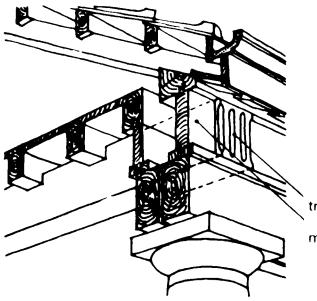
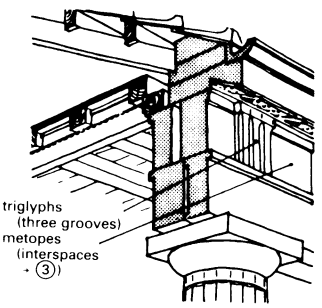
BUILDING DETAILS

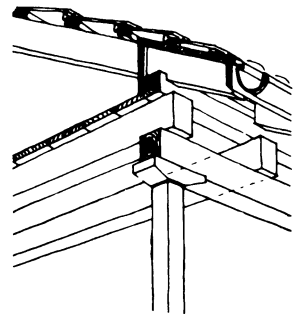
Functional Use of Materials

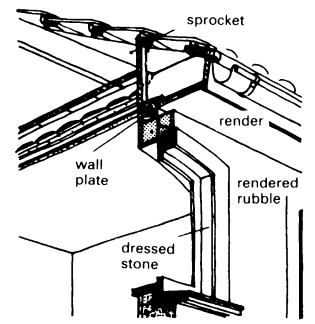




① **Original timber construction used as a basis for the design of the Greek temple**

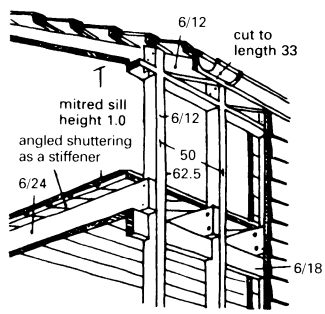
② **Stone construction developed by the Greeks and based on ①**

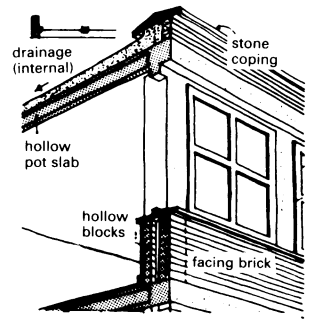




③ **Timber construction (similar to ①) still used in many countries**

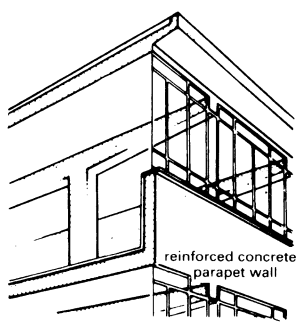
④ **Rubble walls need framing with dressed stones → p. 37**

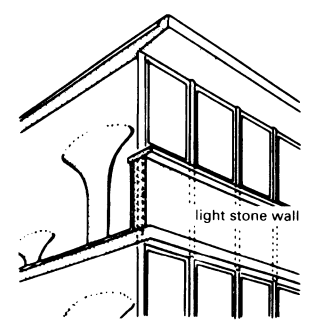




⑤ **Nailed timber frame. Practical and economical but without character; best hidden behind cladding**

⑥ **Reinforced concrete building with supports in external wall, fronted by outer leaf of parapet wall supported by the cantilevered floor**





⑦ **Reinforced concrete structure with internal columns, cantilevered floor and continuous ribbon windows**

⑧ **Reinforced concrete mushroom structure with light steel supports in outer wall between windows → p. 38**

In the earliest civilisations, building form was dictated by the techniques of binding, knotting, tying, plaiting and weaving. Building in timber followed later, and in nearly all civilisations became the basis for architectural form (see the example of the Greek temple → ① and ②).

Recognition of this is relatively recent, but there is an increasing number of examples which support the accuracy of this theory. Uhde researched this matter at length and established that Moorish architectural skills originate from timber construction, in particular the Alhambra at Granada. The internal surface decor of Moorish buildings has its source in weaving techniques (like the ribbons and beaded astragals on Greek buildings), although it was actually pressed into the gypsum by moulds or inlaid as 'Azujelos' (glazed strips of clay). In several rooms of the Alcazar in Seville one can clearly see in the corners of the rooms the knotting together of the walls in the gypsum finish exactly in the way that the wall carpets of the tents were knotted at the corners in earlier centuries. Here the form derived from tent construction was simply transferred to the gypsum mould.

Under the same conditions, forms which result from the material, construction and functional requirements are similar or even identical in every country and time.

The 'eternal form' was traced by V. Wersin with convincing examples. He showed that utensils used in the Far East and in Europe in 3000 BC are strikingly similar to those in use today. With new material, new technology and changing use, a different form inevitably evolves, even though embellishments can obscure or conceal the true form, or even give the impression of something quite different (baroque). The spirit of the age tends to decide the form of the building.

Today, in the buildings of other periods, we study not so much the result as the origin of the art. Each style arrives at its 'eternal form', its true culmination, after which it is developed and refined. We still strive after a true expression with our use of concrete, steel and glass. We have achieved success in finding some new and convincing solutions for factories and monumental buildings, in which the need for extensive window areas determines and expresses the structure.

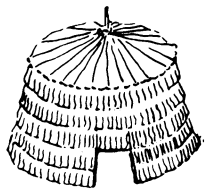
The plain and distinct representation of the building parts, in conformity with their technical functions, provides possibilities for new forms in the details and the outward expression of buildings. Herein lies the new challenge for architects today. It is wrong to believe that our age needs only to develop clean technological solutions and leave it to the next period to cultivate a new form emanating from these structures → ②. On the contrary, every architect has the duty to harness contemporary technical possibilities extensively and to exploit their artistic potential to create buildings that express the ethos of the modern world (→ p. 39). This requires tact, restraint, respect for the surroundings, organic unity of building, space and construction, and a harmonious relationship between the articulation of interior spaces and the exterior form, in addition to fulfilling technological, organisational and economic demands. Even major artists with true creative drive ('those who have something to say') are subject to these restrictions and are influenced by the spirit of the age.

The clearer the artistic vision or the view of life of the artist, the more mature and rich the content of his work, and the longer it will endure as a beautiful object of true art for all time.

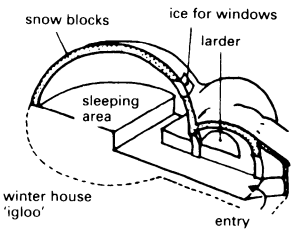
FORM

The Result of Construction

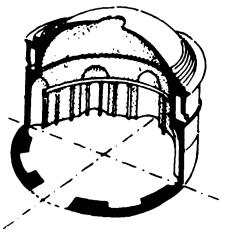
VAULTING



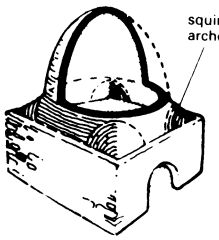
① Primitives build circular huts with local materials: stones, poles and woven lianas are clad with leaves, straw, reeds, hides etc.



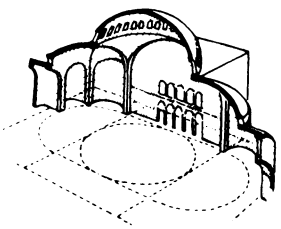
② Similarly, Eskimos build summer houses of skin-clad whale ribs with windows made from seals' intestines, akin to the wigwam; winter houses are made of snow blocks



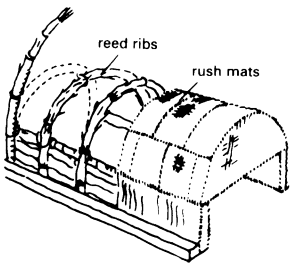
③ The Romans built the first stone domes on a circular plan (e.g., in its purest form, Pantheon, Rome)



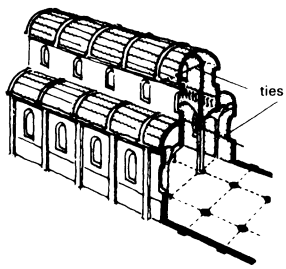
④ The Sassanians in Persia (6th century AD) constructed their first domes on a square plan; transition from square to circle via squinch arches



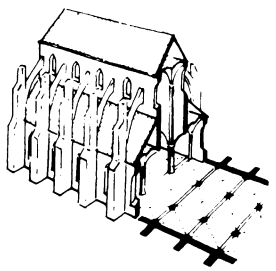
⑤ 1400 years ago, Byzantine architects created domes on the square plan of the Hagia Sophia, using the pendentive. Construction obscured inside (i.e. dematerialisation)



⑥ As well as circular domes, barrel vaulting was widely used (e.g. Mesopotamia: reed ribs were covered with rush mats)

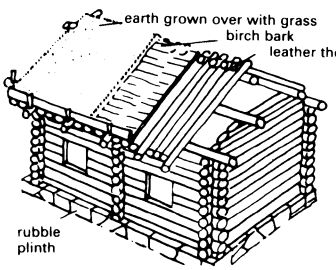


⑦ Barrel vaulting in masonry was first used by the Romans and later appeared in Romanesque architecture (e.g. Šibenik church, Yugoslavia)

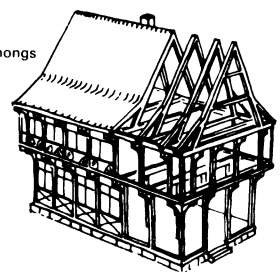


⑧ Gothic architecture evolved from cross-vaulting, allowing the vaulting of oblong bays by using the pointed arch (characteristic buttresses and flying buttresses)

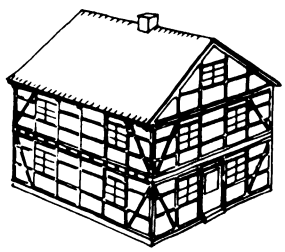
TIMBER



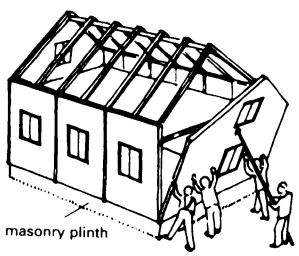
⑨ Block-houses in wooded countries have a universal form dictated by the nature of their construction



⑩ In areas short of timber, buildings used wood posts; posts have windows between them and there are braces in the window breasts

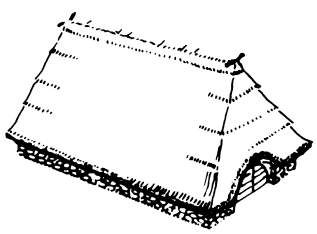


⑪ In contrast, this framed building has isolated windows and corner struts; the panels are interlaced wickerwork with mud or clay rendering (wattle and daub)

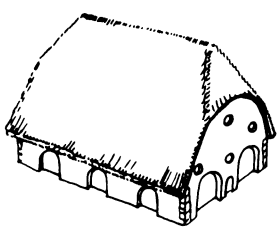


⑫ Panel construction uses large prefabricated wall panels, which are quick and inexpensive to erect

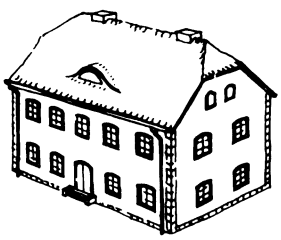
STONE



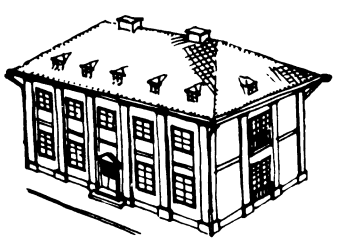
⑬ Buildings of field stones without mortar (uncoursed random rubble) must have a low plinth; the structure consists almost entirely of roof, with a low entrance



⑭ Cut and dressed stones allow the construction of higher walls; with mortar joints, gables in stone with arched or vaulted openings become practicable



⑮ From a later period: framed openings and corners with carefully formed, dressed stones; the rest of the walls in rubble masonry which was then rendered

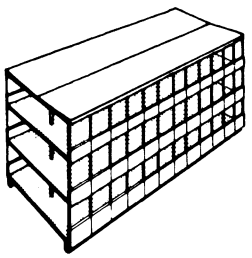


⑯ The desire for larger windows in town buildings led to a stone pillar construction style similar to the earlier timber post method → ⑩

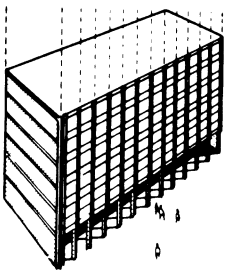
To begin with, it is always construction that is the basis of form. Later it develops onto a pure, and often abstract form, which is initially adopted when new building materials are introduced. Numerous examples of this can be found in history, from ancient stone tombs, in which even the lay observer can discern the basic timber form, to the automobile of 1900 that imitated the horse-drawn carriage (even down to the provision of a whip holder).

Modern Construction Techniques and Forms

STEEL

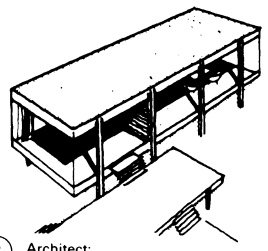


①

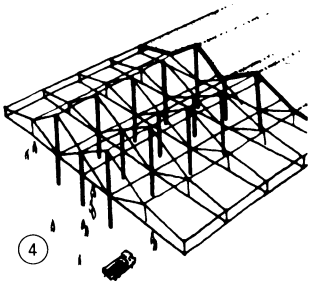


②

Slender supports give steel-framed construction the lightest possible appearance → ①. However, this form is not permitted everywhere. Exterior unenclosed supports are rarely allowed → ② but, if combined with externally visible horizontal girders, can create an especially light but solid appearance of unobstructed space → ③. Steel and aluminium structures are particularly suitable for light open halls with few supports and cantilevered roofs → ④.

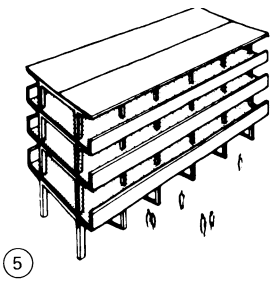


③ Architect: L. Mies van der Rohe

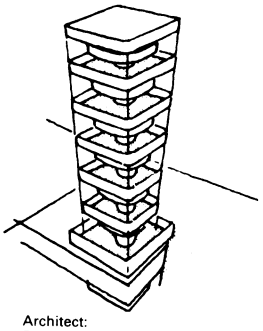


④

REINFORCED CONCRETE

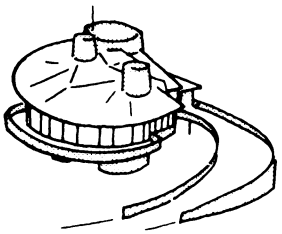


⑤

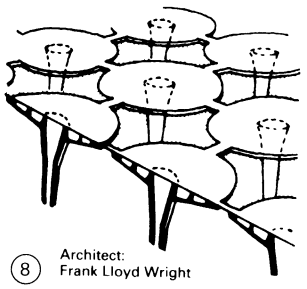


⑥ Architect: Frank Lloyd Wright

For many building types, building regulations require fire resistant or even fire proof construction and encased steel members consequently resemble reinforced concrete. Typical characteristics are cantilevered floors on beams → ⑤ from tower cores → ⑥, or house core supports → ⑦, or as mushroom structures → ⑧.

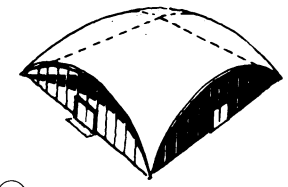


⑦ Architect: Frank Lloyd Wright

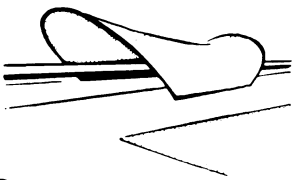


⑧ Architect: Frank Lloyd Wright

SHELL ROOFS

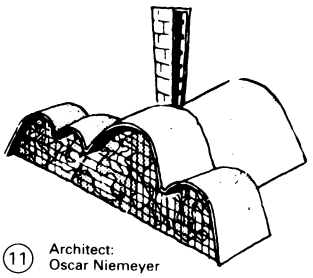


⑨

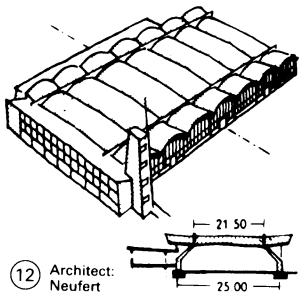


⑩

In shell structures, forces are distributed uniformly in all directions. Types include: cupola with segments → ⑨, oblong shell → ⑩, rhythmically arranged transverse shells → ⑪, rows of shells with inclined supports at neutral points → ⑫.

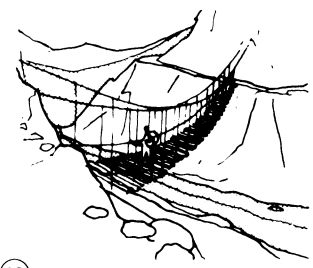


⑪ Architect: Oscar Niemeyer

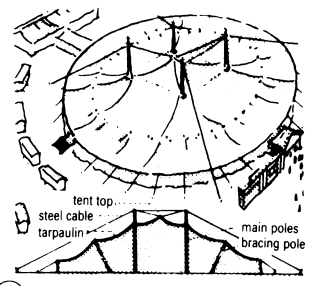


⑫ Architect: Neufert

CABLE STRUCTURES

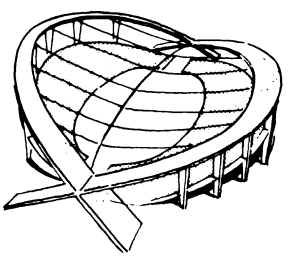


⑬

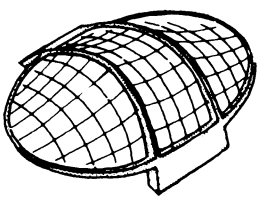


⑭

Cable structures for long spans have been in use since early times → ⑬. Circus tents are the best-known lightweight suspended diaphragm structure → ⑭. Modern reinforced concrete suspended diaphragms with rigid edge beams can create economical and impressive buildings → ⑮, and may be used as basis for cantilever constructions → ⑯.



⑮ Architects: M. Novicki with M. Deitrick



⑯

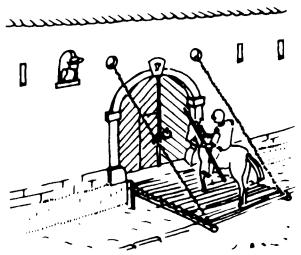
The challenge for architects is to create form based on a fusion of architectural expression and knowledge of the technological principles of modern construction techniques. This unity was lost in the wake of the Industrial Revolution, before which available forms were used on a 'decorative' basis in any construction type, whether in stone, wood or plaster.

The latest fire protection techniques can obviate the need for concrete encasement altogether. Intumescent coatings are often used for protecting structural steelwork against fire (especially the visually expressed elements). These look like normal paint but, in the event of fire, they foam, thus creating a protective layer around the steel.

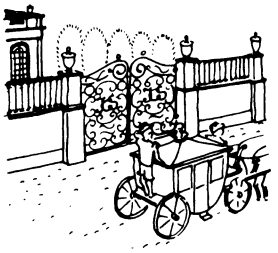
THE DESIGN OF HOUSES

The Expression of the Period and its Conventions

ACCESS

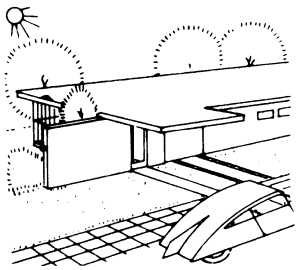


(1) **Around AD 1500, houses and towns were protected by high walls and heavy gates**



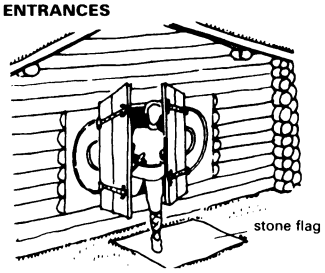
(2) **By 1700 walls and gates were only symbolic, giving glimpses of the garden**

(3) **In the 1800s, detached houses were built in open surroundings with low fences**

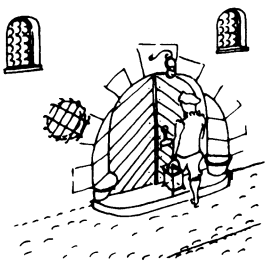


(4) **Twentieth century houses have no enclosure (in the US, particularly) and stand unobtrusively among trees in large communal parks**

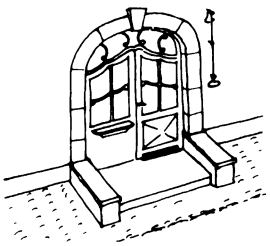
ENTRANCES



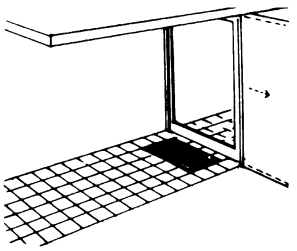
(5) **AD 1000: log cabins had low doors, high thresholds; no windows; lit through an opening in the roof**



(6) **By 1500: heavy, studded doors with knocker, and windows with bars and bull's eye panes**



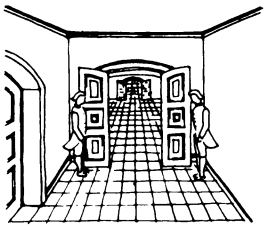
(7) **Around 1700, doors had clear glass panes with decorative glazing bars (also, a bell-pull)**



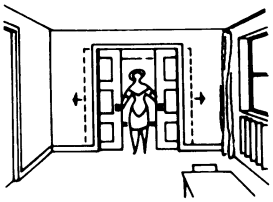
(8) **Twentieth century: covered walkway leads from car to door (wired plate glass), which slides open when an electric eye is activated**

ROOM CONNECTIONS

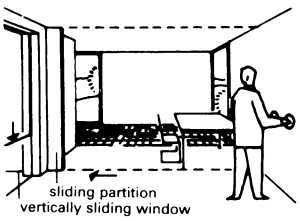
(9) **AD 1500: low, heavy doors, sparse daylighting, and floors of short, wide boards**



(10) **In the 1700s, wide double doors led into suites of rooms with parquet flooring**

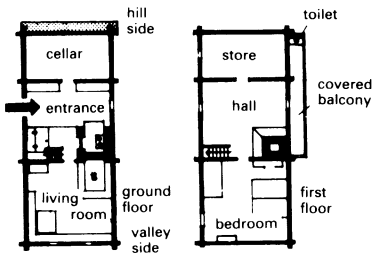


(11) **By 1900, sliding doors were fitted between rooms, linoleum flooring, sliding windows, and draw curtains**



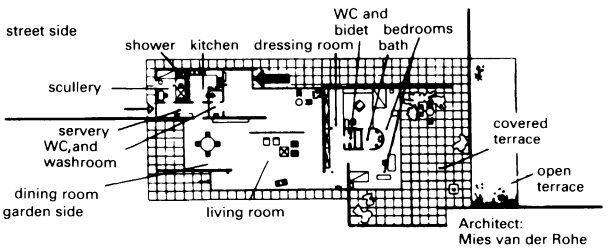
(12) **Twentieth century rooms are flexible: sliding walls and plate glass windows; venetian blinds/shutters as protection from the sun**

HOUSES



(13) **The timber house (AD 1500) was influenced by the environment, method of construction and the way of life; e.g. Walser house**

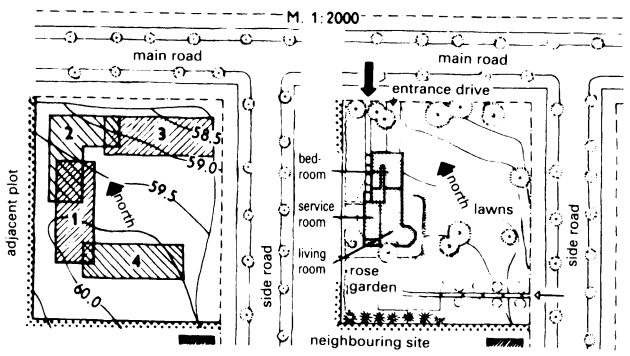
(14) **The stone house (AD 1500): massive walls, to combat enemies/cold, required the same area as the rooms themselves**



(15) **The house of the 2000s will have slender steel supports and slim non-load-bearing curtain walling, the composition of which affords full protection against the weather, and maximum noise and heat insulation. Open plan, with dividing screens between living area, dining room and hall (no doors)**

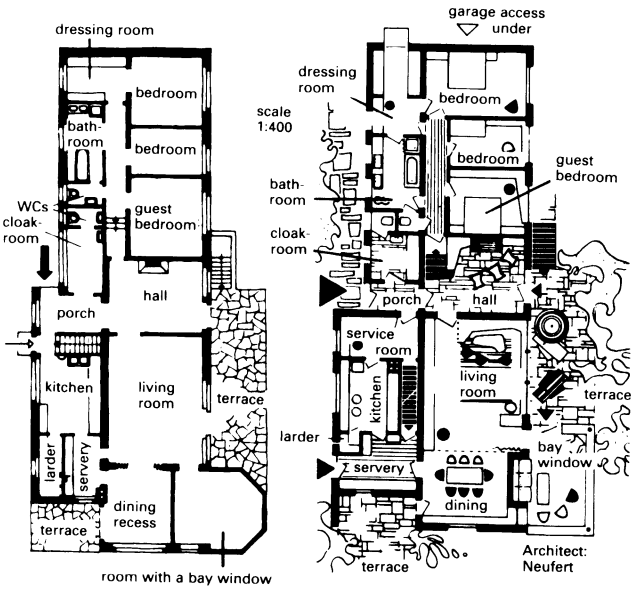
In the time between the beginning of the 16th century (the period of witch-hunts, superstition, leaded lights and fort-like houses, a form which is still occasionally in demand) and the present day, astonishing advances have been made in science, technology and industry. As a result the outlook of society has changed radically. In the intervening centuries it is clearly evident from buildings and their details, as well as other aspects of life, that people have become freer and more self-aware, and their buildings lighter and brighter. The house today is no longer perceived as a fortress offering protection against enemies, robbers or 'demons' but rather as a complementary framework for our way of life – open to nature and yet in every respect protected against its inclemency.

People generally see and feel things differently. Designers must therefore use their creativity as far as possible to translate our shared experience into reality and express it through the materials at their disposal. The attitude of the client is of the greatest significance in this issue. In some ways, many clients and architects are still living in the 15th century while few of each have arrived in the new millennium. If the 'centuries' meet in the right way, then a happy marriage between client and architect is assured.



① **Four site layout proposals for development of a 3000 m² plot with a NE slope: proposal 4 planned by the client; proposal 1 accepted → ②**

② **This development, with a SE slope in front of the house, uses the contours correctly: yard to the west; entry from road to the north**



③ **House sketch design with faults: cloakroom and porch are too big; bathroom and servery are too narrow; the steps in the corridor are dangerous; restricted view from kitchen**

④ **Improved design for ③: better room plans; bedrooms 2.5 m above ground, using the site's natural slope; garage at ground level**

Building programme

The work begins with the drawing-up of a detailed brief, with the help of an experienced architect and guided by the questionnaire shown on the following pages. Before planning starts, the following must be known:

1 Site: location, size, site and access levels, location of services, building and planning regulations and conditions. This information should be sought from the local authority, service providers and legal representatives, and a layout plan to comply with this should be developed.
2 Space requirements with regard to areas, heights, positioning and their particular relationship with one another.
3 Dimensions of existing furniture.
4 Finance: site acquisition, legal fees, mortgages etc. → pp. 43–50.
5 Proposed method of construction (brick, frame construction, sloping roof, flat roof etc.).

DESIGN METHOD

Working Process

The sketch scheme is begun by drawing up individual rooms of the required areas as simple rectangles drawn to scale and put provisionally into groups. After studying the movements of the people and goods (horizontally and vertically), analyse circulation and the relationships of rooms to each other and the sun → p. 272. During this stage the designer will progressively obtain a clearer understanding of the design problems involved. Instead of starting to design at this stage they should, on the basis of their previous work to establish the building area, determine the position of the building on the site, by exploring the various means of access, the prevailing wind, tree growth, contours, aspect, and neighbourhood. Try out several solutions to explore all possibilities → ① and use their pros and cons for a searching examination – unless of course a single obvious solution presents itself. Based on the foregoing, decision-making is normally fairly quick, and the 'idea' becomes clearer; then the real picture of the building emerges → ②.

Now the first design stage can begin, firstly as an organisational and spiritual impression in the mind. From this, a schematic representation of the general configuration of the building and its spatial atmosphere is built up, from which the designer can develop the real proposal, in the form of plans and elevations. Depending upon temperament and drawing ability a quick charcoal sketch, or a spidery doodle, forms the first tangible result of this 'birth'.

The first impetus may become lost if the efforts of assistants are clumsy. With growing experience and maturity, the clarity of the mental image improves, allowing it to be communicated more easily. Older, mature architects are often able to draw up a final design in freehand, correctly dimensioned and detailed. Some refined mature works are created this way, but the verve of their earlier work is often lacking.

After completion of the preliminary design, → ③, a pause of 3–14 days is recommended, because it provides a distancing from the design and lets shortcomings reveal themselves more clearly. It also often disposes of assumptions, because in the intervening time preconceived ideas are put aside, not least as a result of discussions with staff and clients. Then the detailed design of the project is begun with the assistance of various consultants (e.g. a structural engineer, service engineers for heating, water and electricity) firmly establishing the construction and installations.

Following this, but usually before, the plans are submitted to the relevant authorities for examination and permission (which might take about 3–6 months). During this time the costs are estimated and specification and Bill of Quantities produced, and the tendering procedure is undertaken, so that as soon as the permission to proceed is received, contracts can be granted and the work on site commenced.

All these activities, from receiving the commission to the start of building operations for a medium-sized family house, takes on average 2–3 months of the architect's time; for larger projects (hospitals, etc.) 6–12 months should be allowed. It is not advisable to try to make savings at this juncture; the extra time spent is soon recovered during building operations if the preparation has been thoroughly carried out. The client thus saves money and mortgage interest payments. The questionnaire (→ pp. 41 and 42) and the room specification folder (→ p. 31) will be important aids.

Preparatory Work: Collaboration with Client

Preparatory work is often done in a rush, resulting in an insufficiently detailed scheme being put out to tender and commenced on site. This is how 'final' drawings and costs only become available when the building is nearly complete. Explanations are of no help to the client. The only way of solving the problem is faster and better organised work by the architect and sufficient preparation in the design office and on the construction site.

Similar information is required for most building projects, so detailed questionnaires and pro formas, available when the commission is received, can be used to speed things up. Certainly there will be some variations, but many factors are common and make questionnaires useful to all those involved in the project, even if they are only used as checklists.

The following questionnaire is only one of the labour saving pro formas which an efficient and well-run architect's office should have available, along with pro formas for costing purposes, etc.

Briefing Questionnaire

Commission No.:
.....
Employer:
.....
Project Description:
.....
Information collected by:
.....
Copies to:
.....

I Information on the client

1 What is their financial status? Business outlook? Total capital employed? Where was the information obtained? } confidential
2 How does the business seem to be conducted?
3 Who is our main contact? Who is our contact is his absence? Who has the final authority?
4 Has the client any special requests regarding design?
5 Have they any special interest in art? (In particular with regard to our attitude and design method.)
6 What personal views of the client need to be taken into account?
7 Who is liable to cause us difficulties and why? What could be the effects?
8 Is the customer interested in publication of his building later on?
9 Do the drawings have to be capable of being understood by laymen?
10 Who was the client's architect previously?
11 For what reason did he or she not receive this commission?
12 Is the client thinking of further buildings? If so, when, what type, how large? Have they already been designed? Is there the possibility that we might obtain this commission? What steps have been taken in this direction? With what success?

II Agreements on fees

1 On what agreement with the client are the conditions of engagement and scale of professional charges based?
2 What stages of the work are included in the commission?
3 Is the estimated project cost the basis for the fee calculation?
4 What is the estimated project cost?
5 Are we commissioned to carry out the interior design?
6 Has a form of agreement between employer and architect been signed and exchanged?

III Persons and firms involved in the project

1 With whom do we have to conduct preliminary discussions?
2 Who is responsible for what special areas of activity?
3 Who is responsible for checking the invoices?
4 Which system of ordering and checking will be used?
5 Will we have authority to grant contracts in the name of the client? If so, to what value? Do we have written confirmation for this? Who does the client recommend as contractor or sub-contractor? (Trade; Name; Address; Telephone)
6 Is a clerk of works essential or merely desirable, and should he or she be experienced or junior? When is he or she required, and for how long (duration of job or only part)?
7 Have we explained duties and position of clerk of works to client?
8 Is accommodation available for site offices and material storage? What about furniture, telephone, computers, fax, heating, lighting, WC and water?

IV General

1 Is hoarding required? Can it be let for advertising? Is signboard required and, if so, what will be on it?
2 Exact address of the new building and name after completion?
3 Nearest railway station?
4 Postal district/town?
5 Is there a telephone on site, and if not when will one be available? Alternatively is there a telephone in the vicinity?
6 Have we obtained a local edition of the national working rules for the building industry? Are there any additional clauses?

V The project

1 Who has drawn up the building programme? Is it exhaustive or has it to be supplemented by us or others? Has the client to agree again before the design work starts?
2 Has the new building to be related to existing and future buildings?
3 Which local regulations have to be observed? Who is building inspector or district surveyor? Who is town planning officer?
4 What special literature is available on this type of building? What do we have in our files?
5 Where have similar buildings been built?
6 Have we taken steps to view them?

VI Basic design factors

1 What are the surroundings like? Are landscaping and trees to be considered? What about climate, aspect, access, and prevailing wind?
2 What is the architecture of existing buildings? What materials were employed?
3 Do we have photographs of neighbourhood with viewpoints marked on plan? If not, have they been ordered?
4 What other factors have to be considered in our design?
5 What are the existing floor-to-floor heights and heights of buildings? What is the situation with regard to roads, building lines, future roads, trees (types and sizes)?
6 What future development has to be considered?
7 Is it desirable to plan an area layout?
8 Are there regulations or restrictions concerning elevational treatment in district?
9 What is known of attitude of town planning officer or committee towards architecture? Is it advisable to discuss initial sketches with town planning officer before proceeding?
10 In case of appeal, is anything known of the time taken and the ministry's decision in similar cases in this district?

Preparatory Work: Questionnaire (cont.)

VII Technical fact finding

1 What sort of subsoil is common to this area?
2 Has the site been explored? Where have trial holes been sunk? What were the results?
3 What is load-bearing capacity of subsoil?
4 Average ground water level? High water level?
5 Has the site been built on previously? Type of buildings? How many storeys? Was there a basement and, if so, how deep?
6 What type of foundation appears to be suitable?
7 What type of construction is envisaged?
In detail:
Basement floor: Type? Applied load? Type of load? Floor finish? Insulation? Tanking?
Ground floor: Type? Applied load? Type of load? Finishes?
Other floors: Type? Applied load? Type of load? Finishes?
Roof: Structure? Loading? Type of loading? Roof cladding? Protective finishes and coatings? Gutters? Internal or external downpipes?
8 What insulation materials are to be employed? Sound insulation: horizontal/vertical? Impact sound: horizontal/vertical? Heat insulation: horizontal/vertical?
9 Type of supports? Outer walls? Partitions?
10 Staircase structure? Applied load?
11 Windows: steel/timber/plastic/wood/aluminium? Type and weight of glass? Internal or external seating? Single, double or combination windows? Double glazing?
12 Doors: steel frames? Plywood? Steel? Lining? Fire grading? Furniture? With an automatic door closing device?
13 Type of heating: solid fuel/gas/electricity/oil? Fuel storage?
14 Domestic hot water: amount required and at what times? Where? Water softener required?
15 Ventilation: air conditioning? Type? Air change? In which rooms? Fume extraction? Smoke extraction?
16 Cooling plant? Ice making?
17 Water supply? Nominal diameter of supply pipe and pressure? Is pressure constant? Water price per cubic metre or water rate? Stand pipes required? Where and how many?
18 Drainage and sewerage? Existing? Connection points? Nominal bore of main sewer? Invert levels? Where does the sewage flow to? Soak pits? Possible, advisable, permitted? Septic tank or other sewage treatment necessary?
19 Nominal bore of the gas supply pipe? Pressure? Price per cubic metre? Reduction for large consumption? Special regulations concerning installation of pipes? Ventilation?
20 Electricity? A.C. or D.C.? Voltage? Connection point? Voltage drop limit? Price per kW? Off-peak? Price reduction for large consumption? Transformer? High-voltage transformer station? Own generator? Diesel, steam turbine, windmill?
21 Telephone? Where? ISTD? Telephone box? Where? Cable duct required?
22 Intercom? Bells? Lights? Burglar alarm?
23 What type of lift? Maximum load? Speed? Motor at top or bottom?
24 Conveyor systems? Dimensions? Direction of operation? Power consumption? Pneumatic tube conveyor?
25 Waste chutes or sink destructor disposal units? Where? Size? For what type of refuse? Waste incineration? Paper baling press?
26 Any additional requirements?

VIII Records and preliminary investigations

1 Have deeds been investigated? Copy obtained? Anything relevant with regard to the project planning?
2 Map of the locality available? Ordered? Transport details?
3 Does site plan exist? Ordered?
4 Does contour map exist? Ordered?
5 Water supply indicated on plan?
6 Mains drainage drawing checked out and cleared?
7 Gas supply shown on the drawing?
8 Is electricity supply agreed with Board and shown on plan? Underground cable or overhead line?
9 Telephone: underground cable or overhead wires?
10 Have front elevations of the neighbouring houses been measured or photographed? Has their construction been investigated?
11 Has datum level been ascertained and fixed?
12 Is site organisation plan required?
13 Where does the application for planning permission have to be submitted? How many copies? In what form? Paper size? With drawings? Prints? On linen? Do drawings have to be coloured? Are regulations for signs and symbols on drawings understood?
14 Requirements for submission of the structural calculations? Building inspector? (Normally decided by council planning department)

IX Preliminaries

1 How far is the construction site from the nearest rail freight depot?
2 Is there a siding for unloading materials? What gauge? What are the off-loading facilities?
3 What are access roads like, in general? Are temporary access roads necessary?
4 What storage space facilities are available for materials? Available area open/under cover? What is their level in relation to site? Can several contractors work alongside one another without any problems?
5 Will the employer undertake some of the work himself; supply some material? If so what: landscaping, site cleaning/security services?
6 Method of payment, interim certificates, etc.? Otherwise what terms and conditions of payment are to be expected?
7 What local materials are available? Are they particularly inexpensive in the area? Price?

X Deadlines for:

1 Preliminary sketches for discussion with staff and consultants?
2 Preliminary sketches for meetings with the client, town planning officer, district surveyor or building inspector?
3 Sketch design (to scale) with rough estimates?
4 Design (to scale)?
5 Estimate? Specification? Bill of Quantities?
6 Submission of the application for planning permission and building regulations approval with structural calculations, etc.?
7 Anticipated time for gaining permits? Official channels? Possibilities for speeding things up?
8 Pre-production drawings, working drawings?
9 Selection of contractors? Letters of invitation? Despatching of tender documents?
10 Closing date for tenders? Bill of Quantities?
11 Acceptance of tender? Progress chart? Date for completion?
12 Possession of site? Commencement of work?
13 Practical completion?
14 Final completion?
15 Final account?