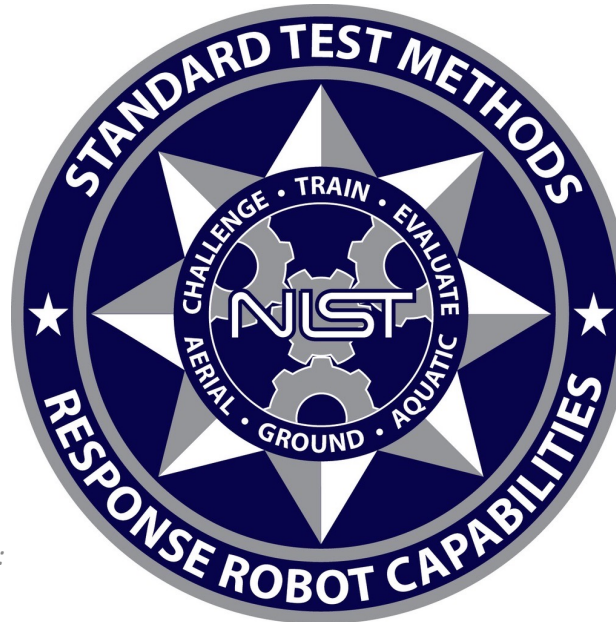


ASTM E54.09 Homeland Security Applications; Response Robots Search Tasks in Labyrinths, Mazes, and Scenarios

Version 2022A



**STARTS AT 10:00 AM EST
WASHINGTON, DC TIME**

Sub Committee Chair:

Adam Jacoff

Intelligent Systems Division
National Institute of Standards and Technology
U.S. Department of Commerce

Committee Chair:

Phil Mattson

Science and Technology Directorate
U.S. Department of Homeland Security

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RobotTestMethods.nist.gov



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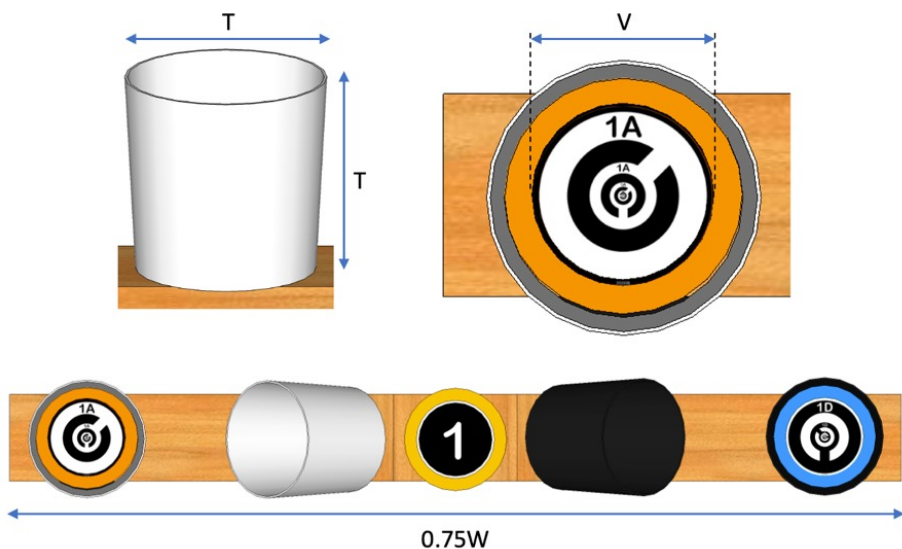
Linear Search Tasks with Measures of Acuity

Search Tasks



Linear Search Tasks with Measures of Acuity

Search Tasks



ALIGNED

ALIGNED

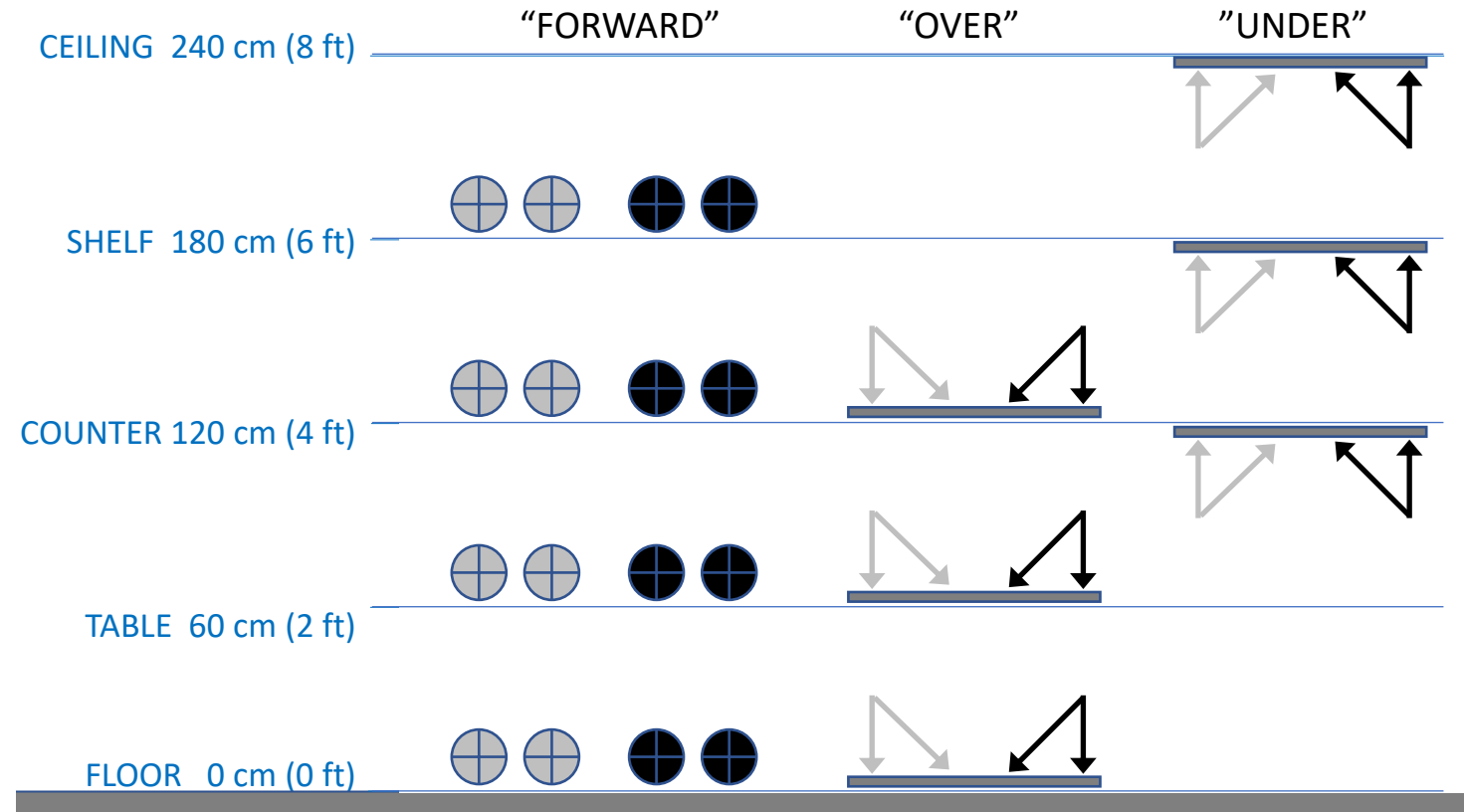
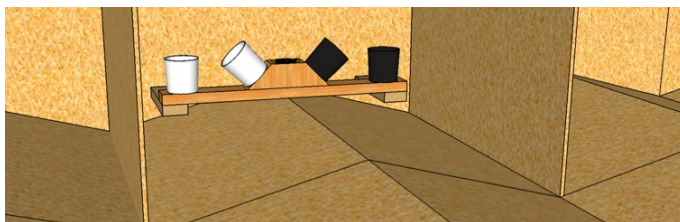
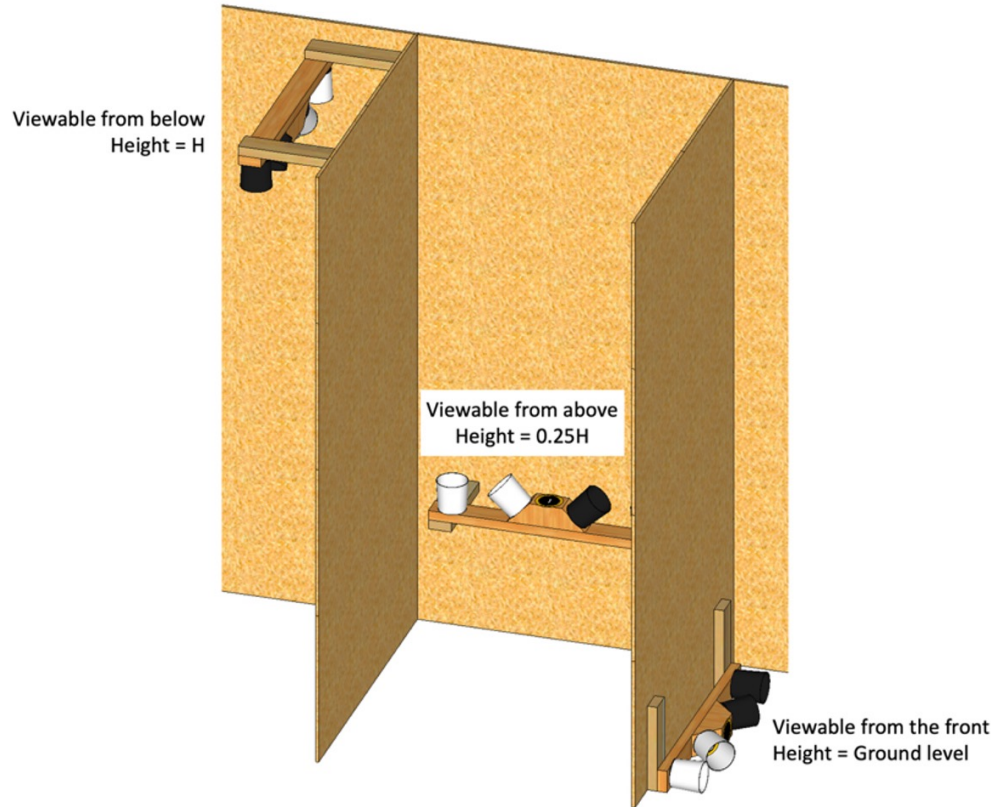
NOT ALIGNED



CONCENTRIC C	GAP SIZE
C1 LARGEST	10.3 mm (0.4 in)
C2	4.1 mm (0.16 in)
C3	1.6 mm (0.06 in)
C4	0.7 mm (0.03 in)
C5 SMALLEST	0.3 mm (0.01 in)

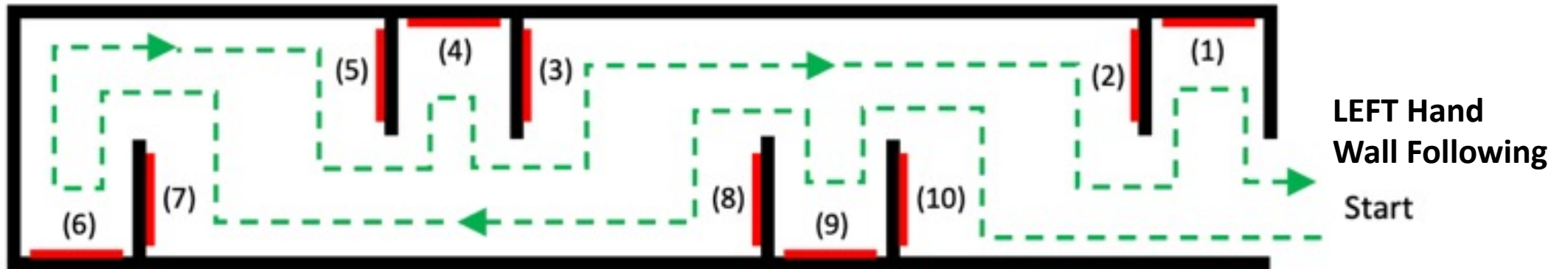
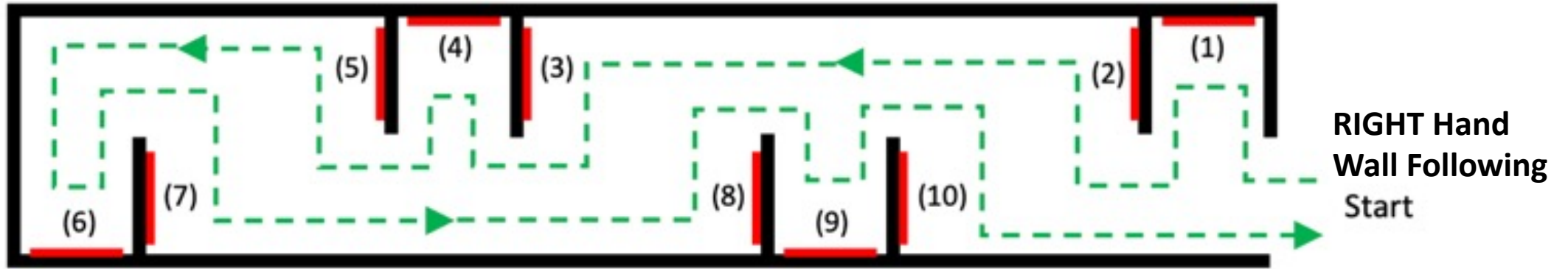
Always Placed in 10 Different Elevations and Orientations

Search Tasks



Rectangular Labyrinth Top View with Search Task Locations

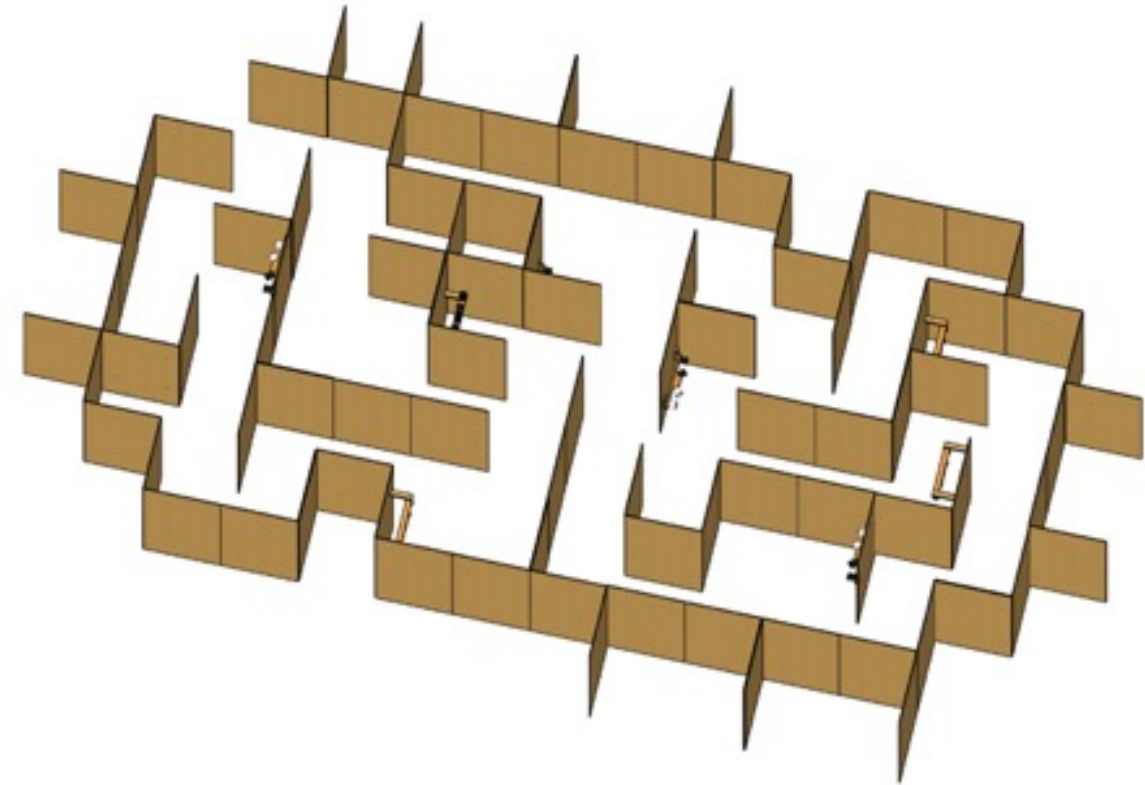
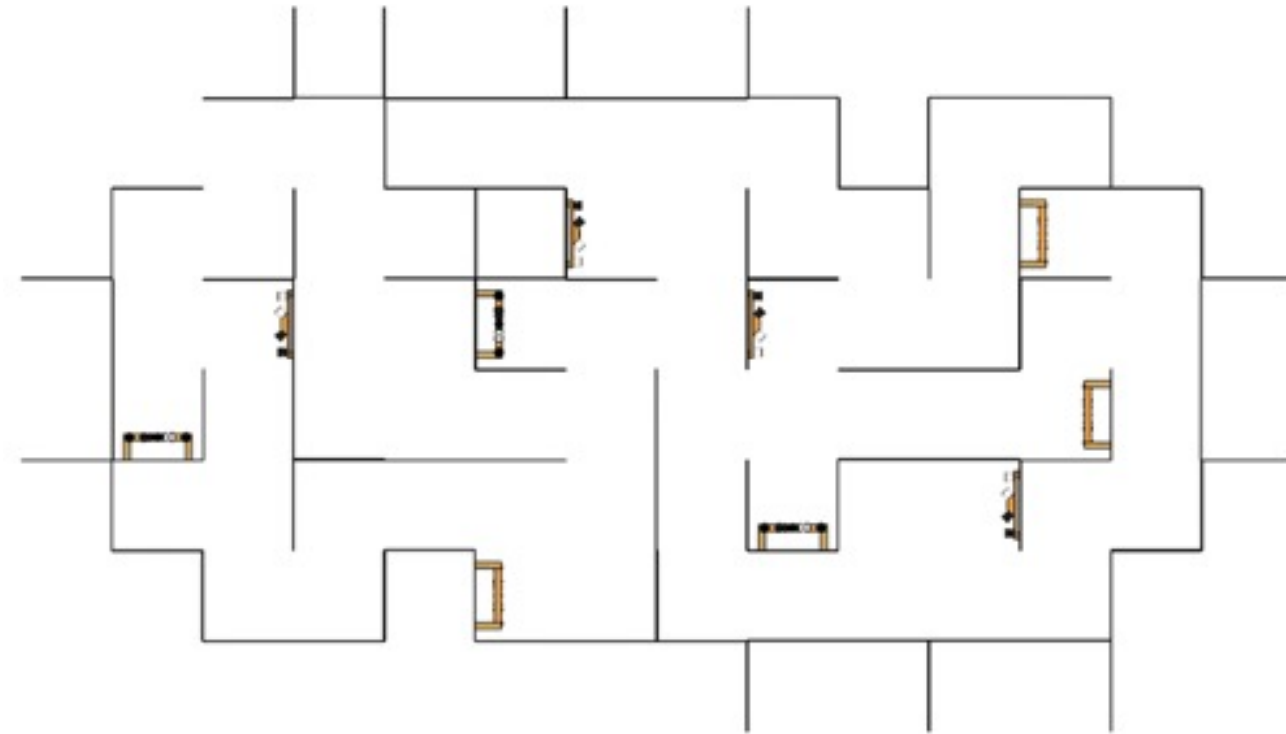
Search Tasks



Key: — Linear rail mounting wall (#) Linear inspection rail

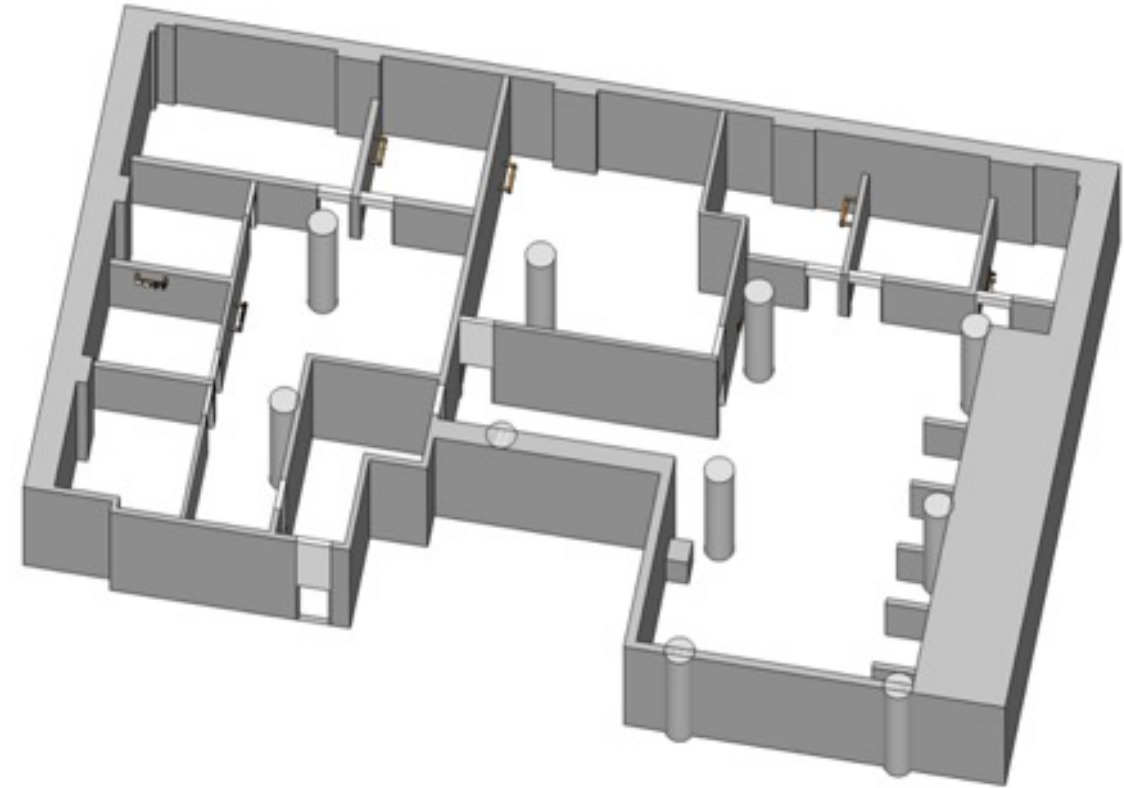
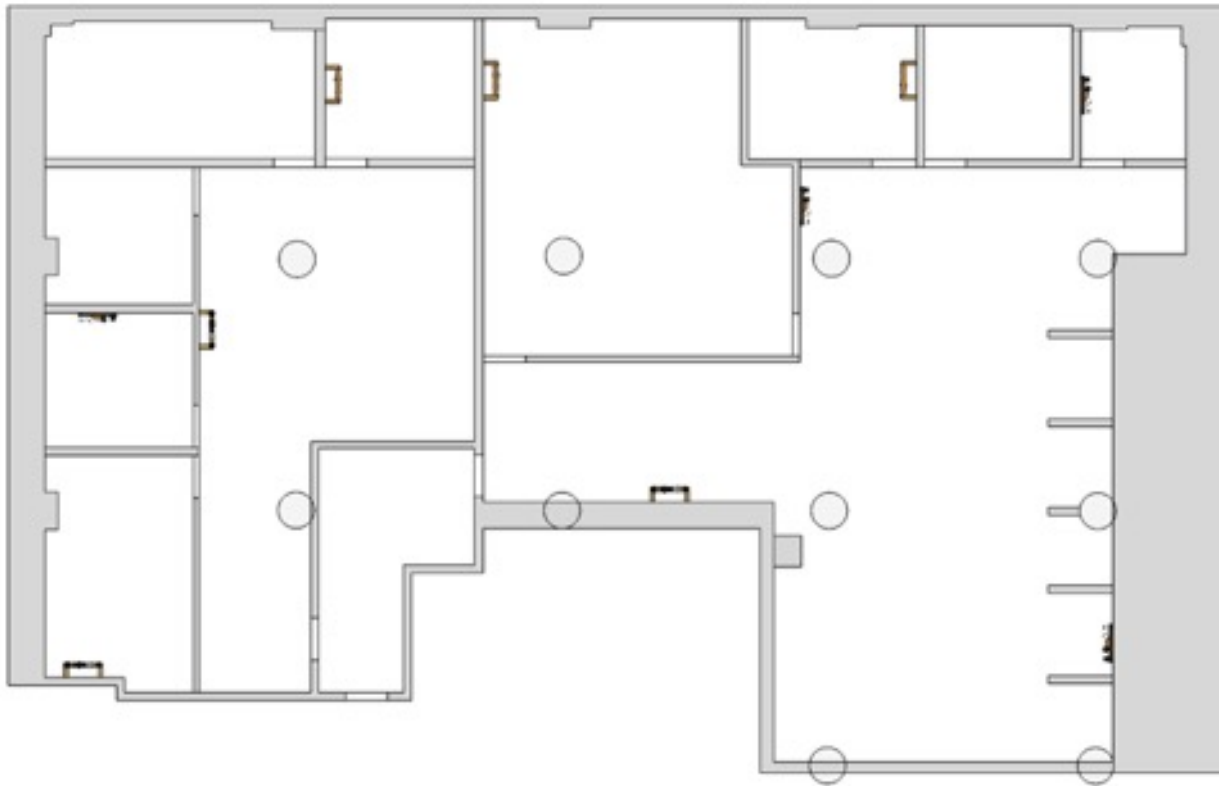
Freeform Maze Top View with Search Task Locations

Search Tasks



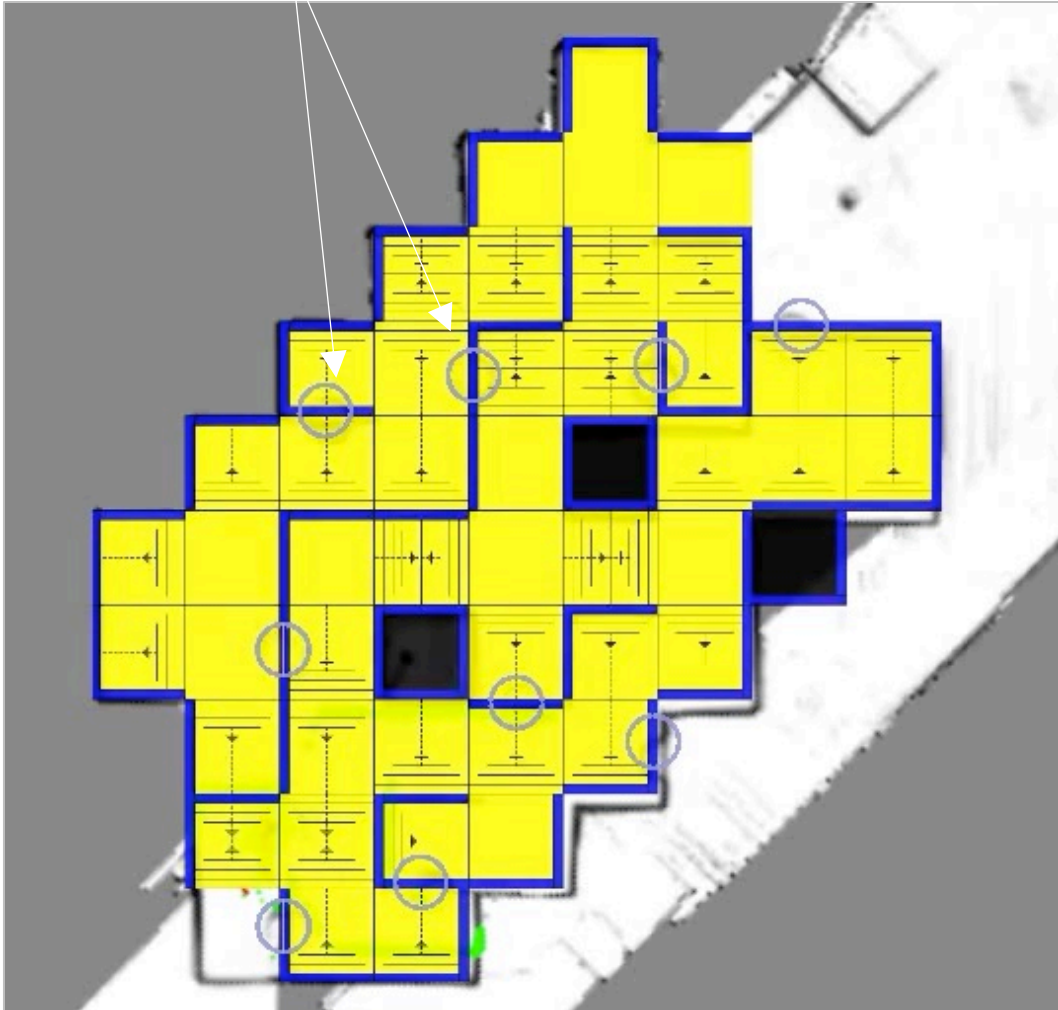
Embedded Scenario with Search Task Locations

Search Tasks

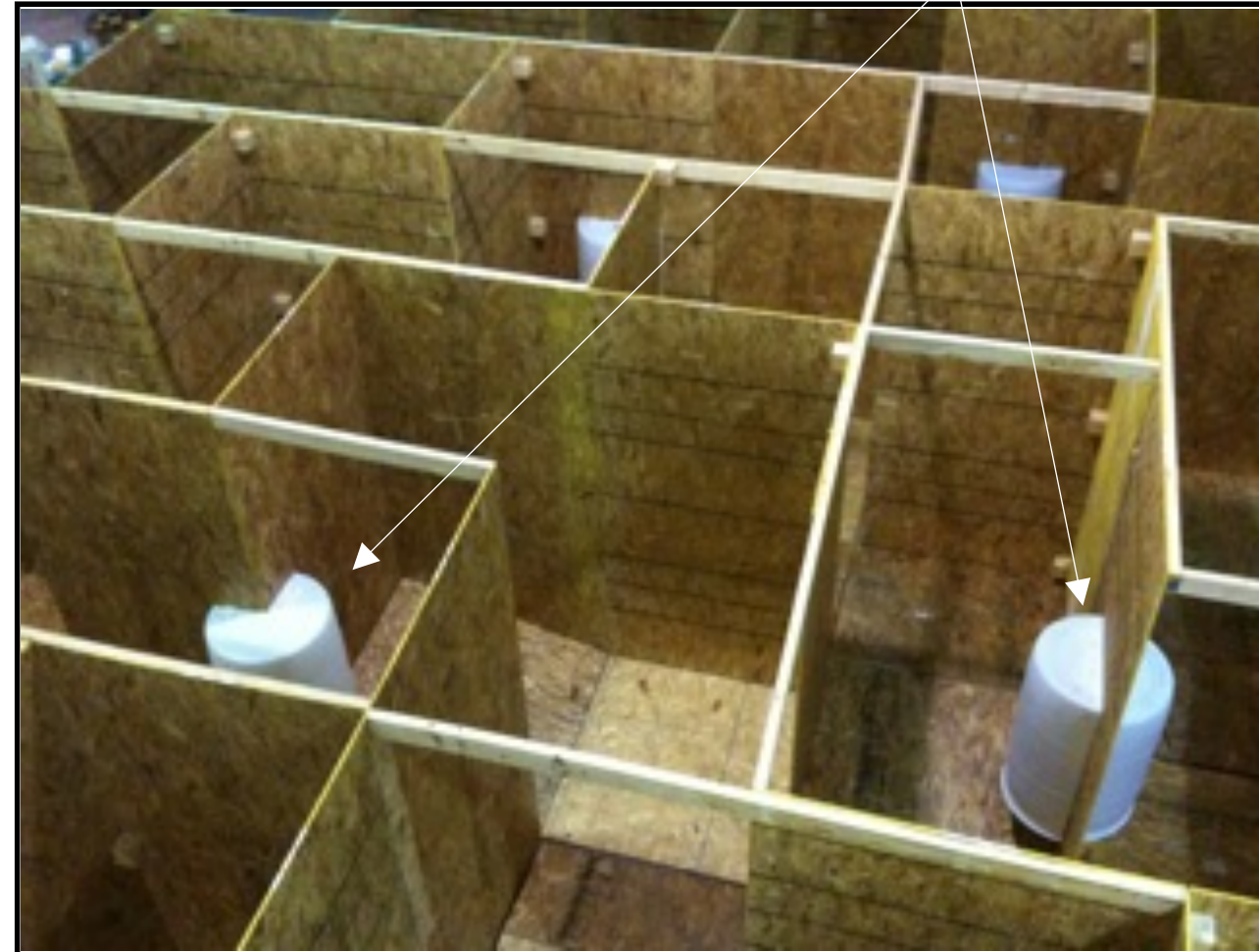


Labyrinth/Maze Navigation

Mapping Fiducials (Half Barrels)



Exploration and Mapping



Mapping Fiducials (Half Barrels)

Complex Terrains Challenge Mapping Systems

Search Tasks



Diagonal Rails



Continuous Ramps (E2826)



Crossing Ramps (E2826)



Symmetric Stepfields (E2828)



Sand (E2992)



Gravel (E2991)

Changes in Elevation and Movable Clutter Do Too

Search Tasks



Open Doors



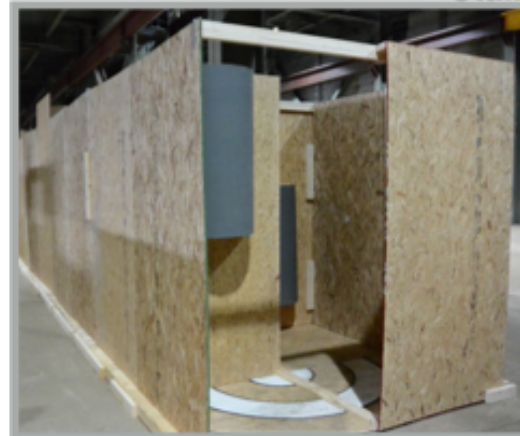
Surmount Hurdle



**Ascend/Descend
Stairs**



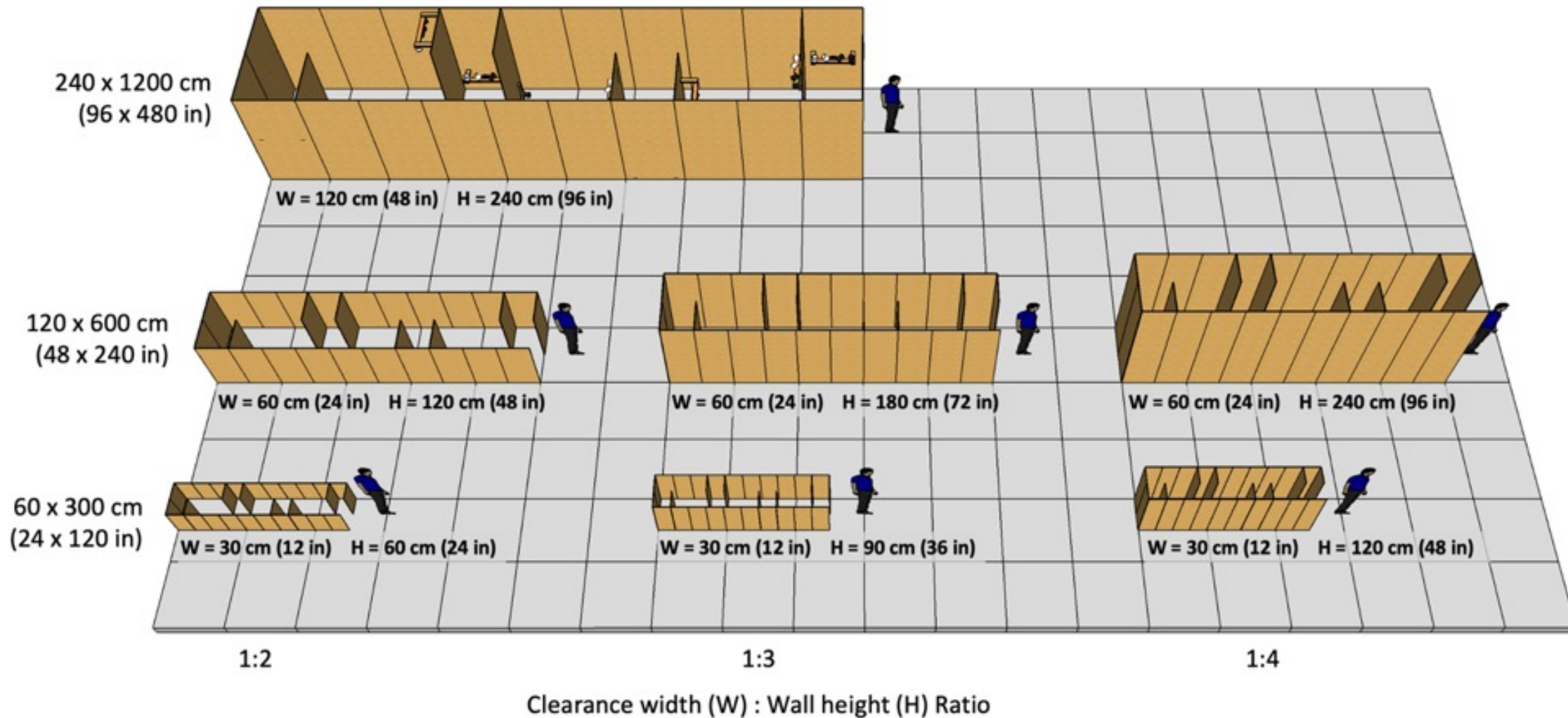
Entangle Obstacles



Negotiate Hallways

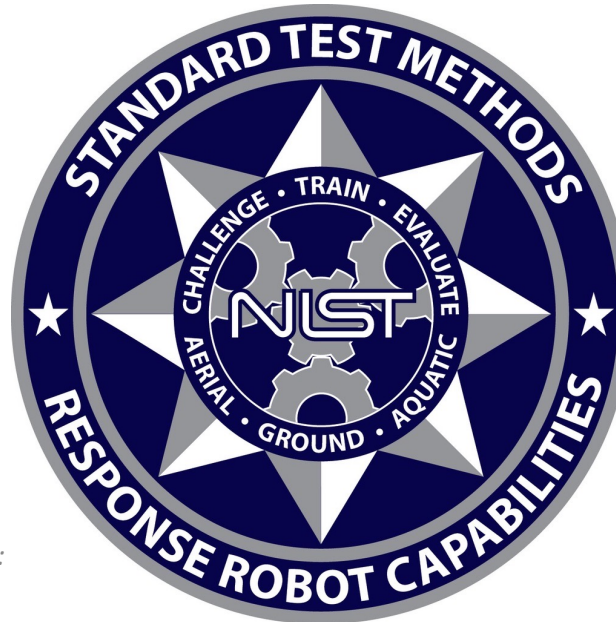
Three Different Scales For Different Environments

Search Tasks



ASTM E54.09 Homeland Security Applications; Response Robots Exploration and Mapping

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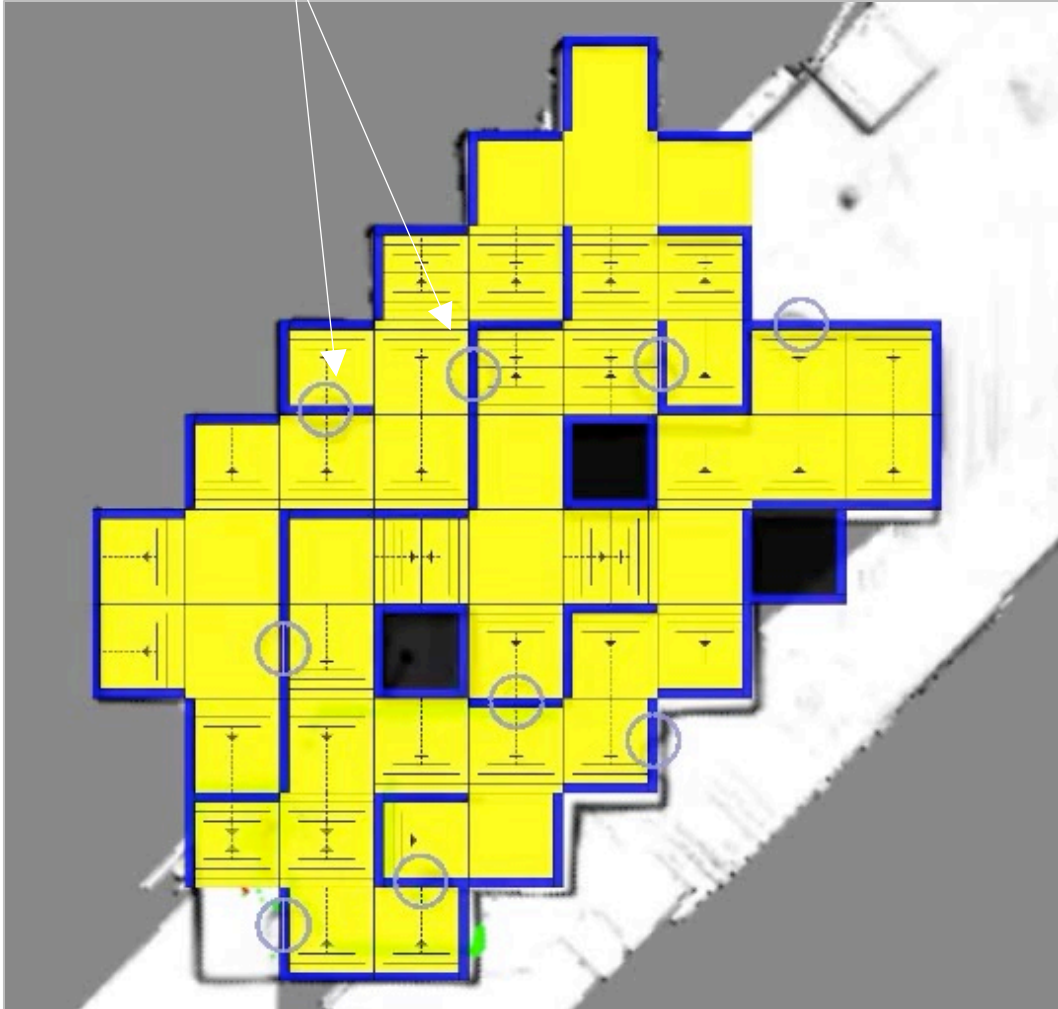


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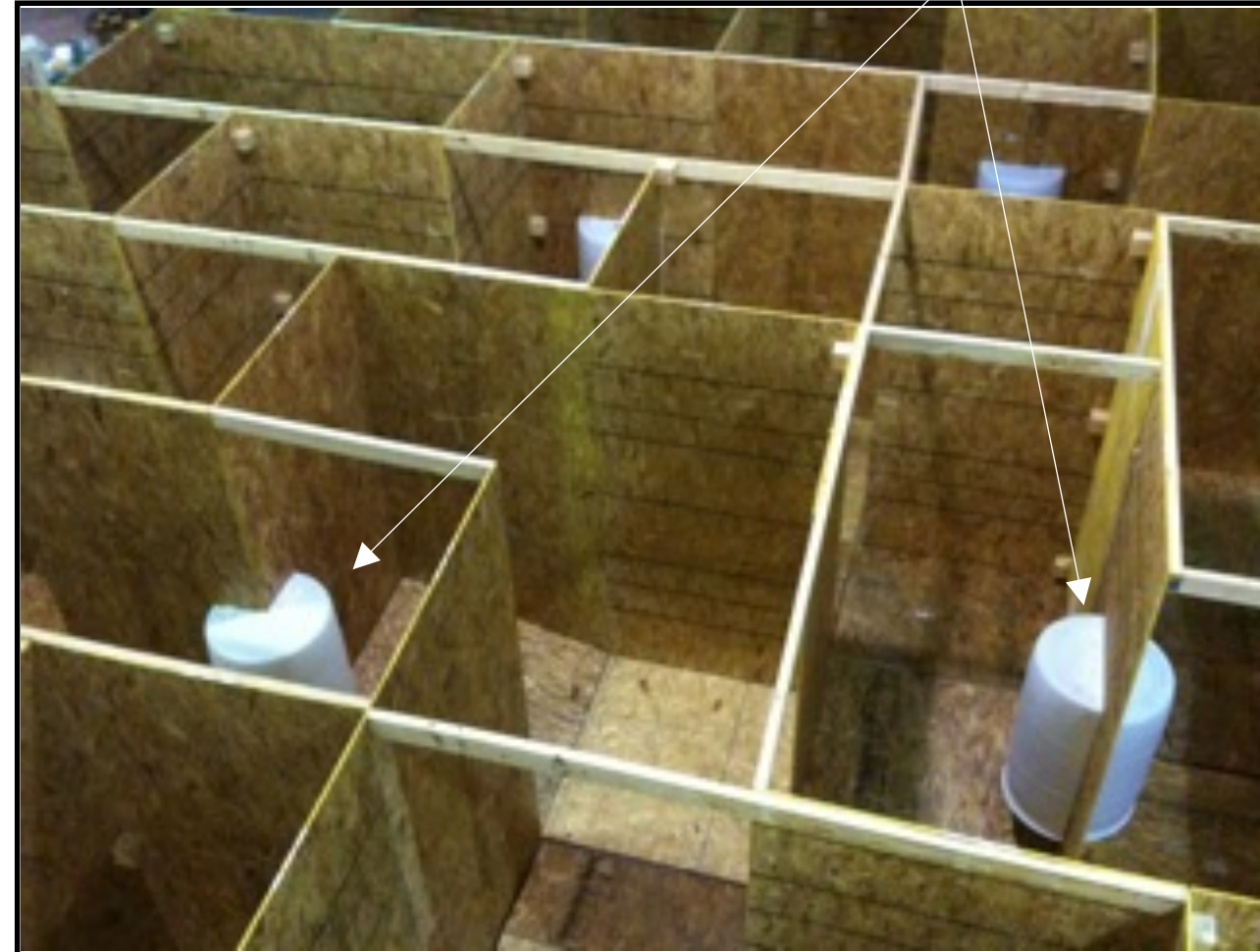
Labyrinth/Maze Navigation

Exploration and Mapping

Mapping Fiducials (Half Barrels)



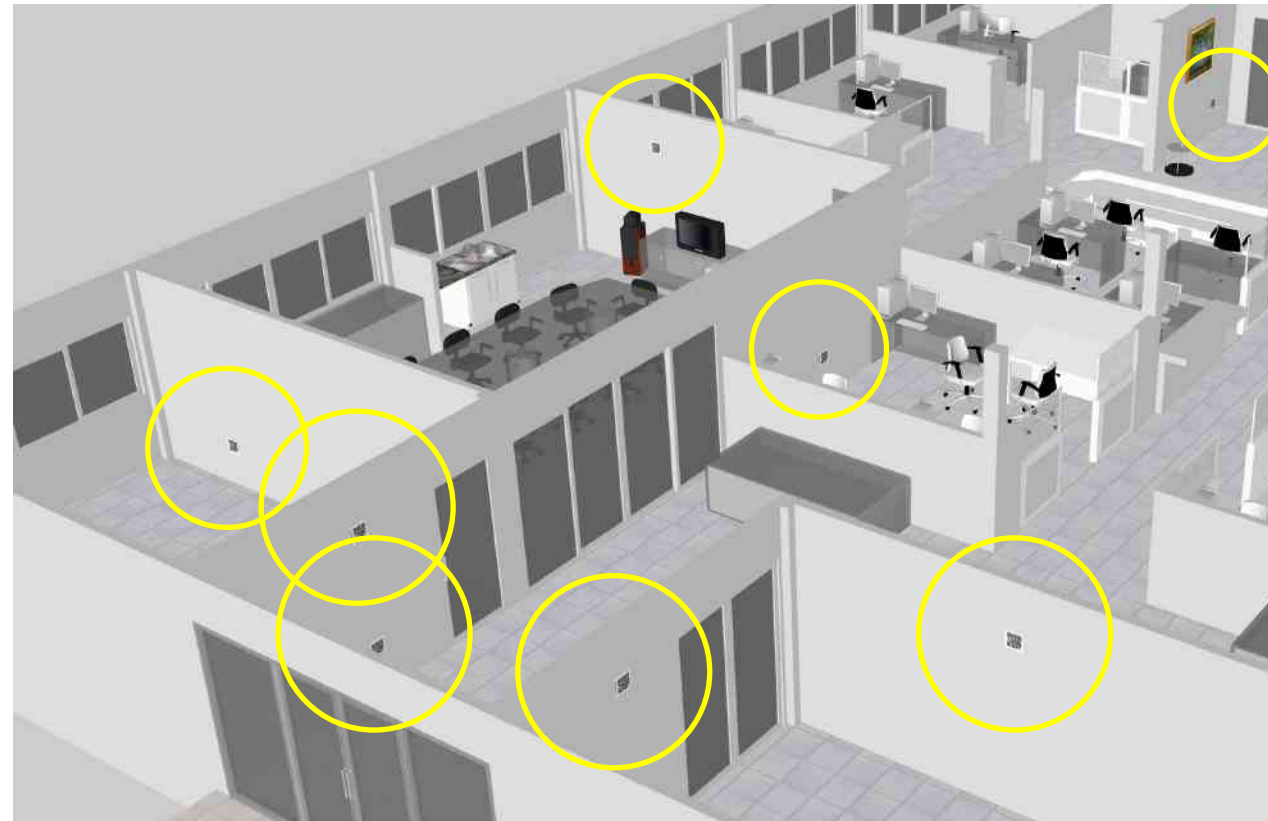
Mapping Fiducials (Half Barrels)



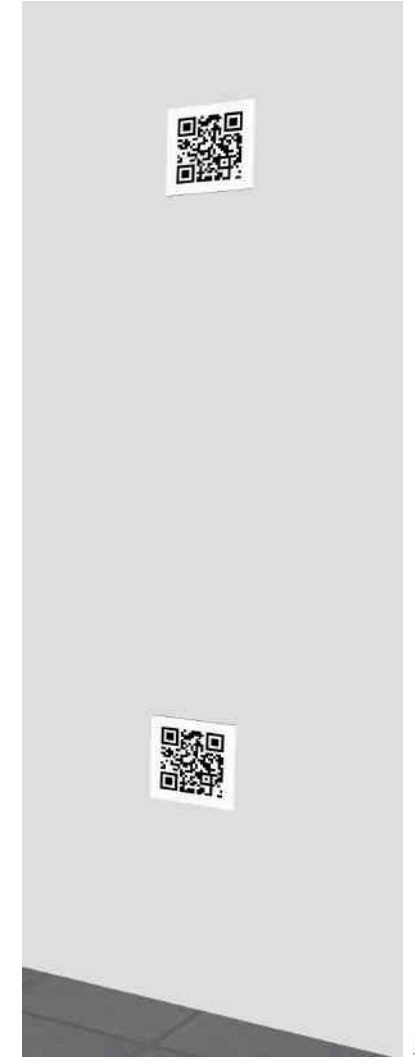
Measure Robot Capabilities and/or Operator Proficiency

Exploration and Mapping Tests

- Validate easy to replicate exploration and mapping tests in YOUR scenarios.
- Focus on reconfigurable task apparatuses that are easy to lay out temporarily and store between trials.
- Compare your 2D and 3D map results over time in variable/repeatable layouts within the same scenario.
- Try different scenarios using all the same layout rules, in houses, workplaces, industrial facilities, outdoor settings.



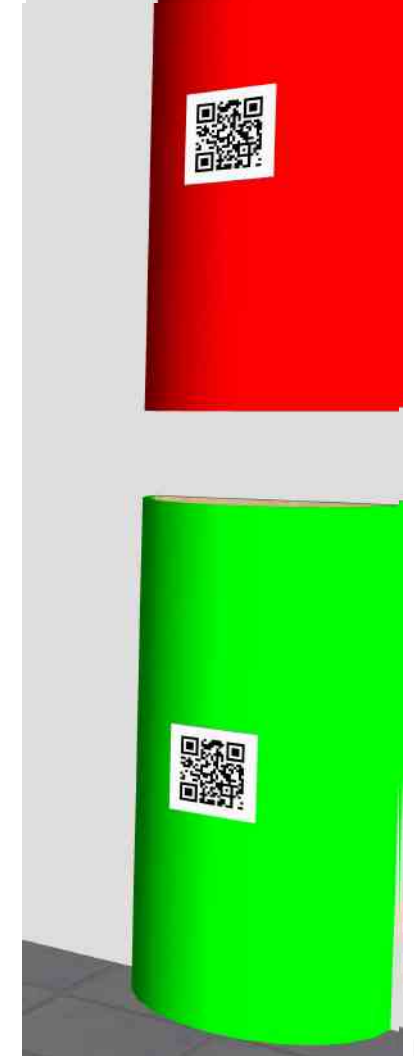
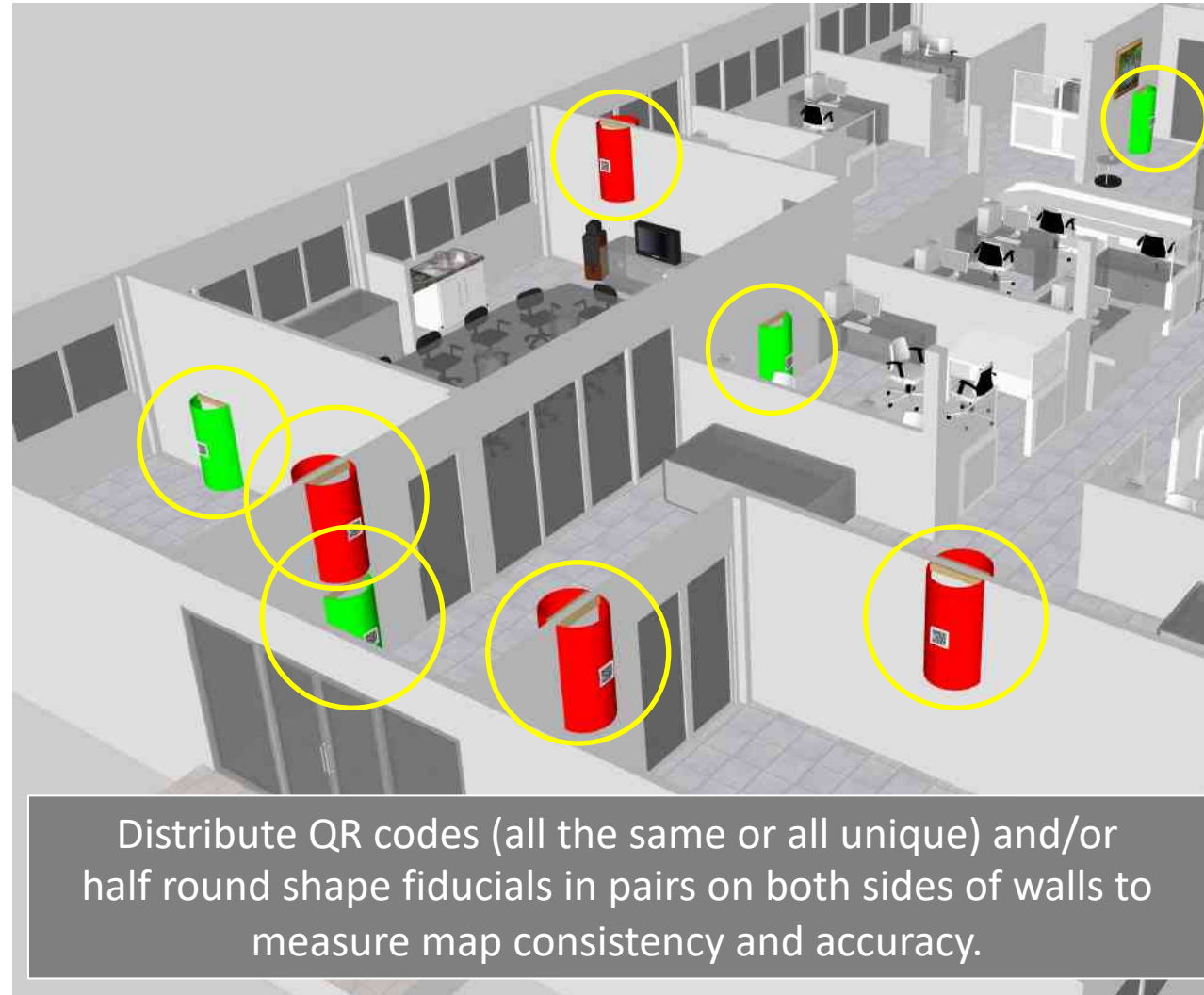
Distribute QR codes (all the same or all unique) and/or half round shape fiducials in pairs on both sides of walls to measure map consistency and accuracy.



Measure Robot Capabilities and/or Operator Proficiency

Exploration and Mapping Tests

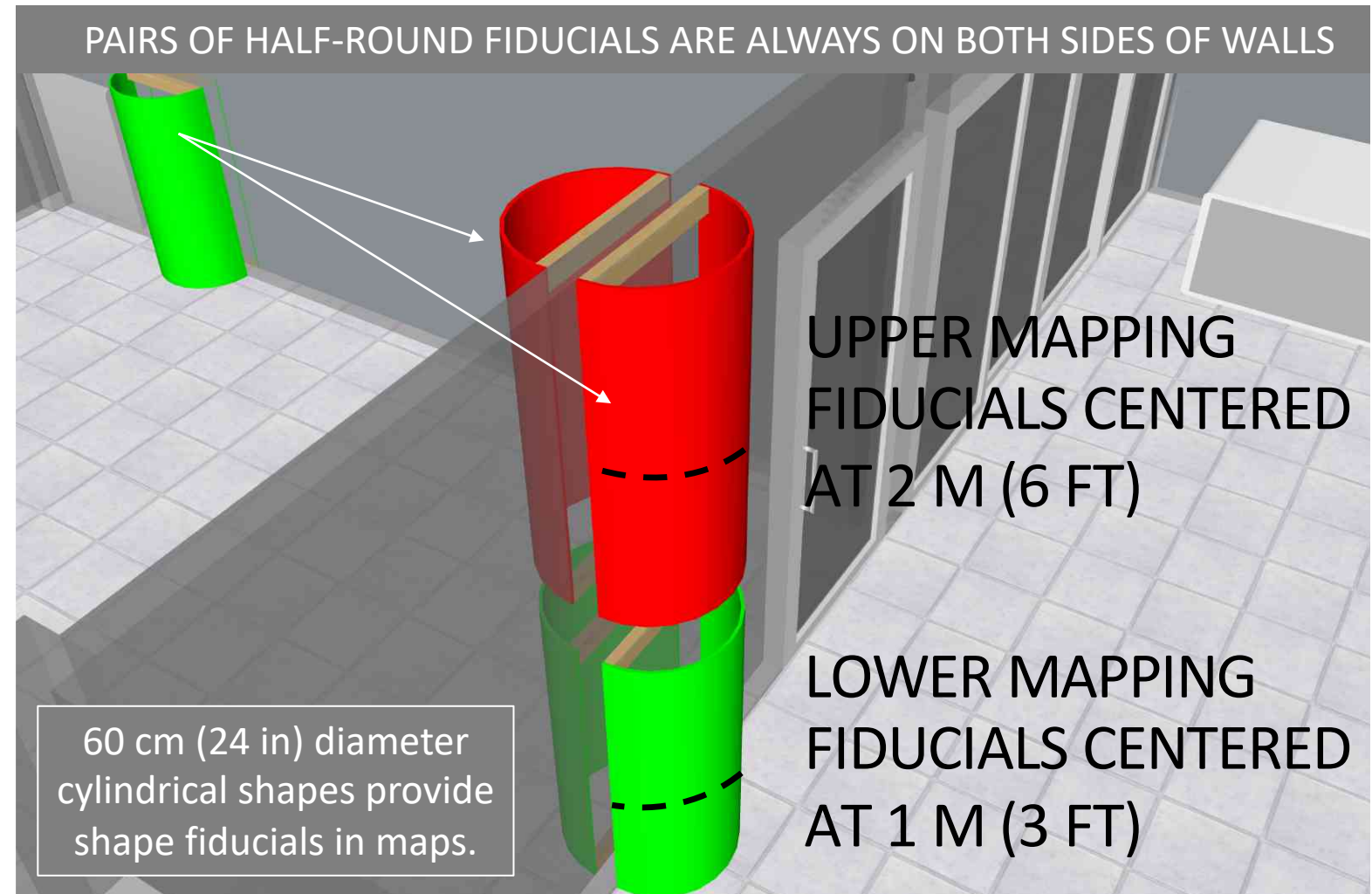
- Validate easy to replicate exploration and mapping tests in YOUR scenarios.
- Focus on reconfigurable task apparatuses that are easy to lay out temporarily and store between trials.
- Compare your 2D and 3D map results over time in variable/repeatable layouts within the same scenario.
- Try different scenarios using all the same layout rules, in houses, workplaces, industrial facilities, outdoor settings.



Distribute Fiducials Throughout Your Scenarios

Exploration and Mapping Tests

- Validate easy to replicate exploration and mapping tests in YOUR scenarios.
- Focus on reconfigurable task apparatuses that are easy to lay out temporarily and store between trials.
- Compare your 2D and 3D map results over time in variable/repeatable layouts within the same scenario.
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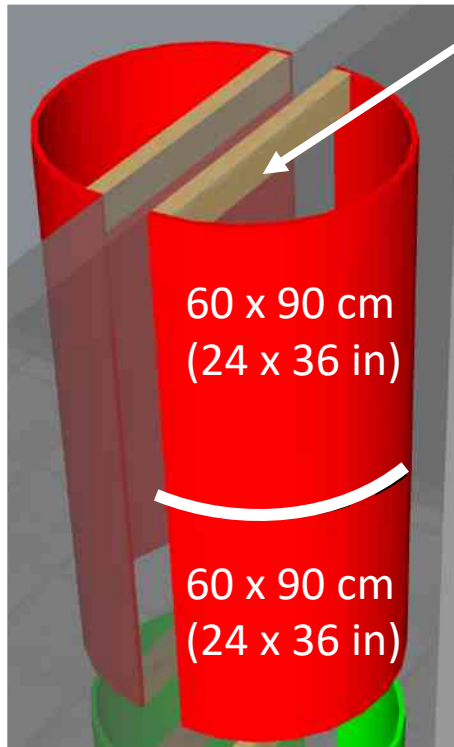


Purchase Mapping Fiducials

Exploration and Mapping Tests

OPTION A

Purchase enough sign panels to make 20 half-cylinders roughly 60 cm (24 in) diameter x 120 cm (48 in) tall.



Wood beam on top, middle, and bottom maintains the diameter and enables hanging.

The middle beam is be shared by both the upper and lower panels.

Bend the panels as smoothly possible

Need 40 panels this size, or 5 packs as shown = \$180 US plus wood beams



Juvale 8-Pack Blank Corrugated Plastic Yard Lawn Signs, White, 24 x 36 Inches

[Visit the Juvale Store](#)

★★★★★ 147 ratings

Amazon's Choice for "corrugated plastic sheet"

Price: \$35.99 & FREE Returns

Get \$50 off instantly: Pay \$0.00 \$35.99 upon approval for the Amazon Rewards Visa Card. No annual fee.

Available at a lower price from other sellers that may not offer free Prime shipping.

- Includes 8 blank plastic corrugated sign boards (stakes not included)
- White; 4 mm Density, 650gsm
- Ideal for garage sales, open house, estate sale, parties, etc.
- Customize signs using markers and stickers
- Dimensions: 24H x 36L Inches

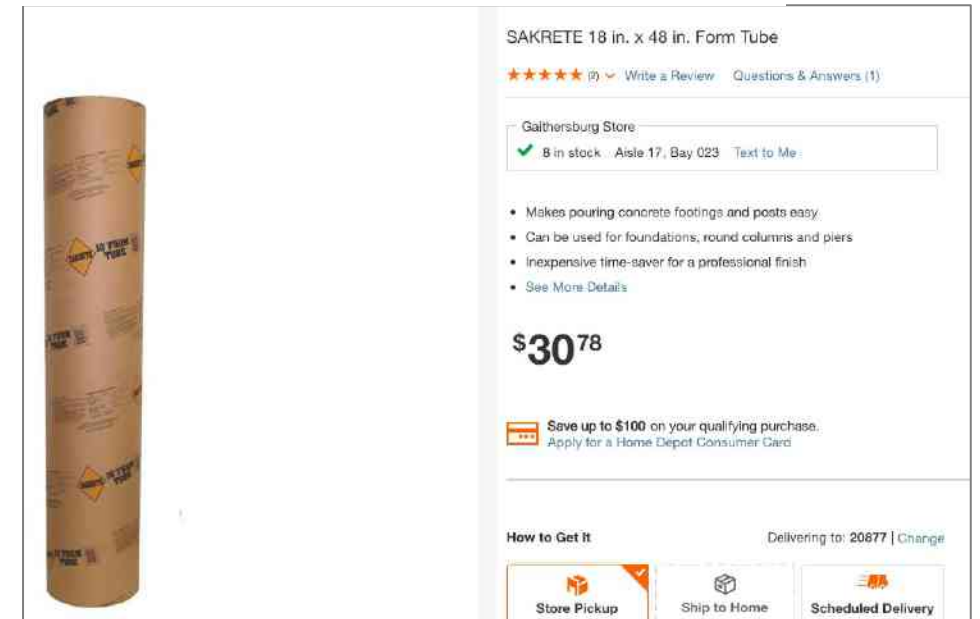
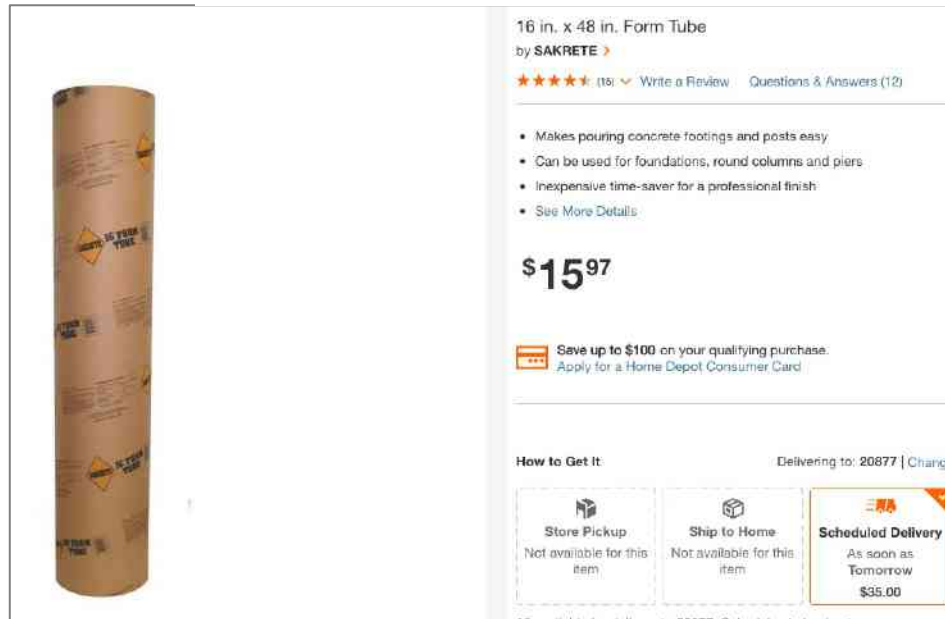
OPTION B

Purchase Mapping Fiducials

Exploration and Mapping Tests

Purchase 10 concrete form tubes (cylindrical)
then CUT THEM IN HALF to make half-round pairs.

60 cm (24 in) diameter fiducials are preferred, although they can be expensive.
These could work for finer resolution maps.



40 x 120 cm (16 x 48 in) = \$16 US

\$160 US TOTAL

45 x 120 cm (18 x 48 in) = \$31 US

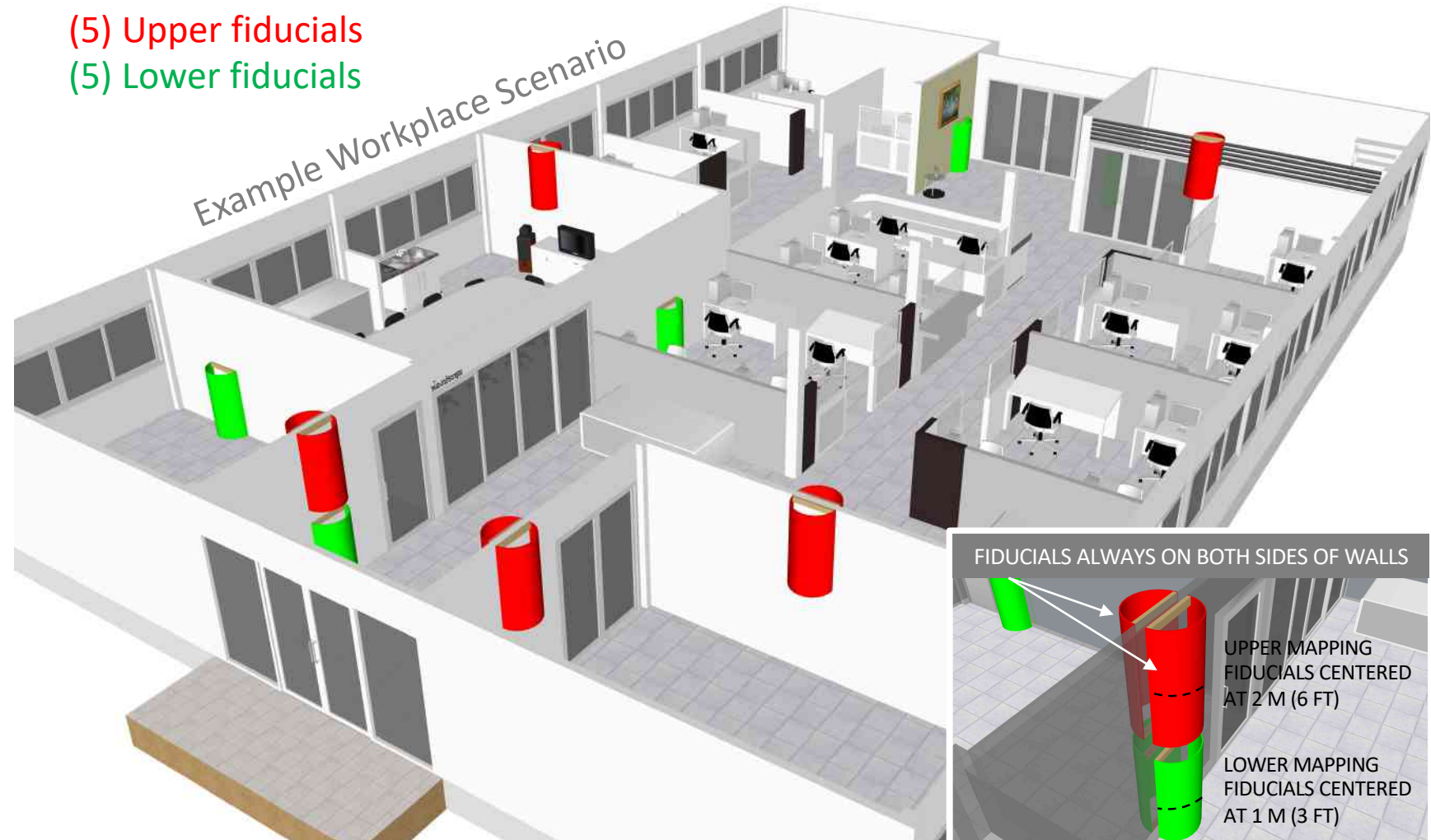
\$320 US TOTAL

Distribute Fiducials Throughout Your Scenarios

Exploration and Mapping Tests

- Validate easy to replicate exploration and mapping tests in YOUR scenarios.
- Focus on reconfigurable task apparatuses that are easy to lay out temporarily and store between trials.
- Compare your 2D and 3D map results over time in variable/repeatable layouts within the same scenario.
- Try different scenarios using all the same layout rules, in houses, workplaces, industrial facilities, outdoor settings.

(5) Upper fiducials
(5) Lower fiducials



Distribute Lower Fiducials Throughout Your Scenarios

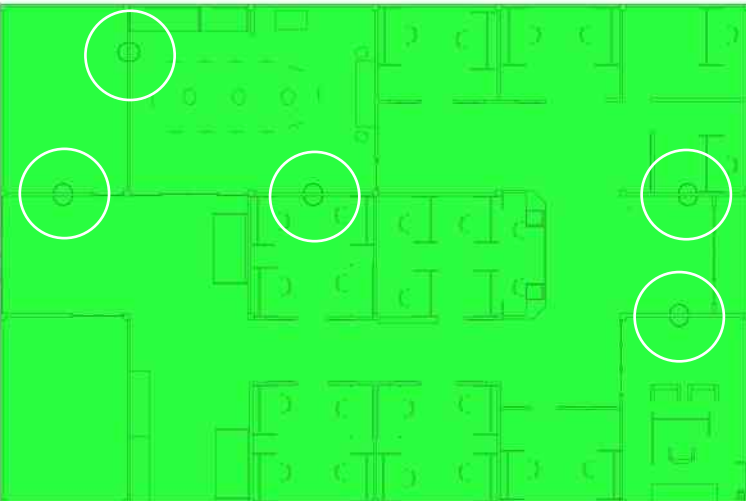
Exploration and Mapping Tests

Lower Fiducial Map

5 pairs of fiducials shown in a 3D map layer at 1 m (3 ft) elevation. The fiducial pairs should form circles in 2D maps.

Map Metrics:

- Coverage (how many of 10 are visible?)
- Consistency (how close are the pairs?)
- Local Accuracy (by room)
- Global accuracy (average overall)



(5) Upper fiducials
(5) Lower fiducials



Evaluative 2D/3D Maps with Lower Fiducial Layer

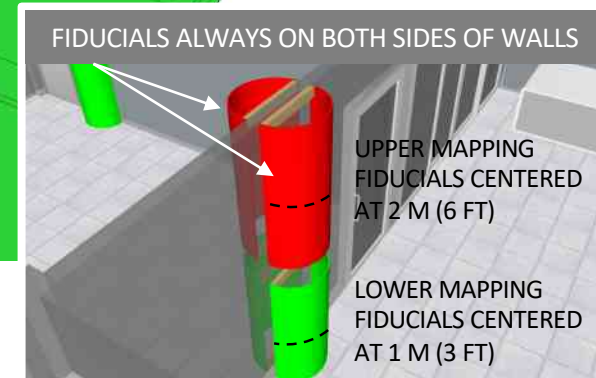
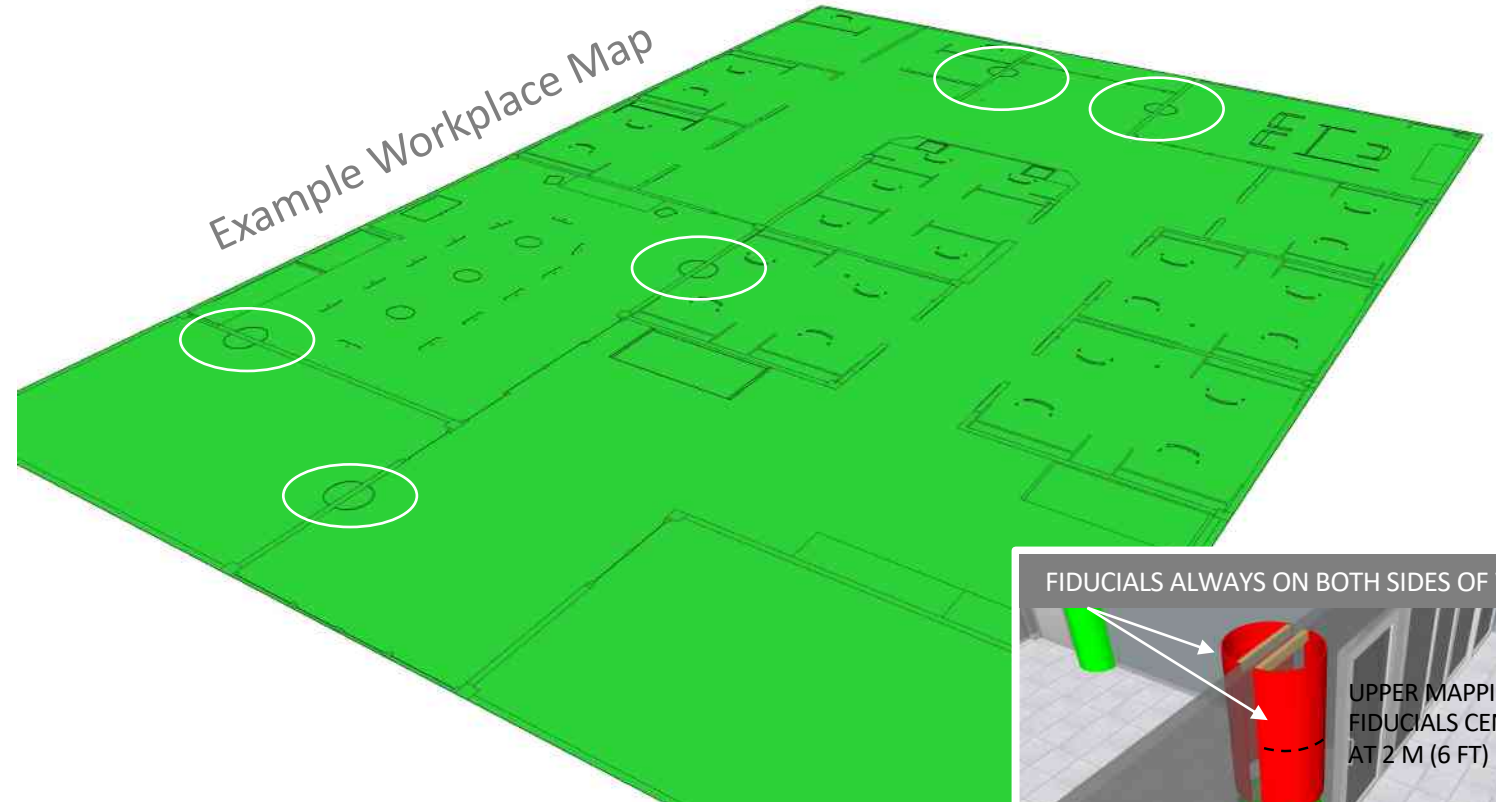
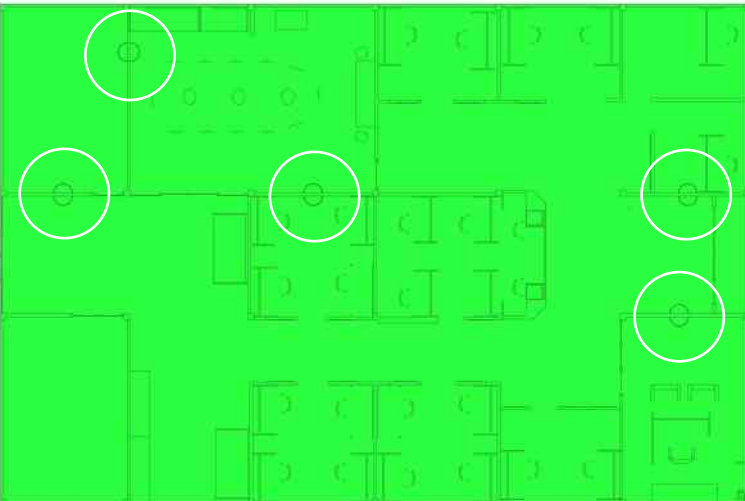
Exploration and Mapping Tests

Lower Fiducial Map

5 pairs of fiducials shown in a 3D map layer at 1 m (3 ft) elevation. The fiducial pairs should form circles in 2D maps.

Map Metrics:

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- Local Accuracy (by room)
- Global accuracy (average overall)



Distribute Upper Fiducials Throughout Your Scenarios

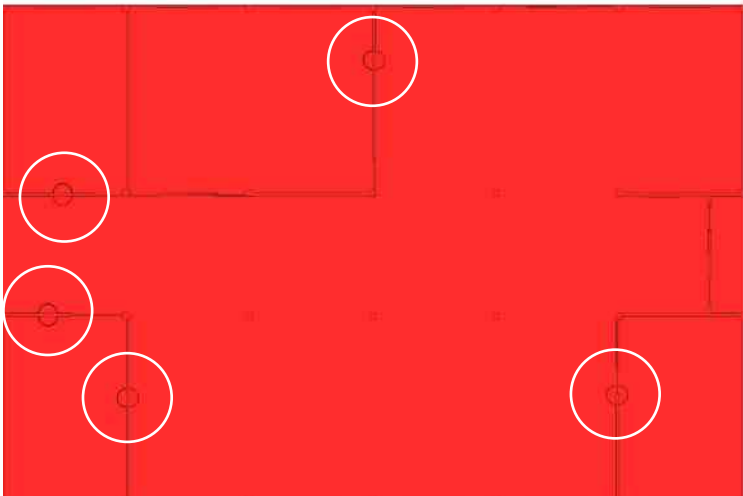
Exploration and Mapping Tests

Upper Fiducial Map

5 pairs of fiducials shown in a 3D map layer at 2 m (6 ft) elevation. The fiducial pairs should form circles in 2D maps.

Map Metrics:

- Coverage (how many of 10 are visible?)
- Consistency (how close are the pairs?)
- Local Accuracy (by room)
- Global accuracy (average overall)



(5) Upper fiducials
(5) Lower fiducials



Evaluative 2D/3D Maps with Upper Fiducial Layer

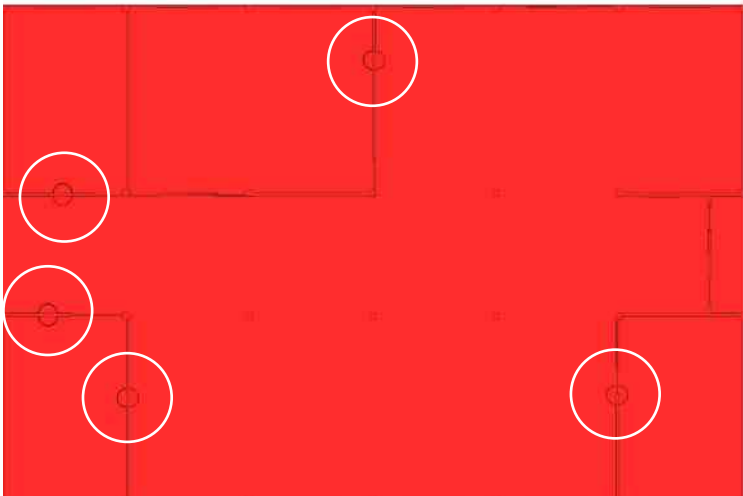
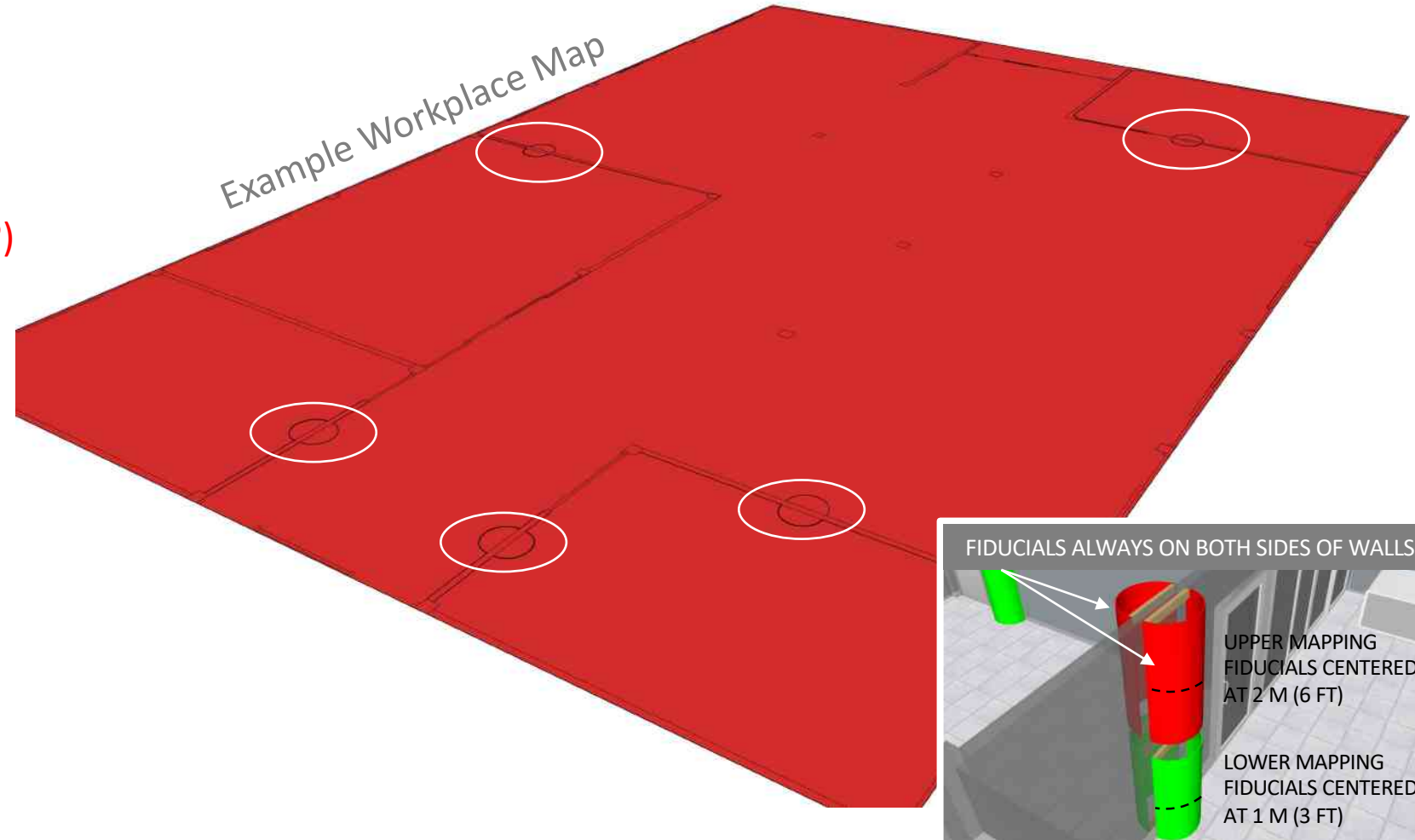
Exploration and Mapping Tests

Upper Fiducial Map

5 pairs of fiducials shown in a 3D map layer at 2 m (6 ft) elevation. The fiducial pairs should form circles in 2D maps.

Map Metrics:

- Coverage (how many of 10 are visible?)
- Consistency (how close are the pairs?)
- Local Accuracy (by room)
- Global accuracy (average overall)





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