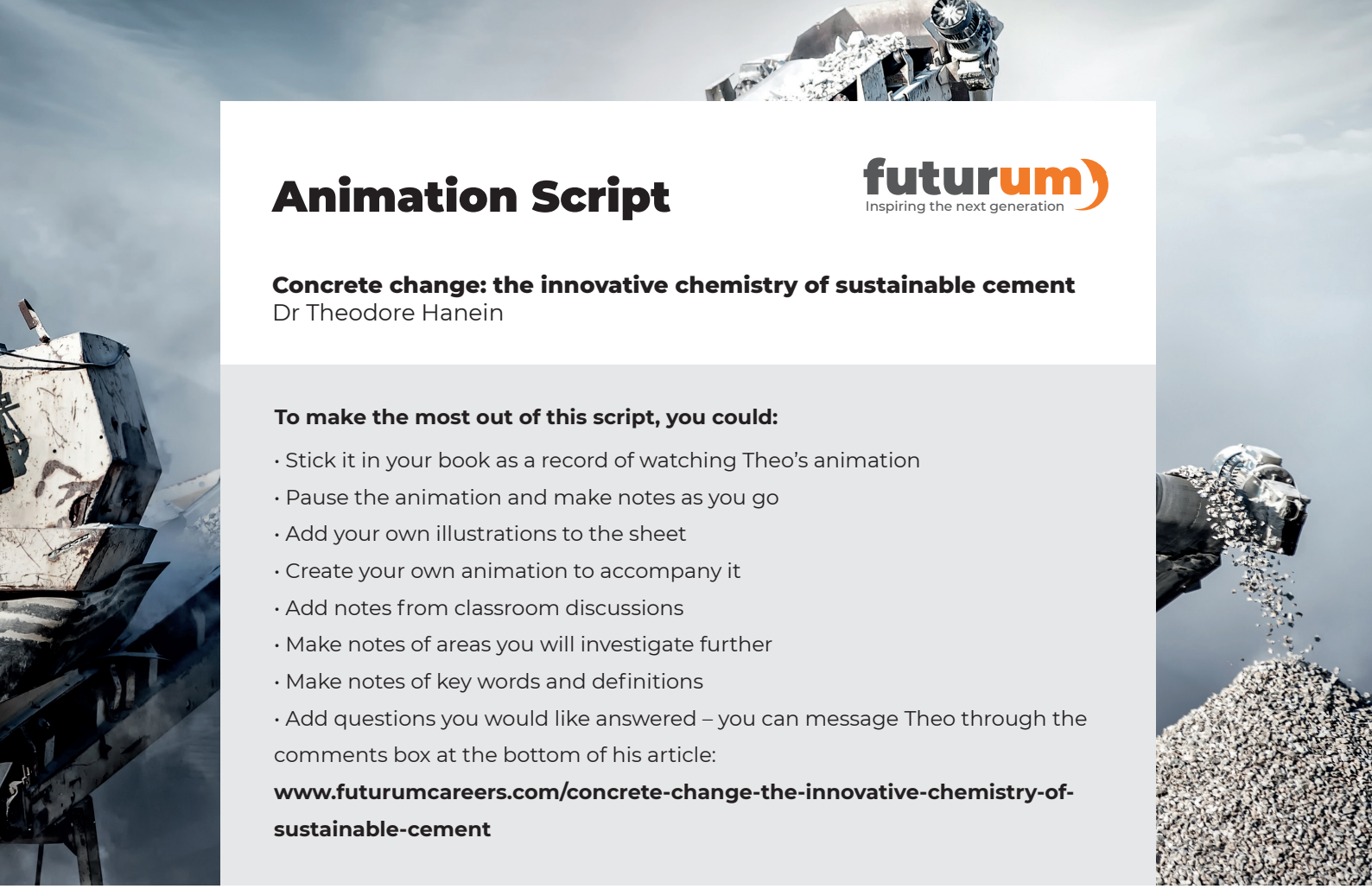

Animation Script

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Concrete change: the innovative chemistry of sustainable cement
Dr Theodore Hanein

To make the most out of this script, you could:

- Stick it in your book as a record of watching Theo's animation
- Pause the animation and make notes as you go
- Add your own illustrations to the sheet
- Create your own animation to accompany it
- Add notes from classroom discussions
- Make notes of areas you will investigate further
- Make notes of key words and definitions
- Add questions you would like answered – you can message Theo through the comments box at the bottom of his article: **www.futurumcareers.com/concrete-change-the-innovative-chemistry-of-sustainable-cement**

SCRIPT:

Cement is the most manufactured commodity in the world, with more than 4 billion tonnes of it used every year. That's one and a half kilogrammes of cement every day for every person on the planet!

As the core material of concrete and mortar, which are used in the buildings and infrastructure that surround us, cement is essential to our everyday life.

However, cement production requires vast amounts of natural resources, and is responsible for 8% of our carbon dioxide (CO_2) emissions – three times what is released from aeroplanes globally.

At the University of Sheffield in the UK, materials scientist and process engineer Dr Theodore Hanein and his team are investigating alternative methods for cement production. This includes replacing raw materials with waste products from other industries and finding techniques to reduce the carbon dioxide released during cement manufacture.

Emissions from cement production are mainly from the conversion of the raw material into clinker in high temperature rotary kilns, which is the key process in cement manufacture.

Animation Script

The most common type of cement produced today is Portland cement, which relies on carbon being removed from limestone (calcium carbonate) to produce lime (calcium oxide). This emits CO_2 and almost half of the limestone's solid mass is lost in the process.

Theo and his team are interested to see if this natural raw material can be substituted with by-products from other sectors.

This could be from steel manufacture or mineral mining, or using old cement from construction or demolition sites. Developing processes to use these by-products would reduce the emissions from cement production and repurpose waste from other sectors, preventing it from becoming landfill.

However, any alternative materials will contain other elements that could change the underlying chemistry of the produced cement.

Theo's project, FeRICH, is investigating this challenge when using by-products from steel manufacture. If the cement and steel industries were countries, they would be the 3rd and 4th highest emitters of CO_2 after the USA and China. So, reducing the environmental burden of both these industries is essential, and the FeRICH team is creating a sustainable relationship between them to do so.

Steel by-products contain the key elements essential to cement production (such as calcium that is not bound to carbon) and an unusually high amount of iron. The introduction of iron leads to the production of calcium (alumino) ferrites – compounds made from iron with one or more metallic element. Theo and his team are interested in fully understanding these compounds and learning how they affect the qualities of the end product, especially its durability and how it reacts with water.

Theo's research feeds into a broader concept known as the circular economy, one element of which is repurposing one industry's waste as the raw materials of another, contributing to a sustainable future for us all.

What could you achieve as a materials scientist and process engineer?