Use of Digital Engineering in Ancillary Civil Design

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Abstract

Word is changing in the digital Era characterized by the technology which increases the speed and breadth of knowledge turnover within the economy and society. There was always a need to develop a digital plan to assist engineering design process. This paper particularly discusses the digital plan implemented on East West Rail re-signalling scheme. East West Rail Phase 2 (EWR2) is progressing from GRIP4 (optioneering) into GRIP5 (detail design), during this cross-over period there is an opportunity to make the Ancillary Civils' team processes more efficient and streamlined. Lessons learnt at GRIP4, the need for an Ancillary Civils Digital Engineering delivery plan become apparent. The purpose of the digital plan is to define the requirements and processes that all Ancillary Civils design and station design teams adhered. Jawaid Malik is Alliance Responsible Engineer, he is delivering the ancillary civil design packages digitally.

Keywords: Digital Plan, Digital Engineering, Ancillary civil design, Platform extensions.

1. INTRODUCTION:

The East West Rail Alliance believed that the integration of digital engineering in to design is essential for the successful delivery of the East West Rail Phase 2 programme.

By selecting and applying the latest digital technologies and systems, there was an opportunity to develop, improve and advance the processes required to deliver design work throughout the project lifecycle. This will result in a significant improvement in the quality of information produced by the alliance, leading to better decision making and delivering best value throughout the programme. In turn this will allow the alliance to interrogate information more effectively and to increase reliability and predictability within the project.

The successful implementation of the Digital Engineering on the programme is based on a culture change within the Alliance team (as well as construction industry) to apply the process and integration of technology into all functional activities. This requires the enthusiasm, passion and commitment of all Alliance members and suppliers to adopt and apply new ways of working. The proactive adoption of digital engineering will drive innovation, enhance the capabilities and reputation of our team and support the future competitiveness of the Rail sector.

This will be achieved through the creation of a high performance collaborative culture within the team and through the utilisation of Digital Engineering systems and processes. This in turn will safeguard the future competitiveness of the rail sector by investing in new and emerging digital technologies with payback periods that exceed the life of the programme.

Digital Engineering can be described as a digital representation of a project's physical and functional characteristics. Digital Engineering creates a shared knowledge and information resource for the project, which can aid the decision making, from earliest conception, through design, delivery, handover, commissioning, operation and maintenance and ultimately demolition. The implication of digital element on East West Rail scheme has proved a positive outcome. Civil design packages at GRIP 5 (Detailed Design Stage) are produced based on 3D modelling and use of several digital tools.

2. PROCEDURES:

2.1 Digital Engineering Enablers and Benefits:

Digital Engineering utilises technology, software and processes to improve design, construction, handover, operation and maintenance activities. It identifies, manages and influences the implementation, use and exchange of digital information which will be produced on the EWR2 Programme.

This information can be:

- Graphical (2D, 3D, Spatial Data)
- Non-Graphical (asset information, databases)
- Documentation (output drawings, schedules and reports)

Successful delivery of Digital Engineering requires the engagement and support from all functions to be successful. This document will be a live document which will be updated over the course of the project lifecycle as required. In the event of any apparent conflict between this document and other Standards, the matter shall be referred to the East West Rail Phase 2 Digital Engineering team for clarification.

2.2 Tools:

2.2.1, ProjectWise:

ProjectWise is used to manage the digital information within the scheme. ProjectWise is a suite of engineering project collaboration software from Bentley Systems designed for the architecture, engineering, construction (AEC) industries. It helps project teams to manage, share and distribute engineering project content and review in a single platform. See Figure 1 from ProjectWise workflow.

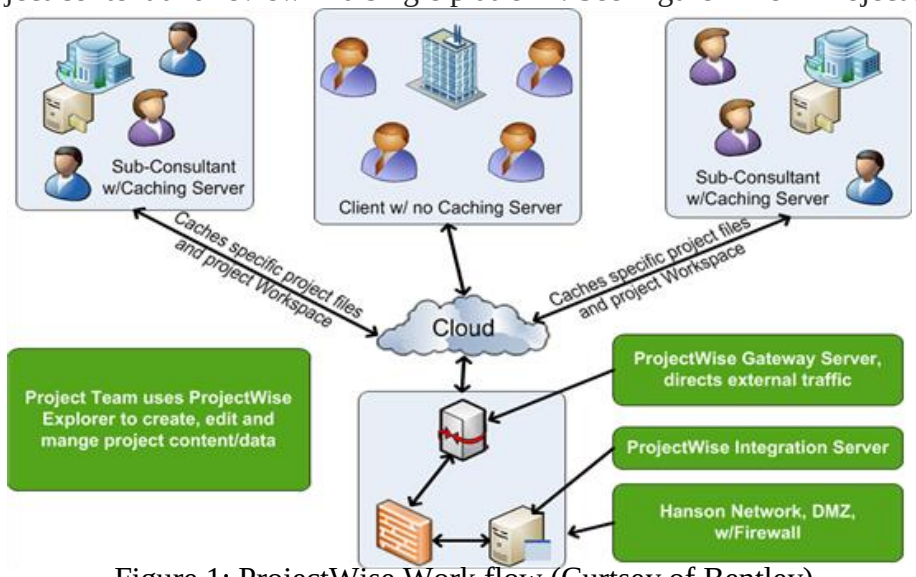


Figure 1: ProjectWise Work flow (Curtsey of Bentley)

2.2.2, Master Information Delivery Plan (MIDP):

The Ancillary Civils Digital Team created a MIDP spreadsheet, capturing all deliverables to be produced in preparation for GRIP 5. The MIDP sets out the deliverables for each asset, e.g. 3-D models, Form F003 documents (Detail design submission document), schedules, specification documents etc.

Each Work Package Manager is tasked to review the MIDP, ensuring that enough deliverables are included, prior to submission to the EIM Team for a final review. The MIDP is a guideline of the Ancillary Civils deliverables and is subject to change. The responsibility of Work Package Managers was set to ensure the MIDP is reviewed periodically and checked against the deliverables saved within ProjectWise. See Figure 2, an extract from level of model defination/Master Input Delivery plan (MIDP).

DELIVERABLE DETAILS (to be completed by Engineering Function)	
Deliverable Title	Title which will be placed within the deliverable
Description	Grouping of deliverables into standard categories e.g. Long Section, Cross Section, Plan, Form 1, Form A
Type	Type of deliverables 3D Models, 2D Models, Reports, Schedule
Native format	Deliverable file format .dgn, .dwg
Exchange format	Exchange format to be delivered .i.dgn, .ifc, .pdf

PROGRAMME (to be completed by Design Package Managers)	
Work breakdown structure ref:	Refers to the Work Breakdown structure the deliverable fall under.
Issue Date Milestone	Refers to the End Date of the Programme activity.

FILE NAME (to be completed by Engineering Function)	
File	EWR2 BS1192 file naming broken down to individual fields

PROJECT INFORMATION (to be completed by Design Package Managers)	
Risk Classification	Refers to risk profile of the work package the deliverable is associated to, please refer to '7.4 Work Package Classification' of the Digital Engineering Execution Plan P02

Figure 2 - Extract from Level of Model Definition (LOMD) / Master Input Delivery Plan (MIDP)

2.2.3, Model / Drawing Creation:
Quantity, repeatability and scale differ throughout many of the Ancillary Civils assets and the designs can lead to confusion and lost time. This is often as a result of modelling unnecessary detail or modelling with lack of detail that then must be included later. The modelling and drawing process varies for each asset, therefore a clear understanding of the Level of Detail and Level of Information requirements helped the designers and modellers deliver efficiently. Models can come in a variety of forms, different model references will give an indication of what dimension (2D/3D) the model has been drawn in, if the model contains references and if the model is a drawing file (Jones, Daniel, (2019)). An understanding of how different models fit and reference each other, will reduce the time taken in getting a 2D model with no
information, through to a fully annotated and rendered model or drawing. Figure 3 below demonstrates the correct process to be followed for completing models.

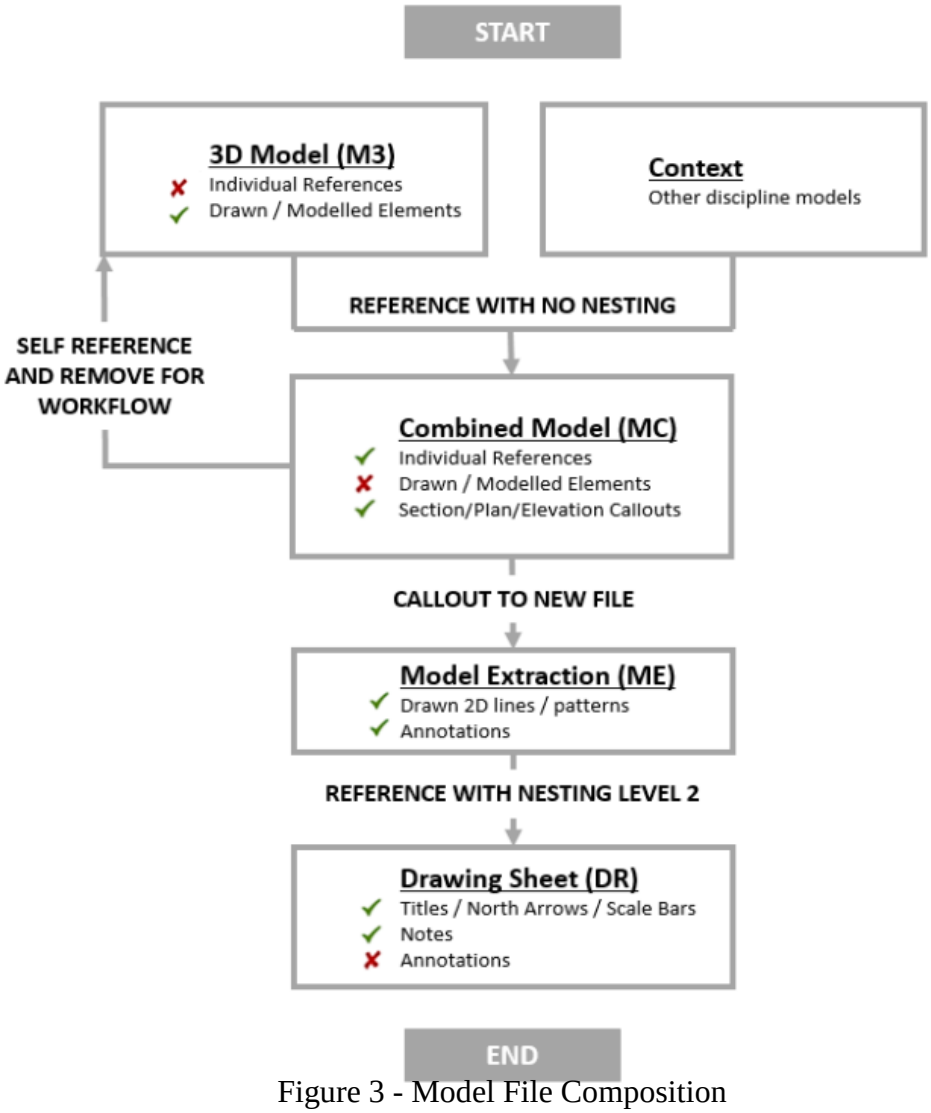
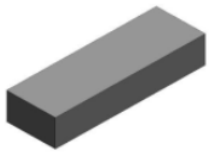
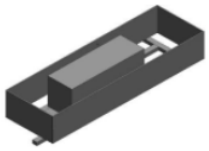
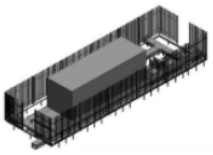


Figure 3 - Model File Composition

2.2.4, LOD/LOI Requirements:
Prior to the commencement of the detailed design, as part of the design start up meeting with the Alliance Engineering Integration Management and Digital Engineering teams, the Level of Detail and Level of Information requirements confirmed and documented by the Works Package Manager. See Figure 4 as an example of LOD for various structures (Alliance DE Team, (2019)).

REB Compound		
LOD 2	**LOD 3**	**LOD 4**
		

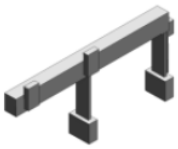
Signal Gantry		
LOD 2	**LOD 3**	**LOD 4**
		

Figure 4 - LOD 04 Requirements

3. RESULTS:

3.1 Master Models

Engineering input required during the detailed design stage to ensure the models are correct. However, to begin the process, GRIP 4 models and information taken from the Technical Notes for Target Cost to initially set up the models. The Master models required updating, as the design progresses. Mark-ups of the Master models are required to provide an audit trail of design / check / review. It was the intention of the Ancillary Civils Digital Team that the Master models will be added to the EWR Alliance project wide 'catalogue' of models and could be used on future projects. Simplified models for use in the route sections will be produced following approval of the Master models.

An example from the fencing deliverables is shown below in Figure 5.

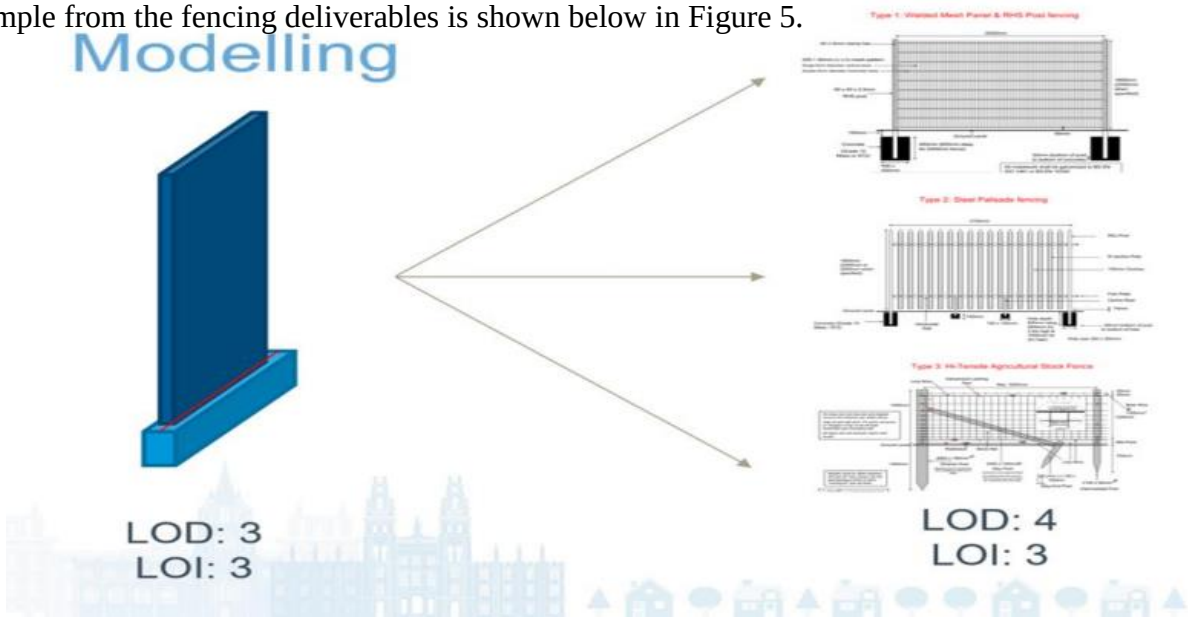


Figure 5 - Examples of the LOD for Fence Panel

3.2 Station 3D Model:

The station 3D modelling produced by integrating 3D models from other disciplines such as earth works, OLE models etc. The clashes of design elements were identified and where required the design was re-produced (Martin, Robert, (2019).). See Figure 6 for examples of Station 3D model.

Figure 6 - Examples of Station 3D model

4. CONCLUSIONS:

Following conclusions can be drawn from the conducted study:

- A concise Digital Model is required to be produced preferably at Feasibility design stage to deliver the scheme digitally.
- 3D models to be produced by each discipline prior to Inter disciplinary Check this includes compatible input data i.e. laser sweep survey etc.
- The survey results acquired from laser sweep method were quick to interpret in 3D model.
- The use Bentley fly over helped in producing 3D detailed flyover video which helped in understanding the present and future constraints.
- A clash analysis to be carried out prior to sharing the models with other parties.
- Design development/Model Update to be shared with other parties periodically.
- Digital models can be used on tablets to for the construction purpose i.e. saving paper print, hence a sustainable process.
- The models help future constructions.
- As build information is readily available with updated construction changes.
- All information saved on ProjectWise is available to be transferred to client in a safe and comprehensive way.

The above approach is more sustainable and safer approach to the design process. The H&S file at the end of the scheme will be helpful for any future refurbishment works etc (Alliance DE Team, (2019)). The digital practice exercised in East West Rail are planned to be used in upcoming schemes. This approach is used widely in aviation and metrology fields. The use of digital practice in Highway and Transportation is the future which can help in achieving a successful, sustainable and safe schemes in future.

ACKNOWLEDGEMENTS:

The authors would like to thank all EWR alliance team members who helped thorough out the research work, particularly East West Rail design teams. The careful review and constructive suggestions by the anonymous reviewers are gratefully acknowledged.

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