Bringing ISO 19650 to Silicon Valley – BIM Challenges on the BART Extension

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About the speaker

Peter Starnes

I work for global engineering firm Mott MacDonald and my role involves championing the use of BIM processes and providing leadership and guidance for collaborative working. I act as information manager on BIM projects working towards ISO 19650 and I devise and monitor suitable workflows for BIM processes, tailored to the needs of the project.

I’m responsible for ensuring consistent quality and on-time delivery of technical models, coordinating a multidisciplinary team across multiple locations, organizations and time zones.
About the speaker

Brindusa Dumitrascu

Senior Digital Delivery Specialist with Mott MacDonald. Learned the ins-and-outs of document management and project delivery by holding a few different roles in the company and by working on some milestone projects.

Experienced in Revit, Navisworks, BIM 360, ProjectWise, SharePoint, BIM Track.
**Project Overview**

- The BART to Silicon Valley ("BSV") Program will extend the San Francisco Bay Area Rapid Transit (BART) system from the city of Fremont in Alameda County through the cities of Milpitas, San Jose and Santa Clara, in Santa Clara County.
- The 16-mile BART extension to Santa Clara County is being implemented in multiple phases.
- Phase II of the Program is a 6-mile, 4-station extension from the under-construction Berryessa Station to Santa Clara (BSVII), and it includes:
  - Approximately 5-mile long tunnel through Downtown San Jose
  - Three below-ground stations (28th Street / Little Portugal Station, Downtown San Jose Station, Diridon/Arena Station)
  - One at-grade station (Santa Clara Station)
  - Maintenance yard and associated works.
Project Timeline

- **Notice to Proceed**: May 2019
- **Team Mobilization**: June – August 2019
- **Digital Delivery Project Set-Up**: August 2019
- **10% Level of Design Development**: December 2019
- **Value Engineering**: January - March 2020
- **Value Engineering**: April – June 2020
- **Expedited Project Delivery**: Present
Delivery Phases

Assessment | Invitation to tender | Tender response | Appointment | Mobilization | Collaborative information production | Information model delivery | Project close-out
---|---|---|---|---|---|---|---
1 | 2 | 3 | 4 | 5 | 6 | 7 | 8
Client BIM Goals for the Project

• Common working environment for **collaboration**
• Mitigate project risk through **connected** data and models
• Use new and **innovative** technologies where appropriate
• Enhance ability to make **informed** and timely decisions
• Increase **confidence** and predictability of cost and schedule
• Simulate construction to identify risks in a **virtual** environment
• Enhance **productivity** and deliver work efficiently
BSVII project adopts the principles of BIM as set out in ISO 19650:

- Confirm the BIM execution plan
- Establish the digital delivery environment
- Establish the list of deliverables
- Mobilize resources
- Establish the processes for the review, approval, and sharing of information
Outcome Oriented Targets (Lean Engineering)

“Begin with the end in mind”

• Reduce waiting and searching for information
• Avoid over production of information with no defined use
• Eliminate defects and re-work through better coordination
• Re-use models and look for interchange opportunities
• Build confidence into models
• Reduce time and cost
Appointment
BIM Execution Plan

- Digital delivery
- Building information modeling
- BIM execution plan details
- Key roles and responsibilities
- Project BIM objectives and goals
- File sharing / document management
- Software and training
- BIM / CAD modeling guidelines
- QA / QC and model coordination
- Final deliverables
MIDP

- Master Information Delivery Plan
- Master file detailing document names by discipline, asset and contract
- Discipline teams responsible for maintaining drawing lists in the MIDP
- BIM team responsible for maintaining model lists (MPDT – Model Production Delivery Table) in the MIDP
- Tracking the completion of files in Power BI
Mobilization
Resources
Mobilization of Team

- 460 Mobilized Staff
- 49 Locations
- 25 Firms
- 10 Disciplines
One Team Way of Working Combined Vision
Skills Survey

[Graph showing data on skills by firm, platform, primary discipline, and platform.]

Average of Rating and Count of Name by Firm and Platform

Average of Rating and Count of Name by Platform

Average of Rating and Count of Name by Primary Discipline and Platform
Training and Support

- Classroom / Online
- Instructional Videos
- Printed Materials

Initial Training

- Information Management
- Team Support
- Surgeries

Ongoing Support

- Champions
- Peer Support

Self-Sufficiency

Project Maturity
Project Wiki

- Step-by-step work instructions
- Training videos
- Training presentations
TRUST

1. Create information once and store correctly.

2. Actively share information. Understand ISO 19650 and respect the workflow.

3. Seek, support and share training knowledge with your colleagues.

4. Send links instead of attachments – keep the single source of truth.

5. Be clear and concise – communication will be a challenge.

6. Don’t be afraid of the models.

7. Only design and model to the required scope and level of detail.

8. Sharing is caring – help others and seek help.
Mobilization Technology
Robust Digital Framework

- BIM 360
- Revit
- Civil 3D
- Navisworks
- Infraworks
- 3ds Max
Digital Delivery Environment

- Power BI
- SharePoint
- Office 365
- Acumen

- Project Planning
- Quality Management
- Security
- Standards
- Meetings
- Budgets
- Health and Safety
- Contracts
- Permitting
- Outreach
- Protocols
- Templates

- P6
- Oracle

- Schedule
- Risk Management

- Reporting & Insights

- ProjectWise
- Connect Edition
- Information & Assurance Management
- Document Management
- Project Management
- Reports & Calculations
- Linear structure modelling

- Autodesk BIM 360
- Vertical structure models
- Design
- Collaboration
- Model Coordination

- Revit
- Navisworks
- InfraWorks

- Autodesk 3DS MAX
- VR
- 4D/5D

- ArcGIS Online
- Geographic Information Systems

- BIM Track
- Model based issue tracking

- assemble
- Quantity take-off

- Sage
- Cost Estimating
SharePoint

- Non-delivery information
- GEC project control and management
- Onboarding and training material
- Links, templates and commonly used files
ProjectWise

- Primary CDE for all deliverables
- ISO 19650 structure including file naming, state and suitability codes
- Embedded workflows for file sharing and validation
- Customizable metadata for enhanced analysis
- Title block integration for DWG files
- PDF renditions
**BIM 360**

- CDE for all Revit models and federated models
- Applied ISO 19650 environment
- Enhanced model visibility
Information Sharing Workflows

• BIM 360
  o Manual set-up of WIP and Shared folders
  o Manual set-up of approval workflows
  o Approved version of the models copied to the Shared folder
  o Custom attributes for suitability code and state

• ProjectWise
  o Automated workflows for the review and approval processes
  o Files shared through suitability codes and states
Assemble

• **Typical Quantity Take-Off Process:**
  o Requires high resolution PDFs (higher resolution = higher accuracy)
  o Elements are traced to obtain areas
  o Design intent can be misunderstood
    ▪ Material types
    ▪ Construction methodology

• **Assemble Quantity Take-Off Process:**
  o Models can be directly imported for material take-off
  o Accurate extraction of areas and volumes
    ▪ No tracing or calibration of scales required
    ▪ Eliminates requirement of specific 1ft PDF drawing plots
    ▪ Less opportunity for design intent to be misunderstood
    ▪ Time and cost savings
BIM Track

- Issue tracking (not just clashes)
- Integrates with main design software
- Accessible online for non-technical staff
- Record and monitor issues
- Bridge the gap between 2D and 3D teams with hyper-modelling
- All parties access
Power BI & Power Apps

- Tracking as-built information through to models
- Monitor and report QC of Civil 3D and Revit models
- Visualize data from BIM 360 and ProjectWise
- Geotechnical – GIS dashboard for boreholes and water levels
- Budget reporting
- RFCs and submittals reporting
- Management performance reporting
- Change analysis and earned value reporting
- Project App for automation of common tasks:
  - Mobilization
  - Document control
  - Project directory
  - Key info
  - Etc.
- Staffing Plan
Virtual Reality

AUTODESK® REVIT® + Rehearsive.io

www.Rehearsive.io

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Communication

- **Teams**
  - Instant messaging
  - Screen sharing
  - Meetings
  - File sharing
  - OneNote
  - Planner

- **Yammer**
  - Open communication
  - Reduced email communication
  - Increased collaboration
  - Team engagement

- **Newsletters**
  - Various information management topics

- **Project BIM Meetings**
  - Standard updates
  - Tips and tricks
  - Round Robin
Collaborative Production
Data Connections

**BIM 360**
- Architectural, Structural, MEP, systems, Industrial, Existing
- WIP model
- Shared model
  - Federated model
  - Clash detection
  - Model QC audit
  - Reporting
  - Drawing sheets
  - 4D & 5D model (schedule)

**ProjectWise**
- Model rendition from BIM 360
- Model rendition from ProjectWise
- WIP model
- Shared model
- Drawing sheets
  - Document control
  - Incoming / IDR / QC / QA / Transmittal
  - Incoming graphical & non-graphical data

**SharePoint**
- Specialist technical models
  - Leapfrog
  - Rhino
  - Steps
  - CFD
- Meeting Notes

**Cloud**
- BIM Track (issue tracking)
- Assemble (QTO)
- GIS (REMS, environmental, etc.)
- Visualization (engagement)

**BlueBeam**
- IDR / QC / QA

**SHARC**
- Share
- Assess
- Review
- Coordinate
Renditions

- Link two graphical CDEs (BIM 360 and ProjectWise)
- Manually created
- Monitored through version control and reporting
- **BIM 360 -> ProjectWise**
  - Notification from BIM 360 when a model is shared
  - Spreadsheet to keep track of the renditions
    - Date of shared model
    - Date of rendition
- **ProjectWise -> BIM 360**
  - Email notification when a ProjectWise model is shared
  - Custom attribute in BIM 360 for the corresponding ProjectWise shared version
  - Power BI:
    - Manual export weekly from ProjectWise with the state and date of files
    - Comparison against the renditions in BIM 360
Suitability Codes

- S0: Work In Progress (WIP)
  - Unchecked Native Data

- S1: Suitable For Coordination
  - Shared for other disciplines to reference.

- S2: Suitable For Information
  - Data shared purely for others' awareness.

- S3: Suitable For Review & Comment
  - Data ready for other parties to provide feedback on.

- S4: Suitable For Stage Approval
  - Data ready for Client approval.
<table>
<thead>
<tr>
<th>ISO 19650 State</th>
<th>ISO 19650 Description</th>
<th>ProjectWise Workflow State</th>
<th>Visible To</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work In Progress</td>
<td>Information in development by the Discipline Team. Not visible by any other discipline.</td>
<td>Work In Progress</td>
<td>Discipline</td>
</tr>
<tr>
<td>Check / Review / Approve Transition</td>
<td>Discipline Data compared against agreed standards, methods and procedures by the Discipline Team.</td>
<td>Content Check</td>
<td>Design Stakeholders</td>
</tr>
<tr>
<td>Shared</td>
<td>Constructive and collaborative development of the data through inter-disciplinary coordination. Non-editable and visible to other disciplines.</td>
<td>Technical Check</td>
<td>PMT / VTA</td>
</tr>
<tr>
<td>Review / Authorize</td>
<td>All data compared against information requirements for coordination, completeness and accuracy. This separates data that can be relied on for the next stage of delivery from that which is subject to change.</td>
<td>Shared (Team)</td>
<td></td>
</tr>
<tr>
<td>Published</td>
<td>Data that is authorized for use.</td>
<td>Shared</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Coordination Check</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Approve</td>
<td></td>
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<tr>
<td></td>
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<td>Authorization</td>
<td></td>
</tr>
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<td></td>
<td></td>
<td>Published</td>
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</tr>
</tbody>
</table>
CAD / Revit QA / QC

Download checklist
- Download latest version
- Revit checklist
- CAD drawings checklist
- CAD base file checklist

Complete the checklist
- Fix issues not compliant in file
- Comment on unresolved issues

Submit checklist
- Upload to SharePoint

Auditor review
- Checks compliance
- Makes comments
- Auditor notifies modeler / CAD designer when complete

Are there comments from the auditor?

Address comments
- Describe actions taken to address auditor’s comments (in red under auditor comments)

Start new checklist

Submit checklist
- Upload to SharePoint

Auditor review
- Checks compliance
- Makes comments
- Auditor notifies modeler / CAD designer when complete

Are there comments from the auditor?

Address comments
- Describe actions taken to address auditor’s comments (in red under auditor comments)

Save checklist and notify auditor
Model Federation

- Federated project wide model
- Tunnel federated model
- Yard federated model
- Station federated model
- Asset model

- Mapping
- Utilities
- Existing structures
- Etc.
Issue Tracking Process

**BIM Track / Navisworks / Revit / Civil 3D**

**New**
- New issue created in BIM Track
- Mandatory attributes defined
- Status
- Asset
- Phase
- Priority
- Type
- Recommended attributes defined
- Assigned to Discipline
- Notify
- Escalation
- Confidentiality

**In progress**
- Automatic notification
- BIM modeler
- Designer

**For review by design lead**
- Design lead

**Closed**
- Issue closed
- Attributes updated to suit

Issues monitored by PM team
Issue Reporting

- Interactive project metrics: instant overview of project coordination performance
- Report templates:
  - Personal
  - Shared
- Scheduled reports:
  - Daily basis
  - Every week
  - Every month
- Customizable report metrics
Room Criteria

- Discrepancies on room numbers and names across the different stations
- Standard room types not complying with the BART facility standard requirements
- Using Ideate BIMLink:
  - Publish room data from federated model to Excel
  - Comparison table of existing room data against the BFS template
SHARC Meetings

• SHARC: **SH**are, **A**ppraise, **R**eview and **C**oordinate
• Discuss and resolve issues that arise during design development
• Present and discuss complete or partially complete elements of the design
• Led by package managers and design unit leads
• Held on a regular basis, usually weekly
  o General overview
  o Specific workgroups
• Model based suitable
• Organized through the Design Integration Manager
4D and 5D

• Requirements defined in the BIM Execution Plan
• 4D federated Navisworks model with all elements linked to the client’s P6 construction WBS activities in timeline
• 5D federated Navisworks model with all elements linked to their respective project WBS items in the Navisworks quantification catalogue
Level of Development

- Requirements defined in the BIM Execution Plan
- Each stage of the project requires a specific level of development (LOD)
- LOD 300 for 30% deliverable
- Discipline leads to record the appropriate LOD in the Model Production Delivery Table (MPDT)

<table>
<thead>
<tr>
<th>Level of Development</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOD 100</td>
<td>The model element may be graphically represented in the model with a symbol or other generic representation but does not satisfy the requirements for LOD 200. Information related to the model element (e.g., cost per square foot, tonnage of HVAC) can be derived from other model elements.</td>
</tr>
<tr>
<td>LOD 200</td>
<td>The model element is graphically represented within the model as a generic system, object, or assembly with approximate quantities, size, shape, location, and orientation. Non-graphic information may also be attached to the model element.</td>
</tr>
<tr>
<td>LOD 300</td>
<td>The model element is graphically represented within the model as a specific system, object or assembly in terms of quantity, size, shape, location, and orientation. Non-graphic information may also be attached to the model element.</td>
</tr>
<tr>
<td>LOD 350</td>
<td>The model element is graphically represented within the model as a specific system, object or assembly in terms of quantity, size, shape, location, and orientation, and interfaces with other building systems. Non-graphic information may also be attached to the model element.</td>
</tr>
<tr>
<td>LOD 400</td>
<td>The model element is graphically represented within the model as a specific system, object or assembly in terms of size, shape, location, quantity, and orientation with detailing, fabrication, assembly, and installation information. Non-graphic information may also be attached to the model element.</td>
</tr>
<tr>
<td>LOD 500 (as-buils)</td>
<td>The model element is a field verified representation in terms of size, shape, location, quantity, and orientation. Non-graphic information may also be attached to the model elements.</td>
</tr>
</tbody>
</table>
Asset Information

- Requirements defined in the BIM Execution Plan
- Non-graphical information attached to the model elements
- CSI 2010 Uniformat II classification system
Outcome
Challenges

• ISO 19650:
  o Awareness of ISO standard
  o ISO workflow different between ProjectWise, BIM 360, SharePoint in order to achieve same aim
• Inertia to change
• Drip feed mobilization of teams
• Technology platforms
• Processes
• Tools
• Feedback
Successful Delivery of First Phase of Project

- **920** FILES SUBMITTED
- **199** 3D MODELS
- **1835** INCOMING FILES
Upskilling of Whole Team

Legend:
- Beginner = 1
- Competent = 2
- Advanced = 3
- Expert = 4
Assemble

Design Intent → BIM Model → Drawing Sheet → Plot PDF → Take-Off Software → Cost Estimate

Variable (Drawings still produced)
10 min/drawing
90 mins/drawing

10 min/drawing
Models Visibility

• **BIM 360 Viewer**
  o Individual models shared on a regular basis
  o Navisworks federated models for the individual assets and Projectwide
  o Used in the asset coordination meetings
  o Visible to all design team members

• **BIM Track**
  o Models published to BIM Track on a regular basis
  o Sheets hyper-modeled
  o Used for issue tracking
  o Visible to all team (including client)
Did We Establish ISO 19650?

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