Construction Engineering Requirements for Integrating Laser Scanning Technology and Building Information Modeling (BIM)

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Presentation Agenda

Scope and purpose of paper
Research objectives
Discussion of BIM/VDC terminology
Discussion of 3D imaging terminology
Laser scanning processes
Discussion of laser scanning applications
Integrated BIM/laser scanning process map
Project phase breakdown and requirements
Summary and future research
Closing Comments

Scope of Research

Purpose
The purpose of this paper is to investigate the processes and workflows associated with terrestrial, mobile, and aerial 3D laser scanning for construction projects and propose a framework for integration with a Building Information Modeling (BIM) approach.

Research approach
1. classify key applications
2. establish technical requirements
3. present BIM/VDC workflows
4. propose integration framework

3D Imaging Terminology

Equipment types
- 3D laser scanner (LiDAR, LADAR)
- 3D range camera (Flash LADAR)
- 3D optical scanner (Total Station)

Measurement methods
- Pulsed Time-of-flight (longer max range)
- Phase-based (shorter max range)
- Broad-field illumination (laser, LED)
- Triangulation (relative coordinates)

Data capture capability:
- Distance
- Intensity
- Color (RGB)
- Photo/Video
- [IMU]
- [GPS]
BIM/VDC Terminology

- **Building Information Modeling (BIM)**
  - "A digital representation of physical and functional characteristics of a facility."
  - National Building Information Modeling Standard (NBIMS)

- **Virtual Design and Construction (VDC)**
  - "Integrated multi-disciplinary performance models of design-construction projects to support explicit and public business objectives."
  - Stanford Center for Integrated Facility Engineering (CIFE)

Key requirements of a BIM/VDC approach:
- **Product**: Intelligent 3D-model based design
- **Process**: Integrated, collaborative workflows
- **Organization**: Life-cycle focused project teams

Laser Scanning Process

- **Acquisition**
  - Planning activities and field operations associated with spatial data acquisition

- **Interpretation**
  - Post-processing, filtering, classifying, and modeling acquired point cloud data

- **Application**
  - Using point cloud data outputs to aid in performing engineering and management tasks

Acquisition
Key requirements for BIM/LS integration:

- Develop comprehensive model management plan with 3D modeling standards
- Establish model management strategy focusing on level of detail
- Establish requirements for acquisition and processing of scan data
Key requirements for BIM/LS integration:

- Develop comprehensive as-built model based on survey, measurement, and inspection goals
- Establish life-cycle approach for point cloud data management
- Identify and scan areas most applicable for design development

- Establish coordinate system and registration requirements
- Determine interoperability and processing limitations
- Reduce mobilization costs by identifying potential areas for detailed scan operations

- Establish frequency and scope of scans based on measurement and inspection goals
- Identify appropriate equipment for speed/accuracy requirements
- Create reporting standards for in-progress analysis and inspection
Process Map

Key requirements for BIM/LS integration:
- develop a comprehensive as-built project database based on operations and maintenance personnel input
- acquire scan data for areas of potential expansion and renovation
- integrate 3D model with maintenance, operations, and security

PROGRAMMING
PLANNING
DESIGN
CONSTRUCTION
O & M

Framework Summary

STEP 1: start by identifying survey, inspection, measurement, and application goals

STEP 2: identify applications that directly improve existing the ability to achieve these goals by
1) providing the same data more efficiently or
2) providing better data with the same level of effort

STEP 3: select applications that provide the best life-cycle benefits

ALWAYS: look for opportunities to supplement laser scanning applications with additional technologies

Future Research

- Evaluate and refine mechanics of framework on 3 case study projects
- Identify and evaluate additional time-based applications of laser scanning
- Further explore integration of point cloud data with 3D engineering design platforms
Proliferation of BIM in industry leads to improved interoperability and data integration

Popularity of laser scanning leads to improved equipment and processing methods

Laser scanning serves as a catalyst for streamlined, accurate, and efficient managing and coordinating of as-built and as-designed data

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