Designing for Flexible Building Services in Office-Based Environments –

Understanding Client Needs

James Brittain	Denice Jaunzens	Hywel Davies
ABS consulting	BRE	CIBSE

Summary

As the pace of change increases in business, so the demands for change within offices and other business premises increases. Businesses want to minimise the costs of changes to their buildings. To assist in this task the Chartered Institution of Building Services Engineers (CIBSE) is publishing new guidance to help construction clients and designers to consider requirements for flexible building services in office based environments. An important element of this is understanding the client's needs early on in the design process. This paper considers the issues that designers should discuss with clients to ensure that building services are designed with appropriate flexibility. It concludes with a set of principles that designers should follow.

Introduction

It has been estimated that British business currently spends over £2 billion a year on moving people or departments around office buildings in response to organisational change (1) – so called *churn.* As this is almost exclusively non-productive overhead expenditure, anything that will reduce it will help businesses to improve their competitiveness and profitability. A 1999 CIBSE survey of 117 facilities managers confirmed that such churn is often one of the highest office premises costs for an organisation – across all business sectors. It should therefore be a high priority for initiatives to reduce costs. In the survey 92% of respondents reported that they incur costs in modifying their building services to cater for operational change – many of these costs were considered to be significant. They feel that flexible building services are an important issue for the 21st Century (51% of them said of 'major importance', 35% said 'vital'). Clients do not want buildings that restrict change. Consequently, they are increasingly seeking to design for future change within their premises to help create buildings that are more sustainable in use.

CIBSE is providing new guidance to help clients and designers to design more flexible building services for office-based environments. These requirements should be considered as early as possible in a project – ideally during *Definition* and developed through *Outline Proposals.* Designers have particularly asked for guidance that can help them facilitate discussion with clients to understand the requirements for flexibility during the early stages of a project – above '*I want flexible building services'.* This paper focuses on this discussion. It is based on work carried out for CIBSE by ABS consulting and BRE, as part of a DETR funded Partners in Innovation project.

Defining flexible building services

Flexible building services can be defined as building services that are able to sustain the operational requirements of a building in a cost and time effective manner – while responding to the short-term changing requirements of an organisation.

The pattern of use within a building over time is almost certain to change. Changes will be driven by many reasons, for example from competitive pressures and customer requirements, new management approaches, new technologies, changing fashions and changes in regulations. These have direct consequences for the way offices are organised – for example encouraging changes in work-styles between individual, shared group or team-based workspaces, as described by Laing, Duffy, Jaunzens and Willis (2).

The CIBSE survey concluded that flexible building services are required to cater for such demands, and that they need to accommodate the following main types of change:-

- *Relocation of desks.*
- *Cellularisation* – relocation of partitioning and shifts between cellular and open plan.
- *Space-use intensification* – where more people are moved into work areas so increasing the loads on the building services plant. 63% of facilities managers reported space-use intensification over the last three years.
- *Changes in office equipment loads.*
- *Changes in occupancy hours* - for example to 24 hour shift working.
- *Changes in sub-divisibility of tenancies* – sub-letting areas of the building to tenants.

Other changes reported include changes in facilities services (for example the provision of additional catering or shower facilities) and, in the longer term, adapting office buildings for changes in building function (for example refurbishment for residential use). It should be noted that change of use issues are not addressed within the scope of the research project or this paper.

Fundamental business objectives

Clients are increasingly asking for construction to be considered on a whole life basis (3) – that is taking into account the total cost of a building or its parts throughout its life, including the cost of planning, design, acquisition, operations, maintenance and disposal, less any residual value of the building (4). As such, designing for flexible building services should not mean justifying a need for plant oversizing. Oversized plant can cause problems in operation, typically accounting for 10 to 15% of HVAC energy consumption in buildings, with problems associated with poor control, occupant discomfort and shortened plant life (5).

To understand the client's requirements for flexibility (in order to select appropriate building services plant), it is important to develop a clear understanding of the fundamental business objectives of the client at the start of the project and how flexible building services can influence achieving these objectives. One method that can be used to identify the value of different objectives, according to their relevant priority, is value analysis (6). To carry out an assessment, designers must clarify the following business objectives with the client:-

1. Building running costs

The 1999 CIBSE survey confirmed that churn is often one of the highest operating costs for an organisation. Churn typically costs between £250 and £1500 per moved person per year, with an average cost of £500 (1). The higher costs mainly arise from the fitting out of space setting and

building services (7). Many of these companies have incurred significant time and costs in modifying their data cabling, communications, electrical, lighting and HVAC services. Such down time can also bring about losses in staff productivity and customer service.

In most cases *churn* cannot be avoided but its impact can be minimised. Designing for flexible building services is an important element of managing churn, facilitating quick and cost-effective implementation of organisational change and keeping premises capital costs down over the life of a building. It is estimated that installing flexible building services could save an organisation up to £625 per moved person per year where otherwise high churn costs would be realised. This will often reduce the business risk of the building – for example making it easier to sub-lease in the future, if required, while offering maximum rent value.

2. Occupant comfort and productivity

46% of those who responded to the 1999 CIBSE survey stated that they have had to compromise occupant comfort, in the last three years, due to problems with modifying building services plant when accommodating change within a building. The most often reported problems were associated with ventilation and cooling (11%) – for example, problems with cellular offices not having their own ventilation supply and/or extract. As staff costs are typically responsible for over 75% of total premises costs, organisations are increasingly keen to enhance occupant comfort and productivity. The BCO Guide 2000 acknowledges that occupant discomfort has a significant influence on productivity (8). Also restrictions in space layout imposed by inflexible building services can reduce overall productivity of an organisation. Inflexible building services which lead to loss of productivity will therefore be far more costly than a flexible building services solution.

Designing for flexible building services can help sustain a good quality internal environment when introducing change into a building, thereby promoting enhanced occupant productivity.

3. Building environmental impact

The choice of building services plant has a significant impact on a building's energy consumption and environmental impact. Example problems reported due to inflexible servicing include increased energy consumption due to a lack of zone and individual control and increased environmental waste from replacing services before the end of their operational lives.

Designing appropriately for flexible building services can help to optimise building energy consumption, costs and environmental impact in accordance with the organisation's building requirements. This is likely to be an increasingly important design factor in view of the climate change levy and proposed amendments to Part L of the Building Regulations.

4. Building capital costs

Flexible building services can cost more to install and so the objectives for building capital costs will set the budgetary constraints for the provision of flexible servicing. This capital budget should depend on the expected impact of churn during building operation. Clients need to realise that undue pressure on the capital budget can result in significant additional operating costs and even reduced productivity in the future, and may therefore be a false economy, even within two to three years.

Churn is usually measured as the percentage of people that are moved around the building in one year – known as *churn rate.* Anticipated high churn rates will bring about high annual churn costs and so will often justify the use of flexible building services. For example, Table 1 illustrates possible annual savings in churn costs for various churn rates. A churn rate of 30% is

typical in the UK (1). The 1999 CIBSE survey found that 30% of respondents have experienced churn rates of over 50% over the last three years. Rates of over 100% are possible if people are moved more than once a year.

Churn rate	Annual possible churn cost savings
10%	£4.50/m^2
30%	£13.40/m^2
75%	£33.50/m^2

Table 1. Example annual churn cost savings from installing flexible building services for various churn rates (where it is assumed that cost savings of £625 per moved person per year are possible with an average occupancy density of 1 person per 14 m^2)

Flexible building services that lead to reduced total installation costs, compared to other methods, should always be recommended to the client if appropriate. For example, appropriately installed modular wiring systems – for lighting, power data and other applications – can cost less overall than a conduit installation due to savings in installation costs and time.

5. Construction programme

Approaches to flexible building services design require that proposals for structure and servicing are established in principle at an early stage of a project to be acceptable to all parties.
This approach can reduce design effort and construction times. It is also easier to accommodate space planning change during construction with reduced disruption to the design team and contractors.

6. Building value

The client may be keen to prioritise the overall building value after construction. For example, the building investor that owns but lets out a building over the longer term may focus on a building's ability to attract future tenants and maximise rents.

To help develop a good quality brief for construction, designers should highlight the benefits of a flexible building services approach that are compatible with the client's aspirations and business objectives. They should then ensure that the brief adequately addresses the need for flexibility in terms of the important types of change the design should cater for.

Types of change

The vision for the use of the building and types of possible change should be discussed with the client as early as possible – ideally involving the people who will be responsible for the services in use, usually members of the Facilities and IT teams.

Table 2 is considered useful in setting the objectives for flexibility to ensure that the building services cater for different types of **future** change in building use - without compromising the building operating brief in terms of occupant comfort, productivity, health and safety and operating costs.

1. Relocation of desks

Maximum movement of desks permitted	Degree of flexibility required
Limited	Low
Standard	Moderate
No restrictions	High

2. Cellularisation

Maximum percentage of floor area that can be cellularised	Degree of flexibility required
Less than 25%	Low
25 to 75%	Moderate
Greater than 75%	High

3. Space-use intensification

Maximum possible occupancy density that can be accommodated	Degree of flexibility required
Less than 1 person per 17 m²	Low
1 person per 12 to 17 m²	Moderate
Greater than 1 person per 12 m²	High

4. Office equipment loads

Maximum possible small power loadings that can be accommodated	Degree of flexibility required
Less than 15 W/m²	Low
15 to 25 W/m²	Moderate
Greater than 25 W/m²	High

5. Occupancy hours

Maximum occupancy hours permitted	Degree of flexibility required
Limited	Low
Standard	Moderate
No restrictions	High

6. Sub-divisibility of tenancies

Maximum possible sub-divisibility of tenancies	Degree of flexibility required
Limited	Low
Easier	Moderate
Good	High

Table 2. Setting the flexibility requirements to accommodate future change

Developing outline proposals

When developing outline proposals, it is important to consider how the structure and building services will affect the different types of change that the design must cater for. Appendices 1 and 2 illustrate the influences of different structural and building services issues respectively. To allow designers to assess the merits of different approaches, these influences should be discussed with clients to inform life cycle cost decisions and develop the Scheme Design.

The 1999 CIBSE survey asked clients which building services have cost the most to modify to accommodate change in the last three years. Figure 1 illustrates that the costs associated with IT and communications, HVAC, electrical and lighting services were rated as being most significant. This can give designers a crude indication of which building services systems will cause the most disruption if flexibility is not sanctioned as part of the design process – and so can be used to inform discussions with clients. Where there are budgetary constraints on flexible services design, this information will assist in setting priorities for flexible design.

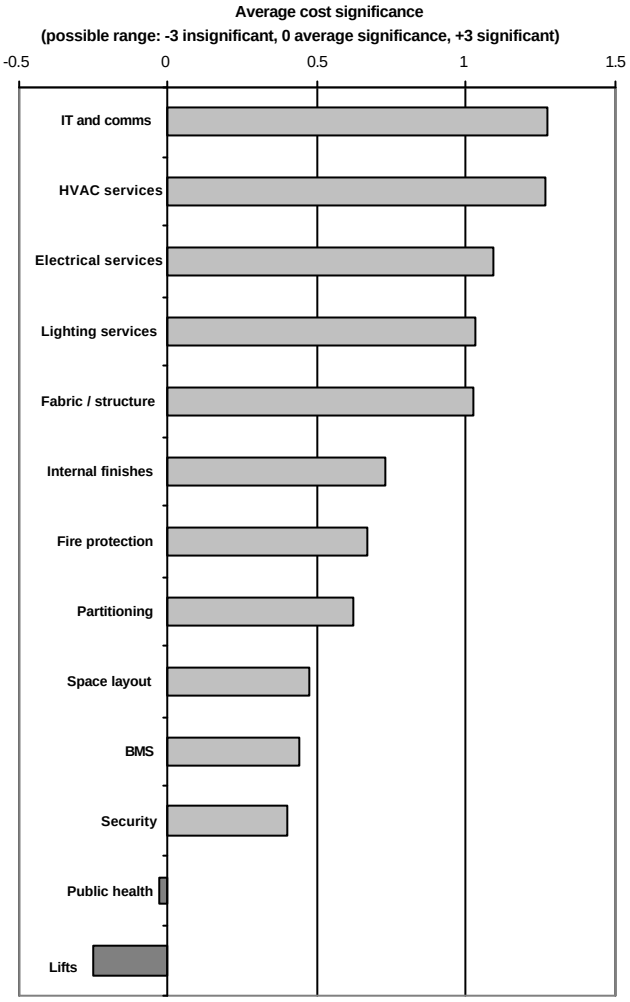

Figure 1. The significance of costs incurred when modifying building services systems to cater for organisation change over the last three years (1999 CIBSE survey of facilities managers)

In general terms, for designing flexible building services, it is prudent to discuss how incremental and radical change may be implemented. The following examples of principles for flexible building services design have been highlighted through consultations with industry.

- In general terms, keep it simple - avoid over-specification, over-complication and design based on short-lived quick-fix technologies.
- A shell and core approach can make it easier to adapt areas of the building to individual needs.
- Design on a grid basis based on the planning grid. *A planning grid of 1.5m provides for good flexibility (8).*
- Provide good services distribution infrastructure - ideally using systems that are easy to reconfigure by non-specialists.
  For example, increased flexibility can be provided by the following (assuming they are appropriately installed): loop cooling, heating or ventilation circuits; busbars within risers; underfloor services for churn rates 30% or above; structured cabling; modular wiring systems for electrical and lighting circuits; plug-in services; wireless systems, etc.
- Design with overcapacity only where it is too expensive to add in later.

For example, for risers, electrical load capacities, public health, lifts and fire escape strategies. Designers should justify such safety margins in the design – see (9) and (10) for more information on design margins.

- Where central and terminal unit plant has been overspecified, if in doubt, design to leave it out - but provide contingencies to allow future occupiers to add the services if required.
  For example: using natural ventilation with local air-conditioning for hot spots and an upgrade path to partial or full air-conditioning; making provision for spare distribution connections, valved and capped for future terminal units if required in the future. Where overcapacity is installed for central and terminal unit plant, incorporate good capacity control – for example using variable speed drives on pumps, inverter driven fans, sequenced modular boilers, modular plant rooms, etc.
- Beware over-congested services: leave sufficient space to alter or add to the services in the future.
- Service the building to cater for sub-tenanting if required. S*ystems should be able to operate on a part-floor basis where large floor plates are designed. Provision of sub-metering should be considered for energy management and future tenant billing, particularly in view of the proposed revisions to Approved Document L of the Building Regulations.*
- Provide good zoned occupancy and time control of terminal unit plant.
- Develop control strategies to allow for quick and easy expansion without the need for expensive engineering and specialist reconfiguration.

In practice, development of the flexible building services design depends on the application and on the main objectives and constraints for design and construction. This is why discussions with the client while developing and testing outline proposals is crucial.

Requirements for building handover

Ensuring that the building occupiers are able to operate the building effectively maximises the flexibility available. Facilities managers consulted as part of the 1999 CIBSE survey stressed that they appreciate information on operational strategies from designers. Discussions with clients, therefore, should consider contingency information to be incorporated in the health and safety file to allow occupiers to plan for proposed future changes and the requirements for end-user training.

Discussions about the *Flexibility Contingency Plan* should focus on describing the degree of flexibility planned for during the design process and modifications to building services plant that will be required to accommodate future change while sustaining building performance. Where necessary the contingencies for upgrade should be discussed for each case of change considered – including considering restrictions imposed by the building structure and the building services systems and opportunities for upgrade.

Conclusions

It is important to consider and assess the requirements for flexible building services during the early stages of a project. To achieve this, designers should discuss the main issues with clients by following a number of principles:-

1. Highlight the benefits of a flexible building services approach to the client.
2. Ensure that the need for flexibility is properly expressed in the client's brief – discuss how flexible building services design impacts on the fundamental business objectives and types of change anticipated during building use.

3. Ensure that the building structure does not restrict future change – discuss how structural issues will affect the objectives for accommodating different types of future change.
4. Consider different strategies for flexible building services and test the design options by discussing how they will affect the objectives for accommodating different types of future change.
5. Hand-over quality – discuss the requirements for documented contingency plans for possible future change and end-user training.

Acknowledgments

This CIBSE project is part funded by the UK's Department of the Environment, Transport and Regions (DETR) Partners in Innovation Scheme and the CIBSE Research Fund. It is supported by Argyle Management Services, Buro Happold, CIBSE Electrical Group, CIBSE Public Health Group, Oscar Faber, Ove Arup & Partners, Roger Preston and Partners, and the British Institution of Facilities Managers (BIFM). The views expressed in this paper are not necessarily those of the DETR.

References

(1) Pettigrew, W. "Thriving on chaos", KYO Issue 3, President Office Furniture, 1996.
(2) Laing, Duffy, Jaunzens and Willis "New environments for working", E & FN SPON, ISBN 0 419 209905, 1998.
(3) "Whole life costing – a client's guide", Construction Clients' Forum, 2000.
(4) ISO 15686-1:2000. "Buildings and Constructed Assets - Service life planning - General principles." British Standards Institution (BSI).
(5) Brittain, J. "The cost of oversized plant" Building Services Journal, April1997.
(6) Hayden and Parsloe "Value engineering of building services", Application Guide 15/96, Building Services Research and Information Association (BSRIA), December 1996.
(7) Bernard Williams Associates, "Facilities economics" BEB, 1994, ISBN 0904237128
(8) BCO Guide 2000 "Best Practice specification for offices", British Council for Offices, June 2000.
(9) Lawrence-Race and Parand "Engineering design calculations and the use of margins" Research Report 4, Chartered Institution of Building Services Engineers (CIBSE), 1998.
(10) Parsloe, C. "Overengineering in building services" Technical Report TR21/95, Building Services Research and Information Association (BSRIA), 1995.

Appendix 1. Types of change affected by building structural issues

Structural issues to discuss	Types of change affected					
	Relocation of desks	Cellularisation	Space-use intensification	Office equipment loads	Occupancy hours	Sub-divisibility of tenancies
Floor plate design						Ō
Building plan depth	Ō	Ō				
Planning and column grid	Ō	Ō				
Circulation space and stairs	Ō		Ō			
Building section			Ō	Ō		
Structural systems		Ō				Ō
Envelope			Ō	Ō		

Appendix 2. Types of change affected by building services issues

Services issues to consider	Types of change affected					
	Relocation of desks	Cellularisation	Space-use intensification	Office equipment loads	Occupancy hours	Sub-divisibility of tenancies
HVAC systems	Ō	Ō	Ō	Ō	Ō	Ō
Daylighting	Ō	Ō				Ō
Artificial lighting	Ō	Ō	Ō			
Control systems	Ō	Ō			Ō	Ō
Office electrical services	Ō	Ō	Ō	Ō		Ō
IT & communications	Ō	Ō	Ō	Ō		Ō
Fire protection/ escape	Ō	Ō	Ō			Ō
Public health	Ō		Ō			Ō
Kitchen facilities	Ō		Ō			Ō
Lifts			Ō			Ō
Security	Ō				Ō	Ō
Plant rooms			Ō	Ō		Ō
General service routes	Ō	Ō				Ō