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## The Design Process

The principal reason for learning how to analyse the behaviour of a circuit is that we shall eventually want to design one or try to understand one that has been designed. So to provide a context for the entire book we look briefly at the design process to see where the material of this book fits in and where it doesn't.

Figure 1.1 provides an overview of the circuit design process. Someone (**A**), somewhere – and it may be you, the circuit designer – needs a circuit designed. You must therefore say what performance you want from the circuit: in other words, you provide specifications (**B**) for its behaviour. The performance may, for example, be the extent to which the voltage captured from an aerial must be amplified to operate a loudspeaker. You, the circuit designer (**C**), must propose an idea (**D**) for a circuit that will exhibit the required performance. This is the hard part! You may achieve this by recalling a circuit designed earlier, and try to modify it; or you may consult a book to find what might be a suitable circuit; or you may ask a fellow engineer for ideas; or you may simply draw upon your experience of circuit design and create a circuit from scratch.

The idea will usually be sketched as a circuit diagram on a piece of paper so that it can be reviewed. But what then? There are three routes that may be followed.

One approach is to build the circuit (**E**) and then measure its performance (**F**). The measured performance (**G**) can then be compared (**H**) with the customer's specification. If the two agree then circuit design might stop at that point. But it would be remarkable if the first idea for a design were satisfactory. In that case you, the designer (**C**) must decide how to modify (**J**) the circuit (or discard it and start again). The circuit would be rebuilt, measured again, and its performance checked against specifications. Again, the circuit may not work exactly as required, so the loop **C–D/J–E–F–G–H–C** is traversed once more. Indeed, it would not be unusual for this loop to be traversed many times in order to ensure a well-designed circuit.

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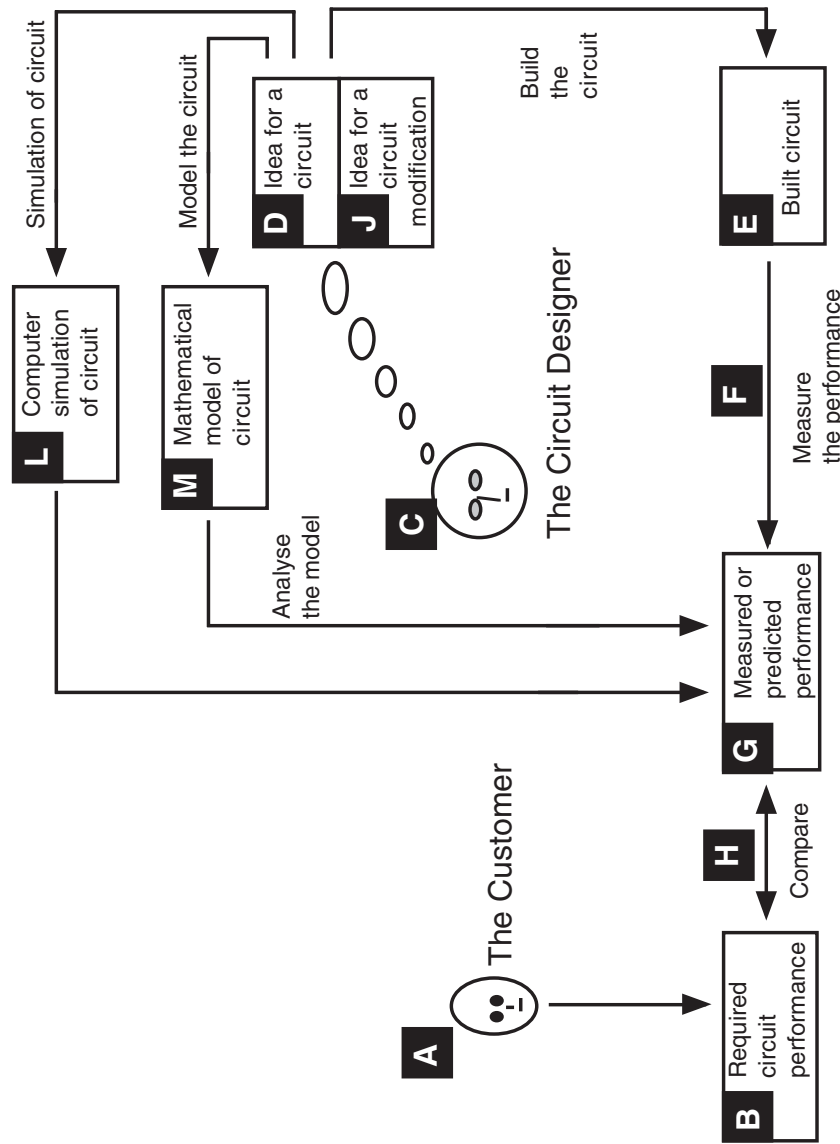


Figure 1.1 An overview of the process of circuit design

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The approach we have just described is totally inappropriate if you are designing an integrated circuit: the cost of manufacturing such a circuit is so high and, moreover, would be multiplied many times if the first few attempts at design were not satisfactory. In this case you would use one of the many available software packages (**L**) to simulate the proposed circuit's performance and compare that prediction (**G**) with the specifications (**H**). Again, the design loop (here, **C–D/J–L–G–H–C**) will probably be traversed a number of times until the simulated circuit performance (**G**) satisfies the specifications (**B**). At that point, with some degree of confidence, a decision may be made to manufacture the circuit.

A third approach is for the circuit designer to write down a mathematical model (**M**) – normally a number of equations – describing the proposed circuit, and then to solve those equations in order to find the proposed circuit's performance (**G**). Again, because the initially proposed circuit may not quite meet the specifications an iterative process may be required.

In what way does this book prepare one to undertake design, and in what way does it not? Its principal value relates partly to the transition from **C** to **D**: in other words the process by which you, the designer, propose what you think might be a suitable circuit. The material of this book, and especially the solution of problems, should provide some experience relevant to this initial stage of the design process. Another principal value of the book is that it shows how a circuit (**D**) can be modelled (**M**) and then analysed to find its performance (**G**), thereby enabling a wide variety of circuit performances to be investigated.

This book does *not* address the task of building a circuit (**E**) and measuring (**F**) its behaviour: such skills are usually acquired in a laboratory course. Equally, it does not address the task of using software (**L**) to simulate circuit performance: again, special classes are often organized to introduce students to this task.

