Opportunities for Enhancing Construction Inspections & Evaluations Using Time Lapse Photography

Steven Lavrenz, Darcy Bullock
Purdue University

Purdue Road School
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JOINT TRANSPORTATION RESEARCH PROGRAM
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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

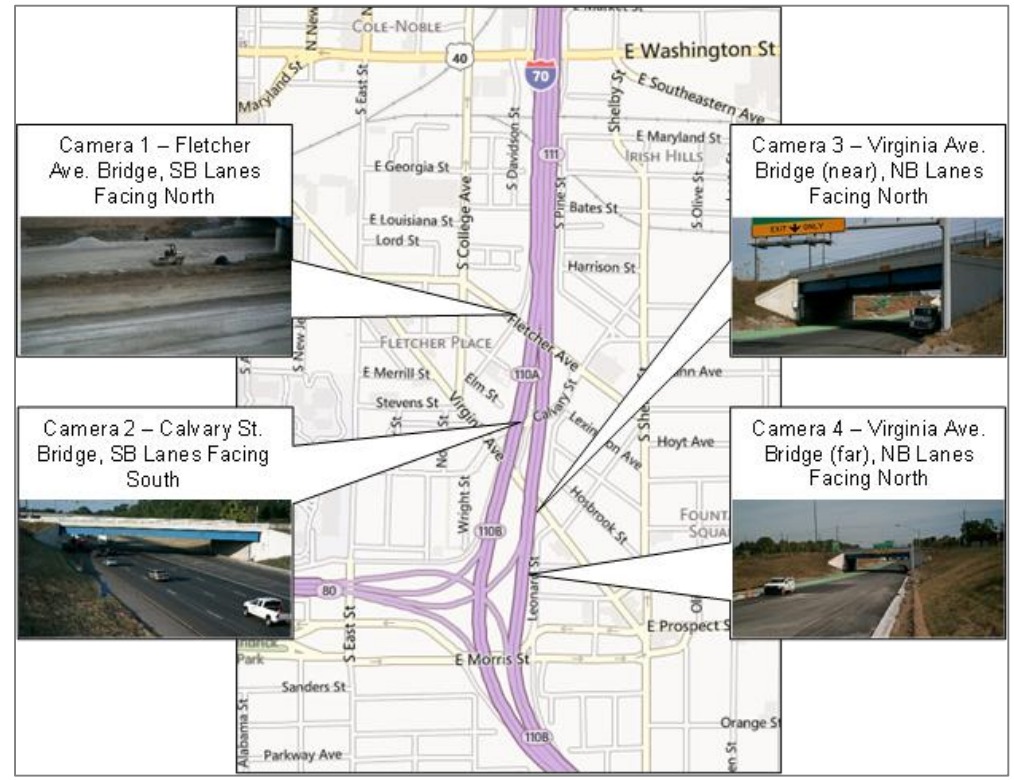
Educational Module Development

Maximizing impact and conveying a message

Conclusions

Lessons learned and looking forward

South Split corridor in Indianapolis, with camera locations and traffic volumes



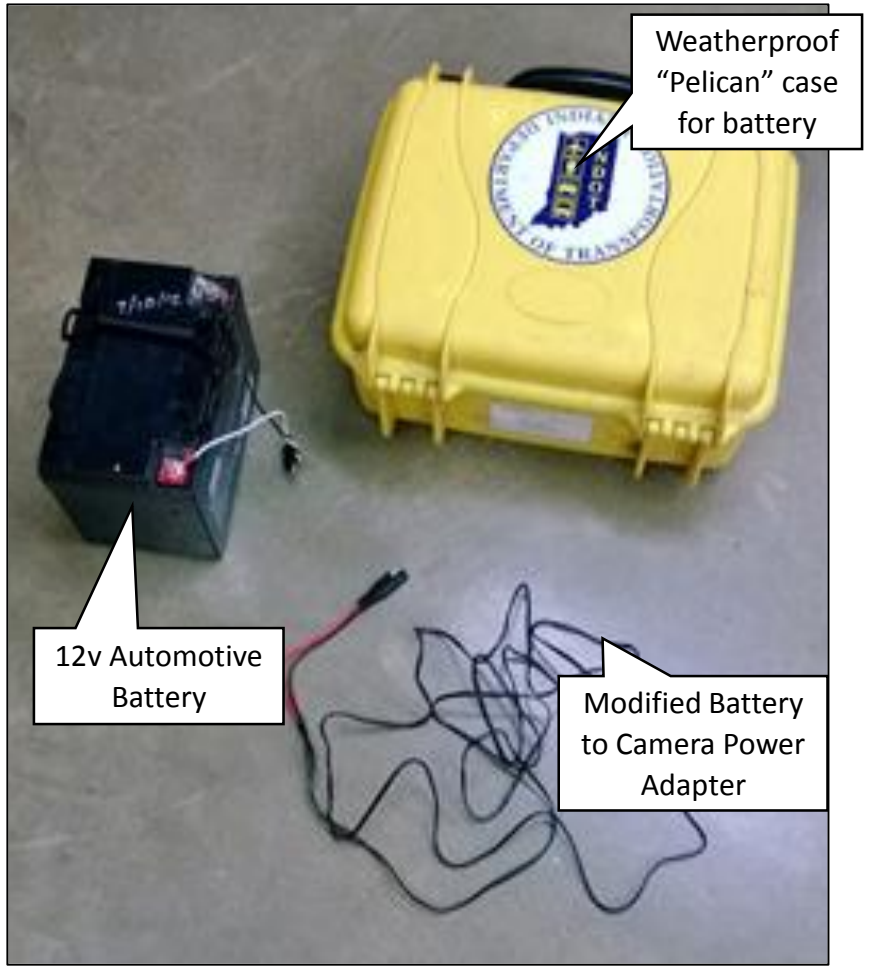
The South Split project included a number of high-profile elements

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

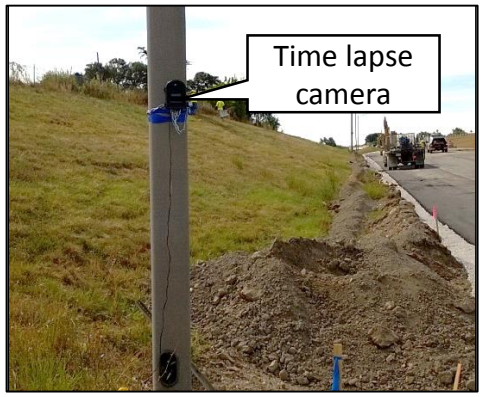
Example Bridge Strike on NB I-65/I-70 “South Split” Corridor

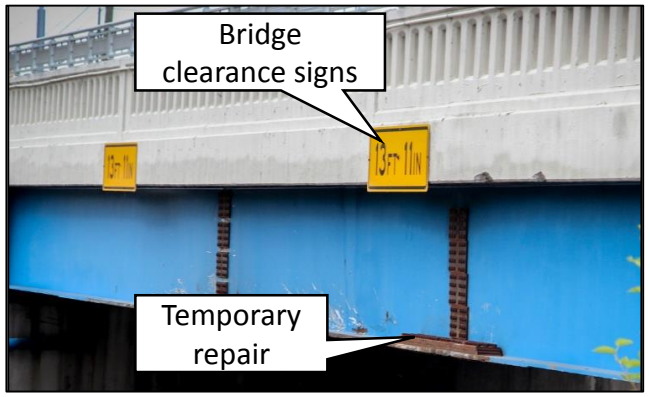
Inexpensive technology and creative field engineering can return outstanding results!

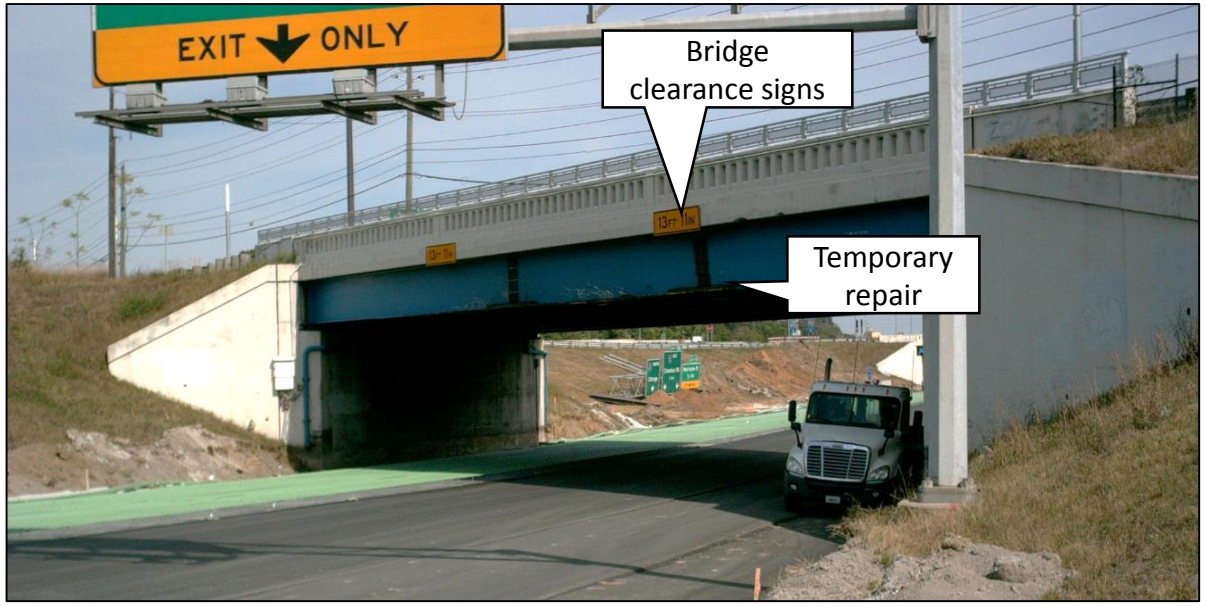
- Mounting challenges
- Power supply issues
- Security issues



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

Camera Droop

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Camera images were grouped by major activities to begin building video sequences

	Activity	Real Time Duration	Video Segment Duration	Time in Video
a.	Excavation	5:21:00	0:00:20	0:01:25
b.	Drainage Installation	7:50:00	0:00:18	0:01:47
c.	Subgrade Treatment	3:13:00	0:00:14	0:02:10
d.	Geotextile Fabric Install	8:00:00	0:00:26	0:02:34
e.	Asphalt Base Paving	6:00:00	0:00:22	0:03:07
f.	Rebar Installation	12:00:00	0:01:13	0:03:30
g.	Concrete Paving	7:30:00	0:00:26	0:04:44
h.	NB Girder Replacement	23:00:00	0:00:49	0:05:21
i.	SB Girder Replacement	23:00:00	0:00:51	0:06:21
j.	Cantilever Sign Foundation	16:15:00	0:01:13	0:06:45
k.	Guardrail Installation	2:00:00	0:00:16	0:07:42
l.	NB Bridge Girder Painting	11:30:00	0:00:50	0:07:59
m.	Box Truss Overhead Sign	2:00:00	0:00:24	0:08:27
n.	Lane Striping	17:30:00	0:00:12	0:08:51
o.	Clearance Sign Removal	0:30:00	0:00:14	0:09:06
p.	Interstate Reopening	3:00:00	0:00:31	0:09:20

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

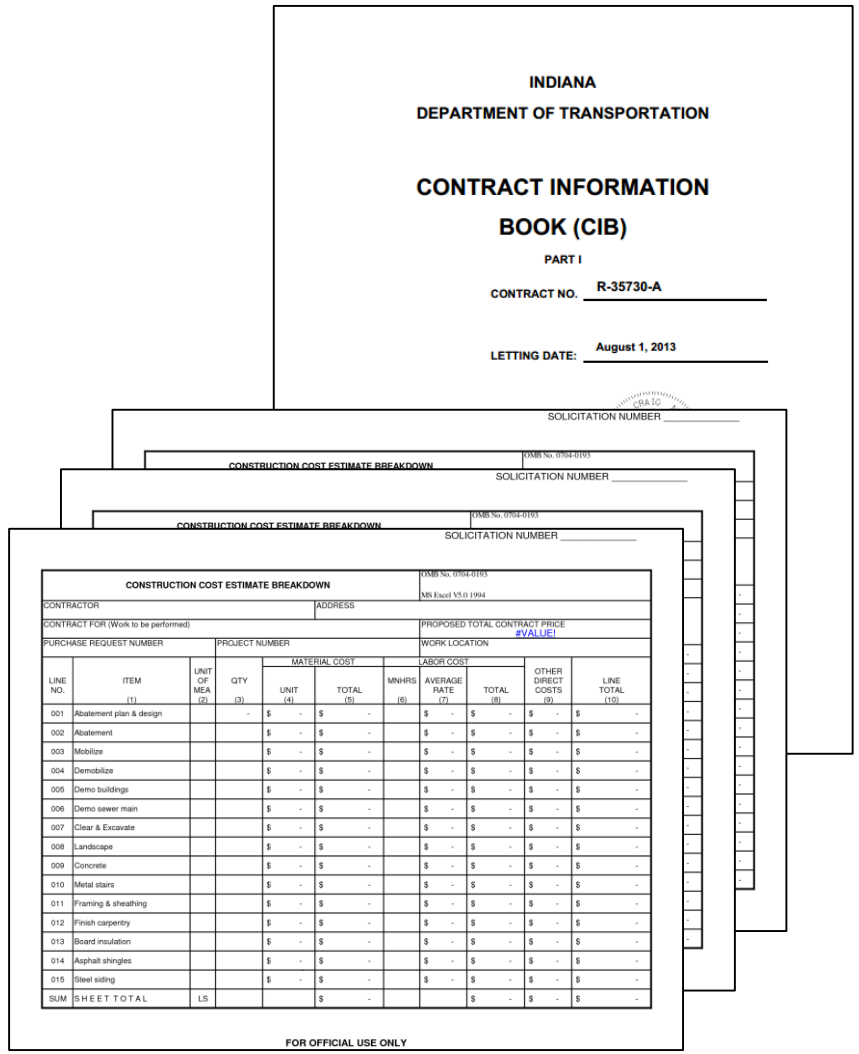
Camera Location & Field of View

Working Web Link: bitly.com/SouthSplit

Various estimation techniques were employed to determine activity quantities & costs

	Activity	Units	Total Project Quantity	Quantity Shown in Video	% Total Project Quantity	Total Project Bid Amount	Approximate Cost Shown in Video
a.	Excavation	yds^3	92,204	1,280	1.4	$1,117,335	$16,511
b.	Drainage Installation	ft	144	---	---	$7,096	---
c.	Subgrade Treatment	yds^2	75,541	2,435	3.2	$472,367	$15,116
d.	Geotextile Fabric Installation	yds^2	80,340	2,950	3.7	$126,134	$4,667
e.	Asphalt Base Paving	tons	10,609	540	5.1	$572,886	$29,217
f.	Rebar Installation	lbs	2,171,500	54,721	2.5	---	---
g.	Concrete Paving	yds^2	64,056	1,628	2.5	$4,547,976	$113,699
h.	NB Bridge Girder Replacement	lump	1	1	100.0	$250,000	$250,000
i.	SB Bridge Girder Replacement	lump	1	1	100.0	$250,000	$250,000
j.	Cantilever Sign Foundation	ea	2	1	50.0	$13,690	$6,845
k.	Guardrail Installation	ft	6,413	138	2.1	$109,021	$2,289
l.	NB Bridge Girder Painting	lump	---	---	---	---	---
m.	Box Truss Overhead Sign	ea	3	1	33.0	$262,563	$87,521
n.	Lane Striping	ft	42,611	2,280	5.4	$23,184	$1,292
o.	Bridge Clearance Sign Removal	lump	---	---	---	---	---
p.	Interstate Reopening	---	---	---	---	---	---

Tabulation of Bid Item Quantities and Relation to Video Footage



Estimation techniques for pavement & soil excavation

- Truckloads of material removed
- $CY_{excavate} = 10 * T_{dump}$
  - $CY_{excavate}$ = cubic yds of material excavated
  - T_{dump} = number of trucks in video
  - Assume ~10 yds^3 material per truck

(a) 9/5/2013 12:39:00

(b) 9/5/2013 13:43:00

(c) 9/5/2013 14:53:00

(d) 9/5/2013 15:51:00

(e) 9/5/2013 16:46:00

(f) 9/5/2013 17:58:00

Estimation techniques for hot-mix asphalt (HMA) paving

- Truckloads of material delivered
- $T_{hma} = 10 * T_{dump}$
  - T_{hma} = Tons of HMA delivered
  - T_{dump} = number of trucks in video
  - Assume ~10 tons material per truck

(a) 9/20/13 13:16:00

(b) 9/20/13 14:16:00

(c) 9/20/13 15:17:00

(d) 9/20/13 16:18:00

(c) 9/20/13 17:18:00

(d) 9/20/13 18:17:00

Estimation techniques for rebar & continuously reinforced concrete

(a) 9/12/2013 12:22:00

(b) 9/17/2013 10:28:00

(c) 9/23/2013 10:58:00

(d) 9/24/2013 12:00:00

(e) 9/24/2013 15:27:00

(f) 9/25/2013 12:17:00

(g) 9/25/2013 15:44:00

(h) 10/17/2013 10:00:00

- Percentage of rebar vs. percentage of concrete (CRCP)
- $CW_{rebar} = \frac{CY_{CRCP}}{PT_{CRCP}} = \frac{10 * T_{dump}}{PT_{CRCP}}$
  - CW_{rebar} = cumulative weight (lbs) of installed rebar
  - CY_{CRCP} = cubic yds of CRCP in video
  - PT_{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

(a) 9/30/2013 10:55:00 (b) 9/30/2013 13:34:00

(c) 10/01/2013 13:42:00 (d) 10/02/2013 07:19:00

(e) 10/02/2013 09:09:00 (f) 10/02/2013 11:09:00

(g) 10/16/2013 13:49:00 (h) 10/17/2013 14:10:00

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Multimedia Module Development
Maximizing impact and conveying a message

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The time lapse camera module is scalable and adaptable to a variety of projects

Wang Hall Construction, Purdue University

Wheat Harvest, Craigmont, ID
(images courtesy of Jeff Zenner)

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

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

Local Media Coverage of South Split Closure

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Purdue University

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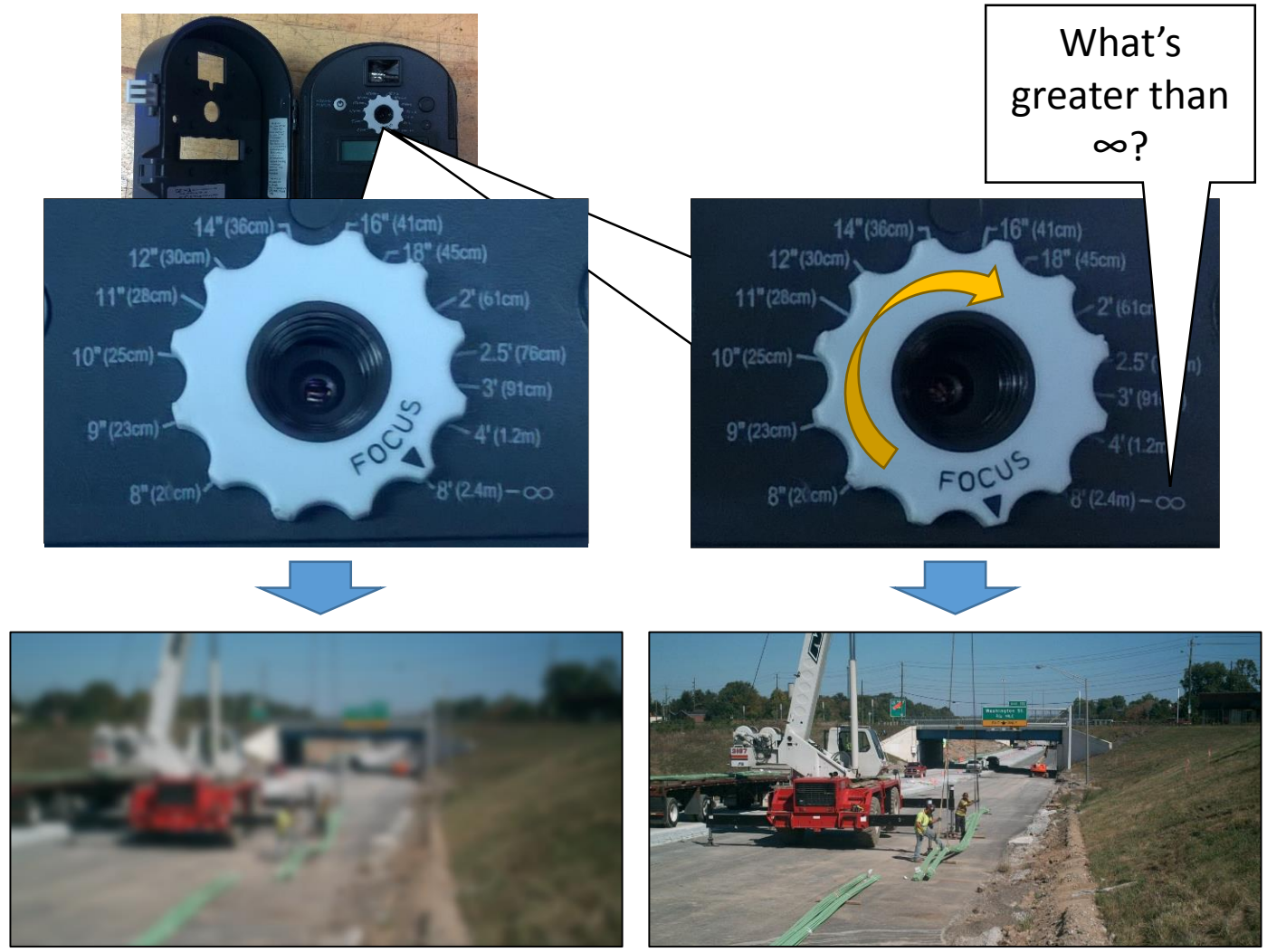
A number of important lessons were learned in the course of the module development

- 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