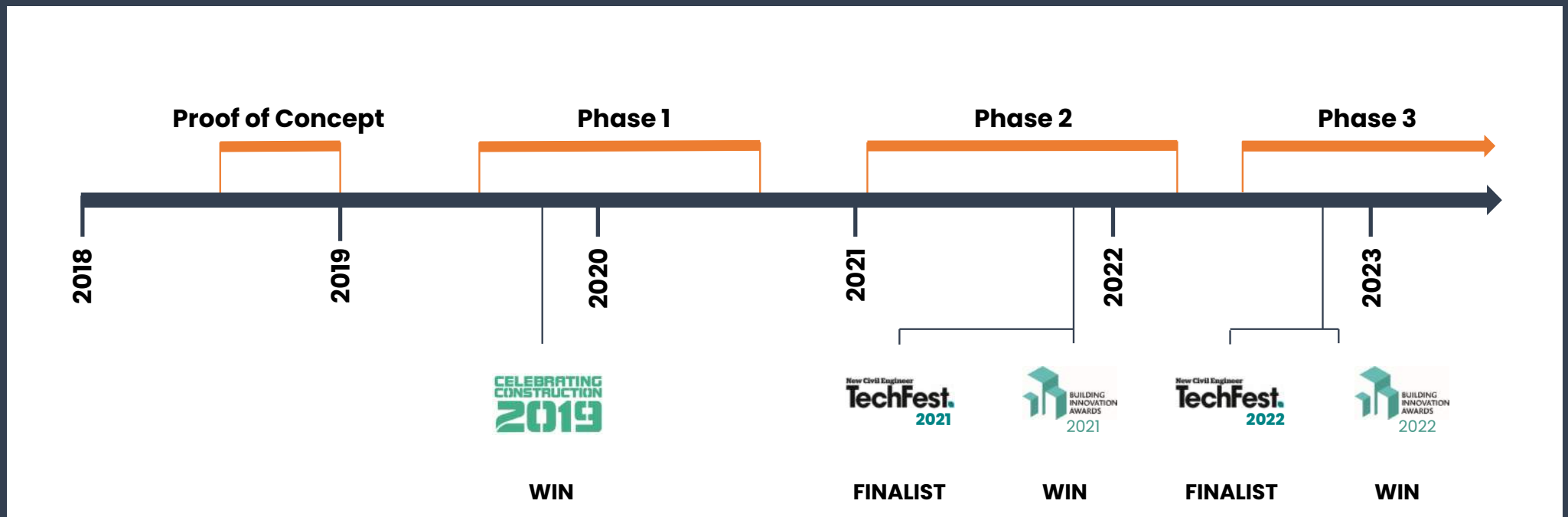


PANOPTIC BRIDGE MANAGEMENT

Capturing Network Rail's assets for better
management and maintenance



THE PROJECT



THE TEAM

Veronica Ruby-Lewis

Associate Director/Lead BIM Consultant

Amy Cheeseman

Head of Digital Capture



2018 – Present

- Digital capture
- Development of workflow and methodology
- Project management
- Algorithm development
- Development of asset visualiser
- Support of BCMI calculation integration



2019 – Present

- Machine learning for defect recognition
- Supporting development of asset visualiser
- Supporting development of algorithm
- BCMI calculation integration



2021 – Present

- Development of web based 360-degree virtual tour environment for examinations

A background image showing a bridge inspection scene. A surveyor in an orange high-visibility suit and blue helmet stands on the left, looking towards a bridge. A tripod-mounted surveying instrument is in the foreground. The bridge has a brick structure and a metal railing. A circular sign with '4.8m 16'0"' is visible on the bridge. The text 'SCOPE' is overlaid in white.

SCOPE

The challenges...

1. There are currently many different methods used across the business to manage and maintain these structures, with varying levels of efficiency.
2. Access for examination of visible and hidden structural elements can prove challenging.
3. Methods utilised are subjective.

PROOF OF CONCEPT WHAT WE DID

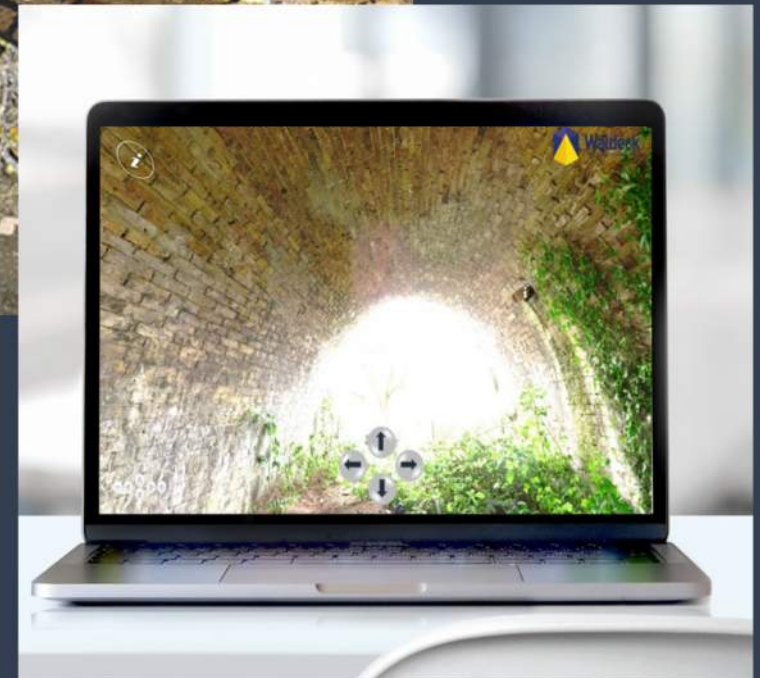
As Network Rail look to streamline their monitoring and maintenance of assets, Waldeck's Research and Development team were tasked to undertake an initial study on 6 brick built assets.

The task was to review digital means of inspection, and to develop a proof of concept which provided demonstratable results.



PROOF OF CONCEPT SURVEY OUTPUTS

- Colourised geolocated point cloud
- Panoramic imagery
- 360 degree annotated virtual tour condition reports



PHASE 1

- Expanded proof of concept works to further 44 structures
- Expanded to include concrete structures
- Further testing of environmental influences on data
- Machine learning for defect recognition



PHASE 1

Average 15 scans per structure



Average 250million points per structure



Night captures



Topside Drone and TLS Capture





D1

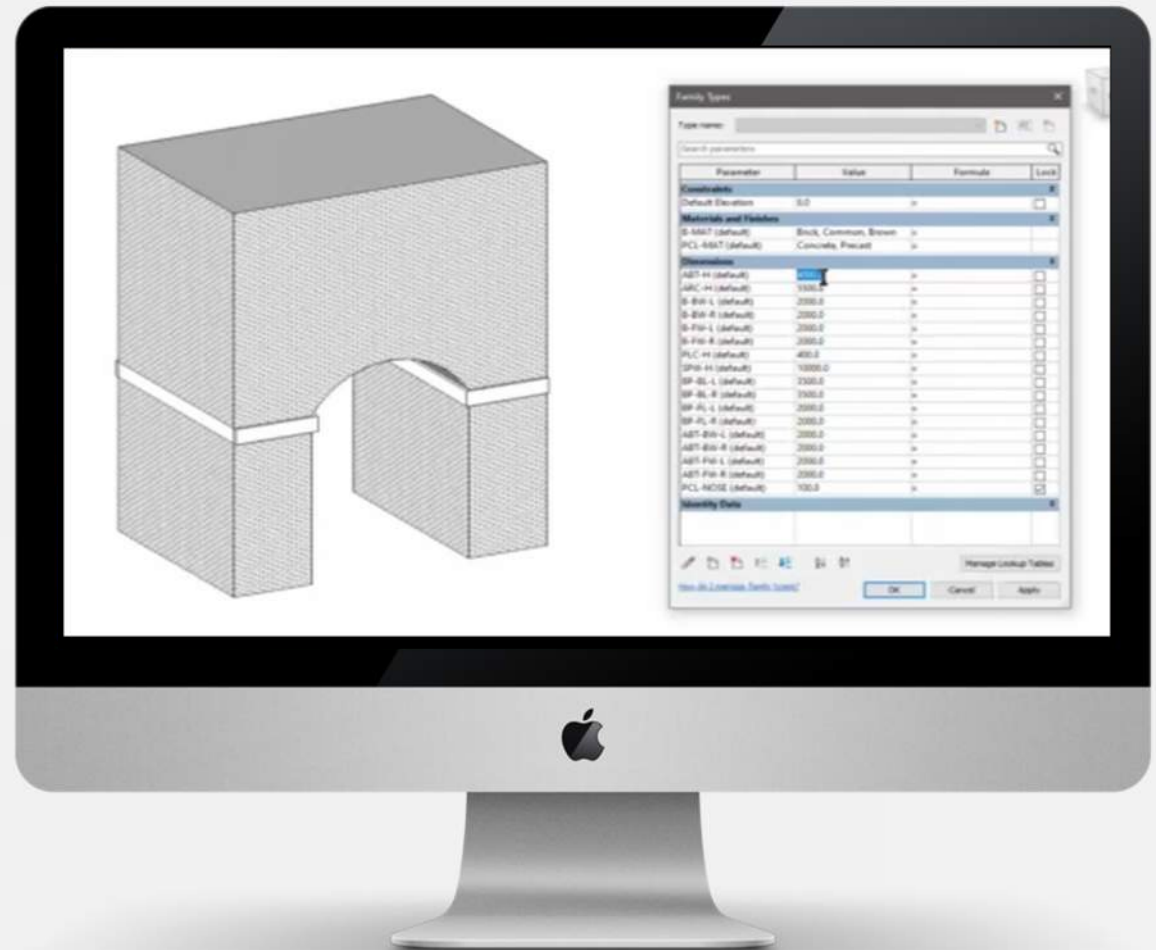
MODEL AUTOMATION

Deliverable D1 focussed on the production of 3D BIM models for each structure.

Model Automation

1. Implement BIM into the workflow.
2. All the bridge components fully intelligent and parametric.
3. Develop a single algorithm which works for typical bridge types.
4. Improve the application of the algorithm.

BIM Components:

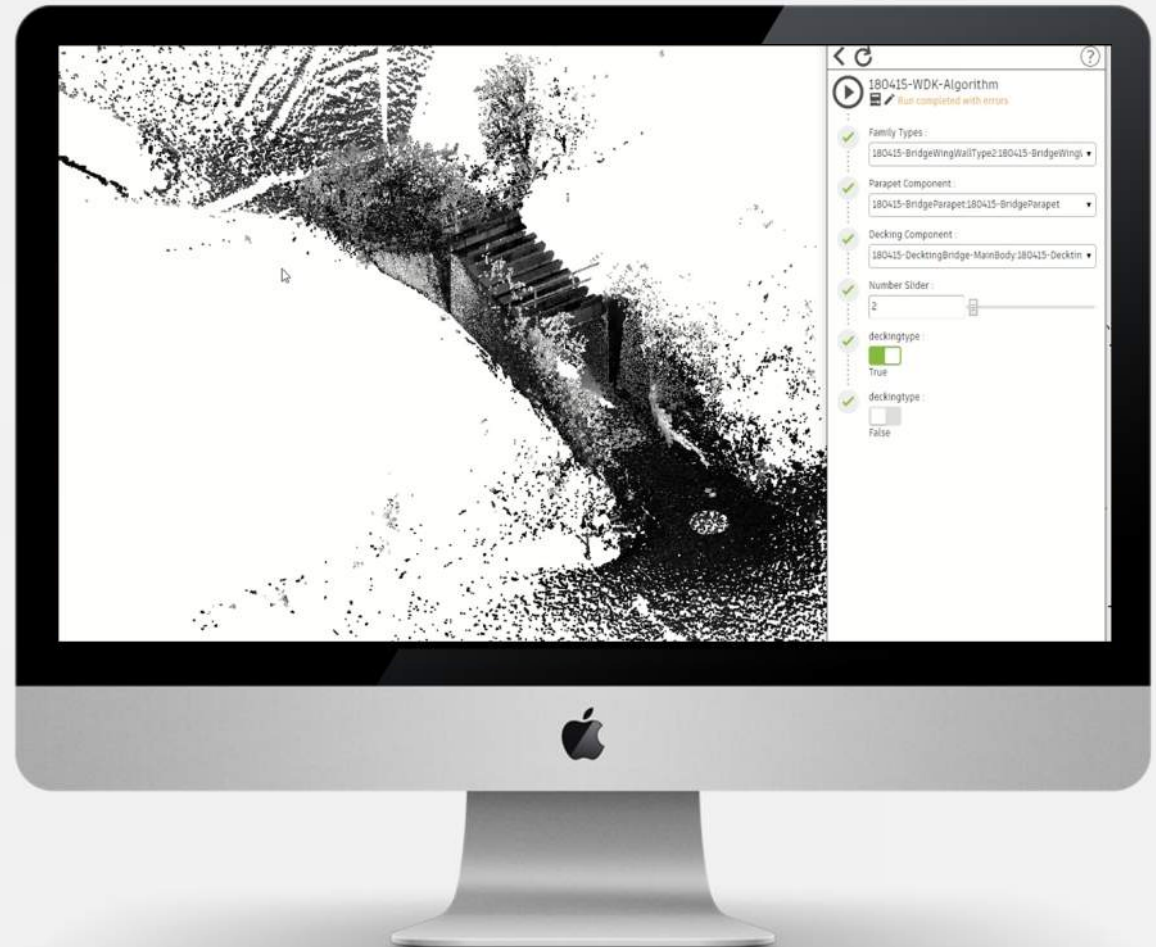


D1

Model Automation

- Utilised parametric components
- Semi-autonomous
- Works with raw point cloud – no editing/cleaning of points required

Algorithm Workflow:



The background image shows a construction or inspection site at dusk or dawn. Two workers in orange high-visibility suits and blue hard hats are standing in the foreground. Behind them is a large, multi-arched brick bridge. A surveying instrument is mounted on a tripod. Several circular signs with '4.8m 16'0"' are visible on the bridge structure.

D2

MACHINE LEARNING

Deliverable D2 focussed on the inspection and machine learning of each structure.

D2

Model Machine Learning Training Data Set (2)



**Vegetation
samples**

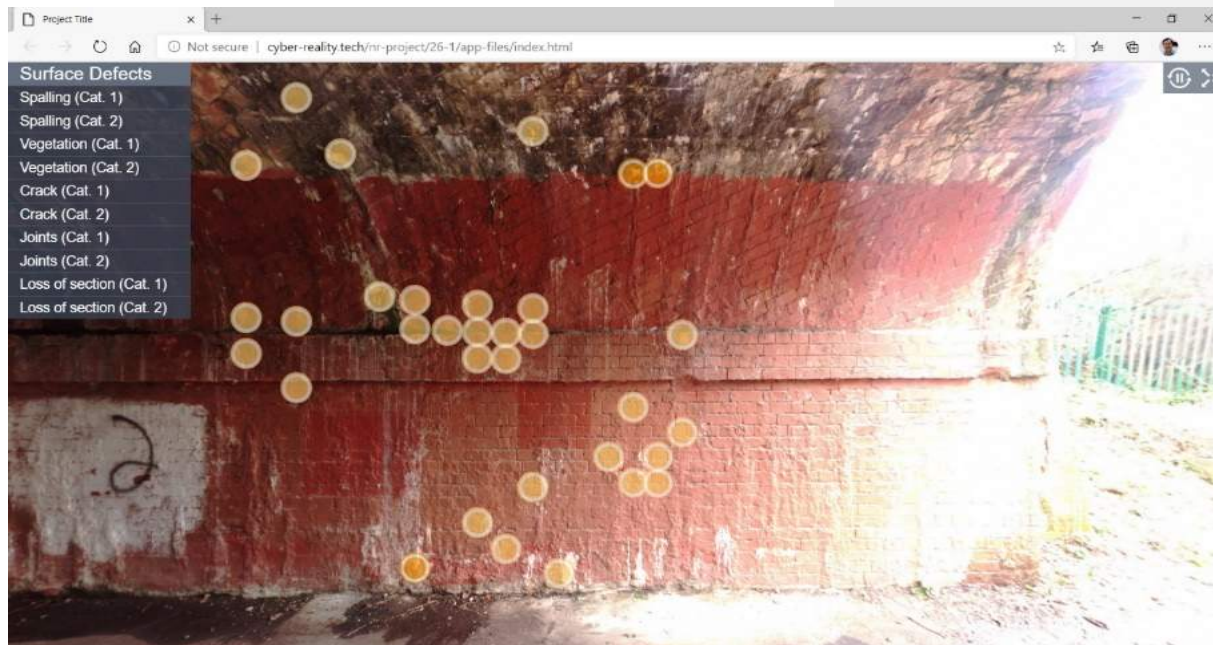


**Spalling
samples**

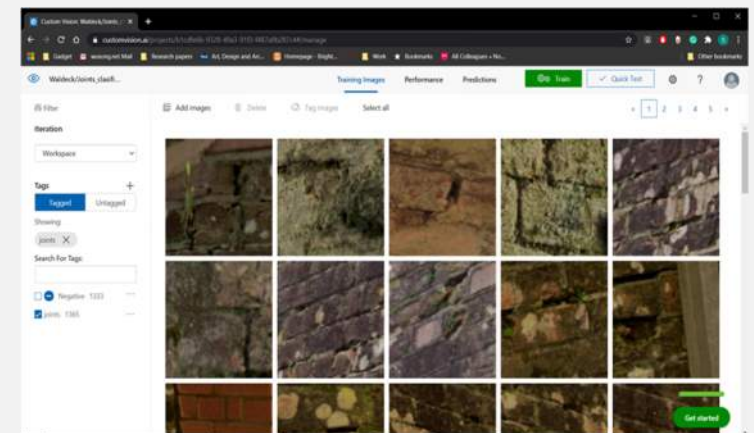
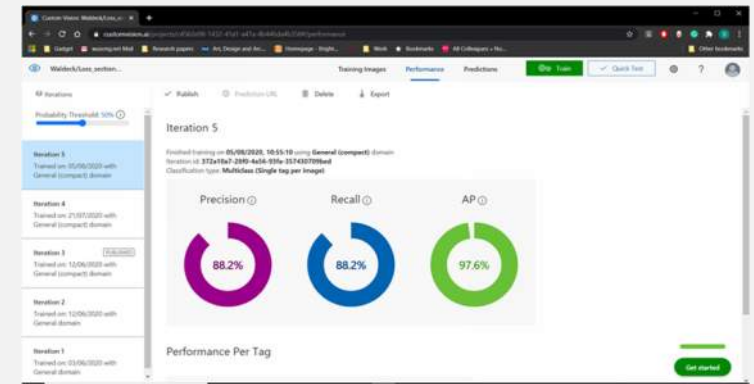
D2

Model Machine Learning

Defect detection using AI



WALDECK / NETWORK RAIL



The background image shows a large brick bridge structure under construction. Two workers in orange high-visibility gear and blue hard hats are in the foreground. A surveying instrument on a tripod is visible. The bridge has several arches and is surrounded by trees and a road. There are circular signs with '4.8m 16'0"' written on them.

D3

REPEATABILITY

Deliverable D3 documented the workflow for ongoing repeatability of the process.

D3

Repeatability, Environmental Influences & Scaling

Light Levels



Environment



Rain Intensity



Topside Data Set
Comparison



The background image shows a bridge with brick piers and a metal railing. Two workers in orange high-visibility gear and blue hard hats are standing in the foreground, looking towards the bridge. A surveying instrument on a tripod is also visible. There are height clearance signs on the bridge piers indicating 4.8m (16'0").

D4

ASSET VISUALISER

Deliverable D4 entailed the production of annotated 3D visual reports which provided a holistic view of the structure and its defects.

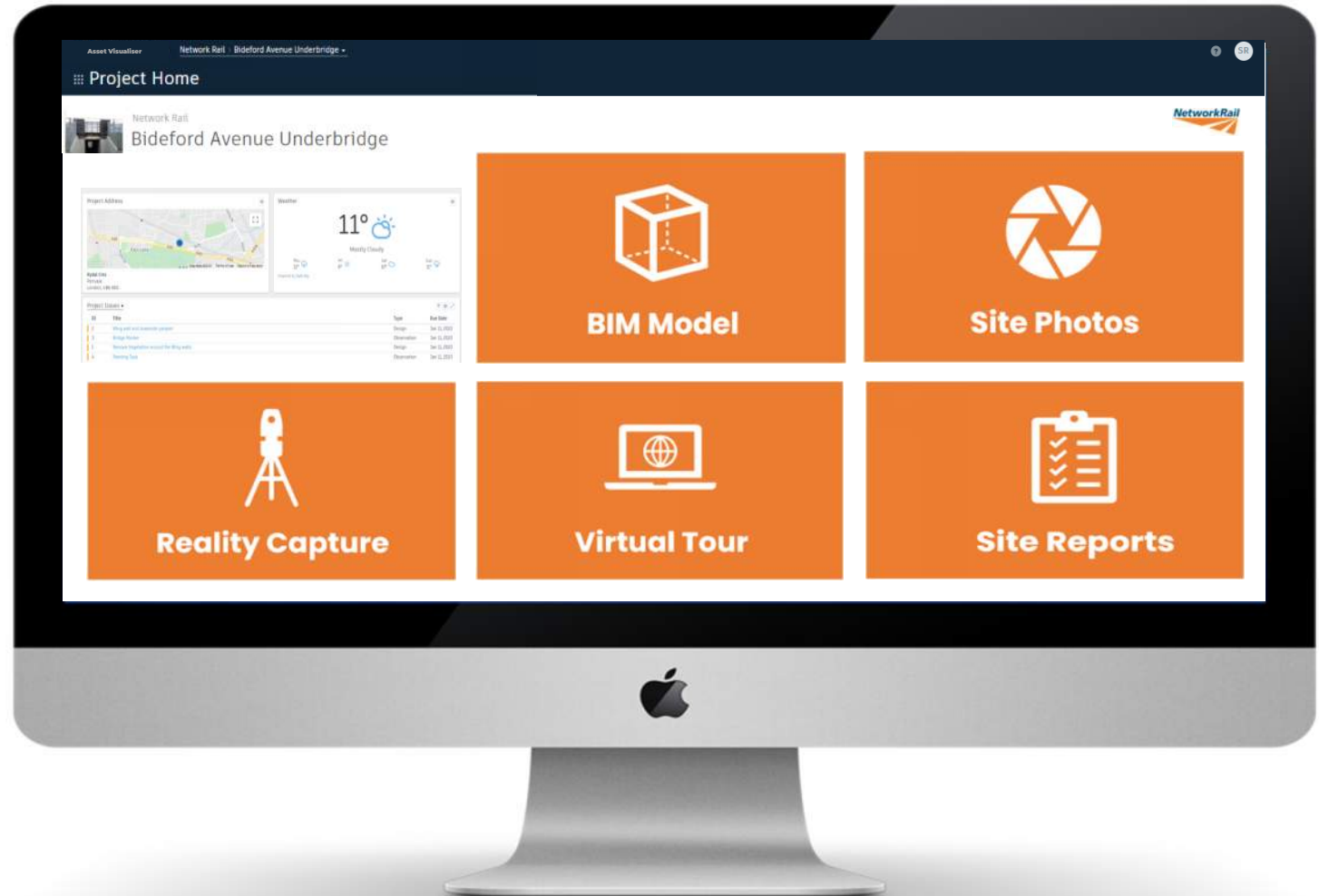
D4

Asset Visualiser



ASSET
VISUALISER
Prototype
Dashboard

WALDECK / NETWORK RAIL



D5

Survey Specification



The background image shows a large brick bridge with multiple arches. Two workers in orange safety gear and blue hard hats are standing in the foreground on the left. A surveying instrument on a tripod is positioned in the middle ground. Several circular signs with '4.8m 16'0"' are visible on the bridge structure. The scene is outdoors with trees in the background.

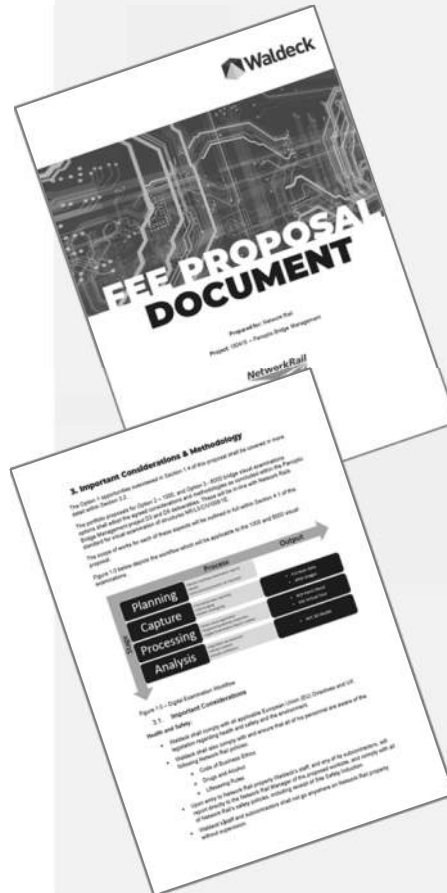
D6

PORTFOLIO PROPOSAL

Deliverable D6 was intended to provide a perspective on how this approach would be applied at a portfolio level of assets.

D6

Portfolio Proposal



	Case 1	Case 2	% cost of indicated fee
Number of structures to be surveyed over 52-week period	1000	1000	N/A
Assumed active weeks	50	40	N/A
Number of structures surveyed per week	20	25	N/A
Number of structures surveyed per day	4	5	N/A
Inspection personnel per day	4	5	33%
Data processing personnel per day	2	2.5	16.5%
Qualified Bridge / Structural Engineers per day	1.4	1.7	20.5%
Quality Control personnel per day	0.75	0.95	2%
Project Management personnel per day	0.5	0.625	2%
Technology Wear / Calibration, Accommodation, Travel & Subsistence costs	N/A	N/A	26%

PHASE 2

- Proof of concept solution for asset management, incorporating BCMI and 360-degree imagery captured from drones
- Data specification
- Trials – 3 viaducts in Wales





D1

AV REQUIREMENTS SPECIFICATION

Deliverable D1 focussed on the production of a detailed technical and functional specification of the Asset Visualiser

D1

Software Requirements Specification for AV



The background image shows a large brick bridge structure under construction. Two workers in orange high-visibility gear and blue hard hats are in the foreground. A surveying instrument on a tripod is visible. The bridge has several arches and is surrounded by trees. There are circular signs with '4.8m 16'0"' written on them.

D2

ASSET VISUALISER

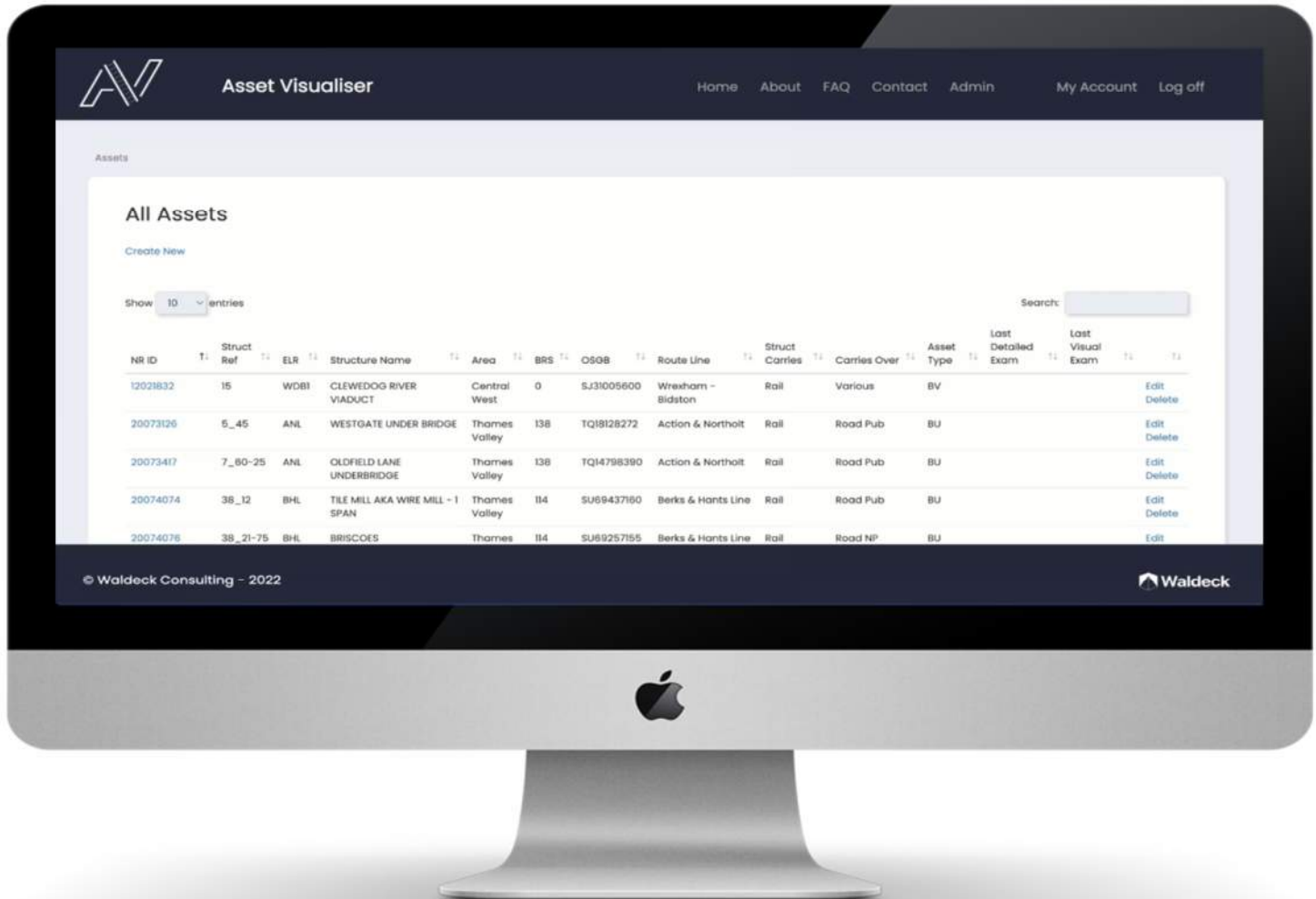
Deliverable D2 entailed the development of the Asset Visualiser Prototype to a proof-of-concept stage.

D2

Asset Visualiser



ASSET VISUALISER
Proof-of-Concept
Dashboard



The background image shows a bridge inspection site. Two workers in orange high-visibility gear and blue hard hats are visible. One worker is standing near a surveying instrument mounted on a tripod. The bridge has a brick structure with arches. There are height clearance signs on the bridge, indicating 4.8m (16'0").

D3

DATA SPECIFICATION

Deliverable D3 documented the data specification to facilitate the whole new approach for undertaking inspections via the Asset Visualiser.

D3

Data Specification

TLS



UAV



BIM Model



Meta Data



The background image shows a large brick bridge with multiple arches. Two workers in orange high-visibility clothing and blue hard hats are standing in the foreground on the left. A surveying instrument on a tripod is positioned in the middle ground. Several circular road signs with a red border and black text indicating '4.8m' and '16'0"' are visible on the bridge structure. The scene is set outdoors with trees and a clear sky in the background.

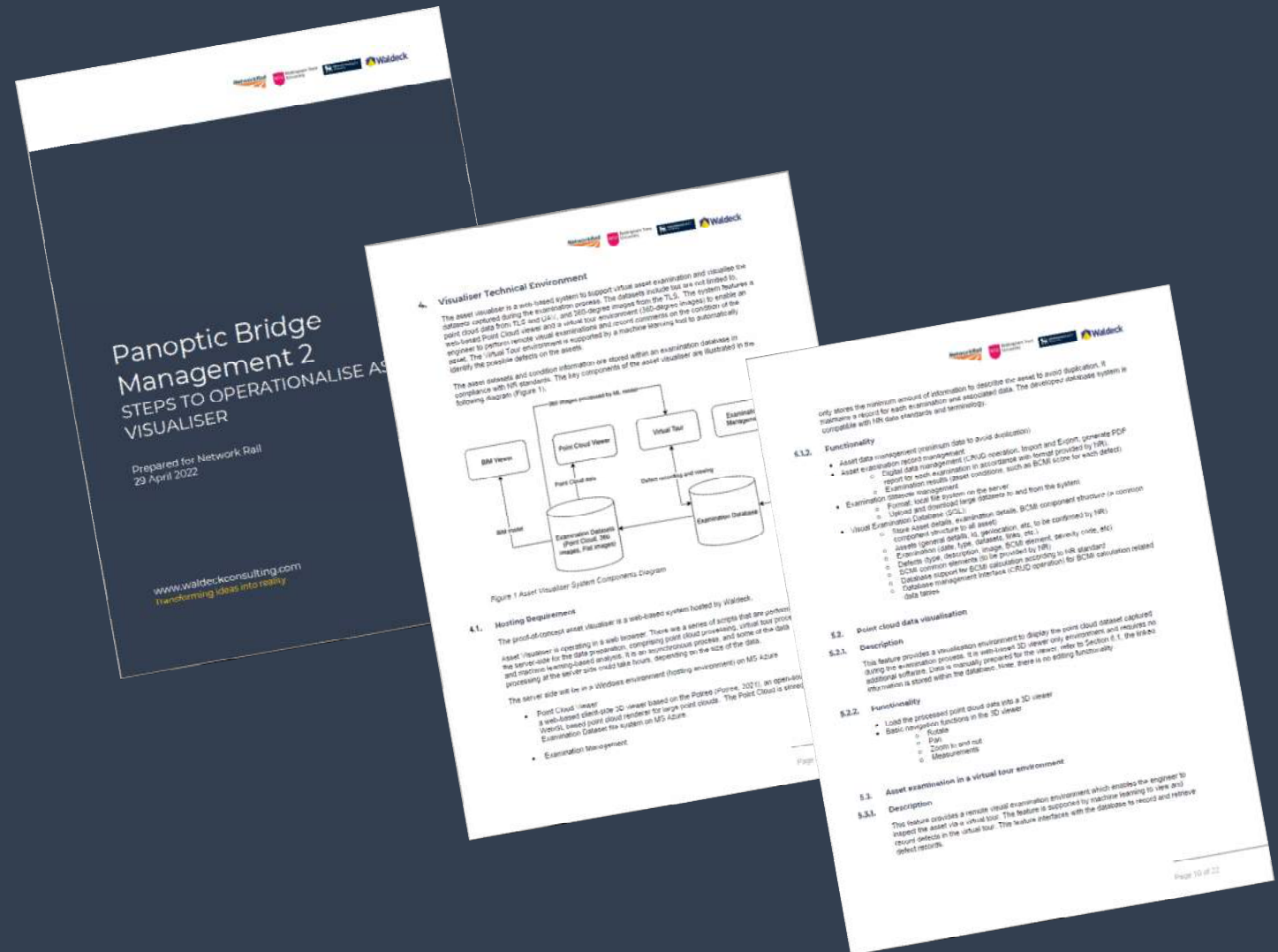
D4

OPERATIONALISE AV

Deliverable D4 entailed the production of a report identifying steps to operationalise the use of the Asset Visualiser

D4

Steps to Operationalise Asset Visualiser



The background image shows a bridge inspection site. Two workers in orange high-visibility gear and blue hard hats are visible in the foreground. A surveying instrument is mounted on a tripod. The bridge structure is made of brick and steel. There are clearance signs indicating 4.8m (16'0") clearance. The scene is dimly lit, suggesting dusk or dawn.

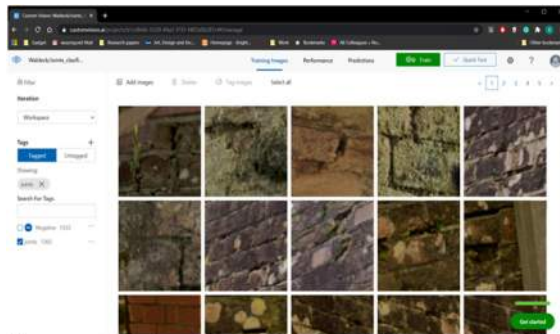
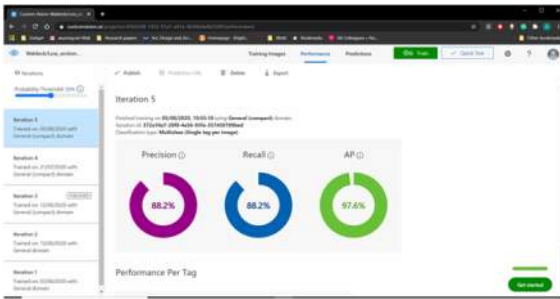
D5


REPEATED EXAMINATION

Deliverable D5 involved the repeated inspection of one structure from Phase 1.

D5

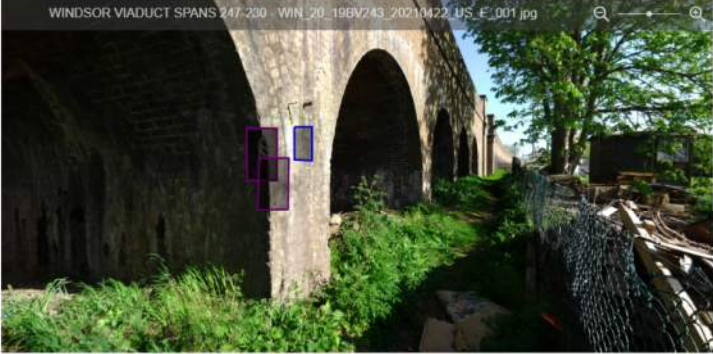
Repeated Examination



 Virtual tour - Previous examination results (BETA) Hello admin@test.com Exit

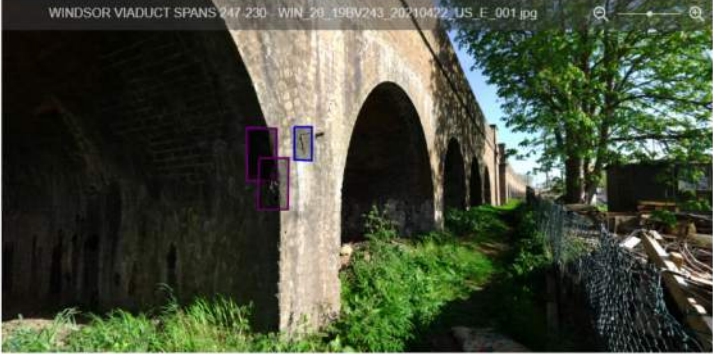
Current Examination - 87 - 2021-12-14

Image WIN_20_19BV243_20210422_US_E_001.jpg - 1 defect



Previous Examination - 85 - 2021-12-13

Image WIN_20_19BV243_20210422_US_E_001.jpg - 3 defects

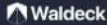


Please choose what you would like to do.

Please choose a dataset image for both the current examination and the previous. Once you've chosen an import option, you cannot change the dataset image unless you click cancel or finish importing defects

Note: the import is based on the pixel information so if the positions are not similar, the defect import will not be precise and will require revision in the main viewer

Import individual Import all Finish import

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Welsh Trials

Loughor

200m long



Spans across water and land



Boat used to capture spans



360 Camera Drone Capture

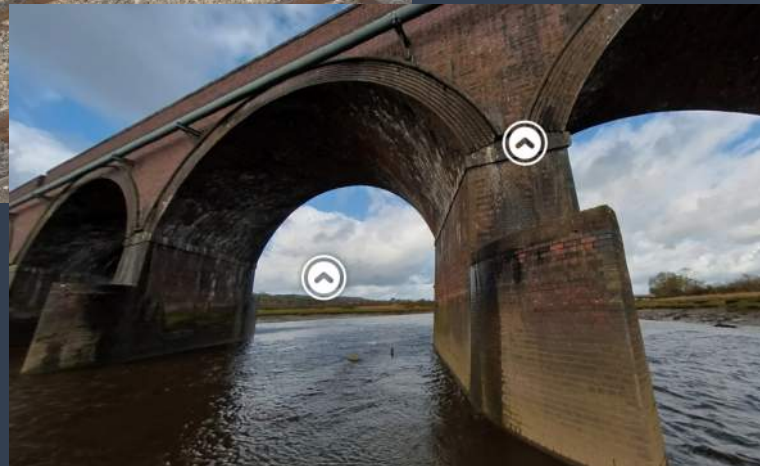


Welsh Trials

1.13billion
points



WALDECK / NETWORK RAIL



100 mega-pixel
photos



Boat used to
capture spans



PHASE 3

- Network Rail's long term vision for digital examinations is to integrate the visualiser into the asset management solution being built under the Intelligent Infrastructure Programme.
- Phase 3 of the Panoptic Bridge Management project provides Network Rail with an interim solution.





D1

Network Rail OSD

Deliverable D1 entailed the development of an outline design solution and associated documents for approval by the Network Rail IT Design Board

The background image shows a railway bridge with brick pillars and a metal railing. Two workers in orange high-visibility gear and blue helmets are in the foreground. A surveying instrument on a tripod is positioned near the bridge. Two circular signs with '4.8m 16'0"' are visible. The scene is dimly lit, possibly at dusk or dawn.

D2

AV Version 1.0

Deliverable D2 entailed the development of the Asset Visualiser to a first trial version release to Network Rail.

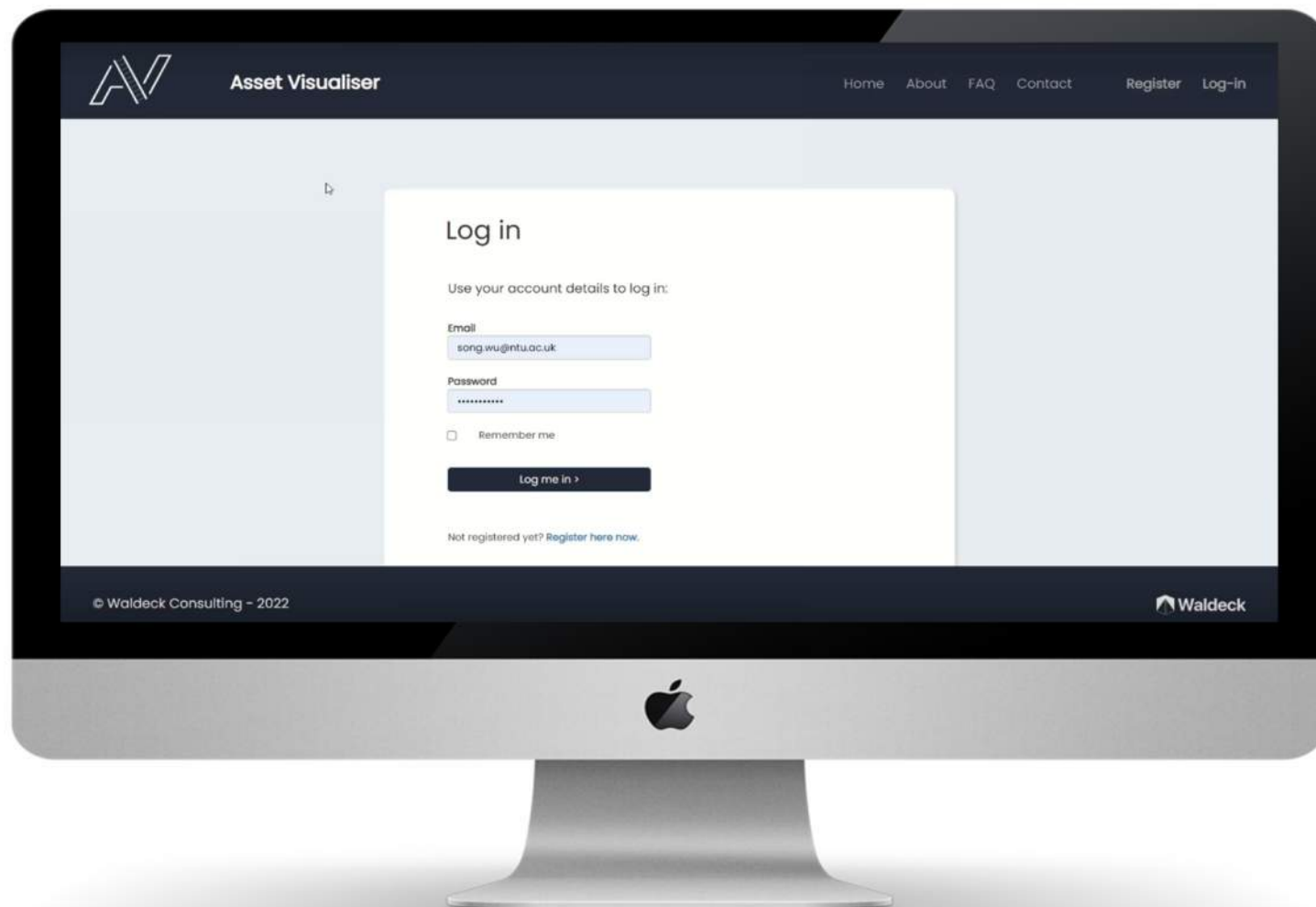
D2

Asset Visualiser



ASSET VISUALISER
Version 1.0

WALDECK / NETWORK RAIL



D3-D7

AV Version 2.0 and Integration

Deliverables D3 to D7 support the route trials, enhancement of the Asset Visualiser with new features and integration activities.



**Thankyou for your time and we hope
you found this presentation of
interest.**

