Experiment Proposal:

(This can be simulated if necessary/possible. The simulation would require a multiplayer framework.)

Have a line of cars start at an intersection. Upon being signaled to go, the cars are simply to drive straight down the road a distance long enough to introduce human error, perhaps 5 miles. There will be equally-spaced traffic lights along this path that are programmed such that if all cards go at exactly the allotted speed limit, they will catch all greens and thus never need to stop; a condition that can easily be achieved with autonomous vehicles. Since the expectation is that manned cars will accelerate and brake unnecessarily, we can measure how much time is actually wasted waiting at red lights; this will be termed “the inefficiency of human drivers”.

A possible control would be to set all cars to cruise control (a feature that should be disabled for the regular group) and have the lineup go at the speed limit. This configuration should be tested to ensure that the convoy does indeed traverse the entire distance without stopping. The aforementioned parameter can then be easily calculated by taking the difference between the travel times of the control group and the regular one.

This parameter can be used to determine the average latency, or reaction time, for humans when it comes to operating car pedals in order to maintain a specified constant speed. This can be done by factoring in the number of cars and number of traffic lights; values that can be adjusted for further trials to give more comprehensive results. Not only will this allow us to quantify the benefit of synchronized, streamlined, automated driving, but also it will help characterize a useful aspect of human response. That is, how quick we are to respond to external inputs (the motion of other cars, traffic lights, road signs, etc.) while in a frame of motion moving at well beyond natural human speeds e.g. 40 mph.

10/6/16

Quantifying the Inefficiency of Human Drivers

To accurately replicate human behavior, we cannot assume or randomize unnecessary accelerating and braking. Since implementing a simulation of this proposal would require a seamless real-time multiplayer feed where each user input controls the behavior of just one car and thus be an infeasible one-term project, I suggest actually carrying out the physical experiment.

Because there will be an initial acceleration and final deceleration at the start and end of the path respectively, the expected traversal time for the control group (automated/cruise control drivers) would be calculated by dividing the distance between the first and last traffic lights by the speed limit; which the cars are expected to have achieved by these points. The same distance will be used when timing the regular group and the time differential would be the parameter of interest; a value that can be manipulated as mentioned previously to determine the average latency per driver for each traffic light.

Logistically, some complications will likely arise. Increasing the number of drivers will require further capital and interest/availability from subjects, whilst increasing the number of traffic lights may require a change of location. Additionally, it is increasingly difficult to find a straight road the longer it is, let alone one with easily spaced traffic lights. Finally, non-experimental traffic must be entirely absent, which means that the trials will probably have to be performed at inconvenient hours. Nonetheless, I still think it is possible to get useful data despite these potential issues.

10/18/16

A fixed number of cars are initialized at random positions and velocities on the road. Each user has control over their respective car and has the options to either modify their velocity or change their lane once per frame. Collisions will be handled appropriately and will occur when the outlines of cars overlap with one another.

A server will be generating the position and velocity vectors for the cars a specific number of times every second (frame rate). It will take input from players should they modify the aforementioned parameters and its output will be fed into a separate program that will read the vectors accordingly and generate the traffic simulation.

10/27/16

Attached are some of the existing models and theories concerning traffic flow that we've found.

Lighthill's 1954 paper has been cited thousands of times. It presents the first kinematic wave theory in regards to traffic flow. It has been so useful over the years that it has been termed the **LWR Model** after Lighthill and his colleagues. The model bases macroscopic traffic flow as the average number of vehicles per unit of space-time.

Daganzo's 1999 paper theorizes about the behavior of multi-lane traffic along long homogeneous freeway sections. The theory proposed accounts for drivers of various attitudes (timid, aggressive, and intermediate) and the specific number of lanes involved. He uses his own **Cell Transmission Model** (nearly identical to the **Nagel-Schreckenberg Model**), in which the road is evenly divided into 'cells' such that microscopic traffic flow on average traverses one cell per time step.

Rui's 2002 paper discusses **anisotropy**, in that drivers will primarily react to traffic in front of them, meaning that their responses (the resultant waves) are inherently asymmetric. He and his coauthors propose a new dynamics model that factors in the mean speed of traffic as well as the equilibrium speed as a function of traffic density.

Daganzo's 2005 paper specifically explores lane-changing in traffic streams, which is as pertinent to our project as any literature could be. He postulates that lane-changing forms 'voids' in traffic streams that disrupt and impede overall throughput.

Yperman's 2007 paper looks at the **Link Transmission Model** (where mesoscopic traffic flow is the propagation of 'links' between vehicles) and shows that it can be effectively used to model traffic flows across large networks.

Best, Paulo and Jay