Team Number: 053
School Name: Santa Fe High School
Area of Science: Behavioral and Social Sciences
Project Title: Evacuation Efficiency

Problem Definition:

The problems that arise during emergency situations, specifically evacuations, can almost all be reduced down to the amount of time it takes to get all people from point A to point B. Point A in this case, and in our primary focus, is a building that is on fire and point B is a safe distance of at least 150 feet from the building[1]. However, large numbers of people increase the amount of time it takes, by causing panic, and blocking passage, to arrive at point B. Large amounts of people faced with narrow or small amounts of exits cause everyone to slow down. The goal for our project is to model a small fire in a building. In our example, we will use Santa Fe High School. The problem lies in the efficiency with which large numbers of people can evacuate under certain conditions, such as more or larger exits or simply changing the way the evacuation plan is laid out.

Problem Solution:

Evacuation time must take into account pre-movement time, meaning the amount of time it takes for someone to organize themselves and develop their own evacuation plan, for any potential people evacuating, the number of potential people that would be evacuating through a single exit, and the various ways in which the flow of people would be constrained. The most important way to reduce this time is to eliminate, as much as possible, the places in which the flow of people is constrained. We have studied a virtual reality simulation of an urban space[4] to monitor these constrained flow places. This gives us a clear idea that the solution to reducing constraints is wider hallways and larger landings for stairs.

Through our extensive research we have come across a recurring similarity: the pathfinding of the agents is abstracted as a straight line between two points[5]. This is not taking into account the obstacles such as furniture, protruding objects, and most importantly the number of other people. Including these variables in a simulation would help give us a more accurate model.
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Progress to Date:

Our progress as of December has only reached the end of the research stage. We now have a decent comprehension of queuing theory. This is arguably the most crucial part of our model; it is a mathematical analysis based on arrival rate, service time, and the number of servers in a system[2]. We can apply this to an evacuation in the sense that all of our evacuees will be trying to complete the same action (exiting the building) at the same time where the servers (exits) are limited.

We have also done extensive research into how most evacuation plans are laid out and how most panicked individuals would react. This has also given us insight into what sorts of complications would arise in a building, especially one with multiple stories. In most cases, to simulate evacuation time, a hydraulic model is used. In this model, people are modeled as water particles which are considered to behave in a manner closely related to human behavior[3].

Expected Results:

Our final results will hopefully be a working model of panicked behavior in a dangerous building that could be applied, with the same core code, to other buildings or situations. Given that this is a large undertaking, our team is going to build up a simulation layer by layer to land somewhere on the way to a universal model by the end of the challenge.

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Works Cited

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2."Queuing Theory Accurately Models the Need for Critical Care Resources." *Home*. N.p., n.d. Web. 01 Dec. 2016.

3.Klote, John H. "Smoke Control and Fire Evacuation: What Every Smoke-control Designer Should Know about Fire Evacuation, the "panic Myth," and Human Behavior."*Heating/Piping/Air Conditioning Engineering.* (2008): 36. *Elportal*. Web. 1 Nov. 2016.

4."Behaviour Based Motion Simulation for Fire Evacuation Procedures - IEEE Xplore Document." *Behaviour Based Motion Simulation for Fire Evacuation Procedures - IEEE Xplore Document*. N.p., n.d. Web. 20 Nov. 2016.

5.Koutamanis, Alexander. "Multilevel Analysis of Fire Escape Routes in a Virtual Environment." *CAAD Futures Digital Proceedings 1995* (1995): 331-42. Web. 5 Dec. 2016.