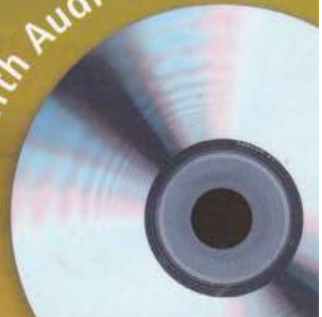
CAMBRIDGE Professional English

Cambridge English for Engineering

Mark Ibbotson
Series Editor: Jeremy Day

With Audio CDs



Cambridge English for Engineering

Mark Ibbotson
Series Editor: Jeremy Day

CAMBRIDGE
UNIVERSITY PRESS

CAMBRIDGE UNIVERSITY PRESS
Cambridge, New York, Melbourne, Madrid, Cape Town, Singapore, São Paulo, Delhi

Cambridge University Press
The Edinburgh Building, Cambridge CB2 8RU, UK

www.cambridge.org
Information on this title: www.cambridge.org/9780521715188

First published 2008

Printed in Italy by L.E.G.O. S.p.A.

A catalogue record for this publication is available from the British Library

ISBN 978-0-521-71518-8 Student's Book with Audio CDs

Introduction

The aim of *Cambridge English for Engineering* is to improve your professional communication skills, whether you are an engineer, an engineering technician or a technical manager. The course covers high-priority language that is useful in any branch of engineering (mechanical, electrical, civil, etc.), focusing on skills such as working with drawings, describing technical problems and discussing dimensions and precision. Each of the ten units contains:

- realistic listening activities so you can learn the language used in technical discussions
- situation-based speaking activities so you can practise the language you've learned
- relevant vocabulary presented and practised in professional contexts
- engaging topics and articles to make your learning interesting and motivating.

On the audio you will hear people in the kinds of situation often encountered at work, for example safety meetings, project briefings and problem-solving discussions. Audioscripts for the listening exercises and a complete answer key, including suggested answers for the discussion activities, are at the back of the book. You can also find engineering case studies and extra activities online at www.cambridge.org/elt/englishforengineering.

How to use *Cambridge English for Engineering* for self-study

If you are working on your own, you can do the units in any order you like. Choose the topic that you want to look at and work through the unit, doing the exercises and checking your answers in the answer key. Note any mistakes you make, and go back and listen or read again to help you understand what the problem was. For the listening exercises, it's better to listen more than once and to look at the audioscript after the exercise so that you can read the language you've just heard. For the speaking activities, *think* about what you would say in the situation. You could also try talking about the discussion points with your colleagues.

I hope you enjoy using the course. If you have any comments on *Cambridge English for Engineering* you can email me at englishforengineering@cambridge.org

Mark Ibbotson

Mark Ibbotson has a BSc (Hons) degree in Construction management, and a BTEC National Diploma in Civil Engineering. He spent the initial years of his career in site engineering and technical management positions on construction projects in the UK. Since relocating to France and entering the field of in-company language training, he has designed and taught technical English courses in a wide range of companies, for process, mechanical, electrical, civil and highway engineers, as well as technicians and technical managers. Mark is co-author of the *Business Start-Up* series (Cambridge University Press).

UNIT 1 Technology in use

- Describing technical functions and applications
- Explaining how technology works
- Emphasising technical advantages
- Simplifying and illustrating technical explanations

Describing technical functions and applications

1 a In pairs, think about two or three products you use regularly and discuss the following questions.

- What are the main functions of the products? (What do they do?)
- What are their different applications? (What are they used for?)

b What do you know about Global Positioning System (GPS) devices? In pairs, describe their main function, and give some examples of different applications of GPS devices.

2 a ▶1.1 Paula, a design engineer for a GPS manufacturer, is discussing product development with José, a senior manager new to the company. Listen to the conversation and complete the following notes.

- the primary application of GPS — (1) _____
- associated applications — Tracking systems for (2) _____
  Tracking systems for (3) _____
- more creative features — (4) _____ alarms
  (5) _____ buttons
- not technical innovations — (6) _____ the technology

b Complete the following extracts from the discussion with words that come from *use*.

1 *Then you've got associated applications, _____ that are related to navigating ...*
2 *... tracking systems you can _____ for monitoring delivery vehicles ...*
3 *... from the end-_____ point of view, accuracy is no longer the main selling point. Most devices are accurate enough. The key is to make them more _____ .*

3 a Match the GPS applications (1–6) to the descriptions (a–f).

1	topographical surveying	a	navigation and safety at sea
2	geological exploration	b	setting out positions and levels of new structures
3	civil engineering	c	mapping surface features
4	avionics equipment	d	applications in mining and the oil industry
5	maritime applications	e	highway navigation and vehicle tracking
6	GPS in cars and trucks	f	air traffic control, navigation and autopilot systems

b In pairs, practise explaining the applications of GPS in Exercise 3a to a colleague who has limited knowledge of the devices using the following phrases.

used for -ing	used to	useful for	another / a similar use

4 a Complete the following extracts from the conversation by underlining the correct words.

1 *... there's a setting on the GPS that* ***allows/prevents*** *it to detect the movement ...*
2 *... an alarm sounds to warn you, and* ***allows/prevents*** *the boat from drifting unnoticed.*
3 *... and* ***enables/ensures*** *that you don't lose track of where you were, which then* ***enables/ensures*** *you to turn round and come back to the same point ...*

b Match the words in Exercise 4a to the synonyms.

1 _____ = makes sure 2 _____ / _____ = permits 3 _____ = stops

c Complete the following extract from the user's manual of a GPS device using the verbs in Exercise 4a. Sometimes, more than one answer is possible.

INTRODUCTION

The core function of your GPS receiver is to (1) _____ you to locate your precise geographical position. To (2) _____ the device to function, it receives at least three signals simultaneously from the GPS constellation – 30 dedicated satellites which (3) _____ receivers can function anywhere on earth. To (4) _____ extremely precise positioning and (5) _____ errors from occurring due to external factors, this device is designed to receive four separate signals (see enhanced system accuracy on page 18).

5 In pairs, explain the main functions and applications of a product made by your company or a product you know about. Student A, you are an engineering manager; Student B, you are a new employee. Use the language from this section and the phrases in the box. Swap roles and practise again.

I see. So ...	OK. In other words ...	So you mean ...

Explaining how technology works

6 a **In pairs, look at the picture and discuss the following questions.**

- How do you think a space elevator would work?
- What could it be used for?
- What technical challenges would it face?
- How seriously do you think the concept of space elevators is being taken at present?

b **Read the following article and compare it to your answers in Exercise 6a.**

Space elevators: preparing for takeoff

IN his 1979 novel, *The Fountains of Paradise*, Arthur C Clarke wrote about an elevator **connecting** the earth's surface to space. Three decades later, this science-fiction concept is preparing to take off in the real world. NASA has launched the Space Elevator Challenge, a competition with a generous prize fund, and several teams and companies are working on serious research projects aimed at winning it.

As its name suggests, a space elevator is designed to **raise** things into space. Satellites, components for space ships, supplies for astronauts in space stations, and even astronauts themselves are examples of payloads that could be **transported** into orbit without the need for explosive and environmentally unfriendly rockets. However, the altitude of orbital space – a colossal 35,790 km above the earth – is a measure of the challenge facing engineers. How could such a height be reached?

The answer is by using an incredibly strong and lightweight cable, strong enough to **support** its own weight and a heavy load. The design of such a cable is still largely theoretical. This would be **attached** to a base station on earth at one end and a satellite in geostationary orbit (fixed above a point on the equator) at the other. Lift vehicles would then **ascend** and **descend** the cable, **powered** by electromagnetic force and **controlled** remotely.

c **Match the verbs (1–9) from the text in Exercise 6b to the definitions (a–i).**

1	connecting	a	carried (objects, over a distance)
2	raise	b	hold something firmly / bear its weight
3	transported	c	climb down
4	support	d	provided with energy / moved by a force
5	attached	e	joining
6	ascend	f	driven / have movement directed
7	descend	g	fixed
8	powered	h	climb up
9	controlled	i	lift / make something go up

7 a **James, an engineer, is giving a talk on space elevators. Complete his notes using the correct form of the verbs (1–7) in Exercise 6c.**

Space Elevators

- *Challenge of (1)* connecting *a satellite to earth by cable is significant.*
- *To (2)* _____ *its own weight, and be securely (3)* _____ *at each end, cable would need phenomenal strength-to-weight ratio.*
- *How could vehicles be (4)* _____ *into space, up cable?*
- *Self-contained energy source problematic, due to weight (heavy fuel or batteries required to (5)* _____ *vehicle).*
- *Two possible ways round problem:*

1 Transmit electricity wirelessly. But technique only at research stage.

2 Solar power. But would only allow vehicle to (6) _____ *slowly. Not necessarily a problem, as car could be controlled remotely, allowing it to (7)* _____ *payloads unmanned.*

b ▶1.2 **Listen to part of James' talk and check your answers in Exercise 7a.**

c **What kinds of word are missing from the notes? In pairs, compare the audioscript on page 86 with the notes in Exercise 7a.**

8 a **Some space elevator designs propose an offshore base station. In pairs, discuss how such a system might work using words in Exercise 6c. What advantages might an offshore base have compared with a land base?**

b ▶1.3 **James goes on to discuss offshore base stations. Listen to the talk and answer the following questions.**

1 How would an offshore base station be supported?
2 What would the function of its anchors be?
3 How would payloads reach the base station?
4 What problem would a mobile base station help to prevent?
5 What would the procedure be if there was an alert?

9 a **You are members of a space elevator research team designing a concept for offshore base stations. In pairs, analyse the notes below, which were made during a briefing given by your manager. Imagine you are giving a presentation. Begin by reading out the abbreviated notes in full.**

OFFSHORE BASE STATION - ANCHORING & PROPULSION ISSUES

Anchoring system

Wind loads on cable will be huge. What implications for anchoring system? Base will need to be moved continually, sometimes urgently. What temp system could be used to hold base in position?

Base in shallow water near coast, or deep water further offshore? Choice will have impact on design of anchor system.

Propulsion system

Will weight of cable allow base to be moved by own propellers? Or more powerful system for propulsion and control nec.? E.g. extern. power source?

b **In pairs, discuss the questions raised in the notes and think of some suitable solutions for the anchoring system and the propulsion system. At this stage, these should be overall concepts, not detailed designs. Remember to make notes.**

c **In small groups, take turns to give a short talk using your notes to explain how the systems work, in general terms. Imagine you are speaking to a small group of colleagues, including your manager.**

d **Write two or three paragraphs to summarise your talk. These will be included in your manager's longer report on offshore base stations.**

Emphasising technical advantages

10 **In pairs, discuss the term *technical advantage*. Give some examples of technology you are familiar with.**

11 **a** **Read the first paragraph of some promotional literature from Otis, a leading elevator company. What is the Gen2™ system?**

b **Match the words (1–6) from the text in Exercise 11a to the synonyms (a–f).**

1	conventional	a	decreases
2	eliminates	b	better / the best
3	superior	c	improved
4	energy-efficient	d	standard, usual
5	enhanced	e	gets rid of
6	reduces	f	has low energy consumption

c **Complete the following text using the correct form of the words (1–6) in Exercise 11b. You will need to use some words more than once.**

OTIS Unique Flat Belt

The key to Otis's patented drive technology

At the heart of the Gen2™ elevator system is a flat belt (developed by and unique to Otis). It is just 3mm thick. Yet it is stronger than **conventional** steel cables. It lasts up to three times longer. And it has enabled Otis to completely re-invent the elevator. The flat, coated-steel belt totally **eliminates** the metal-to-metal effect of conventional systems. Coupled with a smooth-surface crowned machine sheave, the result is exceptionally quiet operation and **superior** ride comfort. Furthermore, the flexible flat belt enables a more compact, **energy-efficient** machine, which can be contained in the hoistway. This **enhanced** technology **reduces** building and system operating costs, and frees up valuable space.

Protecting the environment

Neither the belt nor the gearless machine, with its permanently sealed bearings, requires any lubrication so the Gen2™ system is cleaner for the environment. The highly (1) energy-efficient gearless machine, with its permanent-magnet synchronous motor, (2) _____ power consumption by as much as 50 percent over (3) _____ geared machines and 15 percent over other machines with permanent-magnet motors of axial construction.

Reliable by design

Long-lasting flat belts, smooth, crowned sheaves and minimal moving parts in the gearless machine dramatically (4) _____ wear and increase durability and efficiency. To further (5) _____ reliability and safety, Otis developed the Pulse™ system, which continually monitors the status of the belts' steel cords. Unlike visual inspections of (6) _____ steel ropes, the Pulse™ system automatically detects and reports belt faults to maintenance personnel for rapid response, providing owners with greater peace of mind. With flat belt technology, Otis has created a (7) _____ system that (8) _____ the need for a machine room, is quiet, clean, reliable and economical, and easy to install and maintain.

d **In pairs, summarise the advantages of the flat belt system. Discuss durability, wear, noise, space, cleanliness, efficiency, automation, maintenance and cost.**

12 a Complete the following tips on emphasising technical advantages using the words in the box.

conventional eliminated enhanced reduced superior

When describing technical advantages, it's useful to emphasise ...

a (1) _____ performance, compared with the older model of the same product.

b negative issues that have been (2) _____ , or completely (3) _____ .

c special features that differentiate the technology from (4) _____ systems.

d performance levels that make the technology (5) _____ to the competition.

b ▶1.4 Stefan, an engineer, is briefing some sales colleagues on the advantages of a new pump design. Listen to the briefing and match the tips (a–d) in Exercise 12a to the extracts (1–4).

Extract 1 _____ Extract 2 _____ Extract 3 _____ Extract 4 _____

c Complete the following sentences from the briefing by underlining the correct emphasising word.

1 *We've come up with a* ***completely/significantly*** *unique profile.*
2 *It* ***completely/dramatically*** *reduces vibration.*
3 *Machines like these can never be* ***entirely/highly*** *free from vibration.*
4 *The new design runs* ***dramatically/extremely*** *smoothly.*
5 *Another advantage of the new profile is that it's* ***considerably/entirely*** *lighter.*
6 *So compared with our previous range, it's* ***highly/totally*** *efficient.*
7 *Trials so far suggest the design is* ***completely/exceptionally*** *durable.*
8 *We expect it to be* ***entirely/significantly*** *more reliable than rival units.*

d Match the words in Exercise 12c to the synonyms.

considerably dramatically entirely exceptionally highly totally

1 _____ / _____ = completely
2 _____ / _____ = significantly
3 _____ / _____ = extremely

13 You are Otis engineers back in the 1850s, when elevators were new. In pairs, prepare a short talk to brief your sales colleagues on the advantages of elevators for lifting people and goods. Emphasise the points below, using the phrases and techniques from this section. Remember that people at this time are sceptical about the technology.

Elevators are ...

- safe – a reliable braking system eliminates the danger of a car falling if a cable fails
- simple – they're controlled from the car and are very easy to operate
- convenient – they're easier on the legs than the conventional alternative (stairs)
- valuable – they enhance the value of land by allowing taller buildings on smaller areas

Simplifying and illustrating technical explanations

14 a ▶1.5 **Richard, a structural engineer, often takes clients on guided tours of their new buildings during construction. He is talking about explaining technical concepts to non-specialists. Listen and answer the following questions.**

1 What does Richard say about explaining technical concepts?
2 What does he mean by *dull* explanations?
3 What is *being patronising*?

b In pairs, think of some tips on how to solve the following problems.

1 not being understood
2 being patronising
3 explaining difficult concepts
4 sounding dull

c ▶1.6 **Richard is giving some advice about the problems in Exercise 14b. Listen and summarise his ideas. Compare his tips with your suggestions.**

15 a Richard has made notes for a guided tour of a site. The project is a skyscraper in the early stages of construction. During the tour he explains the technical terms to the non-specialist group. In pairs, discuss the following terms and try to interpret them using everyday language to rephrase them.

SUBSTRUCTURE

- *Pile foundations (in general)*
- *Bored in situ concrete piles*
- *Pre-cast driven concrete piles*
- *Pile driver*
- *Pile auger*
- *Bentonite*

b ▶1.7 **Richard is giving a tour of a construction site. Listen and make notes of his explanations of the following technical terms. Compare your ideas with his.**

1 the substructure the part of the structure below ground
2 a pile foundation .....
3 to bore (a pile) .....
4 in situ concrete .....
5 pre-cast piles .....
6 to drive in (a pile) .....
7 a pile driver .....
8 a pile auger .....
9 bentonite .....

c **Listen again and compare Richard's explanations with the tips in Exercise 14c. Which techniques did he use? Were they successful?**

d **Complete the following table using the words in the box.**

basically (x2) call effectively essentially imagine other picture refer ~~simple~~ simply

Function	Words / Phrases
1 Simplifying the language	in simple terms / put _____ / in _____ words / _____
2 Simplifying the concept	_____ / _____ / _____
3 Focusing on technical terms	what we _____ / what we _____ to as
4 Illustrating with images	if you _____ / if you _____

e **In pairs, practise explaining the technical terms in Exercise 15a using the simplified words and phrases in Exercise 15d.**

16 **Read the textbook description of two types of pile foundation. Use the words and phrases in Exercise 15d and the following notes to rephrase it.**

From a structural perspective, pile foundations can be divided into two categories: end-bearing piles and friction piles.

Like standing on stilts in water

End-bearing piles are driven or bored through soft ground in order to attain firm substrata below. The pile then transmits load vertically to firm subsoil or bedrock. The soft ground surrounding the sides of the pile is structurally redundant.

Imagine water and the seabed

Imagine a leg and a foot

Friction piles counteract downward loads from the structure through frictional resistance between the sides of the pile and the surrounding ground, and do not therefore rely on firm substrata. In some cases, the diameter of the concrete at the pile's base is widened by compaction, allowing the increased area to give the friction pile a certain degree of end-bearing resistance.

Like a nail in wood

17 **You are showing a non-specialist visitor around your company and explaining technical concepts using simplified language. In pairs, practise explaining a product or type of technology that you are familiar with.**

UNIT 2 Materials technology

- Describing specific materials
- Categorising materials
- Specifying and describing properties
- Discussing quality issues

Describing specific materials

1 **In pairs, discuss the benefits and problems of recycling. Use the following examples and your own ideas.**

breaking up ships demolishing buildings recycling electronics scrapping cars

2 **a** **Read the following web page and complete the missing headings using the words in the box.**

Aluminium Copper Glass Plastic Rubber ~~Steel~~ Timber

RECYCLABLE MATERIALS

1 Steel Scrap can be sorted easily using magnetism. If the metal is galvanised (coated with zinc) the zinc is fully recyclable. If it is stainless steel, other metals mixed with the iron, such as chromium and nickel, can also be recovered and recycled. More ...

2 _____ Sorting is critical, as there are key differences between the clear and coloured material used in bottles and jars, and the high-grade material used in engineering applications, which contains traces of metals. More ...

3 _____ Scarcity makes recycling especially desirable, and justifies the cost of removing insulation from electric wires, which are a major source of scrap. Pure metal can also be recovered from alloys derived from it, notably brass (which also contains quantities of zinc, and often lead) and bronze (which contains tin). More ...

4 _____ The cost of melting down existing metal is significantly cheaper than the energy-intensive process of electrolysis, which is required to extract new metal from ore. More ...

5 _____ Hardwood and softwood can be reused. However, the frequent need to remove ironmongery and saw or plane off damaged edges, can make the process costly. More ...

6 _____ Tyres are the primary source of recyclable material. These can be reused whole in certain applications. They can also be ground into crumbs which have varied uses. More ...

7 _____ An obstacle to recycling is the need to sort waste carefully. While some types can be melted down for reuse, many cannot, or result in low-grade material. More ...

b **Match the materials from the web page (1–8) in Exercise 2 to the definitions (a–h).**

1	stainless steel	a	a metal used to make brass, and in galvanised coatings on steel
2	zinc	b	the predominant metal in steel
3	iron	c	a type of steel not needing a protective coating, as it doesn't rust
4	bronze	d	a dense, poisonous metal
5	lead	e	rocks from which metals can be extracted
6	hardwood	f	an alloy made from copper and tin
7	ore	g	timber from pine trees
8	softwood	h	timber from deciduous trees

c **Complete the following sentences using *from*, *with* or *of*.**

1 Bronze contains significant amounts __of__ copper.
2 Galvanised steel is steel coated _____ zinc.
3 Steel is an alloy derived _____ iron.
4 Pure metals can usually be recovered _____ alloys.
5 To produce stainless steel, iron is mixed _____ other metals.
6 Stainless steel contains quantities _____ chromium and nickel.
7 Glass tableware contains traces _____ metals, such as lead.
8 When new metal is extracted _____ ore, the costs can be high.

d **In pairs, ask and answer questions about different materials using the following phrases.**

Can ... be recycled? What's ... made from? Where does ... come from?

3 **a** **Irina, an ecological adviser, is talking to a group of engineers on a training course about environmentally friendly design. In pairs, discuss the ideas from her slide and give some examples.**

Environmental audit

Product phases:

- Pre-use
- In use
- Post-use

b ▶2.1 **Listen to an extract from the talk and compare your ideas with what Irina says. What example does she use to illustrate her main point?**

c ▶2.2 **Irina asks the engineers to do a simplified environmental audit. Their task is to compare steel and aluminium car bodywork from an ecological perspective. Listen to Sophia and Pete, two of the engineers, discussing the topic and make notes of their ideas.**

d **In pairs, do an environmental audit for the following applications and materials. Use the words and phrases in the box.**

	Application	Materials
1	electrical wires in vehicles	copper and aluminium
2	external walls in houses	bricks and softwood

as far as I know ... I think so / I'd say so I'm (not) sure
that's an important consideration that needs to be researched
coated derived mixed recovered recycled

Categorising materials

4 **What do you know about braking systems? In pairs, discuss the following questions.**

1 Generally speaking, what do brakes do and how do they work?
2 What kinds of material are used in brake pads and brake discs in different vehicles?

5 a **Read the article on braking systems. In the title of the article, what do the colours green and red refer to?**

b **In pairs, answer the following questions.**

1 Why do most braking systems waste energy?
2 What are regenerative braking systems, and how do they save energy?
3 What characteristics are required of materials used for the brakes on racing cars?
4 What is meant by *heat soak*, and why is it a problem in racing cars?

GREEN BRAKES

– A RED HOT TOPIC IN MOTOR RACING

As motor racing goes green, Formula 1 is aiming to lead automotive research in finding hi-tech efficiency gains. One of the keys to this ecological drive is regenerative braking (also known as kinetic energy recovery), which recovers energy generated during deceleration, and stores it as a source of power for subsequent acceleration.

Regenerative brakes limit the energy loss inherent in traditional braking systems. In most vehicles, conventional brakes comprise pads previously made from asbestos-based composites, but now consisting of **compounds*** of **exotic**, non-hazardous materials, and discs made of **ferrous** metal. The resulting friction generates heat, which is wasted. In performance cars, this phenomenon is taken to extremes, and due to the high temperatures generated, brake discs are often made out of **ceramics**.

The carbon discs and pads used on Formula 1 cars generate so much heat that they glow red hot. High temperatures are, in fact, necessary for the effective operation of carbon brakes. But there's still plenty of potential for recovering the kinetic energy, rather than merely dissipating it in the form of heat.

The potential for recovering energy also extends to the heat generated by engines and exhaust systems. This area has also been discussed as a possible area for future exploitation in motor racing. Heat recovery might offer the added benefit of reducing heat soak (thermal absorption by the chassis) as delicate **alloy** parts and sensitive **non-metallic** materials, such as **polymers**, are susceptible to heat damage.

c **Match the materials from the text (1–7) to the descriptions (a–g).**

1	compounds	a	materials that are not metal
2	exotic	b	iron and steel
3	ferrous	c	combinations of materials
4	ceramics	d	mixture of metals
5	alloy	e	plastic materials
6	non-metallic	f	minerals transformed by heat
7	polymers	g	rare or complex

d **In pairs, take turns to describe an object using the words from Exercise 5c and the phrases in the box. Ask your partner to guess what it is.**

comprise	consist of	made from	made of	made out of

6 **a** **You are going to give a talk on composites technology at a construction materials trade fair. In part of the talk, you focus on reinforced concrete as a well-known example of a composite material. Prepare your talk using words and phrases from this section and the following notes.**

Composite materials

Common example: reinforced concrete (very widely used composite)

Cement (derived from lime)

Aggregate – fine aggregate (sand) + coarse aggregate (gravel or crushed stone)

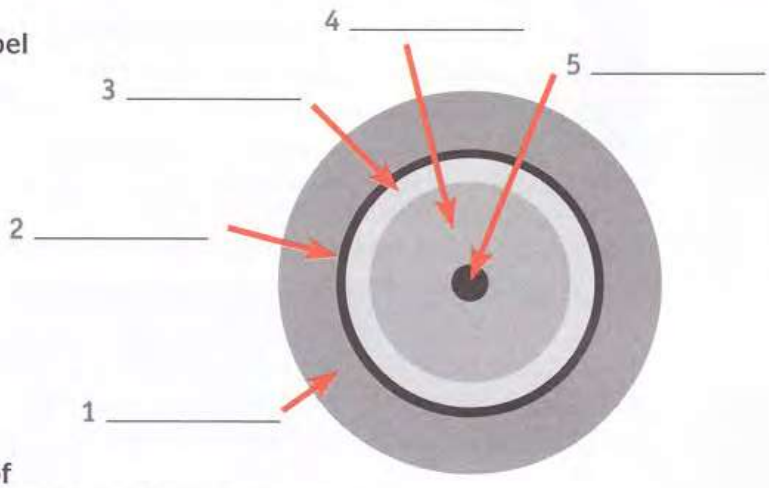
Water + chemical additives (e.g. plasticiser to improve workability)

Reinforcement (steel bars, fixed together with steel tie wire)

b **In small groups, take turns to give your talk.**

c **Margit, a sales engineer, is describing a high-voltage cable. Before you listen, label the cross-section with the parts (a–e).**

a insulation
b waterproof membrane
c outer jacket
d armoured protection
e conductor



d ▶2.3 **Listen to the description and check your answers in Exercise 6c.**

e **Match the parts of the cable (a–e) in Exercise 6c to the following categories of materials (1–5). You will need to use some parts more than once.**

1 non-metallic a _____ _____
2 metallic _____ _____
3 ferrous metal _____
4 non-ferrous metal _____
5 polymer-based _____ _____ _____

7 **Imagine you are presenting a product or appliance you know well to a potential client. Describe the categories of material used to make the different parts.**

Specifying and describing properties

8 a **In pairs, discuss what you know about the properties of Kevlar® and how it is used.**

b **Read the following extract from DuPont™'s technical guide to Kevlar® Compare the information with your ideas from Exercise 8a.**

WHAT IS KEVLAR®?

DuPont™ KEVLAR® is an organic fiber in the aromatic polyamide family. The unique properties and distinct chemical composition of KEVLAR® distinguish it from other commercial, man-made fibers.

KEVLAR® has a unique combination of high modulus, toughness, abrasion resistance and thermal stability. It was developed for demanding industrial and advanced-technology applications. Currently, many types of KEVLAR® are produced to meet a broad range of end uses that require strong, lightweight, durable materials.

c **Find words in the text in Exercise 8b to match the following definitions.**

1 toughness = the opposite of fragility
2 _____ = resistance to damage caused by friction
3 _____ = resistance to problems caused by temperature change
4 _____ = long-lasting
5 _____ = the opposite of heavy

9 a **Match the automotive parts (1–5) to the descriptions (a–e).**

1	drive belts	a	sheets inserted between parts to prevent gas or fluid leakage
2	brake pads	b	pneumatic envelopes in contact with the road surface
3	tyres	c	flexible bands used in transmission systems
4	sealing gaskets	d	protective barriers capable of resisting gunshots
5	bullet-resistant armour	e	pads pressed against discs to induce deceleration

b **Read the information from DuPont™ on the following page explaining some of the automotive applications of Kevlar®. Complete the text using the automotive parts in Exercise 9a.**

Car and truck (1) _____ have incorporated Kevlar® into their construction because it offers superb puncture, abrasion and tear resistance.

The high modulus and abrasion resistance of Kevlar® help (2) _____ retain their original shape and tension over the millions of revolutions they go through over the lifespan of a vehicle.

The frictional forces that (3) _____ are designed to endure take less of a toll on those made with Kevlar® pulp. The enhanced thermal stability and inherent abrasion resistance of Kevlar® allow them to last long and stop the vehicle safely and quietly.

Kevlar® provides an effective, lightweight (4) _____ solution for vehicles that require protection against ballistic attack, allowing cars and light trucks to retain most of their original handling characteristics.

Chemical stability and thermal stability help make (5) _____ reinforced with Kevlar® pulp strong and durable. The galvanic corrosion resistance of Kevlar® also contributes to improved long-term engine performance.

c In pairs, discuss why the properties of Kevlar® are especially important for each application described in the text.

a ▶2.4 Listen to a conversation about the properties of materials used in a specific type of tool and answer the following questions.

1 Where does the conversation take place?
2 What tool is being discussed?
3 Which materials can be used for its different parts?

b Complete the following extracts from the conversation using the properties in Exercise 8c. Listen again and check your answers.

1 The handle mustn't be heavy. *Ideally, you want it to be* _____ .
2 Resisting friction is essential. *The key requirement is* _____ _____ .
3 The bur has to be built to last. *Obviously, they need to be very* _____ .
4 Heat builds up in the bur. *You need a good degree of* _____ _____ .

c Match the words and phrases (1–5) from Exercise 10b to the synonyms (a–e).

1	ideally	a	it's clear that
2	obviously	b	for the best results
3	the last thing you want	c	the most important factor
4	the key requirement	d	a lot of / a high level of
5	a good degree of	e	the worst situation

a You work for a manufacturer of hand tools and have been asked to investigate using alternative materials in your products. In pairs, read the notes and discuss the main properties required of the materials used to make the tools.

Hammers a) Joiners' hammers (for nails)
b) Lump hammers (for masonry chisels)
Consider the hammer head and the hammer shaft.

Saws a) Wood saws (for cutting wood)
b) Hacksaws (for cutting metal)
Consider the saw blade and the saw handle or frame.

b Think of a product you know well. In pairs, discuss the materials used in it and what properties make the materials suitable. Discuss whether alternative materials could be used.

Discussing quality issues

12 **In pairs, answer the following questions.**

1 In advertising, what hi-tech, high-performance situations are often used to promote watches?
2 What messages are they intended to send about the quality of products?
3 What quality issues differentiate higher-quality watches from lower-quality ones?
4 What is the difference between describing something as water-resistant and waterproof?

13 **a** ▶2.5 **Louisa, a marketing executive for a watch manufacturer, is discussing material selection with Tom, one of her engineering colleagues. Listen to the discussion and complete the four quality issues that are mentioned in the meeting.**

1 _____ resistance
2 _____ resistance
3 _____ resistance
4 _____ resistance

b **In pairs, discuss what is meant by each of the quality issues in Exercise 13a.**

14 **a** ▶2.5 **Listen again and answer the following questions.**

1 What point does Tom make about the reasons for selecting materials?
2 What does he say about submarine-grade steel to exemplify the above point?
3 What problem does he describe with regard to the marketability of many materials?
4 What hard commercial fact does Louisa give?

b **In pairs, mark the following statements True (T) or False (F) according to the views expressed in the conversation. Read the audioscript on page 87 and check your answers.**

1 Often, exotic-sounding materials are not that suitable, technically.
2 People think that a submarine steel watch must be tremendously water-resistant.
3 The corrosion resistance of submarine steel is exceptionally good.
4 Submarine-grade steel looks fairly good.
5 Tom thinks submarine steel is particularly suitable for watches.
6 The firm has often used materials that are not adequately durable.
7 Often, the compositions of good watch materials are relatively complex.
8 Materials with complicated names are pretty good for marketing.

c ▶2.6 **Listen to the following phrases from the conversation and underline the stressed syllable. Practise saying the phrases.**

1 not particularly suitable
2 exceptionally resistant
3 not at all suitable
4 tremendously marketable
5 relatively complex
6 not all that good

d **Complete the following table using the words in the box.**

~~exceptionally~~ fairly insufficiently not adequately not (all) that
not particularly pretty relatively tremendously

extremely	quite	not very	not enough	definitely not
exceptionally	_____	_____	_____	_____
_____	_____	_____	_____	
	_____			

15 **In pairs, discuss the key properties and different types and grades of the following materials. Give examples of the properties that make each material good or bad for watch-making, from a quality perspective.**

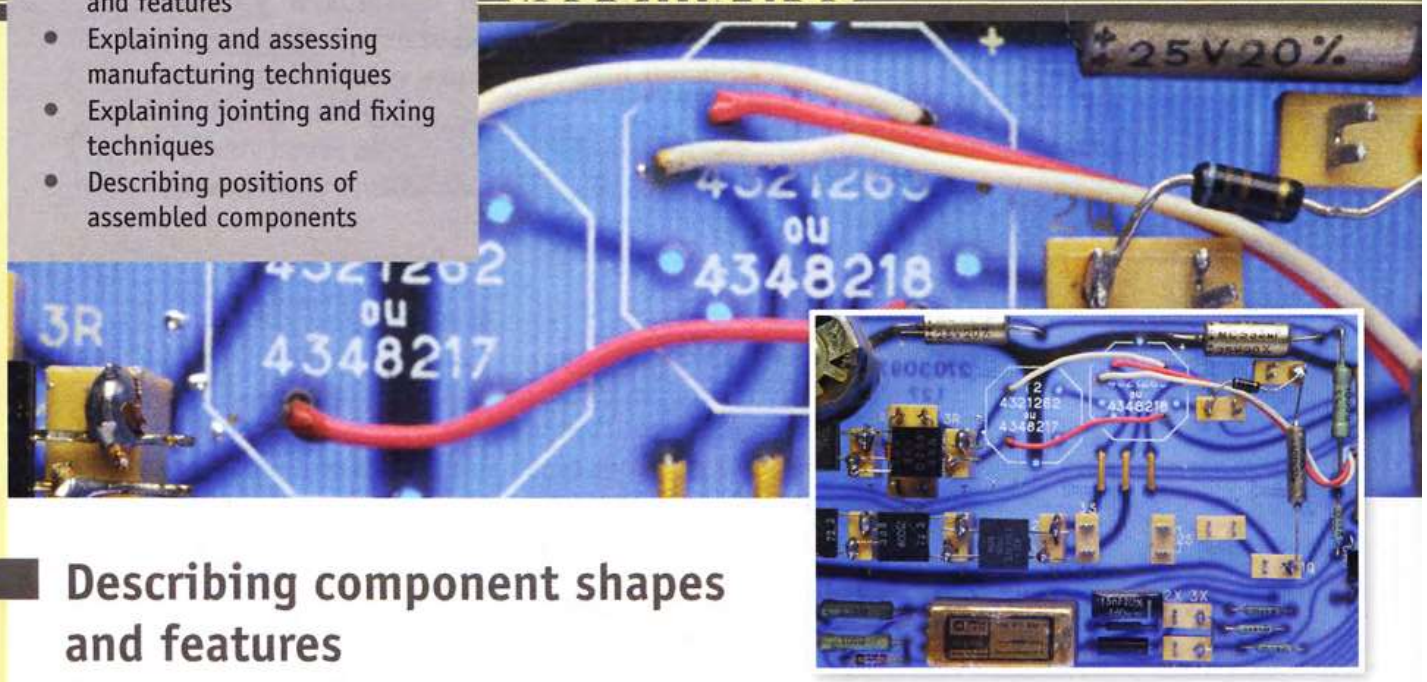
Materials
steel glass aluminium titanium gold plastic copper rubber

Properties
water-resistant abrasion-resistant corrosion-resistant shock-resistant tough
brittle elastic durable heavy lightweight thermally stable

16 **In small groups, choose a well-known consumer product or appliance and discuss it from a quality perspective. How suitable are the materials used? How good is the product, compared with others sold by competitors?**

UNIT 3 Components and assemblies

- Describing component shapes and features
- Explaining and assessing manufacturing techniques
- Explaining jointing and fixing techniques
- Describing positions of assembled components



Describing component shapes and features

1 What do you know about the electrical plugs and sockets used in different countries? In pairs, describe some specific designs.

2 a ▶3.1 Jan, a project manager for a firm that manufactures electrical plugs and sockets, is briefing some of his engineering colleagues. Listen to the briefing and summarise the aim of the project.

b In pairs, discuss what is meant by *profile of the pins* and *standard configuration*.

c ▶3.2 Erin, an engineer with the same company, is describing different electrical plug and socket formats during the briefing. Listen and match the descriptions (1–6) to the pictures (a–f).

a _____

b _____

c _____

d _____

e _____

f _____

d **Complete the following phrases from the descriptions using adjectives based on the words in brackets.**

1 *... there are* circular *pins for live and neutral.* (circle)
2 *... the earth slot's got a flat base with one side* _____ *over to form a semi-circle.* (round)
3 *This one has* _____ *blades for live, neutral and earth ...* (rectangle)
4 *... it has a* _____ *slot to receive the earth pin.* (cylinder)
5 *... the pins are arranged in* _____ *configuration.* (line)
6 *... they're laid out in* _____ *configuration.* (triangle)

e ▶3.3 **Listen and underline the stressed syllable in each of the following words.**

rectangle	rectangular	triangle	triangular
cylinder	cylindrical	line	linear

3 a ▶3.4 **Listen to a longer description from the meeting. Which picture (a–f) in Exercise 2c does Erin describe?**

b **Complete the following extracts from the description using the correct form of the words in the box.**

flush with | groove | ~~hole~~ | pin | recess | ridge | set back

1 *... there's a circular slot at the top. It's obviously a blind* hole *, it doesn't go right through.*
2 *... there are two plastic* _____ *, one on either side of the plug casing, and they slot into corresponding* _____ *at each side of the socket. In addition, the centre of the socket is* _____ *. So rather than being* _____ *the front of the socket, on the same face, the circular area that receives the plug is* _____ *from the surrounding casing ...*
3 *These covers only open when pressure is applied to both by the two* _____ *of the plug simultaneously.*

c **In pairs, describe the different plug and socket formats in the pictures in Exercise 2c.**

4 a ▶3.5 **Andy and Karin, two electrical engineers, are evaluating a plug and socket format in Exercise 2c. Listen to the conversation and make notes of the advantages and disadvantages of the following features.**

1 Plug slots into a recess in the socket:
Advantages _____
Disadvantages _____
2 Covers protect live and neutral slots:
Advantages _____
Disadvantages _____

b **In pairs, discuss the advantages and disadvantages of the plug and socket formats in Exercise 2c. Use the following phrases from the conversation.**

an advantage/disadvantage of this format is ... another advantage/disadvantage is ...
the problem with this system is ... this (shape/format/feature) stops ... from ... -ing
this (shape/format/feature) allows it to / helps it to / makes it easy to / makes it difficult to ...

Explaining and assessing manufacturing techniques

5 **In pairs, think of some examples of machining operations that are often used in manufacturing involving metalworking.**

6 a ▶3.6 **Evan, a sales engineer with a metal fabrication company, is showing Mr Barrett, a new customer, around their plant. Listen to the conversation and mark the statements True (T) or False (F).**

1 The company specialises in sheet metal working.
2 The company does a lot of metal casting.
3 Metal bashing is a precise technical term for hammering.
4 Drills and milling machines are always noisy.
5 Grinding is a process that uses abrasives.
6 The press is used for shearing metal.

b **Complete the following training material for graduate engineers using the words in the box.**

Drilling Flame-cutting Milling Sawing Shearing

MANUFACTURING TECHNIQUE EVALUATION: CUTTING OPERATIONS

Key factors in determining the most appropriate cutting technique are: material characteristics (notably hardness, and thermal and electrical properties), component thickness, component shape and complexity, required edge quality, and production volume. Select cutting options below for a detailed analysis of techniques.

CUTTING OPTIONS

(1) _____ : abrasive cutting, removing a kerf of material. Includes cutting with toothed blades and abrasive wheels. More ...

(2) _____ : use of pressure on smooth-edged blades for guillotining and punching. More ...

(3) _____ : removal of material across the full diameter of a hole, or using hole-saws for cutting circumferential kerfs. More ...

(4) _____ : removal of surface layers with multiple cutting wheel passes. More ...

(5) _____ : using oxy fuel (oxygen + combustible gas, often acetylene). More ...

c **Complete the following definitions using the words in the box.**

abrasive wheel guillotine hole-saw kerf punch toothed blade

1 A punch makes holes by applying pressure to shear the material.
2 A _____ makes straight cuts by applying pressure to shear the material.
3 A _____ is the width of the saw cut.
4 A _____ has sharp edges for cutting or milling.
5 A _____ has a hard, rough surface for cutting or grinding.
6 A _____ cuts a circular piece to remove an intact core of material.

7 a **Read the following extract of promotional literature from a leading producer of ultra-high-pressure (UHP) waterjet cutting machines. In pairs, explain the phrases in bold.**

Flow

What makes waterjets such a popular cutting option? Water jets require few **secondary operations**, produce **net-shaped parts** with no **heat-affected zone**, heat distortion, or **mechanical stresses** caused by other cutting methods, can cut with a **narrow kerf**, and can provide better usage of raw material since parts can be **tightly nested**. As a result of the FlowMaster™ PC control system and intuitive operation, waterjets are extremely easy to use. Typically, operators can be trained in hours and are producing high-quality parts in hours. Additionally, waterjets can cut virtually any material, leaving a satin-smooth edge.

b ▶3.7 **Evan is talking to Mr Barrett about UHP waterjet cutting. Listen to the conversation and match the phrases in the box to the extracts (1–4).**

heat-affected zone mechanical stresses narrow kerf net-shaped parts

Extract 1 _____ Extract 3 _____

Extract 2 _____ Extract 4 _____

c **Complete the following extracts from the conversation by underlining the correct phrases.**

1 *So they are **especially good when / not so good when** you have intricate shapes.*
2 *Saw blades are obviously **perfect when / useless when** you're cutting curved shapes.*
3 *... sawing is **the ideal solution / not the best solution** if you want to avoid altering the material.*
4 *... it's **ideal for / totally unsuitable for** metals.*

8 **In pairs, assess the different cutting techniques in terms of**
- **shape/size of cut**
- **material types/characteristics**
- **cut width/quality.**

Use the phrases in the box.

ideal/perfect/especially good for + -ing the ideal/perfect solution for
not particularly suitable / not so good if you need ...
not the best solution if you don't want ... totally unsuitable / useless

Cutting techniques
drilling with a bit
drilling with a hole-saw
flame-cutting
grinding
guillotining
milling
punching
sawing
waterjet cutting

Shape/size of cut
angular blind holes curved large small straight
thick thin through holes

Material types/characteristics
ceramics metals plastics timber hard tough
brittle

Cut width/quality
heat-affected zone narrow kerfs no kerf rough edges
smooth edges wide kerfs

Explaining jointing and fixing techniques

9 **In pairs, think of some examples of ways of joining materials together.**

10 **a** ▶3.8 **Pedro, a purchasing manager with a kitchen appliance manufacturer, is talking to Alicia, a sales manager from one of their main suppliers. Listen to the conversation and answer the following questions.**

1 What objective does Pedro describe regarding his company's relationship with suppliers?
2 What is Alicia concerned about?
3 How does he respond to her concerns?

b **Complete the following table using the words in the box.**

adhesive ~~bolt~~ clip rivet screw weld

Mechanical fixings	Non-mechanical fixings
bolt	

c **Label the photos (1–6) with the words in Exercise 10b.**

1 weld

2 _____

3 _____

4 _____

5 _____

6 _____

d **Match the types of connection in the box to the following groups.**

bolting bonding ~~connecting~~ fixing gluing joining riveting welding

1 connecting _____ _____ = describes any kind of connection.
2 _____ _____ = describes mechanical connections only.
3 _____ _____ _____ = describes non-mechanical connections only.

11 a Complete the following questions using the words in the box.

each other on onto to together

1 How can we fix these two components _____ ?
2 How can we fix these two components to _____ ?
3 How can we fix this component _____ ?
4 How can we fix this component _____ / _____ this component?

b Complete the following training web page using the words in Exercise 11a.

MANUFACTURING TECHNIQUE EVALUATION: JOINTS AND FIXINGS

The most suitable method of joining components depends on many factors, which extend beyond the obvious issue of required strength.

- Will the joint need to be disconnected in the future? If a part is bolted (1) _____ , it can obviously be removed at a later date. If two components are bonded to (2) _____ with strong adhesive, or welded (3) _____ then subsequent removal will clearly be more difficult. More ...
- What external factors might affect the joint? Water or heat can weaken adhesive joints. And no matter how tightly nuts are screwed (4) _____ bolts, vibration can cause them to work loose over time. More ...
- How quality-sensitive is the jointing technique? Components are rarely joined (5) _____ each other in ideal conditions. Inadequately tightened fixings, improperly prepared surfaces, or flawed welds are inevitable. How could such imperfections affect the joint negatively? More ...

c In pairs, answer the following questions using the information on the web page in Exercise 11b.

1 What are the main advantage and disadvantage of mechanical fixings?
2 What is the main disadvantage of non-mechanical jointing?
3 What issues can negatively affect mechanical fixings and non-mechanical joints?

12 a In pairs, discuss the following jointing techniques used in aircraft and say how the parts are fixed together.

1 Early aircraft: timber frame / adhesive or screws
2 Modern jet aircraft: alloy body panels / rivets
3 Aircraft cabins: seats/floor/bolts
4 Aircraft cockpit: windshield/fuselage/adhesive

b Your company has launched a competition for its engineers to build a homemade model glider that is as cheap as possible to assemble. In pairs, discuss what types of materials and joints you could use.

Describing positions of assembled components

13 a **In pairs, read the title of the article and suggest ways of making a garden chair fly. Discuss any potential problems.**

b **Read the article and match the questions (a–d) to the paragraphs (1–4).**

a How did the actual flight differ from the one that was planned? _____
b What incidents occurred just before and just after the landing? _____
c What is said about the modern equivalent of this type of activity? _____
d What components were used to assemble the flying machine? _____

CRAZY BUT TRUE: LARRY WALTERS AND THE FLYING GARDEN CHAIR

1 On July 2, 1982, a Californian truck driver named Larry Walters sat outside his house on a garden chair. To say that he was out to get some air is an understatement, for projecting above him a cluster of ropes was tied to 42 helium-filled weather balloons. Anchor ropes, situated underneath the chair, were fastened around the bumper of his car, which was positioned just below the makeshift flying machine.

2 Mr Walters intended to climb gently to an altitude of a few hundred feet, before drifting slowly out of town and across country. He then planned to use an airgun to shoot some balloons and descend gradually to earth. But as the helium gas contained within the balloons warmed up in the summer sun, it progressively generated more lift. When the anchor ropes were released, the self-assembly airship shot up like a rocket. Too shocked to reach for the pistol inserted in his pocket, the first-time pilot held on for life. In just a few minutes, Larry Walters was 16,000 feet above the ground, floating over the city of Long Beach. A short time later, there were further complications; he suddenly found himself inside controlled airspace, adjacent to Long Beach Airport. The occupants of passing Delta Airlines and TWA aircraft looked on at the curious spectacle outside, as wide-eyed as the garden chair pilot hovering beside them.

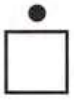
3 Eventually, after managing to shoot some balloons, Mr Walters descended safely to earth despite an anchor rope, which was still suspended beneath the chair, getting tangled with a power line located alongside the landing site (in someone's garden). He was immediately arrested by waiting police officers, and was later fined for breaking Federal aviation laws.

4 Today, cluster ballooning, while still a fairly marginal sport, is steadily starting to gain in popularity.

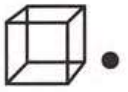
c **Answer the questions in Exercise 13b.**

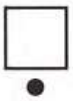
14 a **Label the diagrams using the prepositions in the box.**

~~above~~ adjacent to alongside around below beneath beside inside outside over underneath within

a  above _____ _____

c  _____ _____ _____

e  _____

b  _____ _____ _____

d  _____

f  _____ _____

b **Complete the following sentences about the flying garden chair using the prepositions in the box. Check your answers against the text in Exercise 13b.**

in	above	around	beneath	within

1 Projecting _____ the chair was a cluster of ropes, tied to 42 helium-filled weather balloons.
2 Anchor ropes were fastened _____ the bumper of the car.
3 Larry Walters had an airgun inserted _____ his pocket.
4 The helium contained _____ the balloons warmed up in the sun.
5 After takeoff, the anchor ropes remained suspended _____ the chair.

c **Complete the following descriptions of how the garden chair airship was assembled by underlining the correct words.**

1 A quantity of helium gas was **contained/suspended** inside each balloon.
2 A tube was **inserted/projected** inside the openings of the balloons, to inflate them.
3 The balloons were **situated/suspended** over the chair, in a large cluster.
4 The chair was **contained/suspended** under the balloons by ropes.
5 Arm rests, **contained/located** beside the pilot, at each side, helped to hold him in place.
6 The landing gear, **inserting/projecting** below the seat, consisted, simply, of the chair legs.
7 The pilot was **positioned/projected** underneath the balloons, so his weight was low down.

d **Which two other words have the same meaning as *positioned*?**

contained	fastened	inserted	located	projected	situated	suspended

15

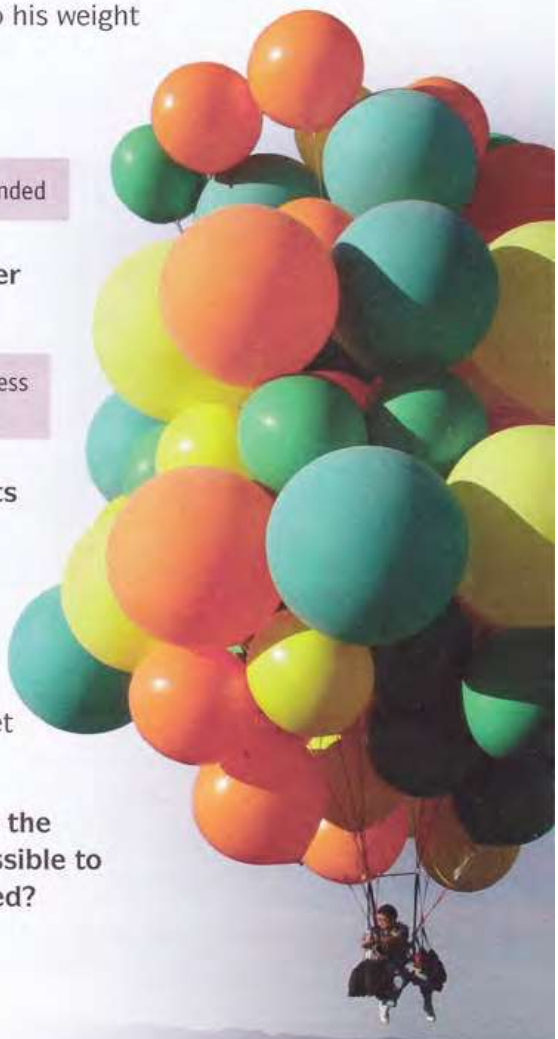
a **In pairs, look at the photo and describe how you think the cluster balloon is assembled from the following components.**

bags	balloons	helium	nylon ropes	nylon straps	paragliding harness
plastic cable	sand/water ballast	ties	tape		

b ▶3.9 **Eva and Lenny, two engineers working for an extreme sports equipment manufacturer, are discussing cluster ballooning. Listen to the conversation and summarise what they say about the following issues.**

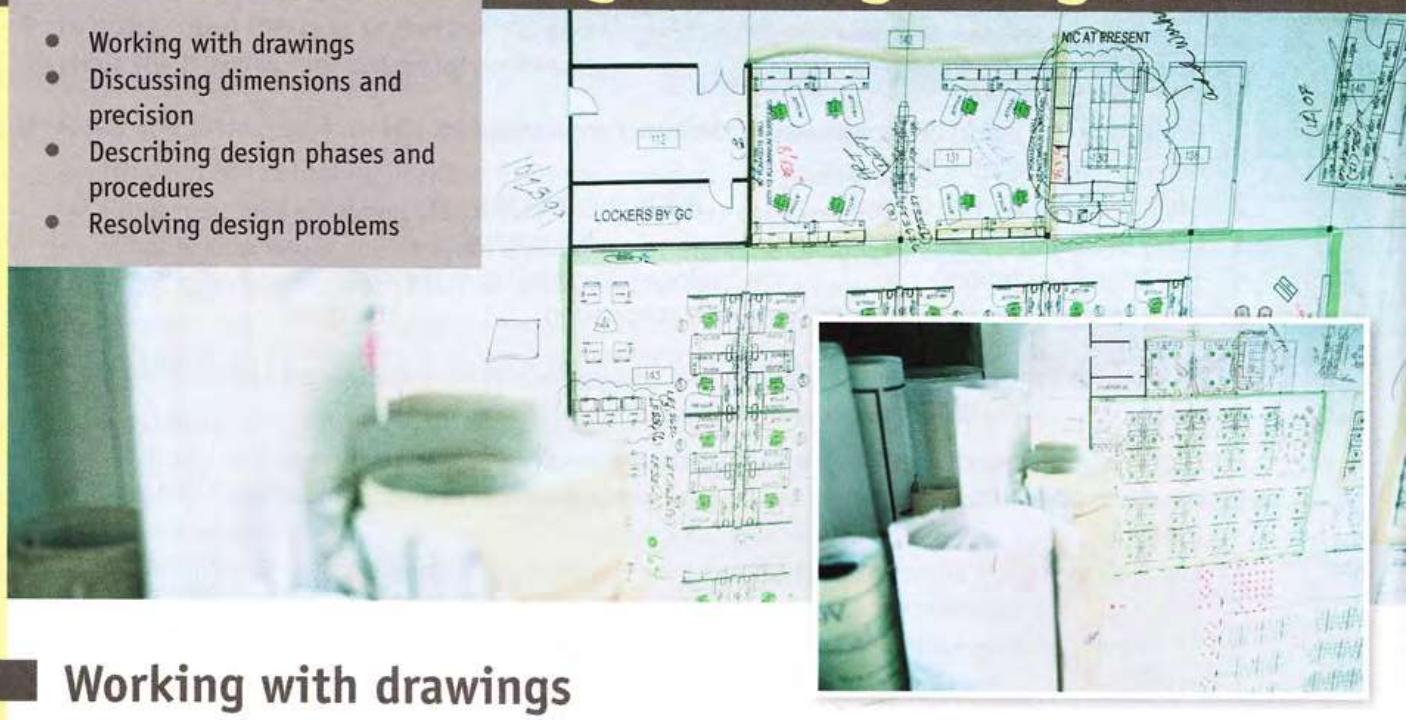
1 assembly time
2 how plastic cable ties are used
3 a tree structure
4 how water bags are used
5 the advantage of tying each individual balloon
6 the problem of using a net to contain the balloons

c **In pairs, discuss ways of overcoming the problems mentioned in the conversation. How could cluster ballooning be made more accessible to a mass market? What other equipment/assemblies could be used?**



UNIT 4 Engineering design

- Working with drawings
- Discussing dimensions and precision
- Describing design phases and procedures
- Resolving design problems



Working with drawings

1 **In pairs, discuss the different types of design information needed on a complex engineering project, such as the construction of a large cruise ship. How many different drawings do you think might be produced for such a project? How would they be organised and categorised?**

2 **a** ▶4.1 **Joe, a technician at a shipyard, is talking to Linda, one of his engineering colleagues in the design office. He is asking about some information which he can't find on any of the drawings. Listen to the conversation and answer the following questions.**

1 What area of the ship are they discussing?
2 What does the technician need to know?

b **Complete the following definitions using the types of drawing in the box.**

cross-section	elevation	exploded view	note	~~plan~~	schematic	specification

1 A plan gives a view of the whole deck, from above.
2 An _____ gives a view of all the panels, from the front.
3 An _____ gives a deconstructed view of how the panels are fixed together.
4 A _____ gives a cutaway view of the joint between two panels.
5 A _____ gives a simplified representation of a network of air ducts.
6 A _____ gives a brief description or a reference to another related drawing.
7 A _____ gives detailed written technical descriptions of the panels.

c **Which two types of drawing in Exercise 2b are examples of general arrangement drawings, and which two are examples of detail drawings?**

d **Read the following technical questions that came up during the shipbuilding project and decide which type of drawing is required to answer each question.**

1 How many panels are there altogether on this wall? _____
2 What profile are these hollow beams: rectangular or circular? _____
3 What are the positions of all the floodlights around the deck perimeter? _____
4 How many branches come off the main sprinkler supply pipe? _____
5 How do all the internal components of the fan unit fit together? _____

3 **a** **What is meant by *scale* on a drawing? In pairs, explain how a scale rule, like the one shown in the picture, is used.**

b ▶4.2 **After receiving the drawings for the panels, Joe is now discussing some details with Pavel, a colleague. Listen to the conversation and answer the following questions.**

1 What piece of information is not shown on the drawing?
2 What *golden rule* is mentioned?

c **Complete the following extracts from the conversation and explain what is meant by each one.**

1 *Is this drawing _____ scale?*
2 *It's one _____ five.*
3 *... you shouldn't scale _____ drawings ...*
4 *... it's actual size, on a _____-scale drawing ...*

4 **You are engineers on a project to design the metal handrail that will run around the perimeter of the top, outdoor deck of a large cruise ship. In pairs, discuss what drawings you will need to produce for manufacturing and installation with regard to the following issues:**

- the types of view that will be required and what each one will show
- the approximate scale of different drawings and views
- what written information you will need to provide in the specification.

5 **You are going to provide design information to enable a production team to manufacture a product or appliance you know well. Make a list of some of the drawings that will be needed, noting what each one will show.**

Discussing dimensions and precision

6 a **In pairs, discuss what is meant by *precision* and *accuracy*.**

b **Read the technical advice web page and answer the following questions.**

1 How is a superflat floor different from an ordinary concrete floor?
2 What accuracy can be achieved with ordinary slabs, and with superflat slabs?
3 What problem is described in high bay warehouses?

Superflat Floors: FAQ

What is a superflat floor?

Compacting and finishing the surface of wet concrete is an inherently imprecise process. For an ordinary concrete slab to be laid within tolerance, engineers can only realistically expect the surface to be finished to plus or minus 5mm. By contrast, superflat concrete floors are finished to meet extremely close tolerances, being accurate to within 1mm across their upper surface.

Where are superflat floors used?

Floor surfaces with extremely tight tolerances are frequently specified in warehouses where Automated Guided Vehicles operate. Uneven floors are especially problematic in high bay warehouses, which use automated forklifts with a vertical reach of 30 metres or more. At such a height, slight variations in floor level are amplified in the form of vertical tilt, causing inaccurate manoeuvring at high level. If these variations are outside tolerance they can lead to collisions with racking elements, or cause items to be dropped from pallets.

c **In pairs, discuss what is meant by *tolerance* in the context of dimensions and precision.**

d **Complete the following expressions from the web page which are used to describe tolerances.**

1 _____ tolerance (inside the limits of a given tolerance)
2 _____ or _____ 5mm (+/– 5mm)
3 _____ tolerance (close tolerance)
4 _____ tolerance (not inside the limits of tolerance)

e **Complete the following sentences using the expressions in Exercise 6d.**

1 The frame's too big for the opening. The opening's the right size, so the frame must be _____ .
2 The total tolerance is 1mm. The permissible variation either side of the ideal is _____ .
3 The engineer specified +/– 5mm for the slab finish, and we got it to +/– 2mm. So it's well _____ .
4 You can't finish concrete to +/– 0.1mm. There's no way you can work to such a _____ .

f **In some situations, engineers describe tolerances using *plus or minus*, for example *+/– 1mm*, and in other situations as *within*, for example *within 1mm*. In pairs, discuss the difference in meaning between these two descriptions, giving examples of situations where each description might be used.**

7 a ▶4.3 **Mei, a structural engineer, is talking to Lewis, a project manager, about the floor specification for a manufacturing plant that is currently at design stage. Listen to the conversation and answer the following questions.**

1 What has the client requested with regard to the floor slab?
2 What are free movement floors and defined movement floors?
3 What issue does the engineer discuss regarding quality?
4 What option is discussed involving grinding?
5 What can be done to the reinforcement to permit grinding?

b Complete the following table using the words in the text in Exercise 6b and audioscript 4.3 on page 89.

	Name of dimension	Large dimension	Small dimension
1	What's the _____?	Is it _____?	Is it short?
2	What's the width?	Is it _____?	Is it narrow?
3	What's the _____?	Is it high?	Is it low?
4	What's the thickness?	Is it _____?	Is it thin?
5	What's the _____?	Is it deep?	Is it shallow?

c Mei has done a revised drawing for the floor slab. Read the extract from her email about the new design and complete the message using the correct form of the words in Exercise 7b.

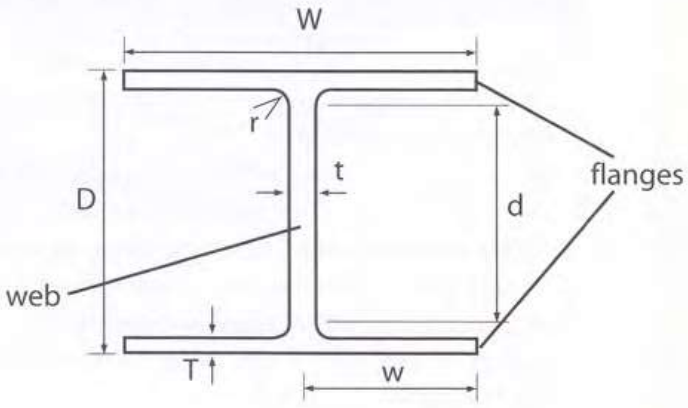
To: Lewis Rosas
Subject: Revised floor slab drawing

Please find attached a revised drawing for the floor slab, now reconfigured for defined movement. In order to accommodate guided vehicles 1 080mm (1) ___wide___ (as specified by the client) we propose a standard (2) _____ of 1 280mm for each superflat lane. At 14.5m, the (3) _____ of the longest lane on the network is within the maximum slab run that can be cast in a single concrete pour, thus avoiding construction joints on straight runs. On curved sections, a standard 8.5m turning radius is used, as per the guided vehicle manufacturer's recommendations.

In order to allow for the eventuality of future grinding, we have located the top layer of reinforcement 10mm deeper below the slab surface. This additional (4) _____ has not, however, been added to the overall slab (5) _____, which remains 275mm. The reinforcing bars also remain in 12mm diameter. As a result, the levels of wall-mounted process installations – many of which need to be fixed at a precise (6) _____ above finished floor level – are unaffected.

d Which two words in the email relate to circles? What aspects of a circle do they describe?

8 The manufacturing plant in Exercise 7 will be built from a steel frame. The vertical elements of the frame will be Universal Columns (UCs). Look at the section of a UC. In pairs, describe the different dimensions that define a UC profile by explaining what the letters on the section refer to.



Describing design phases and procedures

9 **In pairs, discuss what is meant by a *design process*. In engineering, what are the stages in the development of designs?**

10 a **The following extracts from emails relate to a project to build an indoor ski complex in Australia, using artificial snow. The messages were circulated by an engineer to members of the design team, and to a specialist contractor. Read the emails and, in pairs, answer the following questions. Note that the emails are not in the correct order.**

1 What are all the emails about?
2 What different types of documents are mentioned?

a

We now have a full set of working drawings for the main ski lift (attached). These incorporate some amendments requested by the client, which have now been approved. Hard copies have been forwarded to the relevant contractors' premises, for fabrication.

b

I attach a summary of our meeting with the client last Tuesday. It outlines ideas expressed by the client's marketing team, and describes what an experience at the ski complex should be like, from a visitor's point of view. We'll be going through these notes at the project kick-off meeting next Thursday, to clarify the design brief, so please formulate any queries before then.

c

Please find attached a full set of preliminary drawings, as submitted to the client for approval / comments. These are for information only at this stage.

d

Attached are a few rough sketches setting out the overall layout of the ski complex. At this point, these are initial ideas based on the client's suggestions and the approximate dimensions specified in the design brief. I look forward to any feedback by the end of this week.

e

Please note that dwg 18A is currently being revised, to resolve problems encountered during assembly of the ski lift. Revision B will be circulated next week. Until the amended drawing is issued, please treat dwg 18A as superseded. If you require specific details urgently, please contact me, and I will arrange for a suitable sketch to be issued.

b **Put the emails in the correct sequence.**

1 _____ 2 _____ 3 _____ 4 _____ 5 _____

c **Complete the following definitions using the types of drawing in the box.**

design brief preliminary drawing sketch working drawing

1 A _____ is a rough drawing of initial ideas, also used when production problems require engineers to amend design details and issue them to the workforce immediately.
2 A _____ is a written summary intended to specify design objectives.
3 A _____ is an approved drawing used for manufacturing or installation. There is often a need to revise these drawings to resolve production problems. In this case, amended versions are issued to supercede the previous ones.
4 A _____ is a detailed drawing that colleagues and consultants are invited to approve if they accept them, or comment on if they wish to request any changes.

d **Find synonyms for the following words in the definitions in Exercise 10c.**

1 accept / approve
2 amend / _____
3 approximate / _____
4 circulate / _____
5 give feedback / _____
6 replace / update / _____
7 state / _____
8 solve / _____

e **In pairs, suggest what needs to be done next in each of the following situations.**

1 They've found a problem with drawing 63 on site. The detail we've specified doesn't work.
2 I've done a preliminary design for the duct layout, but the client hasn't seen it yet.
3 I've got a feeling the drawing they have on site isn't the latest one.
4 We've just revised drawing 14. The changes are going to affect three different contractors.
5 This is the client's written design brief. How shall we kick off the design work?

11 **a** **Leo is the ski complex project manager. With design work about to begin, he is meeting senior engineers from the design teams to discuss design coordination. In pairs, explain the items on the meeting agenda and suggest what kinds of issue might be discussed.**

Australian Ski complex – Design Coordination Meeting Agenda
Tuesday 8th May
Conference room 9.30am – 11.00am
To: RN, LG, SB, CW, SH

Item

a Design interface (mechanical, electrical)
b Design and information flow procedure (structural, mechanical, electrical)
c Inter-team communication – formal and informal

b ▶4.4 **Listen to three extracts from the meeting and match each extract (1–3) to an agenda item (a–c).**

1 _____ 2 _____ 3 _____

c ▶4.4 **Listen again and make notes about the problems discussed in the meeting. In pairs, discuss some possible solutions to the problems.**

d ▶4.5 **Listen to Leo summarising the solutions that have been agreed in the meeting. What has been decided regarding the following points?**

1 The decision that the senior engineer in each team must make, regarding drawings
2 The circulation procedure that will be used for each drawing
3 The role of the M&E coordinator in relation to the senior engineers and the project manager
4 The arrangement that will make informal communication easier

e **In pairs, discuss how the design procedures discussed in the meeting will work in the following situations.**

1 Issuing the first draft of a specialised hydraulic hose drawing for the ski lift
2 Designing an electrical supply system for some water-cooling equipment
3 Revising the connection details between some ski-lift machinery and its concrete foundation

Resolving design problems

12 **In pairs, discuss problems that can arise when different drawings that make up a design are not properly coordinated.**

13 a **The following records are from the indoor ski complex project. They show correspondence between the design team and construction team. Read through the texts quickly and answer the following questions.**

1 What is the general subject of the correspondence?
2 What is meant by *query* and *instruction*?
3 Some queries refer to earlier conversations. Suggest why these have been followed up in writing.
4 What is meant by *dwg* and *dims*?

CONTRACTOR'S QUERY No. 867	ENGINEER'S INSTRUCTION
Following our telephone conversation today, we note that there is a discrepancy between dwgs 76E and 78E, which indicate conflicting dimensions for the width of the roof opening. Please clarify which dimension is correct.	We confirm the correct dimension is on dwg 76E. Please disregard the dims on dwg 78E.
CONTRACTOR'S QUERY No. 868	ENGINEER'S INSTRUCTION
As discussed this morning on site, we confirm there is a clash between the proposed cable tray (dwg E56) and air-conditioning ductwork (now installed as per dwg M118) in the ceiling void at Grid D14. Please advise on an alternative cable route.	Please work to attached sketch S33. Revision of dwg E56 to follow.
CONTRACTOR'S QUERY No. 869	ENGINEER'S INSTRUCTION
A note on dwg 11A specifies black bolts at the base of the ski lift cable support. This contradicts the specification, which states that all joints to comprise High Strength Friction Grip bolts. We propose using HSFG fixings at this location.	Please provide further details of the HSFG bolts you are proposing.
CONTRACTOR'S QUERY No. 870	ENGINEER'S INSTRUCTION
Further to Query 869, the proposed HSFG bolts are as per those specified for all other bolted joints on the ski lift supports. Our intention is to use a single bolt spec to facilitate assembly.	Approved.

b **Read the correspondence in detail. Write the query numbers in Exercise 13a next to the descriptions (1–5). You will need to refer to some queries more than once.**

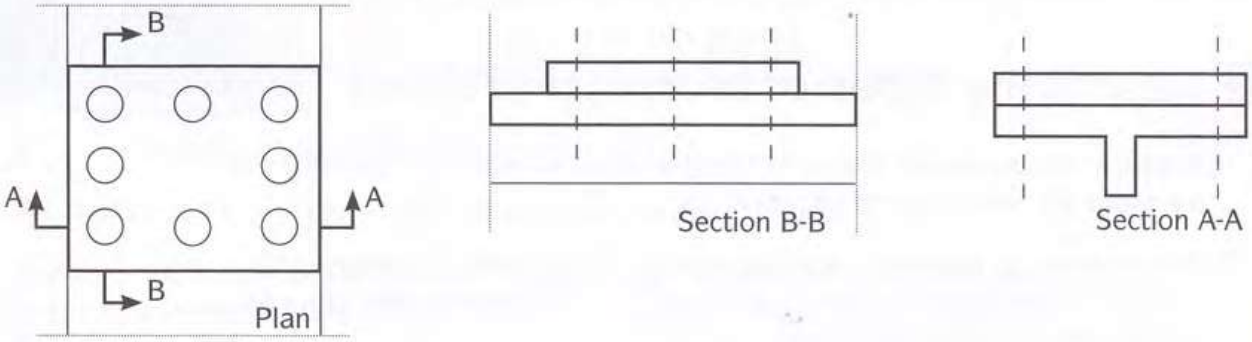
1 An installation that won't fit, as components are in each other's way 868
2 A response from the engineer asking for more information _____
3 Queries that suggest a solution, which will require the engineer's approval _____ _____
4 Requests to the engineer to instruct the contractor or make something clear. _____ _____
5 Separate documents referring to details that don't correspond with each other _____ _____ _____

c **Complete the following pairs of sentences using the verbs in the box.**

advise clarify clash propose request

1 The components are in each other's way. = The components _____ .
2 Please ask for more information. = Please _____ more information.
3 Can I suggest a solution to the problem? = Can I _____ a solution?
4 Please instruct the supplier to send the parts to this address. = Please _____ the supplier.
5 Any conflicting details must be queried. = You must _____ any conflicting details.

14 **a** **In pairs, look at the following plan and sections from a drawing on the ski complex project, showing steelwork details on part of a ski lift. Examine how the rectangular plate is bolted to the T profile below it. Can you find the discrepancy between the details, and the clash preventing the connection from being assembled?**



b **Chen, a technician, is explaining the problem in Exercise 14a to Ron, an engineer. Complete the conversation using the words in the box.**

alternative as per clarify clash confirm contradicts ~~discrepancy~~ propose

Chen: *There's a* (1) discrepancy *between these details that you might be able to* (2) _____ *straight away. On the plan of this plate, it shows eight bolts. But on section A, here, there are no bolts shown in the middle. So there would only be six, which obviously* (3) _____ *the plan. But as you can see, this plate's going to be bolted to a T profile. So we couldn't put a row of bolts down the middle, because they'd* (4) _____ *with the flange running along the middle of the T. So I'd* (5) _____ *just going for two rows of bolts. The* (6) _____ *would be to redesign the T section, which would obviously be a bigger job.*

Ron: *Yes. Let's go for two rows of bolts,* (7) _____ *the sections.*

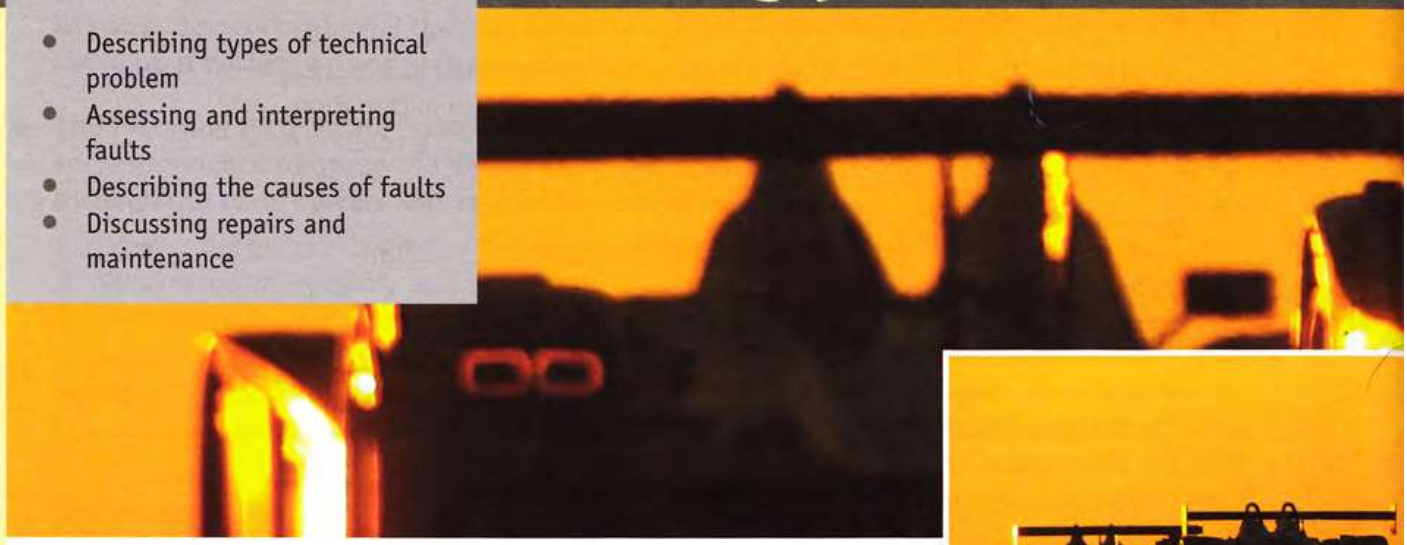
Chen: *OK, fine. Will you send an email to* (8) _____ *that?*

c ▶4.6 **Listen to the conversation and check your answers to Exercise 14b. How does the explanation compare with your description of the problem?**

d **Write an email from Ron to Chen, confirming the revision agreed in the discussion above.**

UNIT 5 Breaking point

- Describing types of technical problem
- Assessing and interpreting faults
- Describing the causes of faults
- Discussing repairs and maintenance



Describing types of technical problem

1 **In pairs, discuss the technical challenges of endurance car races like the Le Mans 24 Hours sports car race.**

2 a ▶5.1 **Sabino, an engineer with a sports car racing team, is giving a talk to some of his team's sponsors at a test session. Listen to the talk and answer the following questions.**

1 What saying emphasises the importance of reliability?
2 What expression refers to things that can cause failures?
3 What expression describes damage caused by normal use?

b ▶5.1 **In the talk, Sabino names five engineering enemies. Complete the following list. Listen again and check your answers.**

1 h_____ = high temperatures
2 p_____ = loads from expanding gases or liquids
3 v_____ = continuous high-frequency movement or shaking
4 s_____ = sudden impacts
5 a_____ = damage to surfaces caused by friction

c **In pairs, suggest which engineering enemies in Exercise 2b can be the most problematic for each of the following car parts.**

1 chassis	4 suspension	7 wings
2 engine	5 brakes	8 cooling system
3 gearbox and clutch	6 tyres	9 nuts and bolts

3 a ▶5.2 **Listen to Sabino talking about some technical problems the team have had at the test and mark the following statements True (T) or False (F).**

1 Some liquid was lost from a pipe.
2 A car lost all its coolant with the engine still running.
3 A car's engine stopped on the circuit.
4 Some tyres were damaged.
5 A wheel nut fell off a car on the circuit.
6 A car's suspension was broken.

b **Complete the following extracts from the talk using the words in the box.**

bend blocking crack jam snap

1 *... you don't want anything* _____ *the airflow to the radiators.*
2 *... they had a wheel nut* _____ *, it wouldn't turn.*
3 *... he didn't hit the barriers and* _____ *the suspension or* _____ *it completely.*
4 *... it didn't* _____ *the tub – the chassis.*

c **Complete more extracts from the talk using the correct form of a verb in box 1 and a word in box 2.**

1	2
blow clog cut leak run wear ~~work~~	~~loose~~ up out

1 *... a nut* worked loose *on a radiator pipe, which resulted in coolant liquid* _____ _____ .
2 *... he switched off before the system had* _____ _____ *of coolant.*
3 *... the engine* _____ _____ *on one of the corners.*
4 *... the openings in the side pods always* _____ _____ *with dirt.*
5 *The tyres weren't close to* _____ _____ *...*
6 *... the radiator problem didn't cause the engine to* _____ _____ .

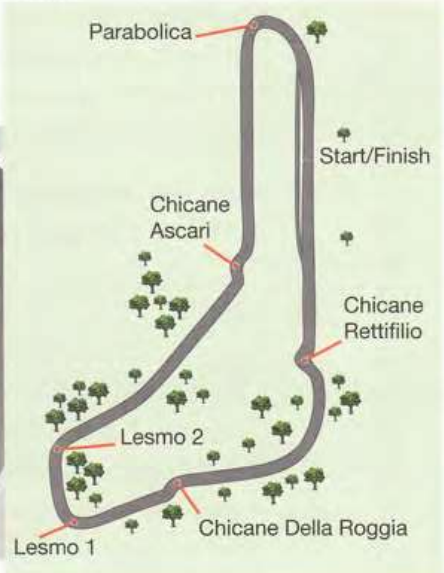
d ▶5.2 **Listen again and check your answers to Exercises 3b and 3c.**

e **Read the following comments made by race team technicians. Complete the following sentences using the correct form of words in Exercises 3b and 3c.**

1 There's smoke and flames pouring out of the engine. It's blown up .
2 There's a pool of oil under the car. Something's _____ .
3 This cylinder head bolt won't loosen. It's _____ .
4 The air filter's full of dirt. It's completely _____ .
5 This wing support's been moving about. The bolts have _____ .
6 Something's stopping the oil flow. The pipe might be _____ .
7 Are you sure that pushrod's straight? It looks as if it's _____ .
8 We'll need to change these brake pads. They're nearly _____ .
9 There's hardly any fuel left in the car. In another lap, we'll _____ .

4 **Read the technical facts about the Italian motor racing circuit, Monza, and summarise how the track is different from most others. In pairs, discuss the technical problems that racing cars could have at Monza as a result of the factors described in the text.**

The circuit is characterised by long straights and chicanes. This means the cars' engines are at full throttle for over 75% of the lap, a higher percentage than most other circuits.
The track requires heavier-than-average braking over a given lap, as the cars repeatedly decelerate at the end of some of the world's fastest straights for the slow chicanes.
The chicanes are lined by rugged kerbs. Riding over these hard is crucial for fast laps.
The long straights require small wings for minimum drag. This means lower downforce, resulting in lower grip on corners and under braking, and less stability over bumps.
The main high-speed corners Lesmo 1, Lesmo 2 and Parabolica are all right turns.
Parts of the circuit are surrounded by trees, which means leaves can be blown onto the track.



Assessing and interpreting faults

5 a **In pairs, discuss a technical problem you've experienced with a device, equipment or vehicle. Describe the fault, and how you tried to solve the problem.**

b **Read the training notes for telephone helpline staff working for a manufacturer of mining plant. In pairs, discuss what each point means.**

Problem-solving checklist

1 *User's observations:*
   - *nature of fault*
   - *circumstances of fault*
   - *external factors*
2 *Process of elimination*
3 *Identify the failure*
4 *Determine action and urgency*

6 a ▶5.3 **Mr Rooney, an engineer at a quarry firm, is talking to Al, a helpline consultant, about a technical problem with a diesel engine. Listen to the conversation and answer the following questions.**

1 What does the warning message say?
2 What external factor is discussed as a possible cause?
3 Why is this possible cause eliminated?
4 In what circumstances does the fault occur?
5 What does the consultant identify as the most likely cause?
6 What action is required, and how urgent is it?

b **Match the words in the box to their synonyms in the sentences (1–7).**

defect defective ~~fault~~ faulty intermittently major minor properly systematically

1 There's a **problem**. fault / _____
2 Perhaps something in the fuel injection system is **wrong**. _____ / _____
3 It's a **serious** problem. _____
4 It's a **slight** problem. _____
5 Is it working **correctly**? _____
6 The problem only occurs **from time to time**. _____
7 The problem doesn't occur **every time**. _____

c **Al made the following notes about three engine problems. Match the faults (1–3) to the possible causes (a–c).**

1 Starter motor sometimes works, sometimes doesn't. Engine is 9 years old.
2 Distribution belt failed. Engine blew. Belt replaced recently - almost new
3 New engine. Runs for 20 mins, then temp. gauge always goes into red, and engine cuts out (safety override)

a Cooling system problem. Fan? Water pump?
b Electrical contact problem. Loose connection?
c Manufacturing defect? Incorrect fitting? Not wear

d **In pairs, describe the problems in Exercise 6c using the following phrases.**

a faulty part a sudden problem a systematic problem an installation problem
an intermittent problem caused by wear and tear It's / It was ... It's / It was probably ...
Perhaps it's / it was ... This is / was a ...

e **Complete the following table using the phrases in the box from the conversation.**

I doubt it's it can't be it could be it might be ~~it must be~~ it sounds like it's

1 It's certainly / it must be
2 It's probably / _____
3 It's possibly / _____ / _____ a problem with ...
4 It's probably not / _____
5 It's certainly not / _____

f ▶5.3 **Complete the following extracts from the conversation using phrases in Exercise 2e. Listen again and check your answers.**

1 *Obviously, it must be some sort of defect in the fuel injection system.*
2 *So _____ a software problem.*
3 *... maybe _____ a defective sensor.*
4 *Presumably, _____ anything too serious.*
5 *_____ water, then, if the fuel went in directly from a delivery.*
6 *_____ a faulty fuel pre-heater.*

7 **a** **In pairs, analyse the problem described below. Underline the words in the box that describe it.**

major minor sudden systematic intermittent

The problem
The driver of a dump truck, which operates in a quarry, has noticed that the truck's diesel engine is slightly down on power. The problem has become progressively worse over several weeks. Apart from the power loss, the engine is performing consistently, with no misfiring and no overheating. The degree of power loss remains constant throughout a given period of use, from starting the engine to turning it off. No increase in fuel consumption has been noted.

b **Read the notes and assess the possible causes of the problem in Exercise 7a using the words in Exercises 6d and 6e.**

Possible causes of the engine problem
- *water in the fuel supply*
- *a lubrication problem*
- *a clogged fuel filter*
- *a blockage in the exhaust system*
- *a compression leak from the piston cylinders*

Describing the causes of faults

8 **Look at the following strategies for preventing and dealing with technical problems in aviation. In pairs, discuss what is meant by the following terms and how they are used by engineers and pilots.**

1 checklists
2 standard procedures
3 back-up installations
4 planned maintenance

9 a **Read the article on the right and answer the following questions.**

1 How did the problem start?
2 What were the initial, unseen consequences?
3 What were the subsequent consequences?

"We have a problem"

The true story of Air Transat Flight 236.

The chain of events began during routine maintenance work on an Air Transat Airbus A330. An incorrect hydraulic pipe was fitted to the right-hand engine. The component was oversized, leaving inadequate clearance with an adjacent fuel line. Subsequently, the two pipes rubbed together, causing the fuel line to wear progressively. The problem went undetected, until the night of August 24, 2001, at 35,000 feet above the Atlantic. With Flight 236 en route from Toronto to Lisbon, carrying 306 people, the fuel line ruptured, resulting in a major leak. Less than two hours later, the aircraft was completely out of fuel, gliding silently through the night sky …

b **Complete the sequence of events that followed the fuel leak on the Airbus A330 using the extracts (a–d).**

04:38 The flight data recorder registered an abnormal increase in fuel consumption. At this stage, however, this slight anomaly was insufficient to cause warning lights to come on to alert the crew to any imminent danger.

04:58 _____

05:33 A warning message came up, alerting the crew to an imbalance between the amount of fuel in each wing tank. Initially, the problem was thought to be an instrument malfunction. But further analysis by the crew revealed that the amount of fuel remaining in the right tank was significantly below the planned quantity.

05:36 _____

05:45 As a precaution, the crew decided to divert to the nearest airport - the Lajes military airbase in the Azores.

06:13 _____

06:26 ENG 2 FAIL appeared, and the left engine cut out. Having completely run out of fuel, and with both engines now down, the Airbus A330 was gliding, descending at 2,000 feet per minute.

06:27 _____

06:46 With the airport in sight, the landing gear was lowered manually. The pilot then performed a series of spectacular zigzag manoeuvres to slow the plane down as much as possible. The aircraft touched down on the runway at 370 km/h – exceeding the standard approach speed by over 100 km/h. The pilot applied emergency braking, causing several tyres to blow out and catch fire. But the plane stopped safely, well before the end of the runway.

a An alarm sounded, a red master warning lit up and the message ENG 1 FAIL came up on the screen. Seconds later, the right engine flamed out, due to insufficient fuel.

b During a routine instrument check, the crew noticed a disproportionate amount of oil had been used by each engine. Oil pressure and temperature readings for each engine were also irregular, but the levels were found to be within acceptable parameters.

c As the aircraft was now powerless and potentially uncontrollable, an emergency ram air turbine was deployed automatically to generate back-up electrical power for the fly-by-wire controls and instruments. However, with the main hydraulics shut down, the flaps and spoilers used to slow the plane before and after landing were inoperable. The co-pilot calculated the plane could remain airborne for 15–20 minutes, and that Lajes airbase was an estimated 20 minutes away.

d The crew decided to take action to correct the anomaly, opening a cross-feed valve to transfer fuel from the left tank to the right tank.

c **Make opposites of the following words using the prefixes in the box.**

ab- dis- im- in- (x4) ir- mal- over- un-

1 correct incorrect
2 undersized _____
3 adequate _____
4 detected _____
5 normal _____
6 sufficient _____
7 proportionate _____
8 regular _____
9 balance _____
10 function _____
11 operable _____

d **Complete the following sentences using the words in Exercise 9c. Sometimes more than one word is possible.**

1 The temperature gauge was faulty. That's why it was giving _____ readings.
2 The shaft was thinner than it should have been, so its strength was _____ .
3 The power output from the motor varies. We don't understand why it's _____ .
4 The bolt's _____ . It's too big to fit into the hole.
5 The machine's not working as it should. There's some kind of _____ .
6 The braking force on both front wheels should be the same. There shouldn't be an _____ .
7 The fault was _____ . None of the maintenance technicians had noticed it.
8 The control panel isn't working, so you can't control the machine. It's totally _____ .

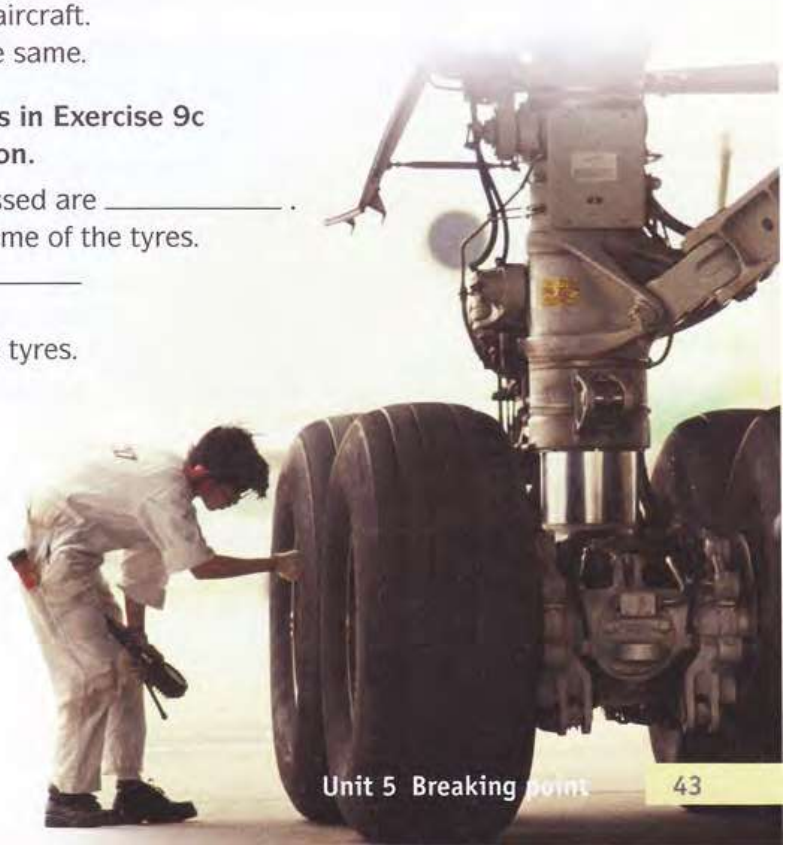
10 **a** ▶5.4 **Julia, an aircraft service technician, is phoning Alan, a colleague, about a problem with the tyres on a plane. Listen to the conversation and mark the statements True (T) or False (F).**

1 The tyre pressures on the block being discussed are OK.
2 There is too little air inside some of the tyres.
3 The tyre pressures are the same across the aircraft.
4 The degree of wear across all the tyres is the same.

b **Complete the following sentences using words in Exercise 9c to make true sentences about the conversation.**

1 The tyre pressures on the block being discussed are _____ .
2 There is _____ air pressure inside some of the tyres.
3 The tyre pressures on that block are _____ to the rest of the aircraft.
4 The wear rate is _____ across all the tyres.

c **In pairs, discuss the possible causes of insufficient tyre pressure in general, and the specific problem Julia describes in Exercise 10a, and say why each general cause you discussed is likely or unlikely in this case.**



Discussing repairs and maintenance

11 a **In pairs, discuss the difference between repairs and maintenance and decide whether the following words relate to repairs, maintenance or both.**

broken clogged defective faulty worn

b **In pairs, compare car maintenance with aircraft maintenance. Which aspects are quite similar and which are very different?**

12 a **Match the content sections (1–10) of an aircraft service manual to the descriptions (a–j).**

Contents

1	Opening and dismantling access panels	£
2	Topping up, draining and replacing coolants and lubricants	☐
3	Replacing filters	☐
4	Safely isolating electrical components	☐
5	Safely disconnecting and reconnecting electrical components	☐
6	Mechanical connections to be checked/ tightened at each service	☐
7	Parts susceptible to wear/damage, to be examined at each service	☐
8	Sensitive devices to be adjusted at each service	☐
9	Information on non-serviceable parts / sealed units	☐
10	Table of component life spans	☐

a Switching off the power supply
b Making sure certain parts haven't worked loose
c Changing parts that can become clogged
d Adding and changing fluids
e Equipment that needs to be set up precisely
f ~~Taking something to pieces to allow maintenance~~
g Taking parts off and refitting them without danger
h Components that can't be repaired on site
i Details of how long parts are designed to last
j Making sure parts are still in good condition

b **Match the verbs (1–10) from Exercise 12a to the definitions (a–j).**

1	adjust	a	carry out planned maintenance
2	drain	b	change an old or damaged part
3	disconnect	c	check carefully
4	dismantle	d	empty a liquid
5	examine	e	add more fluid to fill a tank to the recommended level
6	replace	f	set up carefully by making small changes
7	reconnect	g	take apart assembled components
8	service	h	apply the correct torque, for example to loose bolts
9	tighten	i	establish a connection again
10	top up	j	remove or isolate from a circuit or network

13 a ▶5.5 **A service technician is examining some machinery and talking to a colleague. What does he say about each point on the maintenance checklist?**

Maintenance Checklist

1 Coolant level _____
2 Coolant condition _____
3 Coolant filter condition _____
4 Blade wear/damage _____
5 Blade alignment _____

b ▶5.5 **Listen again. Do you think the technicians are working on an aircraft or on an industrial machine?**

c **In pairs, discuss what maintenance needs to be carried out on the machinery in Exercise 13a, describing the operations step by step.**

14 a **You work for IPS, a producer of industrial packaging machinery. As a member of the global service team your role is to travel abroad dealing with serious technical problems at your clients' plants. Read the following email from a plant in Helsinki and summarise the problem.**

To: Chris McLean
Subject: Forklift damage to IPS15 Helsinki

Following our phone conversation this morning I confirm that a forklift truck has hit our IPS15 unit. The impact has made a large hole in the main panel on the side of the machine. Our technician who is trained to carry out routine adjustments on the machine has made an external visual inspection. He has advised me that the mechanisms for adjusting the precise alignment of the cutting blades have been damaged. Liquid lubricant is also leaking out from under the machine and a crackling sound can be heard inside the unit when it is switched on – presumably due to earthing/short-circuiting resulting from electrical damage.

I confirm my request for intervention by your service team.

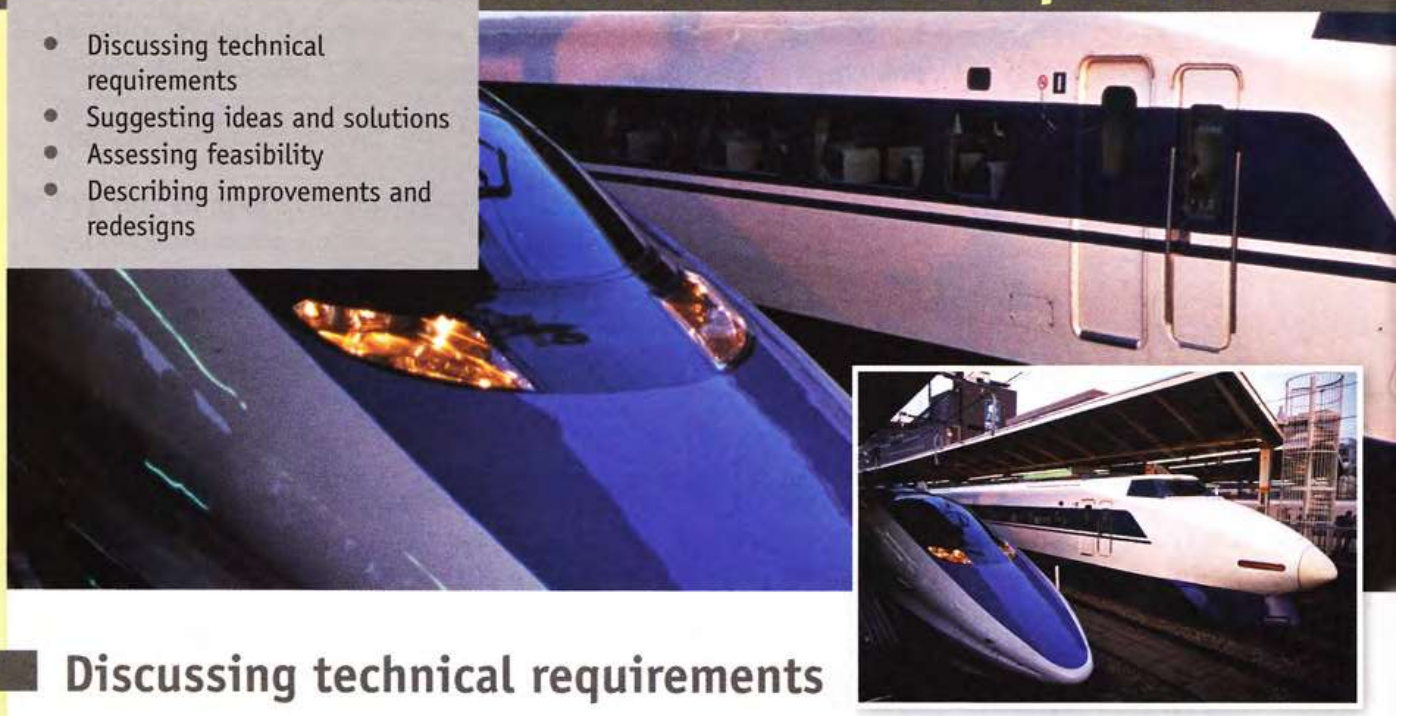
b **In pairs, describe the sequence of steps you'll need to take to carry out repairs when you arrive in Finland, using the notes to help you.**

IPS15 Helsinki
- internal damage
- old parts
- electrical supply: on / off
- lubricant: in / out
- external panels
- alignment of cutting blades
- test
- new parts

15 **Think back to some repairs or maintenance you did, or had done for you, in the past, for example on a car, bike or domestic appliance. In pairs, explain what servicing or repairs were required, and the main steps involved in carrying them out.**

UNIT 6 Technical development

- Discussing technical requirements
- Suggesting ideas and solutions
- Assessing feasibility
- Describing improvements and redesigns



Discussing technical requirements

1 **What is *needs analysis*? In pairs, discuss why the following factors are important in needs analysis, giving examples of products and installations.**

budget capacity dimensions layout looks performance regulations timescale

2 a ▶6.1 **Claudia, an engineer, is asking Kevin and Dave, the managers of a fun park, about their requirements for a proposed space module simulator called *Mars Lander*. Listen to the conversation and note the three main areas Claudia asks about.**

1 _____ 2 _____ 3 _____

b ▶6.1 **How do Claudia and Kevin focus on specific subjects? Complete the following phrases from the conversation using the words in the box. Listen again and check your answers.**

concerned regard regarding regards terms

1 *... with* _____ *to the capacity, ...*
2 *... in* _____ *of the number of people ...*
3 *... as far as size is* _____ .
4 *... And as* _____ *the graphics ...*
5 *...* _____ *the schedule ...*

c **Write questions using the following prompts and the phrases in Exercise 2b.**

1 dimensions: what / overall size / module? With regard to the dimensions, what is the overall size of the module?
2 materials: what / bodywork / made of?
3 schedule: when / work start?
4 power: what / maximum output / need / be?
5 heat resistance: what sort / temperature / paint / need / withstand?
6 tolerance: what level / precision / you want us / work to?

3 a ▶6.2 **Claudia goes on to ask about the physical effects the simulator needs to produce. Listen to the conversation and make notes on the following points.**

1 Possible variation in simulator movement _____
2 Extent of physical effects required _____
3 Best way to assess physical effects _____

b ▶6.2 **Listen again and explain what is meant by the words and phrases in bold.**

1 *... **to what extent** do you want the experience to be physical?*
2 ***The degree to which** it moves can be varied ...*
3 *... it's obviously difficult to **quantify** something like this ...*
4 *The only way to **determine** what's right is to actually sit in a simulator ...*
5 *... you can **assess** the possibilities.*

c Following the meeting, Claudia writes an email to update Rod, an engineering colleague. Read the extract and choose a word or phrase from Exercise 3b that means the same as the words in bold. Sometimes more than one answer is possible.

To: Rod Nelson
Subject: Mars Lander

In order to (1) **find out about** the simulator's dynamic capabilities, we looked at the types of effect the simulator should produce, and (2) **the amount** these physical effects should be felt by passengers. Specifically, the following issues were discussed:

- (3) **How severely** should the module generate vibration, to simulate engine thrust?
- How much buffeting should be simulated? That is, (4) **how severely** the module generates jolting, due to supposed atmospheric turbulence.
- (5) **How much** will passengers be exposed to constant linear G-force, to simulate deceleration?

In order to (6) **work out** the magnitude of the above parameters, it was decided that the prototype will be equipped with variable controls. This will enable the client to (7) **evaluate** different levels of severity through trials inside the simulator.

1 assess
2 _____
3 _____
4 _____
5 _____
6 _____
7 _____

4 You are consulting engineers preparing to work with a space agency to design an unmanned landing module. The module, which will carry scientific equipment, is intended to detach from a space ship orbiting Mars and land on the planet. At this stage, this is all you know about the project. In pairs, prepare a list of the main questions you will need to ask at the needs analysis meeting using the following ideas.

- type of scientific equipment
- size/weight of equipment
- solidity/fragility of equipment
- surface conditions at landing site

Suggesting ideas and solutions

5 **In pairs, discuss the following questions about creative thinking.**

- What are the most effective ways of coming up with ideas and finding ingenious solutions to technical problems?
- What do you think of brainstorming – generating lots of ideas randomly in a group session, without analysis initially, then subjecting each idea to analysis and criticism as a second phase?
- What do you think of evaluating ideas progressively – continually subjecting them to analysis and criticism?
- When creative thinking is required to solve problems, what are the pros and cons of working individually, in small groups, or in large groups?

6 a **Read the newspaper article and answer the following questions.**

1 How is the statue being made, and what is it being made from?
2 What is Rick Gilliam's role?
3 What will the statue be placed on in its final position in front of the museum?
4 What technical problem did they have to solve?

MAMMOTH PROBLEM BAFFLES ENGINEERS, SOLVED BY CAVEMEN

The new statue outside the Museum of Natural History has been a mammoth project, literally. The soon-to-be-completed sculpture portrays a life-sized woolly mammoth, carved from a single block of sandstone. Initially, one aspect of the project had engineers baffled. Rick Gilliam, the engineer overseeing the logistics, admitted that he and his colleagues had fried their brains trying to figure out how the 36-tonne monster could be lowered onto the stone plinth that will support it.

'We knew that we could put slings under the base of the statue, and pick it up with a crane,' he explained, and that transporting it from the stonemason's yard on a low-loader wouldn't be a problem. 'The problem is placing it on the flat plinth that supports it. How do you prevent the crane's slings from getting trapped between the base and the plinth, so that they can be withdrawn? We couldn't think of an easy way to do it.' The creative answer eventually came, not from the engineers, but from the stonemasons, who had affectionately been nicknamed the 'cavemen'.

b **Rick is talking to Gabriella, an engineering colleague, about the problem of placing the statue. Before you listen, explain what is meant by the following terms and try to guess what the three possible solutions are.**

bar drill friction a grab (on the end of a crane jib)
horizontal lifting eyes resin vertical

c ▶6.3 **Listen to the conversation and summarise the ideas. How do their ideas compare with yours? Why is each suggestion rejected?**

d **Complete the following suggestions from the conversation using the words in the box.**

about alternatively another could couldn't don't ~~not~~

1 *Why* ___not___ *come up with a way of hooking onto the side of the statue?*
2 *Well,* _____ *we drill into it, horizontally ...?*
3 *We* _____ *fill all the holes, couldn't we?*
4 *Or,* _____ *, we could make sure the holes were out of sight.*
5 *What* _____ *drilling into the top, vertically?*
6 *I suppose* _____ *option would be to use some sort of grab, on the end of the crane jib.*
7 *Why* _____ *we ask them?*

e **You are engineers working on the mammoth statue project, with the following technical requirements. In pairs, discuss possible solutions to the problem of placing the statue on the plinth using the phrases in the box.**

Alternatively Another option would be ... Couldn't we ... We could ...
What about ... ? Why don't we ... ? Why not ... ?

- No holes, slots or grooves may be cut in the statue. All of its surfaces must remain intact.
- No spacers may be left between the underside of the statue's flat base and the flat upper surface of the plinth. The two surfaces must be left in direct contact with each other.
- The statue must not be subjected to shocks. Sudden drops, even of a few millimetres, are out of the question, given the fragility of the sculpture, especially at its corners and edges, which can be damaged easily.
- Any accessory equipment may be used, within the limits of technical possibility and reasonable cost.

f **The stonemasons suggested a solution to the statue problem. Read their idea on page 99 and compare it with your solution. What external factors could cause some problems with their idea? How could these be solved?**