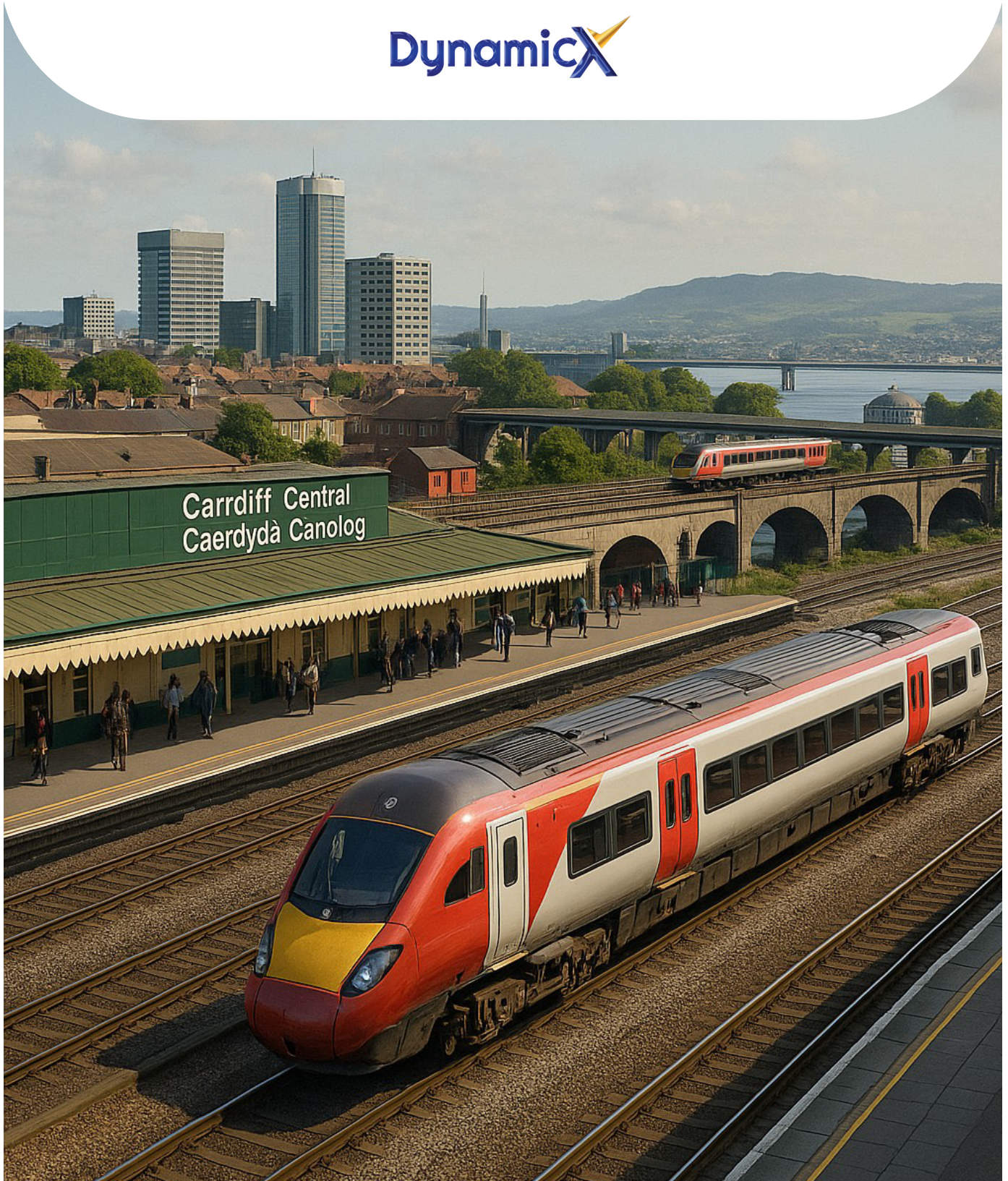


Beyond Models

USING VISUALISATION TO
UNLOCK CLARITY IN
COMPLEX RAIL AND
TRANSPORT PROJECTS

DynamicX



Executive Summary

Modern rail and transport infrastructure delivery is defined by complexity. From the early feasibility stages through to operation, multidisciplinary teams work across digital environments where engineering, environmental, social, and operational factors converge. Despite the use of BIM, GIS, and project scheduling platforms, visual and operational clarity often remains elusive. The challenge is not only to design and construct infrastructure efficiently, but also to communicate how systems interact, how disruptions are mitigated, and how stakeholders understand what is being built.

This paper explores how advanced visualisation, from 4D sequencing and real-time rendering to VR-based stakeholder engagement, can transform communication and coordination within multidisciplinary transport projects. Focusing on the Welsh context, where Transport for Wales (TfW), Network Rail, and local authorities are driving a new era of sustainable connectivity, it outlines a framework for consultancies to adopt visualisation as an enabling layer across design, construction, and operational planning.

Understanding the Multidisciplinary Environment

The rail and transport ecosystem is inherently multidisciplinary. Projects bring together civil, structural, M&E, track, signalling, and systems engineers, alongside planners, environmental consultants, and operators. Each discipline carries distinct data sets, terminology, and objectives. The integration of these domains is managed through frameworks such as GRIP or PACE, which demand consistent coordination and communication between all parties.

Yet, while data integration has advanced, cognitive integration has not. Project teams may share a common model, but they rarely share a common understanding of how the project behaves in time and space.

Visualisation can bridge this gap, creating a shared environment that translates technical information into an experiential understanding of sequence, impact, and operational logic.

Typical Multidisciplinary Coordination Environment

- Inputs: BIM models, GIS data, programme schedules, traffic studies, environmental assessments.
- Interfaces: Design coordination, construction logistics, operational planning, stakeholder communication.
- Outputs: Visual simulations, stakeholder dashboards, and VR environments that represent integrated understanding.

In Wales, schemes such as the South Wales Metro, the Cow Wally Line upgrade, and Cardiff Central enhancements illustrate this complexity. Each involves multiple consultants, contractors, and asset owners operating under different digital ecosystems. For these projects, visualisation provides the common ground that unites technical and non-technical participants alike.

Core Challenges Across Disciplines

Interface Management

Every interface, between structures, track, utilities, and operational assets, represents a risk. Misaligned assumptions can result in rework, delay, and cost escalation. In multidisciplinary teams, engineers depend on each other's deliverables; a small deviation in one model can create cascading issues in another. Visualisation helps by providing a live, comprehensible environment for reviewing spatial and temporal conflicts.

Service Continuity and Accessibility

Maintaining public access and service continuity during works is central to railway and highway delivery. Replacement bus planning, temporary pedestrian routes, and disabled access considerations require precise coordination between designers, contractors, and operators. Traditional Gantt charts and text reports rarely communicate this effectively. Interactive 4D simulations can show exactly how passengers and traffic will move through different stages of work.

Asset Ownership and Governance

Transport schemes in Wales often involve layered asset ownership — Network Rail, Tfw, GWR, and local councils. Determining who owns what, and how each asset is affected by a construction sequence, is critical. A GIS-linked visual dashboard can spatially display these relationships, enabling better decision-making and accountability.

Stakeholder Communication

Public consultation remains a statutory requirement and a reputational factor. Complex engineering drawings and PDF packs often alienate communities. Visual storytelling — through cinematic flythroughs or immersive web dashboards — enables residents, councillors, and regulators to grasp the proposal quickly and engage meaningfully.

Environmental and Operational Impact

Noise, vibration, and visual intrusion assessments must be communicated clearly. Visualisation allows environmental consultants to simulate these effects in context, supporting mitigation and compliance discussions with both clients and regulators.

Dynamic X Approach: Turning Complexity into Clarity

Dynamic X operates at the intersection of technology, design, and stakeholder engagement. As a visualisation partner for infrastructure consultancies, the company provides a bridge between engineering precision and public understanding.

Its philosophy, *Turning Complexity into Clarity*, recognises that data alone does not create alignment; communication does.

Integration with Existing Workflows

Dynamic X does not replace consultancy tools. Instead, it extends them. The team integrates with:

- **BIM and CDE platforms** (Revit, Navisworks, ProjectWise, Vectorworks)
- **Scheduling tools** (Primavera P6, MS Project, Synchro)
- **GIS systems** (Esri, QGIS)
- **Rendering engines** (Unreal Engine, Twinmotion, 3ds Max)

By combining these data sources into a unified visual environment, Dynamic X creates outputs that can be viewed, explored, and understood by technical specialists and decision-makers alike.

Alignment with Project Lifecycles

Visualisation adds value across the full project lifecycle:

- **Concept & Feasibility (GRIP 1-2):** Contextual visualisation and stakeholder narratives.
- **Design Development (GRIP 3-4):** Interface reviews and design logic simulations.
- **Construction (GRIP 5-6):** 4D sequencing and logistics visualisation.
- **Operation & Maintenance (GRIP 7-8):** Accessibility modelling and asset demonstration.

Solution Frameworks Using Consultancy Terminology

Below are five solution frameworks structured to align with consultancy terminology and challenges. Each framework identifies where visualisation adds tangible value.

Design Coordination and Digital Integration

Challenge:

Design coordination across multiple disciplines (civils, structures, track, signalling, drainage, and utilities) often occurs through federated BIM models that lack temporal and experiential clarity.

Visualisation Solution:

- Merge design and schedule data to produce **4D models** showing construction sequence and spatial interface evolution.
- Support **Design Coordination Reviews (DCRs)** with real-time visual simulations.
- Use **Unreal Engine visual environments** for interdisciplinary coordination sessions.
- Enable consultants to visually validate **constructability** and **access routes** prior to issuing IFC models.

Outcome:

Enhanced interdisciplinary understanding, reduced rework, and smoother transitions between GRIP/PACE stages.

Interface and Utility Management



Challenge:

Uncoordinated utilities and third-party assets are major risk drivers. Understanding the physical and temporal relationship between utilities, civils, and track requires more than spreadsheets and static CAD overlays.

Visualisation Solution:

- Develop GIS-linked digital twins showing utility corridors, diversions, and protection zones.
- Use phased construction simulations to illustrate when and how utilities will be affected.
- Present to stakeholders like Dŵr Cymru, Openreach, or power providers to secure early agreement.
- Create visual dashboards showing “no-go zones” and interface risk maps.

Outcome:

Improved utility coordination and reduced clashes, saving programme time and avoiding costly change controls.

Construction Sequencing and Logistics Planning



Challenge:

Construction logistics are difficult to communicate through text. Teams need to visualise how plant, materials, and people move within constrained rail corridors or urban spaces.

Visualisation Solution:

- Build 4D sequencing animations linked to programme data.
- Show compound layouts, access points, and material delivery routes.
- Integrate possession planning to demonstrate operational access windows and safety zones.
- Create scenario-based simulations (e.g., night works vs day works) for planning submissions and stakeholder review.

Outcome:

Better planning of possessions and blockades, improved understanding by operators, and enhanced client confidence.

Operational and Accessibility Modelling



Challenge:

During works, maintaining passenger accessibility and operational continuity is vital. The public and operators need clarity on how they'll be affected.

Visualisation Solution:

- Produce **interactive route models** showing alternative passenger movements during disruption.
- Simulate **replacement bus operations**, signage, and accessibility routes for PRM-TIL compliance.
- Demonstrate **evacuation and crowd-flow** simulations for stations or interchanges.
- Visualise **handover-to-operation sequences**, supporting readiness reviews and O&M planning.

Outcome:

Clear communication with operators (TfW, GWR) and local authorities, ensuring continuity and safety.

Stakeholder and Community Engagement Tools



Challenge:

Complex schemes face opposition when communities fail to understand what's being proposed. Static drawings rarely convey scale, mitigation, or benefit.

Visualisation Solution:

- Create **cinematic flythroughs** and **interactive dashboards** for public consultation.
- Develop **360° virtual tours** accessible via web or VR headsets at consultation events.
- Link visuals to real-world data — e.g., noise levels, landscape views, traffic flows.
- Present design evolution transparently, helping communities feel included rather than imposed upon.

Outcome:

Reduced consultation resistance, better-informed stakeholders, and stronger support for planning and statutory approvals.

Use Case Scenarios: Wales in Focus

Case 1: Cow Wally Line Infrastructure Upgrade

The Cow Wally Line, managed between Network Rail and Transport for Wales, represents the type of coordination challenge common in Welsh transport delivery. With multiple stations, public interfaces, and service diversions, traditional 2D communication often falls short.

Dynamic X's approach can:

- Develop 4D or 3D construction sequences showing station upgrades and track interface work.
- Integrate GIS data to visualise local authority boundaries, footpaths, and utilities.
- Simulate temporary pedestrian diversions and replacement bus movements.
- Provide consultation visuals explaining night-time working and noise mitigation.

Outcome: Shared visual understanding among engineers, operators, and local residents minimising misunderstanding and improving programme certainty.

Case 2: Transport for Wales Station Enhancements

TfW's station improvement programme involves architectural, accessibility, and operational upgrades. Each package demands communication between contractors, designers, and local authorities.

Dynamic X's role could include:

- Station flythroughs showing before/after conditions.
- Accessibility modelling for PRM-TIL compliance.
- Visual dashboards tracking work zones and access points.
- VR presentations for executive and community review.

Outcome: Consistent messaging across all stakeholder tiers and a reduction in design iteration cycles.

Case 3: Cardiff Metro Integration

The South Wales Metro integrates heavy rail, light rail, and bus systems. Here, interfaces multiply — overhead line equipment, platforms, signalling, and road-rail crossings.

Dynamic X can:

- Use Unreal Engine environments to visualise system interactions.
- Simulate construction access in tight urban corridors.
- Create public-facing visuals for community briefings and council updates.
- Link environmental data (noise, air quality) to visual models.

Outcome: Holistic view of the Metro's impact and delivery logic, ensuring design and operational decisions are based on shared understanding.

Benefits to Consultancy Partners

Benefit Area	Consultancy Value	Dynamic X Contribution
Interface Clarity	Reduced design clashes and rework	4D & GIS-linked coordination visuals
Programme Certainty	Improved planning and stakeholder buy-in	Sequenced animations linked to P6
Stakeholder Confidence	Better communication with TfW, Network Rail, and councils	VR tours, web dashboards, consultation visuals
Safety and Access Planning	Clearer visualisation of safe systems of work	Construction access and crowd-flow simulations
Bid and Tender Support	Enhanced presentation of design intent	Cinematic content and interactive assets for bids

In consultancy environments where precision and communication drive success, visualisation offers measurable return on investment. It reduces ambiguity, accelerates approval cycles, and enhances collaboration between disciplines.

Conclusion and Next Steps



The future of rail and transport delivery will not be defined solely by data models, but by shared understanding. As digital transformation continues across Welsh infrastructure, consultancies must ensure that every stakeholder — from civil engineer to community representative — can see the same picture.

Visualisation is the missing layer of clarity.

It translates models, schedules, and GIS data into something tangible: understanding. Dynamic X invites multidisciplinary consultancies such as Amey, Mott MacDonald, WSP, Arup, and others to explore partnership models where visualisation becomes a standard part of the design and delivery process. Through early integration, pilot demonstrations, and collaborative development, visualisation can evolve from optional enhancement to essential project intelligence.