

SPECIFYING CONSTRUCTION MATERIALS AND EMERGING TRENDS OF NEW PRODUCTS

1.0 Introduction

The term specifications (usually plural) is defined (Webster's Unabridged Dictionary) as "A written or printed description of the work to be done, forming part of the contract and describing qualities of material and mode of construction and also giving dimensions and other information not shown in the Drawings". But the Dictionary description will not suffice, Rosen, H.J (1967). As we explore the full meaning of the Term, we discover many areas solely within the province of the specifications which extend far beyond a mere elaboration of the drawings. For example, the specifications alone, as a contract document prepared by the Architect, set forth legal requirements, Insurance requirements, bidding procedures, alternates, options, subcontractor limits, and inspection and testing procedures. In many instances design decisions cannot be shown on the drawings, and the specifications are the only vehicle through which these design considerations may be transmitted to the contractor.

Specifications are written for use by the Estimator in the contractors office who will procure the materials and equipment described in the specifications. They are also written for the project representative or inspector, who must be given a document which will aid him in supervising and directing the work. They are written for the owner, who would like to know what he is buying and what he is entitled to receive. They are written for the sub-contractors, so that each can readily discern the scope of his contract. They are written for the manufacturers of building materials and equipment, so that the grade and type are clearly defined with respect to the many variations they may manufacture.

1.1 Relationship between Drawings and Specifications

Drawings are graphic portrayal of the work and show size, form, location and arrangement of the various elements. Specifications should describe the quality of materials, processes, and workmanship. There should be no duplication between these two documents. To improve coordination between drawings and specifications, there should be standardization of the information appearing in them.

Specifications are, by their very nature, a device for organizing the information depicted on the Drawings. The drawings show the interrelationship of all the parts that go together to make the grand design.

All the general construction details are shown properly on drawings as they relate to one another, with no attempt to separation of diverse materials. It is the specifications that break down the interrelated information shown on drawings into separate, organized, and orderly units of work which we refer to as technical sections of the specifications.

To maintain the separate yet complimentary character of these two documents, and to ensure that they will be interlocking but not overlapping requires the development of definite systems for each. Hence what is better described in the specifications should not be shown on the drawings and, likewise, what is better shown on the drawings should not be described in the specifications.

Drawings should generally show the following information:

- (1) Location of materials, equipment, and fixtures
- (2) Detail and over-all dimensions
- (3) Inter relation of materials
- (4) Schedules of finishes, windows and doors
- (5) Sizes of equipment.

Specifications on the other hand should generally describe the following items.

- (1) Type and quality of materials, equipment and fixtures
- (2) Quality of workmanship
- (3) Methods of fabrication, installation, and erection
- (4) Test and code requirements
- (5) Gauges of manufacturers' equipment.

1.2 Purpose of Specifications

It amplifies the information given in the contract drawings and Bills of Quantities. It describes in detail the work to be executed under the contract and the Nature and quality of the materials and workmanship. Details of any special responsibilities to borne by the contractor, or apart from those listed in the conditions of contract, are often incorporated in this document.

It may also contain clauses specifying the order in which various sections of the work are to be performed, methods to be adopted in the execution of the work, and details of any special facilities that are to be afforded to other contractors or subcontractors.

An excellent arrangement for a building specification is to commence with any special conditions relating to the contract and the extent of the work then to follow with a list of contract drawings, details of the programme, description of the access to site, supply of electricity and water, offices and mesh (rooms) facilities, and statements regarding suspension of work during frost and bad weather, damage to existing services, details of borings if any, ground water levels and similar general matters.

This section could conveniently be followed by detailed clauses covering the various sections of work, commencing with materials in each case and then proceeding with workmanship and other clauses. The specification constitutes a schedule of instructions to the contractor with particular reference to the way in which the work is to be undertaken.

In addition, it often contains general clauses which set out the more important rights and obligations of the parties to the contract (small contracts). For larger contracts, conditions of contract are normally used which prescribe in considerable details the general rights, duties and liabilities of the parties to building contracts, as they may be enshrined in the contract agreements.



1.3 Sources of Information

Information for use in building specifications can be obtained from a variety of sources, and the principal ones are now described.

(1) **Previous specifications:** In the majority of cases specifications for past contracts are used as a basis in the preparation of a new specification for a contract of similar type. This procedure speeds up the task of specification writing considerably, but care must be taken to bring the specification clauses up to date by incorporation of latest developments, techniques and materials. It is also necessary to be constantly on the alert of any changes of specification needed to cope with differences of design, construction or site conditions, as few contracts are really identical. Care must be taken to omit details which are not applicable and insert information on additional features.

(2) **Drawings:** The contract drawings must be the basis of any specifications as they show the nature and scope of the work and frequently contain a great deal of descriptive information. A close examination of the drawings will indicate the matters that are to be covered in the specification. The drawings will also distinguish between new and existing work.

(3) **Employer's Requirements**

The employer may prescribe certain requirements in connection with the work and these will probably need to be included in the specification. Typical requirements of this kind are programming of the works to provide for completion of certain sections at specified dates and the taking of various precautions to minimise interference with productive processes in the employer's existing premises. It is essential that requirements of this kind are brought to the notice of the contractor, as they may quite easily result in increased costs.

(4) **Site Conditions**

With extensions to existing buildings, it is necessary to obtain information on soil conditions, groundwater level and the extent of site clearance work. With alteration work, full details of the existing construction are needed to specify the full nature and extent of the new work. The contractor should be supplied with the fullest information available, to reduce to a minimum the risks

that he must take and the number of uncertain factors for which he must make allowance in his tender.

(5) British Standard sand Kenya Bureau of Standards

British Standards are issued by the British Standards Institution, an organization recognized by the government and industry as the sole body responsible for the preparation of national standards. The institution has a general council which controls a number of divisional councils, one of which is concerned with building, and in addition there are many industry standards committees. These committees are largely responsible for developing industrial standardization as they decide the subjects of new standards and their scope, and approve the draft standards which are prepared by the various technical committees. The technical committees are made up of experts on the subject of the particular standard and consist of representatives of the user, producer, research and other interests.

Thousands of British Standards have now been prepared covering a wide range of subjects. Furthermore, they are kept constantly under review in order that they shall be kept up to date and abreast of progress. They have proved to be an efficient means whereby the results of research can be made available to industry in practical form.

These standards lay down the recognized minimum standards of quality for materials and components and also define the dimensions and tests to which they must conform. British Standards are of great value in the drafting of specifications as they reduce considerably the amount of descriptive work that is required. At the same time they ensure the use of a good quality product and generally meet the 'deemed to satisfy' requirements of the Building Regulations. The standards incorporate the most searching requirements that the latest stage of technical development and knowledge can produce.

Manufacturers and contractors are intimately involved with British Standards and thus can reasonably be expected to have a fair knowledge of the contents of appropriate standards. They will be generally freed from the necessity to examine carefully lengthy specification clauses relating to materials and components. It is however often necessary to specify the class or grade

required where a British Standard incorporates classes or grades. For instance BS 3921 recognises two classes of engineering bricks (classes A and B).

A selection of some of the most common British Standards covering building materials and components used in construction works follows.

BS 12	Portland cement
BS 65	Clay drain pipes
BS 402	Clay plain roofing files
BS 416	Cast iron spigot and socket soil, waste and ventilating pipes
BS 417	Galvanised mild steel cisterns and covers, tanks and cylinders
BS 459	Doors
BS 460	Cast iron rainwater goods
BS 473	Concrete roofing tiles
BS 407	Cast manhole covers, road gully gratings and frames for drainage purposes
BS 544	Linseed oil putty for use in wooden frames
BS 584	Wood trim (softwood)
BS 585	Wood stairs
BS 644	Wood windows
BS 659	Light gauge copper tubes
BS 680	Roofing slates
BS 699	Copper cylinders
BS 743	Materials for damp - proof courses
BS 747	Roofing felts
BS 882, 1201	Aggregate for concrete
BS 890	Building limes
BS 899	Rolled copper sheet, strip and foil
BS 913	Pressure creosoting of timber
BS 952	Classification of glass for glazing
BS 988	Mastic asphalt for building (limestone aggregate)
BS 990	Steel windows
BS 1178	Milled lead sheet and strip

BS 1181	Clay flue linings and flue terminals
BS 1188	Ceramic wash basins and pedestals
BS 1191	Gypsum building plasters
BS 1196	Clayware field drain pipes
BS 1198 – 1200	Building sands
BS 1213	Ceramic washdown WC pans
BS 1230	Gypsum plasterboard
BS 1248	Wallpapers
BS 1281	Glazed ceramic tiles and tile fittings for internal walls
BS 1289	Precast concrete flue blocks for gas fires
BS 1567	Wood door frames and linings
BS 1722	Fences
BS 1860	Structural timber
BS 2028/1364	Precast concrete blocks
BS 2760	Pitch-impregnated fibre pipes and fittings
BS 3260	PVC (vinyl) asbestos floor tiles
BS 3503	Unplasticised PVC pipe for cold water services
BS 3794	Decorative laminated plastics sheet
BS 3921	Clay bricks and blocks
BS 3958	Thermal insulating materials
BS 4449	Hot rolled steel bars for the reinforcement of concrete
BS 4576	Unplasticised PVC rainwater goods

There are many British Standards covering building materials and components and a number of these are constantly being revised and amended whilst at the same time new standards are being formulated. The British Standards Handbook 3, published annually, contains useful summaries of British Standards for building.

(6) Codes of Practice

Codes of Practice are also issued by the British Standards Institution and these cover workmanship requirements and methods of carrying out various classes of work. The following Codes of Practice may be of particular value when drafting specifications for building works.

CP 99	Frost precautions for water services
CP 101	Foundations and substructures
CP 111	Structural recommendations for loadbearing walls
CP 112	The structural use of timber
CP 114	Structural use of reinforced concrete in buildings
CP 121, 101	Walling: Part 1: Brick and block masonry
CP 142	Slating and tiling
CP 143	Sheet roof and wall coverings
CP 144	Roof coverings
CP 151	Doors and windows
CP 152	Glazing and fixing of glass for buildings
CP 153	Windows and rooflights
CP 201	Timber flooring
CP 202	Tile flooring and slab flooring
CP 203	Sheet and tile flooring
CP 204	In-situ floor finishes
CP 209	Care and maintenance of floor surfaces
CP 211	Internal plastering
CP 212	Wall tiling
CP 221	External rendered finishes
CP 231	Painting of buildings
CP 301	Building drainage
CP 304	Sanitary pipework above ground
CP 305	Sanitary appliances
CP 306	The storage and collection of refuse from residential buildings
CP 310	Water supply

The Kenya Bureau of Standards are developed along the same lines as the British Standards and largely relate to materials and components of Building materials available and/or produced in Kenya. Those materials which are not produced in Kenya are either covered by their respective standards from the country of origin or are subjected to Kenya Bureau of Standards Tests into order to allow for their use in the country.

(7) Agreement Certificates (Applicable in Europe)

In recent years the building industry has become increasingly involved in the use and development of a perplexing array of new materials, products and associated techniques. The proliferation of unfamiliar and novel products makes evaluation and selection an increasingly difficult process. The situation is further aggravated by the establishment of firms with little or no experience of building, producing materials or products that have been developed without a detailed knowledge of required performance standards or guidance on actual conditions in use. Nevertheless, the pace of development dictates that some products and processes will need to be used before they have been proved over long periods.

To overcome this problem, the Agreement Board was established by the government in 1996 to investigate new materials, products, components and processes and new uses of established products, and to issue certificates of worthiness where appropriate. The Board established a close working with the European Union and is contributing to the development of common methods of assessment and standards of performance and testing. At the same time, membership of the European Union offers the valuable facility of speedy acceptance amongst other member countries of products granted certificates in the United Kingdom.

During the first 5 year period 1967-71, the Board issued over one hundred certificates. Each of these involved an assessment of the product, its performance related to suitable usage, and devising and carrying out appropriate tests. The samples tested are deliberately chosen as representing the lowest level. Strict quality control has to be maintained to ensure that overall

production is at least as good as the tested samples. The certificate contains details about the proprietary product, the design data appropriate to its use, handling on site and subsequent maintenance. The certificates issued cover a wide range of products from Marleydek sheet PVC roof covering, Thermalite autoclaved aerated concrete blocks, and Ufoam ureaformaldehyde foam cavity wall insulation to the Osmadrain UPVC underground drainage system, Polycell cement paint and Opella plastic taps.

The Department of the Environment notifies local authorities whenever a certificate is issued and is available for consultation on the standard of the product under the Buildings Regulations. Associateships are available on a subscription basis whereby subscribers receive free copies of certificates, a regular newsletter, information sheets and discounts on other documents.¹

The independent safety check in the Agreement system, based on satisfactory performance in use requirements, minimizes the risk of damage in use and subsequent repair, and it ensures compliance with the currently accepted comfort standards where appropriate. The assessment of durability introduces one of the more difficult problems with new materials, especially those for external use. It is now generally accepted that attempts to accelerate the breakdown of products can be very misleading unless there is an adequate background research; the alternative of trying to improve the accuracy of observation on short-term natural exposures is generally more satisfying. It seems likely that the realistic prediction limit is in the range of 10 to 20 years without maintenance other than perhaps periodic washing. The maintenance aspects of the design data on an Agreement Certificate provide a sound guide to the kind of maintenance, which may be needed, and the procedures to be adopted for this work. This can be established and practiced in our country in order to control quality of building materials.

(8) Trade Catalogues

Where proprietary articles are specified, reference should be made to the manufacturers' catalogues for the extraction of the necessary particulars for inclusion in the specification. It is often advisable to quote the catalogue reference when an article is produced to a number of different patterns.

This procedure will reduce the length of specification clauses and will ensure the use of a specific article with which the specification writer is familiar and in which he has confidence. Some public

bodies object to this practice on the grounds that it restricts the contractor's freedom of choice and in some cases prevents the use of local products. Furthermore, it may prevent the contractor from using his regular source of supply and may thus result in higher prices.

(9) Publications

Other publications can be used for reference purposes when compiling a specification such as booklets issued by trade associations, as for example the very useful publications of the Cement and Concrete Association. The annual publication Specification contains a wealth of useful information.

2.0 Form of the Specification

When the specification is accompanied by drawings it should amplify, not repeat; and certainly never contradict the information given on the drawings. The specification should explain the purpose and intent of the drawings more fully and clearly, so that the two documents when taken together leave no doubt as to the work to be executed. Most building operations require both drawings and specification but the specification alone will be adequate for some works, such as re-decorations and repairs.

The specification is a highly technical document and should be written in technical language using appropriate building terms. In this respect it differs greatly from a structural or sanitary report prepared for a client, which is kept as free from technical terms as possible. The architect or surveyor preparing a specification must have a thorough knowledge of the materials and forms of construction that he is specifying and must know exactly how they will be used, in order to draft an entirely satisfactory specification.

A specification should be concise and comprehensive, and avoid duplication of particulars and the inclusion of vague or ambiguous details. Excessively long and involved specifications are apt to produce highly priced tenders. In these circumstances the contractor experiences difficulty in assimilating the document and gains the impression that the requirements of the contract may be more far-reaching than is customary, and so tends to increase his price accordingly. Similarly where the specification places unreasonable risks upon the contractor, he is almost certain to increase the price to safeguard his position. Building specifications normally start with general clauses or preliminaries

which relate to the contract as a whole and define the contractor's general liabilities. The building specification is normally subdivided into trades or works sections, as detailed in the Standard Method of Measurement of Building Works, and each subsection is frequently split into materials and workmanship. The customary trades and works sections are listed in the following schedule and are not entirely coincident.

Traditional trades	Work sections
	Demolitions and Alterations
Excavator	Excavation and Earthwork
	Piling
Concreter	Concrete work
Bricklayer	Brickwork and Blockwork
	Underpinning
	Rubble Walling
Mason	Masonry
Asphalter	Asphalt work
Roofer	Roofing
Carpenter	Carpentry
Joiner and Ironmonger	Joinery
Steel and Iron Worker	Structural, Steelwork
	Metalwork
Plumber	Plumbing and Engineering
Heating and Ventilating Engineer	Electrical Installations
Electrician	Plasterwork and other Floor, wall and
Plasterer	Ceiling Finishings
Pavior	
Glazier	Glazing
Painter	Painting and Decorating
Drainlayer	Drainage
	Fencing

When preparing specifications for works of alteration, conversion and repair, it is often advantageous to depart from the accepted format previously described. Each contract needs to be considered separately and the most logical format adopted. In some cases the natural sequence of work as executed on the site offers the best approach, in others a room by room approach or subdivision of the building(s) into specific parts on a locational basis, or the work may be partly or entirely grouped into trades or work sections as for new work. Some flexibility in approach is desirable to accommodate wide variations in the character, scope and extent of the works.

2.1 Specifying quality

Drawings indicate the quantity of materials to be used and show their finished relationship to each other. It is the written specification that describes the quality of the workmanship, the materials to be used, and the manner in which they are to be assembled. Quality control should be foremost in the mind of the designer. It is a relatively straightforward task to set parameters for achieving quality through the written specification. This is vital because it is the contractor's agent, not the contract administrator, who has control on site.

Trying to define quality is a real challenge when it comes to construction, partly because of the complex nature of building activity and partly because of the number of parties who have a stake in achieving quality. Individuals and organizations concerned with achieving quality include government bodies (regulations, standards and codes), clients (individual and client bodies), manufacturers and suppliers (materials, products and systems), designers (architects, engineers, etc.), assemblers (craftsmen, tradesmen and construction managers), building users (often different from the client and changing over time), insurers and investors. Each group's perception of quality will vary depending on their particular position in the development 'team'. Not surprisingly, there is a great deal of confusion when people talk about achieving quality in construction, despite a growing body of literature addressed specifically at such issues. Usually, the word 'quality' is used in a subjective manner, rather than in an objective sense that can be tested and benchmarked. To confuse the issue further, provision of a quality service does not necessarily mean quality work; nor does a quality building necessarily have to be the product of a quality service.

Before looking at quality levels for materials and workmanship, it is necessary to agree on the quality level of the finished building. The projected life of the building and its use are primary considerations here and should be determined (as far as possible) at the briefing stage. So, too, should the maintenance strategy, life-cycle costing and disposal strategy for when the building has exceeded its design life. Obvious influences on the quality of the completed building are the client's budget and time frame, the composition of the design team, and the choice of contractor. More subtle influences concern the way in which the individuals party to a building project communicate the quality of the project information and the way in which the entire process is managed.

2.2 Quality of materials

Designers can define the quality of materials they require through their choice of proprietary products or through the use of performance parameters. In practice, the determination of quality is a rather complex issue because there are a range of characteristics that must be met, and it is usually necessary to place these in some order of importance for a particular project. Specifiers have to make up their own minds with regard to quality and may not necessarily take the same view as the contractor. The contractor is primarily concerned with getting the contract, thus submitting the cheapest price. to get the job and then to maximise profits during the course of the contract, often through the substitution of products that generate a greater degree of profit. Quality is also dealt with, to a lesser or greater extent, through the use of the master specification combined with the use of approved and prohibited lists of products. The specifier's palette of favourite products could also be viewed as a mechanism for ensuring quality. These issues are taken up in greater detail below.

2.3 Quality of workmanship on site

No matter how good the detail design process and how comprehensive the resulting information, the quality of the finished building depends upon those doing the assembly and those doing the on-site supervision. Designers specify the position, quantity and quality of the building work - they do not tell the builder 'how' to construct it -this is the contractor's responsibility (hence the need for method statements). Choice of procurement route is an important consideration because it will set the contractual obligations of the designers and the contractors with regard to site supervision. With traditional forms of procurement, there are contractual obligations for the project

administrator to inspect the work. With contractor-led procurement routes, such as design and construct the designers may have very little legal say over the quality of construction since it is the contractor who is able to adjust specifications and substitute products without reference back to the designers. For the specifier, the decision to specify using prescriptive and/or performance methods cannot be separated from the type of contract used.

There are two principle users of the written specification on-site, the contractor's site agent and the clerk of works (and/or contract administrator). The written specification is not read frequently enough by site operatives; nor is it understood sufficiently, a situation exacerbated by the use of temporary operatives. Operatives will rely, for the most part, entirely on drawings and tend not to look at the written specification unless ordered to do so by the contractor's agent. Even if they do read the specification, it is unlikely that the standards referred to will be available on site. This may be habit and over-reliance on drawings, but it may well be grounded in a history of poorly written (and hence largely useless) written specifications. In an Australian study, it was found that bricklayers were not familiar with the Australian masonry code and that their work (perhaps not surprisingly) did not comply with it (Nawar and Zourtos, 1994) despite reference to it in the written specification. As soon as there is a problem or difference of opinion on-site, everyone reaches for the written specification to check whether or not the work complies with the standards expressed in the document. For those on-site, the challenge is to be Familiar with, and have ready access to, relevant standards and codes of practice.

2.4 Prescriptive specifications

A prescriptive specification describes a product by its brand name, a proprietary product. For example, a facing brick would be specified as "clay works hand scratched" this gives the name of the manufacturer (clay works) and the type of the brick (hand scratched) from the manufacturer's extensive range. It automatically gives the performance of the brick in terms of size, colour, texture, durability, water absorption, frost resistance, etc., as defined in the manufacturer's technical specification. This method of specification is usually quicker for the specifier than using the performance method and is favoured by designers for materials that will be visible when the building is completed. In the example above, the specifier has been precise and knows exactly what to expect from his selection in terms of appearance and quality.

Manufacturers spend a great deal of time and money in developing new products and/or improving products for which they usually hold patents. This does not stop their competitors from launching very similar products that are cheaper because they have incurred less research and development costs. Whether these alternative products are cheaper because they are of inferior quality is a point for debate, but one worth bearing in mind because there may be considerable pressure to change the specified product during the tendering and building phase of the contract. Furthermore, simply because a specifier has gone to a lot of trouble to carefully select and specify a proprietary product, it does not necessarily follow that the prescribed product will have been used on site. Specification substitution is a major cause for concern, for both specifiers and manufacturers.

One of the inherent problems with prescriptive specification is that of anti-competition. For public works, the practice is not to use proprietary specifications, the principle being that all relevant manufacturers must be able to compete for the work should they wish to do so. This is the case in the United States and Europe. Some large organisations follow similar principles by adding the words 'or equal approved' to allow some choice and competition between suppliers. Proprietary specifying is seen as being uncompetitive and not providing value for money; furthermore, the spectre of corruption is a difficult one to shake off. Performance specifying and compulsory competitive tendering are seen as a way around the problem. However, proprietary specifications are widely used and for very good reasons. For example, the recent trend towards the use of supply-chain management techniques necessitates a working arrangement with chosen suppliers. Although performance standards are used, this arrangement naturally leads to the specification of proprietary products from a particular manufacturer in the chain. Over time, the designers and manufacturers can work together to improve standards and reduce costs, but such arrangements make it difficult for others to compete.

2.5 Proprietary specification (no substitution)

In specifying proprietary products and not allowing substitution, the designer has made a choice and given the contractor precise instructions as to what to use. Responsibility for the specification rests with the design organisation and the implication of not allowing any substitutions is an implied guarantee that the product is fit for purpose and

represents good value for money. Warranties, guarantees, and insurances should be sought from the manufacturer to transfer the implied liability from the specifier's office. The clause 'or equal approved' may be added to provide some latitude for change. Under traditional forms of contract, the contractor cannot make changes without the permission of the contract administrator. Given that a lot of time and effort will have gone into choosing a particular product in the first place, many specifiers are reluctant to change their specification without a very good reason, for example, a problem with delivery or an unforeseen technical difficulty on site. When changes are unavoidable, care should be taken to acquire and check the manufacturer's warranty before issuing the necessary instruction to the contractor in accordance with the contract. Because many changes are made under time pressures, this is not always done in practice but sought after the event; again, it is not good practice and should be resisted.

2.6 'or equal approved'

This clause is common in the majority of prescriptive specifications. By adding 'or equal approved', the contractor has some latitude in changing specified products as long as they are 'equal', and approval is sought from the contract administrator before the change is implemented. The design organisation remains responsible for the final choice of product and has a responsibility to check that any alternatives suggested by the contractor are fit for purpose and equal to that originally specified. Requests for changes must, under the contract, allow the contract administrator sufficient time to consider the proposed alternative. There is also a requirement for the contractor to provide the contract administrator with sufficient information (i.e. the relevant technical details and cost) from which a considered decision can be made. Too often, the contractor merely submits a list of products assuming (or hoping) that the design office has the relevant information. If products are unfamiliar to the office, then literature and samples will need to be sought, which takes time and can be arduous. Care should be taken to ensure that any cost savings are fully documented and passed onto the client (not the contractor). The use of 'or equal approved' can lead to arguments as to whether or not the product is 'equal' (in practice, some characteristics will be, others will not - hence the arguments). Adding 'or equal approved' is one way of dealing with the anti-competitive badge given to proprietary specifying, but we maintain that if a specifier has gone to a lot of trouble to select a particular product, to add such wording would invite substitution and potential problems. Many specifiers use the term 'or similar approved', which is not the same as 'or equal approved' and should be avoided.

2.7 'or equal'

Some designers specify proprietary products and then add the wording 'or equal'. This is an open invite to the contractor to use alternatives without asking for approval and is not considered to be good practice. It is used in an attempt to shift liability for product selection from the specifier to the contractor. If the specified product is used, then the specifier's office remains fully responsible, but if the contractor substitutes a product, then liability is transferred to the contractor. By using the words 'or equal (and not using the word 'approved'), the contractor does not have to seek approval from the contract administrator and can substitute at their own risk. And substitute they will. Uncontrolled substitution for cheaper products is a certainty, and cost savings will not be passed onto the client because the substitutions will have been assumed at tender. The danger with using 'or equal!' is that clients do not get what they think they are paying for: it is the contractor who profits. An additional concern is the quality and long-term durability of the building because substitutions will be made to suit the contractor. Who may not be entirely clear as to the original design intent. In an American study of construction claims, litigation or arbitration related to specifications, nearly 25 per cent of the cases were related to the use 'of equal' clauses (Emmit and yeoman 2001), which was double that of the next most common problem, ambiguous phrasing.

If the term 'or equal' is to be used (and it is not recommended) then the specification should be written to require notice of substitution. This will allow substitutions to be tracked and provide information for an accurate design record of the completed building to be drawn up. There must also be a requirement for the contractor to provide a fitness for purpose warranty. In such situations (of doubt), a performance-specification may be a better option because it transfers the actual choice of product to the contractor but at the same time sets defined parameters of quality.

2.8 Performance specifications

Unlike prescriptive specifications, performance specifications do not identify particular products by brand name; instead, a series of performance characteristics are listed (essentially a technical brief), which must be met. Performance-based specifications vary in their scope. They can be used to describe a complete project, one or more systems, or individual components. For example, clients may produce a performance specification for a design and construct project, engineers may

produce a performance specification for the mechanical and electrical specification, and designers may specify such items as fire resistance and thermal insulation by the performance required {which is quantified). Continuing with the example of the brick, a performance specification would state the required size, colour, texture, durability, water absorption and frost resistance. Depending on the performance standard set, a range of different manufacturers' bricks may satisfy the required performance. This leaves the choice of product to the contractor and is popular in contractor-led procurement routes, such as design and construct, because it gives the contractor greater flexibility over-product selection. Whether or nor the contractor chooses (or whatever else the designer may have had in mind) will depend to a certain extent on how tightly the performance requirements have been written

In passing the choice of product to the contractor, the contractor is given a design function and in doing so is expected to exercise reasonable care and skill in the same way as a designer. With performance specifications, it is not uncommon for the contractor to make last-minute changes to products in order to save money or meet programme deadlines. Care should be taken to record the final product choice, both as evidence in the event of a claim and for reference when alterations are made to the building. It is also important to check that the product selected complies with the performance specification required; sometimes, they do not, the contractor hoping that the specifier does not have time to check thoroughly. Performance specifications are generally regarded as being more difficult and time-consuming to write than prescriptive specifications, but they are used for complete buildings (e.g. design and build contracts) and for sub-systems (especially building services and prefabricated building systems). One of the main challenges for the designer is deciding on the level of performance required: too narrow, and the tender is given little latitude; too wide, and the scope becomes too great to make sensible comparisons from the solutions presented by competing contractors. Care is needed to establish levels of performance that suit the project and the client. Performance specifications tend to be used by client organisations keen to leave the choice open (in the hope of getting the same performance cheaper than if a proprietary product was used). One argument put forward is that performance specifications are more effective in ensuring constructability and hence value for money on behalf of the client. There is little evidence to support this claim; indeed it could be argued that a good design team could ensure constructability and value for money through the use of

prescriptive specifications. It would be misleading to suggest that one method is better than another, rather that different situations require different approaches.

2.9 Open and closed performance specifications

Performance specifications are sometimes referred to as 'open' or 'closed', depending upon the amount of latitude provided by the required performance criteria. An open (loose) performance specification would be written in such a way as to allow a great deal of freedom of choice for the contractor. A closed (tight) performance specification would be written in such a manner as to severely limit the choice of the contractor, sometimes to one or two possible products. Some specifications are so open as to render them worthless. However, some are so closed (usually because a manufacturer's performance specification has been copied from their technical literature by the specifier) that a descriptive approach would have been less time-consuming for all concerned. The designer's office is responsible for the performance specification because, if met, the solution will be fit for its purpose. The contractor remains responsible for ensuring the solution meets the performance criteria.

2.10 Open Specifications

In addition to the use of prescriptive and/or performance specifications is the 'open' specification. These vary from the unintended (and possibly negligent) to their deliberate and considered use.

2.11 Open (silence)

Where there is silence in the documents, i.e. a particular item is not specified; it is referred to as an 'open' specification a situation that usually arises because the specifier has forgotten to specify a particular item. For very minor items, most contracts allow for such situations, and the contractor assumes responsibility by choosing a particular product to suit. However, for major items missing in the specification, then the specifier's office is probably negligent for not specifying, and responsibility lies with the design office. Clearly, it is difficult to decide what represents a minor item and what represents a major item and caution is required. Careful checking procedures should limit the number of omissions in the documentation. An instruction will be necessary to rectify the silence, and there will be an additional cost to the contract that someone has to pay for.

2.12 Open (qualified silence)

Qualified silence is different to silence. An example of qualified silence would be a description such as 'use an approved undercoat', which, although considered, is another way of not specifying, some would argue a lazy way of specifying. Responsibility remains with the design organisation as long as the contractor submits details for approval, essentially, a way of delaying a decision and one that may slow down the contractor if approval takes some time to resolve. In the majority of cases, it would be better to specify a proprietary product or use the performance method.

3.0 Writing the specification

The primary aim of the written specification is to convey information to the reader that cannot be easily indicated on the drawings and schedules. The contents of the document will be concerned with the quality of the materials and the quality of the workmanship, neither of which can be adequately shown on drawings. Although a large proportion of the document will be common to many different projects by many designers, specific details will be dependent upon the nature of the particular building being specified and the design philosophy of the designer or the design office. As noted above, writing the specification does involve considerable knowledge of construction, materials and working methods in addition to good writing skills if this practical document is to be of value to the reader. A guide to specification published in 1930 noted that a complete knowledge and understanding of the details of building construction, properties and cost of materials were paramount. Until this was mastered, it would not be possible to write a specification (Macey, 1930), a sentiment that hold true today.

Badly written. Specifications will result in claims for extras from the contractor. Willis and Willis (1991) claim that there are two essentials to specification writing: to know what is required and to be able to express such requirements clearly {echoing macey's earlier advice). They note that many specifications fail because of shortcomings in the first stage. There may have been insufficient thought and/or insufficient knowledge of building construction.

- (a) 1 Insufficient thought. To accuse professionals of insufficient thought may, on first sight, be a little unfair. As professionals, architects and other consultants have a duty of care to their clients and are expected to behave in a 'professional' manner. They should be

capable of applying sufficient thought and sufficient knowledge to the problem in hand. However, insufficient thought may be given to a specification more because of a lack of adequate resources, especially time, rather than because of simple incompetence. It matters little how knowledgeable or how good an individual is if inadequate time is allowed to consider the options carefully, to make an informed decision and confirm this decision in writing within the specification.

- b) 2 Insufficient knowledge of building construction. At first sight, one might assume that insufficient knowledge is only a problem for those just starting work in the building industry. Little time is spent teaching architects the art of specification, and many observers of architectural education world wide have become increasingly critical of the small amount of technical instruction within architectural programmes (Emmit and Yeoman.(2001)). Because of this, young practitioners have to learn through experience in the design office and thus require close supervision and support in their early years. However, problems of insufficient knowledge can also arise when an experienced designer is" faced with a new type of building, a new problem or new products. Again, time is required for the individual to acquaint himself or herself with the new information before informed decisions can be made.

Naturally, to express requirements clearly in the specification, the writer first has to know what is required. Vague specifications are often an indication that the decision-making process had not been resolved at the time of writing. Bowyer (1985:11) sums it up rather neatly:

Unless the designer knows what he wants he cannot expect either the specification writer to describe it, the estimator to price it or the builder to construct it.

Both of the essentials identified by Willis and Willis can be addressed through:

- adequate time to complete the task, i.e. good programming and management;
- easy access to current and relevant information;
- employment of experienced staff;

- close supervision of less experienced staff;
- continual education and training.

3.1 Adopting a systematic approach

The order in which the specification is written will be determined by the characteristics of the individual and any office procedures. Critical is the ability to approach the task in a logical and ordered manner, completing one section before moving onto the next. Preliminaries are often the last section completed because they are largely independent of the work sections. It is good practice to specify the work required before attempting to complete the materials and workmanship clauses, i.e. to identify what needs to be done and then what materials and methods should be used to achieve the task. Consistency is the key, and using industry-standard formats helps this. In situations where a non-standard format is used, it is essential that the document is set out in a logical manner, complete with an index of main headings to guide the reader. An ability to accommodate design changes and information from others who are party to the design process is also required, in short, the ability to organise one's own work within the programmed time-scale. One way that specification writers can maximise their time and co-ordinate the input of others in the design process is through the use of master specifications. These reduce the costs associated with producing the written document.

3.2 Standard formats

Well-managed design offices recognise the importance of consistency, and the majority have developed standard formats for a variety of tasks, including the written specification. Standard formats can save an enormous amount of time, but care should be taken to ensure that errors are not being transferred from one project to the next through lazy copying without due care. Over time, different countries have developed their own 'standard' specifications as a means of guiding specifiers and also in an attempt to bring some form of consistency and common documentation to the building process, examples being America's CSI SPECTEXT, Australia's NATSPEC, the Netherland's STABU, Kenya's MOW standard specifications and the UK's NBS. Although these are widely promoted and used, other specification packages are available from commercial suppliers, in addition to which

large design organisations tend to use their own particular system. As a result, these 'national' systems have never become universally used.

There is a powerful argument for everyone in construction to use the same system, although this ideal does not seem attainable in the foreseeable future. National systems are a useful tool in ensuring clear, concise and {more importantly} familiar documentation for individual projects. In addition to their economic advantages to both designer and contractor (and hence client), there should be less likelihood of ambiguity and confusion caused by unfamiliar looking documentation. Assuming, for one moment, that everyone in construction could agree to adhere to a national format for specifications, this would form part of a quality-assurance package for the industry. One might be tempted to suggest that some of Construction's persistent ills could be eased by such an approach. Perhaps, this is wishful thinking, and there are also arguments against this approach. National standards do tend to be (too?) complex, and the format and defaults may not be to everyone's taste. Time and skill are required to understand them and apply them correctly, so that they are just as open to misuse and abuse as other systems.

3.3 National Building Specification (NBS)

In the UK, the National Building Specification (NBS) is widely used. Available as computer software, it helps to make the writing of specifications relatively straight forward because prompts are given to assist the writer's memory. Despite the name, the NBS is not a national specification in the sense that it must be used: many design offices use their own particular hybrid specifications that suit them and their type of work.

NBS is only available via subscription to the service provider, which ensures that the user has a document that is kept up to date through regular revisions. The NBS is an extensive document containing a library of clauses. These clauses are selected and/or deleted by the specifier and information added at the appropriate prompt to suit a particular project. The NBS ensures a consistent format, and the provision of prompts reduces the danger that some element is forgotten. However, as with all templates, the quality of the finished specification still depends upon the ability of the individual to fill in the gaps. The NBS is available in three different formats to suit the size of the

particular project, ranging from Minor Works (small projects), to intermediate, and Standard (large projects).

3.4 Specification language

Specifications do have their own language: a language that takes the inexperienced specifier and contractor some time to understand and become familiar with. However, there are guides, and standard formats can go a long way to achieving consistency. Consistency of word usage is key to a well-written document, and the writer must take care always to use the same word or phrase in the same sense throughout the document if confusion of the reader is to be avoided. For example, one of the most common causes of confusion can arise when specifying sizes of components; all sizes should be either 'unfinished' or 'finished' sizes. Where it is necessary to use both conventions, it is important that the specifier makes it clear to the reader whether each size specified is 'finished' or otherwise.

Standards and Codes of Practice can, if used carefully, help to shorten the description of a particular material. The extent to which British (BS), European (EN) and International Standards (ISO) and Codes of Practice are included in a specification is often a point for debate. No one designer will have a working knowledge of all the relevant standards and codes; nor, for that matter, will the contractor. It is the specialist sub-contractors who will know and understand the standards and codes that apply to their particular area of expertise. Many of the standards have sub-divisions relevant to the same material, and so the specifier must make sure that the reference number quoted includes the correct sub-division. A good rule of thumb is to specify only standards that the specifier and/or the design office are familiar with. Unfortunately, it is common practice to quote general standards without taking sufficient care (because of a lack of time or simply through laziness) to ensure that it applies to the particular job, and the specification then becomes somewhat meaningless. This is a particular problem with rolling specifications from one job to the next and, to a lesser extent, with the office master specification, if not maintained on a regular basis.

3.5 Imperative or indicative mood

The manner in which a specification is written is important and can help in reducing repetitious and tedious sentence structures. Specifications can be written in the imperative mood or the indicative mood. The imperative is preferred for its clarity (CSI, 1992; Cox, 1994).

- Imperative mood. The imperative sentence is concise and easily understood because the verb that defines the action forms the first word in the sentence. The reader is directed by verbs such as Apply, Install, Remove, etc. The imperative mood is seen as the major factor in producing clear and concise text, makes it quicker to write (and read) and hence saves time and money. Example: 'Apply two coats of emulsion paint to
- Indicative mood. The indicative mood is written in the passive voice. Sentences require the monotonous use of 'shall' and can be unnecessarily wordy. Example: 'Two coats of emulsion shall be applied to

3.6 Style

Proper style will ensure clarity, brevity and accuracy. The style adopted should be consistent within the design office regardless of the degree of detail required for a particular project. Specification writers should use:

- short sentences;
- simple sentence structure;
- plain words and terms.

Certain phrases should not be used in specifications (or on drawings). A favourite for work to existing buildings is '..... to match existing'. For the majority of existing buildings, directives such as 'brickwork to match existing' is impossible to comply with, simply because the exact brick is no longer produced, and so a brick that is a very close match is used. Moreover, such descriptions invariably forget to mention items that may not be apparent to the contractor. The specifier may be aware that lime mortar is used in the original work, but this need not be apparent to the contractor, who may assume the use of a cement mortar. This phrase is a quick and convenient way of not specifying.

3.7 Clarity, brevity and accuracy

The specification must be written in such a manner that it conveys the intentions of the designer to the contractor. This may appear to be an obvious statement, but specification writers must constantly bear in mind the fact that readers of the specification will not have been party to the decision-making process that led to the contract documentation. The readers can only read the documentation to see what is required of them. There is need to be able to express one's intentions

clearly, for which sufficient thought and sufficient knowledge of construction are prerequisites. In many respects, the use of 'standard' specifications has helped individuals to write specifications because the format is already supplied. The writer then has the relatively simple task of deleting the clauses that do not apply and adding information as appropriate.

Designers have their own way of working, and many have 'golden' rules that they apply when designing, detailing and writing specifications. In offices where managerial control is not particularly good, this can and does lead to information taking a variety of slightly different forms, reflecting the idiosyncrasies of their authors, The end result can look unprofessional, can lead to confusion and, in the worst case, can result in errors on site. Professionally managed design offices take a much more considered and controlled approach. Designers work to office standards of graphic representation and to a standard approach to detailing, product selection and specification writing. six "golden rules" are suggested by Emmet and Yeoman(2001):

1. **Clarity and brevity.** The most effective information has clarity and is concise. This is far easier to state than to achieve because it is impossible to represent everything in an individual's mind on a drawing or in text. The skill is to convey only that which has relevance and hence value to the intended receiver. This can be a matter of knowing when to stop writing. This will help the receiver to avoid information overload and enable him to concentrate on the relevant information without unnecessary distraction. Describe items once and in the correct place. Repetition should be avoided.
2. **Accuracy.** It is important to be accurate in describing requirements because confusion will lead to delay and errors on site. Use correct words to convey exact instructions, use correct grammar, units and symbols, and avoid ambiguity. Words and-symbols should be used for a precise meaning and be used consistently for that meaning throughout the document. Instructions should be given accurately and precisely. Use a limited vocabulary of words. The document should be complete; do not leave out important information or leave clauses partially completed.

3. **Consistency.** Whatever the approach adopted by the design office and the individuals within it, it is important to be consistent, both in the meaning of words and in the approach to specification decisions. For example, if specifiers do have an individual and different approach to detailing, those on the receiving end should be able to interpret instructions as long as the approach remains the same. Use of graphics, dimensions and annotation should be reassuringly consistent across the whole of the contract documentation. CAD packages and the use of the Cl/SfB should both had to achieve this goal.
4. **Avoiding repetition.** Repetition of information in different documents is unnecessary, is wasteful of resources and, when repeated slightly differently (which it invariably is), can lead to confusion. Repetition, whether by error or through an intention to help the reader, must be avoided both within and between different media. Eliminate unnecessary words and sentences in the written specification and avoid notes on drawings wherever possible. Be concise.
5. **Redundancy.** There is always a danger that superfluous or redundant material will be included in a project .specification. Text from the master specification may be redundant because it is not relevant to a particular project. Rolling specifications from one project to the next invariably result in redundant text. A favourite example comes from a large refurbishment project where the specification said 'Remove defective render

There was no render on the project. In this example, the specification had been rolled from another project that did have rendered walls. The document not only becomes larger than it should be but will lead to confusion and may well undermine the credibility of the written specification (and those who contributed to it). Careful editing should help to remove the majority of redundant material.
6. **Checking.** Check and double check for compliance with current codes and standards, manufacturers' recommendations, other consultants' details and compatibility with the overall design philosophy. Common problems encountered by site personnel can be reduced significantly through a thorough check before information is issued to the contractor, and not too long ago, it was common for drawing offices to employ someone

to check all drawings and specifications before they were released from the office. Unfortunately, in the constant drive for efficiency and ever-tighter deadlines for the production of information, such checks have been left to the individuals producing the information. Self-checking is suspect and subject to error simply because of the originator's over-familiarity with the material. Managerial control is essential in this regard and must be costed into fee agreements. Checking for omissions and errors, accommodating design changes and auditing the process through quality management systems can save time and confusion.

3.8 Typical specification formats

Building specifications, whether for new or alteration works, have two main types of clauses. First are those that describe the general conditions under which the work should be carried out and various obligations of employer, contractor and designer. Second are those that describe the materials and workmanship required in detail. The contents of a typical specification are grouped under common arrangement work headings from-A to Z:

- A Preliminaries/general conditions
- B Complete buildings
- C Demolition/alteration/renovation
- D Groundwork
- C In-situ concrete/large precast concrete
- F Masonry
- G Structural/carcassing metal/timber
- H Cladding/covering
- J Waterproofing
- K Linings/sheathing/dry partitioning
- L Windows/doors/stairs
- M Surface finishes
- N Furniture/equipment
- P Building fabric sundries
- Q Paving/planting/fencing/site furniture

- R Disposal systems
- S Piped supply systems
- T Mechanical heating/cooling/refrigeration systems
- U Ventilation/air conditioning systems
- V Electrical supply/power/lighting systems
- W Communications/security/control systems
- X Transport systems.

4.0 Selection criteria for building materials

There are many factors to be considered when selecting and evaluating materials or products to be used in construction. It is imperative that the specifier have a full understanding of the problem confronting him. Partial or incomplete assessment can cause problems or failures since all possibilities have not been evaluated. It is therefore essential to state the problem and then to determine all its parameters.

At the outset, define the problem in terms of its needs to satisfy the design requirements.

The needs or major considerations to be investigated can be listed as follows:

1. Function
2. Aesthetics
3. Serviceability and environment
4. Compatibility
5. Construction demands
6. Code requirements
7. Economics
8. Maintenance

The initial determination in the evaluation of a material must of necessity deal with function. For function, materials are evaluated on the basis of sound reduction, thermal efficiency, fire safety, weather proofing, and other similar requirements. Parameters for each function must then be established and investigated.

Sound reduction may involve sound absorption and/or reduction in sound transmission.

For sound absorption, the criterion is the noise reduction coefficient (NRC). The NRC should be determined for the space involved and then various materials can be reviewed for this rating from which to make the selection. If reduction in sound transmission is essential, the materials or composite constructions are reviewed with respect to the Sound Transmission Class (STC).

When fire protection is essential, the parameters for the building material or product to be checked against include flame spread, or combustibility, or hourly rating.

When thermal efficiency or heat gain or loss is required, the parameter that the material or product must be equated against is its K factor or conductivity which is the time rate at which heat flows through a homogeneous material 1 in. thick by 1 ft² in 1 hr when the temperature difference is 1°F.

Weather proofing can involve water infiltration, moisture migration, vapor transmission, or other similar conditions. In each instance the parameters must be determined and the materials in question investigated to meet the criteria established. For vapor transmission, for example, a specific perm rating might be required and the material would be judged against this requirement.

However, after an investigation is made into the functional aspects of the material, the specifier must then take into account the other needs or design requirements. Not all materials require an evaluation concerning its aesthetics, especially if they are hidden or not exposed in the final construction. However, a sealant that is visual requires an assessment as to whether specific colours will not cause problems. A paint or coating with special requirements for colour, texture, or gloss can be affected in so far as its life potential is concerned since reformulation to meet these requirements can alter the physical properties.

Serviceability and environment are the next variables to be investigated since these determine the durability of the materials under consideration. Serviceability is dependent

on its use, whether it is an interior material subjected to people usage or an exterior material subjected to the environment. The service life within a structure subjects materials to the hazards of people in the form of wear, abrasion, vandalism, or rough usage. Service life within an industrial plant exposes materials to moisture, chemical interaction, industrial fumes, impact, fork lift trucks, skids, and so on. Environmental hazards to which exterior materials are subjected is their relationship to weather conditions. Weather factors that interact with materials are water, ozone, ultraviolet light, wind pressures, hailstones, snow, ice, temperature variation, and combinations of these elements. Again, the degree to which the material or product is subjected must be established to ascertain its performance.

For example, a function involving sound control in an enclosed swimming pool area would require the use of an acoustical material. However, the serviceability factor to be considered is the significant amount of moisture present in the space. The durability of the acoustical material selected to withstand the effect of moisture is of prime importance. A gypsum or wood fiber product would be susceptible to swelling and subsequent damage. A ferrous metal suspension system for the acoustical material would be subject to corrosion. The search for an acceptable system to endure the environmental atmosphere which is a measure of its service life would be narrowed to the selection of a corrosion resistant and moisture resistant material.

After the functional, aesthetic, and serviceability attributes are determined, the specifier must then investigate whether the material under consideration will be compatible with other materials that are combined with one another in a specific detail. The compatibility or ability of several materials to function together without deterioration, degradation, or interaction must be investigated. Generally, the chemical composition of each of the materials in a composite design requires investigation to forestall or minimize the incompatibility. For example, a sealant in an expansion joint must be equated against the filler material and the substrates forming the joint to insure compatibility since incompatibility can result in staining the substrate, reversion of the

sealant, adherence of the sealant to the filler in the joint, or other symptoms of degradation.

The next step is to take into account the problems inherent in construction demands, such as hazards, procedures, and sequences. A construction hazard, for example, is the location of a materials hoist alongside an exterior facade which can result in the deposition of corrosive materials such as concrete or plaster spattering. Erection sequences can cause delay in the application, of covering materials thereby necessitating special precautions or protective measures.

In selecting materials for waterproofing, the specifier must provide a method of protection that will ensure the integrity of the waterproofing during the construction phase. Recognizing that construction will continue on top of waterproofing before final surfacing materials are placed over it, the specifier will require the introduction of a protective covering such as concrete topping, impregnated board, or other materials that will be permanently incorporated in the construction. It is therefore essential to review the selection of a material, determine whether the construction process will have an adverse effect on its properties, and build in certain safeguards if this possibility exists.

Code requirements impose additional constraints that must be investigated to determine whether a material will meet these requirements. Codes impose requirements for fire safety, health, noise abatement, strength, and so on. A material required for a specific function must, after being reviewed for the preceding design requirements, meet the additional requirements imposed on it due to the law of the place of building, namely, the local building codes.

Economics also play a very important role in the evaluation and selection of material. The proposed structure as determined by the building owner will be assumed to have a specific service life of 20, 40, or 50 years. When judgments are made for specific materials, one takes into account the life span of the structure and determines which of the materials will meet the lowest acceptable time elements and be able to perform its selected functions.

The final attribute to be considered is the ease of maintenance of a specific finish material. Some materials may be inexpensive in terms of initial costs. However, a building owner may very well desire maintenance free, or relatively maintenance free, surface and will equate its initial installation plus maintenance cost over its long-term investment and decide in favor of a relatively expensive one-time installation cost.

5.0 Cost and new products

It is not an easy task to establish the cost of some proprietary products, nor is it easy to separate out the cost of the product from the cost of the service provided by the manufacturer. This is an important point to make, simply because the service provided to the specifier will be different from that provided to the contractor. For example, the specifier will require technical details and possibly help with detailing and writing product-specific specification clauses, and the contractor will require information on delivery, costs and possibly assistance with issues relating to buildability on site.

5.1 Principal costs

There are three principal costs to be considered at the outset of a construction project, the initial building cost, the cost of the building in use, and the recovery cost.

5.2 Initial cost

Also referred to as the acquisition cost or the development cost, the initial cost covers the entire cost of creating, or remodeling, the building. For many clients, this is their primary, and often only, concern. Initial costs cover land/building acquisition costs, professional consultants' fees, the cost of the materials that comprise the completed building, and the cost of putting it all together. Cost reductions may be possible by selecting less expensive building materials and reducing the amount of time required to assemble them on site, but this assumes that these costs can be discovered.

5.3 Cost in use

Otherwise known as the running cost or operating cost, the cost in use is set by the decisions made at the briefing stage and the subsequent decisions made during the design and assembly phases:

affected by the choice of materials and the soundness of the detailing. For many years, running costs were only given superficial attention at the design stage, although this has changed with the use of life-cycle costing techniques that help to highlight the link between design decisions and costs in use. Materials and components with long service lives do cost more than those not expected to last so long and designing to reduce both maintenance and running costs may result in an increase in the initial cost. However, over the longer term, say 15 years, it might cost the building owner less than the solution with lower initial cost. It is a question of balancing alternatives at the design stage and educating the client about building costs in use because many clients will need some encouragement to part with their money up front.

5.4 Recovery cost

There is a third cost that is rarely considered—the cost of demolition and materials recovery. This is partly because the client may well have sold the building (or died) long before the building is recycled and partly because such costs are traditionally associated with the initial cost of the future development. Again, this may be of little concern to the current client who is looking for short-term gain with minimal outlay. However, if we are to take environmental issues seriously, then the recycling potential and ease of demolition should be considered during the design phases and costed into the development budget.

5.5 Cost of individual products

The cost of proprietary products is not always known to the specifier at the time of selection. There are a number of reasons for this. First, manufacturers are often reluctant to give the cost of their products to the design team, for fear that the specifier will choose simply on price and not on value. Second, in the UK and commonwealth countries, where it is common to employ a quantity surveyor (QS), it is the QS who gets the cost information, not necessarily the specifier. The effect of this is that some designers show a lack of interest in the cost of building components. The actual cost of the product to the main contractor will be determined by the relationship that the contractor has with the supplier and/or builders' merchants and the level of discount provided by the merchant on certain materials.

There is of course, no such thing as a 'free lunch'. If drawings and specifications are provided free of charge by manufacturers, then the cost of this service is built into that of individual products. Companies offering this service provide added value for specifiers, although the client does not obviously benefit from this service. Guarantees and warranties offer a degree of comfort to the specifier, although such insurances are only valid whilst the company is still trading, and only valid if the product has been installed as stated. Furthermore, product-specific guarantees may be valid only if the product has been installed by an accredited installer. Some products should only be installed by a number of specially trained and certified installers, which should help to ensure quality workmanship. There may be an increase in cost for this, but experience shows that the finished work is of a higher standard, and less problems occur during the installation.

5.6 Availability

Availability should be checked directly with the manufacturer. This is especially important when materials, components or systems are being specified that take time to transport to the site and/or have to be manufactured to order. Availability can have, major implications for the programming of the construction works, both for the designer and for the contractor. Checking availability at the specification stage can help to eliminate problems later in the contract. This is true of both prescriptive and performance specifications - there is little point in writing a specification for a particular element that takes 6 months to manufacture and deliver to site when dealing with a fast track project unless it can be pre-ordered and programmed for. Early involvement of project managers, specialist sub-contractors and suppliers will help to define clear and achievable programme deadlines. This can be of great assistance to the specification writer in helping to determine his or her choice of product(s). Availability, or rather the lack of it, is often used as an excuse by contractors for substituting products on site.

5.7 New Products

For new products there are two major areas that involve materials evaluation. The first deals with the development of a product or a material to fit a particular situation created by specific requirements. The second involves an evaluation of the properties of

a newly developed material or product to determine if the manufacturer's claims match his test results, thus warranting the use of his product.

For a product to be developed to meet a specific requirement, the specifier must establish the conditions under which it is to be used and the criteria for testing and acceptance. For example, if a floor is to be subjected to unusual hazards, such as moisture, acid spillage, hot jet fuels, and printers' ink, a standard flooring material might not be available to satisfy all the design conditions. The specifier would have to establish the design criteria. He would have to determine which unusual fluids would be likely to spill on the floor and to what extent the proposed flooring should resist the effects of such spillage. He would have to take into account resistance to abrasion, slip resistance, indentation, hardness, heat resistance, and similar factors. He can establish the parameters by selecting certain quality control standards (B.S. OR Kbs) test procedures by which these characteristics would be measured. After he determines which test procedure to use, he can set minimum and maximum values for the test results and ask manufacturers to formulate a product to meet these criteria. The end product by a manufacturer could be an epoxy, neoprene, polyester, acrylic, or a urethane formulation. The specific basic ingredient is not important to the architect and specifier. The end result or performance characteristics determined by the materials evaluation is all that is essential.

New products are developed by manufacturers either to fill a specific need or to improve existing products. For the most part, manufacturers have been taking the lead in developing new products rather than architects. After they are developed, the manufacturer proceeds to bring the items to the attention of architects and specifiers. Where the products are referenced by the manufacturer to a reference standard, such as a federal specification, ASTM, or ANSI, Kbs, or B.S specification, there is no major problem involved with evaluating, the new product. However, many new products are specifically designed by the manufacturers to keep ahead of their competition. In these cases, the physical and chemical properties are not referenced to known standards. A specifier investigating these products finds them difficult to evaluate without normal

standards of comparison. Sometimes the manufacturer develops his own test methods, and the results have no correlation with standard test procedures.

What procedures does a specifier follow in evaluating new products? He must take several factors into account. The integrity of the manufacturer. Has he had a successful record in the past for developing good products? Has he field tested the new product? Is there any correlation between his field tests and his laboratory testing? Has he tested the significant properties of the product?

The reliability of the source of information and its authenticity should be investigated. Check with other architects and engineers if they are given as references to determine whether the condition of use is similar to that proposed for your project. Demand additional test data if necessary. Suggest specific properties to be tested.

Review the problems to be encountered in the field in the handling and installation of a new product. Will there be an adequate fully trained corps of trades who understand how to handle the new product? Are there franchised applicators? Are there any special precautions to be observed with respect to volatile solvents, flammable materials, or staining of adjacent surfaces?

The evaluation of new or untried materials for possible use should include discussions with the manufacturer to obtain long-term guarantees to insure additional safeguards for the client and the design professional.

6.0 Staying up to date-a constant challenge

Professionals have a duty to stay up to date with current regulations and codes, current building practices, changes to forms of contract, and developments in materials and products, both new products and those rendered obsolete. Although this may sound a relatively easy thing to do, in practice, it presents a series of challenges. One of the problems facing many designers is that they do not need to access the information sources all the time. Indeed, many designers work on many different stages of jobs, and the physical act of specification writing does not take up a great

deal of their time. This is particularly so of designers who run a project from inception to completion, mainly those self-employed and working in small offices and/or on small projects. For these individuals, access to information to assist them with the specification writing may only be required every 12 months or so, and then only for a few weeks until the task is complete: they therefore need a reliable and current source of information that can be accessed quickly.

Organisations that subscribe to one of the information providers, such as the NBS, are kept up to date with the majority of new developments that affect specification writing. If not, they will have to rely on reading about changes in the professional journals and trade information. In practice, the majority of practitioners try to stay up to date through information from a variety of sources. Knowing where to find a particular piece of information in a crisis is one of the prerequisites of staying in a job. More specifically, the specifier needs to keep up to date with:

- Building regulations and codes. Subscription to one of the on-line information providers will ensure that the regulations and codes accessed during the design and specification process are current.
- Building practices. Staying up to date with current building practices is a little more problematic. In part, this is because it is rare for two designers to agree on the best way of detailing and specifying a building.
- New materials and products. Manufacturers are constantly seeking to improve their products and expand their market share; thus, products may be 'improved' or replaced as part of their strategy. Specifiers have to keep up to date with these developments in order to specify effectively. Another problem is keeping up to date with materials and products that may no longer be available, perhaps because of safety concerns or simply because the product was not commercially viable.

7.0 The impact of specifications on building construction cost rates

The impact of specifications on building construction costs of different materials can be illustrated through examples in a selected building materials or components. Where the specification requirements are high in order to meet the “Fit for Purpose” requirements of the material or component the prices/costs are also high.

The factors affecting choice of building product have always been its properties, its cost and its availability. However, a number of other factors are dependent upon legislation. Such factors include safety of the product (both during construction and in use), its estimated durability in use, its embodied energy and its environmental impact. In practice, some of these factors will conflict. Specifiers have to make a choice within the time and budget available and use their professional judgment. Notwithstanding the above statement illustrations on the impact of specifications will be based on the following trade sections.

- (i) Concrete works
- (ii) Walling
- (iii) Roofing materials
- (iv) Windows
- (v) Doors and
- (vi) Finishes.

Table 1.1: The Impact of Specifications on Building Construction Cost Rates Per Unit of Work

INSITU CONCRETE WORKS		UNIT	RATE (KSHS.)
1.	Plain concrete Class X mix 1:4:8 Blinding	CM	5,337.00
2.	Mass concrete 1:3:6 Class Q in foundations	CM	6,057.00
3.	Vibrated reinforced concrete class 20/20mm (1:2:4) in foundations ground beams/stairs/columns/bases	CM	7,893.00
4.	Vibrated reinforced concrete class 25/20mm (1:1½:3) in foundations/ground beams/stairs/columns/bases.	CM	8,645.00

5.	Ditto class 30/20mm (1:1:2) in ditto.	CM	11,249.00
WALLS			
6.	90mm thick concrete block walls	S.M.	664.00
7.	190mm thick concrete block walls	S.M.	956.00
8.	100mm thick machine dressed (Juja) natural stones jointed and bedded in cement and sand (1:3) mortar.	S.M.	857.00
9.	225mm ditto	S.M.	1,185.00
10.	225mm Ditto Thika natural coloured quarry chiselled stones ditto.	S.M.	1,722.00
ROOFING MATERIALS			
11.	26 Gauge versatile roofing sheets.	S.M.	1,053.00
12.	Mangalore interlocking clay roofing tiles from Clay Works Ltd.	S.M.	442.00
13.	Green interlocking concrete roofing tiles from Mareba Ltd.	S.M.	798.00
WINDOWS			
14.	1500mm x 1200mm Galvanized standard steel casement windows (glass m.s.)	No.	3,995.00
15.	1500mm x 1200mm bronze anodized standard framed aluminum windows (glass m.s.)	No.	14,526.00
DOORS			
16.	50mm thick solid cored flush door size 820mm x 2060mm overall.	No.	2,526.00
17.	Ditto mahogany veneered both sides.	No.	5,712.00
18.	50mm thick mahogany door size 820 X 2060mm overall with 4 fielded and raised panels.	No.	14,707.00
FINISHED FLOORS			
19.	40mm thick cement and sand (1:3) steel trowelled floor paving.	S.M.	323.00
20.	38mm thick Granolithic floor paving	S.M.	557.00

21.	38mm thick terrazzo floor paving	S.M.	777.00
22.	10-12mm thick polished Athi River granite floor slabs, 200mm wide.	S.M.	7,868.00
23.	8mm thick Elgon teak parquet floor tiles (including sanding)	S.M.	1,176.00
24.	100 X 25mm Mahogany strip flooring.	S.M.	3,018.00

Source: *Ministry of Roads and Public Works. Cost Planning Unit. Current construction rates May 2007.*

From table 1:1, it is clear that when the concrete specifications changes from plain concrete mix (1:4:8) and (1:3:6) to vibrated reinforced concrete (1:1½:3) and (1:1:2) the cost per unit of work done changes substantially from KShs. 5,337/= /m³ to KShs. 11,249/= /m³. This change is occasioned by the change in the quality of concrete from a weak mix to a strong mix which is used for reinforced concrete structures.

On the part of walls, when the specification changes from solid concrete block to natural stone walls, again we experience a change in unit cost of walls. Likewise when the thickness of the walls change, there is a corresponding change in the cost per unit area of the walls. When the specification for 225mm thick natural stone wall changed to Thika coloured natural stone walls, the cost per unit area changed substantially.

On the roof covering, when the specifications changed from versatile roofing sheets, clay interlocking mangalore tiles to concrete mareba roofing tiles, again we see corresponding changes in the price per unit area of roofing.

When the specification for windows changed from standard mild steel casement to bronze anodized aluminum standard frames, again we experience substantial changes in the costs per unit window of the same size.

Likewise, when the specification for doors and floor finishes changes, the construction cost rates for the same items changes respectively.

In conclusion, whatever material is specified by the designer, it has a corresponding impact on the cost per unit of the construction works in question.

8.0 The Way Forward

- (1) In the Kenyan construction industry, there is need for the establishment of a body that can develop standard building materials and components specifications for use by the industry. This body should be charged with the responsibility of carrying out research, tests, and innovations on building materials and components with a view to controlling the quality of the built product.
- (2) There will be need for the establishment of building materials and components directory which will indicate what materials are locally available naturally or factory produced. Components are imported materials and their availability, their technical specifications. This directory will also give information on the availability of building materials and components their (materials) manufacturers (for those manufactured locally) and importers/stockists (for those materials which are imported), locational availability within the major townships, municipalities and cities, specifications and modes of use.

This information is important for use by the practitioners and developers as a guide to their use and availability in the country, and should be accessible and available in soft copy to the users.

- (3) The same body should also be charged with the construction of materials price indices which will be updated regularly as prices of certain materials and components change.
- (4) This body should be able to establish research links with Local and International Universities to come up with innovations that could produce environmentally friendly construction materials and components that are sometimes recyclable and therefore produce a sustainable environment.

- (5) This body should compliment the duties and responsibilities of the Kenya Bureau of standards in trying to control the dumping of hazardous and inferior quality building materials and components which are imported by material stockists in the country. Thus vetting the importation of low quality building materials and components.

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