



Material Passports

To address the Climate
Emergency, we believe that
a Circular Economy is a
necessity, not a choice

This document sets out
our manifesto for Material
Passports, with an ambition
to increase material reuse in
existing buildings



**Current construction
and demolition
practices are not
circular**

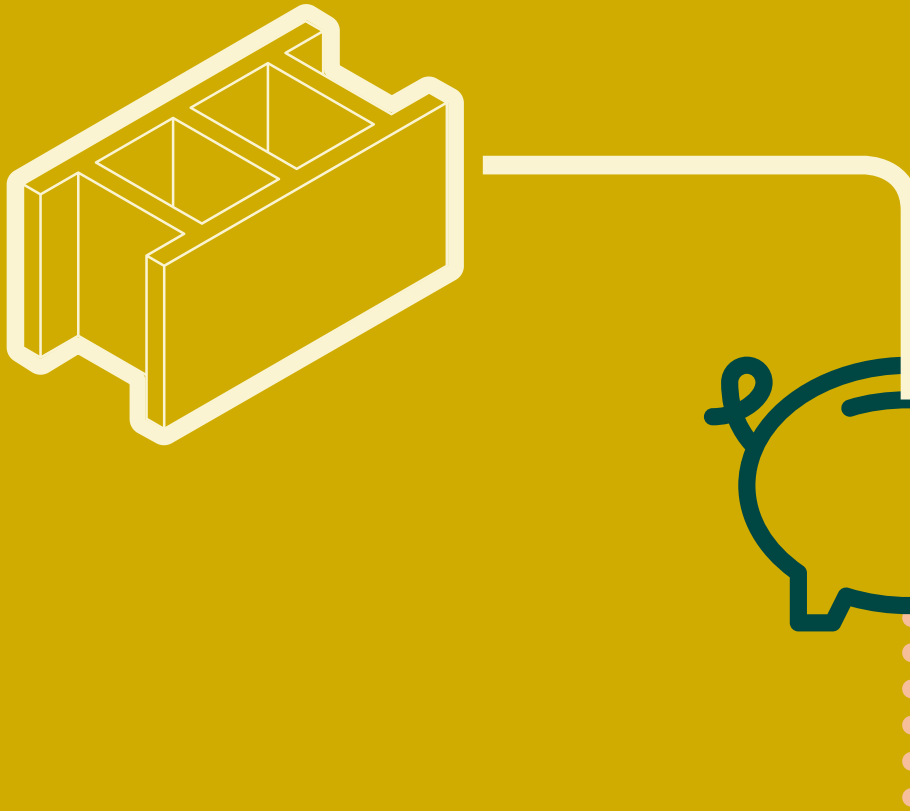
**they produce vast
amounts of waste,
62% of the UK's total
in 2016¹**

¹<https://www.gov.uk/government/statistics/uk-waste-data>

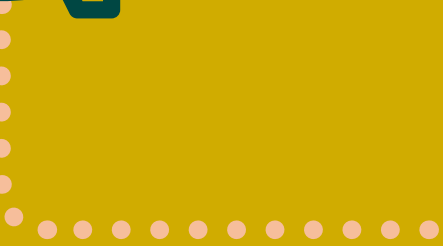
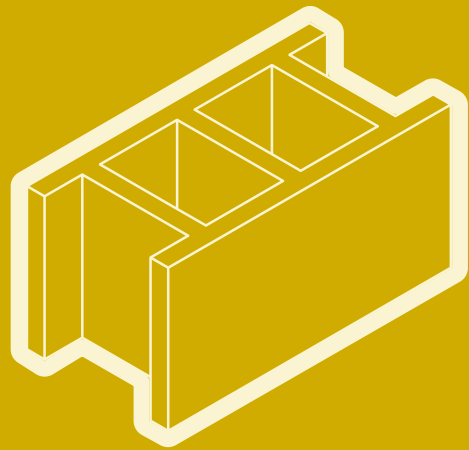
**With this research
we aim to reduce
the amount of
waste produced by
construction**

**by encouraging
deconstruction and
material reuse**





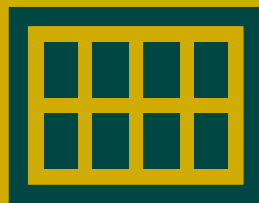
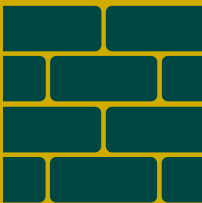
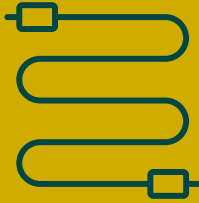
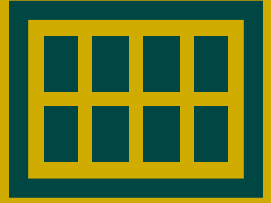
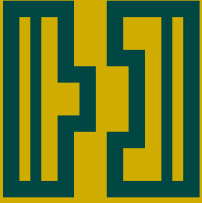
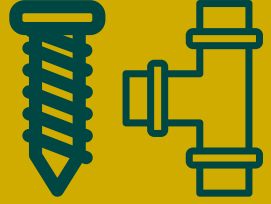
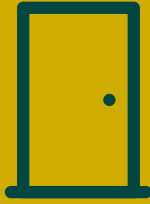
it all starts with
treating buildings as:
Material Banks





Material Banks

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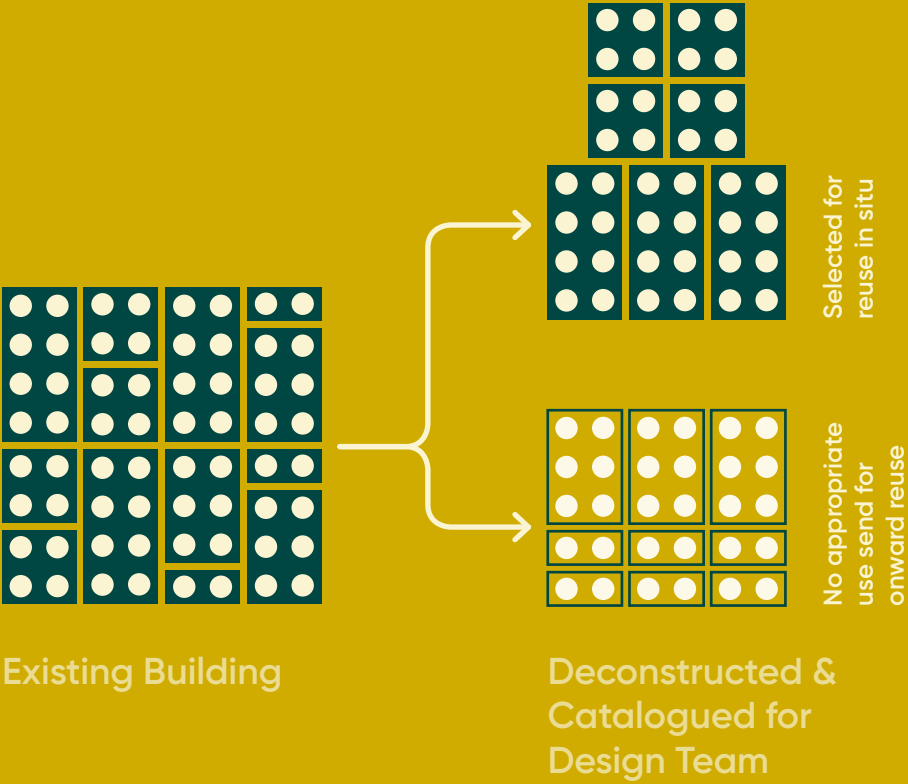


**Treating Buildings
as Material Banks**
is seeing them
as repositories
or stockpiles of
valuable, high
quality materials
that can easily be
taken apart and
recovered²

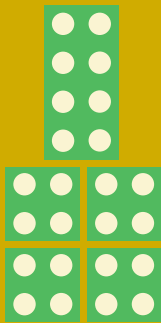
EU BAMB 2020 research group

² <http://www.bamb2020.eu/topics/blueprint/vision/>

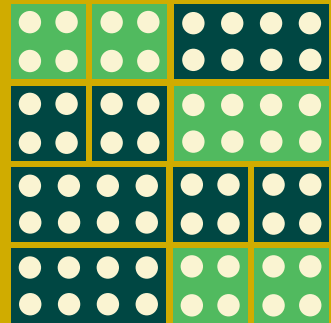
How can we manage the bank's material assets?



Our approach to reuse is similar to building with Lego



Additional
Materials Sourced



Completed Building



Barriers to Material Reuse

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There are a few reasons why materials are not currently being reused



Cost

It's typically cheaper to demolish and buy new, rather than deconstruct and refurbish



Design

Contemporary
construction favours
chemical fixing
over mechanical

Making it time
consuming to
remove materials
and often damages
them in the process



Risk

There is often a lack of knowledge about an existing material, and therefore a lack of confidence in it

How can we trust the material will perform as we need it to?





Material Passports

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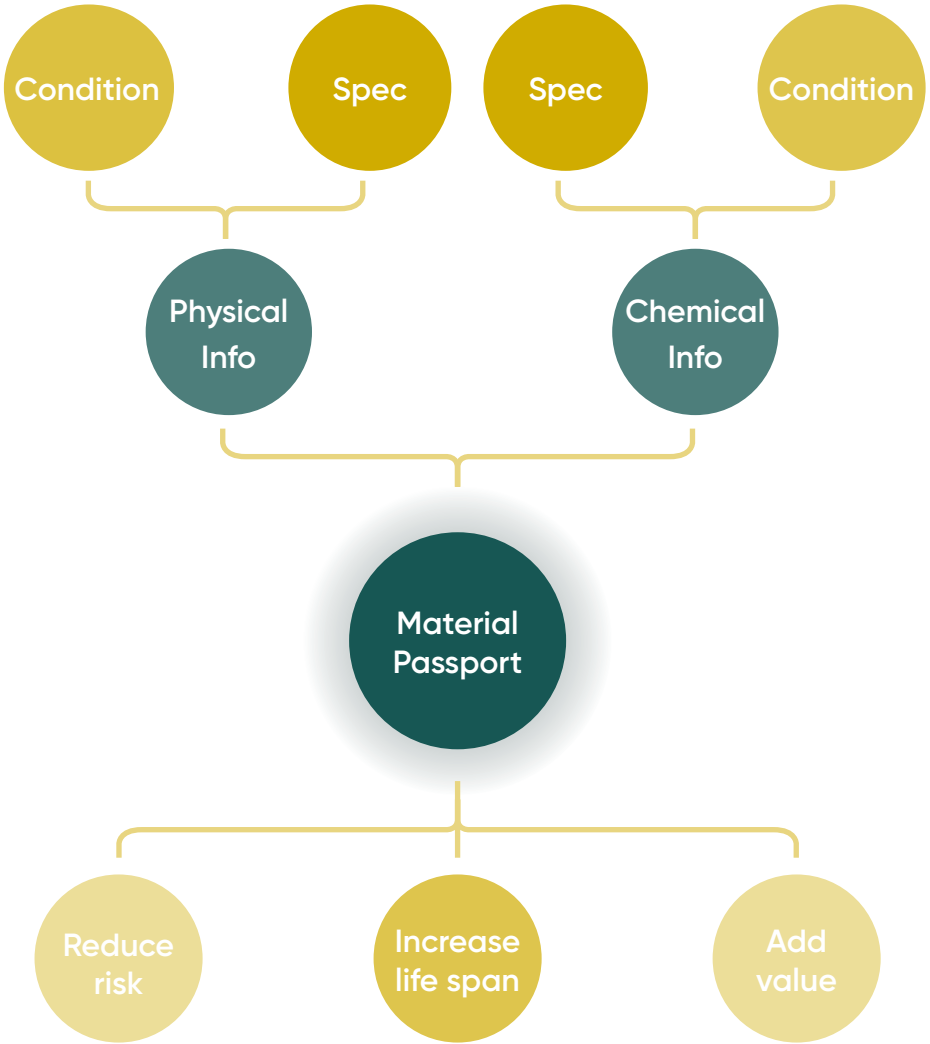
Material Passports

**Waste is a material
without an identity**

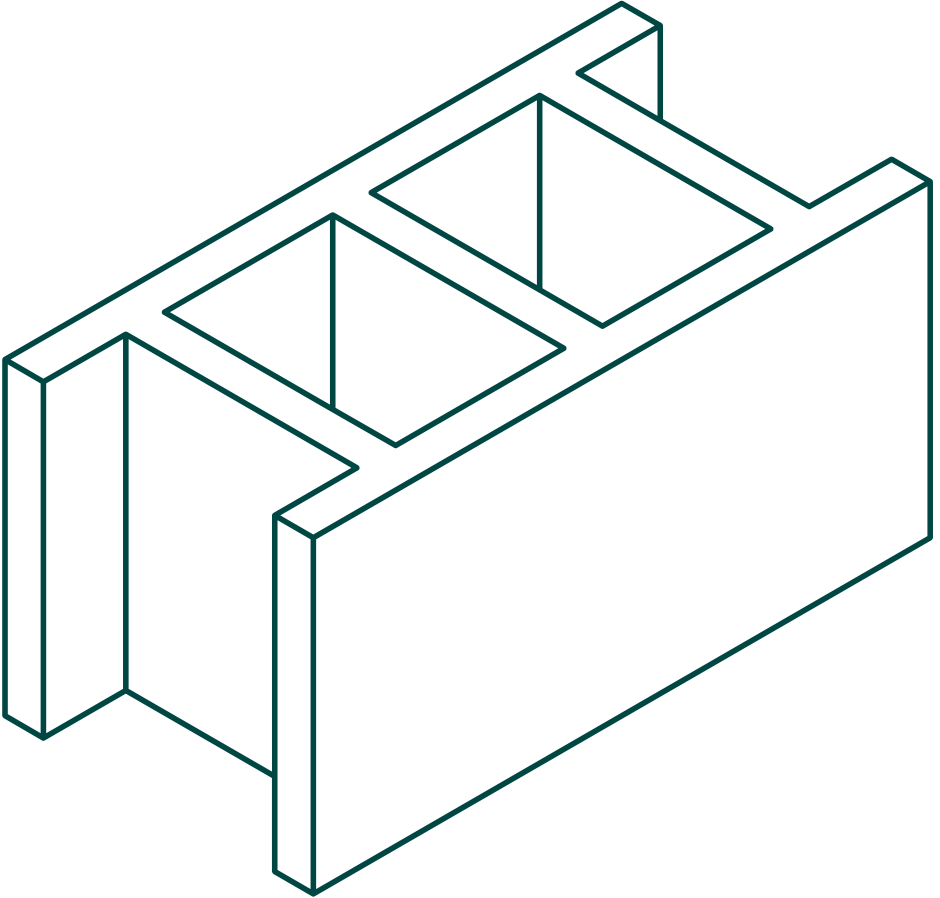
Thomas Rau

**A passport gives that
material an identity**

**Knowledge about a material
gives us confidence in it,
enabling successful reuse**



Material Passport



Unique Identifier:

BLK-X-00001

Name:

Hollow Block

Material:

Concrete

Dimensions (WxHxL):

215 x 215 x 440

Method of Fixing:

Cementitious mortar

Date of Manufacture:

04/2018

Place of Manufacture:

United Kingdom

Installed:

10/2020

Maintenance History:

N/A

Performance grade:

Band A

Aesthetic grade:

Band 1

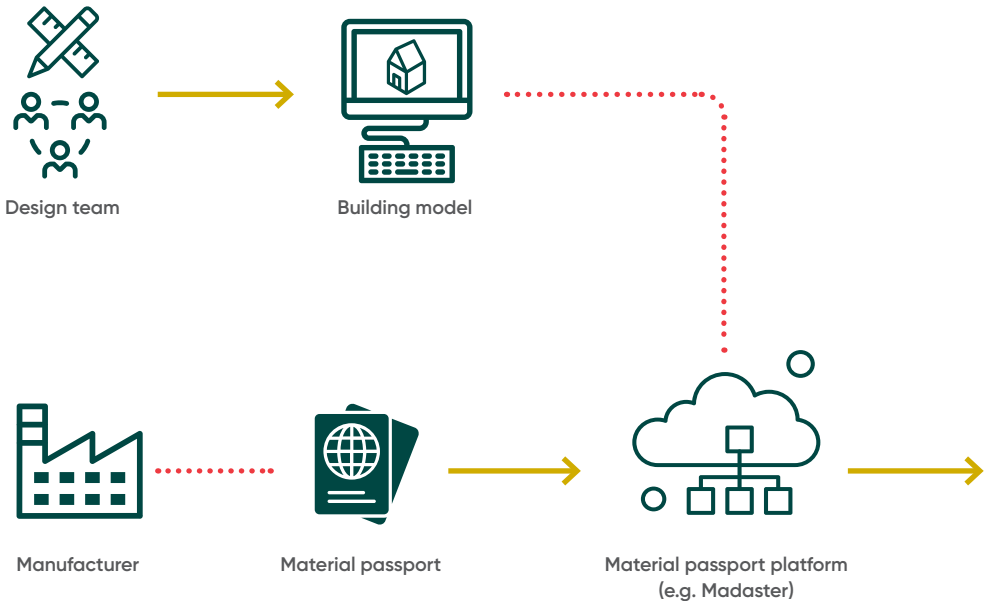
Existing approaches

Existing Research

The EU Buildings as Material Banks (BAMB) project has produced the largest body of research for Materials Passports to date, their work has been adapted into commercially available platforms such as Madaster. Here, IFC files (BIM models saved into an archive format) can be uploaded onto a

platform and materials contained within the model are tagged to create a register.

This register is linked to live commodity values, to give a real time and predicted future value of the materials in the project.



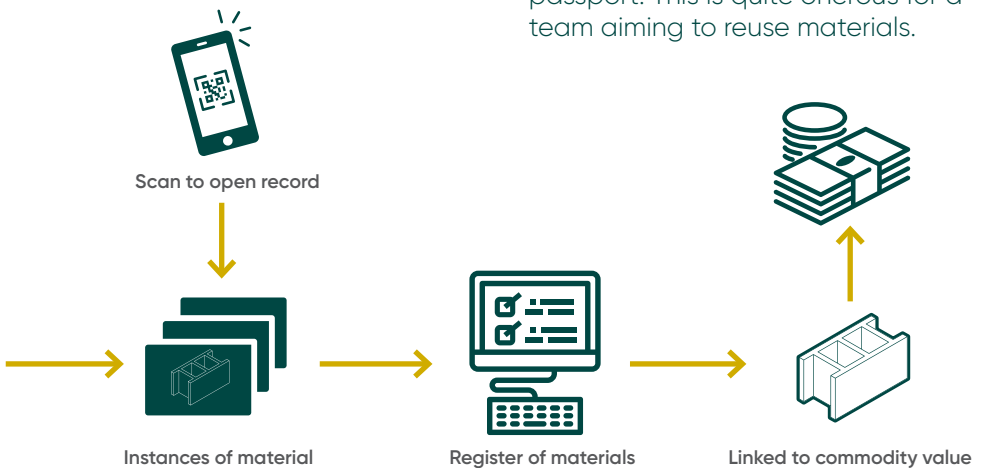
Challenges with the Existing Approach

This approach is suited to a completed project, and has the advantage of applying an actual value to the materials.

However, it is less helpful for integrating with the iterative design process as it uses a copy of the building model. This detaches the information from the live file. Any future uploads must start the tagging process from scratch.

We believe that there is value in being able to access data during the design process, as it encourages material reuse in the new project.

Furthermore, these platforms are best suited to projects utilising 'new' materials, as it is set up for manufacturers to produce the material passports. In scenarios where these don't exist, such as an existing material, the design team must produce the material passport. This is quite onerous for a team aiming to reuse materials.



Our approach

Our strategy has been developed to tackle the challenges associated with the existing approaches. We propose that the Material Passport is the user interface, rather than an input.

Instead of creating a platform which tags instances of a material in a model, we suggest that the Material Passport is a record, reading a Material Database. This database has a bidirectional link to the BIM Model during design, but can also be connected to Facilities Management software during future operation.

Physical tags on the built components will consist of a QR code or RFID tag for active elements. When scanned, these will open the relevant record within the database.

This allows the reader to filter information relevant to them, and also input new information such as maintenance or replacement notes.

If desired, a copy of the model could be uploaded to Madaster to generate the financial data, as part of a wider valuation exercise.



Existing Building to be redeveloped



Building as Materials Bank
Today



Material identification

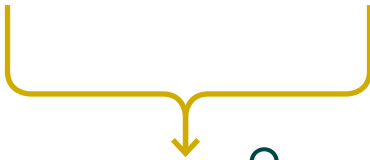




Future release of materials
Year 60



Redeveloped project
Year 2



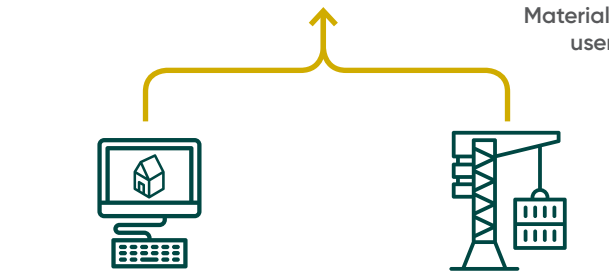
Materials database



Materials passport is a user interface



Scan physical tag



Design team building model
Tomorrow



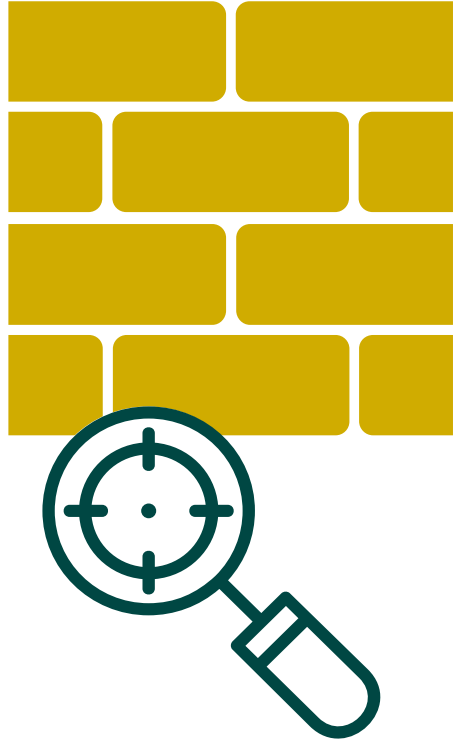
Salvaged materials
Year 1

Material Identification

For most existing Buildings as Material Banks, it is unlikely that we will have sufficient data records to assess the reuse potential of the existing materials.

We recommend that a series of comprehensive surveys are carried out at an early stage, to identify the existing materials within the Material Bank. This allows for informed design decisions to be made.

'A guide to deconstructing buildings for Circular Reuse' has been produced by our collaborators Elliott Wood, to support this work.³

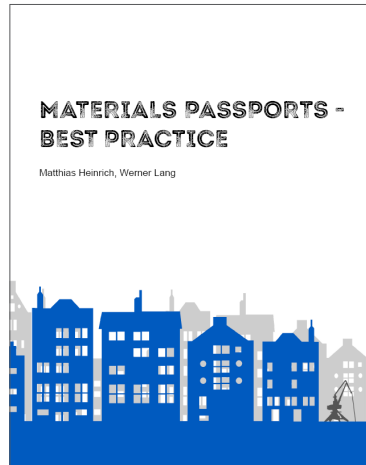


³ <https://online.flippingbook.com/view/915371497/>

The EU BAMB Material Passports Best Practice guide⁴ provides an excellent starting point for teams.

The suggested data to be collected and recorded is extensive and can seem overwhelming.

We prioritised the information that we needed and used this to set up our database.



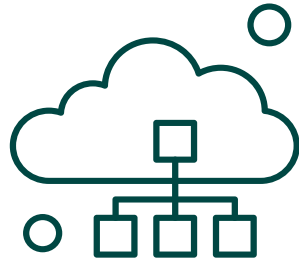
⁴<https://tinyurl.com/tw9mv2nz>

The Material Database

Having investigated a number of options, we opted for an external database. This database connects to the 3D model via a bidirectional link, as populating the 3D model with that much data would cause an information overload.

However, it would be really helpful to have critical information such as material type or age, brought into the 3D elements.

We recommend that Material Passporting is carried out along with the implementation of BIM, to ISO Standard 19650-1/2. BIM offers a standardised process to manage large quantities of data. It also ensures a higher quality 3D model and potential for a digital twin.

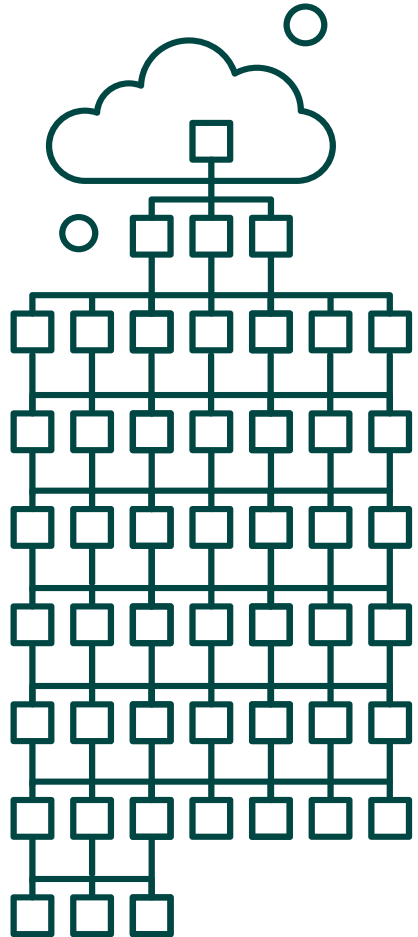


The material database is the core of the circular process.

For the design team, it captures information from surveys, from post deconstruction surveys and from as-builts.

For operations teams, it provides a single location to record or link maintenance information to O+Ms.

It grows as the project evolves.

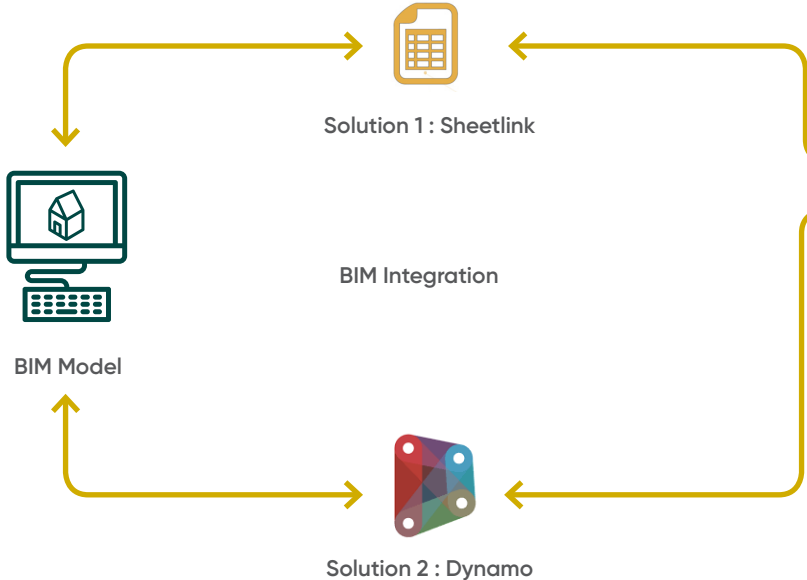


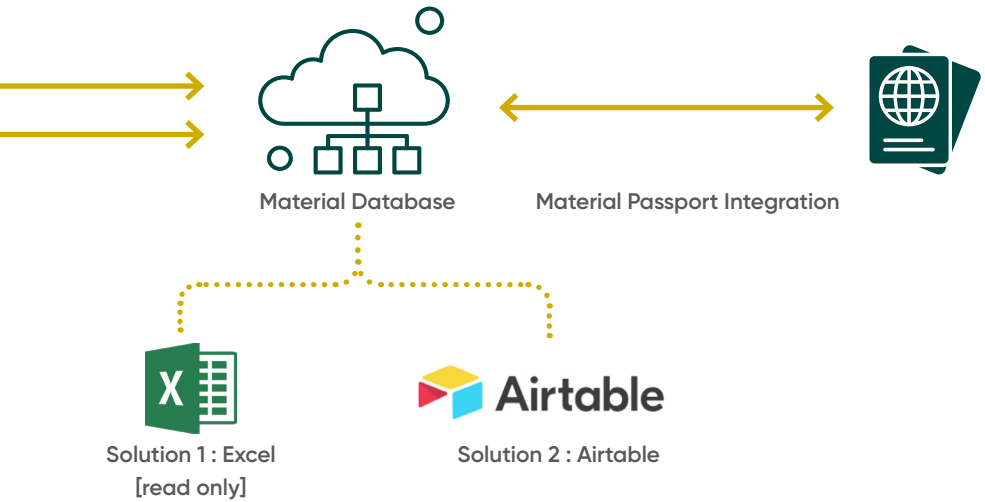
Implementation: Overview

Set up a Material Database.

Connect it to the BIM model.

Develop a Material Passport user interface.





The Tools Available



Tool 1 - Implementation Guide

This guide provides step by step instructions on how to get started, and offers more detailed explanations about the technical challenges that Revit creates, and how to get around them.

Tool 2 - Naming Conventions

To facilitate cross referencing between the database, revit file and physical tags on built assets, we have implemented a human friendly naming format. We have chosen to adopt and expand upon the Building Device Naming Standard.

We have included project site locations to help track material flows at high level.

We advise against using any further location identifiers such as levels or zones that would normally be used in asset data population, as it is very likely that these will change and generate confusion.

Tool 3 - Shared Parameters for Revit

A Shared Parameters file contains the parameters included in the sample excel database. This can be used to expedite the Revit setup and to create consistency across project models.

Tool 4 - Dynamo Script for Revit

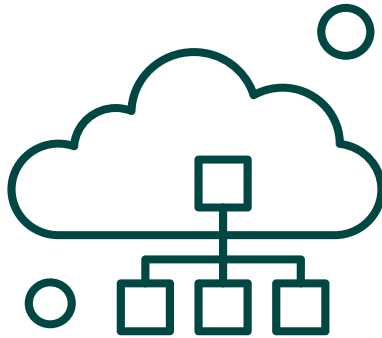
This is provided as a starting point for teams capable of implementing the Dynamo scripting for creating a bidirectional link between the Material Database and Revit.

Tool 5 - Sample Excel Database

For teams using Revit, this is a reference file only. The actual database file must be generated by Revit using either Sheetlink or Dynamo, as this sets up the bidirectional link.

For teams not using Revit, this can be the starting point for a standalone database.

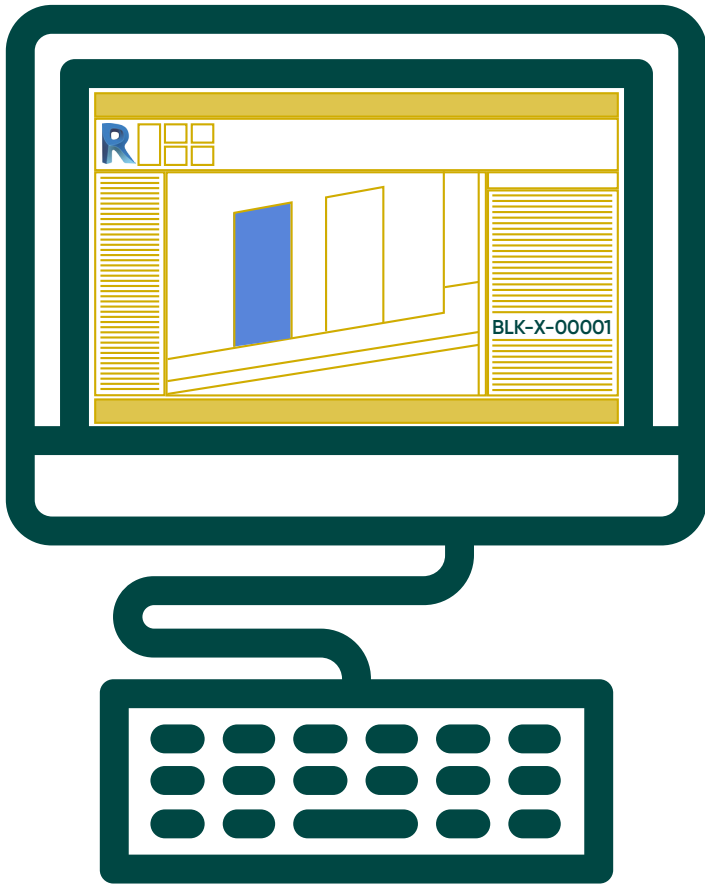
Passporting in action: design



Unique Identifier:	Name:	Material:	Dimensions (WxHxL):	Method of Fixing:	Date of Manufacture:	Place of Manufacture:	Installed:	Maintenance History:	Performance grade:	Aesthetic grade:
BLK-X-00001	Hollow Block	Concrete	215 x 215 x 440	Cementitious mortar	04/2018	United Kingdom	10/2020	N/A	Band A	Band 1
BLK-X-00002	Hollow Block	Concrete	215 x 215 x 440	Cementitious mortar	04/2018	United Kingdom	10/2020	N/A	Band A	Band 1
BLK-X-00003	Hollow Block	Concrete	215 x 215 x 440	Cementitious mortar	04/2018	United Kingdom	10/2020	N/A	Band A	Band 1

Assign Unique Identifier to Revit elements and populate database.

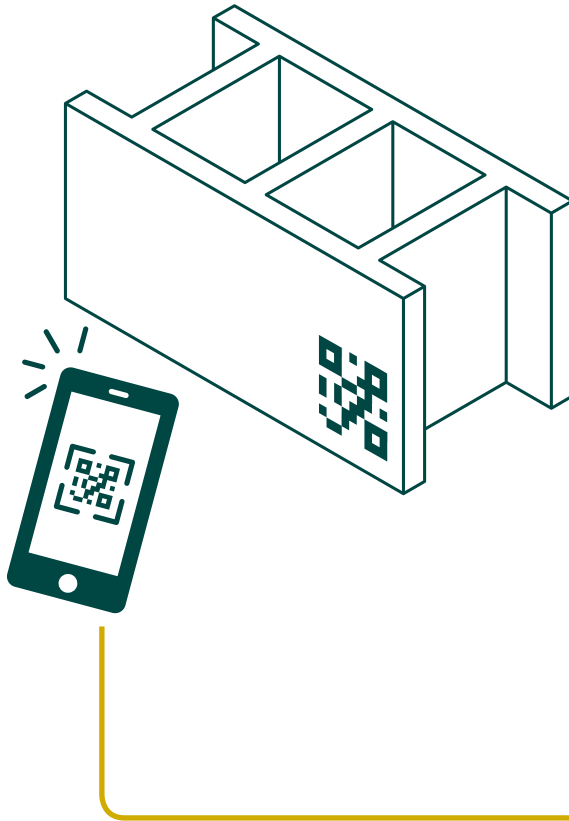


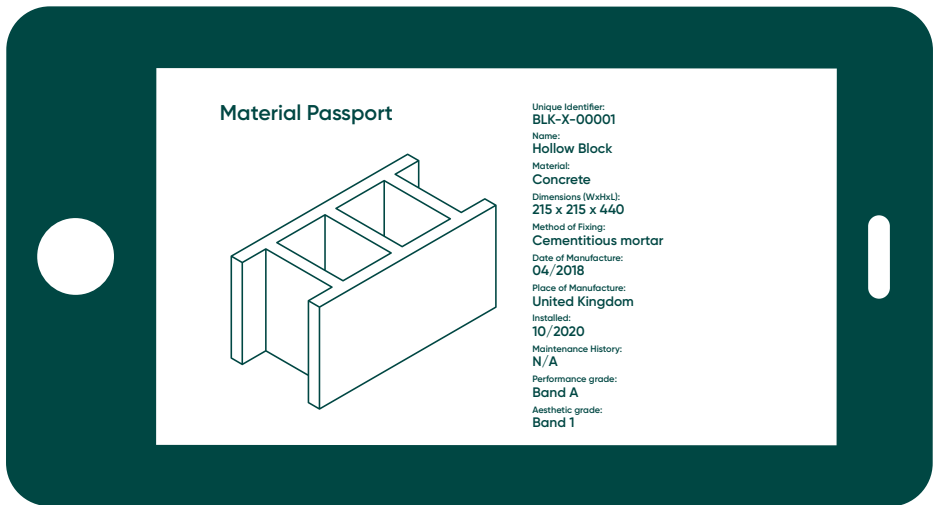


Passport data can be selectively imported into Revit from the database



Passporting in action: in use





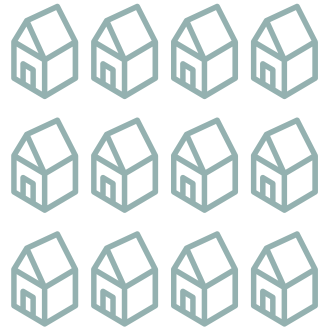
Material Passport appears on phone, which shows data for the material



Future opportunities

We acknowledge that this beta version is still quite a manual process, and isn't the most convenient solution for design teams yet.

The next step is to develop more sophisticated tools for the construction of the materials database and connecting it to it.



Wider Portfolio



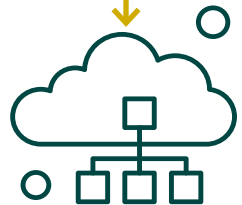
Interface with BIM Model



BIM Model



Material Warehouse



Material Database

Interface with BIM Model

This is the area of greatest opportunity. We imagine the creation of a Revit plug in to replace the Dynamo script. This would give greater control over the fields that are imported for each element category, and increase automation.

Material Warehouse

A technical challenge of phasing within Revit could be addressed by creating a virtual Material Warehouse. Deconstructed elements in the 'Existing Phase' are temporarily stored and reused in the 'New Construction Phase'

Material Database

We are in the process of creating a cloud based database system. This will improve functionality, allow for some automations and deliver an interactive Material Passport which can be accessed by scanning the physical tag in the building.

Interface with Wider Portfolio

Digital Twins have the potential to unlock greater information sharing across a portfolio. Linking or consolidating Material Databases of projects will support future material reuse and insight into real time value of each Material Bank.



Summary

Our goal was to develop an opensource methodology to Material Passporting for existing buildings, that would be accessible to design teams of all sizes and capabilities.

As an industry, we must do better, and the fastest way to achieve this is by sharing our knowledge and collaborating on meaningful solutions.

Therefore we invite you to implement Material Passporting on your project, please get in touch to join our network.

In return, all we ask is that you share your experience, findings and solutions back with us, so that the research can continue to evolve.

This is an exciting time, and we look forward to collaborating with partners as we advance towards a Circular Economy.





GROSVENOR

This research was part of the Grosvenor Britain & Ireland Innovation Project into Material Reuse.

grosvenor.com/materialreuse

Orms

Material Passports

elliottwood

Reuse potential of existing buildings

ARUP

Material Sourcing

HETA

Specifying for material reuse

Additional thanks to:

CIRCuiT: RE:London & Grimshaw, GDMP, Rotor, Twin&Earth

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