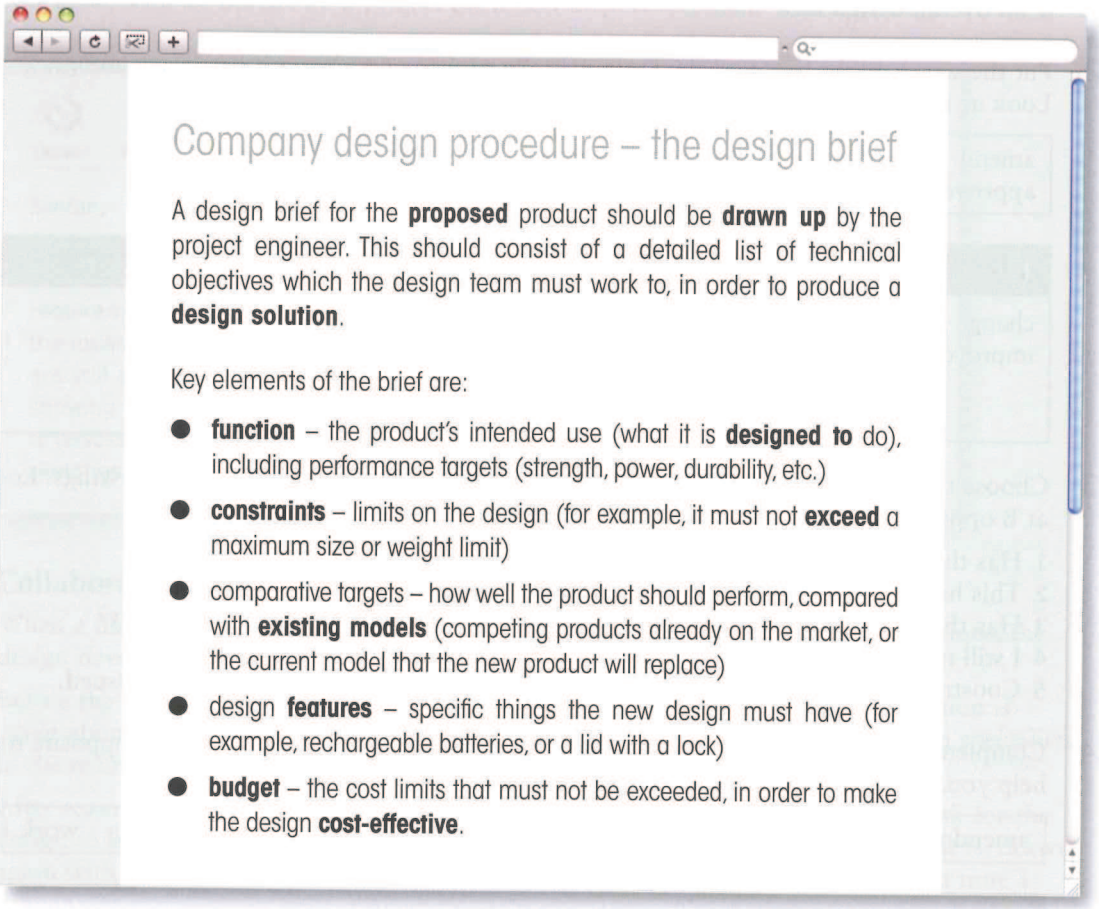
3 Design solutions

A Design objectives

The web page below is from a manufacturing company's intranet.



Company design procedure – the design brief

A design brief for the **proposed** product should be **drawn up** by the project engineer. This should consist of a detailed list of technical objectives which the design team must work to, in order to produce a **design solution**.

Key elements of the brief are:

- **function** – the product's intended use (what it is **designed to** do), including performance targets (strength, power, durability, etc.)
- **constraints** – limits on the design (for example, it must not **exceed** a maximum size or weight limit)
- comparative targets – how well the product should perform, compared with **existing models** (competing products already on the market, or the current model that the new product will replace)
- design **features** – specific things the new design must have (for example, rechargeable batteries, or a lid with a lock)
- **budget** – the cost limits that must not be exceeded, in order to make the design **cost-effective**.

B Design calculations

Design information is shown on drawings, and written in **specifications** – documents which describe the materials, sizes and technical requirements of components. In order to **specify** this detailed information, an engineer must **evaluate** – that is, identify and calculate – the **loads** (forces) that key components will have to carry. To do this, the engineer needs to **determine** (identify) the different loads, then **quantify** them – that is, calculate them in number form. Usually, each load is quantified based on a **worst-case scenario** – in other words, the engineer will **allow for** the maximum load, such as an aircraft making a very hard landing, or a bridge being hit by extremely high winds.

After maximum loads have been quantified, an engineer will apply a **factor of safety**. This is an extra margin to make the component strong enough to carry loads that are higher than the worst-case scenario. For example, a factor of 1.5 increases the load a component can carry by 50%. After this has been **factored in**, the engineer will then **size** the components – that is, calculate their required size.

Engineers are sometimes criticized because they **overdesign** things (add excessive factors of safety), which increases costs. However, according to **Murphy's Law**, 'Anything that can go wrong, will.' This suggests that **belt and braces** – an expression often used in engineering, based on the safest method of holding up trousers – is a sensible approach.

3.1 Complete the sentences from technical conversations using the words in the box. Look at A opposite to help you.

budget constraint	cost-effective designed	exceed existing	feature function	proposed

1 Of course, money is limited. Cost limitations are always a ..... . But some finance is available. A ..... has been allocated for the preliminary design phase – a total of $35,000. But we mustn't ..... that amount.

2 Obviously, if we have to spend €80 on components for each appliance, and the appliances are sold for €70, that's not a ..... design solution.

3 The ..... of this detector is to locate underground cables by giving audio feedback. Since it's ..... to be used in noisy environments, the earphone is an important ..... .

4 Are these already on the market – are they ..... products? Or are we talking about ..... products that are still under development?

3.2 Choose the correct words from the brackets to complete the sentences. Look at B opposite to help you.

1 The types of loads that will be encountered must be (designed / determined).
2 Maximum loads are based on predicted (specifications / worst-case scenarios).
3 On top of maximum loads, additional safety margins are (factored in / sized).
4 For cost reasons, components shouldn't be (overdesigned / quantified).
5 The practice of overdesigning components can be described as the (belt and braces / factor of safety) approach.
6 (Quantifying / Sizing) components means calculating their dimensions.

3.3 Replace the underlined words and expressions with alternative words and expressions from A and B opposite.

Most engineering designs (1) make provision for excessive or abnormal operating conditions. The critical question is, how much of a (2) percentage of extra size or capacity should be applied without (3) adding too much of a margin? To (4) calculate an amount for this figure, it is critical to assess the consequences of a technical failure. Where the stakes are high, in applications such as aviation, designing for (5) the most extreme situations is clearly critical on safety grounds. On the face of it, the result of this may seem costly. But where the human implications and expense of failure are serious, a high level of expenditure aimed at accident prevention can be considered (6) financially viable.

Over to you

Think about overdesign in a field of engineering you are familiar with. How easy or difficult is it to predict and quantify loads? How serious are the consequences (human and financial) of technical failures? As a result, how high are typical factors of safety?