2 Design

1 Spin-offs

START HERE »

1 Work in pairs. Discuss the four statements below and decide if they are *true* (T) or *false* (F).

Many everyday applications on Earth are actually spin-offs from technology originally invented for space exploration. But there are many myths (false beliefs) about spin-offs.

1 Teflon is often added to pans to provide a non-stick surface for cooking and frying. It was originally invented to provide a surface for shields on spacecraft. T / F
2 Portable computers were first developed for use on a NASA shuttle mission in 1983. Laptop computers are now widely used for work and play. T / F
3 Velcro is now used for quickly attaching two items together, such as straps on trainers. It was primarily developed for anchoring items in zero gravity. T / F
4 Microwave ovens were originally invented for use on an early Earth-orbiting space station to enable astronauts to warm up their meals safely. They are now commonly used in many kitchens on Earth. T / F

Language
page 100 + page 101

2 Underline four examples of the present simple passive and four examples of the past simple passive in 1.

3 Fill in the gaps in these sentences with the correct form of the verb in brackets. Add an appropriate adverb from the box to each gap.

originally first primarily often commonly frequently usually

1 A new technology was originally developed (develop) to correct errors in signals from spacecraft. Now the same technology is often found (find) in satellite TV to improve the sound and picture quality.
2 Bar coding _____ (invent) to help space agencies keep track of millions of spacecraft parts. Nowadays bar codes _____ (see) on parcels and products.
3 A laser sensor _____ (install) on the Mars Perseverance rover to search for signs of past life on the planet. Now the technology _____ (use) in hospitals on Earth for identifying bacteria in wounds.
4 A system _____ (create) to change carbon dioxide on Mars into rocket fuel for return journeys. Now a similar system _____ (utilise) in oilfields on Earth to convert methane emissions into green energy.

SPEAKING »

4 Work in pairs. Discuss what applications on Earth you think were developed from these space applications.

Example: *Solar panels were originally invented to provide solar power for satellites. Today solar panels . . .*

solar panels on satellites
UV-resistant visors on space helmets
fireproof fabrics in space suits
pixel sensors for tiny space cameras

READING »

5 Compare your ideas in 4 with the items in the text below. Which ones were similar?

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Spin-offs from space programmes

1 Fireproof fabrics that were originally developed to protect astronauts from fires on spacecraft are now commonly used in clothing to protect firefighters on Earth.
2 Technology originally designed to prevent astronauts' visors from being scratched by dirt and other particles is now regularly used in manufacturing sunglasses that can resist scratching.
3 High-performance solar panels first used on satellites to optimise output when facing away from the sun are now used on solar-powered racing cars.
4 CMOS active pixel sensors that were designed as components of small, high-definition, low-powered digital cameras for space photography are now found almost everywhere in mobile phones and on selfie sticks.
5 Materials primarily used in spacesuit visors to protect astronauts' eyes from ultra-violet rays are now used in clothing which protects people's bodies from the sun's rays.
6 A drill bit on the Perseverance robot arm designed to drill into rock on Mars, break the rock sample off neatly and keep it for examination, can now be used by geologists on Earth to collect perfect rock samples.

Done

6 Match the original space technology 1–6 with the uses on Earth a–f.

1 a visor to protect astronauts' eyes from the sun
2 a fabric for protecting astronauts from fire
3 solar panels that provide power for a satellite
4 a visor which resists cuts and scratches from stones
5 tiny pixels to capture HD images in space
6 a drill bit for collecting rock samples on Mars

a) mobile phone cameras
b) scratch-resistant sunglasses
c) a useful tool for geologists
d) PV panels for solar-powered cars
e) UV-resistant clothing
f) flame-resistant clothing

LANGUAGE »

Expressing the use or function of a device

- *to* + infinitive: *a visor to protect astronauts' eyes from the sun*
- *for* + *-ing*: *a fabric for protecting astronauts from fire*
- *that / which* + present simple: *solar panels that provide power for a satellite*

7 Say the items 1–6 in 6 in two different ways, using language forms in the box.

Examples: *Item 1 is a visor for protecting astronauts' eyes from the sun. Item 1 is a visor that protects astronauts' eyes from the sun.*

8 Make full sentences from these notes. Use a variety of forms from the language box above.

Example: *1 A solar panel is a panel of PV cells which is used for generating electrical power from the sun's rays.*

1 solar panel – panel of PV cells – use – generate – electrical power from sun's rays
2 stress sensor – instrument – monitor – changes in the load on a structural component such as a girder
3 stress sensors – originally – design – monitor – problems with external systems on spacecraft
4 clean air system – originally – invent – clean – air breathed by astronauts in spacecraft, now – commonly – find – in portable sterile rooms – in hospitals
5 CMOS active pixel sensor – device – converts – light signals – into electric signals – and – main component – phone cameras
6 Perseverance drill bit – located – robot arm – precision tool – used – collection of rock samples – surface of Mars

2 Specifications

START HERE »

1 **Work in pairs. Discuss a product or facility that you and your partner both use. Make notes of any problems or features that you would like to improve in the product or facility. Explain your ideas briefly to another pair.**

Examples: a computer operating system, a mobile phone network, a web browser, a gym or sports centre, a canteen or food court, a transport system

TASK »

2 **Work in small groups. Look at the illustration and the information below. What do you think the complaints were about? Make notes under these headings: *safety, performance*, *appearance* and *ergonomics*. Then compare your notes with the information on page 113.**

ergonomics = adapting a machine (or job) to the user so that it is comfortable, safe and efficient to use

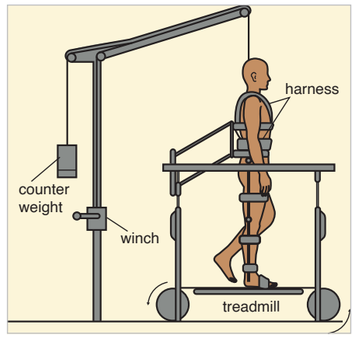
Product: TreadAir

Designed for: people recovering from an accident or injury

Purpose: so that they can exercise on treadmill safely

Method: body is lifted by winch and harness and supported by counter-weight

Feedback: complaints received from users about problems with . . .

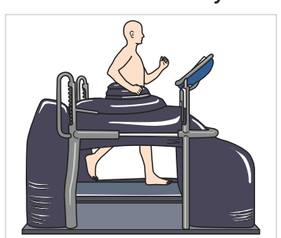


LISTENING »

3 2.1 **Listen to a product design team brainstorming how to improve the TreadAir. Complete this form.**

REQUIREMENTS FOR NEW PRODUCT	
Description	An inflatable airbag enclosing the body which can _____ without _____
Performance	• Maximum support: _____ % of body weight • Air pressure adjustable in increments of _____% • Maximum speed: _____ kph
Ergonomics	• Display type: (1) _____ (2) _____ • Able to control: (1) _____ (2) _____ • Able to alter settings during workout without _____
Dimensions	_____ x _____ m footprint
Weight	Compared with normal treadmill: _____
Operating range	Temperature: _____ to _____ °C
Safety	Standards: (1) _____ (2) _____

4 **Work in groups to discuss this question and make notes. To what extent do you think that the product illustrated here would meet the requirements outlined in the brainstorming session?**



READING »

5 **Mark four items in this draft design specification which were not mentioned in the brainstorming session in 3.**

Draft Product Design Specification

1 Recommended product name: the name should reflect the fact that it is a space spin-off, and suggest weightlessness: for example *MoonWalker* or *SpaceRunner*.
2 Recommended product description: 'an **enclosed** treadmill that utilises air pressure in an inflatable bag to support body weight, without a winch or harness'.
3 Performance requirements for new product:
- reduce user's weight by up to 80%
- give **precise** measured support
- allow **incremental** (1%) adjustment of air pressure
- provide **unrestricted** motion for legs and upper body
- run at a **variable** speed adjustable up to 16 kph
- present a variable incline (or slope) up to 15°

4 Recommended ergonomics features:
- touch button on screen to increase / reduce support for body weight
- adjust speed, incline and air pressure using simple controls
- change settings while running, without needing to stop
- attach body safely to machine using special shorts that zip into airbag

5 Operating environments: machine must be able to function within
- an **ambient** temperature range of 10–29°C
- a **relative** humidity range of 20–95%

6 Dimension and weight requirements:
- maximum 4 x 2.5 m footprint to allow for **adequate** space around machine
- similar weight to a normal running treadmill

7 Safety requirements:
Since the product is intended for export throughout Europe including the UK, compliance with all applicable BS and EU safety standards is essential.

6 **Match these words and phrases with the adjectives (in bold) in the document in 5 which have the same or similar meaning.**

1 changeable	3 surrounding	5 sealed	7 comparative
2 sufficient	4 without constraints	6 step-by-step	8 exact

LANGUAGE »

Expressing necessity, recommendation and ability

A **necessity** *must / have to / need to / have got to*
B **recommendation** *should / ought to*
C **ability** *be able to / be capable of / have the ability to*

SPEAKING »

7 **Work in pairs. Choose eight specifications from the document in 5 which are the most important, in your view.**

8 **Talk about each specification, using a variety of items from the language box above. Use a modal from list A or B, combined with a phrase from list C.**

Example: *The equipment has to be capable of reducing the user's weight by up to 80%.*

WRITING »

9 **Rewrite sections 3 and 4 of the document in 5 as a memo to the manager of your product design team. You want to persuade your manager to support you in designing the product. Describe the product as if it *already exists*. Link the phrases in the document together using present participial phrases where appropriate.**

It reduces the person's weight. It gives precise measured support. It allows incremental adjustment.

➔ *It reduces the person's weight, **giving** precise measured support and **allowing** incremental adjustment.*

Begin: *The new SpaceRunner is capable of reducing the person's weight by up to 80%, giving . . .*

Language
page 103

3 Properties



START HERE » **1** **Work in pairs. The architectural fabric used on these buildings is a spin-off from space technology. Discuss these questions.**

1 What properties must this roof fabric have (e.g. *tensile strength*, *durability*)?
2 What do you think this fabric was originally used for in space?
3 Do you know any buildings in your own country where this material is used?

LISTENING » **2** 2.2 **Listen to a team brainstorming the properties of roof fabric. Write numbers in the boxes to show the order in which these properties are mentioned.**

thermal protection ☐
kilo for kilo stronger than steel [1]
solar translucency ☐
non-flammable ☐
solar reflectance ☐
good acoustics ☐
low maintenance ☐
high melting point ☐

VOCABULARY » **3** **Match the phrases in italics in this text with the words or phrases in 2 that are closest in meaning.**

Tensile roof fabric is a safe, economic and architecturally stunning material for concert hall roofs.

The fabric is extremely fire-resistant. In case of fire, it (1) *will not burst into flames*. Even in a severe fire, the fabric (2) *won't melt until the temperature is very high*, in fact over 650°C.

During the day, when the sun is shining, about 25% of the (3) *sunlight can pass through* it, but the other 75% of the (4) *sunlight is reflected away* from the outside of the fabric. This means that the material (5) *protects the building from the heat* of the sun. As a result, the need for artificial lighting and air conditioning is very low, which means that the building is very cost-effective to run.

The roofing material is lightweight and yet (6) *it has greater strength than steel relative to its weight*. It can easily be formed into sound panels, which means that the (7) *quality of sound is very good* inside the building, which makes it suitable for concerts and gigs.

Finally, we can say that this fabric is durable, and (8) *will not need to be repaired for many years*.

SCANNING » **4** **Practise your speed reading. Look for the information you need on the SPEED SEARCH pages (117–118). Try to be first to answer these questions.**

1 What are *five* properties of the fabrics used for the outer layer of spacesuits following the fire that destroyed the Apollo 1 command module?
2 What is the melting point of the fabric?

LISTENING » **5** **Listen to the brainstorming session again and tick the phrases you hear.**

(a) Inviting suggestions
Who'd like to kick off? ☐
Let's focus on . . . for a minute. ☐
What do you think? ☐
Any thoughts on that? ☐
Any ideas on that? ☐

(b) Introducing ideas
Why don't we . . .? ☐
What about . . .? ☐
I've got an idea! ☐
I'd suggest that . . . ☐
I know! ☐

(c) Praising contributions
That's very interesting. ☐
Great idea! ☐
Yes, that makes sense. ☐
You're absolutely right. ☐
Good point. ☐

TASK » **6** **Work in small groups. Choose a product that you all know something about and which you think needs design modification.**

For example, you could choose a computer operating system or application, a smart phone, a vehicle, a remote control handset, a building, a machine or a piece of safety equipment. Typical problems could include size, weight, performance, appearance, ergonomics or safety.

7 **Make a list of the *current* main features, capabilities and properties of the product in 6, both good and bad.**

8 **Brainstorm the features, capabilities and properties that you think an improved product needs to have. Make notes of your decisions. Use some of the phrases in 5 as you brainstorm.**

WRITING » **9** **Work individually. Using your group's notes, write a product design specification for the new product.**