Predictability, Visibility, and Certainty of Construction Outcomes for Oil and Gas Megaprojects

Guy Penfold
Implementation Consultant
We will explore some high-level challenges facing the oil and gas industry, how operators are looking to capitalize on a data-centric approach through technology to improve project performance. We’ll present a case study from a megaproject demonstrating how capitalizing on 3D models and mobile field devices led to significant efficiency and productivity improvements to deliver client outcomes. The case study will demonstrate how Navisworks software and BIM 360 software were applied as part of a completions-driven philosophy/methodology. This session features BIM 360 Field and BIM 360 Glue. AIA Approved
Presenter

- Based in Sydney Australia
- Senior BIM Technical Consultant - Autodesk
- Strong in Construction and Construction Management
- Accredited Autodesk Integration Consultant
- BIM 360 Glue, field, APL and Ops Implementer
- Experienced Navisworks user, trainer and implementer
Key learning objectives

At the end of this class, you will be able to:

- Discover the possibility of what can be achieved if you know how to capitalize on Navisworks and BIM 360 as part of a construction execution philosophy
- Understand the benefits of a BIM 360 Field capture process to provide visibility for construction status
- Realize the potential productivity improvements gained from utilizing BIM 360 Glue and BIM 360 Field
- See how these benefits have been capitalized on in a real-world oil and gas megaproject
Project and Customer

- Unfortunately during this presentation the actual project and customer can not be named.

- If you wish to know more about this topic please see me after the presentation.
The first rule of any technology used in a business, is that automation applied to an efficient process will magnify the efficiency.

The second is that automation applied to an inefficient process will magnify the inefficiency

Bill Gates
Improving Construction Performance

Completions Driven Approach
Objective

Remove Complication from Complexity

Create alignment within the team

Create Visibility - Remove excuses and create accountability

Create Empowerment - What I CAN’T do v What I CAN do

Get the right information to the right person in the right format at the right time to support a decision or process.

Do it once, do it right, finish what we start

Enablement

“Influence the Outcome”
Process Overview (Construction GPS)

Construction Management System

- Engineering Data
- Engineering Status
- Rules of Credit
- Completions Data
- Contract Schedule
- Contractor Work Packs

Plan

- Change Management
- Material Availability

Improve

- Schedule Optimization
- Field Status

Analyze

Execute

- Controlled Delivery
- Opportunities & Constraints
- Risks & Vulnerabilities
- Management of Change
- Transition to MC
- Commercial Protection

Coordinate

Measure

Validate

Decision Making

Influence the Outcome

Improve

Analyze

Measure

Validate

Execute

Coordinate

Plan

Navisworks Manage

Rationalize

Realize

Visualize
Completions Driven Approach (Why)

Mega Project Trends

Opportunity to reduce schedule

Completions Process

Bulk Construction

Capitalize on completions opportunities early

Project Duration in Months

© 2016 Autodesk
Completions Management (How)

Trigger points (Opportunity / Constraint Analysis) – reduce time lags

Piping
- Spool Install
- Isometric Completion
- Oil Flushing
- Touch up Paint
- Test Pack Inspection
- Heat Tracing / Insulation
- MC Walkdown
- Reinstatement

65% spool install

E&I
- Install Equipment
- Install Supports & Tray
- Cable Pull
- Install Devices
- Terminations
- Loop Checks

65% tray install
Opportunity & Constraint Analysis

Opportunity – “a set of circumstances that makes it possible to do something”
- Move to next stage
- Open work fronts for others

Constraint – “a limitation or restriction”

3 phases of an opportunity / constraint

REPEAT
Completions Management (Piping Example)

20 June 2015
At 64% spool install
586 Test Packs RFW – 31%
Punched – 352 – 18%
Cat A Clear – 118
RFT – 23
Tested - 69

Available to Walk
Walked
Tested
3D Model Overview

- The 3D model is enabled by the construction management system.
- Visualize & analyze what you put in:
  - It can’t plan
  - It can’t execute
  - It can’t make decisions
- But it can improve planning, execution and decision making if used correctly

Construction Management System
Navisworks Data Tools
Super Charged Model
Visualization

- Engineering Design
- Procurement
- Delivery
- Construction
- Completions
- Commissioning

- Structure
- Piping
- Insulation
- Equipment
- Cable Tray
- End Devices
## Visualization – Piping Opportunities

<table>
<thead>
<tr>
<th>Test packs for walk down</th>
<th>Iso’s with 1 spool balance</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Test packs for walk down" /></td>
<td><img src="image2.png" alt="Iso’s with 1 spool balance" /></td>
</tr>
</tbody>
</table>
Visualization – Tray Installation

Overall Status

Tray Not Bolted

Paint & Bolting

Priority Check
Visualization E&I Opportunity

Room Completion (LIR)
Available Cable Pull (LIR)
Available Cable Pull ALL
Sub Systems
Visualization E&I Cable

Individual Cables

Bulk Pull Opportunities
Visualization – E&I Equipment

BLUE – NOT INSTALLED
RED – CHECK INSTALLATION
YELLOW – VALIDATED INSTALLED
ORANGE – VALIDATED INSTALLED & ALL CABLES PULLED
GREEN – VALIDATED INSTALLED & ALL CABLES PULLED

Termination Availability

E&I Room Completion
Visualization – Sub Systems
Progressive Inspection – Leading Indicators

Field status capture independent from what contractors report

Verified data
Channeled correctly
Influence the outcome

Drive Contractor Behavior
Improve Productivity
Realize Performance
Case Study

Leveraging BIM360 to drive Project Performance
Case Study – E&I / Leak Testing

- Data Centric Approach
- Opportunity & Constraint Analysis
- Model Visualization
- Progressive Inspection – BIM360 Field / Glue
- Collaboration with Contractor
Case Study – E&I / Leak Testing

- **Scope**
  - 9 E&I Rooms
  - 85,000m cable tray
  - 1,100,000m cable
  - 18,000 panels / devices
  - 45,000 terminations
  - 26,000 E&I check sheets
  - 9000 instrument loops
  - 55 Leak Tests (6,732 splsCase Study – E&I / Leak Testing
The problem

- NO visibility on cable tray installation status
- Slow, manual processes to capture, verify, analyse & report on construction status
- Discrepancies in Actual vs subcontractor reported status
- Lost opportunities or ability for corrective action
E&I Process Deficiencies

The Solution

- Leverage existing design models (no cost)
- Utilise Autodesk technology for site inspection & near real time reporting
Drivers – Construction Program

- Cable tray on critical path - dependency of other activities such as pulling cable, termination and connection to end devices.
- Identify issues with adequate time to take corrective action
- Capitalise on early completion
Drivers – Process

- Save time in capturing, processing, analyzing and reporting on data from site
- Prioritise activities of site staff
- Validate status reported by subcontractors
Drivers – Communication

- Improved communication of status & priorities with visual (model based) tools to client and project stakeholders.
The Construction database facilitates turning the Engineering Model into a powerful construction model. Project data is continually analyzed to identify opportunities and constraints. Opportunity & Constraint Analysis.

Validated, accurate tray and device install status (data & model visibility)

Full Model Visibility

Accurate Field Status

Project Controls Validation
Return inspection data back to project office

4738m of cable tray installation validated in 55 days

Locate relevant part of plant and begin inspections

Mark up cable tray status on drawings including punch items

Locating scope

Cumbersome Recording

Take Off Cable tray status and update project systems

Revision discrepancies

Time Lag

3-5 days
Progressive Inspection Digitized – BIM360

- Retrieve Inspection scope onto iPad in 3D model format
- Model makes for easy navigation to relevant part of plant
- Mark up cable tray status on 3D Model including punch items

5957m of cable tray installation validated in 11 days 25% more cable tray verified in 1/5 the time

4738m of cable tray installation validated in 55 days

630% efficiency in capture

300% - 500% efficiency in data availability
# Nodal Drawings vs iPads

<table>
<thead>
<tr>
<th>Model enabled iPads</th>
<th>Nodal Drawings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accurate tray installation meterage</td>
<td>Inaccurate tray installation meterage</td>
</tr>
<tr>
<td>Status captured in real time and used in real time</td>
<td>Lag in processing node drawings of approx 3-4 days</td>
</tr>
<tr>
<td>All design tray captured</td>
<td>Not all branches have nodes (15%)</td>
</tr>
<tr>
<td>No lag in model visibility</td>
<td>Minimum 1 day lag in model visualization</td>
</tr>
<tr>
<td>Ability to capture photos of issues / clashes recorded against a branch</td>
<td>Manual process to record photos and node ID</td>
</tr>
<tr>
<td>Immediate update of cable pull availability (by 8am the next morning)</td>
<td>Lag based on processing node drawings (up to 2 weeks)</td>
</tr>
<tr>
<td>Automatic process</td>
<td>Manual process</td>
</tr>
<tr>
<td>Don’t need to look at document revisions, model is synced with the latest model</td>
<td>Need to look for revised drawings then manually mark up status again</td>
</tr>
<tr>
<td>5957m of cable tray installation validated in 11 days</td>
<td>4738m of cable tray installation validated in 55 days</td>
</tr>
<tr>
<td>25% more cable tray inspection in ⅕ the time</td>
<td></td>
</tr>
</tbody>
</table>
# End User Feedback

<table>
<thead>
<tr>
<th>Question</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>How functional is the navigation offered by the iPad?</td>
<td>Very easy, improving every day</td>
</tr>
<tr>
<td>How useful are the current viewpoints?</td>
<td>Have everything they need</td>
</tr>
<tr>
<td>Has this made the validation process more efficient?</td>
<td>&gt;2 times already and improving each day</td>
</tr>
<tr>
<td>How easy is it to update cable tray status?</td>
<td>Very easy</td>
</tr>
<tr>
<td>Would you have capacity to validate end devices if these were color coded to inspect?</td>
<td>+4 iPads for the rest of the team</td>
</tr>
<tr>
<td>Process improvement score out of 10</td>
<td>10</td>
</tr>
<tr>
<td>System score out of 10</td>
<td>8 (some tray missing, colors not always updated)</td>
</tr>
</tbody>
</table>

## Areas of Improvement

<table>
<thead>
<tr>
<th>Area</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automatic coloring of status when updated in the field</td>
<td>Not Possible</td>
</tr>
<tr>
<td>Use of iPad until 6pm to validate more tray</td>
<td>Complete</td>
</tr>
<tr>
<td>Viewpoints to reflect same configuration as the nodal drawing (DY familiar)</td>
<td>Complete</td>
</tr>
<tr>
<td>Ability to filter between ladder or punch tray</td>
<td>Complete</td>
</tr>
<tr>
<td>All tray to be included (currently 97%)</td>
<td>Request latest files from Head office</td>
</tr>
<tr>
<td>Not having to update colors on every viewpoint Lead Planner could save 30 mins / day</td>
<td>Request with Autodesk</td>
</tr>
</tbody>
</table>

## Areas of Concern

<table>
<thead>
<tr>
<th>Concern</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>What happens when planner is on leave</td>
<td>Expand to training to additional personnel</td>
</tr>
</tbody>
</table>
BIM360: Navisworks integration
Model colour coding & management

Information collected in field pushed into model
BIM360 Field: Site use on iPad
Object filtering & status
### BIM360 Field: Site use on iPad

#### Model objects & photos

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Status</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BRANCH 9 of PIPE /LV3A-HOLE-IN(SEON): E23UL2N-TRAY-HHL.rvm</strong></td>
<td>Not Started</td>
<td></td>
</tr>
<tr>
<td>Cable Tray Type: Low Voltage</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>&lt;Top Level&gt;</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>BRANCH 9 of PIPE /E22_cellar-PIN: E22UL1S-TRAY-HHL.rvm</strong></td>
<td>Not Started</td>
<td></td>
</tr>
<tr>
<td>Cable Tray Type: Instruments</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>&lt;Top Level&gt;</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>BRANCH 9 of PIPE /CD19A-PIN-B1-CT: E21UL1S-TRAY-HHL.rvm</strong></td>
<td>Started</td>
<td></td>
</tr>
<tr>
<td>Cable Tray Type: Instruments</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>&lt;Top Level&gt;</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>BRANCH 8 of PIPE /LV3A-HOLE-IN(SEON): E23UL2N-TRAY-HHL.rvm</strong></td>
<td>Not Started</td>
<td></td>
</tr>
<tr>
<td>Cable Tray Type: Low Voltage</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>&lt;Top Level&gt;</em></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
BIM360 Field: Site use on iPad Photos
BIM360 Field: Site use on iPad
Model views & object status
BIM360 Field: web
Object information
BIM360 Field: web
Cable tray & associated photos
BIM360 Field: web Reporting
Cable Tray Validation Timeline

- Thursday 04 June
  - BIM360 implemented
  - Substantial increase in fully validated tray
Achievement – Record Cable Pull

- >3,500m tray / week
- Accurate tray status = available cable pull
- 14 week average = 54,055m

- Best week 73,909m
End Devices

BLUE – NOT INSTALLED
RED – CHECK INSTALLATION
YELLOW – VALIDATED INSTALLED
ORANGE – VALIDATED INSTALLED & ALL CABLES PULLED
GREEN – VALIDATED INSTALLED & ALL CABLES TERMINATED

Termination Availability

18,000
Leak Testing

- Improved visibility of Leak Packs
- Identification of potential leak points
- Improved preparation efficiency for test
- Improved Field Orientation
- Ability to identify Leak Points
- Easy to update preparation status
- Easy to search for valve tags
Benefits

- Significant time savings for the customer
- Minimal overhead, utilises existing model data
- Improved communication across entire project team
- Early identification of issues and opportunities
- Near real-time electronic reporting replaces manual, paper based process
Key Success Factors

- Strong support, especially from lead planner to internal resistance/doubts on site
- Realistic initial scope
- Extensive investigation & pre-testing
- Collaborative approach & acceptance of constraints
Future Opportunities

- Application to new projects at initiation with wider scope & benefit.
- Advantages to client providing real construction visibility
- Extend usage to Quality, Commissioning & Wider Project Completion activities.
- Data handover at project conclusion
- Dispute Resolution – Audit Trail
## Benefit Summary

<table>
<thead>
<tr>
<th>Activity</th>
<th>Improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field Data Capture</td>
<td>Up to 630% efficiency v manual process (cable Tray)</td>
</tr>
<tr>
<td>Inspectors Field Time</td>
<td>Inspectors were able to spend 2 hours more time in the field per day v print drawings, manual offtake of status etc.</td>
</tr>
<tr>
<td>Data Availability for Analysis</td>
<td>Up to 500% efficiency v manual process</td>
</tr>
<tr>
<td></td>
<td>Up to 600% efficiency v Yard reported status (weekly)</td>
</tr>
<tr>
<td>Field Status Accuracy</td>
<td>15% validated v 70% reported tray install</td>
</tr>
<tr>
<td>Cable Pull</td>
<td>Productivity improvement of 250% (Yard norm 22,000m v achieved 54,055m) for sustained average</td>
</tr>
<tr>
<td></td>
<td>Productivity improvement of 350% for peak week</td>
</tr>
<tr>
<td>End Devices</td>
<td>Able to verify further status of cables at device, gland &amp; termination</td>
</tr>
<tr>
<td>Terminations</td>
<td>Ability to identify available terminations (drives loop availability)</td>
</tr>
<tr>
<td>Loops</td>
<td>Completed 4500 / 9000 Loops significantly ahead of schedule based on identification of availability</td>
</tr>
<tr>
<td>Leak Tests</td>
<td>200% efficiency in pack walk down and preparation for test</td>
</tr>
</tbody>
</table>
Project Benefits Summary

- Created accurate project status visibility
- Identified and visualized opportunities and constraints
- Enabled open communication
- Empowered our team to drive desired outcomes
- Realized project sailaway that ensures First Oil target in 2017 is achievable
- Schedule reduction of 3 months over a 12 month period against plan
Summary

- Improved Safety
- Improved Quality
- Increased Schedule Certainty
- Client Satisfaction

Improved Construction Performance

- Completions Focused Approach
- Progressive Inspection
- Capitalize Early Completions Opportunities
- Accountability
- Visualization
- Empowerment
- Influence Contractor Behavior
Anecdote
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