Fire Drill Modeling and Simulation

Macy Fraylick, Craig Harrison, Seth Thomas
Tri-Village Students
New Madison, Ohio
mcfraylick@gmail.com, craigharrison112@me.com, seththomas1994@yahoo.com

ABSTRACT

Over a course of a year, schools belonging to the state of Ohio are required to perform a minimum of nine fire drills. Although becoming much of a standard, this practice proves not very effective in time, thus hampering educational opportunities in the classroom. Because these drills are so necessary for the safety of the student body, our group decided to create a model of Tri-Village High School using both the Valve Hammer Editor and Google SketchUp. This model provided enough fidelity to give the vision of our education facility, minus details that would simply slow the compiling process. We brought our design to life through Source. Through programming, the students and all elements of an actual fire drill were formulated into a realistic simulation.

Fire drills are more ineffective than typically viewed. Students at Tri-Village can have up to 11 possible classroom locations throughout the school year. With the variety of student schedules, it is difficult to find 9 fire drills that will cover the majority of their classroom time. Through a simulation, however, students could train for fire drills covering each possible class. Sometimes weather can determine a positive or negative experience for students, but more often fire drills create hampering disturbances in learner work. Our simulation will prevent these problems and allow for teachers to be more flexible with the procedure. Most importantly, our simulation would present threatening fire scenarios that would be too dangerous to practice in a real environment. For these reasons, we feel as if educators should take an interest in our solution and its efficiencies.

ABOUT THE AUTHORS

Macy Fraylick is a senior at Tri-Village High School. She has been involved with the STEM program through her school for two years. Macy plans on attending Miami University to double major in Mathematics and Middle School Education.

Craig Harrison is a senior at Tri-Village High School. He has been involved with the STEM program through his school for two years and has worked at the Gaming Research Integrated for Learning Laboratory, through Wright Patterson Air Force Base, for two years. Craig plans on attending the University of Dayton to major in Computer Engineering.

Seth Thomas is a senior at Tri-Village High School. He has been involved with the STEM program through his school for two years and has worked at the Gaming Research Integrated for Learning Laboratory, through Wright Patterson Air Force Base, for one year. Seth plans on attending The Ohio State University for Veterinary Medicine.

TABLE OF CONTENTS

Fire Drill Modeling and Simulation

Macy Fraylick, Craig Harrison, Seth Thomas
Tri-Village Students
New Madison, Ohio
mcfraylick@gmail.com, craigharrison112@me.com, seththomas1994@yahoo.com

With the technology of today so rapidly increasing, modeling and simulation proves to be quite effective in training and learning. The opportunities are endless. With this in mind, our group examined our own school and evaluated upon how we might improve such a problem using this technique. The approach we took was transforming fire drills in our school system. The Tri-Village STEM class worked continuously with fire drills throughout the school year, using programs such as Excel and Python. We saw many faults with this drill, and realized the very usefulness of virtual imitation. With the application of Valve Hammer Editor and Google SketchUp, we were able to create an effective fire drill simulation.

TRI-VILLAGE FIRE DRILLS

It is required through the state of Ohio that schools must perform at least 9 fire drills each year. At Tri-Village High School, these drills last typically around 20 minutes each, totaling a minimum of 180 minutes spent on fire drills per year. With all this time spent, most students only get to practice the drill for a few of their many classes. Many of the trainees have up to 11 different classes per school year. With great diversity in schedules, it is nearly impossible for the school system to set up 9 fire drills that will effectively train the students for the majority of their classes. In addition, weather can play a hard toll on students during fire drills. Cold weather and poorly clothed children can result in a miserable, ineffective experience. Very often, these practices will interrupt important classroom time, such as tests, and will distract the learners on many levels. Younger children are often frightened by the fire drills because of the commotion associated with them. Perhaps the greatest fault is the incapableness of the school to train students through dangerous situations, like alternative exits and other solutions when a fire is in threatening view. All of such reasons led our group to an objective that would hopefully fix the faults and allow for a more productive procedure.

PLANNING

After identifying the problems associated with fire drills, our next step was formulating a plan. Because of previous usage of both Google SketchUp and Valve Hammer Editor, we decided to utilize these systems in the process. We furthermore familiarized ourselves with these programs through various tutorials and ran simple source maps to better understand its functions. The decision of key goals was an important point of our group discussion. Lighting, sounds, triggers, objects, physics, and fidelity were design components involved in our thinking process. By creating a gaming storyboard, our group was able to figure the main objectives in project completion.

MODELING

Modeling was a process that required much work and attention from all group members. Creating the floor plans, designing school objects, and importing textures were all important tasks divided among the team. In our simulation, we were able to recreate 69,613 square feet of flooring, replicate 93 school objects, and incorporate 413 textures into the design. Blueprints of the school were examined when creating the outline of the building. This included the creation of every doorway, room, staircase, and hall, crafted completely to scale with brushes in Hammer Editor. Entities found in typical educational facilities were created through Google SketchUp. Because compiling time depends on the amount of vertexes and space in each map, objects were set to the basics in a classroom. Chairs, doors, and desks were typical constructed models. By following an importing procedure, these models became available in Hammer. To create a more realistic model of our school, textures were taken from Tri-Village Schools and imported into the system. Such textures included bricks, flooring, signs, and pictures, serving as wall surfaces and overlays in our map.

SIMULATION

Once our model was made, we then had to create the simulation portion of our program. The first thing we had to do was populate the school with Non-Playable Characters (NPC's) to play the role of other students and allow them to evacuate. To do this, we added ground nodes inside the model so that the NPC's would know their paths of evacuation. By making these ground nodes, NPC's were capable of interpreting their environment. Such things like fires, walls, and other obstacles would be revealed to the NPC's through the ground nodes.

In addition to the creation of ground nodes, we constructed a goal for each group of NPC's. Essentially, a goal would give each NPC a destination. The ground node and goal method allowed for the NPC's to create their path and escape in the event of a fire. We were then able to control their path by placing nodes in a specific direction of the NPC's routes. This resulted in the NPC's traveling to a specific destination in an orderly manner, as well as having the capability to interpret their environment and avoid any harmful obstacles in the way. In the end, this allowed for a more accurate simulation that, in addition, increased the fidelity of our simulator.

Our following objective was adding fire to the simulation. In Hammer Editor, fire is an entity with multiple parameters and specifications. These parameters and specifications included how much damage the fire could produce, the spread rate of the fire, the size of each fire entity, and more. With adjustments, our group created a more tangible fire in the program.

After populating the school with NPC's, giving them a route to evacuate, and adding fire, we installed sound into the environment in order to create a more realistic simulator. To do this, we distributed recorders around our school during an actual fire drill. We were then able to take the recordings and transform them into ambient generic sound entities. The sounds would then play once the fire alarm was pulled.

Our final step for the simulation of our project consisted of creating the starting location of our info_player_start (main gamer). We realized that in the event of a fire you wouldn't always be in the same exact location when the alarm sounded; therefore, in our simulation we allowed the students to pick various locations to escape from. Once the students selected their location at the beginning of the simulation, they would then be placed at that spawn point. These participants may have up to 11 different classes a year. Through various spawning points, they would have the opportunity to train for all of their classes, insuring preparation in the event of an actual fire.

PROBLEMS ENCOUNTERED

With the introduction of this challenging project for our team, there were obvious problems brought forth and later solved while testing our design. Evaluating physic programming on classroom doors was one such element that took time and analyzing to resolve. These doors, first imported, are considered prop_statics; user interaction is disabled. This means that physics must be applied to such objects to present a more realistic simulation. In order to do so, we had to add point entities (function_door_rotating) to these objects. Points of rotation then must be placed on a specific axis. This was where our team encountered the difficulty. We had believed that the placement of our axis in a centered format was correct, when in fact, it was causing doors to open into our walls. Due to poor tutorials, we solved this issue through testing. What was found was that these axis points must exist on the outside corner of the doors, where the door and wall barely touch. Also, adjustments must be made so that this entry only opens in one direction; if not, the gamer will encounter the same problem regarding door interference with the wall while entering.

Multi- textured objects imported through Google SketchUp became another challenge. Sides with darker surfaces behind, rather than in front, will eliminate that object's surface. From different angles, sides of our imported items would vanish. At first, our team directed our attention towards our importing procedure, assuming that a texture had gone missing in the process. After many trials, it was concluded that this was not the issue. Upon examining like objects that contained such a problem, we found that the unstable sides were caused by a darker texture being placed behind a lighter one. Source confused this texture error, eliminating the section of the brush from view.

Perhaps the biggest problem we faced, but learned from, was the immense compiling time. Although minimizing as many objects as possible, it was later found that the conflicting walls, not seen through the Textured Polygon view of Hammer, were creating vertexes that significantly slowed the loading process. By making these fixes and including the "No Draw" function in rooms and on walls not seen in our fire drill procedure, the compiling time decreased.

Correcting the many challenges faced throughout our project time came all with patience, research, testing, and investigation. Without this problem solving process, our group would not have progressed in the creation of our simulation.

TESTING

In order to examine the effectiveness of our simulation, we set up a test for a group of Tri-Village eighth grade students. There were 19 test subjects in our experiment; each given a Pre-Test before moving to the computers. Our Pre and Post-Tests contained a list of 6 random rooms in Tri-Village High School. They were asked to answer, to the best of their abilities, the escape routes from each class in the event of a fire drill. Being the second month of their second year in the High School part of the building, they had experienced 11 different fire drills thus far. That means they have spent 3 hours and 20 minutes going through the fire drill procedures. However, the average Pre-Test score was an 18%. Each student was then directed to the computers in which we had previously set up our simulation. They were asked to go through every room that they had previously been questioned on until they felt they understood each route. This took about 5 minutes to achieve. After doing so, they returned back to their desks and took the Post-Test. Every student improved their score (see Figure 1). The class average, after going through our simulation, was an 86%. This was a 378% increase from the average Pre-Test score. This serves as evidence to support the effectiveness of our training simulation.

SIMULATION EFFICIENCY

As the need for educational progress becomes more enhanced, it is important to utilize our classroom time wisely. Safety training, such as fire drills, becomes more of a disturbance than a helpful tool. We believe that simulations, such as ours, will be the next step in technology to serve as a useful device, not only for educational facilities, but for other various workplaces. Our simulation offers a more flexible, efficient, and broad training exercise than one of real life. It will recreate the exercise without involving all of the downfalls. With our design, we can bring forth dangerous scenarios of fire to calmly allow the students to prepare for various solutions. This means no panic, no worries, and no danger. Students will enjoy their training, allowing for gaming to take on a whole new perspective in their lives. Most importantly, our fire drill simulation will better protect and prepare students for the worst.

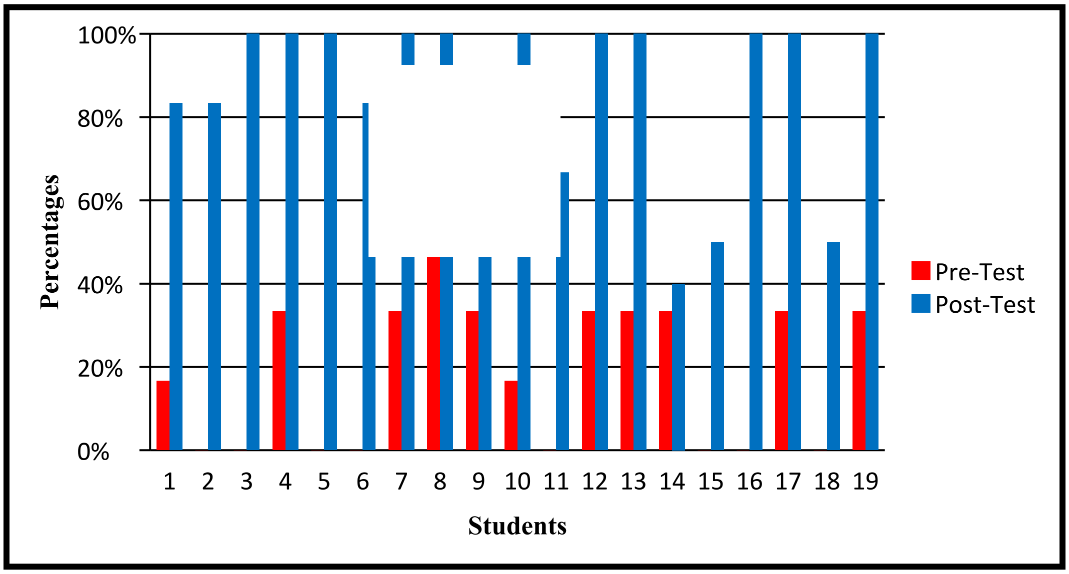

Figure 1. **Results from the Simulation Testing**

CONCLUSIONS AND FUTURE WORKS

In conclusion, the long term goals for our fire drill simulation include utilization of our system in Tri-Village Schools as an alternative to real-life fire drills. Continuation of our simulation to incorporate the elementary wing of Tri-Village is soon being put forth into action. Our local Fire Department has asked our team to modify our school simulation to one that would serve as a training exercise for New Madison's Volunteer Firemen. This would include the model of our school; rather than the evacuation of staff and students, however, our simulation would be focused around training for safe entry for search and rescue procedures. In addition, we could utilize our school model to produce simulations regarding other dangerous scenarios that deserve preparation, such as tornado drills and lock-downs.

We highly believe that modeling and simulation is the future of our society and that we should take advantage of our opportunities. Eventually, our hope is for our idea to spread to various workplaces and school systems, allowing for technical advancements throughout. For our group, this was a learning experience and a stimulus for all the great things yet to come.

AKNOWLEGEMENTS

Our team would like to thank our teacher, Mrs. Puckett, for guiding us during this experience. We would also like to thank the Wright-Patterson Air Force Bases' GRILL Team for providing support for the STEM Educational Program.

REFERENCES

Tornado and Fire Drill Information for Schools. *Ohio.gov.* Retrieved 1 August 2012, from http://www.com.ohio.gov/fire/docs/fire_schoolfiredrillsltr.pdf