United Kingdom Rail Electrification Strategies, Magnitude & Challenges

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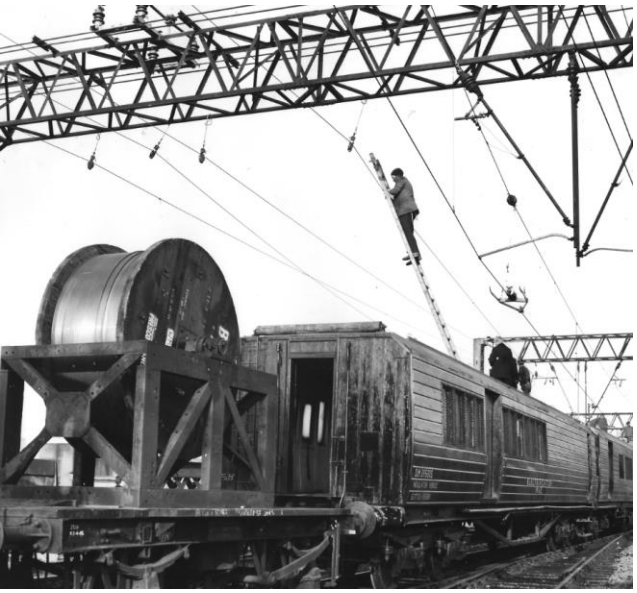
History



- Initial Overhead Electrification 1930/40's
- BR Modernization in 1960's
- Electrification expansion 1980/90's
- WCML Upgrade 2000's
- CTRL/HS1 2000's

New Investment

- Part of Government rail modernization and Carbon Reduction strategies
- Reduces environmental impact at point of use
- Provides an improvement on existing services
- Generates economic growth
- Reduces overall rail industry costs
- Once in a generation opportunity due to life expiry of current rolling stock

Challenges

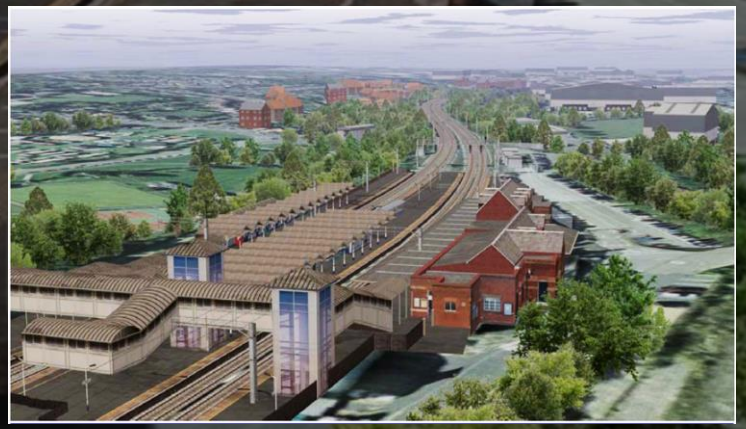
- Skills base shortage
  - **Both in technical competency and quantity**
  - **Competing projects**
- Available and suitable on track machinery
  - **Adaptation of European plant for UK infrastructure constraints**
  - **Improvements in safety**

Challenges

- Antiquated standards
  - **Culture change in industry around safety by design**
  - **Alignment with European Standards (where relevant)**
  - **Poor understanding of risk based design (CSM)**
- Integration with existing infrastructure
  - **Signaling, Telecoms, Civils infrastructure (viaducts/bridges etc.)**
  - **Electrification should be seen as a Route Upgrade**

What We Did - Midland Main Line

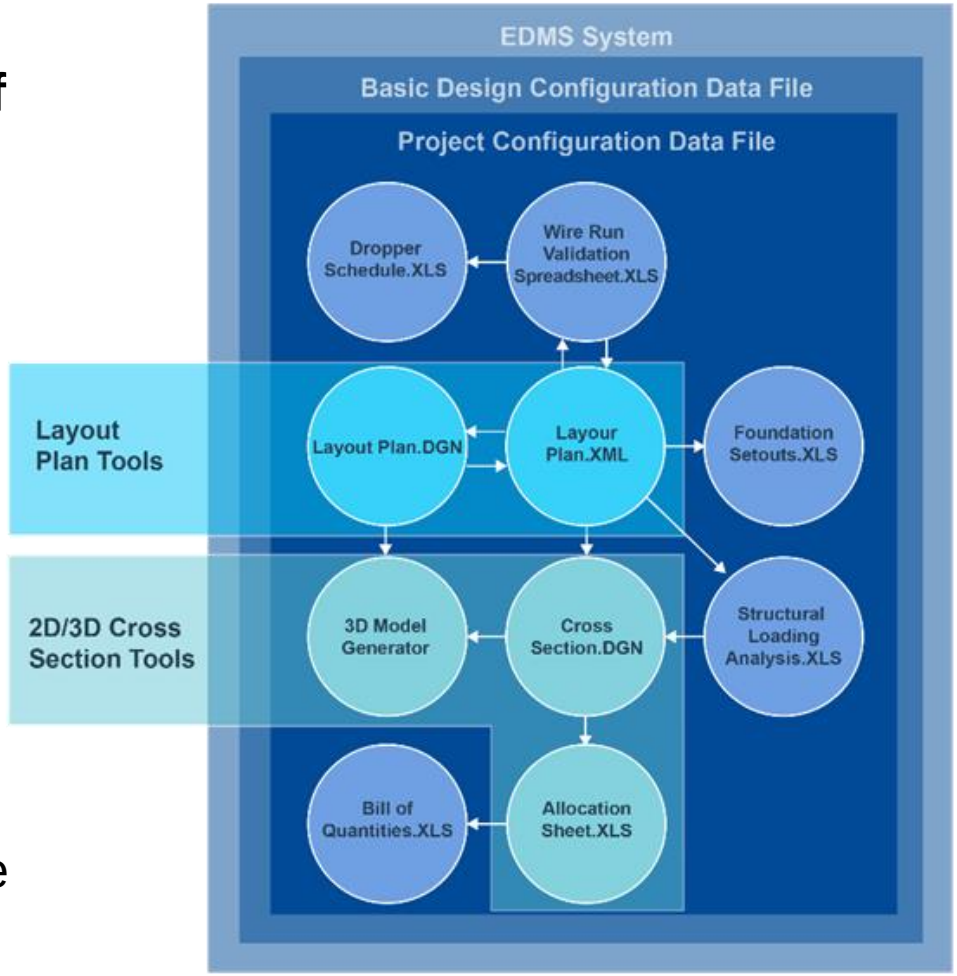
- Modernization of attitude
  - **The greatest challenge – with the ability to provide the greatest benefits**
  - **Required top down leadership and baked into contracting strategy**
  - **Open minded client who Incentivized innovation**
  - **Recognition of the benefits of Upfront engineering**
- Modernization of standards
  - **Adoption of EN's into company standards**
  - **Challenging existing standards, how has the technology changed?**
- Modernization of approach
  - **Utilization of technology**
  - **Automated design**
  - **4/5D planning**



Digital Electrification Design

Developed an innovative suite of tools for OCS design efficiency:

- Faster incorporation of design changes
- Automatic generation of a 3D BIM model (Level 2)
- Reduction in design and site errors
- Agnostic to equipment range and easily scalable for new markets
- Deliver multiple Electrification projects without the need to grow the resource pool



What We Did - Midland Main Line

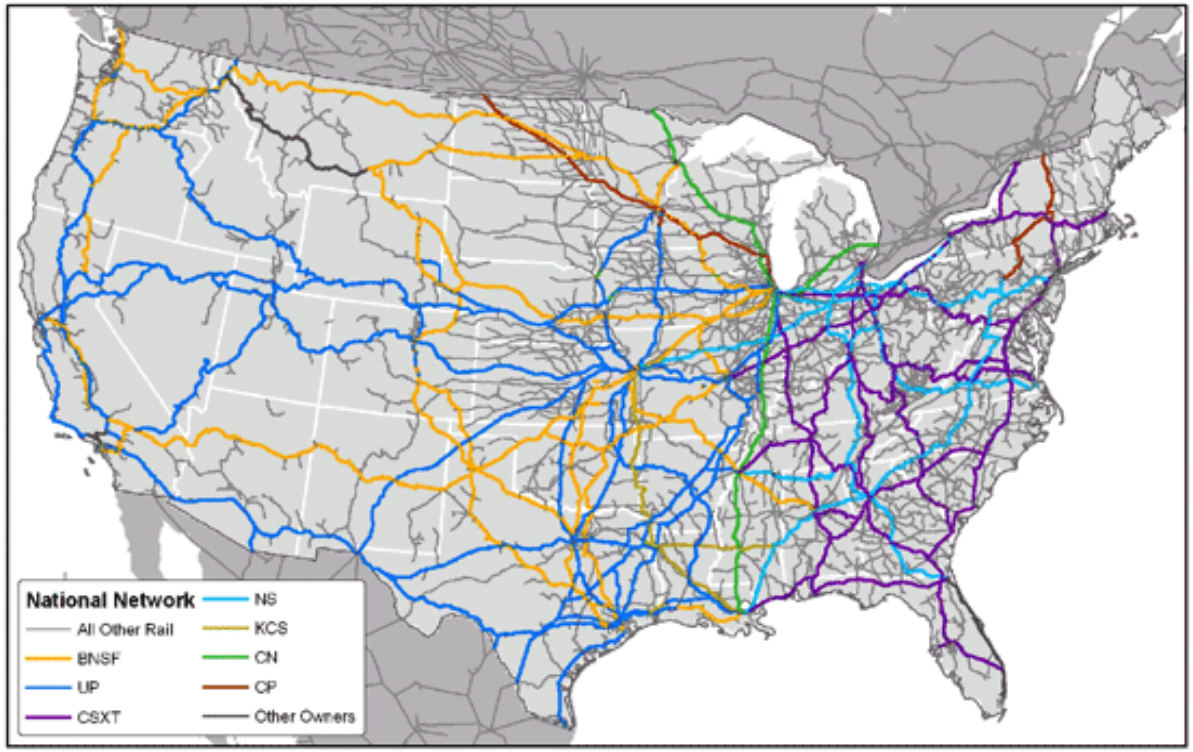
- CSM workshops
  - **Identified additional scope**
  - **Identified conflicts with other railway systems**
  - **Provided an auditable history of risk management**
  - **Involve construction teams early**
  - **Established OCS construction as a competency**
- Whole life cost perspective
  - **Allowed informed decision making**
  - **Balanced CAPEX and OPEX in numerous areas**
  - **In many instances reduced CAPEX due to better understanding of future costs**

Atkins Lite Structure Design

- Optimization using standardized hollow sections
- Increased tolerances improving maximizing output during short blocks
- Integrated lifting cleat built into the capping plate
- Allows AT wiring prior to installation of booms
- All booms are supported by the masts to assist with bolt installation
- Mast to baseplate interface detail designed as through detail for maximum durability
- Removed adapter plate requirement

Lessons Learned

- UK going forward
  - **Better management of scarce Resources and Plant**
  - **Better Industry wide planning of projects**
  - **Need to finalize design concept before progressing with detail and construction**



What do these lessons mean for the USA

- Electrification of existing commuter corridors
  - **Safety improvements - reduction in capitol and operational costs**
  - **Environmental and Social benefits not to be underestimated**
  - **Electrification is a Route Wide Upgrade**
  - **Budgets, Policy and Timing to be aligned with the engineering solution**
  - **Develop standards that are industry (not state) wide**
  - **Innovation includes contracting strategy (behaviors)**

Questions?

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