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Spot on Site

Maximizing Jobsite Robotics for Evaluating Housekeeping

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Emerging Technology Manager | Skanska

Brooke Gemmell

- Work:
  - Emerging Technology Manager
  - Skanska USA Building
  - Portland, OR
- Education:
  - Civil & Environmental Engineering at University of California, Berkeley
  - Sustainable Design Minor

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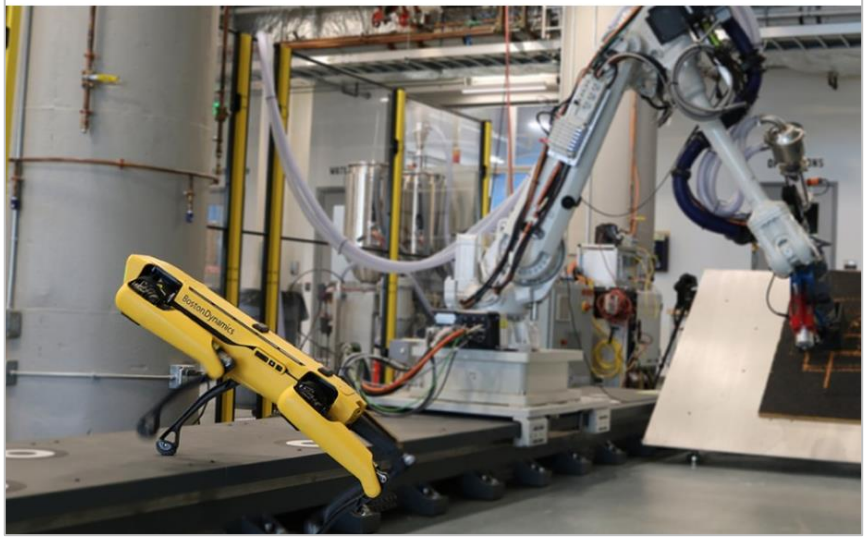
Project Origin

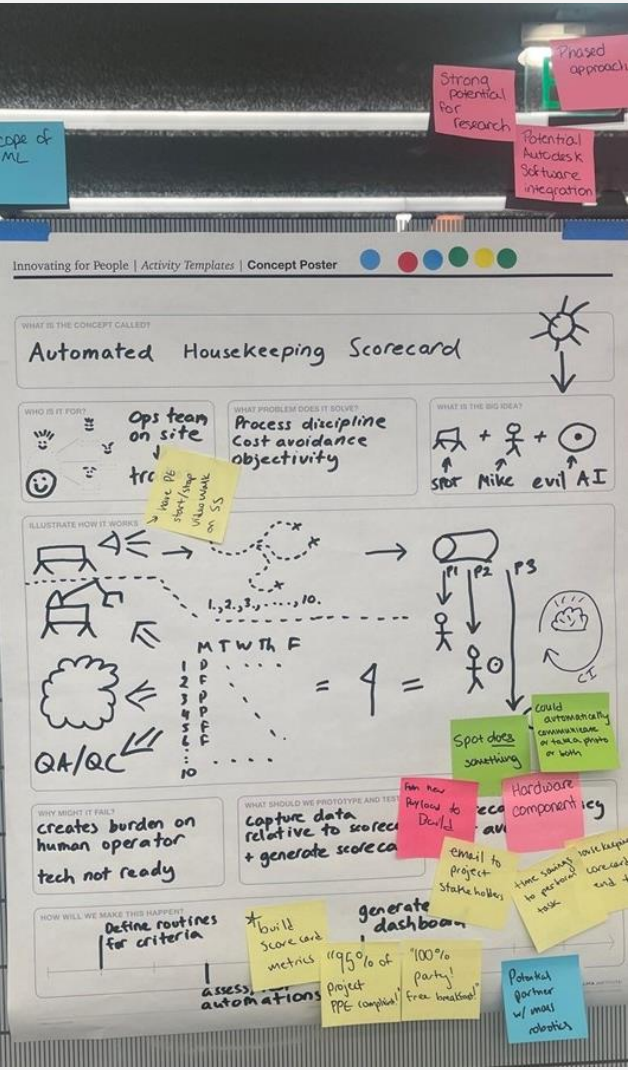
A Collaboration Story

- August 2021: Call for Proposals
- True collaborative approach leveraging resources from all parties
  - **Boston Dynamics** - Spot hardware and expertise
  - **Autodesk** - Technology Center Lab Space and technical support
  - **Skanska** - Construction experience and jobsite testing opportunities

Autodesk Technology Centers Call for Proposals: On-Site Automation and Site-Based Robotics

Published on August 10, 2021





Ideation Session

- Skanska hosted 2-day workshop to ideate and prioritize use cases
- Team chose **Housekeeping** as the primary use case
  - Current process is inconsistent, infrequent, and takes a lot of time
  - Housekeeping is the heartbeat of the jobsite – it is so much more than just keeping your site clean

Project Goal

Automate housekeeping inspections and analysis to improve jobsite housekeeping and safety record over time.

Can we….

- Automate capture of photos to be used in housekeeping analysis?
- Automate analysis of housekeeping photos?
- Successfully navigate around a jobsite with Spot?
- Consistently repeat autonomous Spot missions over time?
- Engage craft workers onsite and educate them about Spot?
- Improve housekeeping and safety record over time?

Solution

Solution

Plan	Walk	Capture	Upload	Analyze
	 +	STRUCTIONSITE		NEWMETRIX

Testing

Dual Approach

- Testing
  - Capture: Human vs. Spot
  - Analysis: Human vs. Computer
- Technology Center Testing
  - Learning and developing processes
- Jobsite Testing
  - Testing in real-world conditions
- Iterative Approach
  - Revisit testing locations after two month to test repeatability


EXIT AUTONAUT
STOP
Drive around until the robot sees a fiducial that was in the mission. The first fiducial in the mission are:
#203, #216
Walk

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Capture

Capture

- Human Method
  - Manually walk site using StructionSite Videowalk, holding 360 camera on monopod
- Spot Method
  - Autonomously walk site using Structionsite Videowalk, with 360 camera fixed on Spot

Capture Criteria: Human vs. Spot

- Capture Speed
- Photo Density
- Photo Quality
- Impact to Site
- Risk of Incident
- Cost to Deploy

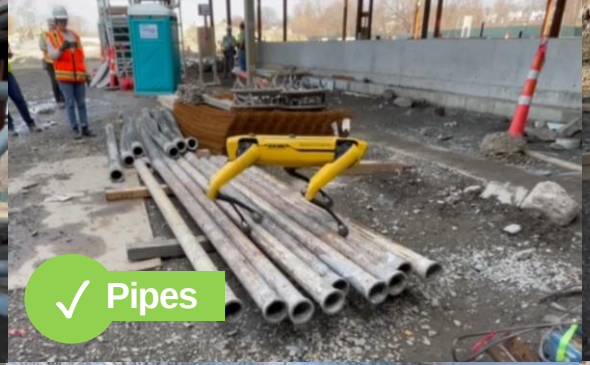
Capture: Human vs. Spot

Criteria	Human	Spot
Capture Speed	✓ (2x faster)	X (2x slower)
Photo Density	X	✓ (2x photos)
Photo Quality	✓	✓ (more consistency)
Impact to Site	✓ (craft engagement)	X (distracting)
Risk of Incident	Same	Same
Cost to deploy	✓	X (5x human)

Maneuverability

- Navigating Obstacles
  - Spot expertly navigated terrain in the lab space and jobsite
  - There was a strong correlation between where spot had issues and where we saw housekeeping issues

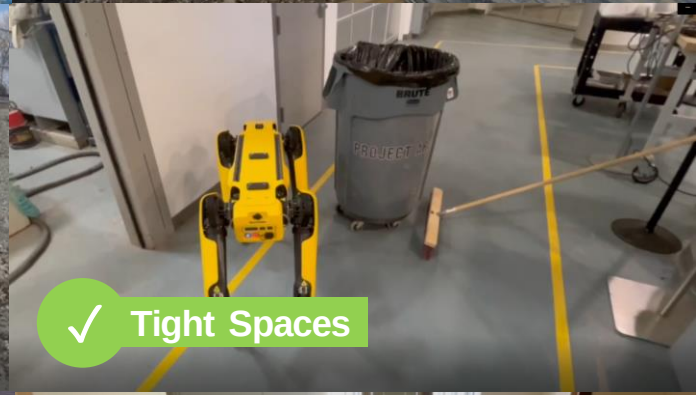

✓ Stairs


✓ Pipes


✓ Metal Decking

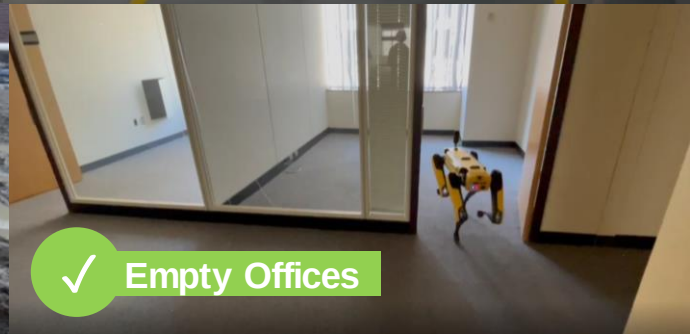

✓ Rocks


✓ Steep Hills


✓ Tight Spaces


✓ Ladders


✓ Mud

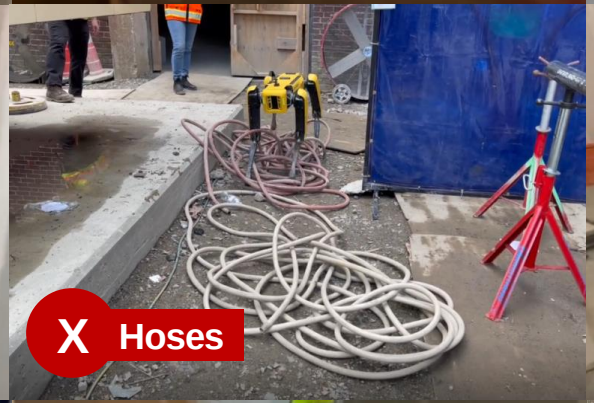

✓ Empty Offices

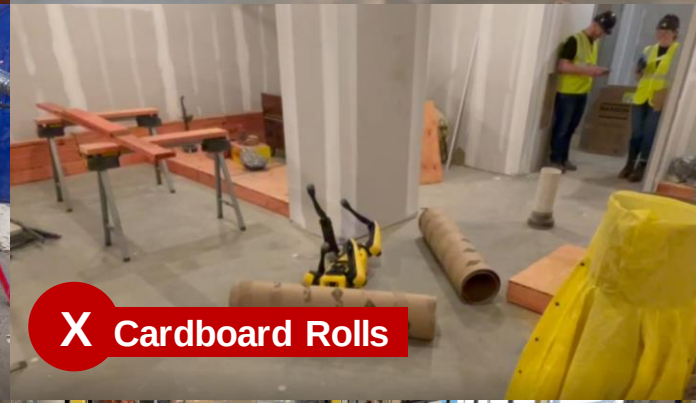

X Glass Walls


X Power Cords


X Clear Partitions


X Plastic Sheets


X Hoses


X Cardboard Rolls


X Cardboard Rolls


X Obstructions


X Caution Tape

Repeatability

- Repeating Autowalks
  - Spot was unable to carry through with the mission in areas with significant material storage and site changes

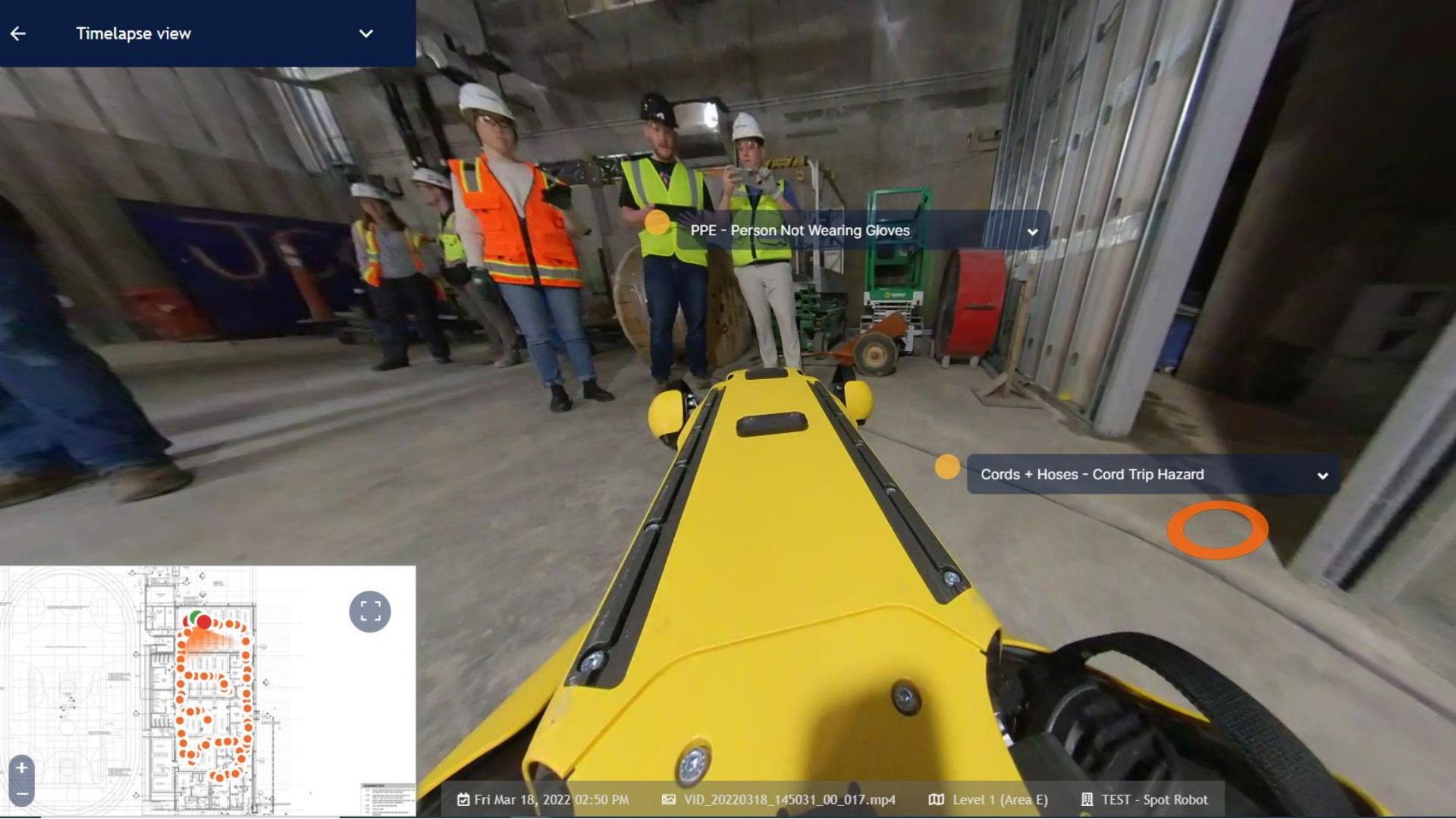

view
Fri Mar 18, 2022 11:50 AM


Timelapse view
Wed May 25, 2022 07:52 AM

Housekeeping Analysis

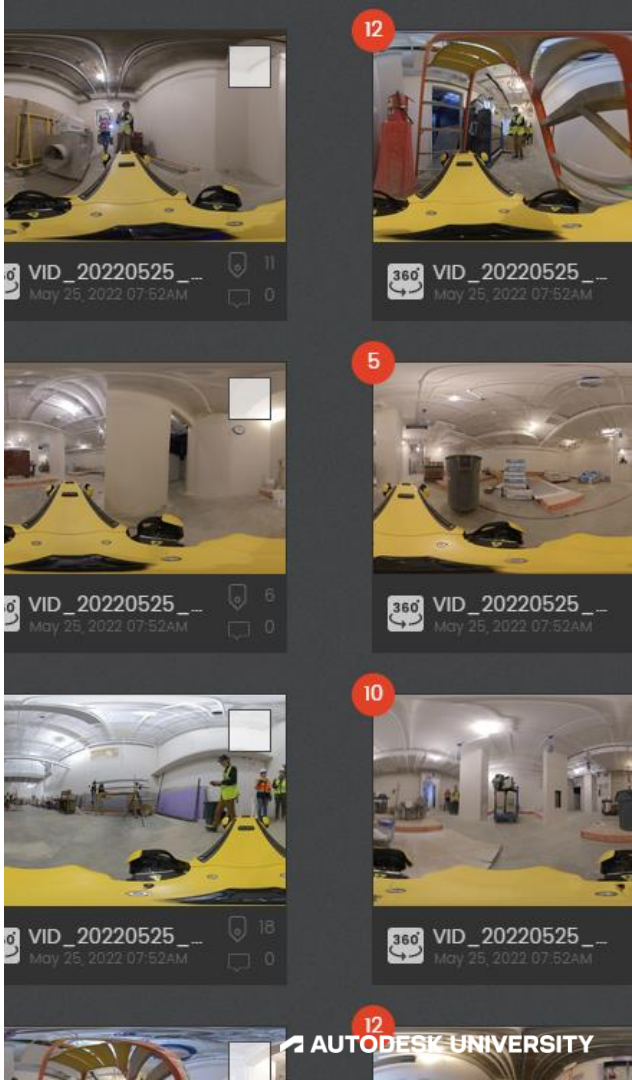
Housekeeping Analysis

- Human Method
  - Human review all photos and flags issues


Timelapse view
PPE - Person Not Wearing Gloves
Cords + Hoses - Cord Trip Hazard
Fri Mar 18, 2022 02:50 PM
VID_20220318_145031_00_017.mp4
Level 1 (Area E)
TEST - Spot Robot

Housekeeping Analysis

- Computer Method
  - AI reviews all photos and flags issues
  - Human reviews flagged photos



Spot Test

Housekeeping | All time - Now | Search

Evan Reilly ER

Projects

Search projects

- Skanska USA Building
- Evan Reilly's Sandbox
  - ! Sample Pro...
  - Spot Test
    - Files
    - Tags
    - Profile
    - Members
    - Integrations
    - Deleted

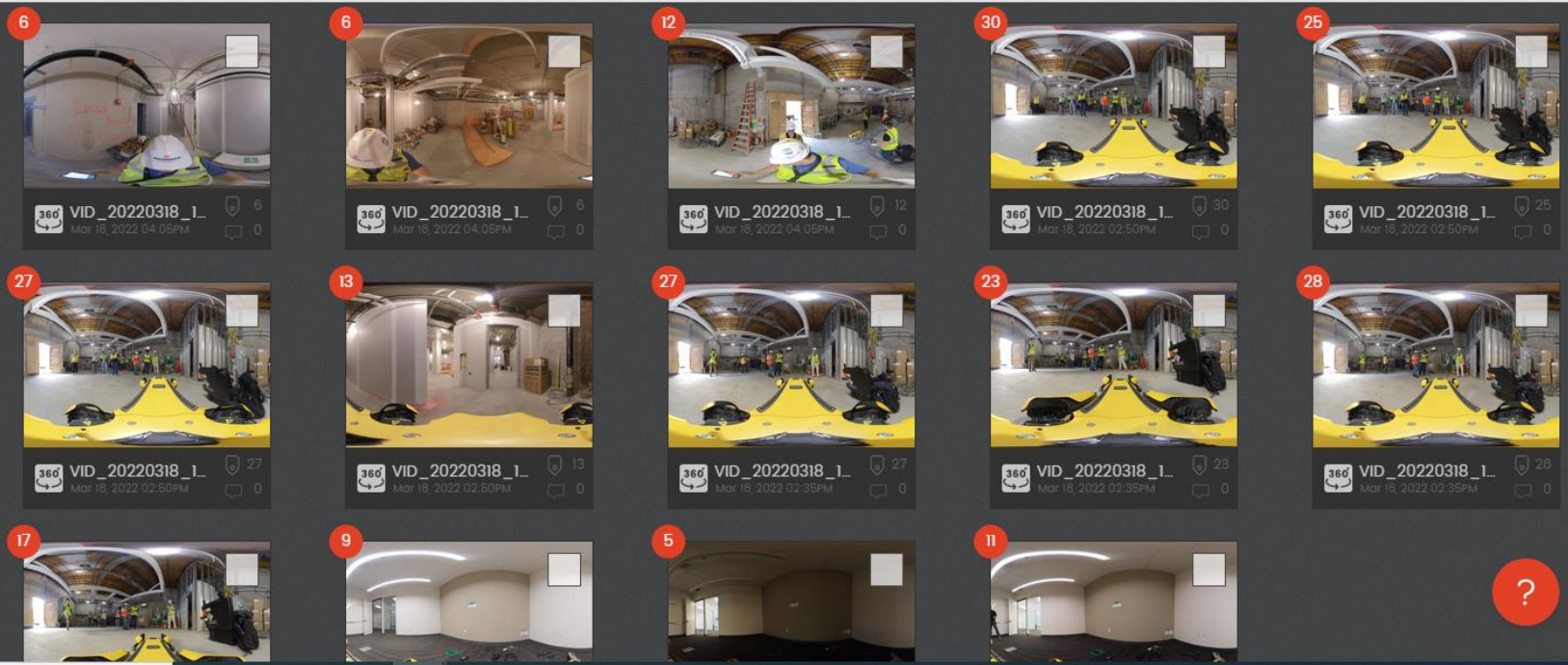
Admin

14 matches found for files tagged **Housekeeping**

SmartFilter

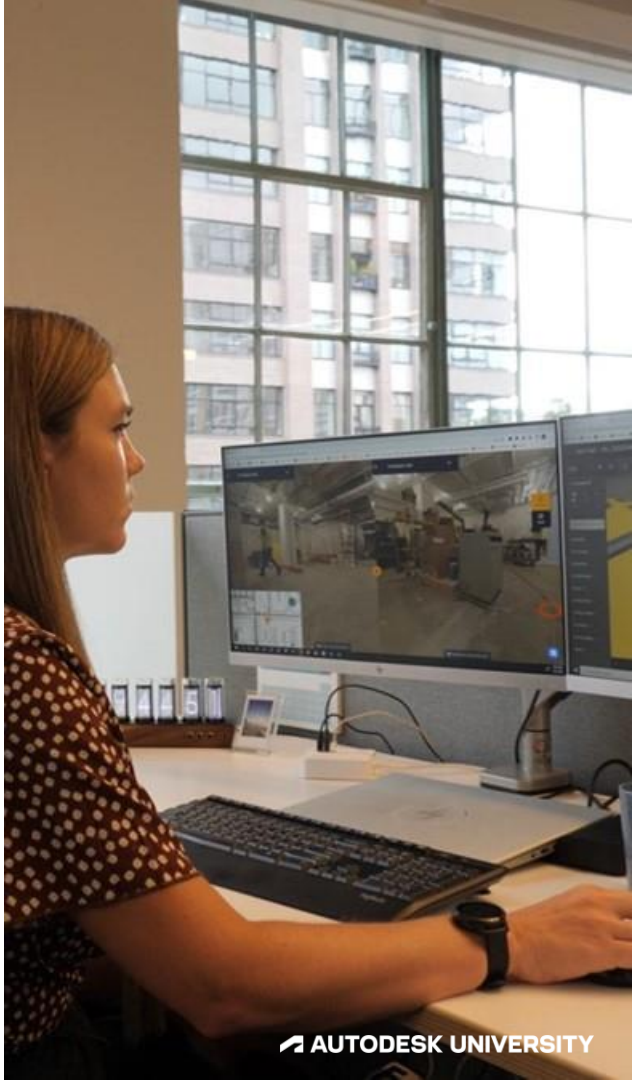
14 — 47 — 125

MORE CONFIDENT — LESS CONFIDENT



Analysis Criteria: Human vs. Computer

- Review Time
- Issues Identified
- Valid Issues
- Unique Issues



Capture: Human vs. Computer

NEWMETRIX

Criteria	Human	Computer
Review Time	X (45 min)	✓ (<2 minutes)
Issues Identified	✓ (24 issues)	X (11 issues)
Valid Issues	✓ (100%)	✓ (100%)
Unique Issues	✓ (24 unique issues)	X (5 unique issues)

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Craft Response to Spot


CAT

Craft Response to Spot

- Somewhat distracted during Spot walks
- Need to clearly communicate what Spot's job is
- In general, lots of excitement and interest in Spot!

Research Findings

Can we….

- Automate capture?
  - Almost! StructionSite/Spot integration is needed to fully automate.
- Automate analysis?
  - Yes! However, the automated analysis is still rudimentary and only identified 20% of issues.
- Navigate the site with Spot?
  - Yes! Spot expertly navigated the jobsite, but struggled with clear partitions, caution tape, and areas with housekeeping issues.
- Repeat Autowalks?
  - It depends. Site changes impact Spot's ability to repeat autowalks.
- Engage craft workers?
  - Yes! High interest and engagement from craft workers.
- Improve housekeeping and safety record?
  - We were unable to evaluate this due to lack of daily jobsite testing.

Big Thanks!

Skanska

Evan Reilly

James Mustico

Boston Ideation Session Attendees

National Emerging Tech Team

Belmont High School Team

380 Stuart St Team

Autodesk Technology Center Staff

Stephanie Pender

Adam Day

Kristen McClary

Joe Aronis

Boston Dynamics

Brian Ringley and Team

Autodesk Research Team

Angie Foss

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Mei-yen Shipek

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