Opportunities for Enhancing Construction Inspections & Evaluations Using Time Lapse Photography

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Purdue Road School
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Building a better “base” knowledge

Field Experience

On-Site Tours

Hands-On Laboratory Learning

VS
Opportunities for Enhancing Construction Inspections & Evaluations Using Time Lapse Photography

Case Study Project
Site Visit Details & Equipment Information

Activity Identification and Estimation
Learning how to parse the data

Educational Module Development
Maximizing impact and conveying a message

Conclusions
Lessons learned and looking forward
South Split corridor in Indianapolis, with camera locations and traffic volumes
The South Split project included a number of high-profile elements

- Rapid response to bridge strikes
- Continuously reinforced concrete pavement
- Accelerated construction schedule

Example Bridge Strike on NB I-65/I-70 “South Split” Corridor
Inexpensive technology and creative field engineering can return outstanding results!

- Mounting challenges
- Power supply issues
- Security issues
Proper site selection and equipment calibration is an iterative process

- Scoping of mounting sites
- Dialogue with contractors
- Camera adjustments
- Additional opportunities for education & hands-on learning
Effective camera management was crucial to successful project documentation

- Lack of visible activity
- Dead batteries
- Malfunctioning equipment
- File management
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Camera images were grouped by major activities to begin building video sequences.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Real Time Duration</th>
<th>Video Segment Duration</th>
<th>Time in Video</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Excavation</td>
<td>5:21:00</td>
<td>0:00:20</td>
<td>0:01:25</td>
</tr>
<tr>
<td>b. Drainage Installation</td>
<td>7:50:00</td>
<td>0:00:18</td>
<td>0:01:47</td>
</tr>
<tr>
<td>c. Subgrade Treatment</td>
<td>3:13:00</td>
<td>0:00:14</td>
<td>0:02:10</td>
</tr>
<tr>
<td>d. Geotextile Fabric Install</td>
<td>8:00:00</td>
<td>0:00:26</td>
<td>0:02:34</td>
</tr>
<tr>
<td>c. Asphalt Base Paving</td>
<td>6:00:00</td>
<td>0:00:22</td>
<td>0:03:07</td>
</tr>
<tr>
<td>f. Rebar Installation</td>
<td>12:00:00</td>
<td>0:01:13</td>
<td>0:03:30</td>
</tr>
<tr>
<td>g. Concrete Paving</td>
<td>7:30:00</td>
<td>0:00:26</td>
<td>0:04:44</td>
</tr>
<tr>
<td>b. NB Girder Replacement</td>
<td>23:00:00</td>
<td>0:00:49</td>
<td>0:05:21</td>
</tr>
<tr>
<td>i. SB Girder Replacement</td>
<td>23:00:00</td>
<td>0:00:51</td>
<td>0:06:21</td>
</tr>
<tr>
<td>j. Cantilever Sign Foundation</td>
<td>16:15:00</td>
<td>0:01:13</td>
<td>0:06:45</td>
</tr>
<tr>
<td>k. Guardrail Installation</td>
<td>2:00:00</td>
<td>0:00:16</td>
<td>0:07:42</td>
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<td>l. NB Bridge Girder Painting</td>
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<td>0:00:50</td>
<td>0:07:59</td>
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<tr>
<td>m. Box Truss Overhead Sign</td>
<td>2:00:00</td>
<td>0:00:24</td>
<td>0:08:27</td>
</tr>
<tr>
<td>n. Lane Striping</td>
<td>17:30:00</td>
<td>0:00:12</td>
<td>0:08:51</td>
</tr>
<tr>
<td>o. Clearance Sign Removal</td>
<td>0:30:00</td>
<td>0:00:14</td>
<td>0:09:06</td>
</tr>
<tr>
<td>p. Interstate Reopening</td>
<td>3:00:00</td>
<td>0:00:31</td>
<td>0:09:20</td>
</tr>
</tbody>
</table>
Rendering a composite informational module for each activity from field data.

Video compilation of time lapse photos.

Activity ID & Timestamp.

Real-time Progression of Visible Activity.

Camera Location & Field of View.

Working Web Link: bitly.com/SouthSplit
Various estimation techniques were employed to determine activity quantities & costs

<table>
<thead>
<tr>
<th>Activity</th>
<th>Units</th>
<th>Total Project Quantity</th>
<th>Quantity Shown in Video</th>
<th>% Total Project Quantity</th>
<th>Total Project Bid Amount</th>
<th>Approximate Cost Shown in Video</th>
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</thead>
<tbody>
<tr>
<td>a. Excavation</td>
<td>yds²</td>
<td>92,204</td>
<td>1,280</td>
<td>1.4</td>
<td>$1,117,335</td>
<td>$16,211</td>
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<tr>
<td>b. Drainage Installation</td>
<td>ft</td>
<td>144</td>
<td>---</td>
<td>---</td>
<td>$7,096</td>
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<tr>
<td>c. Subgrade Treatment</td>
<td>yds²</td>
<td>75,341</td>
<td>2,452</td>
<td>3.2</td>
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<td>$15,116</td>
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<td>d. Geotextile Fabric Installation</td>
<td>yds²</td>
<td>80,340</td>
<td>2,950</td>
<td>3.7</td>
<td>$126,134</td>
<td>$4,667</td>
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<td>e. Asphalt Base Paving</td>
<td>tons</td>
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<td>540</td>
<td>5.1</td>
<td>$572,886</td>
<td>$29,217</td>
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<tr>
<td>f. Rebar Installation</td>
<td>lbs</td>
<td>2,171,500</td>
<td>54,721</td>
<td>2.5</td>
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<tr>
<td>g. Concrete Paving</td>
<td>yds²</td>
<td>64,056</td>
<td>1,628</td>
<td>2.5</td>
<td>$4,247,976</td>
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<td>h. NB Bridge Girdor Replacement</td>
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<td>1</td>
<td>100.0</td>
<td>$250,000</td>
<td>$250,000</td>
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<td>i. SB Bridge Girdor Replacement</td>
<td>lump</td>
<td>1</td>
<td>1</td>
<td>100.0</td>
<td>$250,000</td>
<td>$250,000</td>
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<tr>
<td>j. Cantilever Sign Foundation</td>
<td>ea</td>
<td>2</td>
<td>1</td>
<td>50.0</td>
<td>$13,690</td>
<td>$6,845</td>
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<td>k. Guardrail Installation</td>
<td>ft</td>
<td>6,413</td>
<td>138</td>
<td>2.1</td>
<td>$109,021</td>
<td>$2,289</td>
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<tr>
<td>l. NB Bridge Girdor Painting</td>
<td>lump</td>
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<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>m. Box Truss Overhead Sign</td>
<td>ea</td>
<td>3</td>
<td>1</td>
<td>33.0</td>
<td>$262,563</td>
<td>$87,721</td>
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<tr>
<td>n. Lane Stripping</td>
<td>ft</td>
<td>42,611</td>
<td>2,280</td>
<td>5.4</td>
<td>$23,184</td>
<td>$1,292</td>
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<td>o. Bridge Clearance Sign Removal</td>
<td>lump</td>
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<td>---</td>
<td>---</td>
<td>---</td>
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<tr>
<td>p. Interstate Reopening</td>
<td>---</td>
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<td>---</td>
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</tr>
</tbody>
</table>

Tabulation of Bid Item Quantities and Relation to Video Footage
Estimation techniques for pavement & soil excavation

• Truckloads of material removed

• $CY_{\text{excavate}} = 10 \times T_{\text{dump}}$
  
  ○ $CY_{\text{excavate}} = \text{cubic yds of material excavated}$
  
  ○ $T_{\text{dump}} = \text{number of trucks in video}$
  
  ○ Assume $\sim 10 \text{ yds}^3$ material per truck
Estimation techniques for hot-mix asphalt (HMA) paving

• Truckloads of material delivered

\[ T_{hma} = 10 \times T_{dump} \]

○ \( T_{hma} = \) Tons of HMA delivered

○ \( T_{dump} = \) number of trucks in video

○ Assume \(~10\) tons material per truck
Estimation techniques for rebar & continuously reinforced concrete

• Percentage of rebar vs. percentage of concrete (CRCP)

\[ CW_{\text{rebar}} = \frac{CY_{\text{CRCP}}}{PT_{\text{CRCP}}} = \frac{10 \times T_{\text{dump}}}{PT_{\text{CRCP}}} \]

  - \( CW_{\text{rebar}} \) = cumulative weight (lbs) of installed rebar
  - \( CY_{\text{CRCP}} \) = cubic yds of CRCP in video
  - \( PT_{\text{CRCP}} \) = cubic yds of CRCP on project
Documenting the central project task: bridge girder replacement

• Time lapse cameras solve a number of safety & logistical challenges

• Opportunities for QA/QC assessment

• Public relations/media involvement
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Multimedia Module Development
Maximizing impact and conveying a message

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Lessons learned and looking forward
The time lapse camera module is scalable and adaptable to a variety of projects

- Vertical vs. Horizontal construction operations
- Non-engineering processes
- Flexible & customizable

Wang Hall Construction, Purdue University

Wheat Harvest, Craigmont, ID
(images courtesy of Jeff Zenner)
The modules can be used for a variety of tasks

• Complement existing on-site inspections

• Comprehensive off-site teaching tool
  Virtual labs, remote classrooms

• Public outreach & education
  Online streaming, local media, agency publicity
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A number of important lessons were learned in the course of the module development

- Camera management
- Communication with agencies & contractors
- “On the fly” thinking and practical engineering judgment
The time lapse educational module is practice-ready and prime for field testing

• Easily implemented with minimal equipment and prep

• Useful for documenting new construction techniques and procedures

• Digital distribution and storage can maximize exposure serve as a practical means of archival