Photogrammetric Modelling for Bridge Inspection and Remediation
Introduction

• Current processes
• Limitations of current practice
• Photogrammetric modelling
• Case Study – Modelling for Inspection
• Framework for bridge management - repair / contractual documentation
Current processes - inspection

Time consuming and outdated?
Current processes – repair / remediation

Time consuming and outdated?
Limitations of current practice

- Reliance upon previous information documented in reports
- Oriented towards databases
- Focus on inventorising elements and defects
- Contractual documentation requires contractor assess requirements from limited information
- Reliance upon quantities that are measured on site and may not accurately reflect current condition
Photogrammetric Modelling
Photogrammetric Modelling

Stages of photogrammetry:

- Camera Alignment – geo-located images (reduce processing time and improves accuracy)
- Dense Point Cloud
- Triangulate Point Cloud into mesh (high resolution)
- ‘Baked’ into a low resolution mesh
- Project Photos onto textured low quality mesh (high resolution)

Example:
High resolution mesh information ‘Baked’ into low resolution mesh.
Photogrammetric Model

- Spatial warehouse for images to be projected onto 3-D mesh
- Seamless navigation around model to inspect areas of interest
- Able to assign information to the model and within individual images
- Capable of exporting information to a excel/PDF report
Case Study for Photogrammetric Modelling

- Steel truss bridges for inspection
- Use of drone for data capture
- Level 2 condition inspection
- Photogrammetric modelling used from drone and handheld camera imagery
- Desktop review of photogrammetric model
Case Study - Data Collection

• Multiple passes at varying heights and angles to the structure
• Flights from 2-5m from structure
• Capable of upwards camera orientation
• 25MP Digital SLR Camera with gimbal
Case Study – Post Processing

• 2,000 images collected
• > 3 million points (point cloud model)
• 7 days of processing for a high-resolution mesh
• Images projected onto mesh for accurate photogrammetric model
Case Study – Photogrammetric Model

PhotoVis
A Spacially Referenced Photo Catalogue
Photogrammetric Model

<table>
<thead>
<tr>
<th>Group</th>
<th>Enter Group...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Component</td>
<td>Enter Component...</td>
</tr>
<tr>
<td>Condition State</td>
<td>Choose Condition State...</td>
</tr>
<tr>
<td>Materials</td>
<td>Enter Materials, comma separated...</td>
</tr>
<tr>
<td>Defect Comments</td>
<td>Enter Defect Comments...</td>
</tr>
<tr>
<td>Comments</td>
<td>Enter Comments...</td>
</tr>
</tbody>
</table>
# Photogrammetric Model

<table>
<thead>
<tr>
<th>Group</th>
<th>Span 1 - Bay 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Component</td>
<td>Bottom Chord</td>
</tr>
<tr>
<td>Condition State</td>
<td>Condition State 3</td>
</tr>
<tr>
<td>Materials</td>
<td>Steel</td>
</tr>
</tbody>
</table>

**Defect Comments**
Evidence of coating breakdown on the bottom flange.

**Comments**
Generally in a fair condition, requiring monitoring at future condition inspections, with the view of recoating in the next 5 years.
Case Study - Outcomes

- Significantly improve information retention
- Reduce time required for inspection / desktop review (estimated 30% reduction in reporting time ~ 5-10% of overall project costs)
- Ability to contextualise current condition
- Removes need to reinspect where insufficient information is present or need for information later
- Significant post-processing time
- Considerable amount of data to be stored
Proposed framework for future bridge management

3-D Photogrammetric Model

- Routine Condition Inspection
  - Imagery recaptured to refine model
  - Compared with previous / historic models to enable a more accurate assessment of current condition
  - Assign maintenance requirements within 3-D model

- General Maintenance
  - Routine maintenance works captured in model
  - Maintenance works timestamped in model at date of rectification
  - Develop historical understanding of works undertaken and potentially recurring issues that may be indicative of a more systemic problem

Capital Intervention
- Repair areas highlighted within the model with extents of repairs marked up
- Location of services and other surrounding features included
- Enables contractor to understand site constraints and review the condition independently to assess potential areas that have not been included
Future potential – Repair / Remediation

- Inclusion of photogrammetric modelling as part of repair documentation
- Remove reliance upon paper-based specifications / BoQ
- Reduce risks of variations and unidentified defects
- Reduce delays to mobilisation / access
- Improve quality of information delivered to contractor
- Potential to be used for construction QA
Future potential – Repair / Remediation
Summary

- Photogrammetric modelling demonstrated ability to improve efficiency of inspections and reporting
- Contextualise issues and retain historical build-up
- Able to be capture information that may be pertinent within the model
- Potential to be applied to repair / remediation contracts