1 The operating environment

Organisational structure describes how an organisation is arranged: its hierarchy and how the components of this hierarchy work together to achieve the objectives set out in the vision and mission statements. This determines the operating procedures and the roles and responsibilities of the people employed.

Vision statements articulate organisational goals for the mid-term or long-term future. Ranging from one line to several paragraphs, a vision statement identifies what the organisation would like to achieve or accomplish. A good vision statement provides the inspiration for the daily operations of a business and shapes its strategic decisions. Vision statements may address a range of issues such as: aspirations for relationships with their clients, employees, project team members and suppliers; impact of their services in terms of sustainability and integration with the built environment; attitude to innovation; market positioning in terms of location; and types and sizes of projects. Some organisations may publish these in a very visible way, while others may keep them in-house or even keep them as verbal understandings.
Mission statements are present-based statements designed to convey how the vision statement will be achieved. They should inspire and give direction to their employees rather than to those outside of the company. As circumstances change, mission statements may need to be adjusted, but they should always refer back to the same vision statement.

Examples of mission statements

The following examples are collected from a range of building services design entities.

We shall:

- provide superior client service and delight our clients
- act equitably and honourably with our suppliers
- protect and enhance the quality of the built and natural environment
- encourage innovation and creativity in design
- practice sustainable development.

Neither visions nor mission statements define how to achieve the goals; however, by outlining the key objectives for an organisation, they enable the organisation’s employees to develop business strategies to achieve the stated goals.
The business activity of any organisation can be classed into a particular economic sector according to the business types and the products produced: primary (extracting and processing raw materials), secondary (manufacturing finished goods), tertiary (providing services) and quaternary (providing intellectual activities). The provision of building services engineering design services is an example of the quaternary sector of the economy where the output is based on its intellectual capital. This is the possession of knowledge and experience, lore, ideals and innovation, professional knowledge and skill, good relationships and technological capacities which, when applied, will give organisations a competitive advantage.

1.1 Organisational arrangement

The organisational arrangement of an entity delivering building services engineering design may be configured in many different ways according to:

- ownership arrangement
- scope of building services engineering offered
- integration with other entities
- types of projects undertaken by building sector
- geographical operating span.

Ownership arrangement

Most organisations associated with building services engineering design entities are private sector owned, but some are in the public sector. In terms of legal structure, private sector organisations may be run as sole traders, partnerships or private or public limited companies. Public sector organisations are part of local or national government departments.

It is also possible for building services engineering entities to be under a licensing arrangement. Under this arrangement a licensor grants the licensee the right to use their name and, in return, the licensee submits to a series of conditions regarding the use of the licensor’s intellectual property and agrees to make ‘royalty’ payments; for example, this arrangement may be used when, say, a UK based organisation wishes to open offices overseas and is prepared to have their name used under licence.

A building services engineering entity may link with other entities to form joint venture arrangements. The parties to the joint venture share (equally or otherwise) the provision of resources, risks and profits. The joint venture will have a unique name, which my use the names of the parties or it may be specific to the joint venture arrangement.
Whatever the ownership arrangement, building services engineering entities are usually independent of manufacturers, suppliers and installers of building services engineering equipment and systems. This enables them to offer unbiased opinions, judgements and decisions without any potential conflict of interest.

Scope of services

A building services engineering design entity may provide services for only one of the three main engineering disciplines that embrace building services engineering – mechanical, electrical or public health – or they may offer a combination of two disciplines, or provide all three disciplines.

Mechanical, electrical and public health engineering each comprise a range of core subject areas. With increases in the size of a project, the core subject areas are more likely to be dealt with by specialist building services engineers. With increasing complexity of a project more specialist subject areas will be added. Some entities may not be able to offer some or all of the additional specialisms for a particular project. Figure 1.1 illustrates this for lighting.

Some building services engineering entities may provide services for all stages of a project, from preparation to handover and operation in use, while others may specialise in certain stages only; for example just doing feasibility studies and concept design work, or just doing the detailed design stage.

![Electrical building services engineers core subject areas](image)

**Figure 1.1** Effects of increasing project size and complexity on resources required.
Integration with other entities

The building services engineering entity may be standalone or integrated with other entities. This integration may be vertical or horizontal, as illustrated in Figure 1.2.

In a vertical integration arrangement, building services engineering entities may be part of a subcontractor or the main contractor organisation or a client organisation.

In a horizontal integration arrangement, building services engineering entities may be part of a multidisciplinary organisation with other design-related disciplines: civil and structural engineering, architectural or quantity surveying services.

These arrangements are not necessarily mutually exclusive, nor are they necessarily rigid; for example an in-house building services entity may also seek project work outside that organisational structure. These arrangements usually evolve over time, with entities being traded to fit into portfolios, usually with the ultimate aim of increasing efficiency and profitability.

Types of projects by building sector

Building projects can be classified according to building use as illustrated in Figure 1.3.

Some buildings services engineering entities will be able to provide services to all sectors, while others may specialise on a particular sector or subsector(s). Although building services engineers may be involved with buildings that support infrastructure projects, the design of the infrastructure for the utility services comprising distribution and transmission falls outside the remit of building services engineering.
Geographical operating span

Building services engineering entities may be delivered from a single geographical location which may serve a specific local market, national market or international market. The services may be delivered from more than one office, again serving local, national or international markets.

1.2 The internal environment

The internal environment relates to the culture and climate of an organisation and will influence how resources are used to create value and attain goals. It includes factors over which an entity has some degree of control.

Capital, in the business context, refers to any asset that will produce future cash flows. The stock of capital determines the services
delivered and their values. Intellectual capital broadly comprises human capital, relationship capital and structural capital. These can be broken down further as illustrated in Figure 1.4.

**Human capital**

A successful building services engineering entity achieves client satisfaction, provides technically sound professional services and maintains a supportive and rewarding working environment for its people. These aims are achieved by treating human resources as assets rather than expenses and liabilities. Human capital is a blend of knowledge, skill, innovativeness and the ability of each employee to fulfil the requirements of their job descriptions so as to add value to the organisation: when an employee leaves, the value of the human capital and their tacit knowledge also leaves.

Tacit knowledge is the knowledge that people carry in their minds and is, therefore, difficult to access. People may not be aware of the knowledge they possess or how it can be valuable to others. Tacit knowledge provides context for people, places, ideas and experiences. Effective transfer of tacit knowledge generally requires extensive personal contact and trust and falls under knowledge management.

To meet human capital requirements, entities must understand the core proficiencies they require and seek to employ and retain
appropriate people. These competencies embrace a body of knowledge, supported by appropriate education and experience that result in effective job performance. These involve both ‘hard’ and ‘soft’ skills.

‘Hard’ skills consist of having the appropriate understanding of the concepts and terms in a particular subject area, and being able to translate ideas into practical designs expressed in written specifications, sketches, scale drawings and models.

‘Soft’ skill sets are equally important to the success of the building services engineering design to deal with the particular culture which building services engineers inhabit. This is influenced by the large number of people they have to work with during the lifetime of the project: these will be in-house and with external organisations. Individuals will usually have no choice over who they work with, and these relationships are subject to vulnerability owing to the temporariness of projects and the one-off nature of the product. Strong communication skills, both on paper and orally, are important to deal with the need to pass over information, liaise and discuss solutions with other parties.

In this transitional set-up, people have a tendency to base their relationships upon preconceived and standardised expectations of others’ motives and behaviour patterns. The influence of stereotypes may also be strengthened by other factors such as the construction industry’s confrontational, macho and time-pressured culture. Care is needed to ensure that any goodwill underlying interpersonal relationships, since it is delicate and precarious, is not destroyed by insensitive managerial practices.

If, in an organisation, the current pool of human resources needs supplementing, the main options are:

- recruiting suitably experienced permanent staff. This involves producing a job and person description, sourcing and selecting suitable applicants. Thereafter, a formal offer can be made
- hiring suitably experienced contract staff who are engaged either to provide a specific set of services or to work for a specific length of time. Contract staff may be either hired via an agency or as self-employed contractors. They are typically used to staff for peak periods in the work load or to provide specific expertise
- recruiting trainees, where the employer acknowledges that there are shortfalls in their competencies which they intend to address through providing on-the-job experience and training. Trainees are also permanent staff, but may have no experience or be part experienced. Raw trainees may be sourced from school leavers or graduates, or those seeking a career change. Part-experienced staff may be those already working in other building services engineering entities or who have transferrable skills, either
related to building services engineering such as electricians ‘off-the-tools’, technicians, facilities managers or those interested in changing discipline

- subcontracting or outsourcing packages of work to a third party by entering a contractual agreement with an external entity to perform a certain amount of work that might otherwise be performed by in-house employees.

With the exception of subcontracting and outsourcing, where the responsibility for retaining staff is transferred to a third party, an entity’s success in retaining staff, for the period they are required, is the result of the effectiveness of its human resource management efforts. This includes providing suitable mentoring and training, active career and professional development guidance, offering involvement in a variety of project types, creating a collaborative office environment and providing competitive salaries and benefits in order to motivate people.

As people develop, further skills are needed. These skills may include the ability to develop new business, manage time efficiently and communicate effectively with clients and team members. As the building services engineers move up the ladder in their entities they will undoubtedly become involved in planning and managing people and resources and directing activities ranging from billing and collecting fees to developing business plans.

**Structural capital**

Structural capital comprises process and innovation capital that support human and relationship capital so as to realise optimal business and intellectual performances in a repeatable and scalable way. When an employee leaves, the value of the structural capital stays in the organisation: it has organisational memory.

Process capital covers the value in creating infrastructure and business practices that support knowledge generation. The infrastructure comprises hardware, software, proprietary databases, drawing packages and information systems and the explicit information hosted on these platforms.

Hardware comprises equipment used to gather information, (e.g. cameras and video equipment), process it (e.g. computers and all their associated paraphernalia and networking equipment) and present it (e.g. projectors and screens, printers and plotters). There will also need to be means for data storage. Other hardware, such as smartphones and tablets contribute multiple functions.

Software may be used for calculations and modelling either for isolated or multiple elements of building services engineering design: for example, thermal performance, energy usage, lighting levels
(daylighting and artificial), electrical distribution, ventilation patterns and impact of renewable energy sources. Software may also be used for checking and demonstrating compliance with codes and standards. Software is seen as adding benefits by being able to undertake calculations quicker and more accurately.

Databases are collections of information organised so that it can easily be accessed, managed and updated: for example, lessons learnt, standard details, standard reports and descriptions of previous projects and CVs of employees.

Drawing packages allow drawings to be represented on screen rather than having to be drafted by hand. This makes it easier to twist, stretch or move portions of a drawing, after which the information as a whole will automatically adjust. Users are able to zoom in and out for close-up and distant views. Depending on the particular package, it may be possible to switch between two-dimensional (2D) and three-dimensional (3D) views and to rotate images to view them from different perspectives.

The components of infrastructure need management to determine the requirements, specify and purchase the equipment, arrange delivery, put them in place, provide training, provide ongoing maintenance and ultimately dispose of the equipment. In the past, organisations typically developed their own software and databases in-house, some still do, but nowadays much proprietary software is developed, and databases created and managed, by specialist organisations and sold to organisations.

Information systems are a further development that combine hardware with business processes to support operations, management and decision making. They can generate models which may ultimately simulate the planning, design, construction and operation of a facility. The resulting model being a data-rich, intelligent and parametric digital representation of a building, including the building services engineering systems within. This allows views and data appropriate to users’ needs to be extracted and analysed. This can generate information that can be used to make decisions and to improve the process of delivering the building.

Explicit knowledge is generally understood to be knowledge that has been or can be articulated, codified and stored so that it can be readily made available to others. The most common forms of explicit knowledge found in design are reports, specifications, procedures, drawings and calculations. These can also include videos, photographs, sound recordings and test results on samples.

Innovation capital is an intangible value driven by the recognition and mindset to solve a particular problem or the commercialisation of an invention. The outcome will comprise new products, services, processes or systems which may be legally protected as intellectual property and recognised by patents, copyrights and trademarks. Depending on their vision and objectives, organisations may make different strategic choices regarding their approach to innovation. There
Technology is not the total answer

Unfortunately, among many organisations and technology suppliers the concept of knowledge management has taken on a very narrow definition, to cover implementation of information technology to develop ‘structural capital’. A common example of this is the misguided assumption that merely implementing shared databases or document libraries will enhance knowledge creation and use. While managing each element of intellectual capital is essential, it is seldom sufficient. Managing the integration of human, structural and relationship capital is the key to effectively building intellectual assets.

may be a range of approaches, from a fully resourced R&D facility staffed by building services engineers whose remit is to innovate, to encouraging a mindset of innovation as part of the day-to-day working of all staff. The extent of this support will be determined by the organisation’s attitude to empowerment, creativity and risk taking. This may be one of the few instances when building services engineering entities relax their stance on being independent and autonomous of suppliers, and actively corroborate with them.

A balance needs to be struck between the risks to be accepted by building services engineers and the liability they are prepared to accept. As the liability of building services engineers increases, the innovation which they introduce may be diminished to the disadvantage of clients in terms of the project’s life and/or life cycle costs.

Relationship capital

This consists of all value that building services engineers get from their clients, who pay for their services (either directly or indirectly as a subcontractor to an intermediate party), and suppliers who provide goods and services to them. Relationships are on both a personal and an organisational level.

The multidisciplinary nature of building design leads to very many relationships which are legally only limited by formal contractual lines. The lack of direct contractual relationships made the lines of authority subtle, hence the ability of groups to collaborate and work together, and this is, fundamentally, a function of trust. Trust is a valuable resource in the creation and use of knowledge. Formal contractual rules may bring about and legitimise behaviours and strategies that are at odds with common sense perceptions as to how trustworthy and cooperative exchange partners should act.

As building design complexity increases, the number of relationships involved rises, as does the level of involvedness of the relationships, all needing information from each other as a basis for their design decisions.
Depending on the contractual arrangement the ‘client’ to building services engineers may be the party procuring the building, a project management organisation, an architectural practice, a contractor or subcontractors – where they undertake the design work in the subcontractor’s package. The relationship may be ad hoc, or more formal through preferred building services engineers lists or through framework agreements.

Building services engineers need to accept responsibility for making the relationships with clients work for mutual benefit and value gain. The value of relationships that an organisation builds with its clients leads to a more satisfactory working association, and this is reflected in their loyalty to an organisation and their services. This may be rewarded by repeat work, better fees, favourable references for other clients and recommendations for awards.

Suppliers to building services engineers provide the resources necessary to develop and deliver their services: for example, software for drawings and modelling and access to databases. Suppliers also include technical specialists who can assist by bringing new knowledge of their developments in service, or materials technology or other breakthroughs.

Building services engineers may work exclusively with one or more suppliers for a particular service. Supplier relationships may be ad hoc, or more formal though preferred suppliers’ lists or through supply chain management procedures. Working with a variety of suppliers may insulate the organisation from potential setbacks if an exclusive supplier goes out of business or does not perform as required.

**Summary**

There are many different ways of organising how building services design is delivered. As an intellectual process, the entities providing building services design need their human, structural and relationship capital to be arranged to add value to the projects they work on. Individuals who are driven primarily by money are usually not the best fit for building services engineering design. Successful building services engineers tend to be motivated by performing at a high professional level for their clients, integrating with all the stakeholders in the process, delighting in problem solving and being rewarded both financially and in terms of professional recognition.