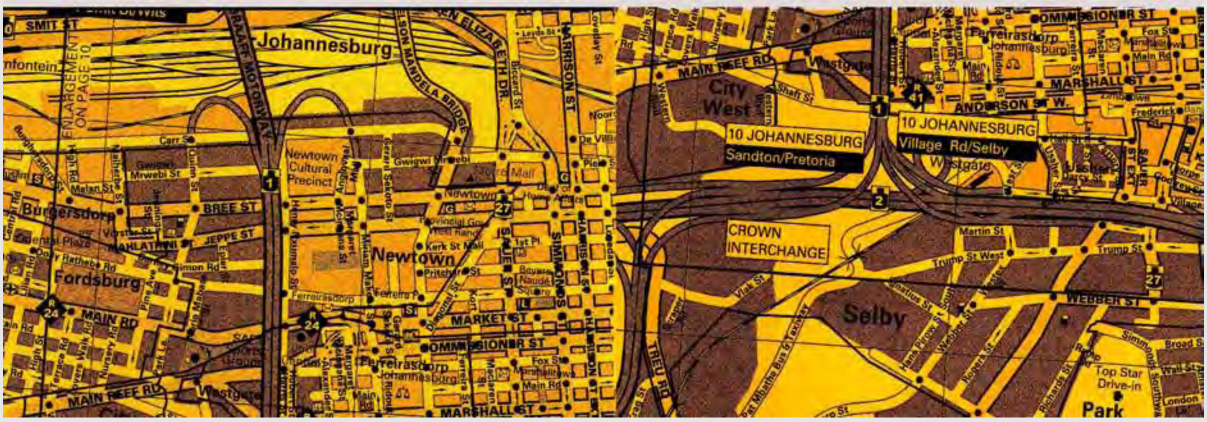
Crown Interchange

[N1]Rd1e



Composer / Researcher:

Dimitri Voudouris

Annum:

2011 - 2012

Composition:

CI [N1] – **H**:1e

T	Day/s	Group/s	Duration
1	**D**:3,17	[**G**:1]	**1**m.22s
2	**D**:19,20	[**G**:3,4,5]	**1**m.01s
3	**D**:14,17	[**G**:2,5]	0.53s
4	**D**:3,14,17	[**G**:3,4]	0.13s
5	**D**:3,17	[**G**:4,5]	**1**m.14s
6	**D**:3	[**G**:2]	0.16s
7	**D**:12	[**G**:2,5]	**2**m.02s
8	**D**:6,13	[**G**:2,3,4]	**1**m.01s
9	**D**:2	[**G**:1,2]	**2**m.24s

Behaviour of complex macroscopic systems:
examining kinetic flow disturbances occurring in vehicular motion during phantom traffic jam formations in a three lane uni-directional system.

Duration:

10 min 37 sec

Computer generated composition

for

sound projectionist , 6.1 speaker diffusion

INDEX

Overview of traffic mobility

Three lane vehicular mobility in a unidirectional system:

Study: Traffic flow occurences resulting in phantom traffic jams and observing the kinetic flow disturbances and advanced properties of jamitones in three lane unidirectional system.
Location: Crown [N1-Highway] Interchange – Johannesburg, Gauteng, South Africa.
Date: 13 /February - 4 /March/2010.
Time: Peak hour 7h00 -9h00 and 16h00 -18h00
Speed: Tracking vehicle behaviour [recording speed variations, jamiton formations, number of vehicles entering / exiting marked areas, increasing and decreasing vehicle densities, grouping and selective regrouping] .
Camera: Two cameras installed [in area most common for jamiton formation].
Road: Uniform, straight road.
Weather: Sunny, with clear view.

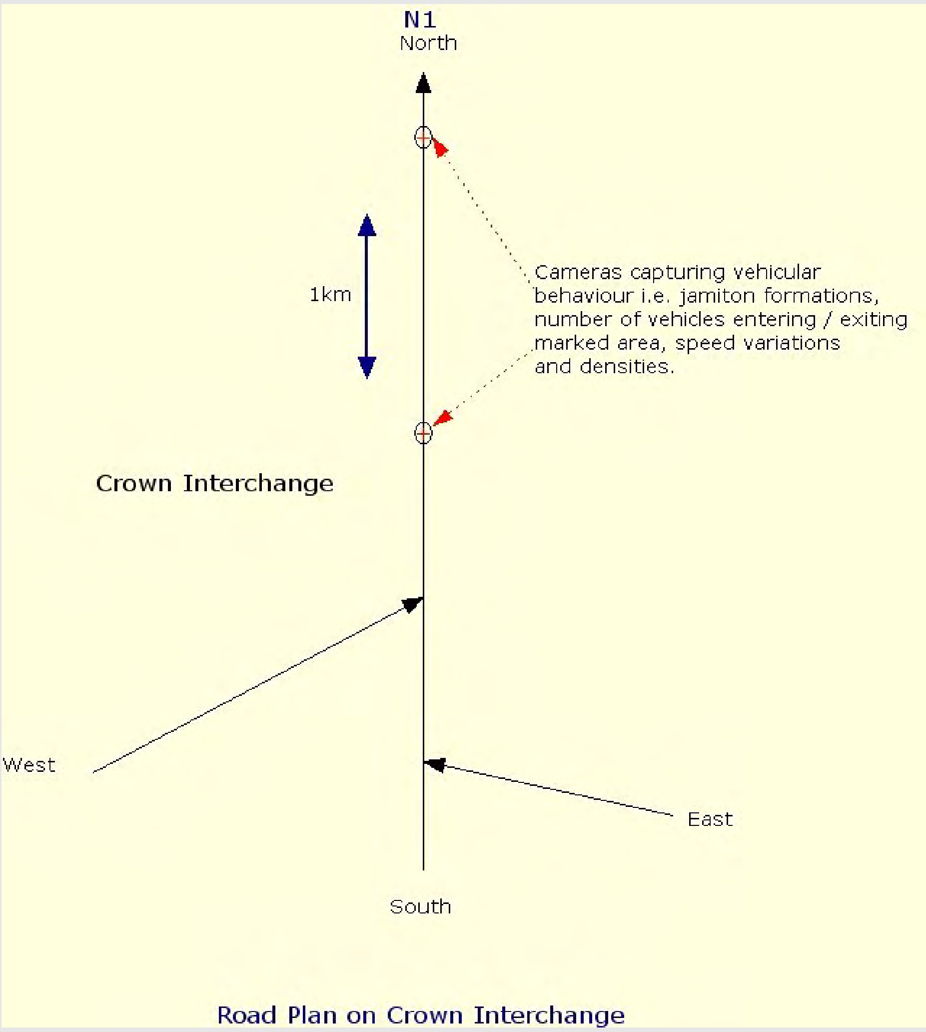


Fig:1

Considering the use of mathematical equations that model traffic similar to the equations of fluid flow. Specifically, considering the use of Vlasov-Fokker-Planck multilane model for analytical purposes. These equations of the Vlasov-Fokker-Planck type are suggested for multilane traffic flow model on a highway. The equations include nonlocal and time-delayed braking and acceleration terms with rates depending on the densities of relative speeds. The braking terms include lane change propabilities and generalizations thereof. All drivers behave according to the same laws. The considered traffic models predict a uniform traffic flow at low traffic densities. However, above a critical threshold density (that depends on the model parameters) the flow becomes unstable, and small disturbances amplify. This phenomenon is typically addressed as a model for *phantom traffic jams*, i.e. jams that arise in the absence of any obstacles. The instabilities are observed to grow into travelling waves, which are local peaks of high traffic density, although the average traffic density is still moderate (the highway is *not* fully congested). Vehicles are forced to brake when they run into such waves. An analogy to other travelling waves, so called *solitons* [is a self-reinforcing solitary wave (wave packet or pulse) that maintains its shape while it travels at constant speed], calling such travelling traffic waves *jamitons*. My research is based on observations that the considered traffic models are similar to the equations that describe detonation waves produced by explosions. In the language of detonation theory, such *traffic roll waves* are very similar to roll waves in shallow water flows. A central result is that sharp shocks must always face towards incoming vehicles. Furthermore it can be proved that jamitons always travel slower than the individual vehicles. Hence, vehicles run into a sharp and sudden increase in density (the end of a phantom traffic jam), which forces each vehicle to break very suddenly. Then, vehicles accelerate again out of the jamiton. Our analysis also shows that jamitons are stable structures. They can only vanish by strong smoothing effects (extremely cautious drivers) or a lowering of density (a widening road, vehicles exiting). While one jamiton does not delay the travel time of individual vehicles significantly (vehicles travel through a jamiton very quickly), the sharp jump in vehicle density is a potential hot spot for accidents.

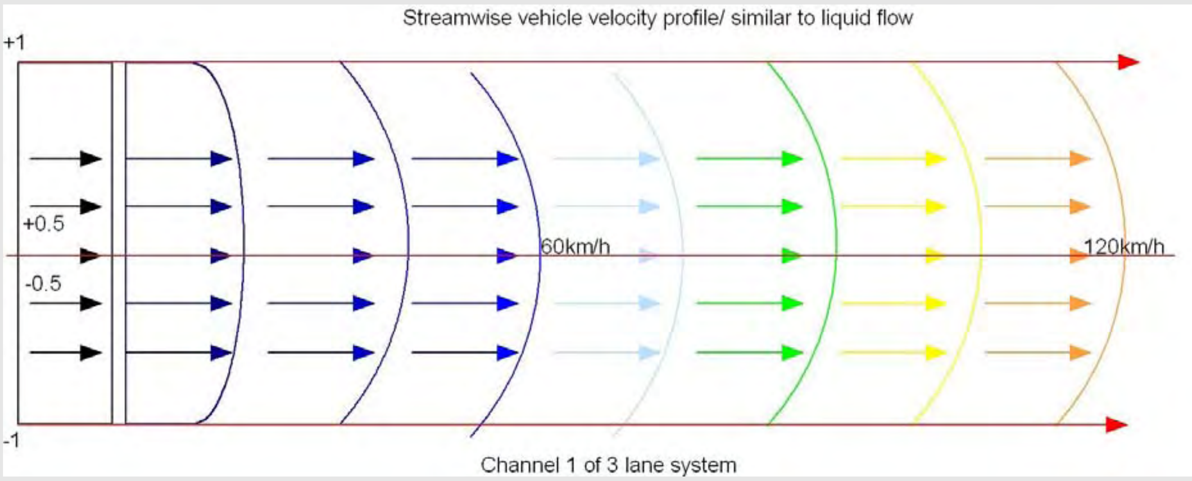


Fig:2

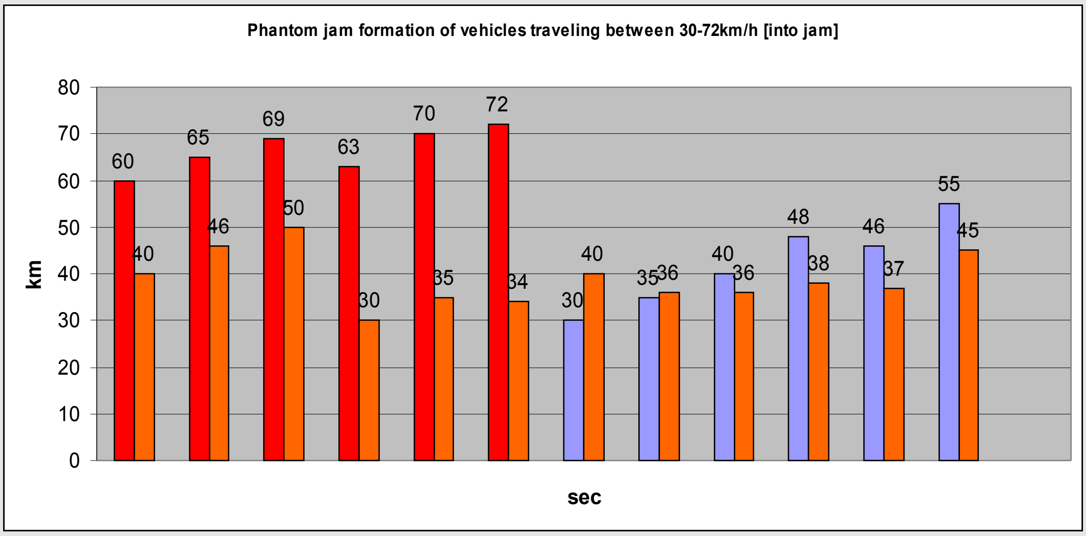


Fig:3

Vehicles travelling between speeds of 60-72km/h were most likely to enter the phantom traffic jam before the vehicles which were travelling with speeds between 30-55km/h

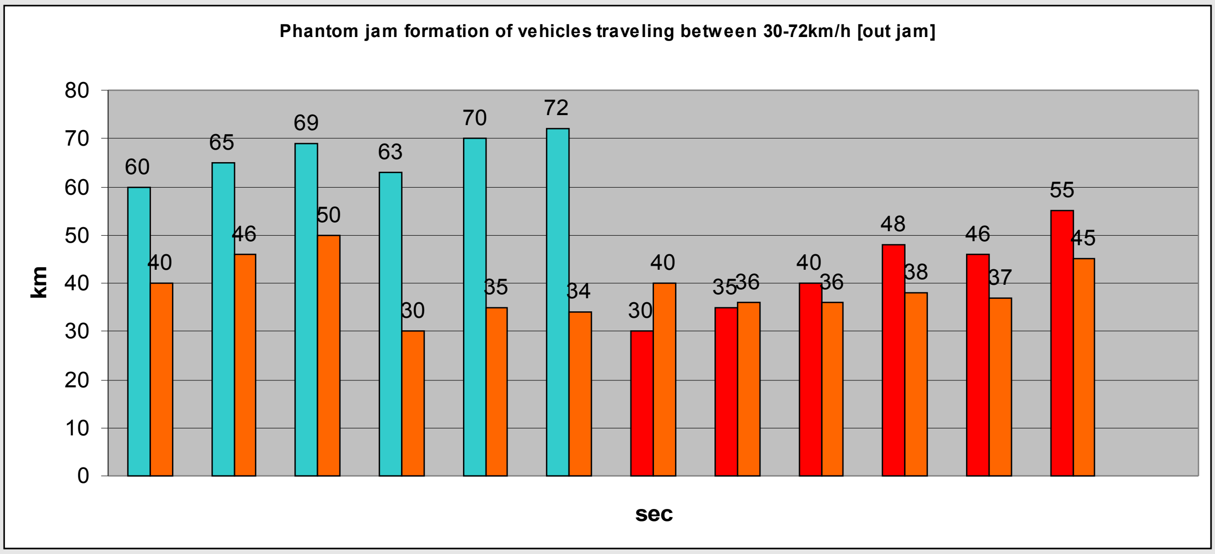


Fig:4

Vehicles travelling between speeds of 60-72km/h were least likely to exit the phantom traffic jam formation first, whereas the vehicles which were travelling with speeds between 30-55km/h were able to exit a traffic jam at speeds between 15-25km/h Fig:4 without stopping
Thus the speed entering and exiting a traffic phantom jam can be attributed to braking / acceleration terms.

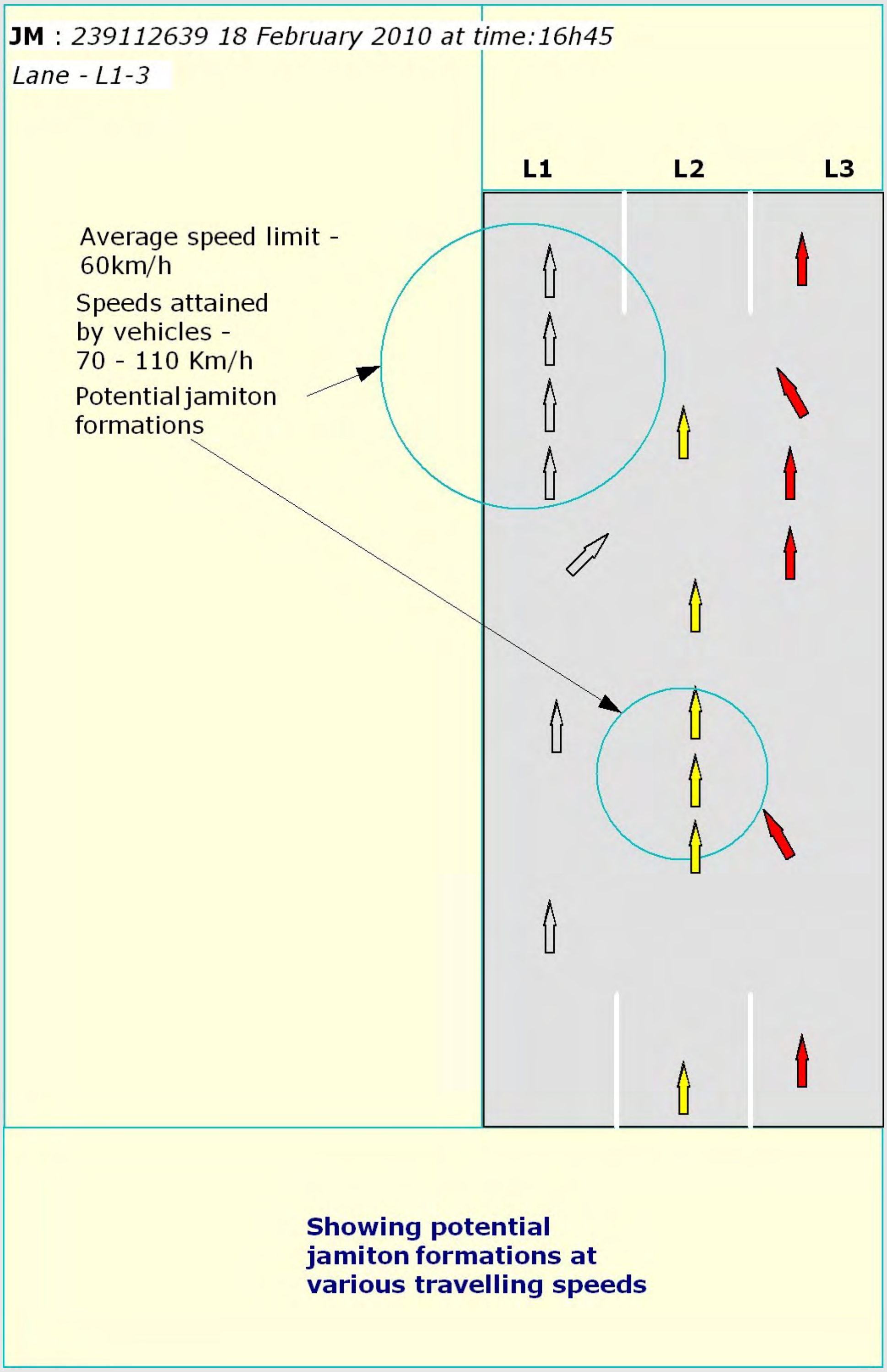

JM : 239112639 18 February 2010 at time:16h45
Lane - L1-3
L1
L2
L3
Average speed limit - 60km/h
Speeds attained by vehicles - 70 - 110 Km/h
Potential jamiton formations
Showing potential jamiton formations at various travelling speeds

Fig:5

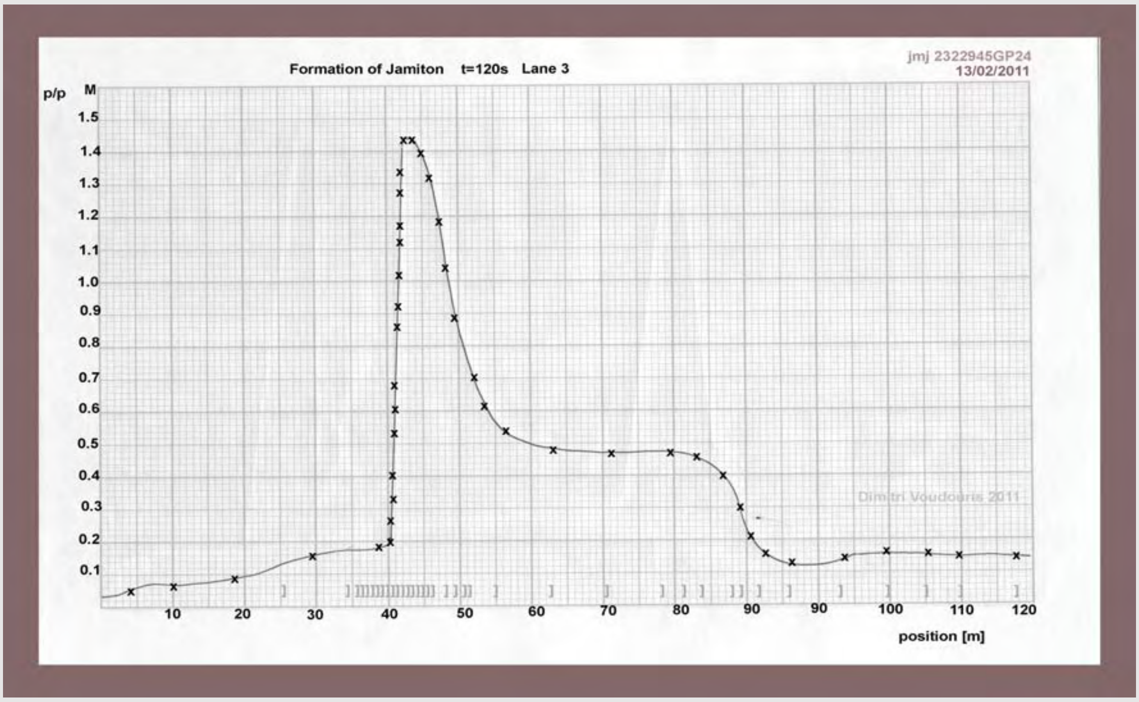


Fig:6

Jamiton wave formation

Traffic jam is analogous to a self-sustained detonation wave in that it also consists of a shock followed by a transonic flow. Similar to that of the ZND model of detonation [in a one-dimensional model], the existence of a sonic point allows one to find the jamiton speed. [Detonation is complicated in that it involves mechanics, chemistry and thermodynamics simultaneously. The detonation product particles move multi-dimensionally, and there are transport effects, such as friction, diffusion and heat transfer, between particles. Because of the difficulty of simulating such complex configurations, classical detonation theory, which employs the ZND model, neglects the transport effects and simplifies detonation as one-dimensional movement. However, experiments have shown that the complex movement and transport effects play important roles in detonation and should be taken into account.]

Braking/Acceleration terms

The braking and acceleration term depends on the relative speed of driver under consideration with respect to the average speed as observed by this driver [a reaction time earlier and the appropriate threshold distance ahead]. Emphasizing that other modelling assumptions can be incorporated at this point e.g. that the driver will pay attention to the slowest driver ahead.

Some equations of Vlasov-Fokker-Planck used in the first steps of formulating results

Simplified formulae:

$$p_i^B = p_i(x+T_B v, t), u_i^B = u_i(x+T_B v, t-T)$$
$$p_i^A = p_i(x+T_A v, t-T), u_i^A = u_i(x+T_A, v-T)$$

Diffusion Coefficients:

$$D[f](p,u,v) = \sigma(p,u)|v,u|^{\gamma}$$

Lane changing probability:

$$P_i(u,v) = \frac{(v-u/u_{max}-u)^{\delta}}{0} : \begin{matrix} v<u \\ v\leq u \end{matrix}$$

$$R(u) = \frac{1}{a} 1 - \exp - (\frac{a}{2}u^2) - \int_0^{u_{max}-u} s \exp(\beta s^2)[\frac{s}{3(u_{max}-u)} - \frac{1}{2}] ds$$

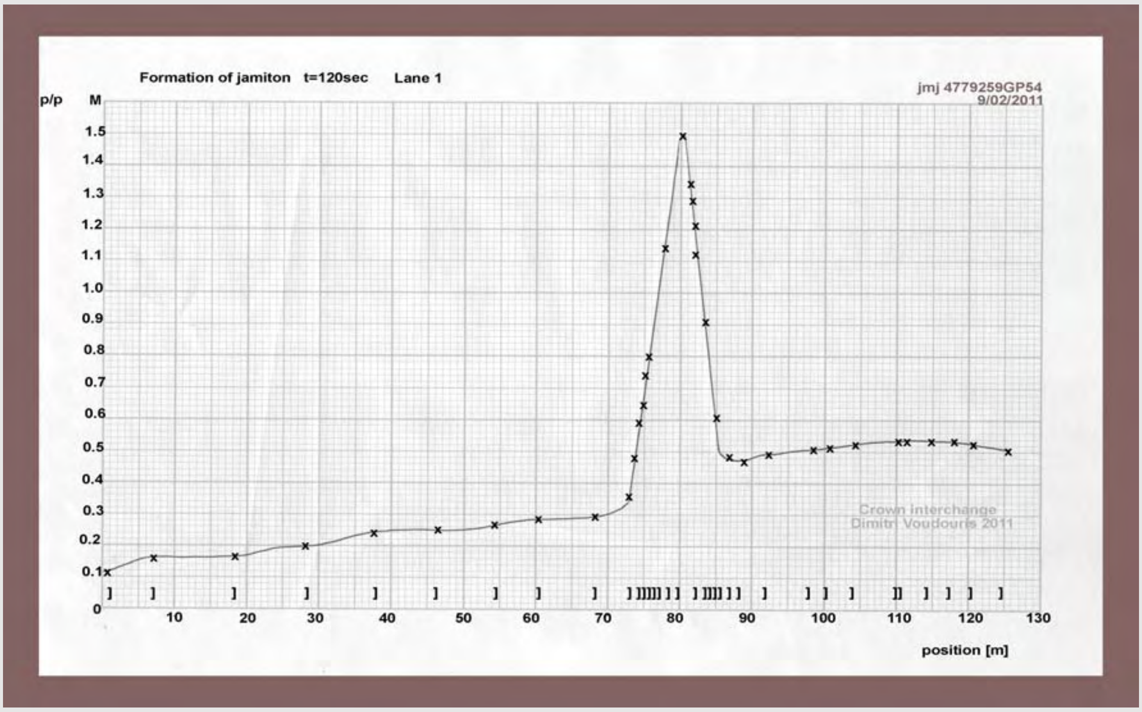


Fig:7

Formation of jamiton wave

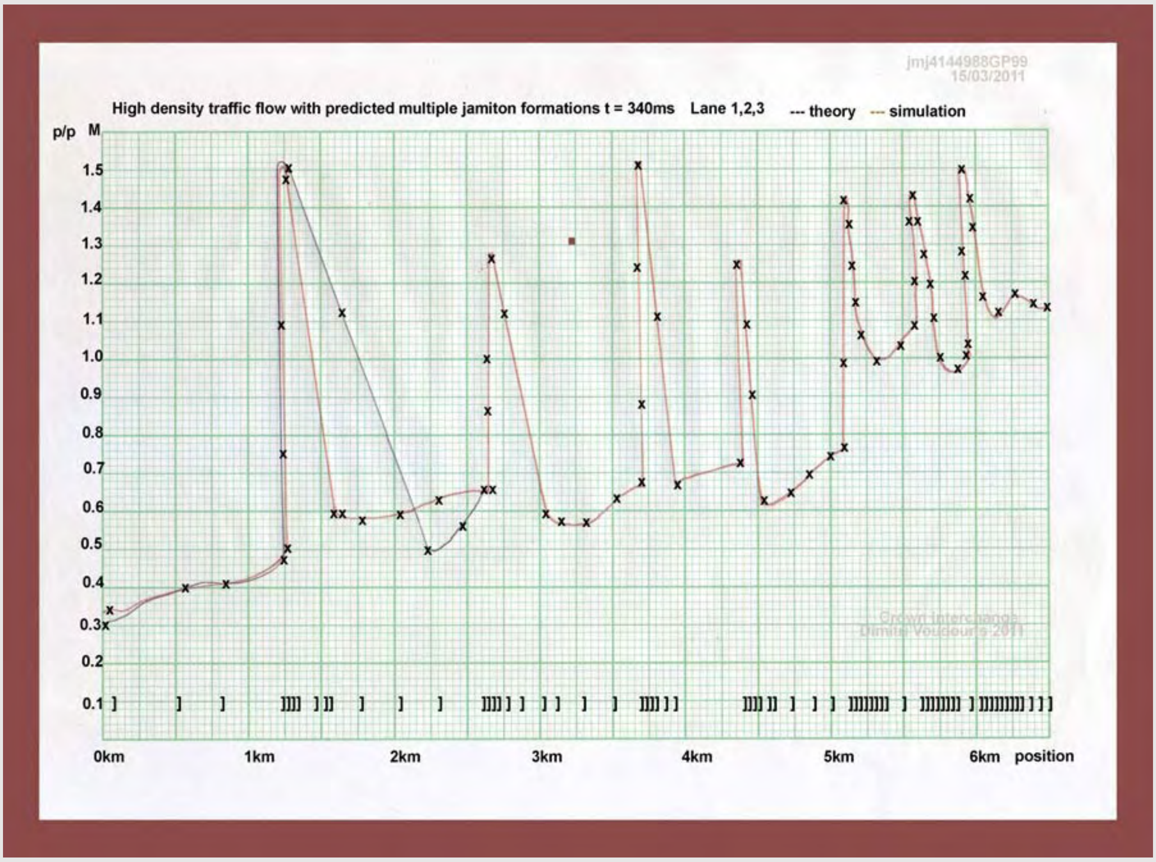


Fig:8

High density traffic flow with jamiton wave formations

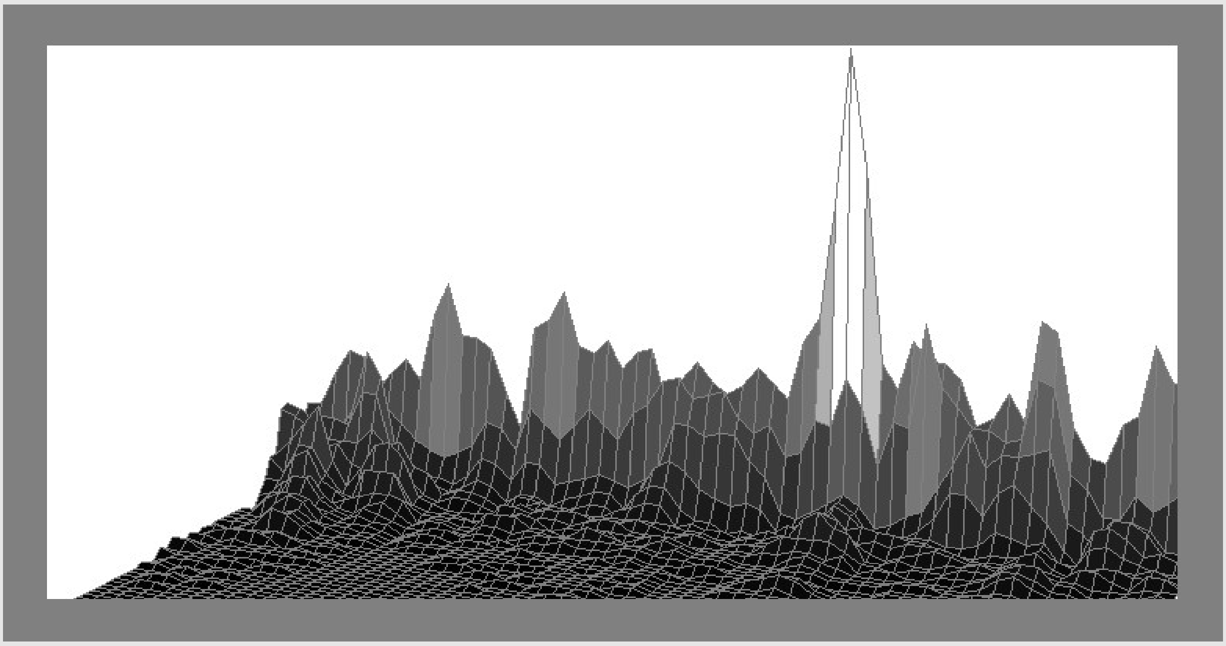


Fig:9

Posterior view:

CI [N1] – H:1e - sound spectrum analysis *[high density of sound equivalent to a phantom jam build up] – D12*

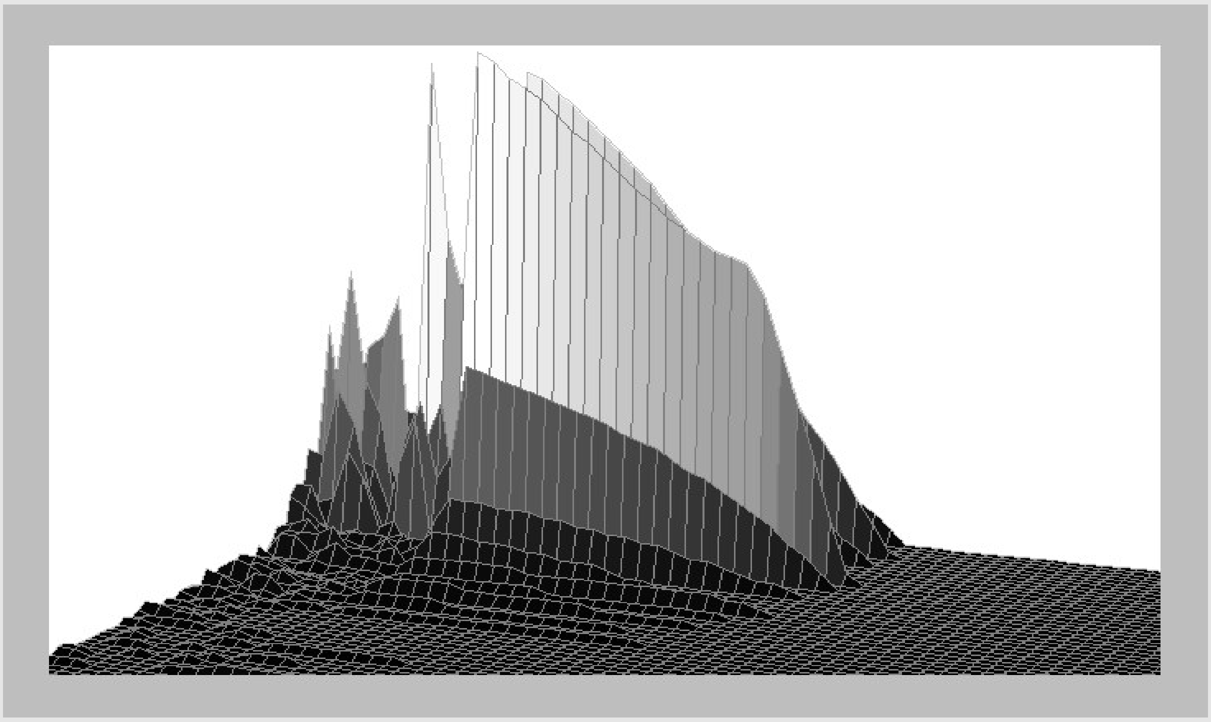


Fig:10

Anterior view:

CI [N1] – H:1e - sound spectrum analysis *[dismantling of high density area of sound equivalent to a similar phantom jam release mechanism] – D3*

Particular observations

**** D3,17 and D6,13 –*** This included various groups presenting moderate to high densities, kinetic flow disturbances are the most prominent. The analysis showed a variety of phantom traffic jams that were of longer or shorter duration, located at various points / areas in the mapped location. Showing a slow flow of vehicles through the jamitone.
In the audio work I adjusted [tweaked the jamitones in such away so as to make audible sense] in over a minute so as to sketch to the listener the chaotic nature of a hindered, unstable flow.

**** D2 -*** The seven traffic jams recorded in one day had similar properties allowing for moderate kinetic flow through them. Focusing attention to speed variations, analysing vehicle speeds on entering and leaving the jams. The only way one could make sense of the situation and to produce an audio composition that does justice to the seven jam formations was to choose two groups of vehicles that represent fragility in the system. The behaviour of the vehicles entering / leaving the nozzle of jam represent a uniform speed flow [The groups entering / leaving the nozzle of the jam had slightly different to similar speed variations].

**** D19,20-D14,17-D3,14,17 –*** Jamitones having a variety of almost similar densities, that show a strong kinetic flow.

Strategy

Cl [N1] **– H**:1e, using the same technology as in [W}-Rd:1e the various speeds of vehicles irrespective of size were noted in a 60km zone and observations were made on the lifespan of various vehicle densities [number of vehicles per unit length of road] the propagation of non linear features of detonation waves that would lead to the formation jamitons. Matlab allowed for the application of Vlasov-Fokker-Planck multi-lane traffic flow model to be used. Conditions of various: velocities, time duration relationships examining free flow, synchronized flow / synchronized equilibria and congested flow / moving jams. The vehicles were placed into various speed categories/groups [G1:20-40], [G2:40-60] , [G3:60-80], [G4:80-100], [G5:100-120] km/h with specific frequency ranges. Furthermore vehicles moving left from lane 3 into lane 1 and 2, from lane1 into lane 2 and 3, from lane 2 right into lane 3 and left into lane 1 were allocated with specific frequency properties in left and right directions.

Composition

Each group/category is allocated with audio frequency parameters, which was fed to a Pitch-to-Midi converter, the pitches were then read and turned into a sequence(s) of pitches and rhythms the computer could understand. The various vehicle velocities were analysed with Fast Fourier Transform software. This gave the harmonic spectra which were used to determine the timbres of the electronic tones [the composition has these electronic timbres playing the exact rhythms to the vehicle mobility through the lanes]. The end result shows a micro timbral transformation of sounds, the multitude of data transformed had spectral sonification properties.

Speaker set up for diffusion

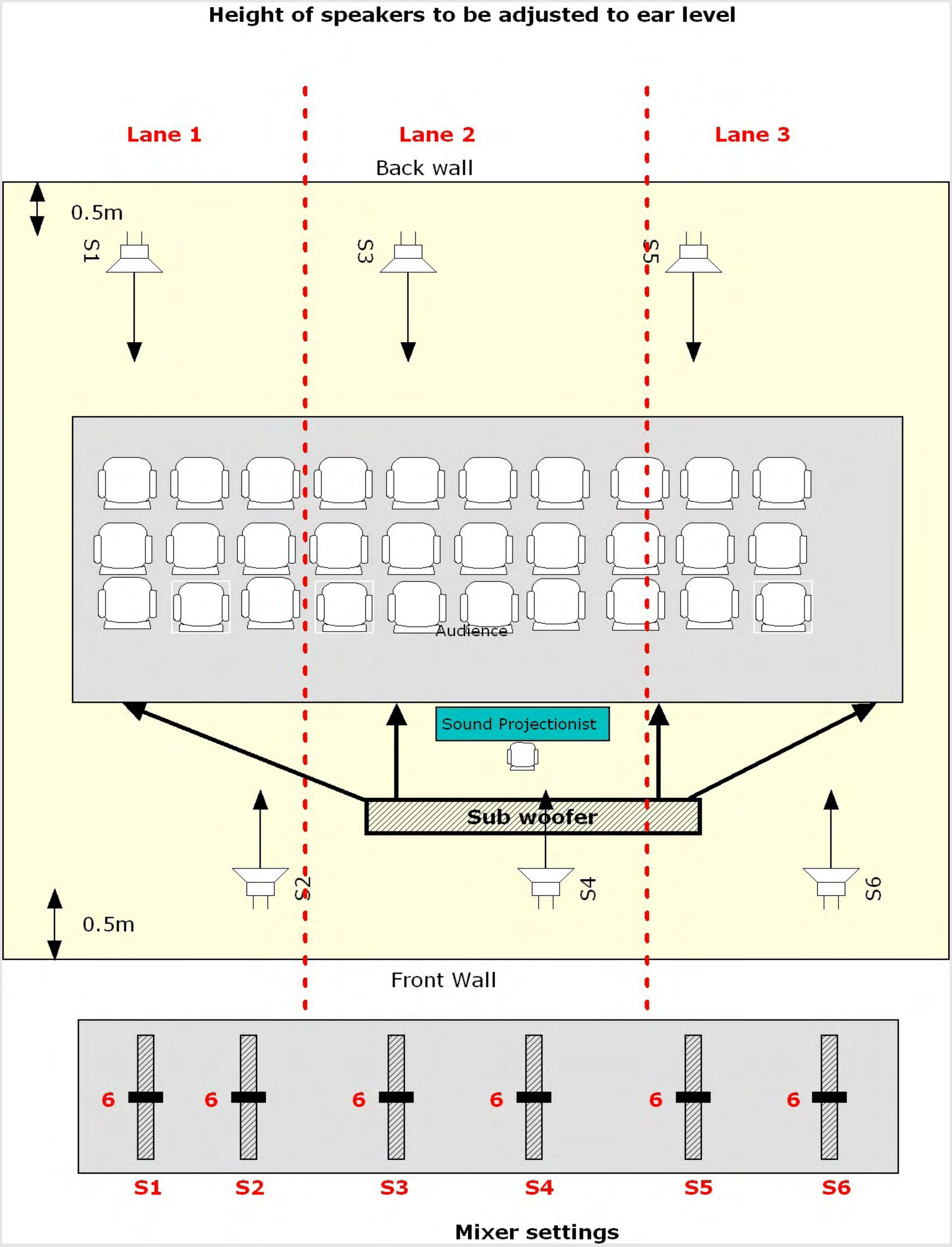


Fig:11

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