should a function be regarded. For instance, the use of an electric motor to provide motive power can be assumed to be a single function, that is provide torque. In fact, of course, a motor contains many functions within it and is essentially a subsystem in its own right. This is an example of where one can regard a subsystem as a 'black box', and when one does or does not do so this has to be an arbitrary decision.

In order to compile a FAST diagram, it is necessary to link each of the individual functions together to form a network. This is done by asking two questions relative to each individual function: 'Why?' and 'How?' The answers to 'why' are placed to the right and the answers to 'how' are placed to the left. When the final network is completed, we can progress across the network from left to right by asking 'why' and from right to left by asking 'how'. In simple terms this means that the box on the far right represents the ultimate function of the system design and the boxes on the far left represent the parametric functions for the system operation (Fig. 3.10).

Drawing a FAST Diagram

The FAST diagram represents the functional relationships between all the functions of a system. It shows which ones are dependent on others and which functions occur at similar times or in parallel. The diagram has the benefit of bringing a greater understanding of how the total system functions and can act both as a stimulant for new ideas in design and as a check-list for designs already under development.

Since the FAST diagram contains all the functions of the system, a good way to start is to write down all the known functions of the design under consideration. This enables the designer to begin to assimilate a picture of the total system. Write them in the form of a noun–verb combination, such as shaft turned or valve opened, etc.

Starting with any one of the functions known to the designer, ask two questions. Ask 'why' does the function exist and then 'how' does the function occur. Answer each of these questions with more noun–verb answers representing other functions. It is a good idea to use sticky backed notes to write the functions on so that at a later stage the elements can be moved around into a more logical order as the diagram develops. Place the answers to all the 'whys' to the right of the relevant function and all of the 'hows' to the left. Generally there will be more answers to the question 'how' as this breaks down the make-up of the function in question. For instance, to turn shaft might require apply torque, provide bearing, etc. Link the functions together with lines so that all the necessary 'hows' link into the function that they enable. Once more functions have been added to the diagram; repeat the 'how' and 'why' question format for each one and allow the diagram to expand (Fig. 3.11).

Sometimes it will be noticed that the same verb–noun function is

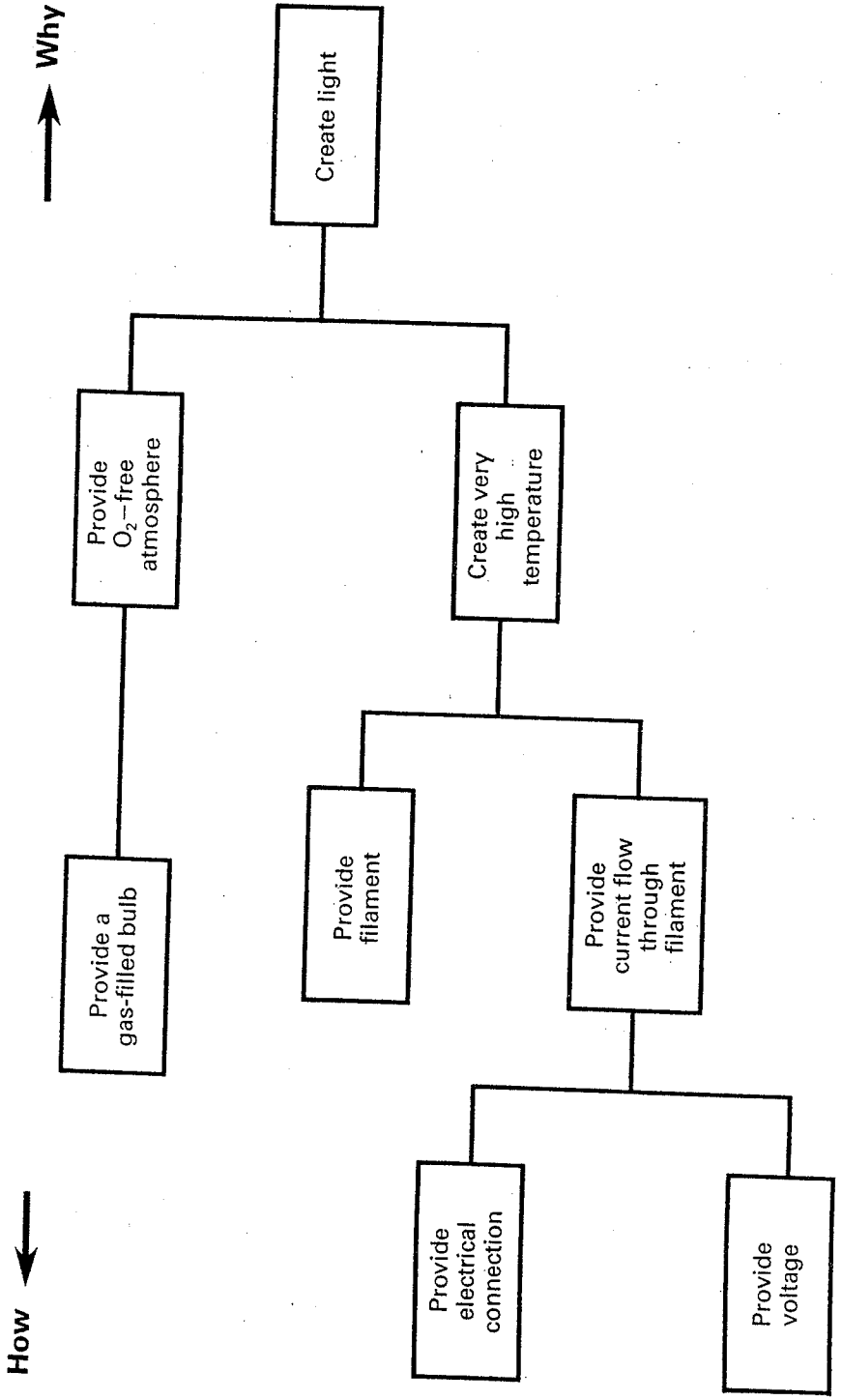

Figure 3.10 A simple FAST diagram for the light bulb.

repeated. If both of these represent the same function in the design then only write it once, but link it to both parts of the diagram that this enables. If they are just the same noun–verb combination but represent functions that happen separately or in different parts of the design, then keep them separate and write them down twice or as many times as they occur independently. This will be beneficial later as it will draw attention to functions that are similar but are addressed separately.

Keep working the diagram asking the 'how' and 'why' questions until you are satisfied that the diagram is a true representation of the system function. One of the most usual errors is to answer the questions with too all-encompassing an answer. For example, 'How is the valve opened?' By applying force, providing spring and providing guide. In fact 'valve opened' is achieved by 'applying force' and 'providing guide' only, 'providing spring' being 'how' we apply force. It is important to break down the system into its smallest elements to make the diagram most effective.

It will soon become clear that the functions at the left of the diagram, usually prefixed 'Provide . . .', actually represent the parts, while those on the extreme right of the diagram represent the customer's requirements. The completed diagram can be used immediately to gain a broad understanding of the elements of the system. Look for areas that seem overcomplex for the function contribution that they make. Look for areas where functions are repeated and ask whether these could be combined. Break sets of functions into groups and study whether these appear to be the most efficient way to achieve performance or whether this gives the designer alternative ideas for achieving the same. Just a cursory look at the structure of the diagram can help to initiate new ideas of how the job can be done in a better or more efficient way. Later I will describe more formal ways of using the diagram to reduce costs and improve reliability.

In using the diagram it will be necessary to define boundaries of the work. For example, in some tasks it will not be necessary to get down to the

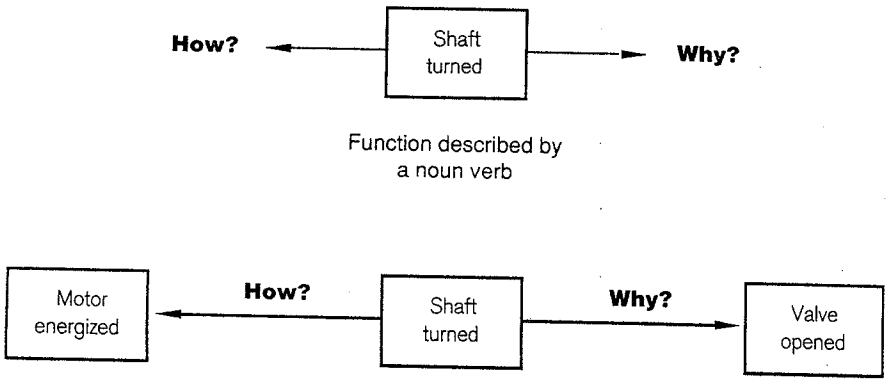

Figure 3.11 Building a FAST diagram.

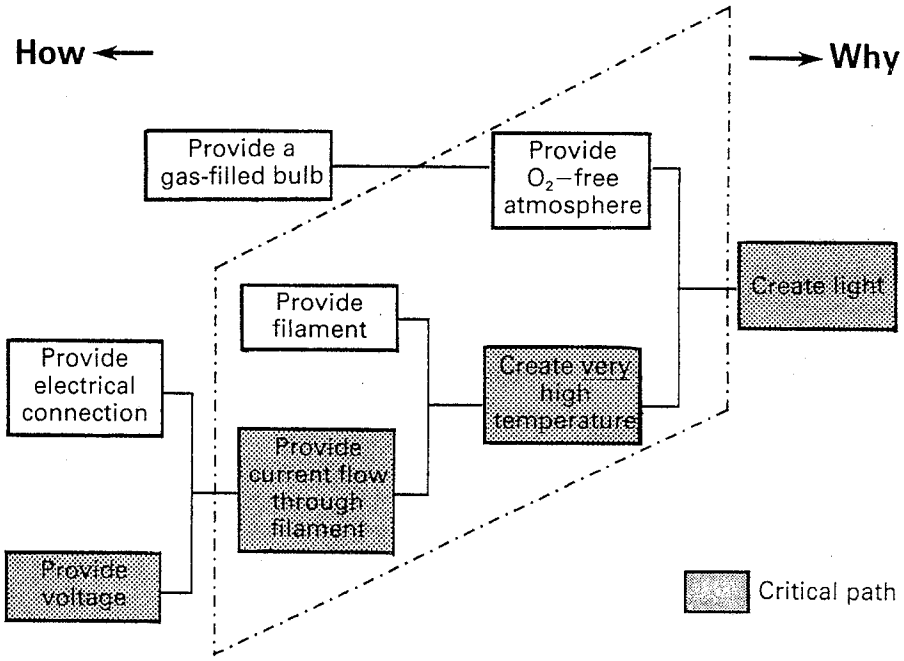

Figure 3.12 The FAST diagram for the light bulb showing critical path and boundaries.

parts level, so a boundary can be drawn to the right of this. Similarly, if ultimate customer's requirements do not come into the exercise being undertaken a line to the left of this can define the boundary.

It is often useful to draw the critical path through the diagram from left to right. This line represents the central functions of the system at all levels (Fig. 3.12).

3.4 THE FUNCTION DIAGRAM

Having prepared a FAST diagram, the designer has a clear view of the overall system design and can begin to look at this structure to see, firstly, if it seems to be the most efficient arrangement that can be configured and, secondly, to highlight the most significant functions of the system. It will usually be the case that there are just a few key functional areas to the system. (Indeed, if there are a large number this tells the designer that the system is too complex to be dealt with in its present form without further breakdown, and enables the process of breaking down the system into smaller components to be studied.) For each of these key functions a function diagram can be configured (Fig. 3.13).

The function diagram is the heart of the process called critical parameter management (see Sec. 3.5). It provides the foundation upon which the