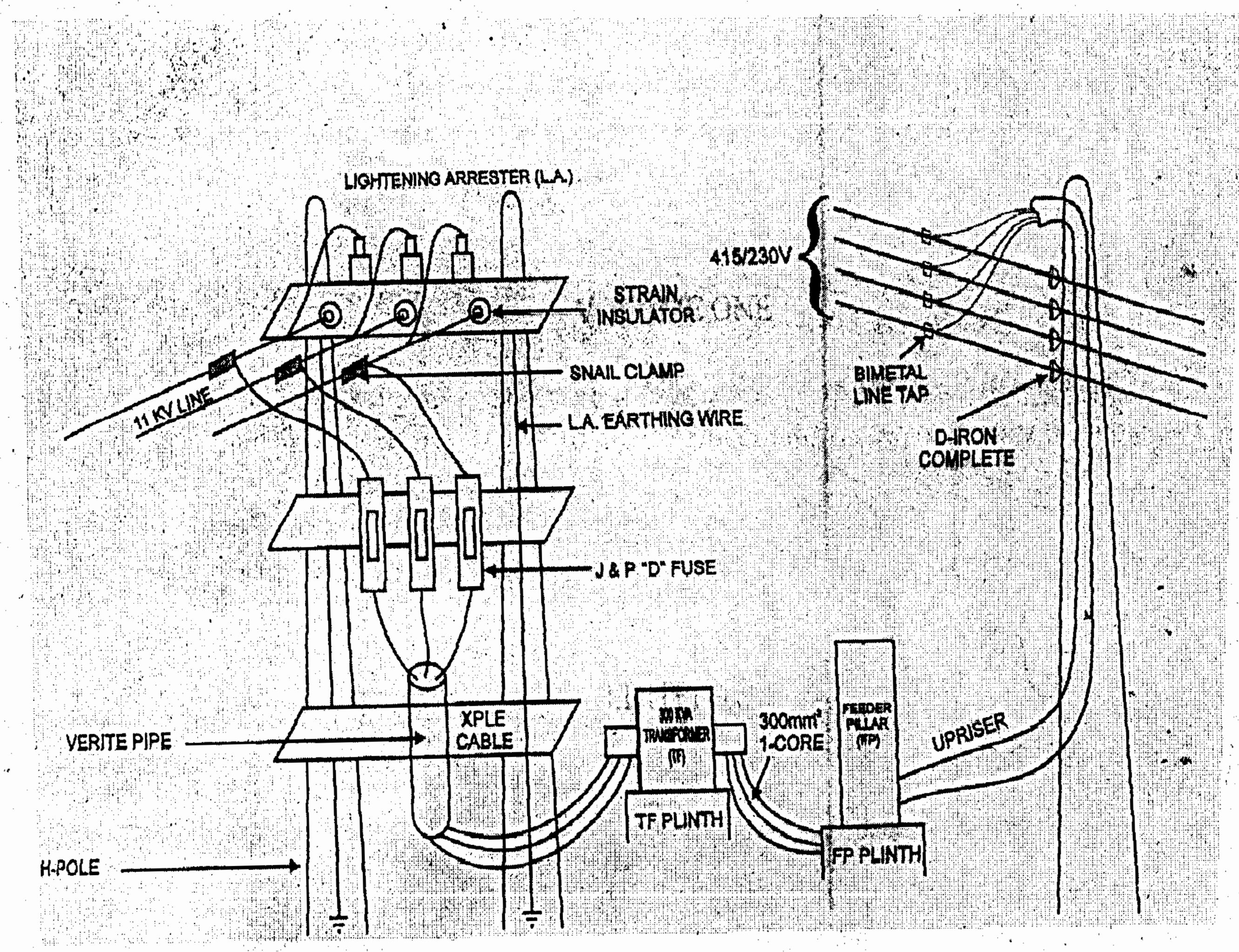
ELECTRICAL ENGINEERING PRACTICE

VOLUME ONE



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CHAPTER ONE

BUILDING SERVICES AND THE ENGINEERING CONSULTANT

BY

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1. INTRODUCTION

In recent times the engineering services contents in buildings has grown continuously in quantity and complexity. What used to be the province of the plumber and electrician now demands the services of a body of highly educated and specially trained professional engineers. To meet the growing demand, a body of such professional and technical engineers has been expanding rapidly. It is of relevance to have a wide ranging view of the environment in which the building services engineer operates, the relationship he has with the industry and the other professionals involved, the technological content and the management skills which are needed. There are high prospects in building services engineering for graduates. A demonstration of the skills required, and the degree of challenges involved, offers prospects of a rewarding and varied career. The demand for competent building services engineers is greater than the supply. Presently, this is an aspect of engineering administration and management.

For the sake of clarity, the term 'building' is used to describe the whole of the 'built environment', as we know it today. It includes 'enclosed space' for whatever purpose and any external space which provides a facility or amenity in relation to our domestic, working, welfare or leisure needs. Major projects will almost always include both.

1.1 THE SCOPE OF BUILDING SERVICES ENGINEERING

Buildings services engineering, commonly abbreviated to 'engineering services', comprise all the engineering systems associated with building, other than civil / sewage which are normally derived from the public utilities. The services engineer must expect to be involved from time to time in all or part of these provision on site.

It is difficult to provide a 'complete' list of all the services, which can be included within the services engineer's responsibility. In totality they will represent 20% of the cost, in the simplest of buildings, to 50% or more in the more complex high-technology buildings. In general, the services engineer will deal with the following:

(i) environmental comfort: heating, ventilation, air-conditioning and lighting, including all relevant plant, such as boilers, airplants, refrigeration units, water treatment etc.

(ii) water distribution and public health systems

(iii) electrical power distribution; this will commonly include high-voltage distribution and the provisions of substations

(iv) gas distribution

(v) security, fire detection and alarm, an anti theft systems, as well as battery operated emergency lighting

(vi) communication systems; telephones, staff location paging systems.

(vii) Clock installations

(viii) Mechanical transportation; lifts, escalators and conveyors

(ix) lightning protection

(x) control and supervisory systems for all the above.

Specialized provisions commonly required include:

(i) public address systems, including multilingual conference facilities

(ii) refrigeration for process in industry and commerce

(iii) hospital systems; medical gas and vacuum systems, steam plant and distribution, sterilization equipment, laundry equipment, disposal plant, specialist lighting etc

(iv) external lighting, including street lighting

(v) water treatment for swimming pools

(vi) refuse and noxious effluent disposal,

(vii) catering equipment

(viii) fume and dust extraction

(ix) industrial cooling water systems

(x) acoustic control

(xi) standby generator and distribution

(xii) uninterruptible power supplies for special applications

(xiii) sewage disposal plant

(xiv) material handling plant

(xv) process air-conditioning and sterilization for sterile manufacturers, e.g. drugs.

1.2 ORGANISATION OF DESIGN CONSULTANCY IN THE CONSRUCTION INDUSTRY

1.2.1 THE CONSULTANT TEAM

The services consultant will receive some commissions on which he acts alone, but these are a minority, and usually consist of studies and reports on particular problems and probably some limited but specialized provision or refurbishment of an existing installation.

More generally, the services consultant will be commissioned as a part of a consultant team. Traditionally that team has been 'professional', as opposed to 'contractor'. The team will be responsible jointly for carrying out the design and specification of the project and appointment of the contractor and his team, followed by program and quality control of the construction, to the point of commissioning and handover. Overall cost control and expenditure management is a joint responsibility throughout.

The formation of the professional team within this form of organization will vary with the type of project. As for multidisciplinary projects, there are broadly three classes of work involved. The detailed duties of the services consultant do not vary greatly between them, but there are differences in the leadership of the professional teams and the respective contract arrangements in general use.

1.2.2 BUILDING

This is the area of activity in which the services engineering consultant will be called upon for the major proportion of activities. It will include every aspect of the built environment within both the private and public sectors for living, working, welfare and leisure. There is considerable overlap with civil engineering in some areas, for instance in defense, but the principal characteristic is that the projects will usually be designed and managed by the traditional architect-led team.

The latest edition of the 'conditions of engagement', which applies to all the respective members of the professional team, has been designed to radically improve harmonization, and to establish explicitly that while the architect has no responsibility for the detail design of other disciplines he does have overall responsibility for properly incorporating the design of his structural and services colleagues into his design. Similarly, during construction the architect alone has direct responsibility for monitoring progress and issuing certificates as required by the contract. Quality control is the responsibility of each consultant in his own field.

The most widely used contract for building is known as the 'JCT contract'. It is produced by a 'joint contract tribunal', on which all interests, professional, contractor and client's are represented. The prime document (there are others) used for major projects is extremely complicated, and regarded by many as somewhat rigid in its application, making for much difficulty for the professional team. One particular point is that neither the structural nor services consultant is referred to in the contract document. His control can, therefore, only be directed through the architect's administration, or in the last analysis through the client.

From the consultant's point of view, the JCT contract is extremely rigid in respect of availability and accuracy of design documentation to the sole requirement of the contractor. Even sub contractor's information in this area is the responsibility of the design team. The most trivial of omissions in this area generally leads to claims for delay. It is a fact of life that for many contractors, the 'claim game' is a way of life. In these circumstances, it is imperative for the designer to avoid going to tender until the most complete design information practicable is available.

Nevertheless, with the notable exception of the 'poverty services agency', the JCT document is widely used, where the traditional professional team is appointed.

1.2.3 HEAVY ENGINEERING

In the context of this paper, term 'heavy engineering' is used to define the very wide area of construction which falls outside what is generally regarded as the architectural scene, although an architect is often employed to make a contribution to the aesthetic quality, or in relation to a building subsidiary to the main project.

A high proportion of these projects will be civil-engineer-led. These will include harbours, dams, bridges, major road systems, infrastructure, water supply and drainage etc.

Teams engaged in the generation and distribution of electricity, major pipelines and pumping stations will obviously be led by electrical and mechanical consultants, respectively. Civil engineers are more often than not the lead consultants in projects for 'heavy' industry, such as steel, cement, grain or oil.

The extent of the contribution of services engineering to these fields will vary substantially, but is always significant. For example, the structure of an oil platform represents most of the cost, but the comfort and safety of the work force in the service element is vital. In the industrial field, services consultants play an ever-increasing role.. The raising of standards of effluent control and safety systems and the like, to guard against industrial and local environmental health and other hazards, is just one example of the changing scene.

1.2.4 SPECIALISED SERVICES PROJECTS

There are a limited but significant number of projects on which the services consultant is required to carry out the leadership role of the professional team, and subsequently co-ordinate control of the construction. The following are typical examples:

(a) District heating and cooling.

(b) Central services plant installation, with distribution for major sites.

(c) Services refurbishment, where the structure is not significantly altered.

(d) Total energy plants

(e) Combined head and power schemes.

(f) Modest-scale plant for main or standby generator, together with its distribution.

The contract document mostly used for this purpose is the 'model form A', as published by the IEE and the Institution of Mechanical Engineers. The arrangements have been used for many years, and there is no evidence that it raises any particular problems.

The above represents the most commonly used methods for the respective areas of work, but there is growing criticism of the traditional method, particularly in urban building.

Comments in present circular include the following:

(a) The traditional team is too fragmented, with individual vested interest taking precedence over the clients' interest.

(b) The architect's management talents are sometimes less than adequate.

(c) The sequential nature of the traditional process delays project completion, and the design, which precedes contractor selection, takes no account of contractor expertise.

A number of alternatives have in consequence been offered from time to time. There are many computations of these methods in detail; but they fall into three main categories:

(a) **Project Management Consultancy**
Nearly always a professional, who will represent the client during the whole design and construction process, often where the client is not experienced in building procurement.

(b) **Design and build**
A total service provided directly between the contractor and client; although projects using this method are sometimes large in scale, they are rarely complex in character.

(c) **Management Contracting**
This is a method where the client appoints a major contractor on a fee arrangement to act globally on his behalf. The management contractor will himself, sometimes with the client nomination, appoint the professional design team and subsequent sub contractors, as and when they are required. The management contractor will not normally carry out any of the construction work himself. The advantage claimed for this method is speed and efficient construction, in that construction can begin almost immediately after basic design information is available. The disadvantage is that there can be no certainty of final cost, comparable with the traditional method.

These nontraditional methods, engineering services consultants, in common with other consultants, can be as duly employed as with the traditional methods, always providing that professional codes of conduct are adhered to and the client clearly understands any limitations of responsibility inherent with the method of organization.

It is difficult to analyze simply the factors on which judgements have been made on the relative merits of the traditional and non traditional methods, and indeed much of the criticism of the traditional methods and indeed much of the criticism of the traditional method is ill-informed and misguided.

While undoubtedly some design firms had inadequate management ability, the problems of the last two decades, of delay, cost escalation and sometimes failure, arose in my opinion or number or prime reasons:

(a) Drastic reductions in cost allowances.

(b) Use of new and largely untried materials and techniques.

(c) A rapid increase in engineering content, often only housed with difficulty in buildings designed by architects without adequate advice from engineers; this often led to additional design and alteration late in the process.

(d) Shortage of experienced skill in all areas of craft, management and design; the latter is particularly true of engineering services, and is referred to alter in this paper.

Today, most of the problems have been largely identified and the building process is now substantially better managed in terms of time and cost targets.

Wherever the precise cost of a project must be known, particularly for complex technological buildings such as hospitals, the traditional method of tendering on a complete design is indispensable, although some modification to the method is available, to involve the constructors earlier in the process.

However, when the speed of building is paramount, and the financial loss arising from delay outweighs some increase in building cost and efficiency, then methods which allow building to start in advance finalized design detail are being used more and more. While the method does not necessarily demand contractor management, a growing number of clients are happily paying an additional fee for management in one form or another. My own experience demonstrates that while management contracting does provide an effectively fast method, design consultants are presented with substantial additional work arising from the lack of continuity in the design process, a multiplicity of small contracts, often with limited integration, and an increase in site attendance inevitable inherent with the method.

1.3 DUTIES OF A SERVICES CONSULTANT

1.3.1 THE AGE CONDITIONS OF ENGAGEMENT

The majority of consultants as principals in private practice are members of the Association of Consulting Engineers (ACE). This is about the case in Nigeria the Association of Consulting Engineers of Nigeria(ACEN).

The ACE publishes a series of documents, known as the 'ACE conditions of engagement', which provide agreements for the use of its members, of all engineering disciplines for work in the U.K.(ACEN provides the same for professional engineering consultants in Nigeria).

The duties described here summarize in general terms the ACE 'Agreement 4A(I), full duties for engineering services in relation to subcontract works'. This Agreement has been chosen because it concludes the fullest range of duties faced by services consultants, whereas other legislate for more limited duties. In addition, it represents the basis for many other forms of agreements, for example, agreements with central government for hospital work, defense work and the like. It can be used with minimum adaptation for any form of project organization, traditional design and build, management contracting or whatever. Indeed, many forma of agreement used in Commonwealth bear a remarkable resemblance to earlier editions of this form. The summary does not go into the complex financial and legal arrangements between client and consultant included in the form. The form is readily available from the ACE.

The duties listed in the form comprise eight stages, which were designed to match as nearly as possible the work stages used in the architect's conditions of engagement.

In the interest of simplicity, this paper divides the arrangements into three parts:

(a) Inception and feasibility

(b) Design and documentation process

(c) Construction stage.

Before going into some detail under these headings, it must be stressed that whatever the organization of the particular project, and regardless of who is employed to lead, be they professional or constructor, the services consultant is a member of a team of designers and constructors, and all must continuously ensure total compatibility with each other, to achieve the end product and its efficiency in service. To achieve this continuos understanding and communication between the design professionals is paramount. For many years, it was common practice to appoint the services consultant after completion of the inception and feasibility stage, and to present him with an established building design, into which the M & E engineering was 'struck on'. To some degree it still happens.

It cannot be stressed too much that if the service engineer is not consulted from day one, the quality of the finished project will suffer.

1.3.2 INCEPTION AND FEASIBILITY

1.3.2.1 IDENTIFYING THE CLIENT'S REQUIREMENTS

Although the requirements of every project must always be treated as unique, the scale of this exercise is very much related to the designer's experience of the kind of building involved. A major hospital is an extremely complex technological project, but years of experience of the requirement exist. On the other hand, if one is appointed to design, say, an opera house or a micro chip-manufacturing plant, then experience is limited, and considerable study of and travel to the best existing examples are vital, often to find out how not to do it. The consultant must, therefore initially advise the client on the need for such studies, investigations and surveys he considers relevant to understanding of the problem.

He will in parallel, expect to be briefed on the scope of the services in terms of content and performance, finance available, and not least the precise terms of his appointment. During this process the consultant will have established his relationship with other members of the design team. Where relevant, special investigations will be carried out jointly with the other designers.

Before proceeding further, the consultant must confirm to the client that he is satisfied with the brief and the 'order' of finance available, and obtained authority to proceed on an agreed program.

1.3.2.2 PRELIMINARY TECHNICAL APPRAISAL

Having established the client's initial brief, the services consultant will, in collaboration with the other designers, consider the range of options which will affect the building's size, shape and orientation in terms of noise and weather protection, and establish construction standards in terms of glazing, thermal insulation, thermal capacity, natural and artificial lighting and solar gain etc to ensure optimum energy consumption.

Computer software available today makes it quite practical to examine the whole range of options quickly and efficiently. Given the will for designers to co-operate properly, there is no reason for not achieving a building with the highest environmental and energy efficiency, compatible with the resources available.

Following the resolution of the broad anatomy of the building, the services consultant will proceed with the assessment of the technical content of the scheme, the operational requirements in principle, methods of control and means of energy supply, distribution and heat recovery systems, as relevant.

The latter will involve first contracts with local authorities and public utilities to establish availability of facilities and matters of principle in planning.

The consultant must prepare a report summarizing conclusions and options available at this point, together with first approximate costs and an outline program for design and construction, taking account of the proposed contract procedures. The report will include the firs sketch drawings and outline calculations.

This report must be clear and comprehensive, to ensure that the client understands and confirms without ambiguity the content of the engineering services which the consultant considers he has to provide.

1.3.3 DESIGN PROCESS

1.3.3.1 ACCEPTANCE OF RESPONSIBILITY

Acceptance of the above report by the client, with or without modifications, represents the authority to proceed with the design. The consultant must know the exact extent of his duties and those of the other members of the design team. For example, it will need to be decided whether the engineering services consultant is responsible for the entire cost management function or, alternatively, if the quantity surveyor is to do this, and if the engineering services are to be the subject of 'bills of quantities' or a 'lump sum' tender.

The design process is divided into three stages, followed by preparation of the documentation required for consideration.

1.3.3.2 SERVICES PROPOSALS: DEVELOPMENT IN PRINCIPLE

This period will involve the examination and consideration of each services requirement in detail, and determination of the most suitable systems of providing for them, within any restraints that apply, financial or otherwise, and always in collaboration with other members of the team. A number of further studies will be necessary. Some of these studies will be unique to a particular project, for instance services requirements to specialized manufacturing equipment etc. Others occur on most projects. Some examples are:

(a) Energy study to resolve the fuel to be used.

(b) Consideration of availability and location of public utilities, including tariffs, to establish principles of supply e.g. high or low-voltage electrical supply.

(c) Traffic studies, to establish details of mechanical transportation such as lifts, escalators, conveyors etc.

(d) Planning and fire officer's requirements.

Having established detailed design requirement in principles, it is now credible to produce and agreed cost plan for the whole project, to ensure viability before proceeding to the development of the first scheme designs.

1.3.3.3 OUTLINE DESIGN AND SKETCH PLANS

This is the first stage in which all the members of the team will jointly produce a set of drawings which provide the accommodation required by the client and provisions for the engineering services, and provide the first 'hand information for the structural design. At this time the design team will consult each other almost continuously, to ensure co-ordination between them.

The service consultant will be:

(a) Assessing and preparing schedules of loads for power, heating and cooling, and establishing size and location for plant rooms, major ducts and services routes.

(b) Principles of location and access with respect to false ceiling and under floor systems utilized for services distribution.

(c) Providing information to the structural consultant of approximate size and weight of major plant to allow his design to proceed.

(d) Establishing with the architect the acceptability his provision of space for services. The successful resolution of this task at this stage is fundamental to the success of the project, not only at completion, but throughout its life. The services consultant will not achieve optimum success on any project unless he ensures that his space provides for good access for preventative maintenance, as three foot high fitters are hard to come by these days, proper facilities for rapid removal and replacement of equipment, installation of additional services and ultimately complete services refurbishment. There are countless major buildings less than 20 years old which cannot viably be refurbished to provide services for computers and other electronic and communication equipment now coming into use, because original space provision is inadequate.

(e) The services consultant will also need to confirm with the Architects finalized building details, which affect his load calculations, such as glazing standards and insulation details.

(f) Revised estimates will be prepared and incorporated into the overall cost plan, following which is the normal for a presentation of the scheme to be made to the clients, which will include confirmation of the of thee services provisions included.

1.3.3.4 DETAIL DESIGN AND PRODUCTION INFORMATION

This is the 'slogging process' of giving effect, in detailed terms to all the decisions made prior to this stage.

It comprises the detailed calculations and drawings necessary to size all equipment, pipe - work, ductwork and cables from main plant to final outlet, together with detailed specification to enable procurement of all materials and equipment suitable for required purposes, as well as the method of their installation and system operation.

The drawing, schedules and specifications are, in essence, the means of conveying comprehensively, the intent of the designer in detail to the constructor, and will be the basis of the contract.

Within this stage, the services consultant must ensure that all his drawings and specifications are compatible with those of other members of the design team. There is now a growing practice for the services of consultant to produce co-ordination drawings to a scale necessary to show the physical inter – relationship between the respective services, as well as their relationship to the structure and architecture, all in sufficient detail to demonstrate that the services will be separated, one from another, and can be properly installed and maintained. In order to produce these drawings, the consultant will have taken actions to invite quotations from major plant, where it is necessary to have equipment finally selected in order to resolve fixing and similar details.

In parallel with this, the service consultant will also:

(a) Produce drawings demonstrating the builders work necessary to accommodate and fix the engineering services.

(b) Establish final details with the utilities for incoming services.

(c) Obtain all approvals necessary from planning authorities, fire officers etc.

(d) Resolve with the other members of the design team conditions of contract and the form of tender action to be used.

(e) Check that the cost plan is still valid.

1.3.4 CONSTRUCTION STAGE

1.3.4.1 TENDER ACTION: PREPARATION OF BILLS QUANTITIES

Where it is agreed that 'bill' for engineering services are to be used, these will either be prepared in their entirety by the services consultant, or by the quantity surveyor appointed to prepare all the bills for the project. In the latter case, the consultant has the duty of providing 'additional' information to the quantity surveyor, to enable him to prepare the bills. On completion, the bills are priced to establish a final estimate.

In collaborating with the other professionals, the service consultant will advise on the choice and suitability of firms for the execution of the works, including consideration on whether tenders should be sought on a single or multidisciplinary basis.

The consultant must have a watertight tender procedure thoroughly understood both internally and externally, to ensure fair tendering to all.

On return, the tenders will be analyzed to ensure they are complete in Detail, in accordance with the tendering conditions. A cost analysis will be prepared, compared to the cost plan service, and a report prepared for the client with appropriate recommendations.

The consultant may have some supplementary duties in respect of alternatives or special equipment involved. In addition, he will be expected to comment on the formal contract or sub – contract documents relating to acceptance of tender.

1.3.4.2 EXECUTION OF THE WORKS: SITE SUPERVISION

The services consultant is appointed to have appointed specialist staff for this purpose. They may be full time or part – time, but on major work full – time staff are essential, in either case, it is solely the consultant's decision. The staff shall in all circumstances take no instruction other than from the consulting engineer. The consultant will provide instruction to the site staff as to their duties.

There are occasions when clients do not easily agree to their supervisory staff being totally controlled by a consultant. If this occurs, and it does, the client is advised that the responsibility and therefore accountability for the supervisory performance, is removed from the consultant.

The services contractor are responsible for producing installations and detailed shop drawings. The consultants will be required to examine these drawings submitted to him as proposals, to ensure they are compatible with the design intent.

If necessary, he will collaborate with other members of the design team to resolve any problems, which may arise.

There has long been some controversy regarding the preparation of drawings by service contractors. Clearly, where fabrication by a specialist manufacturer is involved, for example duct work for air systems, detailed shop drawings will always be necessary. But when a consultant is appointed to prepare detailed co – ordination drawings, the continuing requirements for comprehensive installation drawings from the contractor are debatable. The most important distinction between consultant's and contractor's drawings is that the consultant alone should be responsible for system design, calculation and sizing, as well as ensuring the proper accommodation, in all respects of the equipment within the building.

The consultant will make visits to the sites, as he thinks necessary to ensure the site staffs are fulfilling their duties and that the work is being carried out in accordance with good engineering practices.

If so appointed, the service consultant will provide a comprehensive cost control service. This will include the initiation and administration of any variation, which may become necessary. If others are responsible for cost control, the service consultant will still be responsible for all the technical aspects involved in the variation process. The above also applies to issuing interim certificates for work in progress and ultimately, final accounts.

Testing and commissioning if the installation is the responsibility of the contractor, and the procedure will have been included in some detail in the service consultant's specification. Nevertheless, precise procedures and programs must be agreed with the consultant so he is satisfied that they are properly carried out and witnessed as appropriate. This process will need to be fully recorded and certified, to satisfy the client and all outside regulating bodies relevant to the particular project.

Finally the service consultant will receive and examine copies of record drawings, operating instructions and maintenance schedules, all provided by the contractor.

1.4 SKILLS OF THE SERVICES CONSULTANT

It is evident that with the range of technology and duties involved in any large-scale service work, there cannot be an individual who could truly project himself as a total service consultant. We must therefore define the term consultant as a team in whatever form, whether partnership, company or even in- house teams, within a large organization. Service Consultancy organizations vary considerably in size, numbering from a handful to several hundred. Their capability will vary accordingly.

In such a team, there will be engineers of three prime disciplines: electrical, mechanical and public health engineering aided by a number of auxiliary specialists. The latter might be building economists, to produce cost plans, bills of quantities and the like, as well as manage cost control during construction; a computer team and specialist site staff, whose training and experience is practically orientated. Large teams may also include specialist for lighting, acoustics specialized control systems and the like.

The engineering members of the team are generally specialists in their own discipline, and a multidisciplinary design engineer is a very rare animal. Nevertheless, every professional engineer is expected, from his initiation as a trainee, to acquire a growing knowledge of the problems of his fellow professionals, if proper co-ordination of the services is to be achieved both in installation and subsequent operations and maintenance. He will also need to acquire a considerable understanding of architecture, building construction and structural engineering.

In essence, a building service engineer is a systems designer, but efficient equipment selection is of equal importance. He is not expected to be able to design a boiler or transformer, but he has to be competent enough to specify equipment which is capable of meeting the required performance, with design characteristics to achieve adequate life with minimum maintenance. Much of the requirements involved today are very sophisticated and mostly computerized, such as environmental control systems, communications equipment, security systems etc. In such cases, some specialist advice might be appropriate, but this does not absolve the service engineer from his responsibility of meeting his objectives.

The average service engineer will also be responsible for day to day duties during construction, such as dealing with variations, quality control and the like. He will also be responsible for compliance with all appropriate regulations, with which he must be fully conversant.

The above represents the basic skills of a building service engineer. To advance his career he must demonstrate many other talents.

The building service consultant and other members of the professional team have a prime responsibility of ensuring the success of the project for their client. In doing so, they will need to overcome the inevitable individual interests of themselves and the contractor team. Good communications and wisdom are vital qualities necessary to achieve co-ordination of purpose and overall success.

Cost and program control demands a high level of planning and management. In particular, cost planning and contract cost control demand sophisticated organization, with the ability for precision. Clients today will tolerate nothing less.

Wherever appropriate, services consultants must be prepared to accept project management in totality, including the administration and co-ordination of other professionals, as well as the contractors in the broadest sense.

As with all consultants, the service consultant will need a complete understanding of the intricacies of the whole range of contract documents in use in the construction industry, and there are many. This will include an ability to arbitrate fairly between client and contractor when resolving differences, which occur on almost every project.

Above all, a successful service consultant must be not only the master of his technology, but have the ability to continually initiate new ideas and techniques. This particular, engineering discipline has been developing and expanding at a phenomenal rate, decade by decade. Building construction and the means of installing services have changed as much as the engineering itself. Accuracy in performance, combined with high energy efficiency, all at minimum cost, have led to most practitioners and offices of substance being fully computerized for calculation and literally for drawing and administration. The profession has produced virtually all the software for itself.

In this climate the services consultant will need to provide, within his own office, substantial resources for training, not only initially for graduates etc, but for continual professional development.

Inevitably, he will be contributing on a major scale to the work of institutions, Nigerian(British) Standards committees and the like.

1.5 RECRUITMENT, EDUCATION AND TRAINING

The EDC for Building, chaired by Sir Monty Finniston, included two comments in a draft report prepared recently to assess technological change in the construction industry to 1990.

(a) The building services elements in most contracts is growing as a proportion of the total, and the technology is changing faster than in other parts of the contract. The two aspects of technology change are firstly developments in the main services themselves, these changes being mainly to do with improving energy efficiency, and secondly, new types of demand arising from technological change taking place in the activities of building occupants, the outstanding case being computing and information technology. The spread of information technology, that is, the electronic office, is the outstanding center of the new demands being made on building services, stimulating now thinking on their design and effectiveness, the results of which are bound to have wider application than just in office which the new technology is installed.

(b) Already there is a clear demand for many higher level technology-related skills, particular those which cross traditional boundaries, such as design engineers, programs, systems analysts, maintenance engineers and biotechnologists. An increasingly wide range of occupations is now likely to be involved in contact with this technology in various forms and many people need basic familiarity with it in order to operate and monitor the new equipment. A shortage of these skills would hamper the optimum use of new technology, and have an adverse effect on competitiveness.

Ted Happold, Professor of building engineering at the University of Bath, wrote in November 1982:

> It is easy to be critical of the music graduate who wishes to work as a musician and cannot. It may have happened to you in your day. But you were lucky enough to discover the growth field of services engineering and the creative opportunities it allows. Yet, strangely enough, the university courses in services engineering are dying from lack of good applicants, in spite of the glamour that should attach to them, let alone the money. I am 'snowed under with offers to take our sandwich students on placement and each one of our graduates gets at least ten job offers. Yet I have trouble filling our course, and it is one of the few remaining'.

Building services now generally make up between 25 and 50% of the value of new construction, depending on the complexity of the type of building, while the structural value may be approximately 20%.

There is a large shortfall of professionally qualified building services engineer which demand has to be met one way or another. Most consulting engineers are using technician engineers and engineers without any formal qualifications in an attempt to fill the gap. Even the latter are difficult to recruit.

Comparison with other disciplines engaged in construction suggest that there should be something like 15000 specialist building services engineers at professional level, of which 60% should be mechanically oriented and 40% electrically oriented.

Consulting can, and does, recruit non specialist graduate mechanical and electrical engineers, but in spite of intensive recruitment efforts, much enhanced salaries and post-graduate education facilities, the take-up is low. The reason is clearly that regard for employment in the construction industry is minimal, for teacher and student alike. Since the major engineering institutions have taken the same view for decades, it is hardly surprising.

The problem is one of available educational resources, but there is some evidence that the Engineering Council is putting its considerable weight behind the effort to increase and enhance those resources.

1.6 THE CONSTRUCTION INDUSTRY IN SOCIETY

Finally, it is appropriate to take a view of the construction industry and its contribution to our society.

The following is an extract from an address by Mr. John Stanley, the then Minister of Construction, in 1982, to an RICS Conference:

'In the successive transport revolutions of canals, railways, roads and airports; in the laying down of modern industrial economy in the last century and this; in meeting the demand for housing from a rapidly expanding population; and in the exploitation of North Sea oil: in each and every case the construction industry has been the indispensable engine of advance.

The same is bound to be true in the future. The major expansion of the nuclear power program; the necessary replacement of our nineteenth and early twentieth century infrastructure; the adoption of rising standards for buildings in which people work, shop and live; the demand for ever more cost-effective heating systems and building maintenance systems: these must all ensure a continuing and large-scale demand for the construction industry's services.

By any yardstick, the construction industry holds a key position in the economy. This is as true today as it has been in the past.

If you include construction materials in the ambit or construction, and you should, the construction materials industry employs about 2 million people; that is more than in engineering, and nearly three times the number in car manufacturing.

Construction accounts for some considerable level of our total GDP. That is nearly twice as much as engineering, four times as much as vehicle manufacturing and five times as much as agriculture and chemicals.

By its nature, construction is supposed to be largely home-based, making a significant contribution to our exports: on visible and invisible earnings per year, that is, almost as much as our total oil exports, and as much as the balance of payments benefit from either tourism or other sources.

The central economic significance of the construction industry cannot be questioned though in Nigeria, it has been left in the hands of expatriate firms like Julius Berger and the likes.