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# AN OUTLINE FOR A CLASSIFICATION THEORY AND ITS APPLICATION IN THE FIELD OF BUILDING

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# TABLE OF CONTENTS


| | Pages |
|---|---|
| Basic assumptions ..... | 1 - 2 |
| Terminology used ..... | 3 |
| The scope of building classification ..... | 4 - 5 |
| Object classification and material operations ..... | 5 - 12 |
| Aspect classification and the imaginative and management operations ..... | 12 - 14 |
| Summary ..... | 14 - 15 |
| Fig.1 The line of material operations (pre-construction and construction) | 16 |
| Fig.2 The field of building and related fields | |
| Fig.3. The flow of information on building costs | |

APPENDICES

I. The SfB standard arrangement of works; (Main headings) (Sub-division of SfB lower case letters for material as appropriate)

II. Low cost housing. Cost break down according to CIB recommendation (the SfB system)

III. Aspects to be classified in building (draft outline)

# AN OUTLINE FOR A CLASSIFICATION THEORY AND ITS APPLICATION IN THE FIELD OF BUILDING 1/

## Basic assumptions

Classification is fundamentally an agreement on similarities and dissimilarities. To a certain extent classification depends on logic, but basically it depends on habit. People who communicate daily may agree easily on their habits, but they may well find it difficult to change habits in order to agree with foreigners.

Before we discuss any kind of theory on classification, thereofe, we have to answer the fundamental question: Do we want to agree? or do we each one for his group, play around with our habits trying to convince others that they should change theirs?

This paper assumes that there is a need for a building classification to promote international co-operation but that difficulties arising from differences in local building habits are substantial.

The theory present recognizes the necessity of leaving certain arrangements to individual choice. It is based on the assumption that macro-arrangements and micro-arrangements should not be included in international recommendations on classification.

By macro-arrangement is meant for instance the splitting of a collection of documents into libraries. This splitting may be done differently without changing basic classification concepts. A specialist normally wants to separate "my field" from "the rest". Certain facets may turn out to be important for macro-arrangement although they may not be suitable for international agreements on classification. In building this is especially true for facets such as "contract" (contractor) and "trade" (trade union way of classifying work). The human relation to any activity is most important in practice but entirely unsuited for international agreements on classification, because the splitting up in contracts and trades is irritatingly sensitive and very much bound to local tradition. Most builders no doubt macro-arrange their activities in contracts and trades although this way of arranging is not universal. This is the reason for avoiding macro-arrangement recommendations in classification for international co-operation.

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By micro-arrangement is meant the splitting up of a classified collection of information into smaller well identified units. Again this splitting is a necessity in specialized offices but mostly not universally agreeable. Take as an example the class "windows" in the facet "building elements". The need for further splitting of a collection of for instance trade catalogues on windows will be entirely different in an architects office in Kenya and an architects office in Sweden. Window is a universal concept suitable for classification but whether to subdivide according to number of panes for insulation, way of opening, materials used for window frames, suppliers, or any other locally conditioned way of specification, that must be agreed upon locally - not internationally. This is the reason for avoiding micro-arrangement recommendations in classification for international co-operation.

Classification for international co-operation thus will have to focus:

(a) a defined field of activity within which international co-operation is essential and feasible;

(b) those concepts within the field which may be universally understood and named.

The classification system as such is a selection of suitable concepts and an agreement on the grouping of these concepts into facets and facet-combinates.

The theory presented is illustrated by building classification. Building is defined as the process by which buildings (as distinguished from civil engineering works) are created. Building in this sense is a typical field of activity. The theory is based on the assumption that fields of activity may be considered as main classes in a universal classification of human activities. The background analysis for this assumption will not be presented in this paper.

Terminology used

A field of production activity, such as building, is known by the objects produced. In our field these are the buildings (houses, schools, hospitals, etc.) and the building elements (walls, floors, windows, etc.).

Building production activities are called construction. The construction total is the sum of numerous construction operations. The operators are workmen and machines. When a construction operation is finished the building products used have been transformed into construction works. The construction work, thus, is the end-result of a long series of operations from the extraction of materials from a natural resource to the building product finally made to a construction work. This series of operations has been called the line of material operations (Fig. 1).

Each construction work is defined by one main building product although secondary products may be included too. Brickwork is bricks (and mortar) after the final construction operation; bricklaying has been added.

Each building element is made of one or more works in much the same way as each building component is made of one or more constituent materials.[1/] A building element is dimensionally defined but work is a non-dimensional concept in the same way as a building component is dimensionally defined but constituent material is a non-dimensional concept. For example, a wall (dimensionally defined) may be made of brickwork, plaster work and paint work(non-dimensional concepts).

1/ For definition of building product, building components and constituent material see CIB, Report No.6 (reprinted in BUILD INTERNATIONAL Volume 2, No.4, May 1969, page 15).

The scope of building classification

In figure 2, the line of material operations is the horizontal line 1-5.

The building classification is focused on station 4, construction, although station 3, distribution of building products, and station 5, the building in use, are directly related; and from the wider view of dimensional co-ordination and standardization also station 2, manufacture of building products, is involved. Station 1, the extraction of raw materials from natural resources, is most important to developing countries.

All five stations supply information from experience to the imaginative level of building including research (studies) and documentation. From the documented ( or otherwise collected) knowledge, regulations (including standardization and legislation) and new design will benefit. There is a line of imaginative operations in each building project. The imaginative operations are those which lead to decisions, including also the act of decision (or agreement).

Between the imaginative level and the actual construction is the important level of the contractor's management. There is a line of management operations in each building project. The management operations are those which bring the decisions to realization by material operations (construction).

Both the imaginative operations and the management operations are considered to be service operations for the material operations resulting in buildings. The material operations are fundamental.

The imaginative operations and the management operations, which guide the extraction, manufacturing and distribution activities are not included in the field of activity called Building.

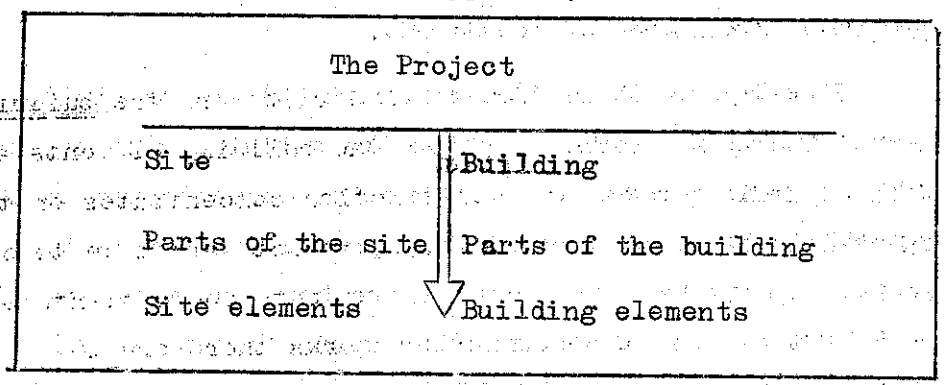
The owner's specific aspects of building, his administration, land acquisition and the related finance are considered as periferic items for building classification.

In figure 2 one border line for Building is cutting right through the research and documentation. This indicates that building classification must be considered as part of a more comprehensive classification relationship.

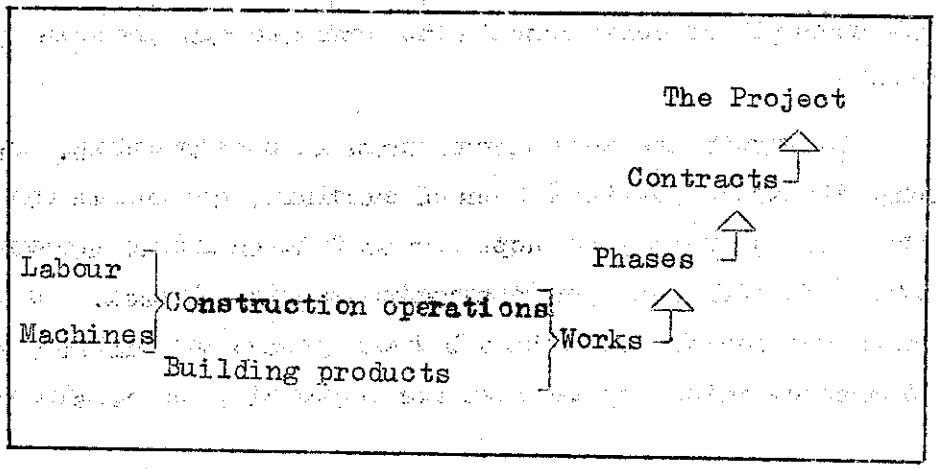
Object classification and material operations

Concentrating on an individual project we find two ways of approaching it:

(a) Analytically (the static approach)




(b) Synthetically (the dynamic approach)



The fundamental difference between these two approaches (a) and (b) is evident but not always observed in proposals for cost coding or other applications of building classification.

The objects to be focused under (a) are the building elements. Types of building elements have been listed for instance by SfB, but the identification of a specific element in a project requires not only the classification of type of element but also of its location. This is especially important in cost coding. The different parts of a project have to be numbered. This is normal project-classification; it must be done in each project separately; it must be provided for in a comprehensive system; but no general list of "parts of project" can be proposed for international (or even national) agreement. According to SfB a partition wall is (22). The coding of a partition wall in a building is for instance 162(22) where 162 is the relevant part of the project (the number of location).

The objects to be focused under (b) are the building products, constituting the works of which the building elements are made. The total dynamic process of construction concentrates on the construction operations by which the building products are made to construction works. Operations and products are both constituents of the works. A classification of construction works therefore will give a basic coding applicable both to products and to operations. This classification of construction works will automatically involve the concepts of contracts in the construction process and of their phases.

Contracts are well known units in construction. But there are many different possibilities of combining contracts for a project, and there is apparently no hope for an international agreement on a classification based on contracts as main classes. On the other hand there are certain relations between groups of building elements and contracts, which may be used for a grouping of construction works.

This is true especially for sanitary installations, central heating installations, ventilation installations, electrical installations, lifts, etc. Each one of these may be considered as a group of a certain type of building elements constituted by a certain type of works. In most cases these groups of building elements are being identified as sub-contracts or parts of sub-contracts. Without reference to contracts we may be able to agree internationally on three main categories of works:

Works; construction (proper)
Works; sanitary, heating and ventilation installations
Works; electrical installations

Accepting this main grouping of works related to defined groups of building elements we may proceed in our analysis of phases. Experience shows that the phases in building construction are defined by the construction proper. The proceeding of sanitary, heating and ventilation installations as well as the proceeding of electrical installations will have to follow the proceeding of the construction proper.

Construction works may be divided into site works and building works. The building works, especially, are in need of grouping in phases. The phases may not be strictly separated in time but they may be understandable as main groups of works for instance in the way they were conceived by SfB:

A Basic conditions
B Preliminary and general works
C Site works
D Building works
E/H Structural works
K/N Complementary works (insulation, roofing, etc.)
P/V Finishing works (plastering, flooring, painting, etc.)
X Installation works (prefabricated non-structural elements)

There may be other ways of grouping construction works according to phases in building but since SfB is the only classification system consistently built on the concept of works, this system has been used for illustration of the theory.

Appendix 1 is a list of main headings of works classified SfB and macro-arranged in contracts (the macro-arrangement is arbitrary).

The classification of work items is intimately linked to the cost aspect of building. Figure 3 illustrates the flow of cost information based on experience in construction. Intense discussions have taken place in order to find the best code by which expenditure types in the construction enterprise may be - with a minimum of effort - transformed into accurate knowledge of the cost carriers (building elements and works).

Many codes have been invented by the contractors themselves for their private use. There is, however, a legitimate request for the inclusion of a generally accepted code for cost analysis in the comprehensive building classification.

For better understanding of the cost consequences of decisions taken in the design stage of a building, there must be a feed-back of cost information from earlier projects. This feed-back calls for a direct relationship between the accounts for cost carriers in the construction stage and the design units described in specifications and bills of quantities (where applicable) and illustrated by drawings. A comprehensive building classification must take this relationship into account, which means that the classification must supply identical headings for specifications and for accounts of cost carriers. There is also the need for a simple method of transforming market prices of cost carriers into market prices of design units (walls and floors of different types, etc.). Any other use of cost information will have to follow the system thus developed.

In cost analysis the content of products in works (and elements) is not a major problem. Mostly the on-site price of any product can be fairly accurately fixed. The classification of products according to SfB (that is in relation to the resulting works) facilitates the cost accounting of the product price content in the work. The amount of each work in each building element is accurately known from drawings and specifications and needs no measuring in the construction process.

The operation (labour and machine) content of a work cannot be traced from drawings and specifications. For the full and accurate knowledge of the operation content of a work, the contractor's code has to be applied on the daily performance lists of workers and machines. Most contractors keep such lists and many of them do also apply their private coding on these lists.

SfB offers the possibility to unify the coding used by contractors and a standard list of headings to be used for specifications (and BQ where applicable). (Appendix 1).

Each main type of product may be handled in several ways. SfB foresees this but does not classify (for international use) the different possibilities. The micro-arrangement is left for individual choice.

The different possibilities of handling the same type of product may, according to SfB, be classified by point numbers following the classification of the type of product. Point numbers indicate detail specifications of works and may also - if wanted - include detail specifications of the products used. Point numbers are proposed to be added as needed in each project. It may be advantageous to agree on certain point numbers nationally but it is not recommended that point numbers be introduced for international agreement. The main condition for the use of point numbers is a clear definition of the meaning of each point number used, so that the conditions for any work price in a specific project is clarified.

Another statement may be important. Even if a work in one part of building may seem identical to the same work in another part of a building, the cost of the work may differ due to the location of the element built up by the work. This will not alter the classification (including the point number) of the work, but it demands an indication of location in the coding.

If the SfB system is used for coding of operations this means:

(a) That parts of the building (and the site) have to be adequately numbered in each project individually for location of elements and works.

(b) That SfB bracketed numbers are used for the identification of the type of the relevant building element.

(c) That SfB letters (capital and lower case letter + one figure if needed) are used for the identification of the type of construction work that results from the construction operation.

(d) That a point number is added (according to definition valid for the individual project) to specify in detail the character of the work, whenever appropriate.

The following code number may serve as an example:

26(21)Fg2.12

indicating:

(a) 26 = west wing sixth floor

(b) (21) = wall

(c) Fg2 = brickwork (= standard specification heading)

(d) .12 = defined type of brick in specified cement mortar
( = individual specification unit)

Appendix 2 is an illustration produced by the United Nations Economic Commission for Africa showing how the double breakdown in elements and works may be applied for the breakdown of the cost of African "low-cost houses". Principally this method may be used for any building.

Not regarding the specific way in which SfB solved the classification problem of the material line in building the theory of classification presented in this paper asks for:

One agreement on the classification of building elements unrelated to the works of which the elements are made.

One agreement on the classification of building products related to the construction works for which they are made; remembering that construction operations should be classified in the same way. It seems evident that both the material of which the product is made and other work characteristics of the product will have to be expressed by the classification.

The theory presented rejects independent classifications of products and operations since most construction operations in building are characterized by the building products used.

The theory asks for identic standard headings (and classification notations of headings) in specifications (and BQ where applicable) and in accounts of costs resulting from the contractor's cost coding. In individual projects the specification units with their notations and the work units as cost carriers should also be identic.

The theory is based on the assumption that building parts have to be classified in each project individually.

Buildings as such have not been included in the material line. They are objects needing a separate classification. There are three main aspects which may need to be expressed in this classification.

the functional (architectural) aspect
the structural aspect
the climatic aspect

The first of these aspects is given by names of building types (houses, schools, hospitals, churches, etc.). There are lists of building types in the Universal Decimal Classification, UDC. These lists were used by SfB under the covering symbol (9) following the SfB classification of building elements (1)/(8). This is one possibility. It was recommended because UDC is readily available. Structural and climatic aspects of buildings may also be expressed by UDC classification.

Whatever future decisions may be taken on the classification of buildings it should be observed that buildings are objects forming one distinct main class.

There is another main class of objects which will have to be considered; tools, machines and other aids (scaffoldings, etc.). This class will hereinafter be called tools. Several lists of construction tools exist already. The tools to be used for the imaginative and management operations in building are mostly not defined as "building" tools (e.g. office furniture, drawing equipment, computors, etc.). It may be suitable to have a full list of all tools which may be needed, but the need for such a list is not of primary importance. An attempt may be made to list tools in relation to the operations for which they are meant. In construction, no doubt, there is a direct relation between operations and tools.

This makes the set of lists of objects in building classification complete.

Buildings
Building elements
Building tools
Building products; and related
Resulting works
Construction operations

Aspect classification and the imaginative and management operations

Having listed all relevant objects and related activities (operations), which are constituting the material line in building, we may now turn to the aspects and related activities (operations), which are constituting the imaginative and management lines in building as defined on page 4.

We will have to avoid the concept of "actors", (such as architects, engineers, authorities, contractors, etc.) because personality aspects are not stable enough for an international agreement on classification. We will have to find aspects not based on personalities but on properties of the objects. This has been done only sporadically. The SfB, when listing the objects and activities (operations) constituting the material

line in building, assumed that the UDC, which is a typical aspect classification (although UDC frequently lists objects under aspect headings), could for the time being serve as a classification for the imaginative line and the management line in building.

Some information centres have followed this way of arranging information which leads to the "SfB+UDC" classification presented in BUILD INTERNATIONAL, Volume 2, No.4, May 1969.

Even if "SfB+UDC" has proved to satisfy needs in the building information centres where it was consistently applied, development asks for a better aspect classification than the one presented by the UDC. There is apparently a need for classification symbols of aspects which can be added to the symbols of objects thus allowing for a "faceted" approach of the type: object:aspect. This way of combining "object classification" and "aspect classification" has been called "the principle of complementarity". The weakness of the whole system of building classification as it stands today (SfB+UDC) is the fact that although objects are classified independently of aspects according to the "material line" (SfB) there is no clear classification of aspects to satisfy the needs of the "imaginative line" and "the management line". The UDC apparently does not satisfy those working in these lines. Appendix 3 presents a draft outline of the main features of what may be called a building aspect classification. It does not present a final solution, only a presentation of some concepts and relations to be considered.

The next step in building classification research according to the theory presented should be a thorough study of the needs for classification in the "imaginative line" and the "management line" (the aspect classification including activities related to aspects). Compared to this basic need for research the possible improvement of SfB-tables as presented in CIB report No. 6 seems to be of secondary importance. It should be remembered, however, that

Building has many links to other fields and that the advantages of a universal system such as UDC should not be thrown over board. As long as there is no alternative to UDC for the aspect classification UDC may well be used for this purpose.

Summary

1. A classification serving the flow of information should be comprehensive in a well defined field of activity.

2. Any proposal for a building classification to be applied internationally should avoid classes related to persons (professions, trades, contractors, etc.) but should fit into any possible system of co-operation between specialists.

3. Macro-arrangements and micro-arrangements should be left for individual (or local, or national) choice but the main classification within any macro-group chosen should be according to an internationally recommended system.

4. The classification (or listing) of the objects, which characterize the field of activity, should be independent of the classification (or listing) of aspects. The comprehensive classification should be based on the complementary use of object classification and aspect classification. Activities (operations) are not independent but related either to objects or to aspects.

5. There are three levels in building needing separate studies (Fig.2). These levels present different sequences of activities which in this paper have been called lines of operations. They are: (definitions on page 4 )

The line of imaginative operations
The line of management operations
The line of material operations

6. The material operations are fundamental. By the successive adding of operations, raw materials from natural resources are made into building products which ultimately end up in buildings as construction works (definition on page 3). The final operation transforming a building product to a construction work is called construction operation. The inter-dependence between construction works, building products, and construction operations is the basis for the parellel classification (grouping) of works, products and related operations.

7. The arrangement (classification) of headings in specifications (and BQ where applicable) must be identic with the work headings used for cost coding in construction.

8. Buildings and building elements are two separate main classes. The construction work is a non-dimensional constituent of a dimensionally defined building element.

9. Building elements and building products (related to resulting works and construction operations) have been classified (grouped) in the SfB system. This classification may be improved but should not be basically changed. Adequate lists of buildings and building tools have to be added to make the object-classification in the field of building complete.

10. The line of imaginative operations and the line of management operations are serving the line of material operations. Activities (operations) in the imaginative line and the management line are mainly related to aspects. There is no adequate classification, neither of the aspects involved nor of the imaginative and management operations. Building classification research should aim at establishing lists of aspects and related operations covering the needs of people working in the imaginative and management lines. These lists should be complementary to the lists of objects so that the double entry object: aspect may be achieved by a comprehensive building classification whenever wanted. Until this complementarity has been achieved UDC should be used for aspect-classification in building.

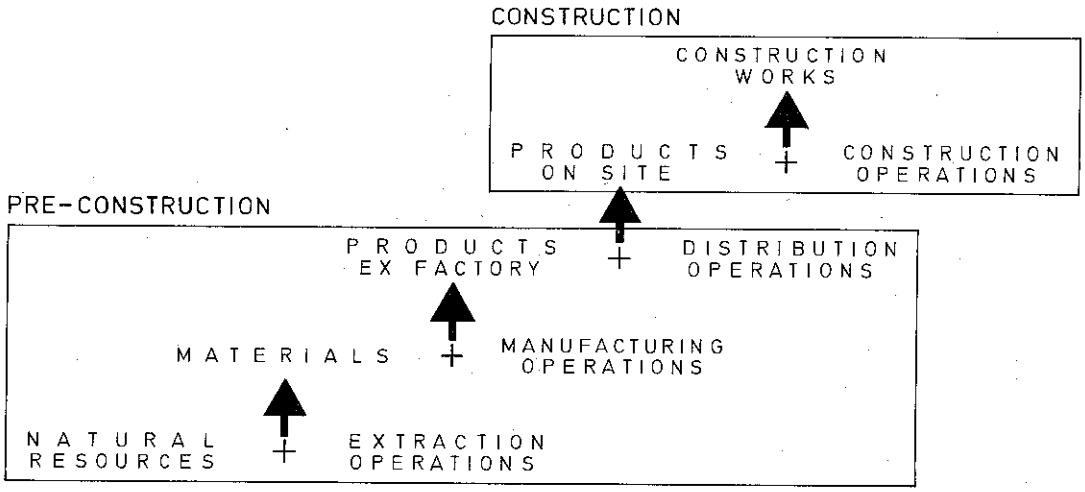



FIG.1. THE LINE OF MATERIAL OPERATIONS (PRE-CONSTRUCTION AND CONSTRUCTION).

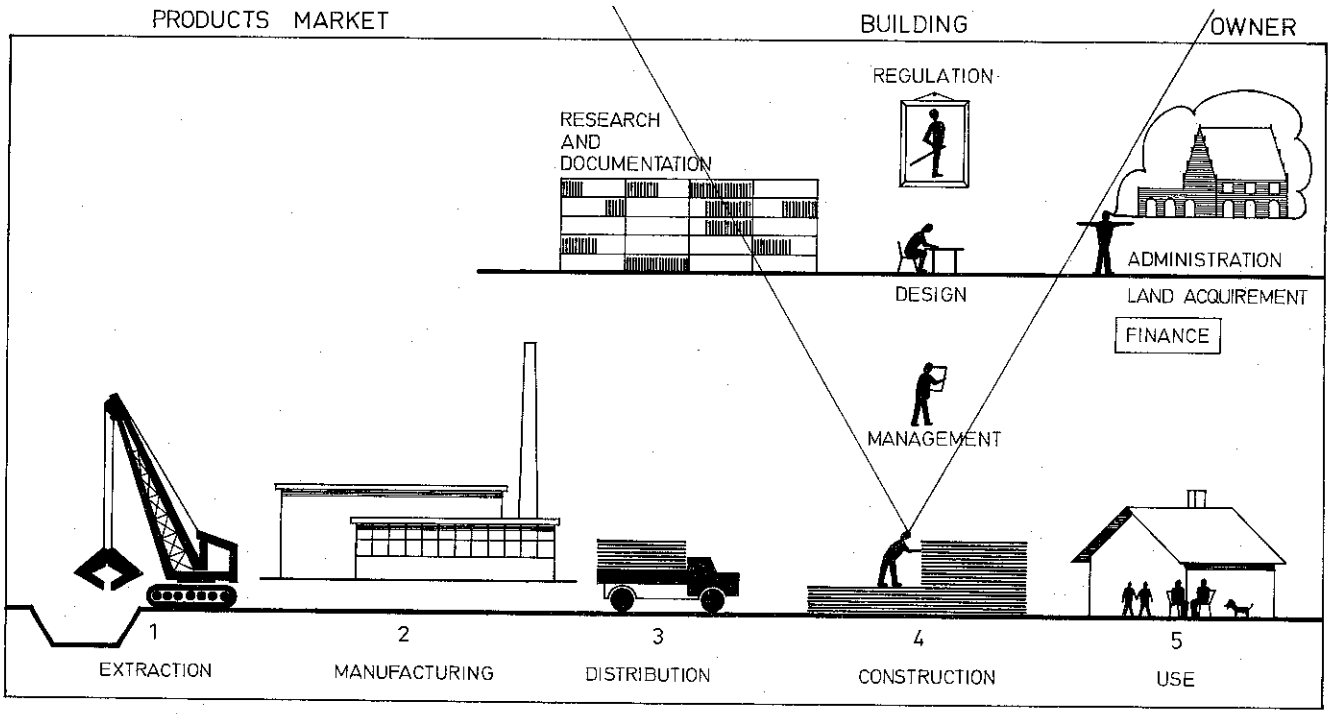



FIG. 2. THE FIELD OF BUILDING AND RELATED FIELDS.

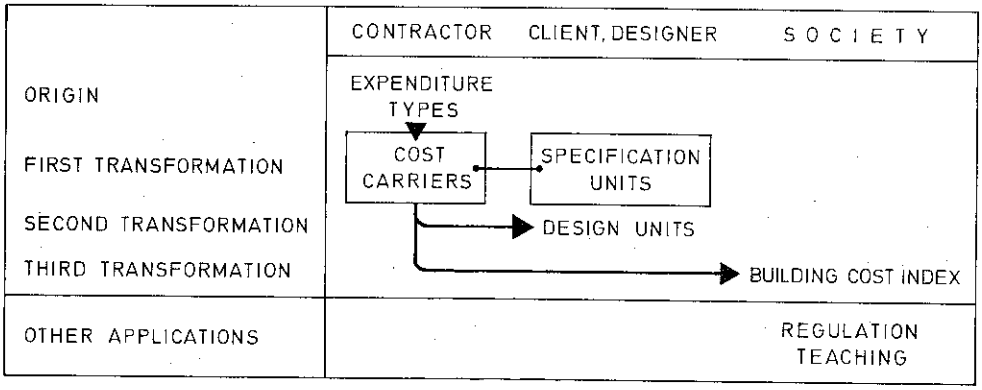



FIG. 3. THE FLOW OF INFORMATION ON BUILDING COSTS.

APPENDIX I

The SfB standard arrangement of works ; Main headings.
(Sub-division by SfB lower case letters for material as appropriate).

I. Construction works (main contract)

- A Introduction (contract arrangements)
- B Preliminary and General Works (incl. prime cost sums)
- C Site works
- D Building works
  - E Concrete works (incl. formworks and reinforcement)
  - F Brick and Block works
  - G Erection works (prefabricated structural units)
  - H 'Profile' works (steel construction and timber construction)
  - K Insulation works (thermal sound and vibration insulations)
  - L Membrane works (asphalt, etc.)
  - M Sheet works (sheet metal etc.)
  - N 'Overlapping tile' works (roofing and siding)
  - P Plaster works
  - R Board and pane works (fibre boards, glass panes etc.)
  - S Tile works (ceramic wall and floor tile works etc.)
  - T 'Flooring products' works (parquet, linoleum, jointless flooring etc.)
  - U/V Decoration and Paint works
  - X Installation works (prefabricated non-structural units)
    - e.g. (31) windows
    - (32) doors
    - (7.) fixed furniture

II. Sanitary, Heating and Ventilation Installation works (sub-contracts)

- A Introduction (contract arrangements)
- B Preliminary and General works (incl. prime cost sums)
- C Site works
- D Building works
  - I Piping generally
  - K Insulation works (pipes and boilers etc.)
  - X Installation works, e.g.:
    - (52) Drainage installations
    - (53) Water installations, cold and hot
    - (56) Space heating installations
    - (57) Ventilation and air conditioning installations
    - (73) Kitchen fixtures
    - (74) Bathroom fixtures
    - (75) Laundry fixtures

III. Electrical Installation works (sub-contracts)

- A Introduction (contract arrangements)
- B Preliminary and General works (incl. prime cost sums)
- C Site works
- D Building works
  - I/J Piping and wiring generally
  - X Installation works, e.g.
    - (63) Lighting and power installations
    - (64) Telecommunication installations
    - (66) Lift installations

# LOW COST HOUSING • COST BREAK DOWN ACCORDING TO CIB[1] RECOMMENDATION (the SfB system)[2]

| COST PER HOUSE | THE HOUSE PLOT<br>With utility services | THE BUILDING<br>Without service installations | SANITARY<br>Service installations | ELECTRICAL<br>Service installations |
|---|---|---|---|---|
| PLOT<br>OWNER'S ADMINISTRATION<br>DESIGN | DESIGN A | DESIGN A | DESIGN A | DESIGN A |
| CONSTRUCTION<br>MANAGEMENT<br>GENERALITIES<br>BUILDING NET COST<br>Specification: | GENERAL B<br>WORKS SPECIFIED: / ELEMENTS SPECIFIED: | GENERAL B<br>WORKS SPECIFIED: / ELEMENTS SPECIFIED: | GENERAL B<br>WORKS SPECIFIED: / ELEMENTS SPECIFIED: | GENERAL B<br>WORKS SPECIFIED: / ELEMENTS SPECIFIED |
| (1) Elements on the plot, Foundation | Ground works C<br>Levellings (11)<br>Drainage (12)<br>Roads (14)<br>Gardens (15)<br>Other (18) | Excavation C<br>Construction<br>Cast in situ E<br>Masonry F<br>Prefab G<br>Steel works Hh<br>Carpentry Hi<br>Foundation (16) | | |
| (2) Building, primary elements | Pipe works I | Completion<br>Insulation K<br>Membranes L<br>Sheet Metal Mh<br>Overlaps N<br>Walls<br>-external (21)<br>-internal (22)<br>Floors (23)<br>Stairs (24)<br>Roofs (27) | Pipe works I<br>Insulation K | Tube works I<br>Wiring J |
| (3) Building, secondary elements | | Windows (31)<br>Doors (32)<br>Ceilings, susp. (35)<br>Other (38) | | |
| (4) Building, finishes | | Finishing<br>Plastering P<br>Fibre boards Rj<br>Glazing Ro<br>Tiling S<br>Flooring, other T<br>Painting V<br>Finishes<br>-external (41)<br>-internal (42)<br>-floor (43)<br>-stair (44)<br>-roof (47) | | |
| (5) Installations, sanitary | Installations X<br>OTHER:<br>Services<br>-waste (51)<br>-sewerage (52)<br>-water (53) | Installations X<br>OTHER: | Installations X<br>OTHER:<br>Services<br>-waste (51)<br>-sewerage (52)<br>-water (53)<br>-ventilation (57) | Installations X<br>OTHER: |
| (6) Installations, electrical | Misc. materials Y<br>-electricity (63) | Misc. materials Y | Misc. materials Y | Misc. materials Y<br>Services<br>-power and light (63)<br>-tele (64)<br>-lifts (66) |
| (7) Fixture elements | | Fixture elements<br>-kitchen (73)<br>-bathroom (74)<br>-laundry (75)<br>-store (76) | Fixture elements<br>-kitchen (73)<br>-bathroom (74)<br>-laundry (75) | Fixture elements<br>-kitchen (73)<br>-bathroom (74) |

1/ International Council for Building Research Studies and Documentation. Consultant status B with the UN

2/ For details see: CIB Report No.6 Building classification practices (Price Sw. frs 15,- P.O. Box 299 Rotterdam, the Netherland.)