



Pathfinder



Pathfinder

Verification and Validation

Quality Assurance Process



- Source Code Control
- Continuous Integration
 - Entire system rebuilt after every change
- Automated Testing
 - Tests run automatically after every build
 - 117 test cases in 2012
 - 308 test cases in 2014
- Testing Dashboard
- Automated Error Reporting
 - Reports categorized and scheduled weekly

Source Control

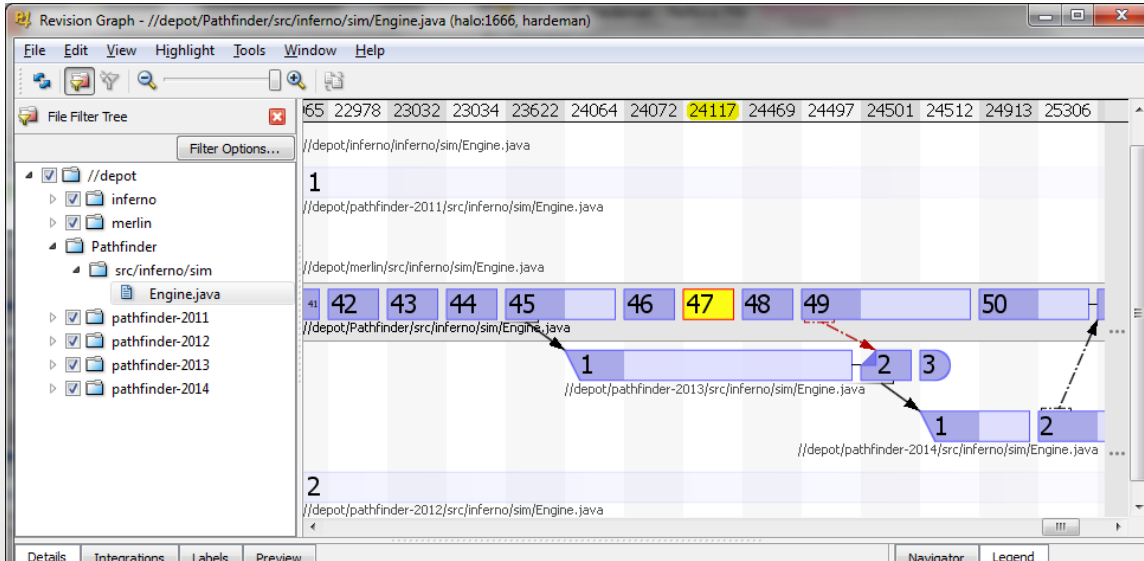


The screenshot shows a source control interface for a depot named 'halo:1666, hardeman - Perforce P4V'. The interface is divided into three main sections:

- Left Panel (File Tree):** Shows a hierarchical view of the source code. The 'inferno' directory is expanded, showing sub-directories like 'data2', 'finite', 'geom', 'io', 'parse2', 'sim', 'test', 'util', and 'vis'. Files like 'SPTTest.java' and 'TestSim.java' are also visible.
- Center Panel (Revision History):** A table listing revisions with columns for Revision, Change, Date Submitted, Submitted By, and Description. Revision 24117 is highlighted.
- Bottom Panel (File Details):** A table showing details for the selected revision, including Name, Revision, Action, Filetype, and In Folder.

Revision	Change	Date Submitted	Submitted By	Description
24342		1/6/2014 1:43:47...	okonski	[Pathfinder:inferno] Fixed a crash that could occur if a security camera is initializ...
24198		12/16/2013 1:39:...	thornton	[Pathfinder] changed a variable name to improve clarity
24197		12/16/2013 1:38:...	thornton	[Pathfinder] added a method to WingedEdge that can be used to verify that t1 a...
24181		12/13/2013 4:00:...	thornton	[Pathfinder] removed and unused import
24166		12/12/2013 2:13:...	okonski	[Pathfinder FP] Added the ability for the decals from appearance mods come an...
24158		12/11/2013 10:4:...	thornton	[Pathfinder] fixed a bug in our TestSim runner that caused all PTH files to run in ...
24152		12/10/2013 8:59:...	okonski	[Pathfinder FP] Updated the teci libs and began work on damage regions/textur...
24117		12/4/2013 3:14:1...	thornton	[Pathfinder] removed the dual geomesh / navmesh in favor of just the mesh. ...
24115		12/4/2013 2:52:3...	thornton	[Pathfinder FP] added a -sphere selector to the STATUS api command for agents ...
24112		12/4/2013 10:27:...	okonski	[Pathfinder:inferno] Added a couple methods to find triangles and edges.
24072		11/27/2013 5:00:...	okonski	[Pathfinder FP] Added the API to remotely control security cameras and made it...
24048		11/25/2013 2:43:...	okonski	[Pathfinder] Made security cameras (formerly "controlled" cameras) have a maxi...
24010		11/19/2013 4:02:...	okonski	[Pathfinder FP] Began work on viewing cameras in Behemoth and FP Instructor. ...
23976		11/14/2013 2:13:...	okonski	[Pathfinder] Updated the teci libs.
23898		11/7/2013 4:12:2...	thornton	[Pathfinder] Added "severe" injuries to FP. Right now they are pretty similar to "a...
23897		11/7/2013 4:10:4...	thornton	[Pathfinder] removed an unused variable
23802		10/23/2013 4:49:...	thornton	[Pathfinder FP] Added API command IDLE {on/off}. Idle occupants always think ...
23775		10/17/2013 11:5:...	thornton	[Pathfinder FP] changed the add_agent command in the following ways: -door ...
23660		10/2/2013 4:35:1...	okonski	[Pathfinder:inferno] Fixed BugId: 23232 - Occupants don't use door right next to ...
23622		9/30/2013 10:25:...	thornton	[Pathfinder] in the summary file node names are now left justified, flow rates no...
23503		9/10/2013 10:40:...	okonski	[Pathfinder:inferno] Fixed BugId: 22892 - Improve acceleration.

Name	Revision	Action	Filetype	In Folder
DoorTarget.j...	8	edit	text	//depot/Pathfinder/src/inferno/sim/steering/locallyquic...
Elevator.java	8	edit	text	//depot/Pathfinder/src/inferno/data2
Engine.java	47	edit	text	//depot/Pathfinder/src/inferno/sim
EngineOp.ja...	17	edit	text	//depot/Pathfinder/src/inferno/sim
Estimate.java	22	edit	text	//depot/Pathfinder/src/inferno/sim/path
ExitGoal.java	10	edit	text	//depot/Pathfinder/src/inferno/data2/ai
GLView.java	8	edit	text	//depot/Pathfinder/src/inferno/vis
InfernoUtil.j...	54	edit	text	//depot/Pathfinder/src/merlin/actions
KB.java	42	edit	text	//depot/Pathfinder/src/inferno/sim



Revision: //depot/Pathfinder/src/Inferno/sim/Engine.java#47
Date submitted: 12/4/2013 3:14:11 PM
Submitted by: thornton
Workspace: AUTUMN_thornton
Action: edit
Description: [Pathfinder] removed the dual geommesh / navmesh in favor of just the mesh. For a confusing. Code archeologists may be interested in knowing that the navmesh is the

```
Engine.java#46 and Engine.java#47 - Perforce P4Merge  
2 diffs (Ignore line ending differences) | Tab spacing: 4 | Encoding: System  
//depot/Pathfinder/src/Inferno/sim/Engine.java#46  
public boolean isStuck(Engine engine)  
{  
    update(engine);  
    return d_stuck;  
}  
  
private void updateVis()  
{  
    d_ticks.begin("RENDERER");  
    if (d_param.show_vis)  
    {  
        final List allRender = new ArrayList();  
        allRender.addAll(Arrays.asList(d_kb.getGeomMesh().getVerts()));  
        allRender.addAll(Arrays.asList(d_kb.getGeomMesh().getEdges()));  
        allRender.addAll(Arrays.asList(d_kb.getGeomMesh().getTris()));  
  
        allRender.addAll(d_ooAgents);  
        for (ANode node : d_kb.getNodes())  
        {  
            IDensityField df = node.getDensityField();  
            allRender.add(df);  
        }  
  
        try  
        {  
            if (!EventQueue.isDispatchThread())  
            {  
                EventQueue.invokeAndWait(new Runnable()  
                {  
                    public void run()  
                    {  
                        synchronized (Engine.this)  
                        {  
                            if (d_giView != null) { d_giView.render(allRender);  
                        }  
                    }  
                });  
            }  
        }  
        else  
        {  
            updateVis();  
        }  
    }  
}
```

```
//depot/Pathfinder/src/Inferno/sim/Engine.java#47  
}  
  
public boolean isStuck(Engine engine)  
{  
    update(engine);  
    return d_stuck;  
}  
  
private void updateVis()  
{  
    d_ticks.begin("RENDERER");  
    if (d_param.show_vis)  
    {  
        final List allRender = new ArrayList();  
        allRender.addAll(Arrays.asList(d_kb.getMesh().getVerts()));  
        allRender.addAll(Arrays.asList(d_kb.getMesh().getEdges()));  
        allRender.addAll(Arrays.asList(d_kb.getMesh().getTris()));  
  
        allRender.addAll(d_ooAgents);  
        for (ANode node : d_kb.getNodes())  
        {  
            IDensityField df = node.getDensityField();  
            allRender.add(df);  
        }  
  
        try  
        {  
            if (!EventQueue.isDispatchThread())  
            {  
                EventQueue.invokeAndWait(new Runnable()  
                {  
                    public void run()  
                    {  
                        synchronized (Engine.this)  
                        {  
                            if (d_giView != null) { d_giView.render(allRender);  
                        }  
                    }  
                });  
            }  
        }  
        else  
        {  
            updateVis();  
        }  
    }  
}
```

Automated Tests - Dashboard



Test Matrix

halo/autotests/dashboard.php

Results For

- 0 - Pathfinder 2012
- 1 - Pathfinder 2014-0528
- 2 - Pathfinder 2014-0801
- 3 - 24 Hours Ago
- 4 - Latest Build

0	1	2	3	4	Model	Error
?	?	■	■	■	stadiums/merging_flow STEERING	Expected t=242.40 err_tol=5.0%; found t=264.28 err=9.0%
?	?	■	■	■	stadiums/problem1b STEERING-FSMAX	
?	?	■	■	■	stadiums/problem1c STEERING-FSMAX	
?	?	■	■	■	stadiums/stuck_merge STEERING	
?	?	■	■	■	stadiums/stuck_narrow STEERING	
?	?	■	■	■	stadiums/up3-smaller STEERING-FSMAX	
?	?	■	■	■	stadiums/up3-smaller counterflow STEERING-FSMAX	
?	?	■	■	■	stadiums/HolonArena STEERING	
?	?	■	■	■	stadiums/Holon-Arena STEERING	
?	?	■	■	■	stadiums/ArteVeldeStadionGent-Simplified-g01-e16 STEERING	
?	?	■	■	■	stadiums/problem1d STEERING-FSMAX	
?	?	■	■	■	stadiums/problem1d SFPE	
?	?	■	■	■	stadiums/problem2 STEERING-FSMAX	
?	?	■	■	■	stadiums/problem2 SFPE	
?	?	■	■	■	stadiums/up3 STEERING-FSMAX	
?	?	■	■	■	stadiums/optim3-modif-01 STEERING	Max sim time exceeded. Expected t=1007.60 tol=200.0%
?	?	■	■	■	stadiums/Scn 1C fixed STEERING	Expected t=1104.60 err_tol=5.0%; found t=1266.78 err=16.7%
?	?	■	■	■	elevators/disabled_doors/disabled_doors STEERING	

Verification and Validation Guide



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Verification and Validation

Pathfinder 2014.2
Release 0730 x64

Pathfinder Verification and Validation

6 Comparisons to Experiments

This section presents Pathfinder models designed to reproduce experimental results.

6.1 Seyfried et al.

This validation test compares Pathfinder to a series of small-scale experiments (Seyfried, Passon, et al., Capacity Estimation for Emergency Exits and Bottlenecks 2007). The experiments were conducted in a room constructed with dividers and an adjustable-width corridor. Once occupants had exited the corridor they were clear of the experimental environment. Figure 37 illustrates the experimental setup.

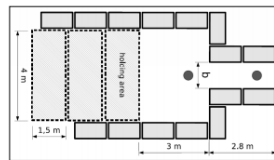


Figure 37: Experimental setup (Seyfried, Passon, et al., Capacity Estimation for Emergency Exits and Bottlenecks 2007).

Each holding area can accommodate 20 occupants, allowing for experiments to be run with 20, 40, and 60 occupants. The corridor width was adjusted in the range from 0.8 m to 1.2 m at 0.1 m intervals. These two variables provide for 15 test cases. Figure 38 shows the Pathfinder model used to simulate all 15 cases. Currently, only the bottom row of test cases can be compared because the experimental data available for direct comparison is limited to the N=60 cases.

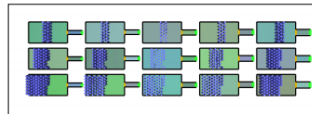


Figure 38: A Pathfinder model designed to replicate all 15 cases of the experiments.

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Pathfinder Verification and Validation

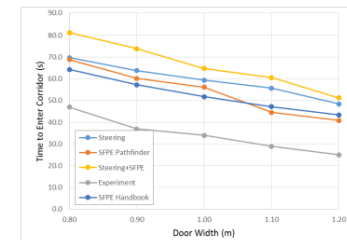


Figure 39: Comparison of times to exit room

In addition, we are able to compare the overhead camera footage in the experiment to the results visualization in Pathfinder. The exact scenario shown in the video at the left of Figure 40 is unknown, but based on the apparent door width and ability of occupants to form two distinct columns, the results video for a steering simulation using door width of 1.1 meters was selected for comparison (at right). The figure was created using the cylinder visualization that illustrates occupant orientation with an inset triangle.

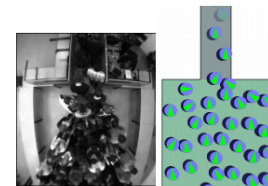


Figure 40: Experimental video (Seyfried, Passon, et al., Pedestrian and Evacuation Dynamics NETWORK 2009) compared to Pathfinder visualization.

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Error Handling



Pathfinder Error

Pathfinder has encountered an unknown error and must shut down.

Log File: [pathfinder_crash1409695118688.log](#)

What were you doing at the time of the crash?

Include action history

Please enter your email address to help us fix this bug.

Reply address:

To see what data this error report contains, [click here.](#)

Error Report

```
9:57:30 PM: Merlin3DSelector.selectSingle
9:57:29 PM: Merlin3DSelector.selectSingle
9:57:18 PM: Merlin3DSelector.selectSingle
9:57:12 PM: Merlin3DSelector.selectSingle
9:57:09 PM: Merlin3DSelector.selectSingle

Pathfinder Version: 2014.2.0818 x64
Date: Sep 2, 2014 10:11:11 PM

Stack Trace:
java.lang.RuntimeException
    at merlin.MerlinApp$AWTCrashAction.actionPerformed(Unknown Source)
    at javax.swing.SwingUtilities.notifyAction(Unknown Source)
    at javax.swing.JComponent.processKeyBinding(Unknown Source)
    at javax.swing.JComponent.processKeyBindings(Unknown Source)
    at javax.swing.SwingUtilities.processKeyBindings(Unknown Source)
    at javax.swing.UIManager$2.postProcessKeyEvent(Unknown Source)
    at java.awt.DefaultKeyboardFocusManager.dispatchKeyEvent(Unknown Source)
    at java.awt.DefaultKeyboardFocusManager.preDispatchKeyEvent(Unknown Sour
    at java.awt.DefaultKeyboardFocusManager.typeAheadAssertions(Unknown Sour
    at java.awt.DefaultKeyboardFocusManager.dispatchEvent(Unknown Source)
    at java.awt.Component.dispatchEventImpl(Unknown Source)
```

Verification Tests



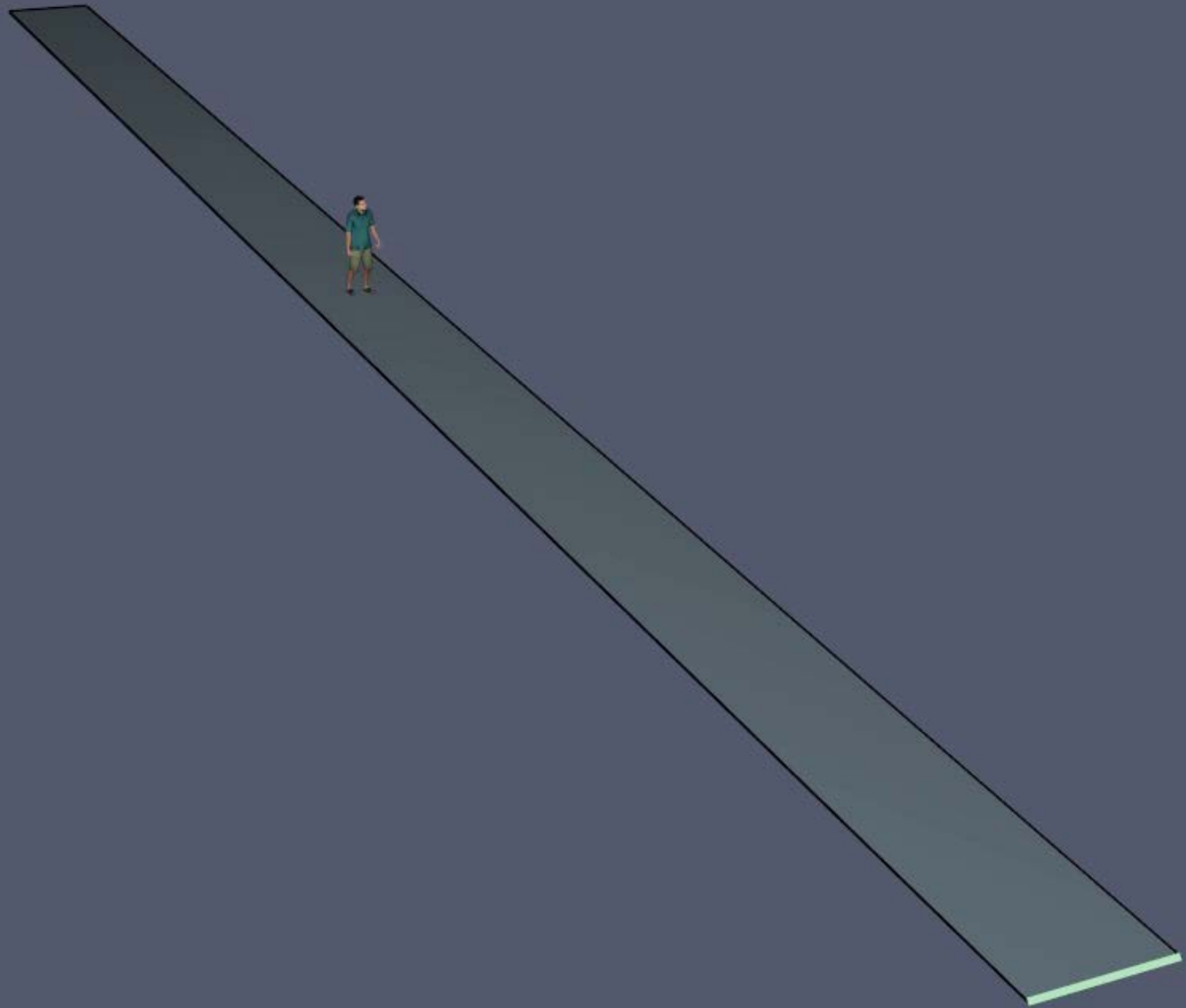
- IMO
- RIMEA
- NIST Tech Note 1822
- SFPE Handbook

Verification Tests



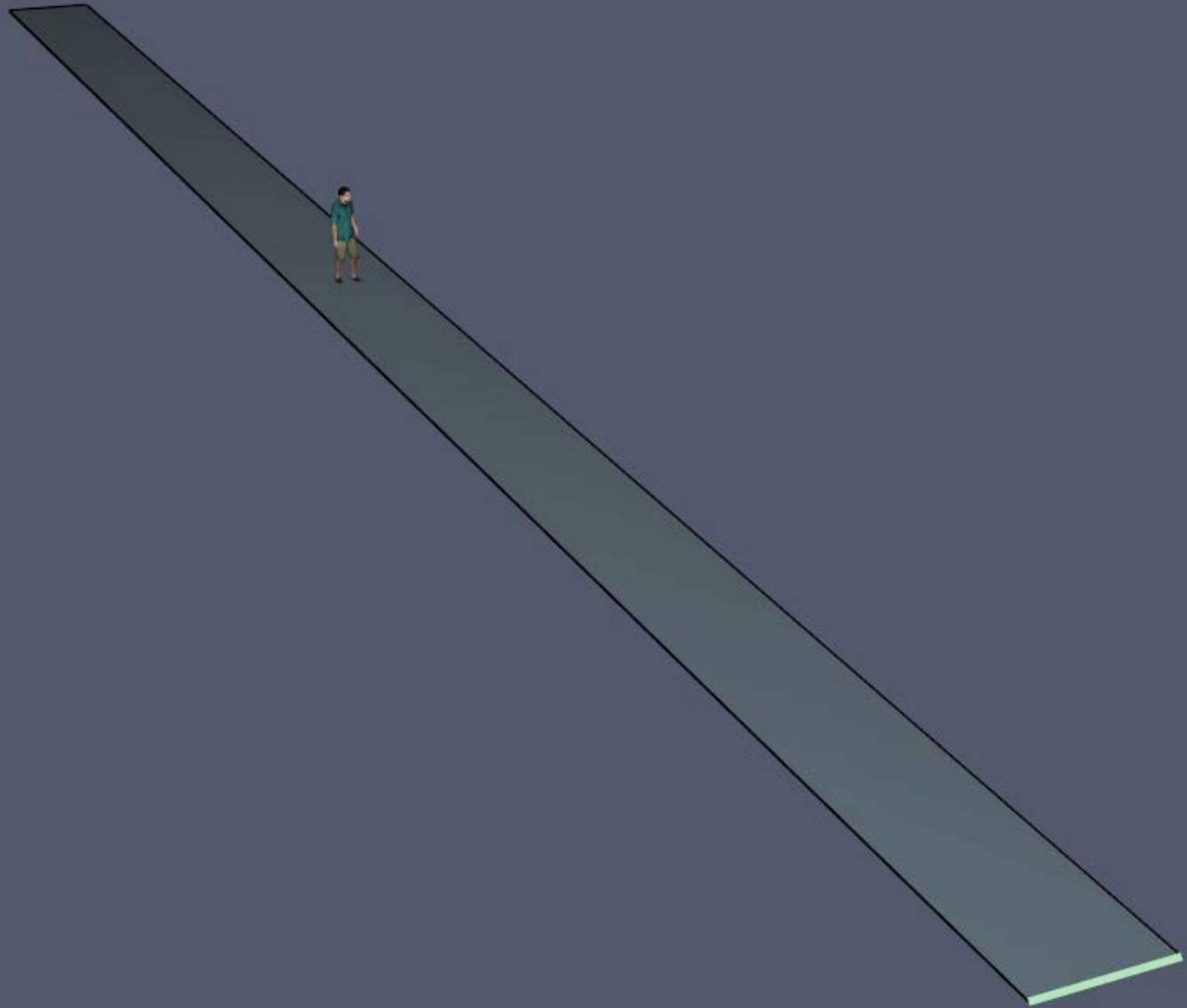
- Locomotion
- Wayfinding
- Behavior

Exited: 0/1



20.0

Exited: 0/1



10.0

Exited: 0/1



5.0

Exited: 0/1

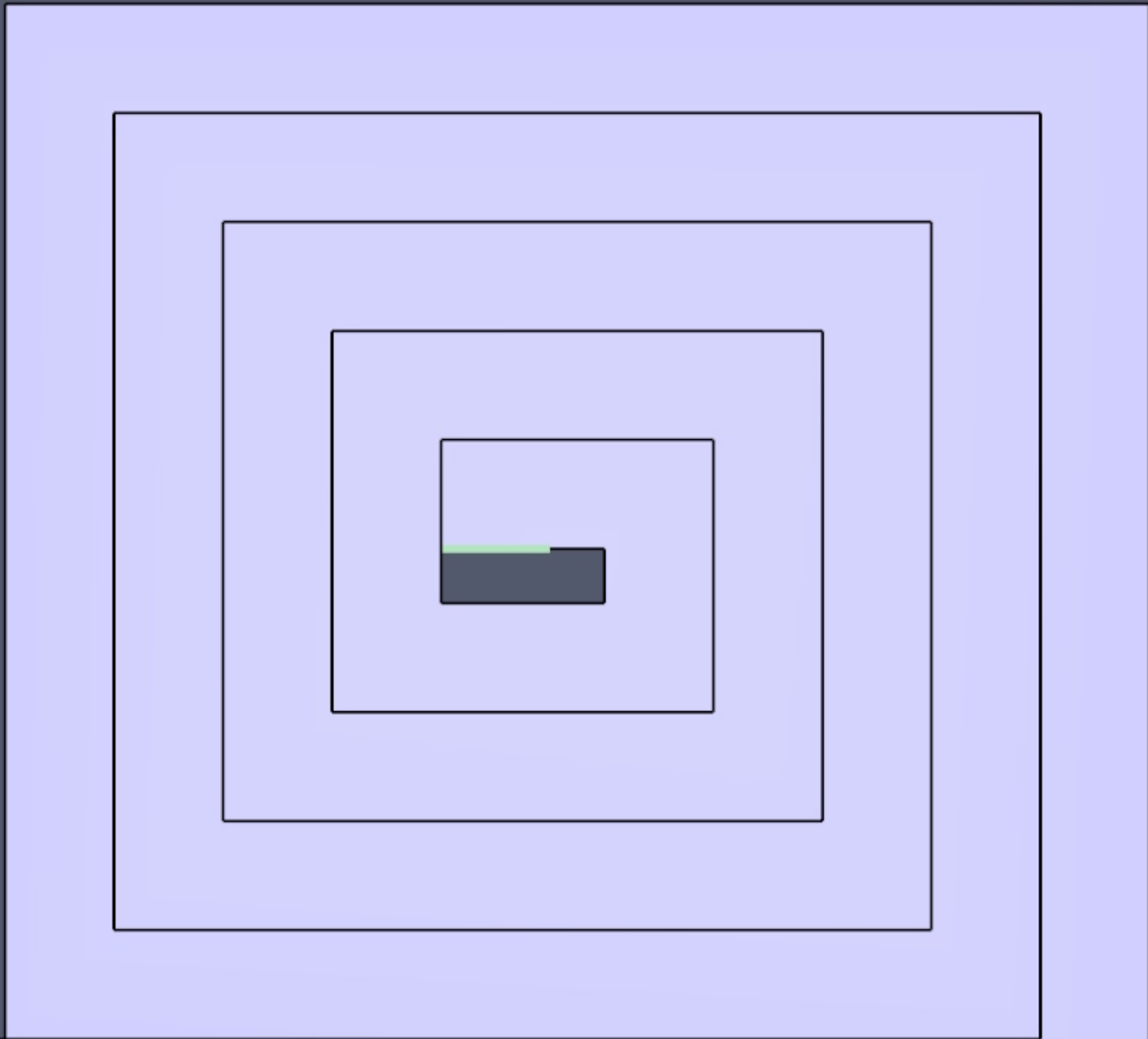


5.0

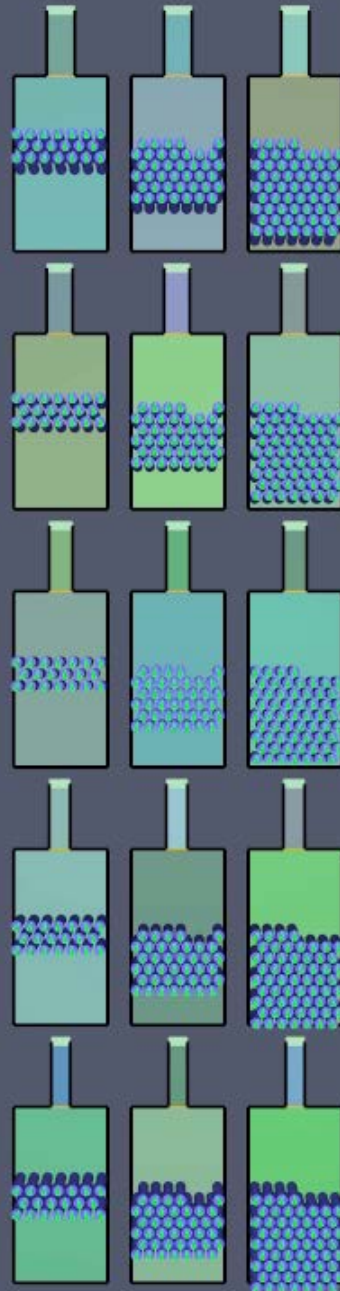
Exited: 0/1



0.0

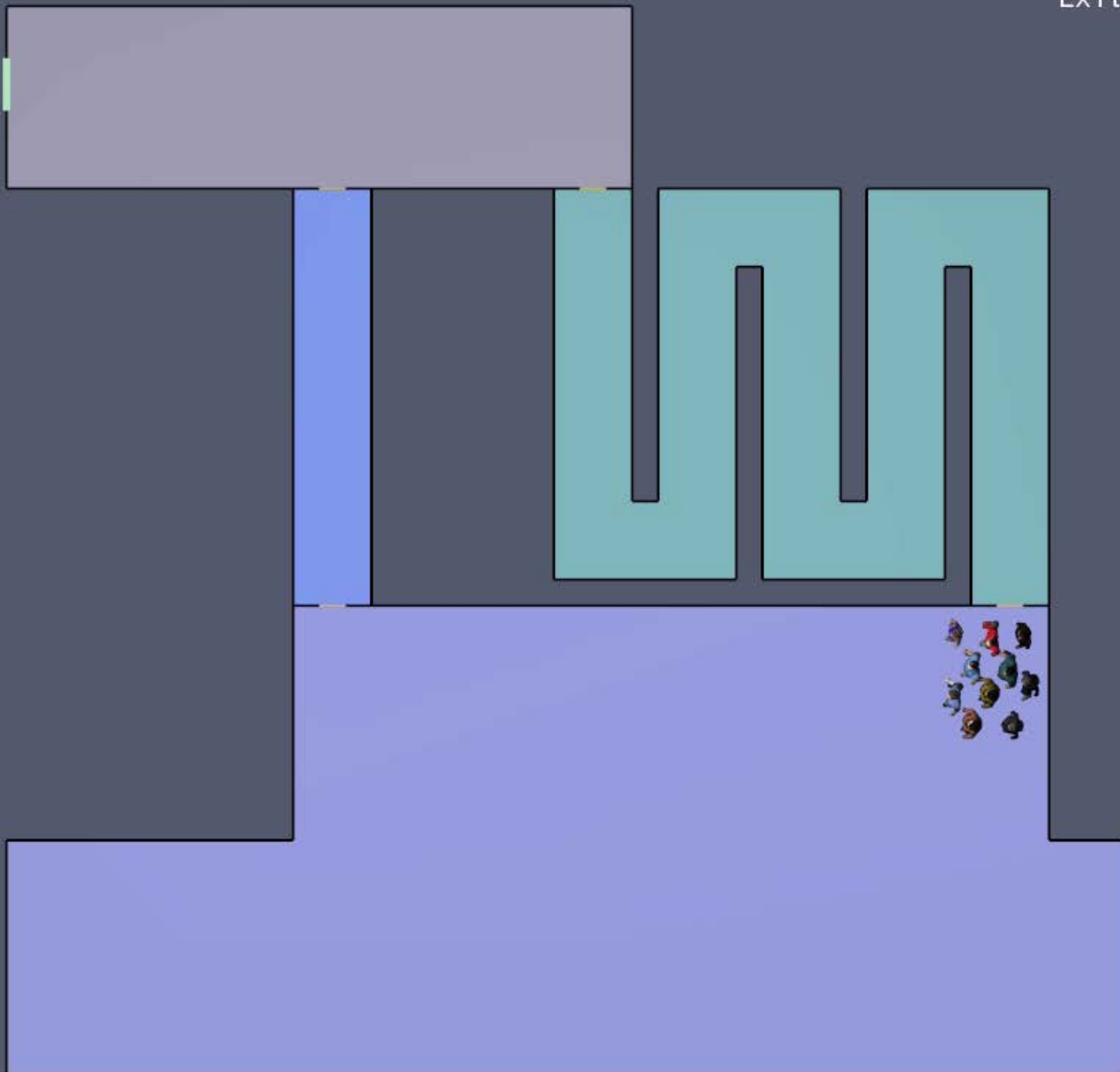


Exited: 0/600



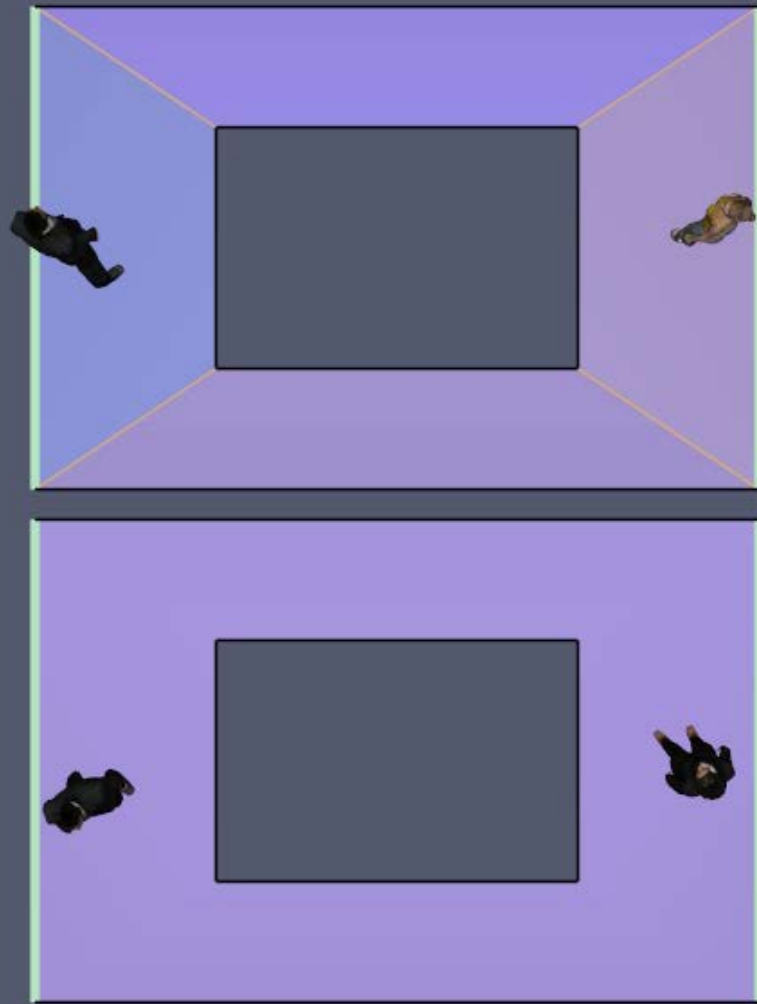
0.0

Exited: 0/10



0.0

Exited: 0/4



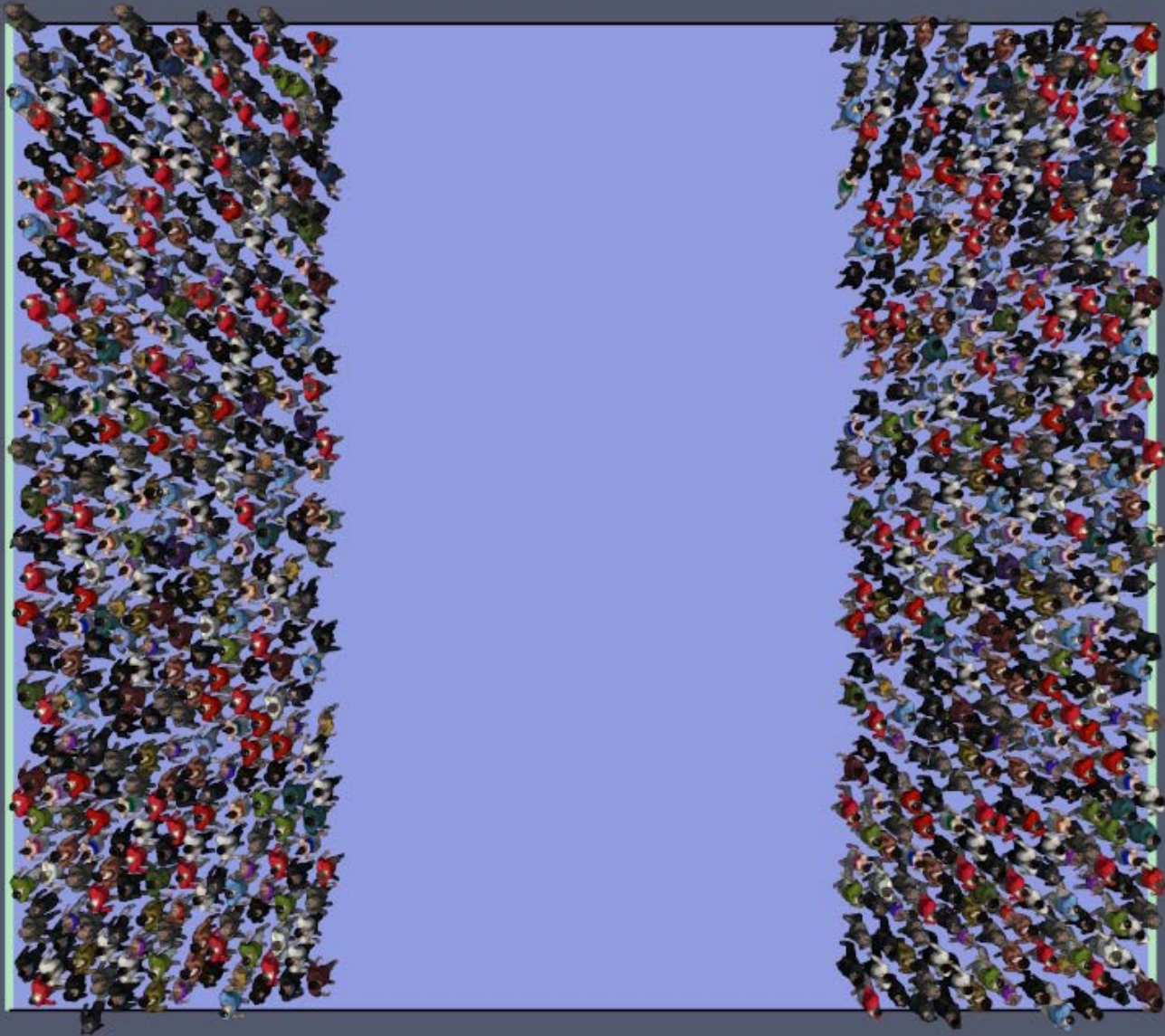
0.0

Exited: 0/2



0.0





Exited: 0/1000



0.0



How do we apply this to development?

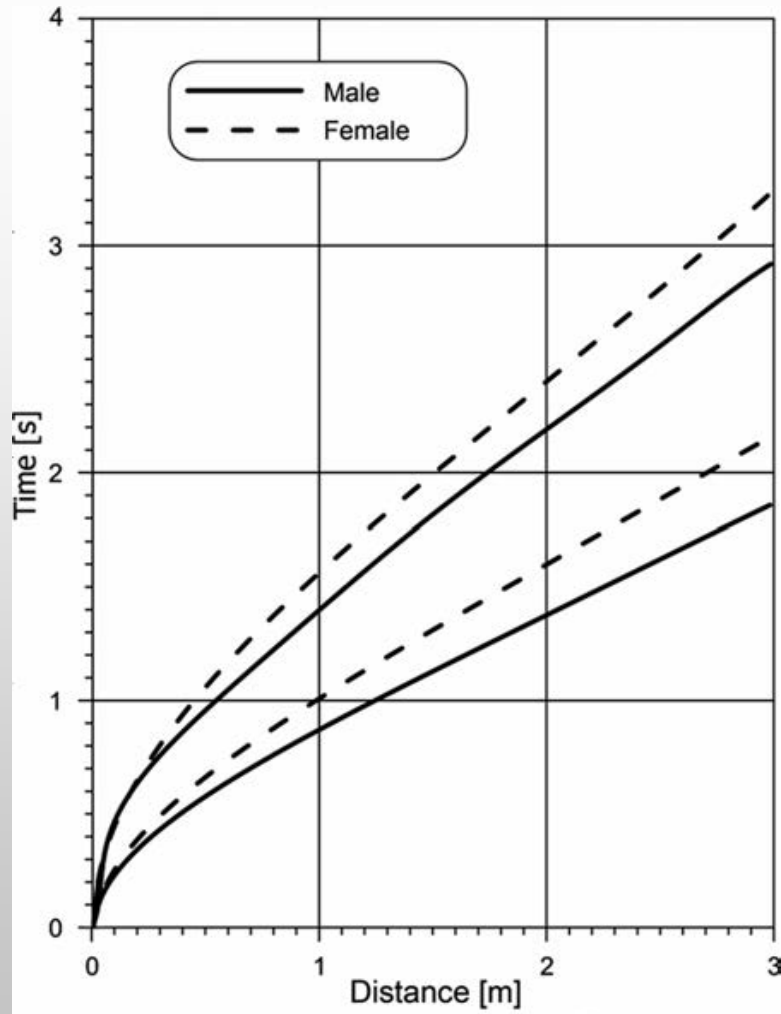
Pedestrian Acceleration



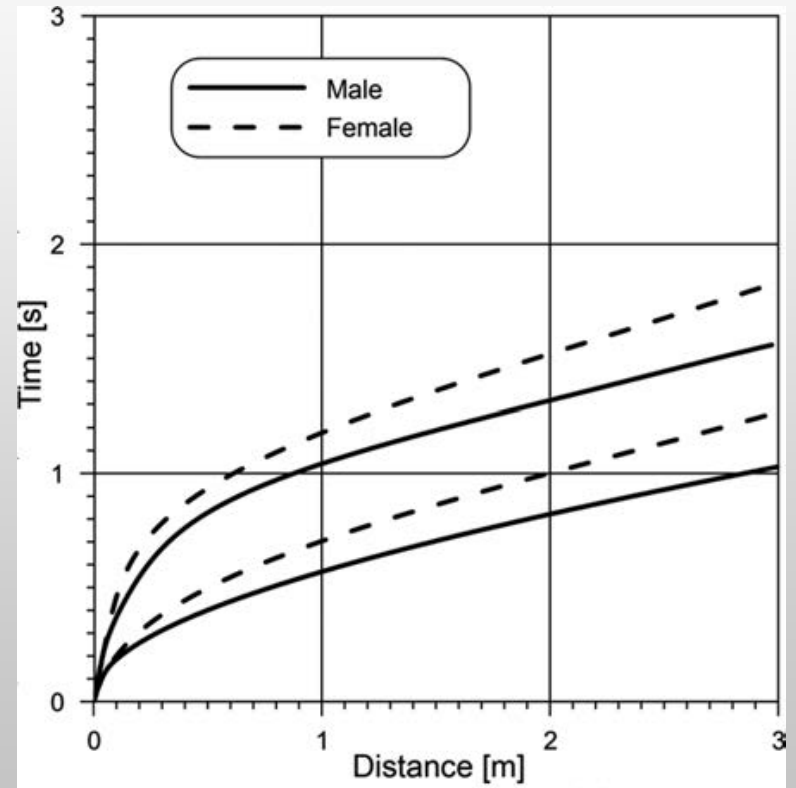
Problems of Forensic Sciences 2012, vol. 91

Jakub Zębala, Piotr Ciępka, Adam Reza

Institute of Forensic Research, Kraków, Poland

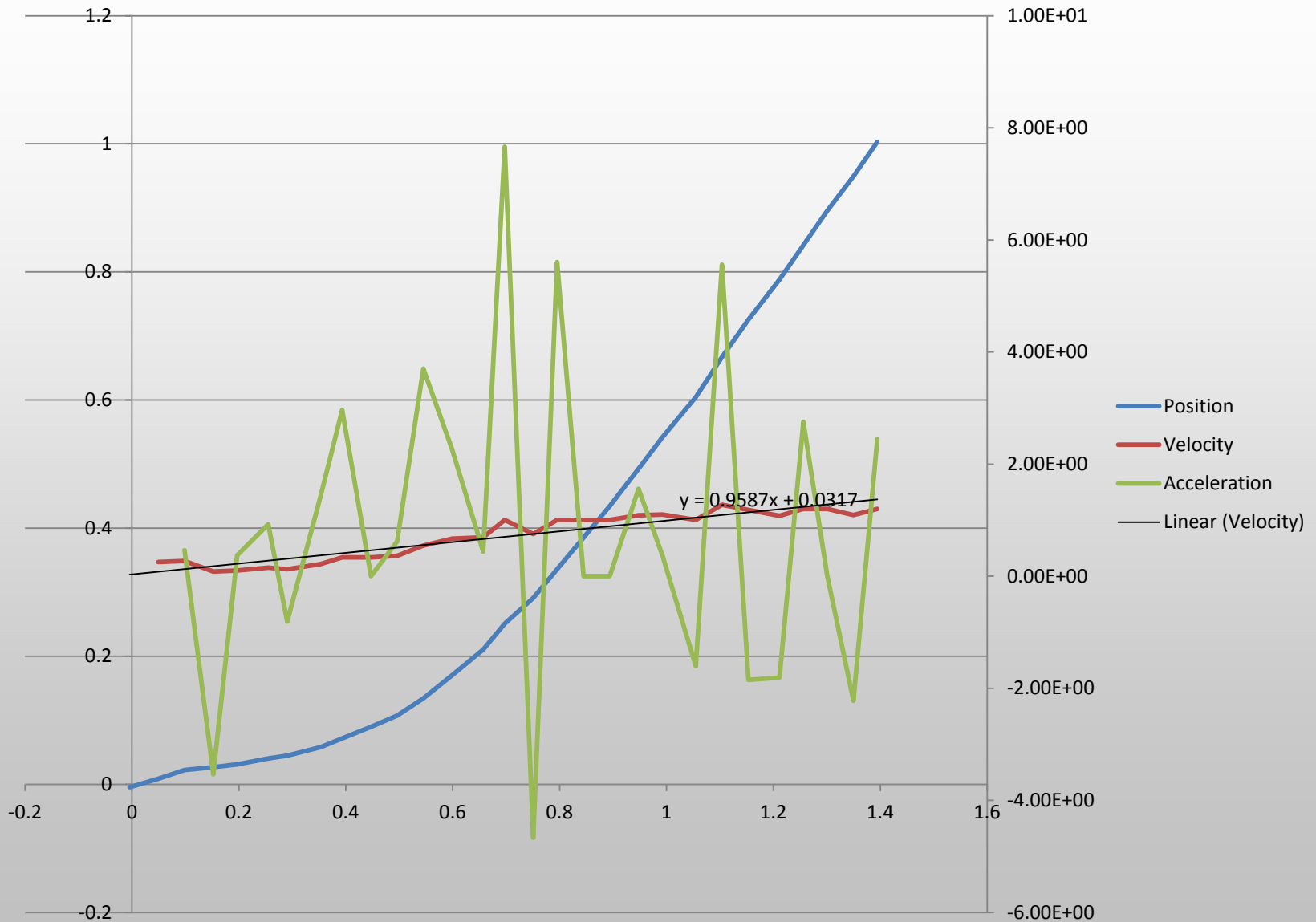


Walking

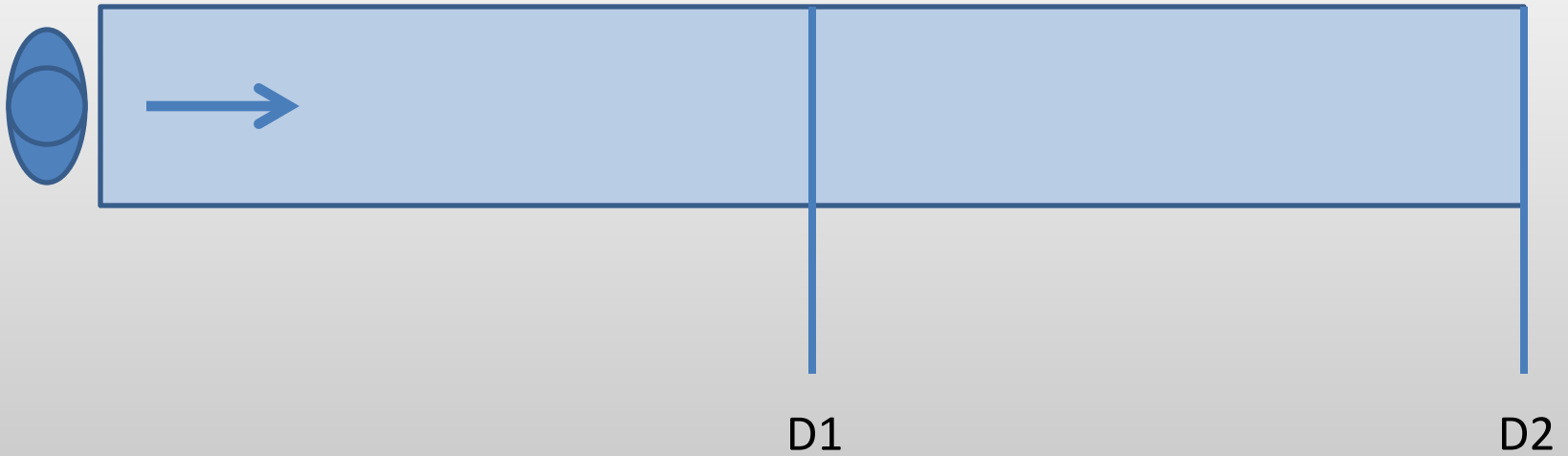


Sprinting

Acceleration to Ordinary Walking, Lower Bound



Hallway Experiment

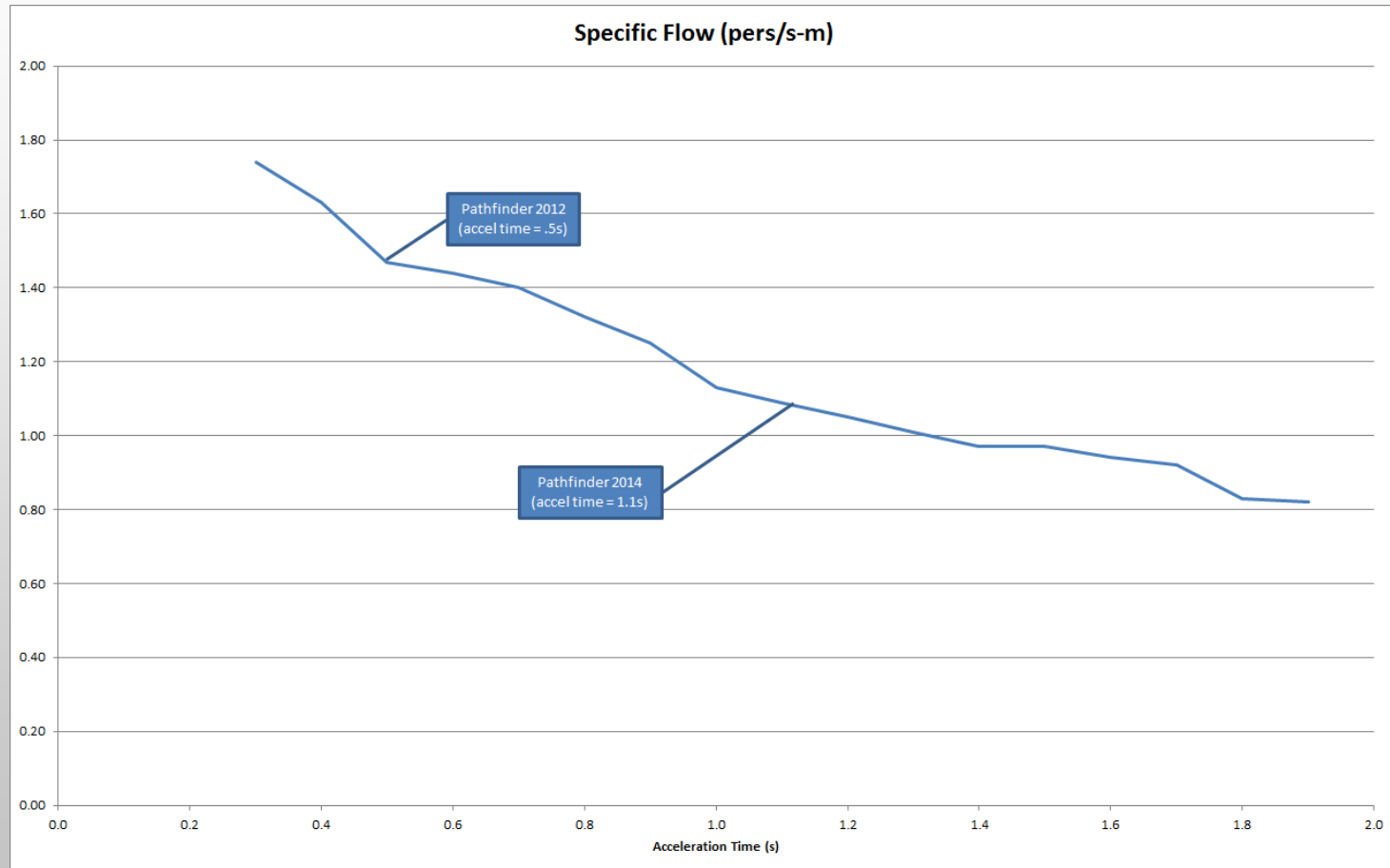


Hallway Results



	D1	D2	t	v	a	a/v	t_accel
Richard1	4.24	3.55	7.79	1.3	0.9	0.7	1.4
Richard2	4.25	3.63	7.88	1.3	1.0	0.8	1.2
Richard3	4.4	3.9	8.3	1.2	1.2	1.0	1.0
Jon1	3.81	3.61	7.42	1.3	3.2	2.5	0.4
Jon2	4.11	3.55	7.66	1.3	1.1	0.9	1.1
Brian1	3.45	3.35	6.8	1.4	6.8	5.0	0.2
Brian2	3.67	3.11	6.78	1.5	1.3	0.9	1.1
Brian3	3.23	3.13	6.36	1.5	7.3	5.0	0.2
Charlie1	4.2	3.74	7.94	1.2	1.3	1.1	0.9
Charlie2	4.38	3.81	8.19	1.2	1.1	0.9	1.1
Joe	3.97	3.7	7.67	1.2	2.3	1.9	0.5
Dan1	3.83	3.25	7.08	1.4	1.2	0.9	1.2
Dan2	3.82	3.07	6.89	1.5	1.0	0.7	1.5
Average					2.3	1.7	0.9

Flow vs. Acceleration



Agent Acceleration

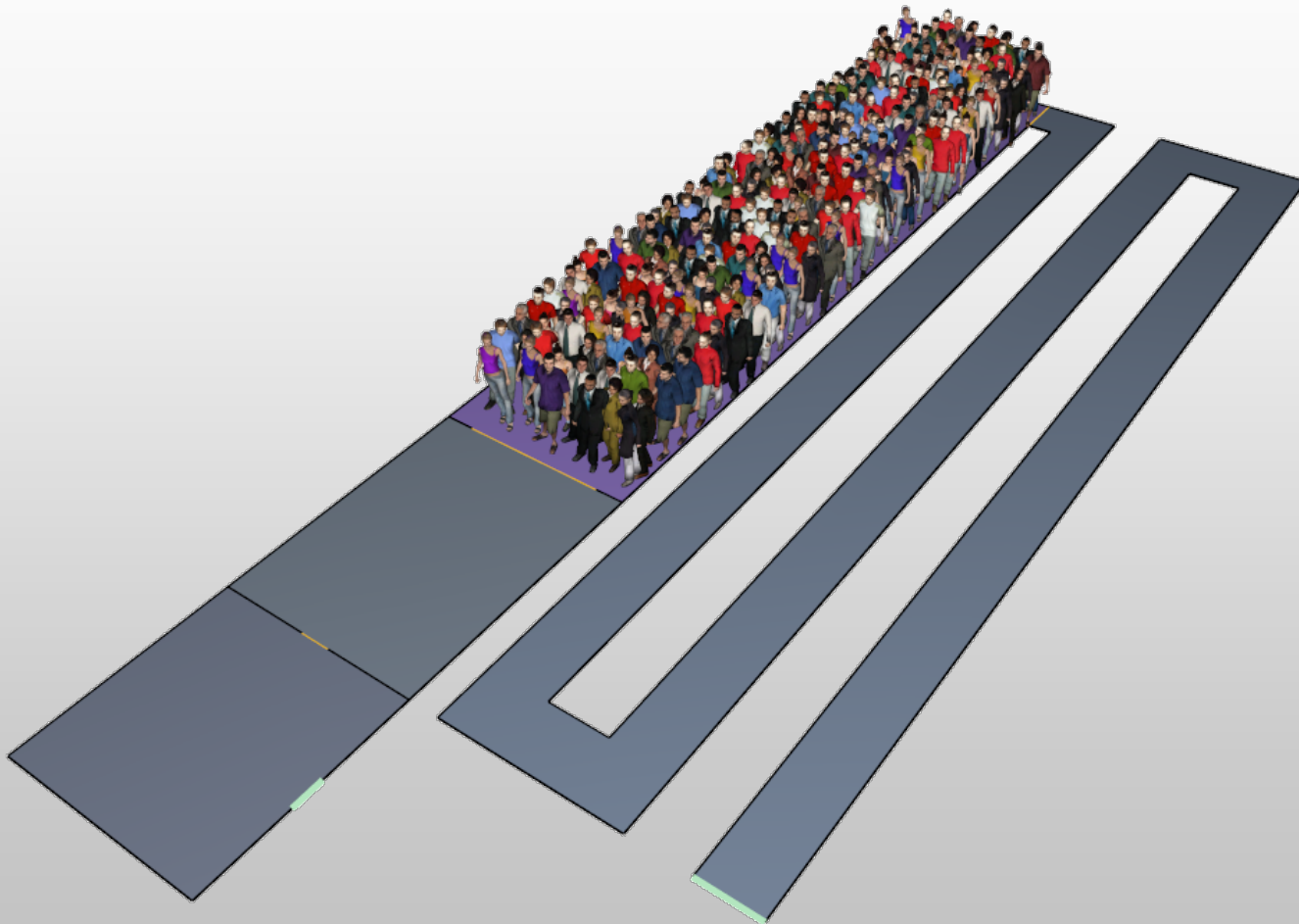


- Changed default value
- Exposed parameter for user input
- Re-run verification problems
- Update tests with new results

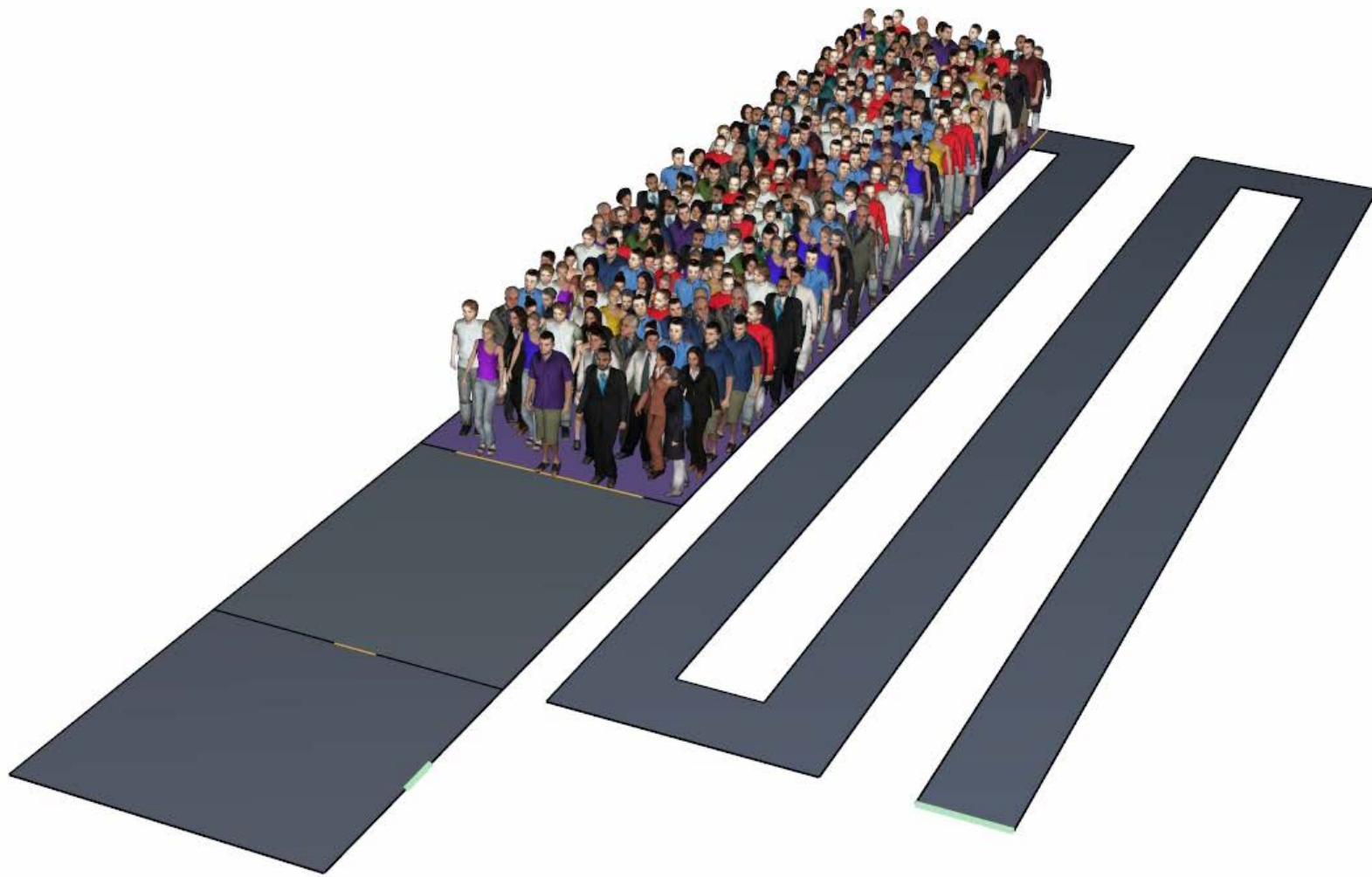
Improving Locally-Quickest Door Choice

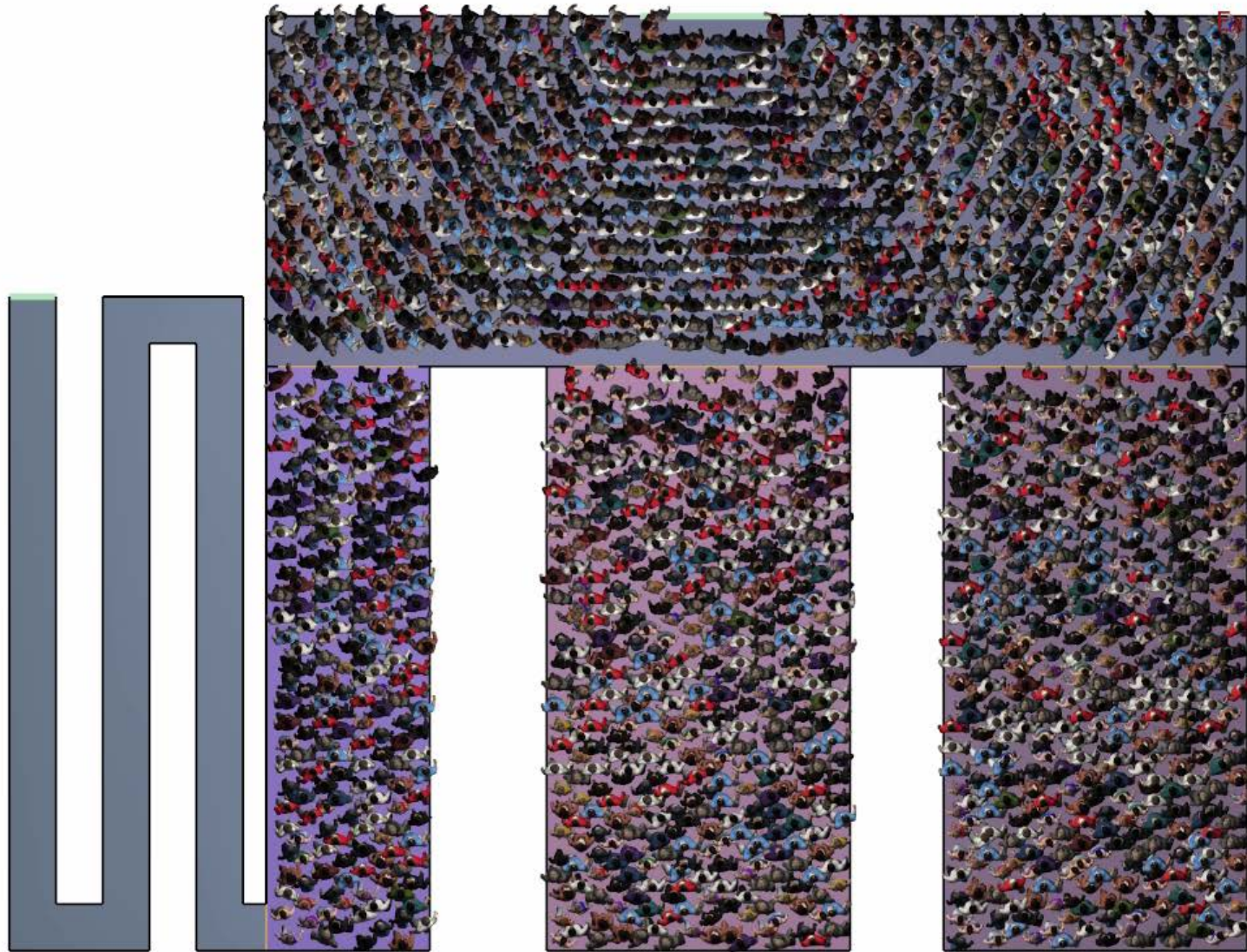


Exited: 0/252



0.0

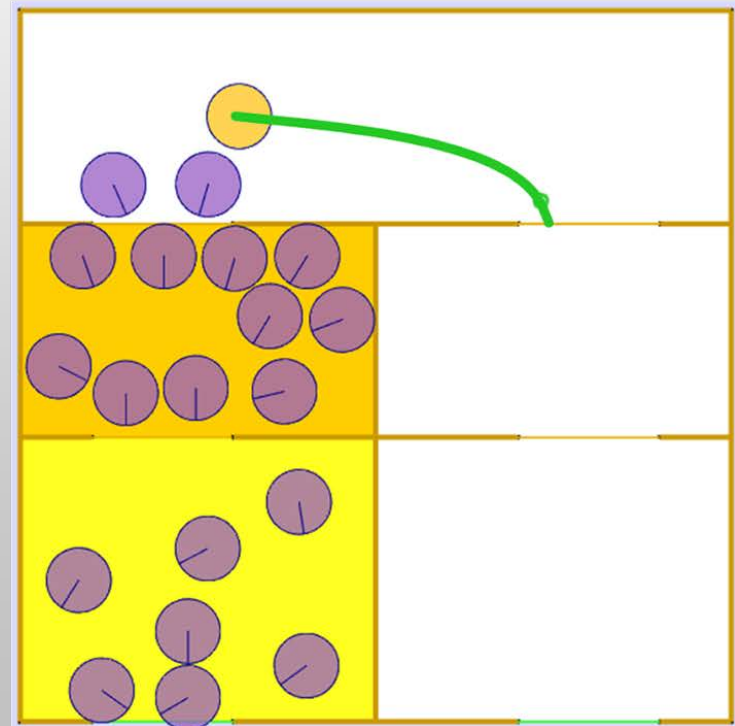
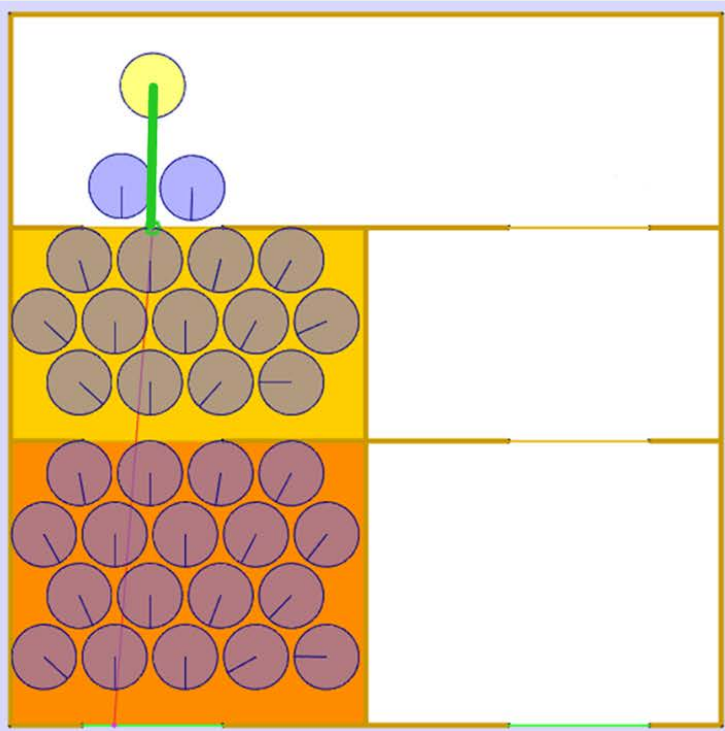




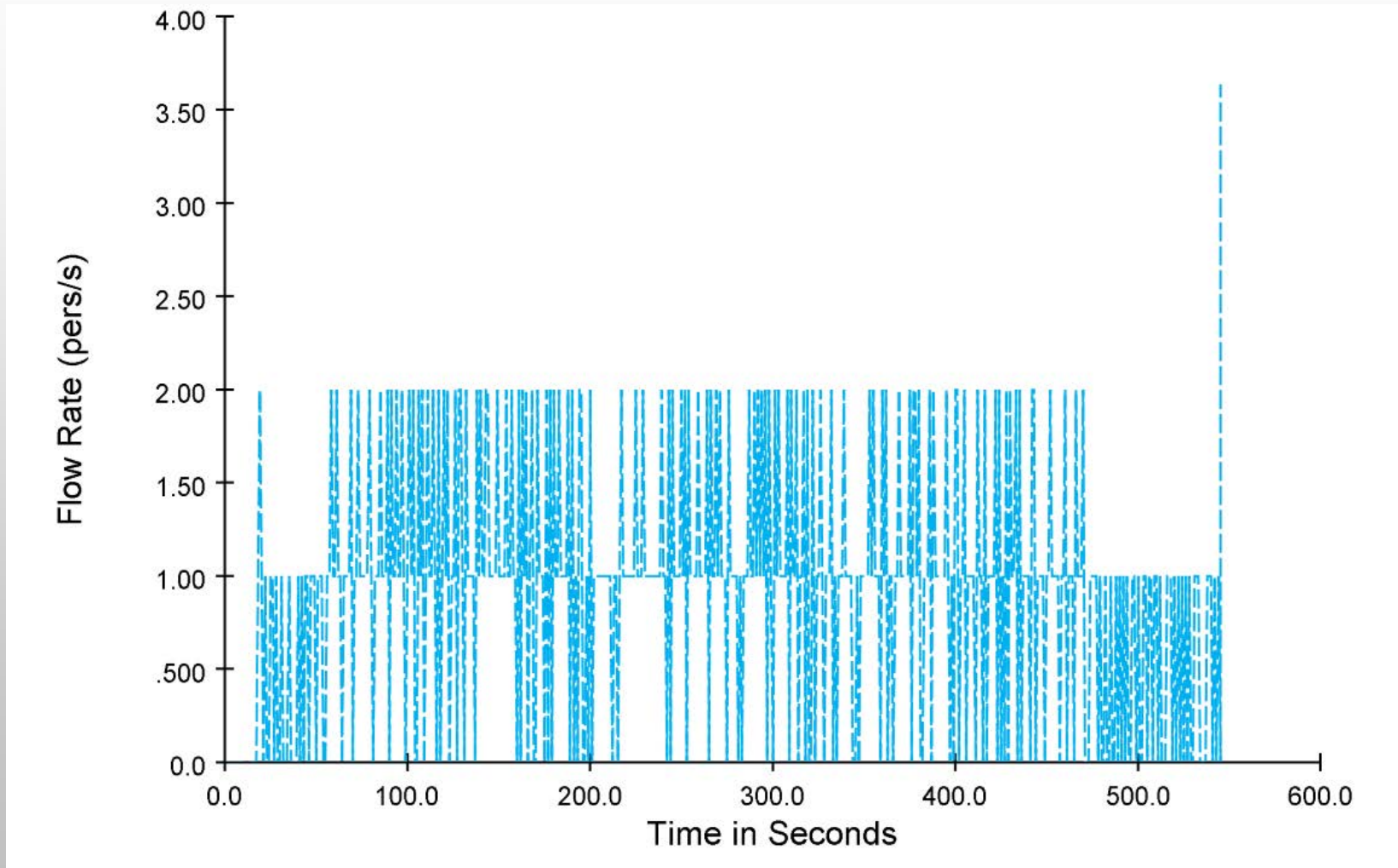
Proposed Solution



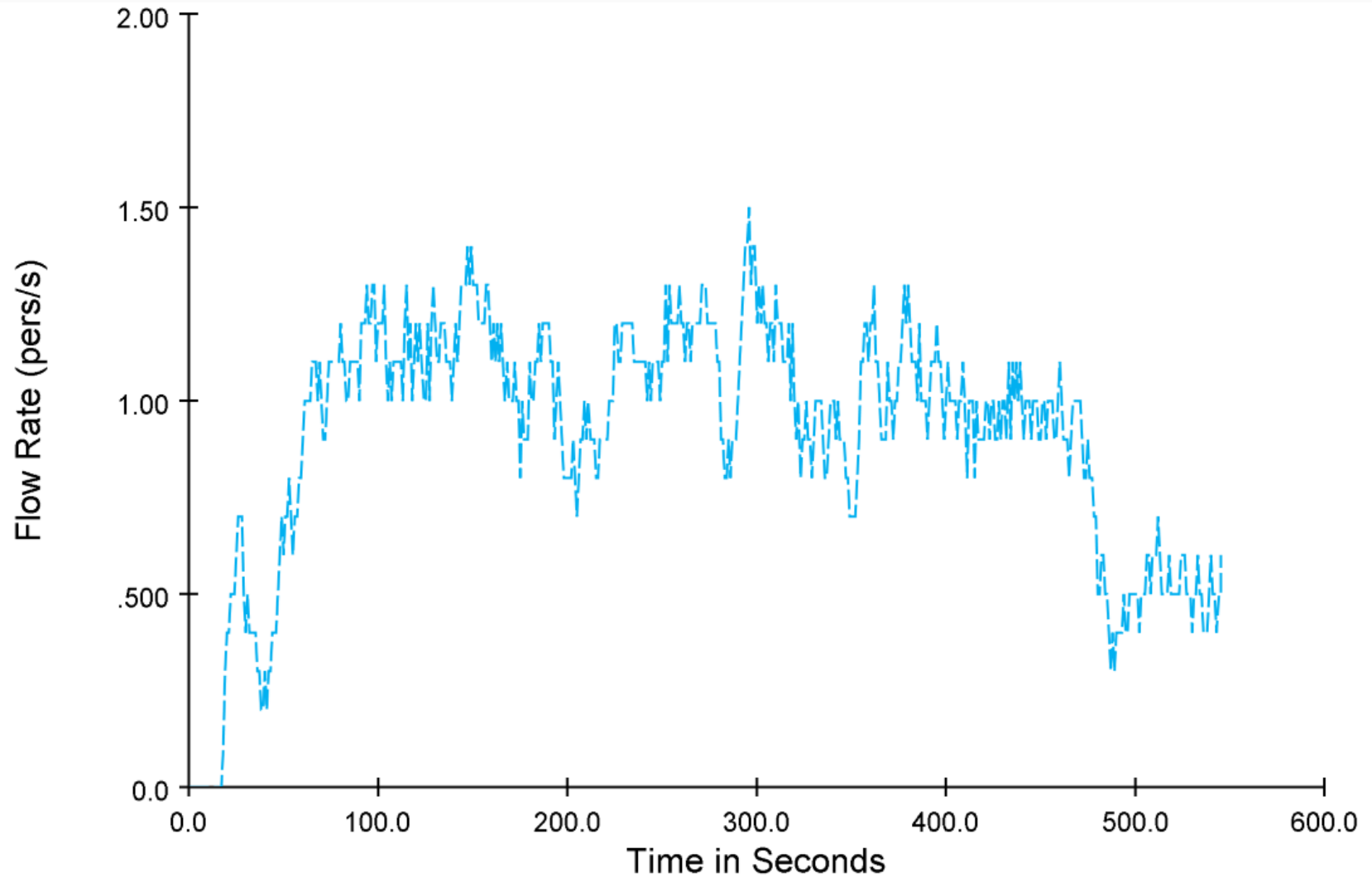
- Use actual door flowrates to estimate queue wait times



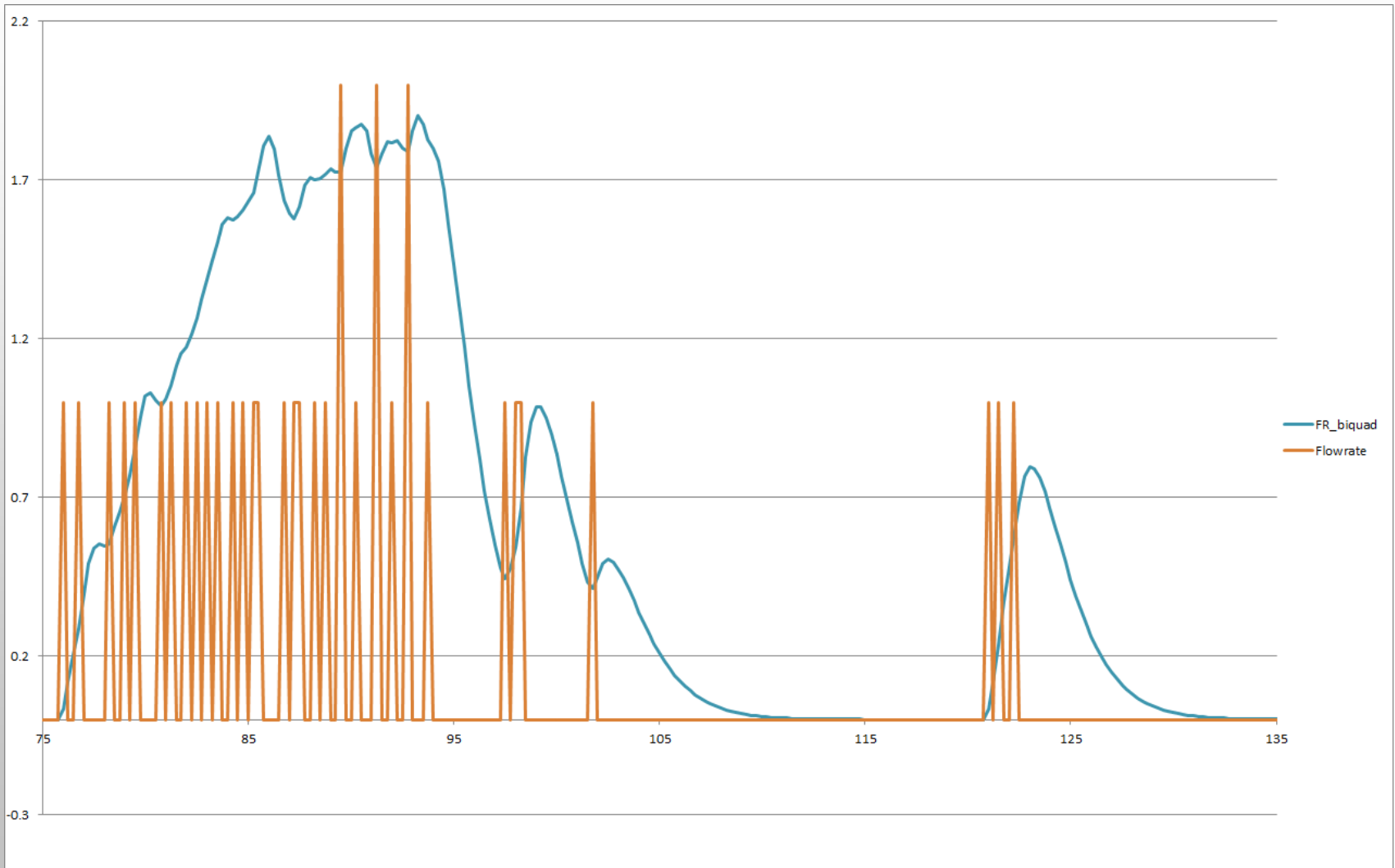
Measuring Flowrate



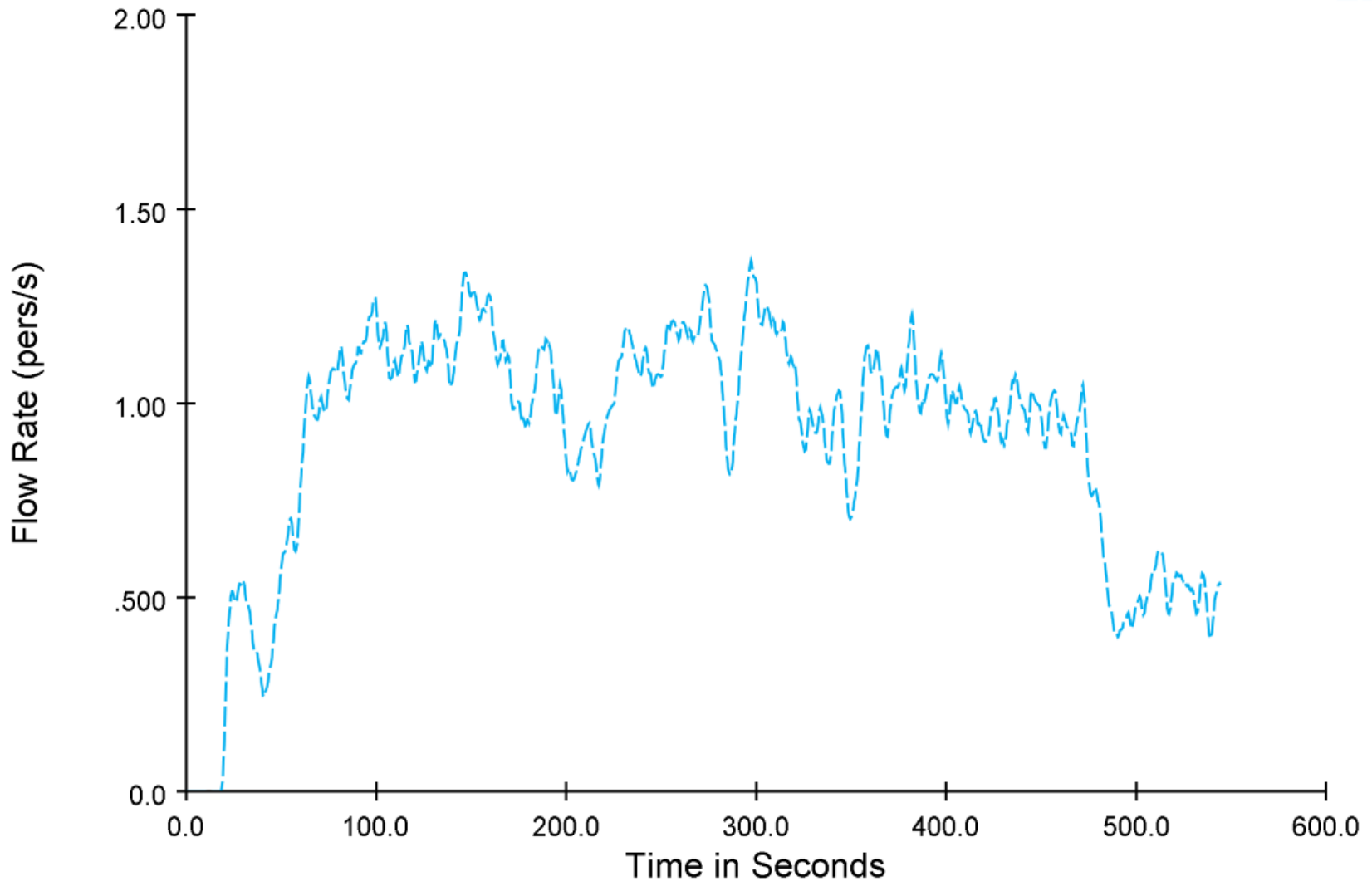
Moving Average



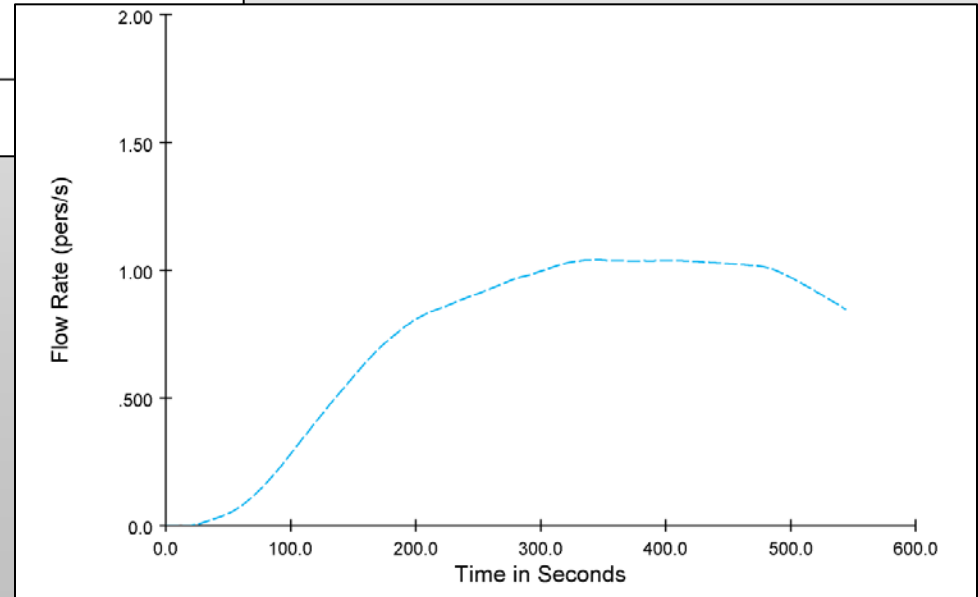
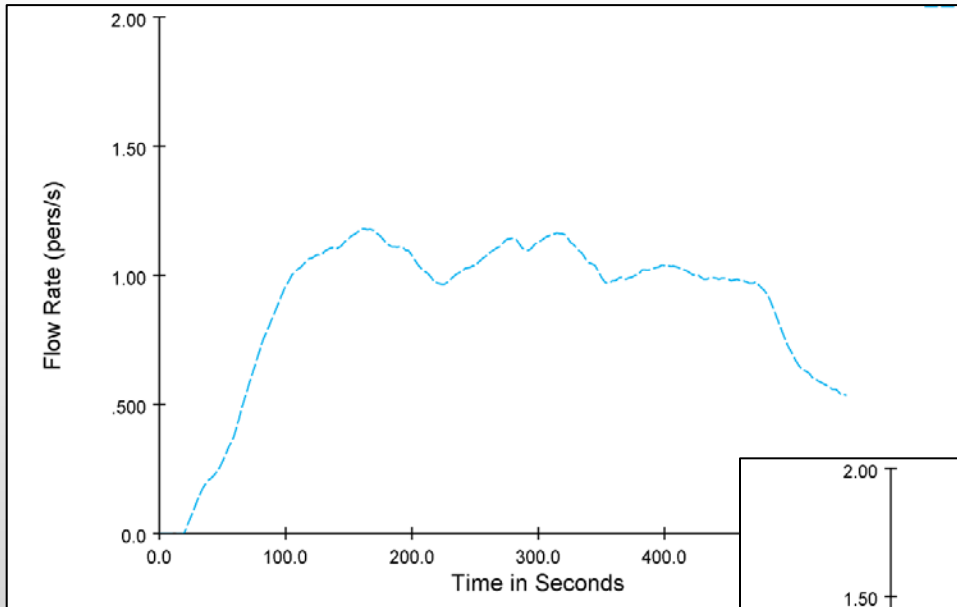
Low-Pass Filter

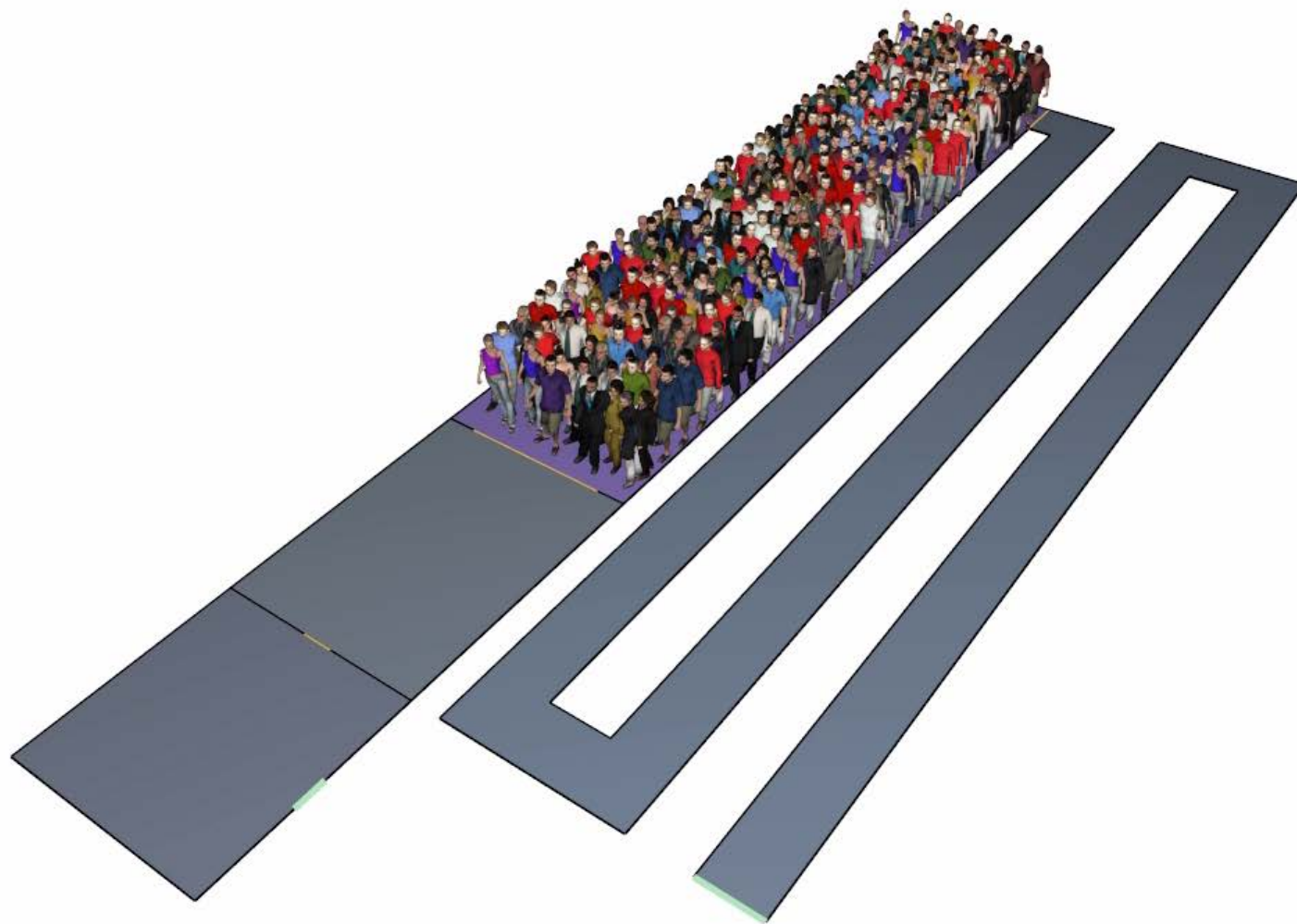


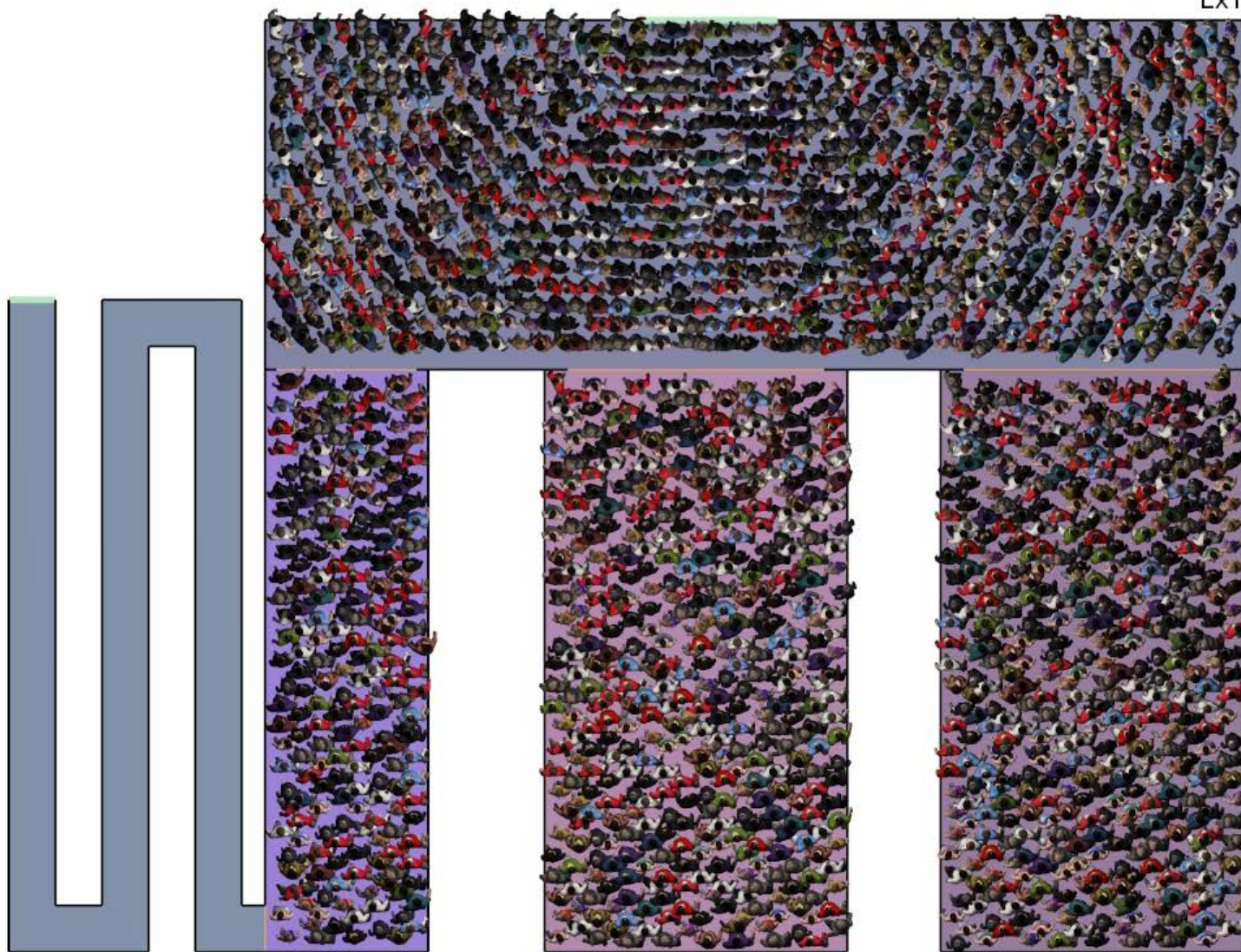
Low-Pass Filter



Low-Pass Filter







Door Choice Improvements



- Use actual flowrate to calculate local queue time
- Optimal flow used if no queue formed
- Re-run verification problems
- Update tests with new results



Thank You

Questions?