3-D Laser Scanning
A Case Study in Retrofit Masonry Ties

Presented by:
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Matt Kutzler
Project Manager

- Graduate of Penn State (architectural engineering)
- At FEA since 2004
- Registered Engineer and Construction Document Technologist
- Primary focus has been repair and restoration
Learning Objectives

• The basics of 3D laser scanning
• The challenges of gathering information in the field
• How scanning can be applied to a repair project
Why are we here?

Source: www.villageofjoy.com/50-strange-buildings-of-the-world/
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Just the (background) facts

3D Laser Scanning
  - How many wall ties?!  
  - When is enough enough?
  - The Technology of the Future
Just the (background) facts

› Philadelphia enacted a façade ordinance in 2010

› Scheduled façade inspections to be performed by a licensed Professional Engineer or Registered Architect
Just the (background) facts

› 20-story commercial office building
› Center City district of Philadelphia
› Constructed in 1970
› First inspection required by June 30, 2012
Just the (background) facts
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Source: maps.google.com
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How many wall ties?!

Original design drawings

› Corrugated galvanized metal ties
› Vertically: every three to four courses
› Horizontally: one on each side of mechanical chases (two into face of larger projections)
How many wall ties?!
How many wall ties?!
Repair project in early 1990’s

- Prompted by general deterioration and water infiltration
- Brick removed at top of mechanical chases
- Lack of brick ties uncovered
How many wall ties?!
How many wall ties?!

Solution A: Install retrofit masonry ties throughout the building
How many wall ties?!

Solution A: Install retrofit masonry ties throughout the building

Solution B: Don’t do anything

Solution C: Do something in between
• Just the (background) facts
• 3D Laser Scanning
  • How many wall ties?!
  • When is enough enough?
  • The Technology of the Future
When is enough enough?

Typical façade assessments include:
When is enough enough?

Observations are made from:
When is enough enough?

Drawbacks of visual assessment

› Limited by scope, schedule, cost
› Subjectivity
› Affected by factors such as weather, fatigue, etc.
› Potential for human error
When is enough enough?

Coming back to our building...
When is enough enough?
When is enough enough?
Just the (background) facts

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The Technology of the Future
How to overcome challenges?

› Inaccurate estimate could lead to cost overruns

› Impact on schedule

› Contractor would have little to no direction

› Increased access to façade did not make financial sense
Answer:

Three-dimensional laser scanning

3D laser scanning involves gathering millions of data points to manifest into lines and planes for documentation of existing conditions.
Data Collection:

› Similar to surveying

› Typically a two person crew

› Establish a baseline of reference to link to GPS
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Data Collection:

› Scanner set up on tripod and attached to computer

› 360° sphere captured during 20 second rotation
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Data Collection:

› “Time of flight” of laser recorded and converted to distance, referenced to baseline, and given GPS position
Data Analysis: Millions of data points are “cleaned”
Data Analysis: “Noise” must be removed

Steam from rooftop units appears in scan
Data Usage:

› Drawings in CAD
› Comparative analysis to look for trends in movement
› Accurate within a thousandth of a foot
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Data Usage:

› Data can be manipulated for desired output

Example: Identify points more than $\frac{1}{2}$-inch away from base plane for possible retrofit masonry tie installation
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Data Usage:

› Repeatable data for future comparisons

Example: Point data can be used as a baseline against detection of future movement, such as updating a façade ordinance submission in five years
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Cost Considerations:

› Costs dependent on desired outcome

› Reduced assessment fees (less staging, fewer professional hours)

› Benefits of point data comparisons

› Concentrated repairs where needed, avoidance of unnecessary repairs and possible change orders, etc.
Final Thought

Laser scanning should be considered supplemental to professional engineering judgment, not a replacement.
3D Laser Scanning:

› Useful for a variety of applications

› Augments visual observations, not replaces them

› Data records can be used for other purposes or revisited at a later date
Contact Information

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Thanks!