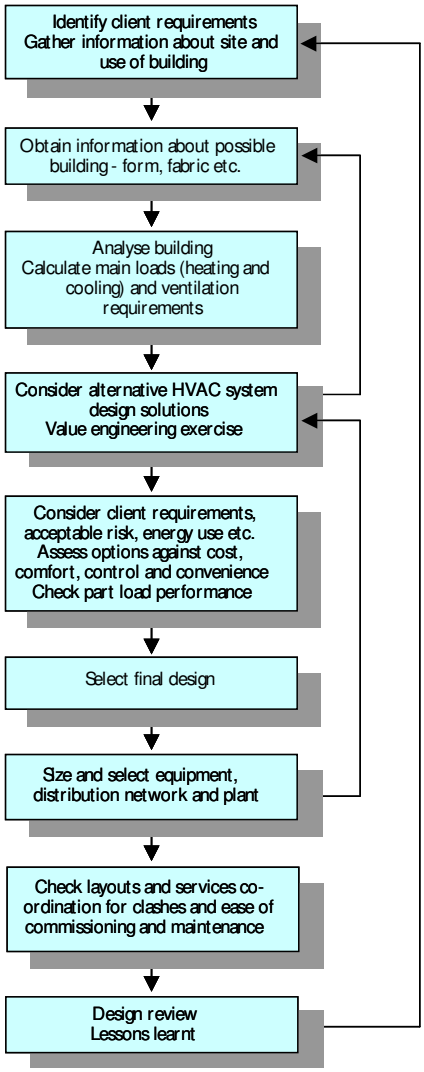
THE BUILDING SERVICES DESIGN PROCESS

Design, in any discipline, is a complex process which involves the activity of translating ideas, proposals and statements of needs and requirements into precise descriptions of a specific product(s)[7]. Design problems are often ill-defined, their solutions often not obvious or self-evident and there is rarely one "correct" answer to a design problem. Designers try to achieve a solution that is satisfactory or appropriate – different designers will arrive at different but possibly equally satisfactory solutions. Two major features characterise the design process. Firstly design tends to evolve through a series of stages at which the solution is increasingly designed at greater levels of detail, moving from broad outline through to fine detail. Secondly design tends to contain iterative cycles of activities during which designs, or design components, are continually trialled, tested, evaluated and refined. Feedback loops are therefore an essential component of design. Most models of the design process therefore involve many feedback and iteration loops, in fact some simple ones use a spiral model to illustrate this process.



Design within construction increasingly involves a number of interdependent professional disciplines with concurrent design processes, and is invariably iterative. Although design may originate with a client need and then a design brief, the design brief itself is not a finite object and often evolves during the design process. In practice the design process involves constant communication and clarification between team members, with many design steps being revisited as the design evolves and develops. This is recognised to some extent with the standard process stages of outline design, scheme design and further/detail design.[8] There are a number of models of the building process, most of which show this as a largely linear process, ranging from the stages in the RIBA Plan of Work to the Generic Design and Construction Process Protocol developed by Salford University[9]. This breaks the design and construction process down into ten distinct phases which are grouped into four broad stages – pre-project, pre-construction, construction and post-completion.

However none of the commonly used models show the design part of the process in detail, let alone the building services design process. One of the tasks proposed for this project was to model the building services design process in order to provide relevant guidance and show the various design tasks that form part of the process in context. This proved to be very complex as, if the integral iterative and feedback loops are included, the model effectively needs to be three dimensional (if not four, with addition of a time base), and is therefore impossible to represent clearly in two dimensions.

A detailed analysis of design procedures and tasks was carried out for building services design. After considerable research and consultation with industry a model was successfully developed that departs from the evolutionary model of design, where design proceeds through a series of stages from broad outline through to fine detail. Instead a simple linear model was proposed that is much closer to a pure design process, giving a single design sequence, from statement of need, through problem analysis, synthesis and evaluation to final solution. This enables design tasks to be clearly linked to both preceding and succeeding actions.

The building services design process was mapped both as a sequence of design tasks and as a series of topics that make up the design process. This provides an overview of the design process to both inform the designer and enable design elements to be seen in context.

The processes set out in this guide are therefore presented as a sequential linear flow for simplicity. In practice there will be overlap from one stage to another, and it may be necessary to revise calculations or modify assumptions at almost any stage. This may in turn lead to a series of knock on revisions. These have associated cost implications which should also be considered in managing and controlling the overall process.

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HVAC building services design tasks and design map

The flow chart opposite shows a very simplified linear version of the main HVAC design tasks. Some primary feedback loops are shown, but in practice there are often feedback loops between all tasks and even within specific tasks.

This sequence of design tasks was then linked to the detail of the design process and the various design choices and considerations in order to develop a design map. This is shown in the form of an Ishikawa or "fishbone" diagram, starting from **client need** on the left with various branches feeding into the main design line to eventually reach **design completion**. An essential part of this design process is the need for design feedback to inform future projects.

A simplified map is shown below and the full detailed design map for the HVAC design process is provided as a fold-out on the back cover. As previously explained the map presents a linear view of design, with iteration and intermediate feedback omitted. The main branches feed into a central spine/node in approximate sequence of design output. The individual branches and sub-branches show relevant design topics which can be related to specific Design Guidance sheets. Some simplifications or expansions have been made for clarity eg heating, ventilation and air conditioning have each been given a separate branch as many designs will not involve all three systems. In cases where all three will be provided then the designs should obviously be integrated. In practice many design tasks would be carried out concurrently but the map illustrates an approximate design sequence.

Although the map inevitably simplifies what is a very complex design process it does provide an overview of the HVAC building services design process to inform both designer and client. It can also show the impact of early assumptions or late changes on the design process eg it can clearly show the amount of design assumptions that have to be made if a design task such as plant sizing were carried out at an initial project stage. Equally the impact of a late client change on design rework is clearly visible eg if there is a change to occupancy or to future needs when the design has already reached the stage of system selection and detailed sizing and layout.