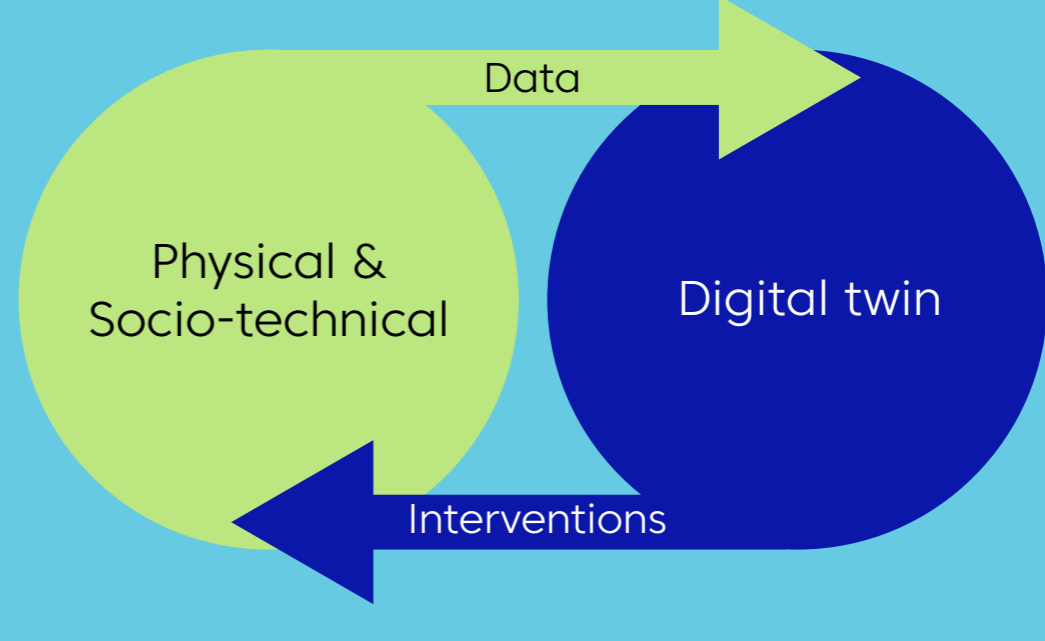# Digital Twin Journeys:
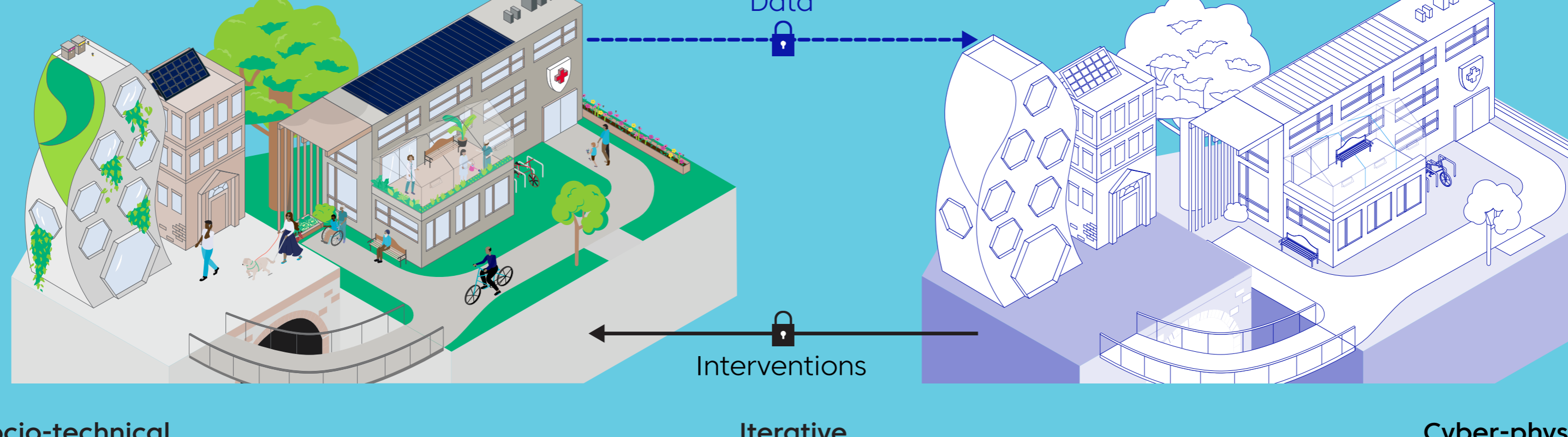## An iterative approach to prototyping digital twins

Embarking on a digital twin journey can help you better understand a problem and provide insights that can help you solve it. This infographic is a guide to capturing value through prototyping digital twins, based on lessons learned from the digital twin research delivered by the Centre for Digital Built Britain as a partner in the Construction Innovation Hub and undertaken by the University of Cambridge.

Please visit https://www.cdbb.cam.ac.uk/research/digital-twin-journeys for more information about this research.

Physical & Socio-technical → Data → Digital twin → Interventions

What is a digital twin?

A digital twin is a digital representation of a physical asset (e.g. a bridge, a building, a train car or a rail network) based on timely data that allows for analysis, insight, decision-making, sense-making and interventions in the physical world.

Data → Interventions

Socio-technical

Digital twins involve developing technology, but also designing processes and tools that are run by people, enable collaboration, support human decision-makers and create positive outcomes for society.

Iterative

Digital twins scale up and improve through an ongoing cycle of prototyping, deployment and reflection. You don't need to solve all of your problems with your first prototype.

Cyber-physical

Digital twins bridge the physical world around us with a world of digital data and models, which represent the state of the asset, how it is performing and potentially predict its future state, enabling better interventions in the physical world.

Getting started on your first digital twin

Start with a minimum viable twin – one that does only the most essential tasks and enables the best environment to develop a digital twin that is fit for purpose.

If you take an iterative approach to digital twins, it will result in Digital Twins that are aligned to emerging requirements. It is much easier for stakeholders to assess the uses of a digital twin if they are able to test it.

By focusing on creating value and realising benefits, you can create small prototypes that are working toward broader goals, like better performance of assets, and environmental and social good.

Mara, a digital twin guide, is about to help Desmond develop his first digital twin prototype.

Hi, Desmond. I heard you have ambitions to deliver net zero emissions for your building stock. How can I help?

We have these targets, but I don't know what data we have or how to use it to make better decisions. Where do I start?

Let's see how developing a digital twin prototype can help.

Follow Desmond's digital twin journey below...

Purpose

The requirements for a digital twin clearly describe what job it is doing or the problem it is solving. Why are you developing this digital twin?

It is important to set a clear goal that the project stakeholders agree upon.

Define the requirements

Start with a problem that can be observed using sensors and up to date information sources. Connect these information sources to people who can use it to make better informed decisions.

You need to figure out what question you want to answer. Start with a small problem to learn how to integrate digital twins into your decision process.

How do I get started with developing a digital twin?

What questions should we have asked? How should we have structured the data? What other sensors are available to help us answer our questions better? How could this be applied in another area?

Analysis

Analysis involves digging into why people use your service, why it is valuable and what you might get out of developing a digital twin.

Understand how people use your asset/service

What are their needs and expectations? How would they be impacted by changes in your problem space?

Read more

Involve your stakeholders in a participatory process. It's important to gather diverse points of view and understand how your digital twin can serve their needs.

I think my asset manager will understand this process better than anyone. Maybe I can ask them for help on mapping out the digital twin prototype.

These might already be expertise you can draw on in your organisation, or in your sector. The digital twin hub can connect you with others you can learn from.

Identify your enablers and resources

Consider what you have to hand that can help you. What can you use that's here? Can't? What can you buy? What might you need to make yourself? Who in your organisation can help you?
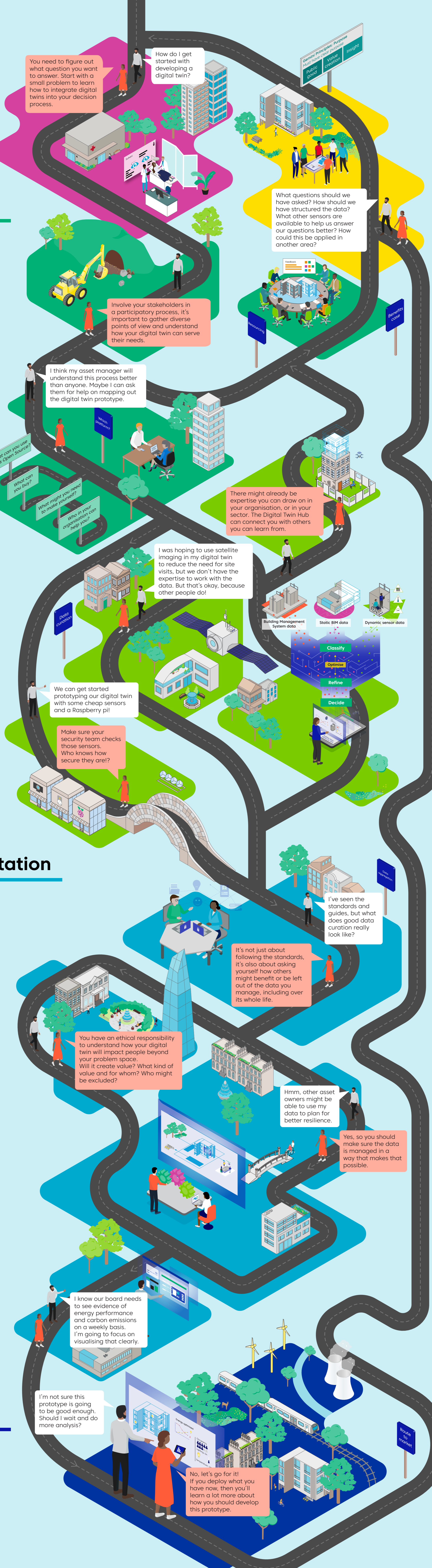
There may be free sources of data that you can draw on. For example, some remote geospatial data is free to access, though it requires a specialist to process.

Read more

I was hoping to use satellite imaging in my digital twin to reduce the need for site visits, but we don't have the expertise to work with the data. But that's okay, because other people do!

We can get started prototyping our digital twin with some cheap sensors and a Raspberry pi!

Sensors don't need to be expensive or bespoke

Off the shelf sensors can be combined in innovative ways to meet the information need. You may already have sensors you can use to infer other information.

Read more

Make sure your security team checks your sensors. You want to make them secure against cyber attacks, while those have secure they are?

Design

Put the right people in the right roles

To be able to create an agile, innovative organisation that is able to respond to insights from the digital twin, consider your organisational structure and culture.

Read more

Look for people and roles who can help you

Identify existing roles or create roles that specialise in data curation and analysis, as well as systems-thinking. Sometimes the expertise you need will be outside of your organisation.

Read more

Evaluation

Learn from your prototype digital twin and iterate to improve on or expand it

Exploit the next iteration into a new problem space, improve the data quality, curation or visualisation, or address any issues in the decision process.

Talk to your stakeholders and get their feedback

How did your key stakeholders feel the prototype went? What value did they get from it? Remember that some of your key stakeholders are outside of your organisation.

Implementation

Consider security implications of the data you are collecting and managing

Will the risk increase when aggregated with other data or digital twins? Will data be managed securely? Will anonymous data remain anonymous when considered in the context of a real building?

Read more

Understand the ethical and legal frameworks in which your digital twin will operate

Data and digital technology don't exist in a vacuum; they impact people's lives. Look at the legal landscape, but also consider the people who will be impacted by your decisions.

Read more

Communicate data visually for better insights

The visual interface with the digital twin should be appropriate to the stakeholders who will be using the twin to make decisions. The style of the visualisation, the information it provides, the frequency and uncertainty are decisions you need to make consciously at this stage.

It's not just about following the standards, it's also about asking yourself how others might benefit or be left out of the data you manage, including me as a whole life.

You have an almost responsibility to understand how your digital twin will impact people beyond your problem space. Will it create value? What kind of value and for whom? Who might be excluded?

Hmm, other asset owners might be able to use my data to plan for better resilience.

Yes, so you should make sure the data is managed in a way that makes that possible.

I've seen the standards and guides, but what does good data curation really look like?

Implement good data curation from the beginning of your prototype

Data curation throughout the whole life of assets – is vital to ensure value from your digital twin. Standards and best practice guidance to aid and maintain data curation practices throughout.

Read more

Consider interoperability of your data and your digital twin

Think about how others might use the data you're collecting and how they'll fit into an ecosystem.

Read more

Understand the way digital twins function and how they fit into the decision-making process in your organisation

How will this prototype supplement or teach you more about your existing business intelligence? Think about how to capture benefits and impacts to help you evaluate it.

Read more

Testing

Develop your prototype

Take all of the decisions and insights you've gained from this process and have a go at developing something, even if it's not perfect, you will learn from evaluating its performance against the purpose with which you set out.

I know our board needs to see evidence of energy performance and carbon emissions on a weekly basis. I'm going to focus on visualising that clearly.

I'm not sure this prototype is going to be good enough. Should I wait and do more analysis?

No, let's go for it! If you deploy what you have now, then you'll learn a lot more about how you should develop this prototype.

What's next for digital twins?

Digital twins are still pretty new, though, right? What are the gaps that I should know about?

Of course. We're still early in developing the technical capability of digital twins and the process and skills for people to use them well.

Timely, accurate, predictive insights about your energy performance requires time and effort. It's important to understand what's achievable and test different possibilities to understand the way forward.
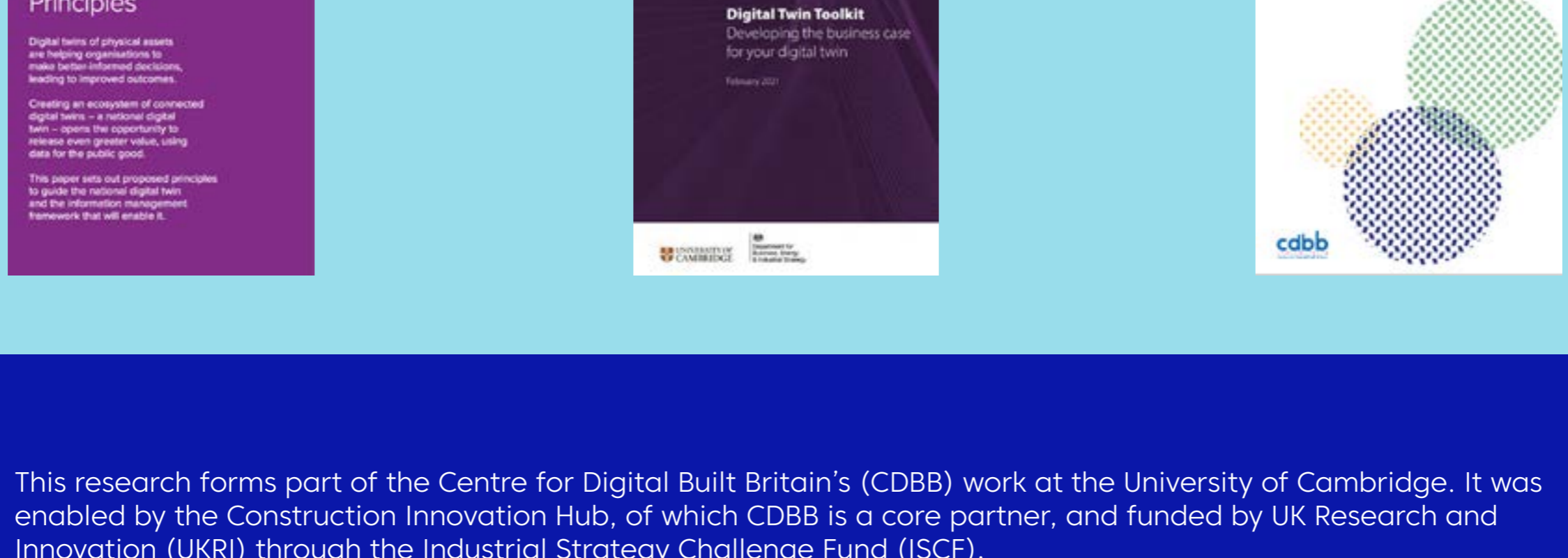
But by developing a prototype and sharing your experience, you're starting to fill some of those gaps!

Getting started on your first digital twin

To explore all of the Digital Twin Journeys research projects and outputs, visit the home page.

Staffordshire Bridges	Sensors and Sensibility	Satellites for Remote Sensing	Creating value from high-volume built environment data
	Understanding the information need – a bridge to better information management		Digital Twins from Space
West Cambridge Digital Twin – Institute for Manufacturing	Data Ingestion	Smart Hospital	The journey to the smart hospital of the future
	Data for asset managers		Ecosystems of services enabled by connected digital twins
West Cambridge Digital Twin – Computer Lab	Training a Computer to See	Project OAK	Playing the digital twin ethics game
	Coffee Time		

Other key resources

The Gemini Principles

Digital Twin Toolkit

An integrated approach to information management

cdbb Centre for Digital Built Britain

CONSTRUCTION INNOVATION HUB

UKRI UK Research and Innovation