Rollercoasters

Journalist Kashmira Gander found out about how rollercoasters are designed.

Imagine you're on a rollercoaster in an amusement park. Palms clammy with fear, nails digging into the harness, you come to a grinding halt and inhale sharply before the carriage creeps slowly upwards. A pause. Then a sharp drop and your stomach is suspended in the air. Teeth gritted, you hurtle quickly forwards, sharply left, then upside down. Your senses a blur, you let out a roar of fear that comes from the pit of your gut. But you only have yourself to blame: after all, like hundreds of millions of others each year, you were happy to pay the price of getting into a theme park.

What's somewhat mystifying to me is that amusement parks, with their hair-raising rides aimed at pulling in crowds, are a huge industry. To deliver the thrills and ultimate-escape-from-reality that guests seek, behind the scenes there are huge teams of highly inventive – and arguably a little cruel – structural, mechanical, industrial and electrical engineers, as well as designers and marketing experts.

'Rollercoaster designer' sounds like the career aspiration of a primary school child when asked what they want to be when they grow up. In reality, it's a big challenge: not just creating the perfect balance of pleasure and fear while ensuring that passengers are not in any danger, but also introducing enough novelty to keep visitors wanting more.

While the layperson may imagine that rollercoasters have become ever more intense, in fact, most of the techniques used today – including the wheel that allows rides to go upside-down – were invented by the USA designer John Miller in the early 20th century.

I spoke to three experts on rollercoasters. 'The skill,' said Professor Brendan Walker, a 'thrill engineer' with a background in aeronautics, 'is in compiling the pieces.' And what that means, said Dr John Roberts, a fellow of the Royal Academy of Engineering, is 'swapping very rapidly between plus and minus, so people get the sense of being sort of thrown around but kept safe. It's a very fine line between people feeling the ride is thrilling and that feeling they've been bumped around.'

In the search for a superlative ride, the teams behind rollercoasters must piece together a strong narrative, be it a space adventure or a high-paced chase in the jungle, that works with any innovations – the tallest ride, the most twists, the steepest drops – to create a seamless experience. However, said Professor Walker, in the end, as in many creative industries, gut instincts, years of experience and trial-and-error are what work. 'It helps to be a bit of a thrill-nut if you are designing rollercoasters, in order to understand exactly what passengers are looking for, and to test your rides before they're opened to the public,' agreed Jeff Hornick, a senior director of theme park development.

Surely though, I asked them, as technology has transformed industry after industry, rollercoaster designers will also have to embrace the latest advances, such as virtual reality? Walker said we shouldn't hold our breath. 'Virtual reality can add a veneer, but only in the way that an old fashioned rollercoaster was fantastically painted,' he said. 'New technology comes along all the time, and the parks are very quick to embrace it because it is exciting and can add to ride experience. But underpinning that is the physical coaster experience, and I think that will remain king for many years to come.'

31 What does the writer say in the first paragraph about people who ride on rollercoasters?

A They spend too much money trying to find excitement.
B They can't complain when they feel terrified.
C They often don't realise how frightening the experience will be.
D They should try to control their emotions more effectively.

32 What do we learn in the second paragraph about the writer's attitude towards rollercoasters?

A She is concerned that they may have a negative effect on passengers.
B She believes they promise more excitement than they can deliver.
C She regrets that people feel the need to spend their leisure time in this way.
D She finds it hard to understand why so much effort is put into creating them.

33 What is suggested about rollercoaster designers in the third paragraph?

A They have had the courage to follow their dreams.
B They should try harder to please theme park visitors.
C They deserve credit for doing a demanding job effectively.
D They are not the kind of people who can be taken seriously.

34 What is emphasised by 'it's a very fine line' in lines 46 and 47?

A how very unpredictable people are
B the speed at which so many rides can go
C the possible risks involved in going on a ride
D how difficult it is to get a ride exactly right

35 What does 'that' refer to in line 53?

A a superlative ride
B a strong narrative
C a space adventure
D a high-paced chase

36 What does Walker suggest about new technology in the rollercoaster industry?

A Designers are reluctant to use it.
B It has proved problematic in the past.
C It has a limited role to play.
D Passengers rarely notice its impact.

How trees communicate

Can trees communicate with each other? Surprisingly, the answer seems to be that they can. Forest ecologist Dr Suzanne Simard, from the University of British Columbia in Canada, has been studying tiny living organisms, or fungi, which form underground communication networks between trees in North American forests. Big old trees, nicknamed 'mother trees', are central to this network, playing a key role in supporting smaller trees in the forest – in particular, their own offspring.

Simard explains that if you're a mother, you put your children first and tend to give them special treatment. 37 In situations where they would normally compete with other trees, they adjust their behaviour to make room for their own family members. They communicate their presence through their fungal networks, so when a very young tree tries to establish itself on the forest floor, it can just link into the mother tree's root systems and so join the fungal network, taking advantage of its considerable resources.

What is more, these networks don't just operate between related trees. They may also form between different species in the same community. For example, Simard also traced the amounts of carbon, nitrogen and water moving between a Douglas fir and a paper birch tree, both native to the forests of British Columbia. In one experiment a tree was artificially prevented from getting the light it needed to grow healthily. 38 The nutrients it needed flowed into the tree from others, through the networks between them.

In another study, Simard showed that within a 30 by 30 metre wooded area, an estimated 250 to 300 different trees were connected by fungal networks. This is of huge benefit to the trees and these networks allow a wider variety of tree types to survive in one area. 39 This diversity creates a basis for a forest that's resilient to disease, climate change and pests such as insects.

Other research has suggested that trees use fungal networks to warn their neighbours about impending attacks from pests. According to Simard, when trees are attacked, they increase their own protection against the invaders by producing a substance which helps them to defend themselves. 40 When these messages are detected, the other trees upgrade their protection systems by producing chemicals of their own.

41 Western Australia, for example, is dominated by healthy trees that don't rely on them, possibly due to the fact that the soil there is richer in nutrients. However, Australian Eucalyptus forests do have networks, although no research has yet been done into what their function might be.

Simard believes her findings have implications for forestry practices which involve the cutting down of old trees. 'We need to leave these trees standing so that they are able to send their messages into the soil to surrounding plants.' Forests are frequently damaged by fire, she says. 42 And it may be that protecting old trees will not only contribute to the restoration of these wooded areas, but may also prevent non-native species from invading them.

A Each species has its own strengths and weaknesses.

B These can travel between trees in as little as six hours.

C As they do this, chemical signals pass through their networks to nearby trees.

D In response, the surrounding trees began to share resources rather than compete for them.

E Whether fungal networks are used may depend on the local ecosystem.

F Conserving their networks could help them recover after such an event.

G Research suggests that trees do the same thing.