

Digital Twins

Resources:

Teacher Notes; PowerPoint slide; Activity Sheet

🔗 Siemens Digital Twin resource: Siemens Digital Twin digitaltwingame.co.uk

Introduction

Teaching materials can be used in a variety of ways, a suitable method is suggested below:

1. Use the PowerPoint slide to introduce the interactive resource and explain the context. Get students to understand that they need to make decisions about how to set up the system they will be trialling, using the information provided and ensure their understanding of the value of different options.
2. Get students to use the interactive resource, setting up a system and seeing how it works. Ideally, provide them with enough time to modify their design and see if they can address any shortcomings indicated in the simulation feedback.
3. Follow up with the activity sheet, this presents students with feedback from a hypothetical system and asks them to interpret the data.

Learning objectives	Learning outcomes
• Use and evaluate a digital twin to meet a design brief by choosing appropriate options.	• Clear explanation of the purpose and value of a digital twin.

Why this technology is important:

Digital twins eliminate the need for physical prototypes, reduce development time and improve quality by combining multi-physics simulation, data analytics and machine learning to demonstrate the impact of design changes, usage scenarios, environmental conditions and other variables.

Digital Twins are used in many ways:

Manufacturing

Digital twins of manufacturing processes and equipment can optimise production schedules, predict equipment failures and improve overall efficiency.

Smart cities

Digital twins of urban infrastructure, such as transportation networks and utilities, can enhance traffic flow, manage energy consumption and enhance public services.

Healthcare

Digital twins of patient physiology and medical devices can support personalized treatment plans, monitor health metrics remotely and simulate surgical procedures.

Energy

Digital twins of power plants and renewable energy systems can optimize energy production, predict equipment failures and manage grid stability.

Answers to support Student Activity Sheet

Activity sheet:

Q1:

Changing the body style will affect the amount of energy needed to make the car move. This won't make the engine less powerful, but it will affect the performance and economy and therefore the range as well.

Q2:

The engine choice will affect the power output, performance and range.

Q3:

The material the wheels are made from won't affect any of the design factors, but the diameter will, as it will change the gearing. Larger wheels will tend to reduce the performance but improve the range. Greater tyre width increases the grip (and therefore the cornering), but this pushes the energy consumption up so straight-line performance and range may suffer.

Q4:

Digital twinning means that the impact of design decisions can be explored quickly and easily.

Q5:

A digital twin is only as good as the performance factors that have been built into it. For example, the performance of the car will also be affected by temperature, weather, driver skill, vehicle condition, etc. and the digital twin may not be able to replicate all of these. A full-size prototype may show things up that the digital twin can't.

Answers to the Powerpoint Slides

PowerPoint Slide Answers:

Q1:

A 'Digital twin' is a copy of the key features of an object, system or idea but in digital format. It should respond in the same way as the original to any changes.

Q2:

- The power output of the engine may need to be increased to improve the top speed, the acceleration, the load carrying capability or to support systems in the car such as air conditioning.
- Having a more powerful engine is likely to increase the cost, the fuel consumption and the emissions.

Q3:

Increasing the range of an electric car means fitting a larger battery, which adds weight and takes space.

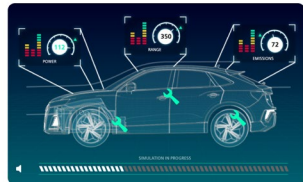
Q4:

Manufacturers need to manage emissions effectively to stay within the law – there are legal limits they must comply with.

Q5:

Building a full-sized car and change the features on that would be much more expensive and time consuming. Digital twinning allows for a much more efficient design process.

Digital Twins
Digital Twin and Simulation



This image shows the digital twin for a car design. Features can be changed in the digital twin and it will then show the effect of changing these on a full-size car.

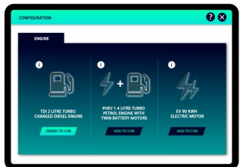
Q1. What do you think the term 'digital twin' means? Look at the words and suggest a meaning.

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Digital Twin and Simulation

Q2. One of the features that can be changed is that of the power output of the engine.

- Why might this need to be increased?
- What might other consequences be of having a more powerful engine?



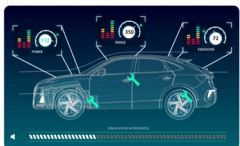
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Q3. Increasing the range of a petrol or diesel car is relatively easy – a larger fuel tank can be fitted. However, for an electric car it is a bit more complicated. Suggest why.

Q4. Why is it really important for manufacturers to manage emissions effectively?

Q5. Why not just build a full-sized car and change the features on that to see how it works instead of setting up a digital twin?



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Design the Future

Explore a smart factory and discover how the future is being made today.