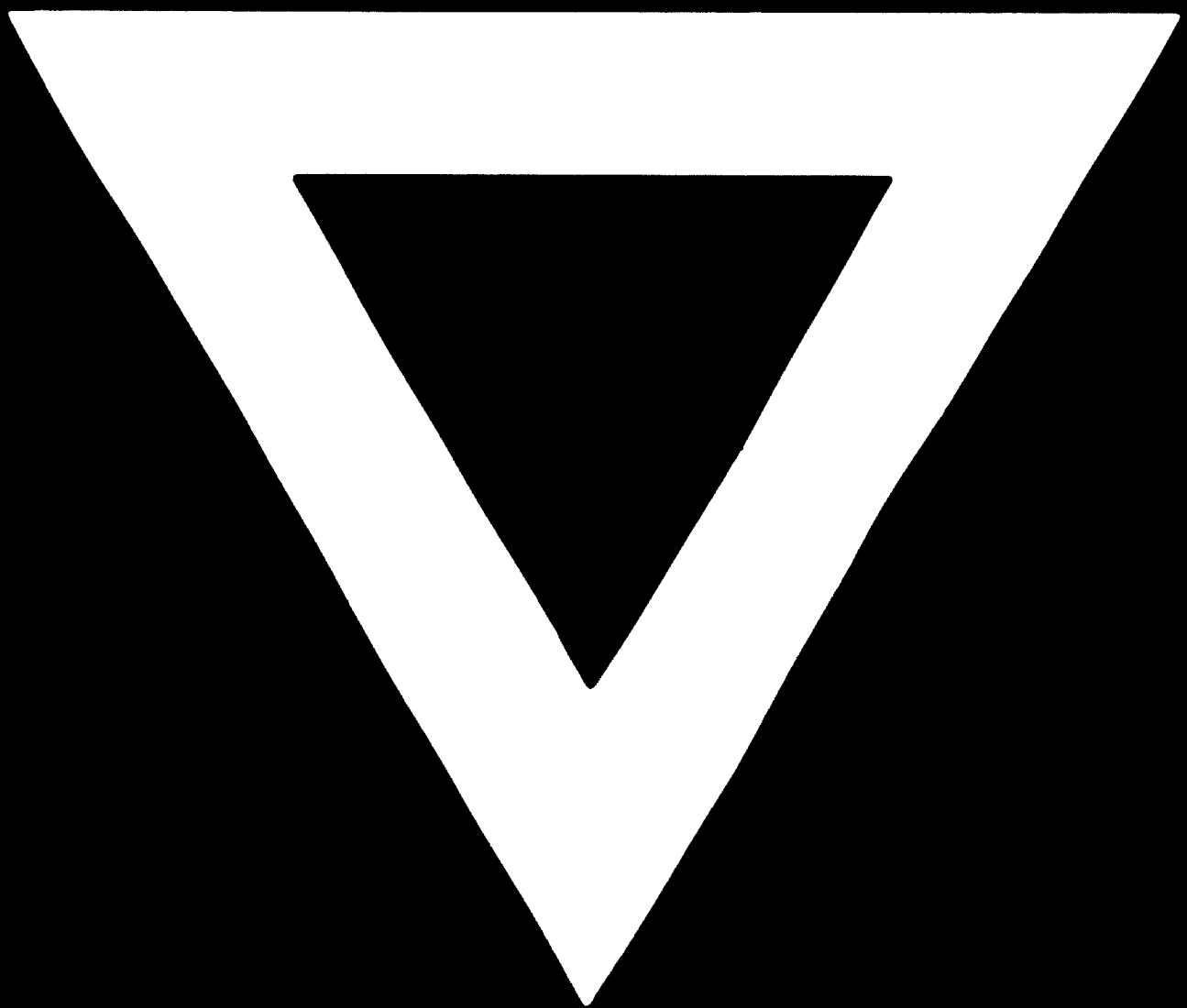
Staffing the centre

This aspect of the project is probably the most crucial of all. Of course the number of staff present in any one centre is dependent on the scope and range of functions for which the centre has been organized. Certainly, positions in the technical sections must be staffed by those trained in the corresponding functions. Furthermore, the managers of these sections must have actual experience in their fields of specialization in developing countries. Other staff sources could be appropriately matched staff from university and technical staff in both industrial and developing countries. It is most important to recruit the administrative services and support staff from the territory serviced by the centre.

Funding the centre

The initial support for the centre will have to be from UNIDO with the host country contributing as much as it can. However, since several studies of a more general nature are relevant to all subsequent centres,

these should be funded primarily by UNIDO. Direct implementation costs (staff, quarters, operating costs, etc.) should be primarily from the countries to be served. Eventually, charges for the services rendered by each centre should make the centre sustaining. This last recommendation is based on the fact that the industrial construction industry even in developing countries is profit-motivated and competitive and therefore should be able and willing to support requests for assistance.



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