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9 October, 1995

ABSTRACT

This report details the aerodynamic performance of individual members of 2, 3 and 4-vehicle platoons. The primary purpose of the tests described here is to quantify the behavior of vehicle drag as a function of vehicle spacing. One-eighth scale models of the 1991 GM Lumina APV are used as the prototype vehicle. Each model is fitted with a force balance capable of measuring drag, side force and yawing moment. A porous ground plane equipped with suction is used to simulate the road surface. Results show a reduction in average drag for all platoon members as a function of both inter-vehicle spacing and the number of vehicles in the platoon. The average drag coefficient for a platoon of four vehicles is measured to be about 55% of the drag coefficient in isolation at spacings in the range 0.1-0.3. Extrapolating the experimental results to platoons of greater length suggests even lower average drag coefficients are possible. These low average drag coefficients for platoon operation translate directly to increased fuel savings and to less pollution per mile traveled.

Keywords: Platoon, Drag, Close-following

I. OVERVIEW

A. Establishing Confidence in Wind Tunnel Test Results

When bodies under aerodynamic study are modeled in a wind tunnel test, all possible care must be taken to establish conditions consistent with full-scale operation. In principle, the model test should reflect perfect dynamic similarity as well as perfect geometric similarity. Such perfection is never realized in practice. Even if the model tested is a full-scale vehicle, complete in every detail, the presence of the wind tunnel walls destroys perfect geometric similarity. In most wind tunnel tests, dynamic and geometric similarity are only approximately established for a variety of reasons. Wind tunnel tests still give valuable information about aerodynamic performance, provided the limitations of the test are kept in mind.

Dynamic similarity first requires the definition of force coefficients for the body. Since we are primarily interested in drag force, a drag coefficient is defined,

$$C_D = \frac{D}{\frac{1}{2}\rho U^2 A} \tag{1}$$

where D = measured drag

ρ = air density

U = vehicle forward speed, wind tunnel speed

A = Maximum cross-sectional area of the body perpendicular to the flow

Couching discussion in terms of *drag coefficient* rather than in terms of *drag* automatically accounts for differences in vehicle size and vehicle relative velocity. It allows one to make predictions for the performance of the full-scale vehicle from wind tunnel model measurements. In addition, perfect dynamic similarity requires that the Reynolds number of the model flow be made to match the Reynolds number in the full scale operation.

$$Re = \frac{Ud}{\nu} \tag{2}$$

where d = characteristic length scale

ν = kinematic viscosity of air

The magnitude of the Reynolds number expresses the ratio of fluid inertia force to fluid viscous effect, or shear stress. When the Reynolds number is large, the fluid moves in response to differences in pressure within the flow field. Only in very thin *boundary layer* regions adjacent to surfaces are viscous shearing stresses important. The characteristic length scale of our vehicle model is 1/8th that of the full-scale vehicle. Since the test is conducted with air as the fluid, the viscosity ν is the same for both cases. To keep *Re* constant, the freestream velocity in the test case must be 8 times higher than the full-scale vehicle velocity. This, of course, is not possible—model Reynolds numbers are lower than Reynolds numbers for full-scale operation. An automobile traveling at highway speed may correspond to $Re = O(10^6\text{-}10^7)$, while our wind tunnel tests are conducted at Reynolds numbers about one order of magnitude lower. To account for these differences, and to judge the *sensitivity* of the force measurements to changes in Reynolds number, we will frequently present measurements at several Reynolds numbers. Another simulation technique is to utilize a series of small roughness elements to artificially "trip" the boundary layer on the model. Tripping insures a turbulent boundary layer more nearly in character with a boundary layer at higher Reynolds number.

The model and full-scale vehicle are geometrically similar in the sense that all body dimensions have been scaled by the same ratio. The mold used to cast the models is fashioned by a stereo-lithographic process using computer-generated coordinates. For all practical purposes, the model is an exact replica. However, all minor external features such as window frames, side mirrors, door handles, windshield wipers, etc., have been removed. Also, the details of the undercarriage have been left out, and the wheels are stationary.

B. The Unwanted Presence of the Ground Plane Boundary Layer

In the case of ground vehicles, an additional effect is introduced by the presence of the road surface. If one uses a flat plate to model the road surface in a wind-tunnel, a layer of slow moving fluid (the ground plane boundary layer) grows continuously in the downstream direction. This layer does not exist on the actual road surface since it is the vehicle that is in motion and not the medium (air). It is necessary then to minimize the thickness of the ground plane boundary layer, δ, in wind-tunnel tests. The growth of a turbulent boundary layer on a flat plate can be approximated by

$$\delta = \frac{0.37x}{Re_x^{0.2}} \tag{3}$$

where x is the distance from the leading edge. Based upon the above expression, the thickness of the boundary layer at 4 model lengths (1.22m) from the start of the ground plane at 25m/s would be about 2.46 cm. Four model lengths would correspond to a case where 2 models are in the tunnel at 1 length spacing, the first model being placed 1 length from the leading edge. Further down the plate, say at x=5 m, δ would be about 7.71 cm.

Hucho and Sovran (1993) suggest that for a passenger car model affixed to a ground plane, the displacement thickness, δ^*, should be less than 10% of the model ground clearance, H, (in our case H is about 37 mm). The displacement thickness can be thought of as the amount by which an outer flow streamline is displaced due to the presence of the boundary layer. For turbulent boundary layers, δ^* is approximately (1/8)δ. The range of δ^*/H for our tests would generally be greater than the accepted value of 0.10, unless some means for controlling boundary layer growth is adopted.

Control of boundary layer thickness can be achieved by several methods. Conceptually, the simplest way to eliminate the unwanted boundary layer is to move the ground plane at the wind tunnel speed, U. Unfortunately, this scheme is mechanically complex and impractical for the long ground plane length required to test a platoon of vehicles. Our choice is to siphon off the boundary layer through a uniformly porous ground plane surface. This is a much simpler method to implement. Other possibilities, such as tangential blowing or single slot suction, are not viable because their effectiveness would not extend over the entire length of the ground plane.

C. Organization of the Manuscript

This report, and the earlier PATH report Zabat et al. (1994), are repositories for all the experimental data we presently have available. In our concern for completeness, we have sacrificed some of the natural flow of a well-balanced, shorter manuscript. What we believe to be the most important portions of this work to date have been summarized in three published papers Zabat et al. (1994b), Zabat et al. (1995), and Zabat et al. (1995b). These papers, although they contain the data which is included in Zabat et al. (1994), as well as in this report, should be considered an important part of the written record for this project. Copies of these papers will be on file with CALTRANS and with PATH, or they can be obtained directly from conventional SAE and ITS sources.

This report serves as the final report for the three-year project. It is more complete than the earlier PATH report in that it contains a considerable addition to the experimental results. For the sake of a single source for all the drag data, we have included in the appendix of this report, the results contained in the appendix B of Zabat et al. (1994). Please note however, that much of the discussion has not been repeated, so this earlier report remains an important source of information—particularly with regard to wind-tunnel flow uniformity and the design and testing of the force balances and ground plane.

The various sections of this report are arranged as follows. **Section II** contains a discussion of the improvements made to the force balance, and the general procedure followed when taking measurements. **Section III** presents the results for all the single vehicle measurements made and discusses the effectiveness of the blockage correction used, the effects of the ground plane surface, Reynolds number and boundary layer trips on the model. **Section IV** contains the drag measurements on 2, 3 & 4 vehicle platoons. The data from the 2, 3, and 4-vehicle platoon cases are used to predict the drag performance of an *n*-vehicle platoon through extrapolation. **Section V** presents the drag measurements for a 2-vehicle platoon with variations in geometry and ground plane surface condition. The results of the various geometries are used to define an average C_D ratio that takes account of geometry. In **section VI**, the fuel-savings benefits that precipitate from the drag reduction are examined. **Section VII** presents model surface flow visualizations and measurements of the floor pressure distributions which will ultimately help explain the drag behavior as a function of spacing. In **section VIII**, results from tests on misaligned platoons are presented and the effects of misalignment on platoon operation are discussed. **Section IX** outlines future studies that will further the understanding of platoon aerodynamics. The raw data discussed in **sections III, IV, V, VII** and **VIII** are tabulated in the appendices. All the data–including the surface streamline photographs–are stored in digital format and can be retrieved and transmitted upon request to PATH.

II. EXPERIMENTAL METHOD

Tests are conducted at the USC Dryden Wind Tunnel. This facility has a test section that is hexagonal in cross-section, 1.37 m wide and 7.4 m long. Ground simulation is accomplished using a porous plate and suction system to control the boundary layer growth on the ground plane. The majority of the tests are run at a nominal velocity of 23 m/s. Further details of the wind tunnel and ground plane are provided in Zabat et al. (1994) and Zabat et al. (1994b).

A. Improving Force Balance Performance

The internally mounted, 3-component force sensors used previously have been designed for nominal loads of 9.8N with an accuracy estimated at ±0.035N—0.35% of the full scale load, and well above the analog-to-digital converter least count resolution of ±0.006N. This kind of sensitivity requires that the flexures be very thin (0.6mm). Several significant modes of oscillation have been observed for the sensor alone, particularly at 45 and 80 Hz. When models are attached to the sensors, the additional weight reduces the lowest resonant frequency to about 20 Hz.

For a bluff body, the major unsteady loads will probably be due to vortex shedding in the wake. The frequency of this shedding can be approximated by

$$\frac{fd}{U} \cong 0.2 \qquad (4)$$

where f = the shedding frequency
d = the effective diameter ($\sqrt{A, \text{the cross-sectional area}}$)
U = the wind speed

Equation (4) results in a shedding frequency of about 19 Hz for a nominal velocity of 23 m/s. This value is very close to the natural frequency exhibited by the force sensor. The original balance had very little natural damping which prevented measurements at close spacings—where significant unsteady fluctuations are present. It was previously documented that the mean values of force measured by the sensor were not affected by the fluctuations experienced by the model at spacings greater than 0.5 vehicle lengths. At smaller spacings, the oscillations became much larger in amplitude, presumably because of larger pressure fluctuations in the region between the models. Since we felt the mean measurements might be unreliable in the presence of significant oscillations, no measurements at close spacing were presented earlier.

To address the limitations of the force sensor, two piston-in-pot type liquid mass dampers have been designed and installed in each sensor as shown in figure 1. The damper is, in essence, a small cylinder containing a central piston. A narrow gap of approximately 1–2mm exists between the cylinder and the sides and bottom of the piston as shown in figure 1. The piston is attached to the model via the upper balance plate, while the cylinder is attached to the support structure through the lower balance plate.

Silicon oil, which is available in a large range of viscosities, is used in the cylinder as the damping fluid. The viscosity of the oil used can be varied to adjust the amount of damping applied. For the tests shown here, each pot is filled with silicon oil with viscosity of approximately 25,000 centistokes.

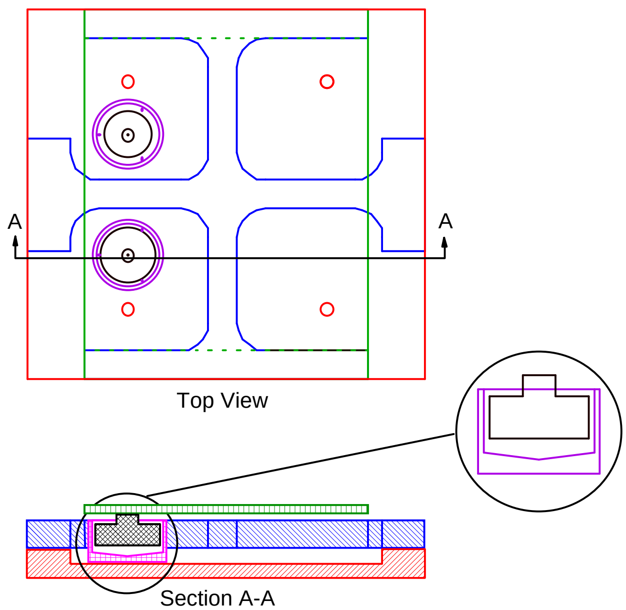


Figure 1: Schematic of force sensor dampers

The response of the sensor to a drag impulse, with model attached, before and after the dampers are installed is presented in figure 2. It shows that the system is still underdamped but no longer oscillates for an extended time. The addition of the dampers has increased the damping coefficient by about a factor of 4. The useful dynamic range of the sensors can be further improved by increasing the viscosity of the silicon oil until critical damping for this lowest mode is achieved.

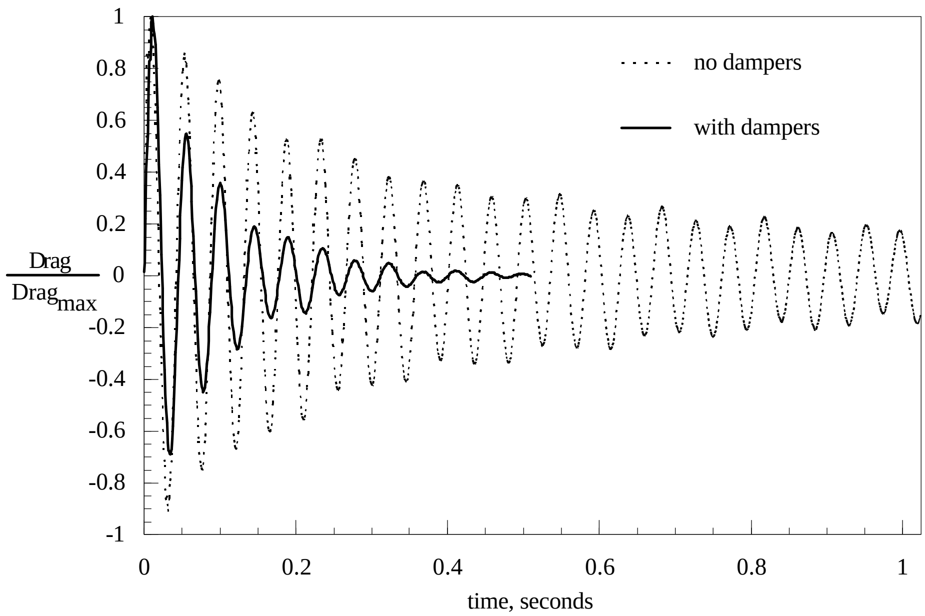


Figure 2: Response of a typical sensor to a drag impulse

B. Measurement Procedures

To minimize uncertainty in the measurements, each model\force sensor combination is calibrated prior to use in a new set of tests. Depending on the test, one or more models are mounted on the carriages and moved to the desired x-locations. The carriages are then locked in place, and a zero reference is provided by recording the residual voltage outputs. The value of C_D is measured for each vehicle as a member of the platoon, and again in isolation at the identical position in the wind tunnel. These single vehicle drag coefficients—termed $C_{D\infty}$—are used to normalize the drag coefficients determined during platoon operation.

In each of the cases where the suction ground plane is used, the two axial fans that provide the pressure drop in the plenum are set so that the differential pressure across each fan is about 3.74 mmHg (2”H_2O). This corresponds to a variac setting that is 35-40% of maximum.

Data is acquired using an Apple Macintosh Quadra 950 equipped with a National Instruments NB-MIO-16H-9 multipurpose I/O board and AMUX multiplexer. Typically, drag, side force and yawing moment are measured and averaged over 8-second blocks of data—1024 points per channel at 8 ms between points. There are 38 static pressure taps along the length of the test section ceiling. The free-stream velocity and the static pressure at one position along the tunnel ceiling are recorded for each 8 second data block. A Scanivalve is commanded to step between static taps, and the entire procedure is repeated until all 38 taps have been sampled. Each run then consists of a measurement of the static pressure distribution along the test section and a set of 38 force measurements—drag, side force, yawing moment—for each of the vehicles in the tunnel. The 38 force values are eventually averaged to produce a single measurement point. The entire procedure is computer-controlled using LabVIEW. Updated real time results (at 8 second intervals) are displayed on the computer screen, and are stored in permanent files. After each run of approximately 7-8 minutes, the vehicles are repositioned and data recording continues until all spacings are explored.

III. SINGLE VEHICLE DRAG MEASUREMENTS

A. Measurement Accuracy Estimates

The results of drag measurements on individual vehicle models at different locations in the wind tunnel are presented in figure 3. Five different model-force balance combinations are employed. They are all outwardly similar, and are referred to by color (e.g. "the blue model"). The data points shown represent separate measurements taken over a span of over 2 years. They provide a good indication of the reliability of the experiments. They also give an indication of the effectiveness of the blockage correction method described in Zabat et al. (1994). Before correction, the mean measured C_D for all the models is 0.361 with a standard deviation of 0.0126 or about 3.5%. The uncorrected measurements show a dependence on position in the wind tunnel, and reflect the behavior of the static pressure distribution over the usable portion of the empty tunnel—shown as an insert in figure 3. C_P is the local pressure coefficient at the tunnel ceiling, defined as the difference between the static pressure at any location in the streamwise direction and the static pressure at a reference location (x=0.864 m) divided by the dynamic pressure at the reference location. The decrease in C_P in the streamwise direction is due primarily to boundary layer growth at the tunnel walls.

The blockage-corrected estimate is $C_D = 0.332$ with a standard deviation of 0.0085 or 2.6% (note the axis shift in figure 3). The measured C_D is corrected for blockage using the formula, $C_{Dcorrected} = C_D/(1-C_P)$. The C_P used is at the location of maximum ΔC_P (difference in C_P when the tunnel is empty and with a model present). The corrected values are sensibly independent of position in the wind tunnel. The standard deviation in the corrected drag coefficient will be taken as an estimate of the reliability of the measurements. It is shown in the succeeding plots as the *reliability bar* to reflect the possible measurement error.

Figure 4 gives similar drag coefficient data for the vehicle facing backward (reversed). The corrected drag coefficient for the yellow model is noticeably greater than for the other two models. The reason for this discrepancy is unclear at the moment, but will be investigated further. The average C_D for all three vehicles is 0.367, and the standard deviation is 0.0108 or 2.9% .

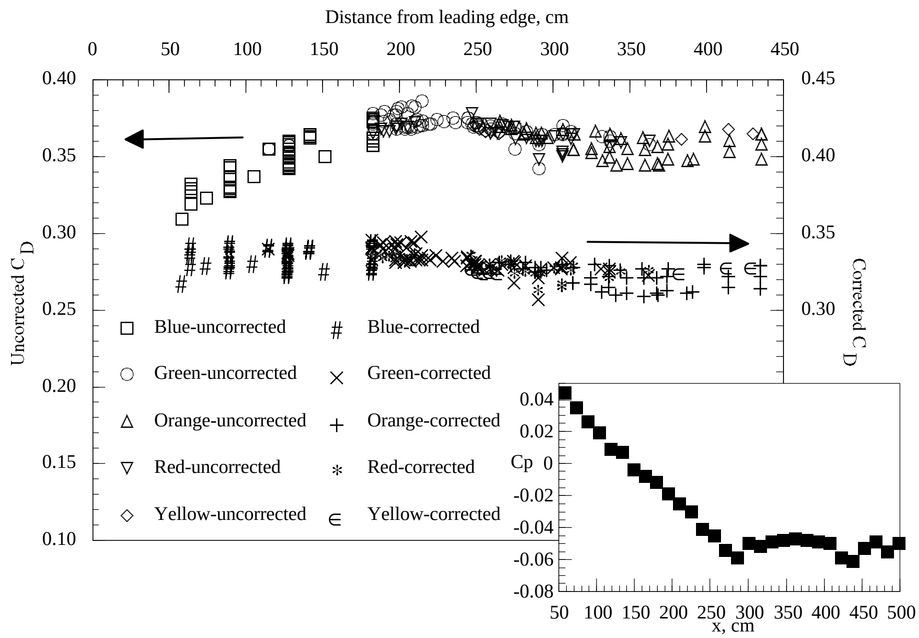


Figure 3: Single vehicle C_D values before and after blockage correction

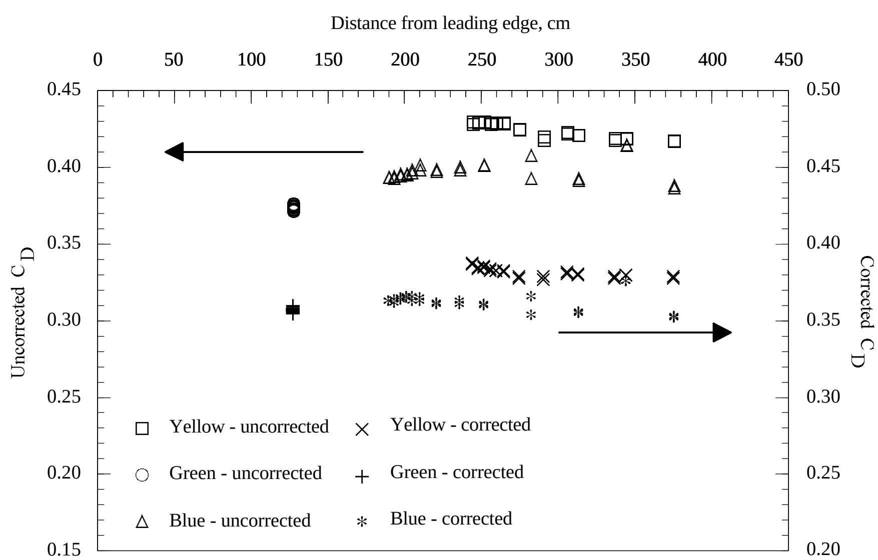


Figure 4: Single vehicle C_D values for rear facing models before and after blockage correction

B. Effectiveness of the Ground Plane Suction System

Figure 5 shows the streamwise pressure gradient in the empty wind-tunnel for three different ground plane surface conditions; the porous surface with no suction applied, the porous surface with 3.74 mmHg of suction applied, and finally the porous surface completely covered (using self adhesive shelf paper). The pressure coefficient is $C_p = (p_{local}-p_\infty)/(½\rho U_\infty^2)$, where the subscript ∞ refers to measurements taken at the *reference* Pitot-static tube at about x = 1m. The pressure p_{local} is measured along the wind tunnel ceiling utilizing a series of pressure taps designed specifically for this purpose. The significance of the pressure gradient along the wind tunnel axis indicates slight changes in local flow velocity. A decrease in C_p represents an increase in flow velocity. The increase in velocity apparent in all three cases shown (up to 2.5m at least) is due to the constriction of the flow by the growing boundary layers on the walls of the tunnel. In the case of the covered surface, there is additional boundary layer growth on the ground plane which serves to constrict the flow even more. It appears that, in the cases where the porous plate is used, suction affects the pressure gradient significantly only downstream of about x = 3.5m. Even when no suction is applied, the pressure gradient in the tunnel interacts with the porous surface. Flow enters over the forward portion of the ground plane where the pressures are high, and exits at the rear of the ground plane, from x = 400–500cm, where the pressures are lower. This return flow from the plate further restricts the wind tunnel cross-section, and results in even higher velocities in the free stream. When suction is applied, the flow into the porous surface is permanently removed from the test section (and replaced just upstream of the fan). Finally, in all cases, there is a strong pressure increase between x = 550-600 cm as the flow leaves the tapered trailing edge.

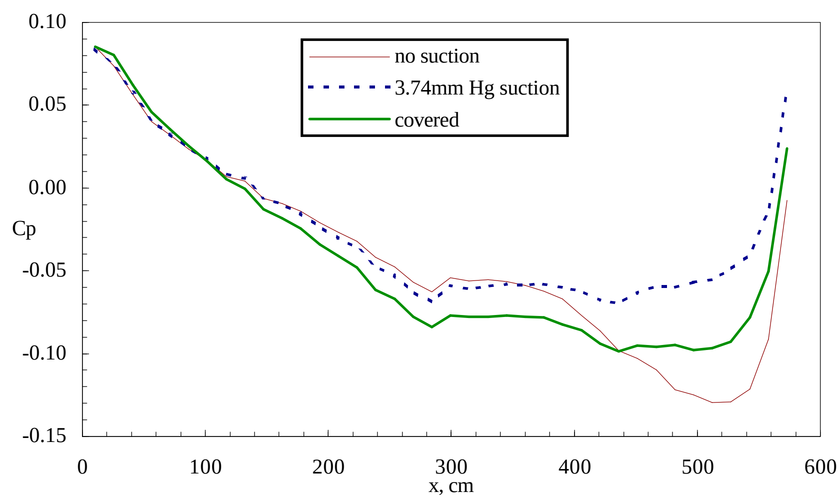


Figure 5: Streamwise pressure gradient in the wind tunnel under different ground plane suction conditions

Based on calibration data for the suction fans, a voltage setting of 35% represents a fan RPM of about 3800-4000. At this speed and with a pressure difference of 3.74 mmHg between the inlet and outlet, the flow rate is estimated to be about 0.4 m^3/sec for each fan. The total flow rate through the porous plate is thus 0.8 m^3/sec, representing about 3.5% of the volume flow through the test section at 23 m/s. This is about twice the volume flux contained in the covered plate boundary layer, and represents an acceptable level of flow removal.

In Zabat et al. (1994) and Zabat et al. (1994b), it was shown that for a single vehicle model, the C_D measured using this ground plane surface was 15% higher than if the surface were solid. This indicates that the flowfields for the two conditions are slightly different, although no details are known. The *single vehicle* drag coefficients measured over a covered surface are shown in figure 6 and figure 7 for forward and rear facing models respectively.

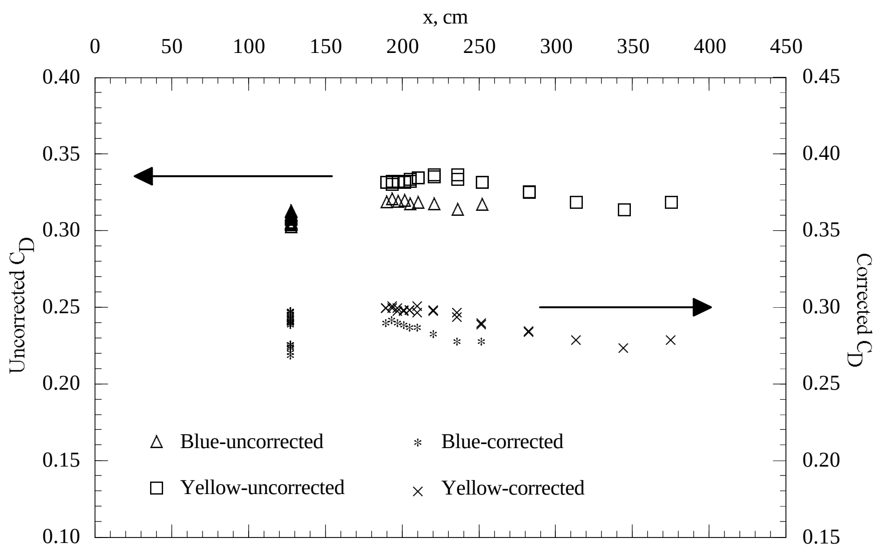


Figure 6: Single, forward-facing vehicle C_D using solid ground plane

C. The Effect of Reynolds Number and Boundary Layer Trips

The dependence of the results upon Reynolds number (Re is based on the effective diameter, $d = \sqrt{4(\text{FrontalArea})/\pi}$) is checked by varying the freestream velocity between 8 m/s and 32 m/s for a selected number of 2-vehicle platoon tests. Admittedly, this range of variation is limited, and lies well below full scale Reynolds numbers which are a factor of 7-8 higher than can be reached in the wind tunnel. In some cases, the flow on the models is tripped using a serrated rubber strip which is stretched over the nose of the model and positioned about 153 mm from the leading edge of the front bumper. The thickness of the strip is approximately 0.6 mm. It is of the order of the estimated boundary layer displacement thickness at that location on the model at U_∞ =23 m/s. The dependence of the single vehicle C_D on Re and tripping was presented in Zabat et al. (1994) and Zabat et al. (1994b). A decrease of approximately 3% in C_D was found when the Re is increased from 2.4×10^5 to 4.1×10^5. This is expected since the drag contribution due to skin friction decreases approximately proportional to the inverse 1/5 power of the Re. The trip caused a slight increase in drag at all Re probably due to drag on the trip itself.

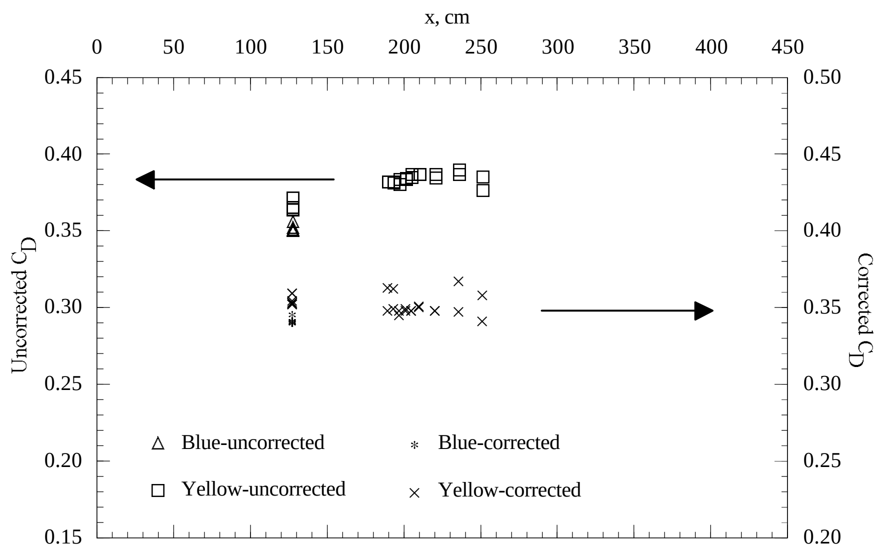


Figure 7: Single, backward-facing vehicle C_D using solid ground plane

Additional results for a 2-vehicle platoon at several spacings are summarized in figure 8 as a function of Reynolds number. The drag coefficient ratio, C_D / $C_{D\infty}$, is plotted, and because of this, the small trend in C_D as Re increases—which is no longer of interest—is not visible.

What is made evident in figure 8 are the *changes in drag* experienced during platoon operation when Reynolds number is varied. The results show a small consistent decrease in drag coefficient for the lead vehicle, and a small increase for the trail vehicle as Reynolds number increases. These changes are the same order as our estimate of reliability.

The effect of the presence of the trip is to increase the drag coefficient slightly for the lead vehicle (less drag savings), and to decrease the drag for the trail vehicle (more drag savings). The increments are similar, and roughly independent of Reynolds number. The conclusion is that neither the presence nor absence of an artificial trip nor the variations in Reynolds number (at least over our range of variation) have a significant effect upon the flow. The results to follow are presented for no artificial tripping and for a Reynolds number, Re = $3.7\text{x}10^5$.

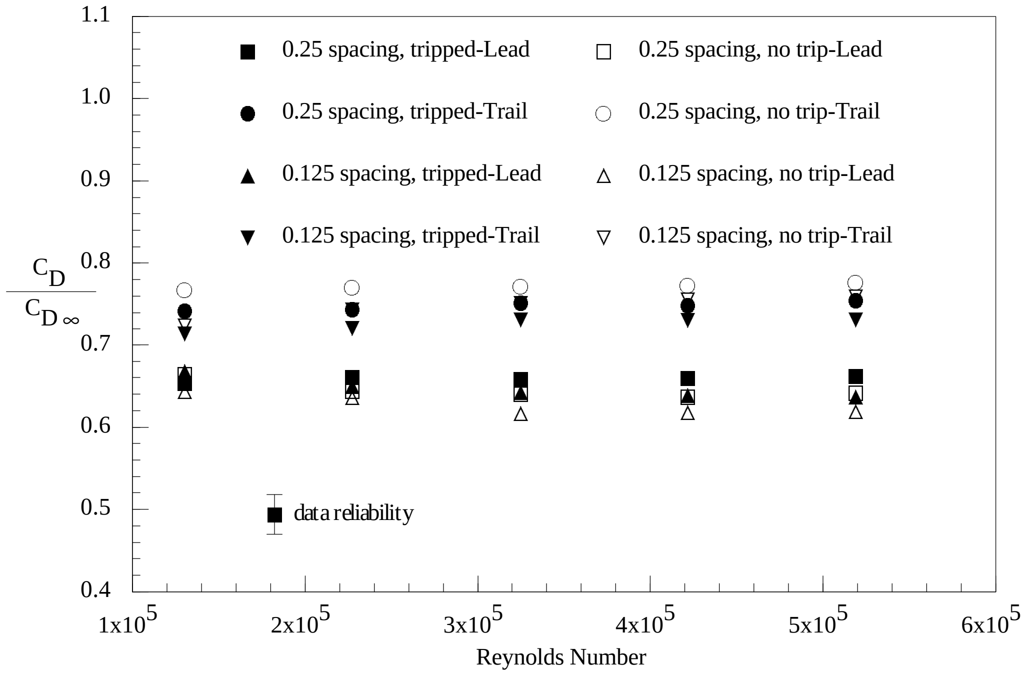


Figure 8: Effect of Reynolds number and model boundary layer trip

IV. THE DRAG OF 2, 3 & 4-VEHICLE PLATOONS

A. Drag on a 2-Vehicle Platoon

Figure 9 presents the change in drag of each platoon member as a function of the spacing between two vehicles using the porous ground plane surface. The C_D of each platoon member is divided by the C_D for the same model in isolation at an identical position in the wind tunnel. This C_D *ratio* represents the *change in drag* resulting from the unique aerodynamics of the platoon. The ratio is less sensitive to possible variations in C_D resulting from small differences between models, location in the wind tunnel, etc. Presenting the drag coefficient ratio, rather than the drag coefficient itself, roughly accounts also for the lack of complete geometric similitude when surface detail has been ignored. Spacing is measured on the centerline from the rear bumper of the lead model to the front bumper of the trail model and is normalized with model length (0.619 m).

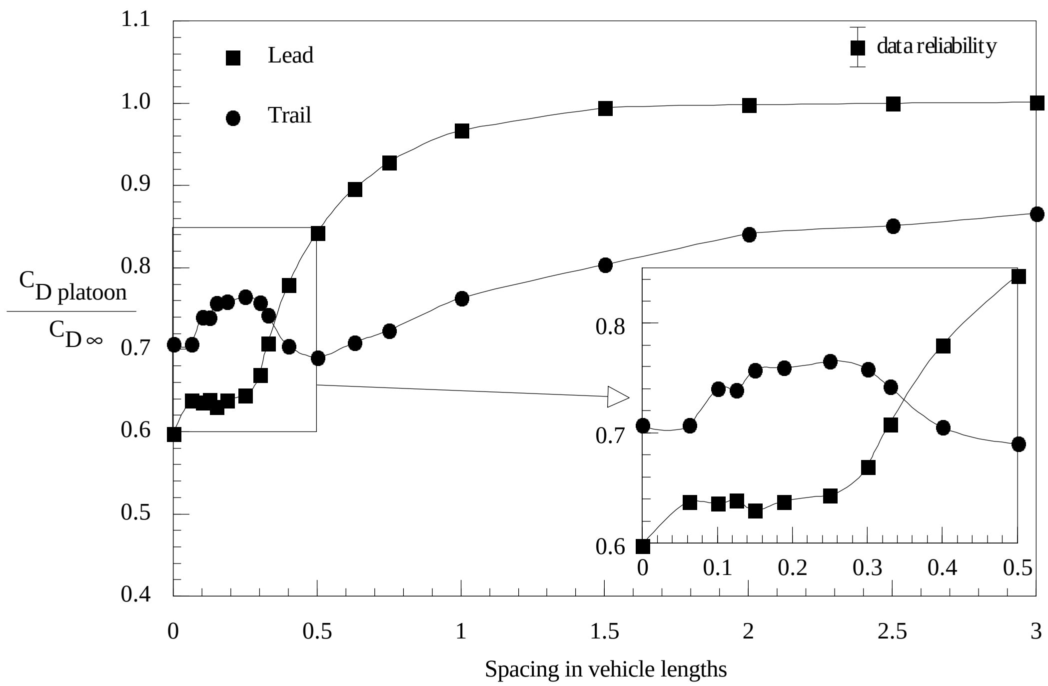


Figure 9: Results for a forward-facing 2-vehicle platoon using a porous ground plane

The points shown in figure 9 represent the average values of data taken over four separate but identical experiments. The reliability bar in the upper right corner of the figure is an estimate of the possible measurement error.

Several important qualitative features can be seen in figure 9. At spacings greater than unity, the lead vehicle is unaware of the presence of the trail vehicle (this is also true when more than two vehicles are present). The trail vehicle, which is contained in the wake of the lead vehicle, experiences a decrease in drag as expected. Extrapolation of these results to greater spacings suggests that a measurable decrease in drag will persist perhaps to a spacing of ten. This circumstance may be termed *weak interaction* because it is one-sided—not mutual—and is entirely understandable. As spacing decreases below a value of unity, the drag of the lead vehicle begins a substantial decrease. The drag of the trail vehicle is also decreased, in what might now be termed the *strong interaction* regime. As spacing continues to decrease below the value one-half, the drag of the trail vehicle abruptly turns upward, crosses the lead vehicle drag curve at about 0.35 spacing, and remains the greater of the two drags all the way to zero spacing! For two vehicles of equal performance and throttle setting, the crossover position is a stable fixed point—meaning that the distance between the two vehicles will naturally equilibrate to this separation. The observation that separations of approximately this value—or slightly greater separations—are often observed in the drafting of stock cars on race tracks lends support to the wind tunnel result.

B. Drag on 3 & 4-Vehicle Platoons

The results of drag measurements as a function of spacing on 3 and 4-vehicle platoons using the porous surface ground plane are presented in figure 10 and figure 11. The intervehicle spacing within the platoon is uniform and is measured in the same manner. As in the 2-vehicle case, the points presented here are averaged over four data sets. The data reliability bar is an estimate based on the root mean square of the data scatter.

As far as we know, these are unique measurements which document the remarkably large drag savings obtainable in platoon operation. At first glance they may appear "noisy" because of the numerous small and unexpected variations—particularly at short spacings. Much of this variation is in fact greater than our estimated error and reflects, we believe, the actual physical changes taking place in the flow field at short spacings. Many of the details show consistent trends as the number of vehicles within the platoon increases.

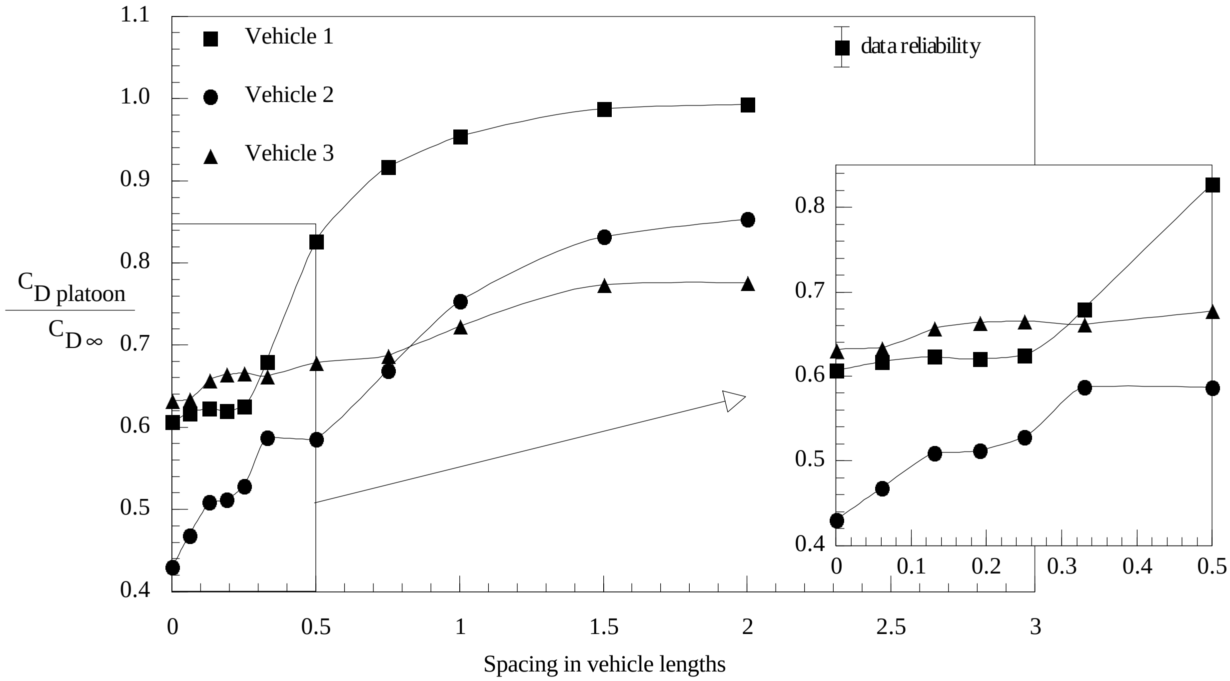


Figure 10: Results for 3-vehicle platoon

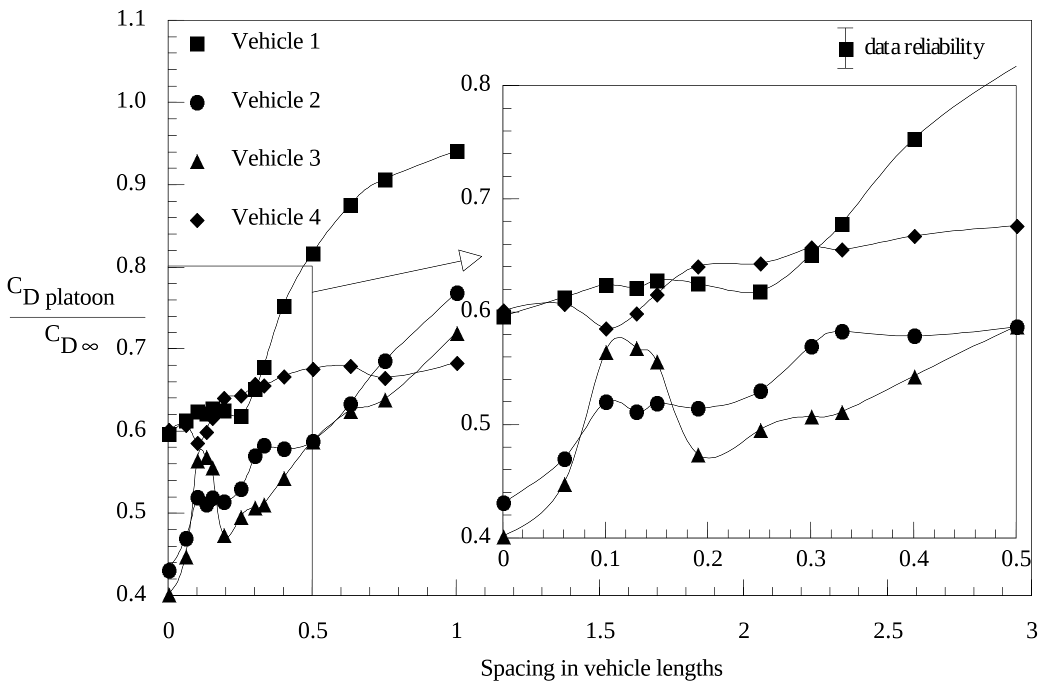


Figure 11: Results for 4-vehicle platoon

As the number of vehicles in the platoon increases, one observes more complex behaviors in the *strong interaction* regime (figures 10 and 11). As might be expected, the interior vehicles have the lower drags, but there are also curious small plateau regions which form. For example, the drag of the lead vehicle decreases steadily with decreasing separation until a value of about 0.25 is reached, and thereafter drag remains roughly constant. The drag of the second vehicle in a three-vehicle platoon contains two small plateau regions—extending from 0.1-0.2 and from 0.3-0.5. The second vehicle experiences similar behavior in the four-vehicle platoon, and the third vehicle exhibits even more dramatic drag variation—a plateau at 0.6-0.7, a decrease to a relative minimum (plateau) at 0.2-0.3, then a dramatic rise (to a plateau) at 0.1-0.2 before finally decreasing to an absolute minimum. The narrowness of the plateau peak in drag at 0.1-0.2 suggests a flow-induced resonance which is quite sensitive to vehicle spacing and to position within the platoon. Such steep drag gradient regions will be of importance to control system modelers, and therefore warrant our further study.

C. The Platoon-Averaged Drag Coefficient: Extrapolation to Large Platoons

A closer study of the 2, 3 and 4-vehicle platoon behaviors allow several general conclusions to be made regarding the possible behavior of a larger platoon.

(1) The drag coefficient ratio for the lead vehicle and for each succeeding vehicle—say the n^{th} vehicle—is independent of the number of vehicles in the platoon provided there are at least (n+1) vehicles.

(2) Each vehicle added to the platoon experiences a lower drag over most of the strong and weak interaction range, but may be subject to rather sharp, local drag changes (flowfield resonances).

(3) The final vehicle in the platoon experiences the least drag variation as vehicle spacing varies.

An overall measure of platoon drag performance may be obtained by defining an average drag coefficient ratio.

$$\left(C_{Dp}\right)_{avg} \Big/ C_{D\infty} = \left(\frac{1}{n}\right)\sum_{i=1}^{n}\left(C_{Di}/C_{D\infty}\right) \qquad (5)$$

This ratio is shown in figure 12. As might be expected, platoon-averaged drag coefficient ratios possess much smoother behavior than the drags of individual vehicles. In a platoon containing just four vehicles, the average drag has been reduced by a factor of 1/2 at zero spacing! More importantly perhaps, the average drag coefficients are dramatically lowered, and vary only moderately, in the range of spacings 0.1-0.3 where platooning could be implemented. The addition of each succeeding vehicle decreases the platoon drag, but as the number of vehicles increases the increments become smaller. One would expect the average drag ratio to approach a limit as the number of platoon members increases indefinitely.

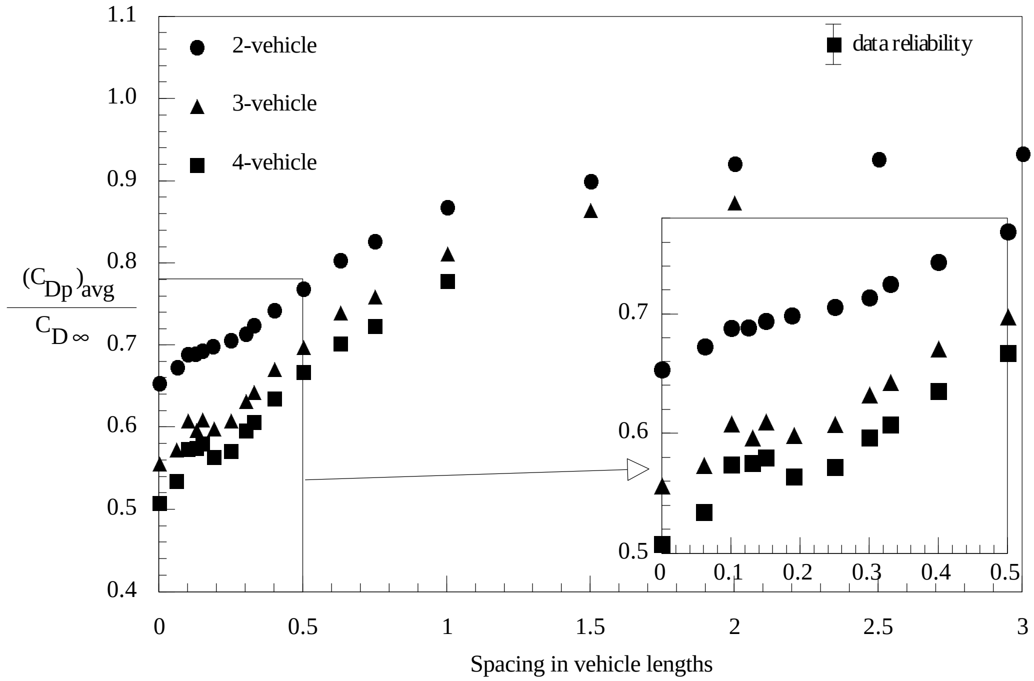


Figure 12: Average drag for 2, 3 & 4-vehicle platoons

An extrapolation to larger platoon size may be obtained by the following procedure. The platoon-averaged drag coefficient ratios are plotted for a series of separations as a function of the inverse of the number of vehicles in the platoon. Continuing the drag coefficient ratio into the domain between one-quarter (1/n = 1/4) and zero gives the desired behavior. This is accomplished in figure 13 using both linear and quadratic fits to the four data points at 1/n = 1/1, 1/2, 1/3, 1/4. The difference in the results from these two fits can be used to estimate a range of uncertainty in the predictions. The resulting two-dimensional combined extrapolation\interpolation is shown in figure 14, expressing platoon-averaged drag coefficient ratio as a function of separation distance and number of vehicles. Of course the extrapolation assumes a smooth behavior as platoon size increases, but this is not an unwarranted assumption—at least for the *platoon-averaged* behavior. Contours of constant drag savings show a diminished dependence upon platoon size beyond 6-7 vehicles, and suggest that the 4-vehicle platoon results are probably sufficient to make a reasonable extrapolation.

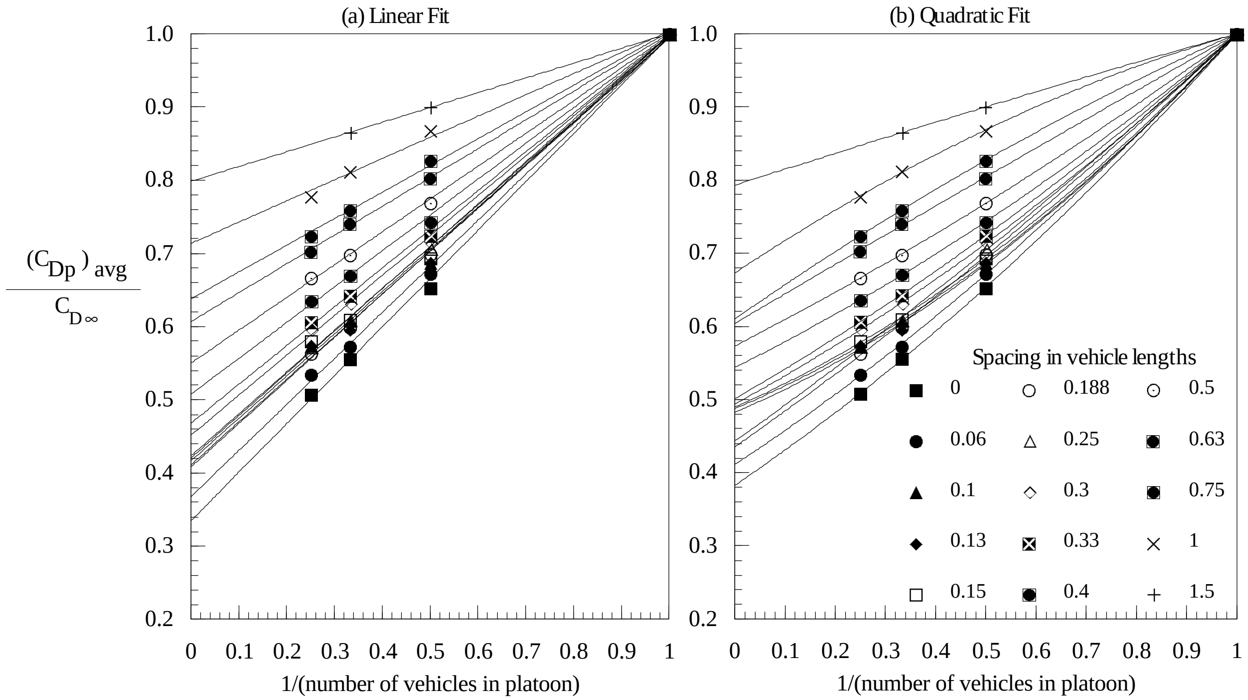


Figure 13: Extrapolation of data to platoons of larger size using least squares fits

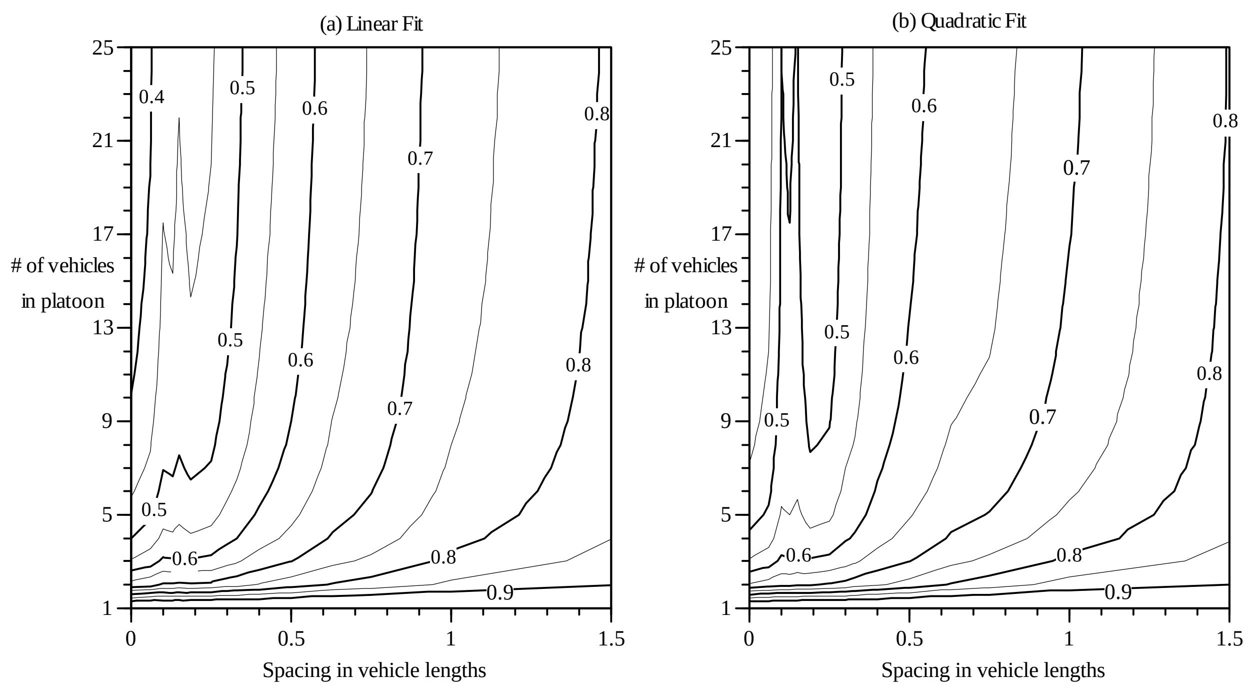


Figure 14: Estimate of reduction in drag for large platoons based on least squares fits of data

V. DEFINING THE IMPORTANCE OF VEHICLE SHAPE:
2-VEHICLE PLATOONS IN OTHER ORIENTATIONS

A most important variable in estimating possible platoon drag savings is the geometry of the vehicles themselves. It was anticipated early-on that some means for judging the sensitivity to changes in vehicle shape would be needed. The Lumina APV was originally chosen for testing because it presented a strongly raked windshield and a blunt base. The model can be tested in the conventional forward facing condition, or be reversed to provide quite a different front-to-back geometry. In fact, these two geometries are probably more extreme than would be encountered in a group of contemporary automobile vehicles.

The sensitivity of the drag coefficient ratio to changes in geometry is examined by utilizing the 2-vehicle platoons with the models in various orientations with respect to one another. In addition to the conventional (forward facing) configuration–the results of which were presented in section III–three variations are possible: back-to-back; front-to-front and reversed. These are illustrated in figure 15.

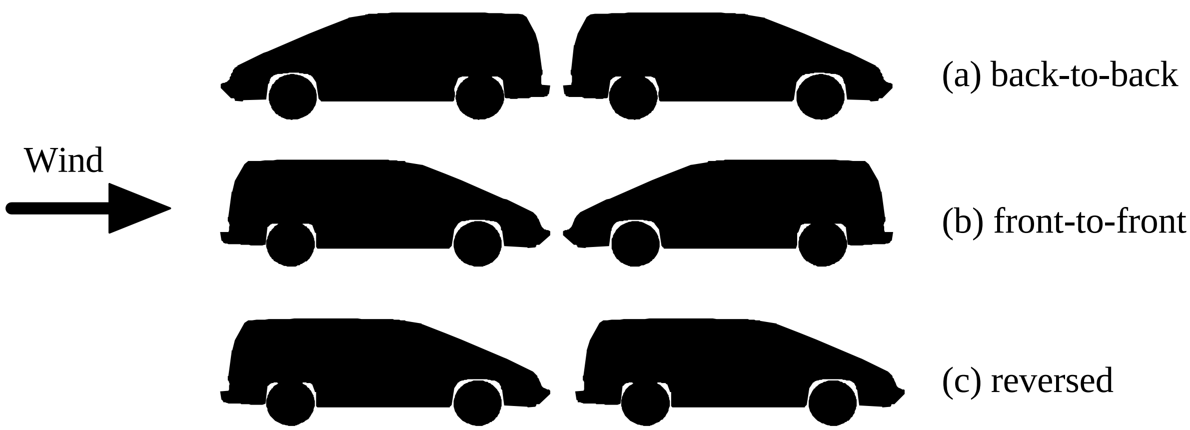


Figure 15: Variations in 2-vehicle platoon geometry

In addition, the 2-vehicle platoons are also tested over a solid surface. Provided measurements are limited to a 2-vehicle platoon at separations no greater than unity, the boundary layer growth on the solid surface remains acceptably small ($\delta^* \approx 6$ mm or 16% of the model clearance from the ground plane). It has already been shown that the condition of the ground plane has an effect on the drag measurements. This effect is probably due to changes in the flowfield that occur as a result of the additional flow through ground plane or the lack of it. The change in the flowfield that results from the two different ground plane conditions is of the same order as the change one would expect if the shape of the vehicle were changed slightly. Because of this, measurements with the modified ground plane are presented here as if they had been another change in geometry.

The results for all the 2-vehicle platoons with different geometries can be consolidated to provide an estimate of the variation possible, in the results of drag as a function of spacing, due to changes in geometry. This estimate is in the form of a variability envelope which is also a function of spacing and is based on the standard deviation from the mean of the data for *all geometries tested*. Although this estimate is obtained using only a 2-vehicle platoon, it would not be unreasonable to apply it to the 3 & 4-vehicle data as well.

A. Measurements of Drag - The drag coefficient ratios for each of the eight cases of geometry studied are presented separately in figures 16-19. Figure 16a is the same as figure 9 and is included here for convenience. Each data point plotted is an average of at least two separate, but identical, experiments (except for the back-to-back case with a solid groundplane, where only one data set was taken). The reliability bar at the upper left corner of the figures is our estimate of the possible measurement error. (The results for the separate but identical experiments do indeed lie within the error bounds established by this reliability estimate.) We believe it is important to present all of the data in the least confusing manner. To facilitate comparisons, the figures have identical sizes and scales. Since the measurements over the solid surface are limited to less than one vehicle length, these data plots are continued to three vehicle lengths using the suction surface results.

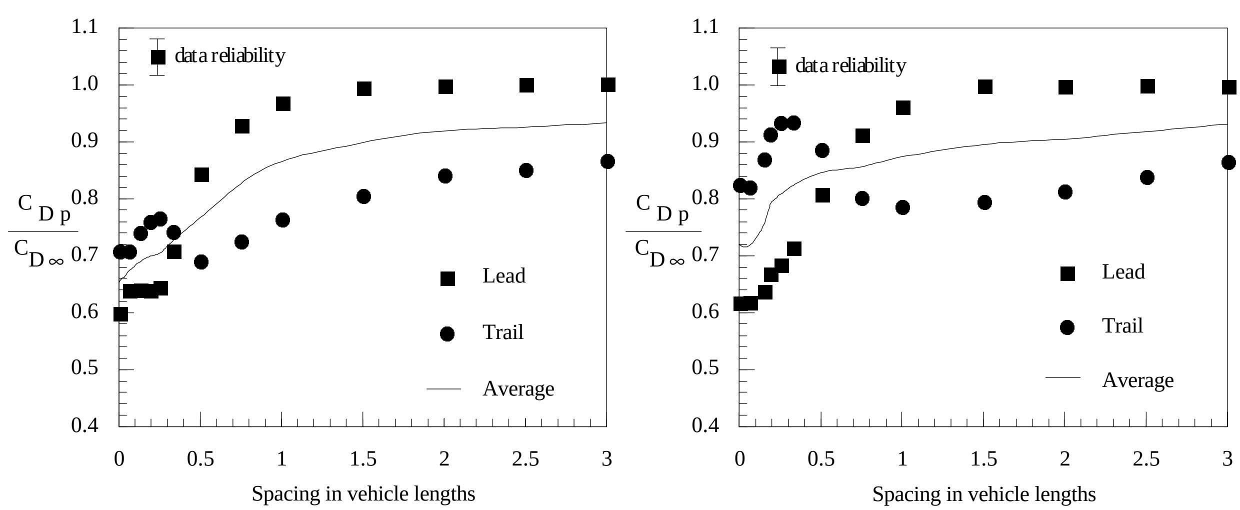


Figure 16: Results for forward facing 2-vehicle platoon using (a)porous and (b)solid ground plane

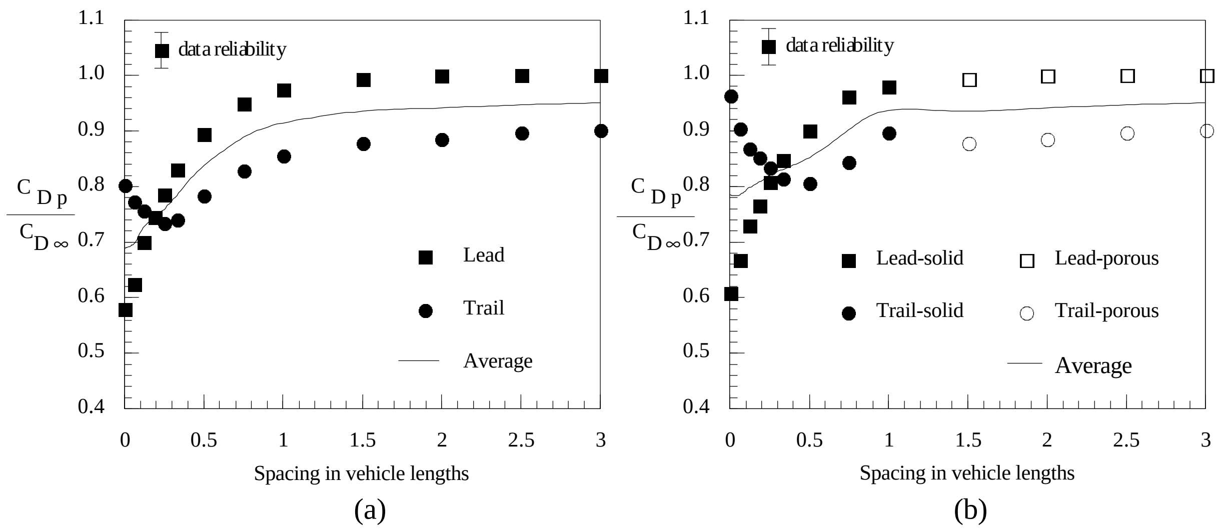


Figure 17 Results for front-to-front 2-vehicle platoon using (a)porous and (b)solid ground plane

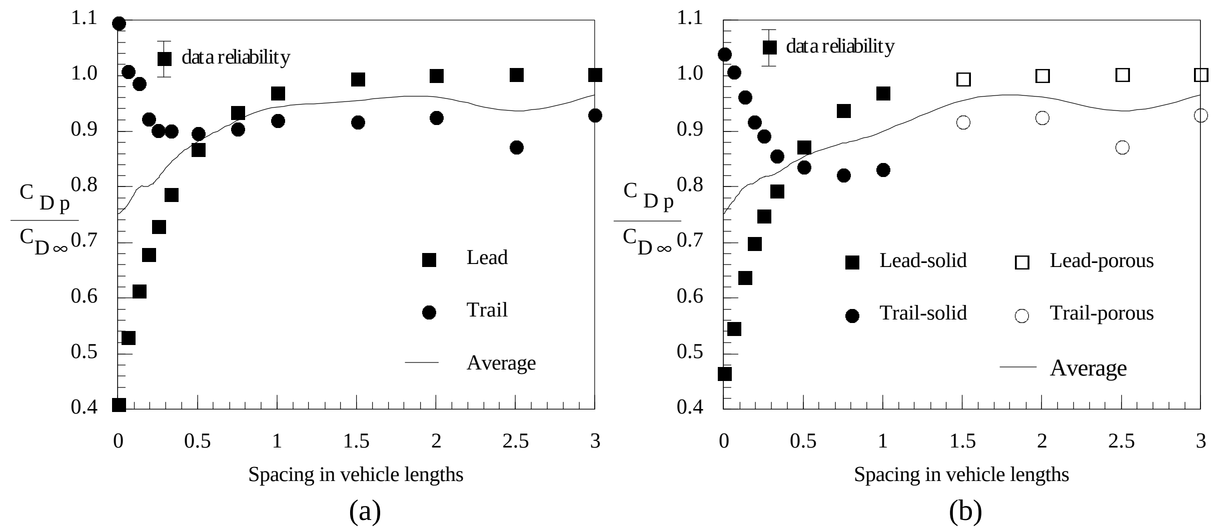


Figure 18: Results for reversed 2-vehicle platoon using (a)porous and (b)solid ground plane

Since we presently have insufficient information about the flow fields and little understanding of the causes for these differences, there is no point in discussing details at great length. We do wish to make several remarks about the results, however.

(1) All the 2-vehicle results have the same general form, and all configurations contain a stable fixed point lying somewhere in the range of spacings 0.2-0.6.

(2) The magnitudes of the drag coefficient ratio for the individual vehicles do vary measurably among the different geometries.

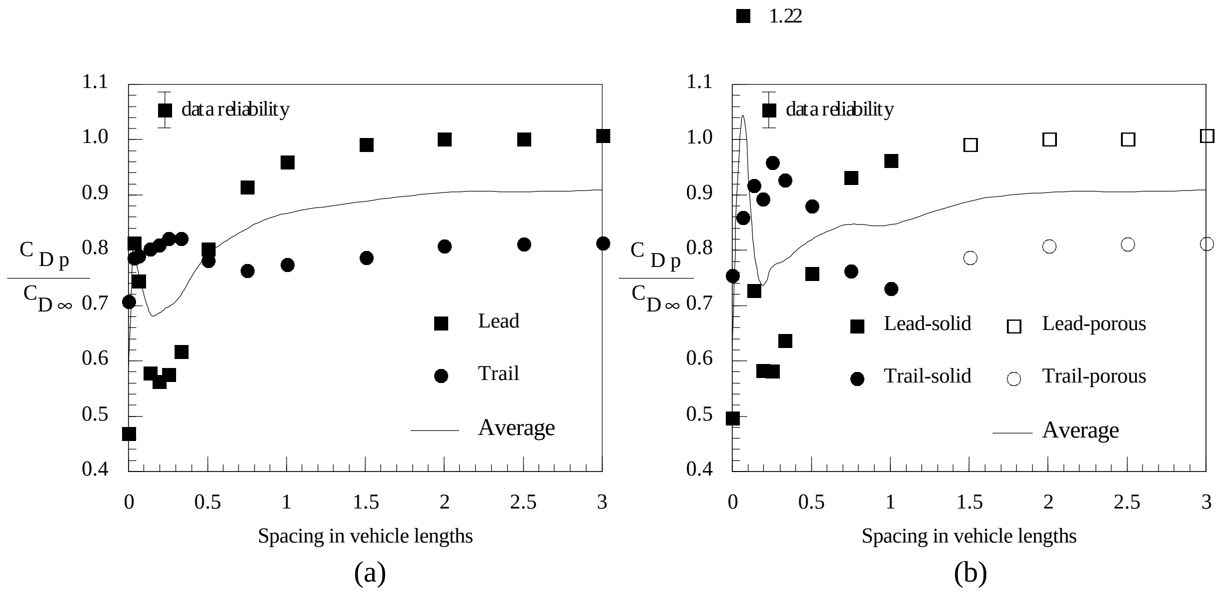


Figure 19: Results for back-to-back 2-vehicle platoon using (a)porous and (b)solid ground plane

(3) There are differences between the results using solid surface and suction surface, and these differences are generally less than the differences created by varying other geometric shape parameters.

(4) There is an extremely sharp peak in the drag coefficient at a spacing of about 0.1 for the back-to-back geometry, figure 19. This is a real effect and not a measurement error (as the multiple data points for the porous groundplane demonstrate), and it appears more severe over the solid surface ground plane. We believe the effect is produced by a strong flow-feedback interaction initiated when the spacing of vehicles (forming the separation cavity) becomes an integral of the number of wavelengths of the turbulent vortices in the separating and reattaching shear layers (bordering the separation cavity). It is therefore legitimate to term this effect a *resonance*. Its first appearance is most evident in the back-to-back geometry, where the separation dimension is most uniform around the cavity, but we also see evidence of resonance between the third and fourth vehicle in the four-vehicle forward-facing platoon. The resonance seems to generate unwanted increases in drag on the forward vehicle, indicating a decrease in cavity pressure. In addition to undesirable drag increases, such resonances represent steep spatial gradients in drag which will require management by the automatic control system. We also anticipate there will be significant unsteady force magnitudes and noise production if the resonance is strong. These are issues we are presently studying.

B. The All-Geometries Average Platoon Drag Coefficient

The solid lines drawn in figures 16-19 represent the *average platoon drag coefficient ratio* for the two vehicles in the platoon defined as

$$\left(C_{Dp}\right)_{avg} \Big/ C_{D\infty} = \left(\frac{1}{n}\right) \sum_{i=1}^{n} \left(C_{Di} / C_{D\infty}\right) \tag{6}$$

The average platoon drag coefficient ratio is much smoother than the individual vehicle drag ratios and makes it easier to evaluate the overall drag performance of the platoon. The solid lines on figures 16-19 are replotted together on figure 20 as symbols. The solid line in figure 20 represents the mean value for the average C_D ratios for *all eight geometries* tested. Termed the *All-Geometries-Average*, it is one means of providing a generalization which takes into account the dependence upon vehicle shape. The bar length in figure 20 represents ± one standard deviation of these average drag coefficient rations from the mean. It can be taken as an estimate of the variability to be expected for various geometries.

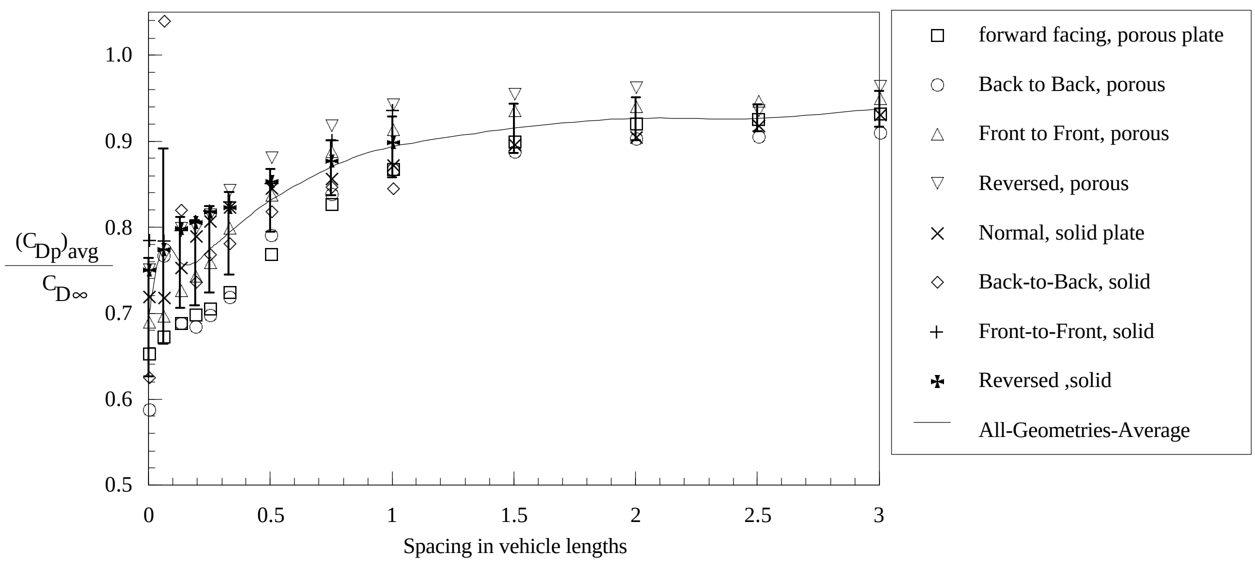


Figure 20: Average platoon drag coefficient ratios

The *All-Geometries-Average* drag coefficient ratio is shown more clearly in figure 21. At the top of the figure for each spacing is this same variability bar representing ± one standard deviation. It can be centered on the average value to give an indication of the variability in drag savings which might be anticipated to result from variations in vehicle geometry. As a comparison, the average drag coefficient ratio for the forward facing platoon is also presented. The results show that for spacings greater than unity—in the *weak interaction* region—the geometry of the vehicle does not influence drag savings significantly. The variance between geometries is about the same magnitude as the estimated measurement accuracy. In the *strong interaction* region, geometry definitely plays a role in determining the possible drag savings—as inferred from the considerably larger variability at short spacings. The *All-Geometries-Average* is viewed as an overly conservative estimate of possible drag savings for several reasons. The majority of the data that lie above the average correspond to the front-to-front and reversed platoon cases. The geometric differences between forward facing and the front-to-front and reversed platoons are probably more severe than would be experienced in practice. Second, the bump in the average, and the extremely large variability at spacing of 0.1, are the result solely of the resonance observed in the two back-to-back cases. In practice, one would avoid operating the platoon at spacings where resonance occurs.

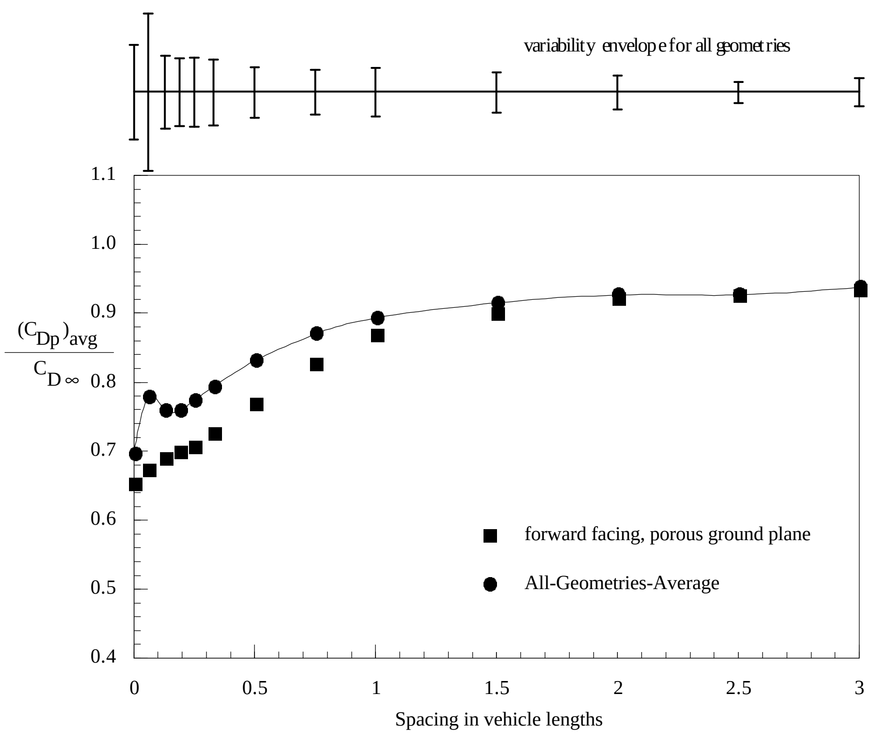


Figure 21: All-Geometries-Average drag coefficient for 2-vehicle platoon

This latter result suggests the importance of platoons having non-uniform spacings when operating with vehicles of different shapes. Since all platooning vehicles are to be equipped with onboard computers and engine performance sensors, it would be a relatively simple additional task to optimize spacings to achieve a local minimum power expenditure (minimum drag).

VI. FUEL SAVING BENEFITS DERIVED FROM PLATOONING

A. The Relationship Between Aerodynamic Drag and Fuel Expenditure

The total resistance encountered by a vehicle in unsteady forward motion can be described by the following equation

$$\text{TOTAL RESISTANCE} = D + R_R + R_g + R_A \tag{7}$$

D is the aerodynamic drag and is expressed as

$$D = C_D \tfrac{1}{2} \rho V^2 A\ , \tag{8}$$

where ρ is the density of air, V is the driving speed (assuming no relative wind) and A is the cross-sectional area of the vehicle. C_D is the non-dimensional coefficient of drag. Aerodynamicists use the drag coefficient as the comparison quantity rather than the drag itself, because C_D is relatively independent of size and speed. The drag coefficient does depend upon vehicle shape, and in our case, C_D also depends upon the proximity of other vehicles in the platoon. The rolling resistance, R_R, is a function of vehicle mass, M, and tire rolling resistance coefficient, r_o, which in turn depends upon speed.

$$R_R = r_o M g\ , \tag{9}$$

g is acceleration due to gravity. R_g is referred to as the gravitational or climbing resistance, and is a function of vehicle mass and the road grade, ϕ.

$$R_g = \sin\phi\, M g \tag{10}$$

R_A is the acceleration resistance depending upon mass and rate of change of speed (acceleration).

$$R_A = M(1 + \varepsilon_i) \frac{dV}{dt} \tag{11}$$

ε_i accounts for the rotating masses in the various gears. The only component of the total resistance which is appreciably affected by platooning is the aerodynamic drag.

The engine power output required to overcome total resistance at speed V is

$$P = \frac{[\text{TOTAL RESISTANCE}]V}{\eta_T} \tag{12}$$

where η_T is a number typically of the order of 0.9, and accounts for losses in the engine powertrain (transmission). Combining equations (7)-(12) gives the power required for operation at speed V.

$$P = \left[\frac{1}{\eta_T}\right]\left[C_D \tfrac{1}{2} \rho A V^3 + MgV\left(r_o + \sin\phi + \frac{(1+\varepsilon_i)}{g}\frac{dV}{dt}\right)\right] \tag{13}$$

The fuel consumption of an automobile in liters per kilometer (liters/km) or gallons per mile (GPM) depends upon the specific fuel consumption (sfc), the engine power level, and velocity.

$$\text{liters/km} \quad \text{or} \quad \text{GPM} = \frac{P \times \text{sfc}}{V} \tag{14}$$

(A conversion factor should appear in (14) to keep the units consistent). Finally, combining (13) and (14) yields the following relation between fuel consumption and the various components comprising the total resistance.

$$\text{liters/km or GPM} = \left[\frac{1}{\eta_T}\right]\left[C_D \tfrac{1}{2}\rho A V^2 + Mg\left(r_o + \sin\phi + \frac{(1+\varepsilon_i)}{g}\frac{dV}{dt}\right)\right] \times \text{sfc} \tag{15}$$

If one considers unaccelerated travel on a level road, equation (15) simplifies further, and an equation for the fuel used to overcome aerodynamic drag, $(\text{liters/km})_{DRAG}$ or GPM_{DRAG} , as a percentage of the total consumption can be written

$$\frac{[\text{liters / km}]_{DRAG}}{\text{liters / km}} = \frac{GPM_{DRAG}}{GPM} = \frac{\left[C_D \tfrac{1}{2}\rho A V^2\right]}{\left[C_D \tfrac{1}{2}\rho A V^2 + Mgr_o\right]} \tag{16}$$

A similar equation, representing the rolling resistance contribution to the fuel consumption, $(\text{liters/km})_{RR}$, can be written by replacing the numerator in equation (16) with Mgr_o. The behavior of $(\text{liters/km})_{DRAG}$ and $(\text{liters/km})_{RR}$ as a percentage of liters/km is shown in figure 22 for a range of velocities using parameter values which approximate the performance of a Lumina APV. Notice that at velocities under 65 km/hr (40 MPH), the rolling resistance is the dominant force that the engine must overcome. Above 80 km/hr (50 MPH), drag is the major contributor, accounting for almost 80% of the consumption at 130 km/hr (80 MPH)

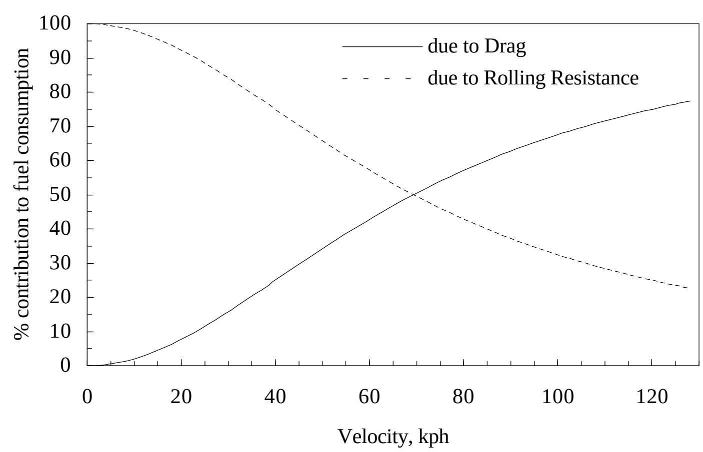


Figure 22: Fuel consumption due to drag and to rolling resistance as a percentage of total fuel consumption

B. The Fuel Consumption Estimates of Sovran

Sovran (1983), suggested a general method for determining the effect of aerodynamic drag on fuel consumption. It is based upon an extension of equation (15) to include engine performance during breaking and idling, and utilizes the standard Environmental Protection Agency (EPA) driving cycle model for 1983. A determination of the actual rate of fuel consumption requires detailed information about the engine and drivetrain for a particular vehicle. Sovran, in his paper, limits his analysis to changes in the fuel consumed per unit distance, Δ(liters/km) or ΔGPM, as a result of specific changes in the vehicle drag.

The result of Sovran's analysis applied to platoon operation is the linear relationship

$$\left[\frac{(\text{liter}/\text{km})_{\infty} - (\text{liter}/\text{km})_{\text{platoon}}}{(\text{liter}/\text{km})_{\infty}}\right] = \left[\frac{\text{GPM}_{\infty} - \text{GPM}_{\text{platoon}}}{\text{GPM}_{\infty}}\right] = \xi_A \left[\frac{C_{D\infty} - \left(C_{D\,\text{platoon}}\right)_{\text{avg}}}{C_{D\infty}}\right] \tag{17}$$

where, for the EPA urban driving schedule

$$\left(\xi_A^*\right)_U = \frac{0.74}{1 + \left\{0.0683\, r_o + 0.00134\right\} \Big/ \dfrac{C_{D\infty} A}{M}} \tag{18}$$

and for the EPA highway driving schedule

$$\left(\xi_A^*\right)_H = \frac{0.89}{1 + \left\{0.0310\, r_o + 0.000126\right\} \Big/ \dfrac{C_{D\infty} A}{M}} \tag{19}$$

ξ_A is the influence coefficient that relates percentage changes in C_D to changes in fuel expenditure, and depends upon the particular vehicle chassis, the engine, the fuel, the drivetrain, and the accessories. These items are reflected in the various coefficient values in expressions (18) and (19). ξ_A^* represents the highest attainable value of ξ_A. When a vehicle traveling at its cruising speed is subjected to a smaller load, say due to a change in drag, the driver can use the extra power available to speed up or, he/she can maintain the original speed by reducing the throttle setting. In opting for the latter, the engine is subsequently operated at a less than optimum condition (lower efficiency) where its specific fuel consumption is slightly higher. This will be reflected in the above equations by a value of ξ_A which will be lower than ξ_A^*. To maintain ξ_A^*, the driver should instead be able to shift to a different gear that would recover the original engine operating condition.

C. Fuel Consumption Calculations

Table 1 lists information on the 1991 GM Lumina APV that is pertinent to this discussion. The tire rolling resistance is nominal for 205/70SR15 tires.

Table 1: Vehicle specifications for 1991 GM Lumina APV

Nominal Coefficient of Drag, C_D	0.32
Vehicle mass, M (based on mfr.'s curb weight)	1736 kg
Cross-sectional area, A	2.816 m^2
Fuel consumption per unit distance, urban $(\text{liters/km})_U$	.138 (1/17 GPM)
Fuel consumption per unit distance, highway $(\text{liters/km})_H$	.098 (1/24 GPM)
Tire rolling resistance coefficient, r_o	0.012

Based on values listed above, the influence coefficients for both urban and highway driving conditions are found to be:

$$\left(\xi_A^*\right)_U = 0.143$$

and

$$\left(\xi_A^*\right)_H = 0.454$$

These values can now be used to determine the percentage change in fuel consumption using equation (17). For the platoon operations in question,

$$\left[\frac{\Delta(\text{liter / km})}{(\text{liter / km})_\infty}\right] = \left[\frac{\Delta \text{GPM}}{\text{GPM}_\infty}\right] = \left(\xi_A^*\right)_{\text{U or H}}\left[1 - \frac{\left(C_{\text{Dplatoon}}\right)_{\text{avg}}}{C_{D\infty}}\right] \qquad (20)$$

The result of using the experimental data for 2, 3 & 4-vehicle platoons in this relationship is shown in figure 23 and figure 24 for highway and urban driving schedules respectively. Also shown is the quadratically extrapolated limit for a platoon of many vehicles, $N \rightarrow \infty$, for both schedules.

For the 2-vehicle platoon, the result is based on the all-geometries-average of figure 21. The 3 and 4-vehicle results are based on the platoon averages of figure 12. One could (although it is not done here) modify these to reflect the possible variability with geometry by multiplying the drag ratio by the fractional difference (at each spacing) between the 2-vehicle platoon average and the all-geometries-average (figure 21). The many-vehicle limit is based on the $N = \infty$ ($1/N = 0$) vehicle extrapolation results in figure 13(b).

The variability bar given at the top of the figure for particular spacings is a measure of the possible variability due to the differences in vehicle geometry. It is based on the standard deviation of the drag data for all geometries from the all-geometries-average. We believe this estimated variability to be *conservative*.

As expected, there is a considerable savings in fuel as a result of the reduction in drag due to platooning; as much as a 27% reduction from the isolated vehicle consumption is possible at spacings of 0.1–0.2 for very large platoons on the highway. Using the envelope at the top of the figure suggests that the saving is likely to lie within the range 22–32% regardless of geometry at this spacing.

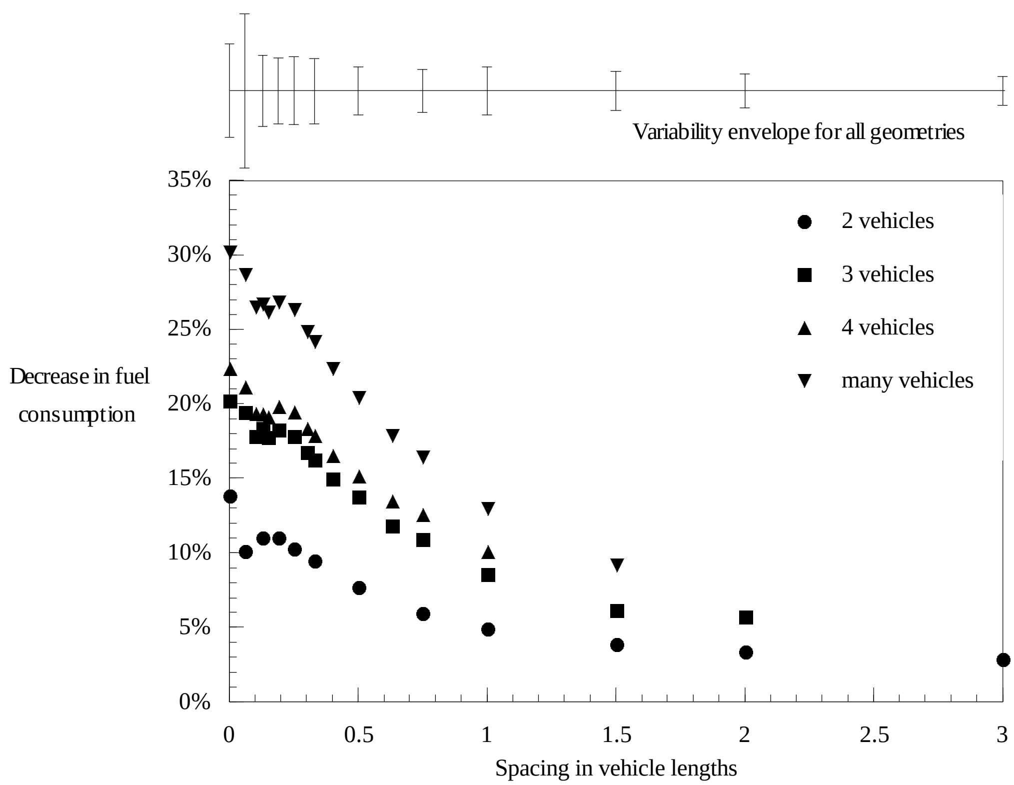


Figure 23: All-geometries-average decrease in fuel consumption for platooning vehicles in highway operation

In the city, the savings is not as great since drag is a much smaller percentage of the overall vehicle resistance at low speeds. Platooning in urban stop and go traffic is not contemplated, but savings nonetheless amount to a respectable 5-10%.

It is clear from the results shown that the reductions in drag as a result of platooning can be significant. The development of AVCS technology that will permit platoon operation should be pursued since the benefits, in terms of reduced fuel consumption as well as reduced emissions would be considerable, especially considering the percentage of miles traveled on the highways.

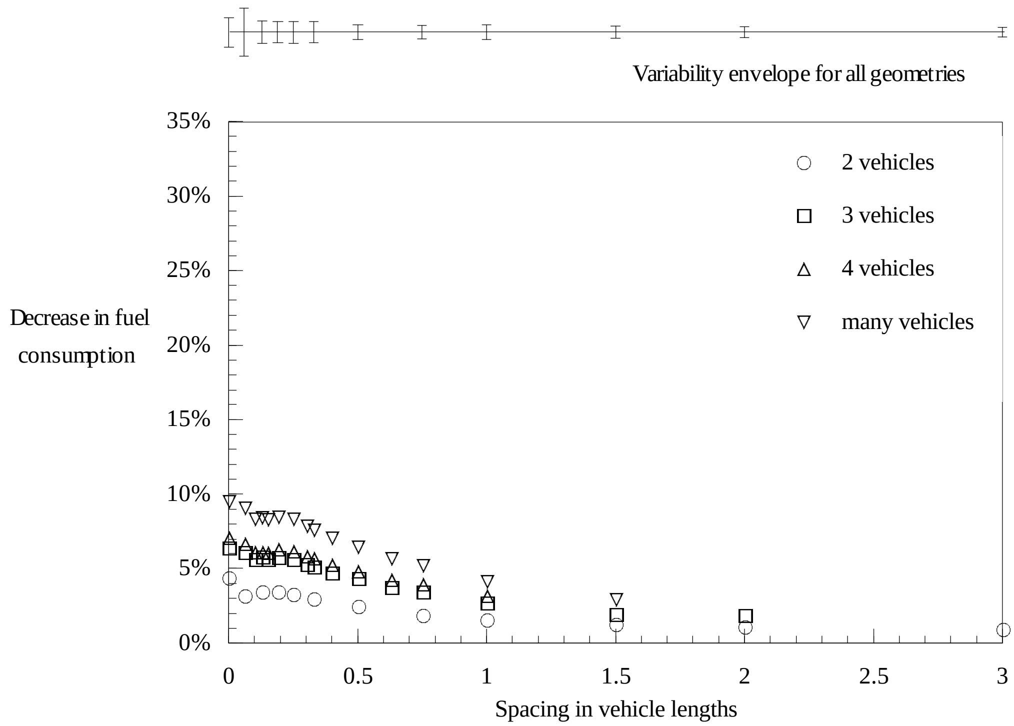


Figure 24: All-geometries-average decrease in fuel consumption for platooning vehicles in urban operation

With regard to fuel savings, there is an additional and unaccounted for benefit to be realized from platooning. In an actual congested highway traffic flow, fuel is consumed by the frequent accelerations and decelerations of the traffic stream. Platooning would *smooth* these acceleration/deceleration peaks, resulting in effectively increasing the fuel savings presented here. A more accurate measure of the efficiency of platooning might better contrast a congested highway model with the EPA highway schedule used here. Such a comparison would quantify the savings accrued from elimination of fuel consumed to accelerate the vehicle as well as savings from the reduced drag.

The results also indicate that the vehicle geometry can significantly affect the effectiveness of platooning in terms of drag reduction and gas mileage. It suggests that, if platooning is to be implemented, vehicle bodies might be designed to optimize drag reduction in platoon operation. Also, as mentioned previously, gearboxes, if not continuously variable, ought to include a *platooning gear* that will maintain ξ_A^* when a vehicle joins a platoon.

VII. SURFACE STREAMLINE PATTERNS AND GROUND PLANE PRESSURE DISTRIBUTIONS

In order to better understand the drag behavior of platoons, it is important to know the behavior of the flowfield around the vehicle. Numerical methods are still a long way from being able to correctly model a high Reynolds number separated flow, such as that about an automobile. Of course, complete flowfield *measurements,* accurately resolved in space and time, are also beyond practical possibility. However, two types of experiments have been conducted that might provide clues for the differences between vehicle flowfields in platoon operation compared to operation in isolation. The work in this section is insufficient to provide definitive descriptions of the intervehicle flowfields, but it will be incorporated with additional results from the future studies outlined in section IX.

A. Surface Flow Visualizations

A mixture of kerosene, oleic acid and 5μ-size titanium dioxide particles is brushed evenly onto the models in both single vehicle operation and in a 2-vehicle platoon. When the wind tunnel is turned on, the airflow about the models causes the mixture to move in the direction of the airflow. After about ten minutes of operation, the kerosene has evaporated leaving the titanium dioxide in a pattern that can allow some inferences to be drawn regarding flow along the vehicle surface. The models are removed from the tunnel and photographed from the front, back, top and sides. The photographs are digitized for later processing and storage. This procedure is quite tedious and is performed only for a limited set of test conditions. A complete set of digitized photographs is included in the appendix. Presented here are three cases showing evidence that dramatic changes occur in the flowfield under platoon operation.

Figure 25 shows the resulting front, top, rear and side views of a single model after following the procedure described above. In the side view, note the streaks, which indicate a vortex, along the hood-body panel junction continuing to the top of the A-pillar. The top view shows the flow moving outboard along the hood which is consistent with the formation of a vortex structure just downstream of the A-pillar. The top view also gives indication of a local separation bubble on the forward portion of the roof, just behind the top of the windshield. It is probable that vortical flow is shed from the surface of the vehicle in the vicinity of the roof A-pillar juncture to form a pair of wake vortices. Farther back, the slight downward slant of the surface streaklines along the sides of the vehicle indicates that vorticity of the same sign is also shed at the juncture of the side and read deck. The rear deck itself contains an interesting horseshoe shaped pattern (see rear view). The present, tentative interpretation is that the horseshoe represents a line of reattachment for a recirculating flow moving back towards the rear deck. Although the picture is far from complete, surface streakline patterns do suggest that the wake flow contains at least two sets of streamwise vortices, as sketched in figure 26. The distribution of vorticity within the wake will have important bearing on the possible interactions with trailing vehicles.

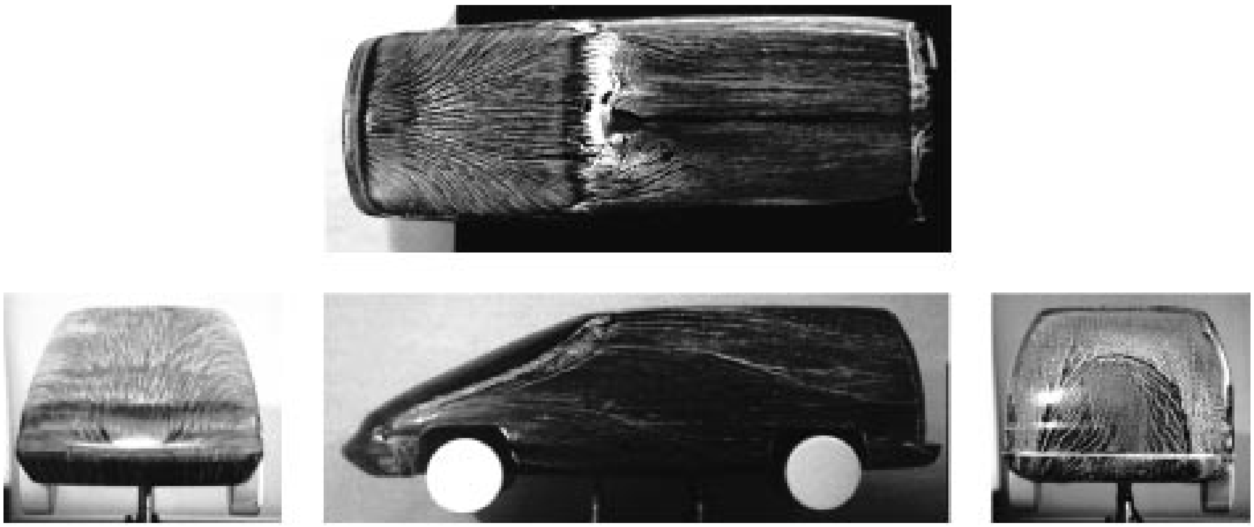


Figure 25: Front, back, top and side views of surface flow streaks on a single vehicle model

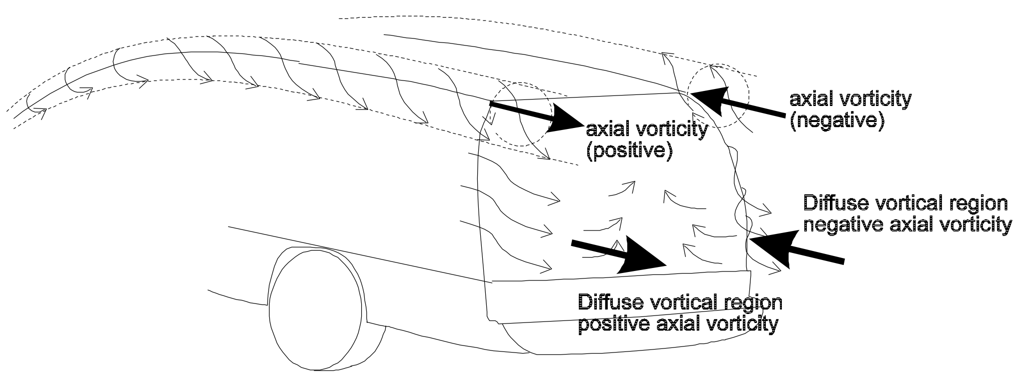


Figure 26: Sketch of possible wake vortex structure deduced from surface streakline visualization

The lead vehicle in a 2-vehicle platoon at 1/4-spacing on the porous ground plane is shown in figure 27. The noticeable difference in the flowfield is in the separation at the rear. The rear view now lacks the distinctive horseshoe shaped marking characterizing separation from the single vehicle. The trail vehicle of the (2-vehicle) platoon is shown in figure 28. The rear view contains a horseshoe marking characteristic of the vehicle in isolation. The comparison between side and top views in figures 25 and 28 respectively evidence dramatically different flow structure. The vortex streaks along the forward edge of the body and A-pillar, and the separation on the forward part of the roof are completely absent from the trail vehicle. The flow thus seems to progress more smoothly about the body of the second vehicle at this close spacing.

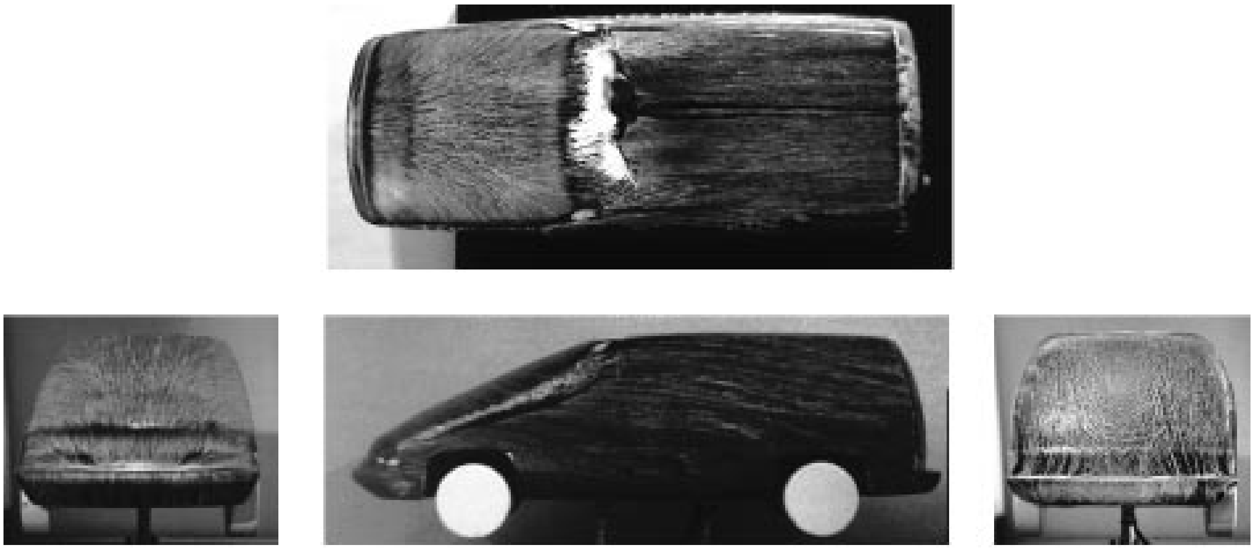


Figure 27: Surface flow streaks on lead vehicle in a 2-vehicle platoon at 1/4-spacing

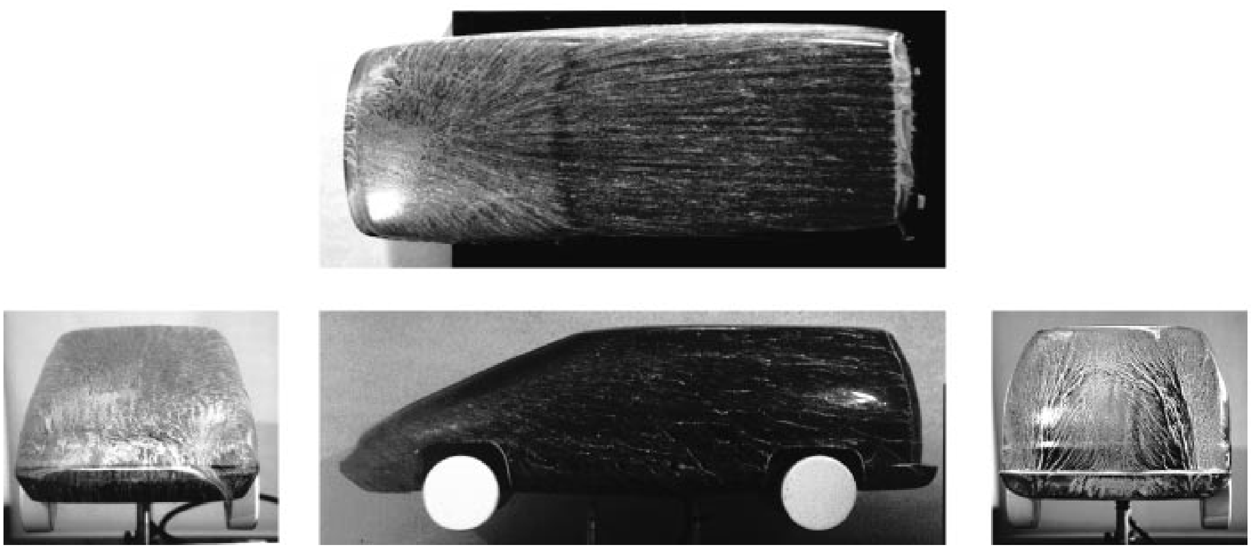


Figure 28: Surface flow streaks on trail vehicle in a 2-vehicle platoon at 1/4-spacing

These results suggest major structural changes within the flowfields of interacting vehicles. Such structure is not particularly easy to interpret solely on the basis of surface streakline patterns. One must keep in mind that the surface streaklines represent a time-averaged view of the flow. The instantaneous flow may or may not resemble the time-averaged flow. For example, the horseshoe shaped separation/reattachment pattern does not fit any of the generic categories of three-dimensional separation studied previously (see e.g. Hornung and Perry (1984), Perry and Hornung (1984), Perry and Chong (1987)). We suspect the horseshoe may be evidence for a highly unsteady separation which is free to move (wander about) over the rear deck. More information will be required to understand this complex flowfield.

B. Surface Pressure Distributions

Covers for the center slot of the ground plane are modified to incorporate a series of pressure taps that lay along the centerline of the ground plane underneath the models. The static pressure on the floor is measured for the single vehicle case and 2-vehicle platoon cases for a limited number of separations and geometries. Measurements generally start at approximately 0.5 lengths forward of the first model and end 0.5–2 lengths downstream from the last member of the platoon. The pressure taps are spaced 0.5 cm apart but only every other tap is used for the measurements shown here. These pressure distributions allow inferences to be drawn about the underbody flowfield and the flow within the near wake.

Figure shows the pressure distribution on the ground plane when a single model is present. The two surface conditions used in the tests are shown along with data provided by General Motors based on full scale tests. The coefficient of pressure, C_p is defined as $\left(p_{local} - p_{ref}\right) \Big/ \left(\tfrac{1}{2}\rho U_\infty^2\right)$, where p_{local} is the static pressure at the individual pressure taps and p_{ref} is a reference pressure measured at the static rail on the wind tunnel ceiling. The denominator is the dynamic pressure in the tunnel. Notice that the ordinate is inverted, with negative values increasing in the upward direction. The abscissa is normalized in terms of vehicle length and has been offset so that zero is at the center of the vehicle. No pressure is measured in the gap between the model supports at about ±0.15 scaled lengths from the model centerline.

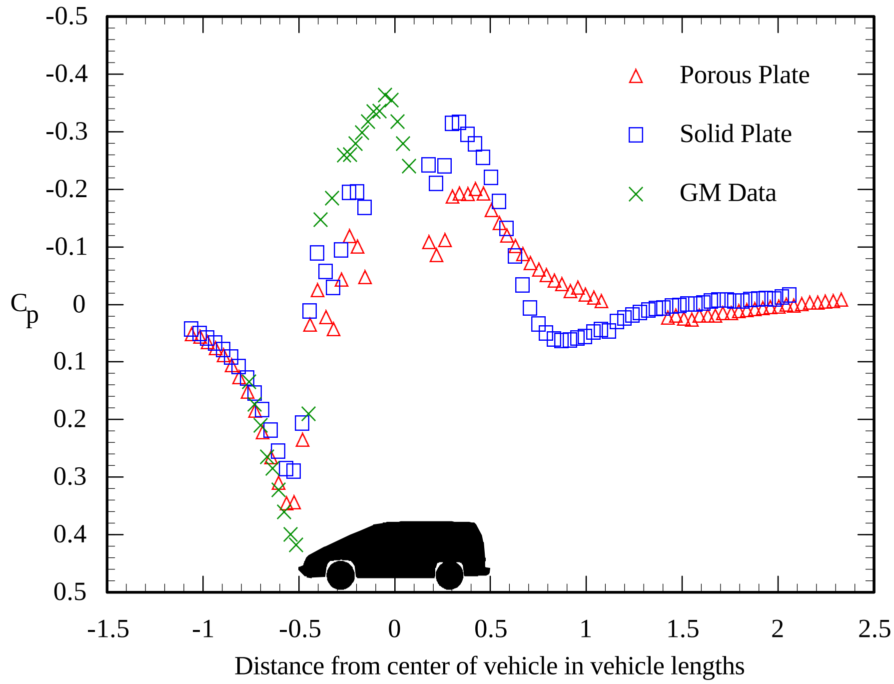


Figure 29: Ground plane surface pressure distribution in the presence of a single model

The behavior of C_p forward and just aft of the front bumper of the vehicle is consistent in all three cases. They all show a sharp increase in Cp indicating a deceleration of the flow as the vehicle is approached. Shortly beyond the front bumper, the flow accelerates rapidly as indicated by negative values of Cp. The data from the model tests seem to indicate two negative pressure peaks underneath the vehicle close to the position of the wheels (and axles). The increased speed can be understood by noting that the presence of the wheels decreases the cross-sectional area available to the underbody flow, thus flow speed must increase locally. The General Motors data does not extend much beyond the vehicle centerline, and cannot verify the presence of the second peak.

The difference between the flows over the porous and solid ground planes can be seen particularly well in this data. Generally speaking, the effect of the porous ground plane is to smooth out the pressure highs and lows. That is, the low pressures are not as low and the high pressures are not as high over the porous surface (compared to the solid surface). The smoothing is undoubtedly accomplished by small flows into, or out of the surface. Smoothing is most noticeable as the flow exits the undercarriage (see figure 29). Over the solid ground plane, pressure coefficient increases rapidly from a negative peak (near the axle) to small positive values at a distance of 0.2–0.3 vehicle lengths from the rear bumper before relaxing to the value of the undisturbed stream at about one vehicle length downstream. Over the porous surface, the pressure coefficient relaxes more gradually to the freestream value in about the same distance, but the positive values are missing. We plan future comparisons with road test data to evaluate the significance of these differences (see section IX).

Floor pressure measurements have been made for 2-vehicle platoons at spacings of 1, 0.5, 0.25 and 0 vehicle lengths. These are depicted in figure 30 through figure 33, respectively. For comparison, the pressure distribution under a single vehicle is also shown. As spacing decreases between vehicles, several interesting features can be observed in the floor pressure data.

i) The ground plane pressure distribution on the forward vehicle is altered by the downstream vehicle. As the rear vehicle moves forward, the point of alteration also moves forward. However, the alteration never extends further forward than the midpoint of the undercarriage. This finding suggests that changes in the flowfield (and changes in drag) are confined to the rear portions of the forward vehicle. It is consistent with the surface flow studies indicating little or no difference in the flow structure over the forward portion of the lead vehicle, figure 27 (and appendix).

ii) The wake pressure recovery at the ground plane below and beyond the trailing vehicle is similar to the pressure recovery for a single vehicle. This is most clearly demonstrated by taking the recovery line for the single vehicle (in figure 33), and translating it downstream exactly one vehicle length. Such similarity is also consistent with surface streamline visualization, Figure 28 for example, which shows flow structure similar to the undisturbed vehicle over the rear deck of the trail vehicle.

iii) Finally, the ground plane pressure measurements suggest that there is an increased pressure in the gap between vehicles above the pressure that would be experienced in the wake of a single vehicle. For example, take the ground plane pressure at the center of the gap (between vehicles) as a rough indication of the pressure level within the gap. Compare the pressure at x = 0.675 in figure 32 with the single vehicle value also displayed. Higher pressure in the gap between vehicles will lead to a decreased drag on the forward vehicle, and will lessen the drag savings on the rear vehicle. This, of course, is in accord with the actual drag measurements (see figure 9).

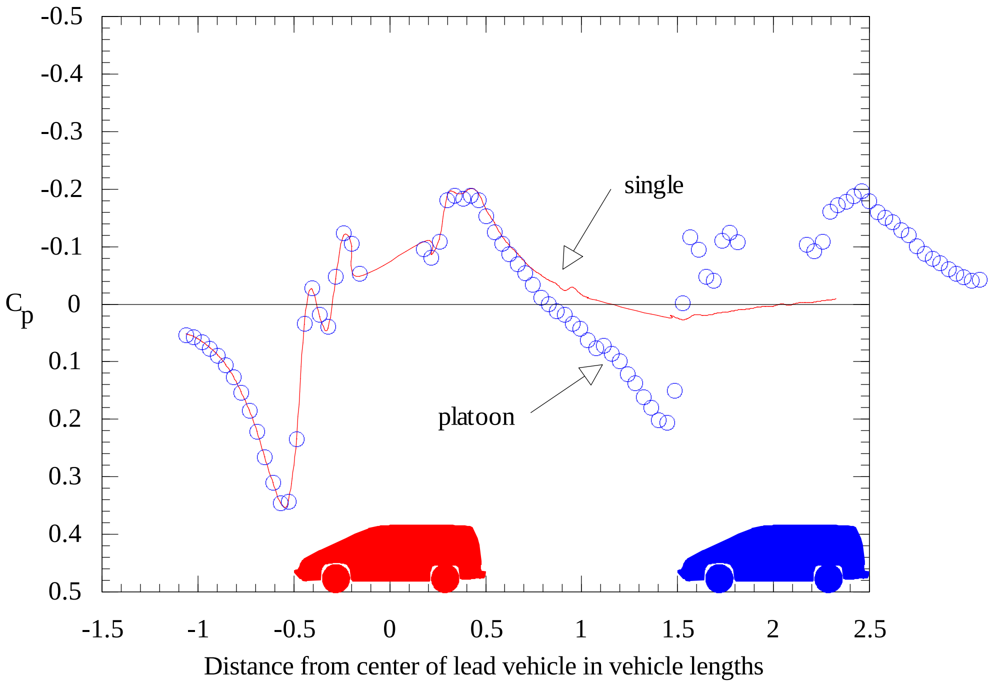


Figure 30: Floor pressure distribution for platoon at spacing 1 on porous plate

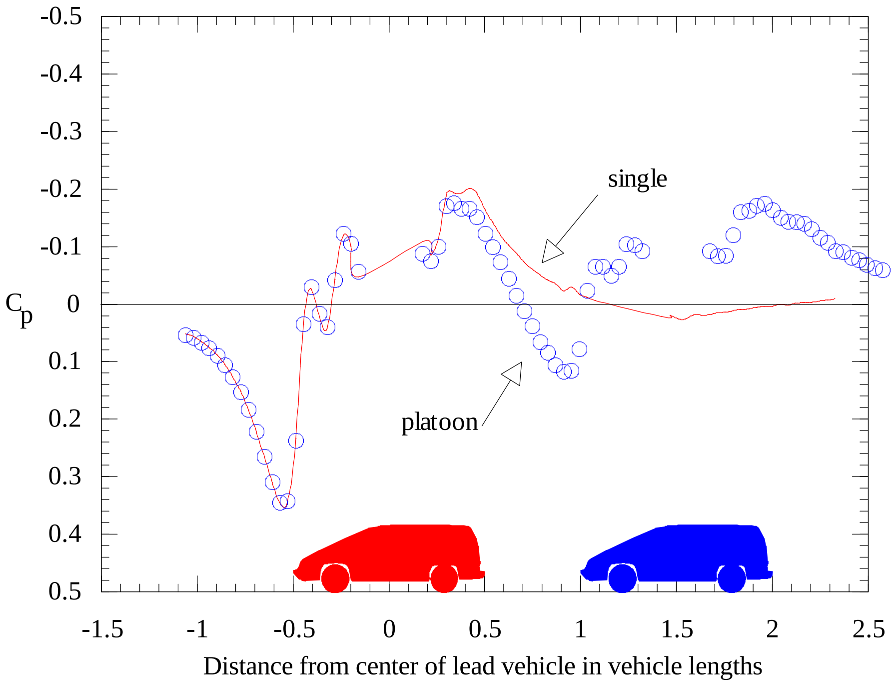


Figure 31: Floor pressure distribution for platoon at 1/2-spacing on porous plate

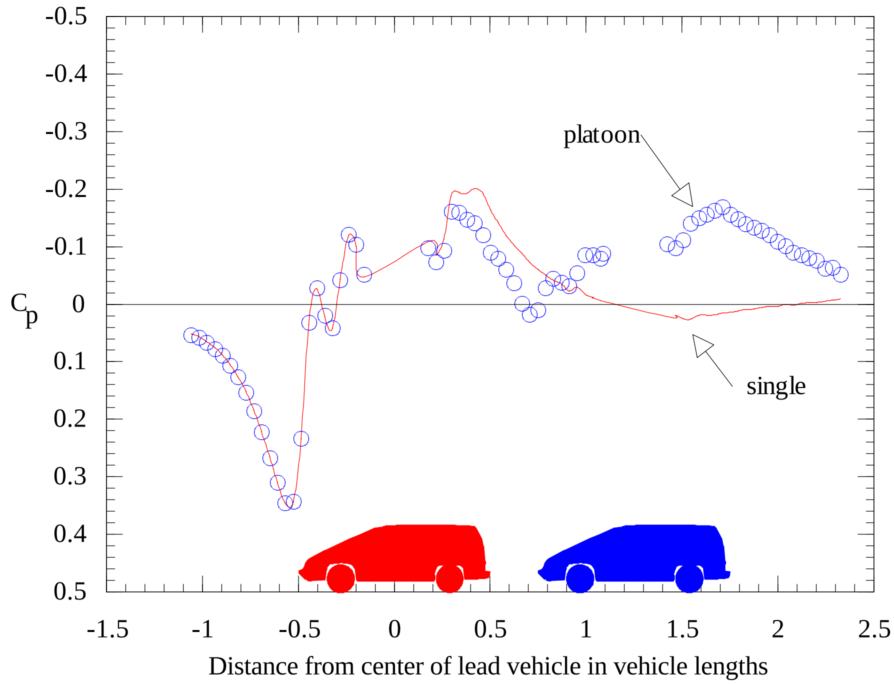


Figure 32: Floor pressure distribution for platoon at 1/4-spacing on porous plate

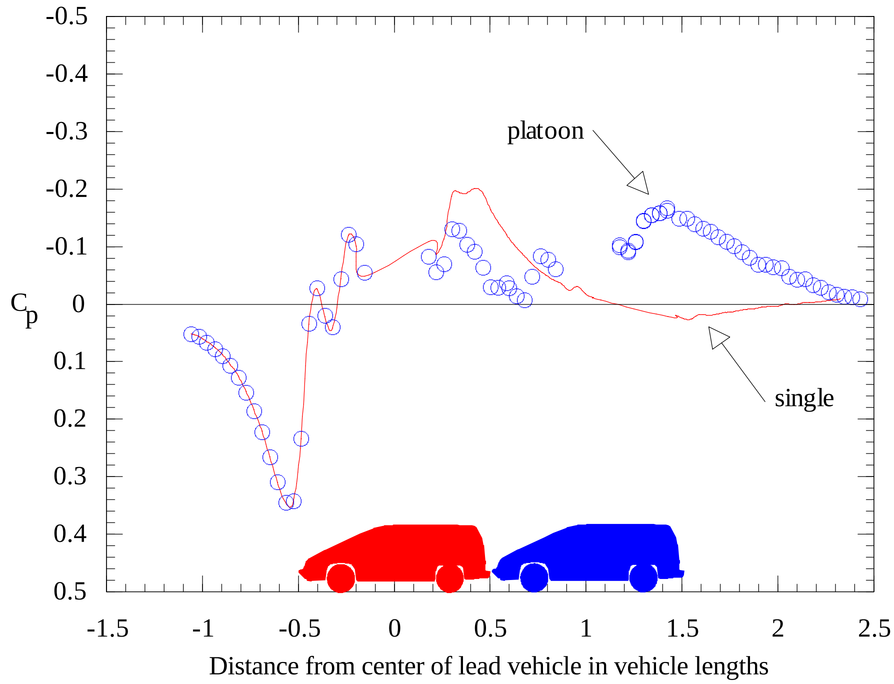


Figure 33: Floor pressure distribution for platoon at zero-spacing on porous plate

VIII. FORCES ON MISALIGNED PLATOONS

In previous chapters, the emphasis has been placed upon an accurate determination of the drag force as it depends upon vehicle spacing. Of course, vehicles perfectly aligned along the axis of the platoon experience no other in-plane force or moment. But vehicles must enter and leave the platoon. In addition, vehicles also have the freedom to move both laterally and longitudinally about their respective equilibrium positions in a space set by the control system parameters. An entering or departing vehicle, or a vehicle displaced from perfect alignment, will experience side force and yawing moment as will the neighboring vehicles. It is important to ask how the magnitudes of these applied forces—and their rates of change—vary with the degree of misalignment. (In aircraft stability analyses, these rates of change are often referred to as *stability derivatives*.) The sensitivity of drag savings to the degree of misalignment is also an important practical consideration. If it were determined that drag savings could evaporate as a consequence of small platoon misalignments, the concept of platooning would be much less appealing—at least as a means for fuel saving and pollution abatement. Happily this is not the case. Drag savings do decrease with platoon misalignment, but there is a range of misalignments about the symmetry plane where the changes are relatively weak.

A. The Role of Quasi-Steady Misalignments

In the present study, misalignment is defined as the lateral offset between the centerplane of the platoon and the centerplane of the misaligned vehicle. Misalignment is produced by repositioning the vehicle support posts, which normally lie along the model centerplane (see for example figure 25), to (one of) several distances outboard from the centerplane. Models are placed in the wind tunnel in this misaligned position, and drags, side forces and yawing moments recorded. This measurement represents the *quasi-steady force limit*, in that sufficient time has been given for the flow field to sense and respond to the altered model arrangement. The time required for flow adjustment is a flow transit time—typically the time for the fluid itself to traverse the flow field. In the platoon case, this time might be the time to travel a distance of several vehicle lengths. For vehicles traveling at 97 km/hr (60 MPH), the flow time is of the order of 300-400 milliseconds. Vehicle movements taking place on time scales shorter than the flow timescale are inherently *unsteady,* and must be modeled by unsteady movements. Vehicle movements taking place on time scales comparable to or greater than the flow time can be approximated as *quasi-steady*. The quasi-steady limit is always an important base to establish, and from which to judge unsteady flow forces.

Drag, side force, and yawing moment are measured following the same sign conventions described in section IIB. The yawing moment is measured about the center of the force balance. This point lies in the vehicle centerplane at a distance of 0.535±.003 vehicle lengths behind the front bumper. Forces are non-dimensionalized in the usual manner, except that the yawing moment requires an extra length. This scale is taken to be the square root of the model frontal area, so the following equation is obtained for moment coefficient.

$$C_Y = \frac{\text{YAWING MOMENT}}{\frac{1}{2}\rho V^2 A^{3/2}}$$

When presenting results, it is desired to have the side forces and yawing moments expressed as a percentage of model drag (in isolation in the wind tunnel). This is accomplished simply by dividing the side force and yawing moment coefficients by the single vehicle drag coefficient.

B. Special Procedures

It is possible to misalign one vehicle in the platoon by 0.032, 0.067, 0.099 and 0.135 meters from the centerplane, corresponding to 0.135, 0.287, 0.423 and 0.575 vehicle widths respectively. These odd distances are a limitation imposed by the necessity of finding satisfactory positions for new holes in the bottom of the force balance. After altering the mounting post positions, the models are calibrated, making sure that the drag force is applied along the centerline of the models. The resulting calibrations for all misalignments show good repeatability—comparable to the previous cases discussed in Zabat et al. (1994).

The bulk of the measurements—those presented in the appendix in tabular form—have been recorded for the three-vehicle platoon. The three-vehicle platoon, consisting of a lead, a trail, and one interior vehicle, is the shortest platoon to contain all the essential platoon elements. Even with only three vehicles, the number of possible misalignment arrangements is large. We have chosen what we think to be the most representative case—the interior vehicle is misaligned while the lead and trail vehicles remain aligned. Drag, side force and yawing moment are measured on each of the three vehicles as the central (interior) vehicle is progressively misaligned. The process is repeated for all eight values of vehicle spacing lying within the range 0-1.0. Values of vehicle spacing are always the same between the lead and interior vehicle and between the interior and trail vehicle.

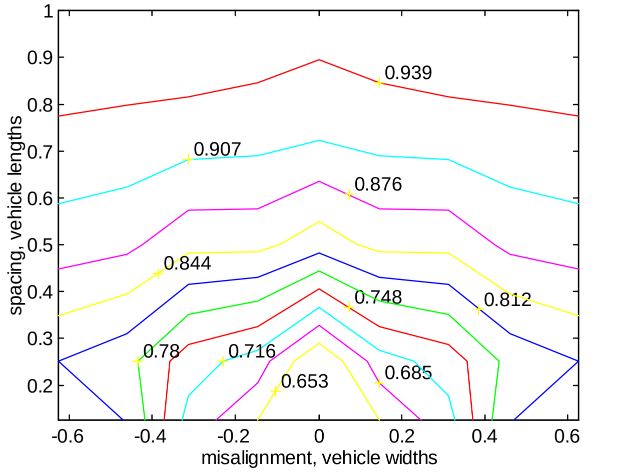
The results are presented in the form of contour maps in the two-dimensional space represented by vehicle spacing and misalignment. Contours are either drag coefficient ratio, side force coefficient ratio, or yawing moment coefficient ratio. The maps are generated from the discrete data by means of linear interpolation in two dimensions. The present results should be viewed as preliminary—particularly for side force and yawing moment, because the values observed are small and difficult to measure. Typical side force and yawing moment values are of the order of 0.05–0.10 of the single vehicle drag value, which is a small fraction of the design range of the instrument. A typical measurement error of 0.005x(Full Scale) becomes an error twenty times larger when judged against an amplitude of 0.05x(Full Scale). In addition, the number of measurement points—typically forty per plot—are insufficient to provide smooth contouring. We have since determined a better way to make the measurements, which involves modification of the vehicle supports to allow positioning of the models under computer control. The expanded results will be more complete and more accurate, and will be accomplished as a part of the unsteady force measurement program discussed in section IX.

C. Drag Contour Maps

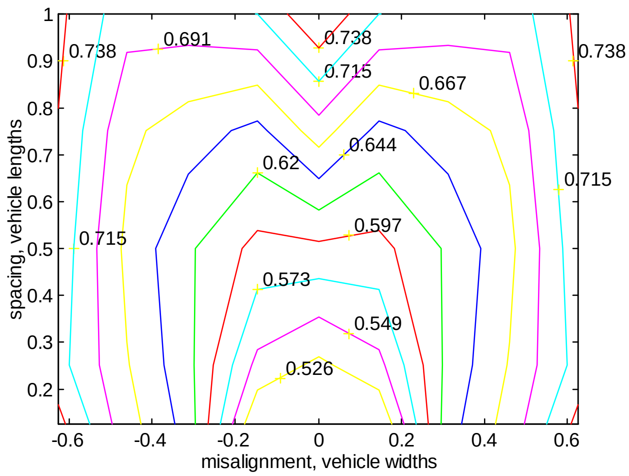
Drag contours for each of the three vehicles in the platoon are presented separately in figure 34 (a), (b) and (c). Several tentative conclusions can be drawn.

i) For any spacing and for all three vehicles, the lowest value of drag occurs at zero misalignment. This is to be expected. The single exception might be in the region 0.75-1.0 spacing, where the interior vehicle shows a slight off-axis minimum at a misalignment of about 0.15 vehicle widths. We are not presently convinced this is a real effect. More importantly, since the drag coefficient ratio must be an even function of misalignment, there will always be a region of modest drag variation near the centerplane. Our measurements suggest that for values of misalignment less that about ±0.1 vehicle widths, the drag coefficients variation is small.

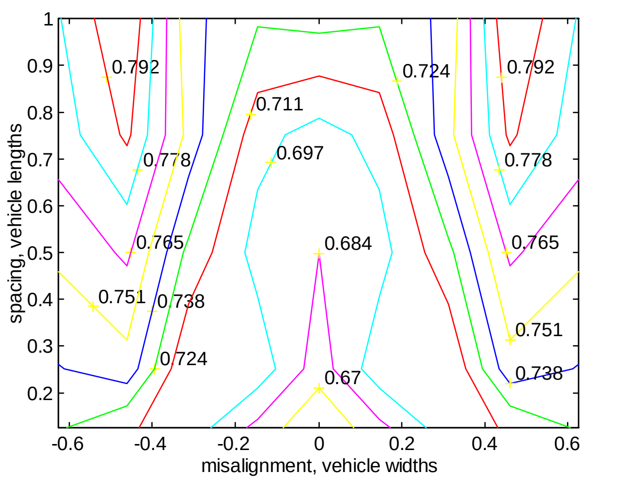
ii) Over most of the range of spacings, the drag ratio for the lead vehicle is more sensitive to changes in spacing than to changes in misalignment. This is reflected in contours which appear mostly horizontal. The drag ratio for the interior vehicle is much more sensitive to misalignment; this sensitivity is reflected in contours which are mostly vertical. The drag ratio for the trail vehicle falls between these behaviors, and displays the least variation with either spacing or misalignment.



(a)



(b)



(c)

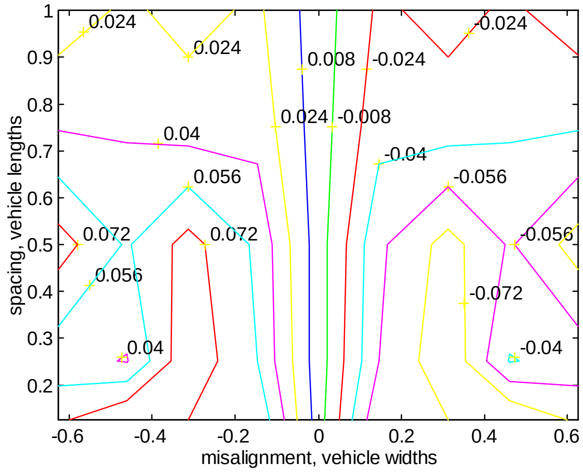
Figure 34: Drag coefficient ratio contours for (a)lead, (b)middle and (c)trail vehicles with middle vehicle misaligned

D. Side Force and Yawing Moment Contour Maps

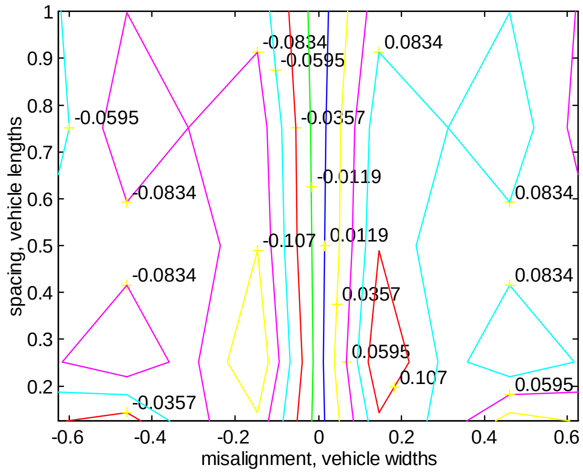
Lastly, figure 35 (a), (b) and (c) and figure 36 (a), (b) and (c) present side force coefficient ratios and yawing moment coefficient ratios, respectively. Figure 37 contains a sketch illustrating the observed directions of side force and yawing moment experienced as a result of positive misalignment.

i) The greatest magnitude of side force is experienced by the *interior* vehicle, figure 35(b). While side force coefficient ratio changes rapidly with increasing misalignment (as the nearly vertical contours indicate), the peak values achieved at ±0.15 vehicle widths are modest—of the order of 0.11 drag units. This force is *destabilizing* in the sense that it lies in the direction of increased misalignment.

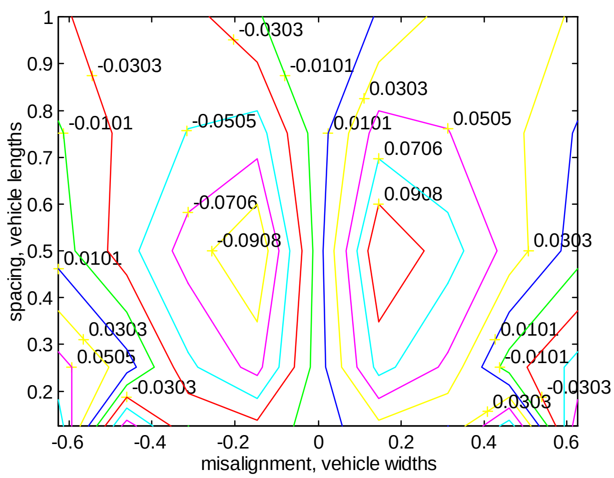
ii) The greatest yawing moment is experienced by the *trailing* vehicle, figure 36(c). Yawing moment coefficient ratio is sensitive to misalignment at all spacings, and continues to increase with increasing misalignment to the edge of the map. The largest value contained in the domain is approximately ±0.15 drag units. Yawing moment on the trail vehicle is destabilizing in the sense that the nose of the vehicle is turned so as to increase the centerplane distance between the trail and the misaligned vehicle.



(a)

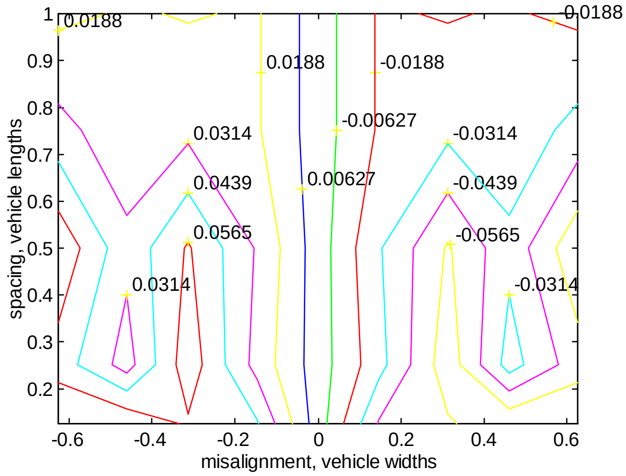


(b)

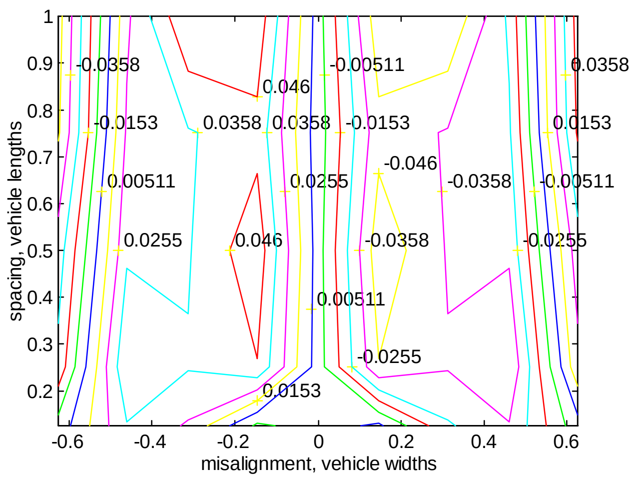


(c)

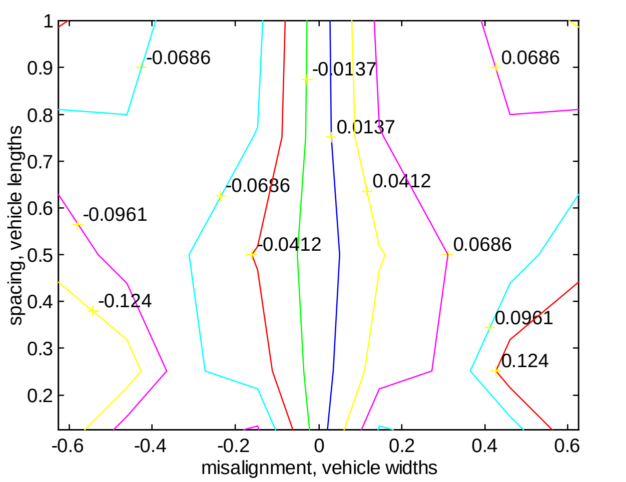
Figure 35: Side force coefficient ratio contours for (a)lead, (b)middle and (c)trail vehicles with middle vehicle misaligned



(a)



(b)



(c)

Figure 36: Yawing moment coefficient ratio contours for (a)lead, (b)middle and (c)trail vehicles with middle vehicle misaligned

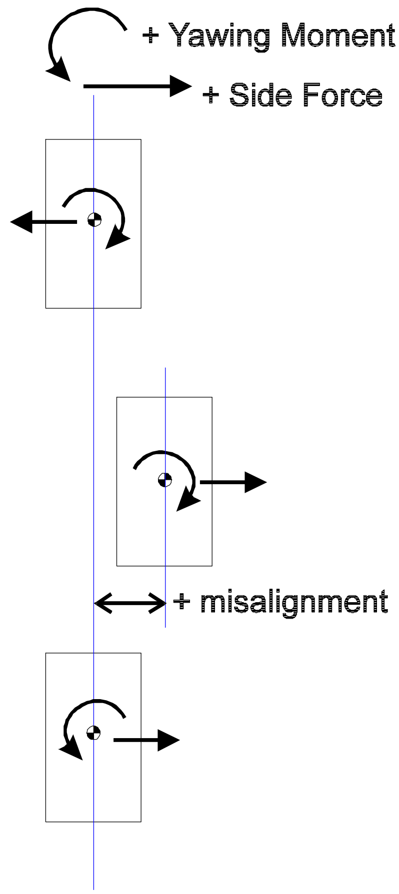


Figure 37: Sketch of directions of side force and yawing moment on platoon members as a result of positive misalignment

IX. ADDITIONAL RESEARCH GOALS

This report and the earlier PATH report summarize a three-year project on experimental measurements of the aerodynamics of platoons. Three papers emphasizing the most important findings to date have been presented at conferences, and should be considered part of the written record. They are Zabat et al. (1994b), (1995) and (1995b). Additional results will be added to the present findings over the coming several years to provide a more complete picture of platoon operation. The following items have either been proposed for study or are actually underway.

i) Definition of intervehicle flowfields. Measurements presented here document forces and yawing moments, but do not provide explanations for how these forces and moments are achieved. A more detailed understanding is required to extrapolate the present results with confidence to other, related situations. Knowledge of inter-vehicle flowfields is also important to insure adequate engine and passenger compartment airflows. Several means for determining the detailed inter-vehicle flowfield include: additional investigations of surface streamline flow patterns; flowfield visualizations utilizing "fog juice"; and the mapping of local flow velocity and flow direction in regions between vehicles using 7-hole cone probes and hot wires.

ii) Characterization of unsteady forces. The steady forces we have discussed represent the mean or averaged values. There are additional unsteady force components which can be significant at high speeds—particularly for vehicles traveling in the near wake of another vehicle. For platoon operation, the unsteady force components are expected to be significant for control system design when vehicles are operating within the strongly interacting regime (spacing less than one vehicle length). We have also identified certain, unusual spacings for which gap width and turbulent structure in the separating flow "resonate" to produce dramatic variations in drag coefficient over very short distances (see page 27). For control system purposes, it will be particularly important to document the aerodynamic loads associated with such resonances. As an additional part of this study, the forces and moments arising from platoon misalignment will be repeated with better spatial resolution. These results will extend the preliminary results described in section VIII.

iii) Measurements of aerodynamic forces in a crosswind. The presence of a crosswind is another important platoon misalignment. The present wind tunnel set-up has provision for a ten degree yaw of the platoon direction with respect to the axis of the wind tunnel. At 100 km/hr (60 MPH), ten degrees of yaw simulates the effect of an 18 km/hr (11 MPH) sidewind.

iv) Full-scale platoon measurements of drag and cooling flow. The wind tunnel tests described here are being conducted at Reynolds numbers about an order of magnitude lower than those experienced under full-scale conditions. Other differences between model and full-scale include: the lack of model underbody and trim detail, the lack of rotating wheels, and the unwanted wind tunnel ground plane boundary layer. In spite of the high quality of the measurements taken in the wind tunnel, these differences will always reflect uncertainty in translating model results to full-scale operating conditions. To make a stronger connection between model and prototype, we propose a limited series of drag measurements for 2, 3 and 4 vehicle platoons operating at full-scale on a roadway (a test track). Additional valuable information on cooling flow rate and engine compartment temperature can be collected during platoon operation. This will provide actual data for corroboration of the wind tunnel intervehicle flow field studies. Ground plane pressure distributions will also be recorded by driving the platoon over a fixed pressure sensor located on the roadway (test track). These ground plane pressure distributions provide information about the underbody flow field, and can readily be compared to the pressure distributions measured in the wind tunnel.

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2, 3 & 4-Car Platoon Series (Set 1)

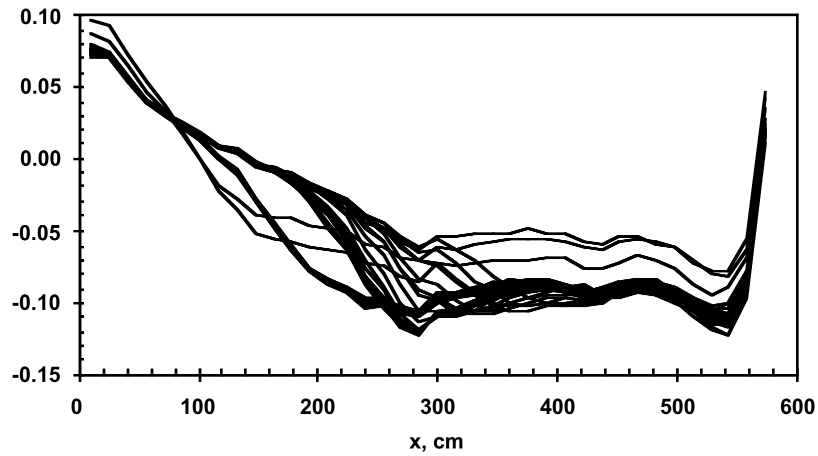
Nick's Data. Each data set contains its own single car reference values. There are two subsets of data, a & b.

2-Car Platoon Subset A

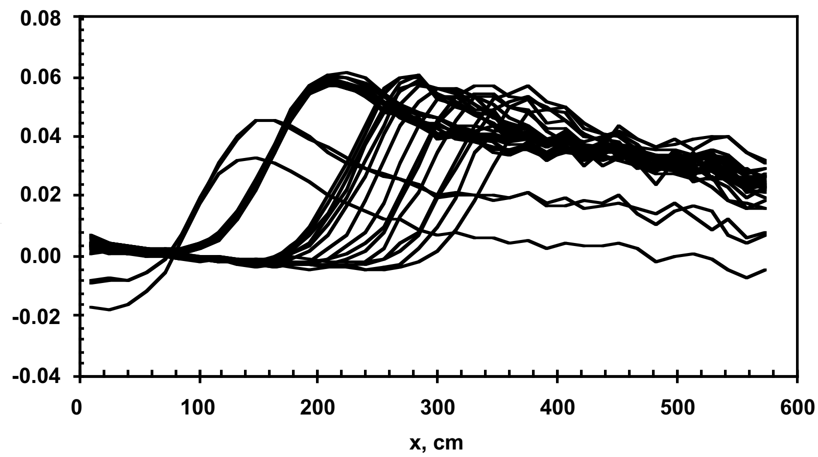
Single Car Data

Car1#	X1	D1	SF1	Y1	CDref1	Xlocal	Cplocal	CDlocal
green	114.30	5.097	0.276	-0.061	0.355	147.28	-0.0390	0.342
green	127.00	5.094	0.331	-0.057	0.357	147.28	-0.0517	0.339
green	127.00	5.099	0.347	-0.057	0.357	162.48	-0.0553	0.338
blue	181.61	5.116	-0.045	-0.015	0.357	223.28	-0.0921	0.327
blue	181.61	5.090	-0.027	-0.014	0.357	223.28	-0.0931	0.326
blue	181.61	5.137	-0.026	-0.009	0.357	208.08	-0.0849	0.329
blue	181.61	5.167	-0.037	-0.009	0.360	208.08	-0.0873	0.331
blue	181.61	5.167	-0.026	-0.012	0.362	208.08	-0.0869	0.333
blue	181.61	5.183	-0.089	-0.023	0.362	208.08	-0.0994	0.329
green	181.61	5.337	0.365	-0.069	0.374	223.28	-0.0894	0.343
green	181.61	5.328	0.396	-0.075	0.373	208.08	-0.0857	0.343
green	181.61	5.309	0.404	-0.073	0.372	208.08	-0.0851	0.343
green	181.61	5.319	0.411	-0.068	0.371	208.08	-0.0853	0.342
green	181.61	5.328	0.397	-0.073	0.372	208.08	-0.0842	0.343
green	181.61	5.345	0.387	-0.075	0.373	223.28	-0.0894	0.343
red	246.38	5.425	-0.222	0.020	0.378	284.08	-0.1212	0.337
yellow	247.36	5.273	-0.348	0.016	0.370	284.08	-0.1217	0.329
yellow	251.26	5.247	-0.371	0.009	0.368	284.08	-0.1225	0.327
yellow	255.16	5.213	-0.401	0.000	0.366	284.08	-0.1204	0.326
red	258.83	5.224	-0.150	0.000	0.365	344.88	-0.1078	0.329
yellow	259.00	5.243	-0.388	-0.004	0.366	284.08	-0.1193	0.327
yellow	263.95	5.221	-0.411	-0.015	0.365	284.08	-0.1187	0.326
green	274.48	5.068	2.632	-1.004	0.355	299.28	-0.1087	0.320
green	289.92	4.879	0.118	-0.011	0.342	314.48	-0.1068	0.309
green	305.44	5.222	0.160	0.117	0.364	329.68	-0.1057	0.329
red	312.74	5.183	-0.325	-0.013	0.364	329.68	-0.1051	0.330
red	336.40	5.081	-0.193	0.013	0.356	375.28	-0.1054	0.322
green	336.40	5.204	-0.139	0.059	0.363	375.28	-0.1014	0.329
red	343.70	5.132	-0.289	-0.007	0.359	375.28	-0.1009	0.326
red	361.95	5.147	-0.357	-0.025	0.360	405.68	-0.1016	0.327

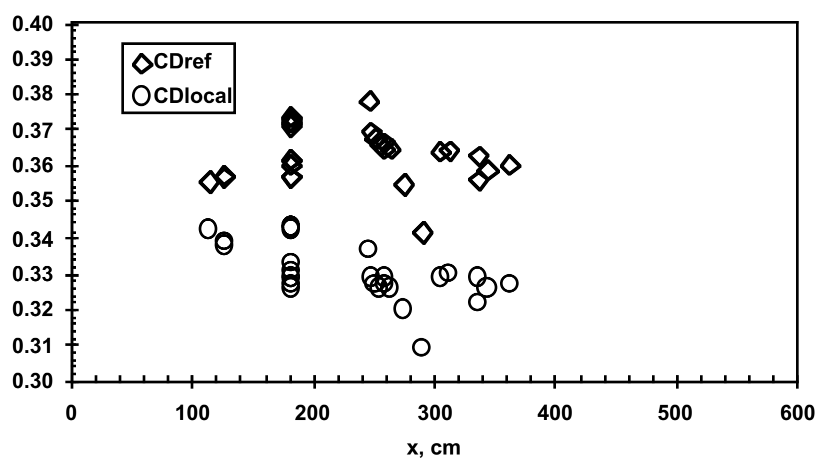
C_P distribution



ΔC_P distribution



C_D scatter



Note: Blockage correction $C_{Dlocal} = C_{Dref}/(1-C_P)$ does not improve data scatter.

	Uncorrected	Corrected
Average CD	0.363	0.331
St. Dev.	0.008	0.008

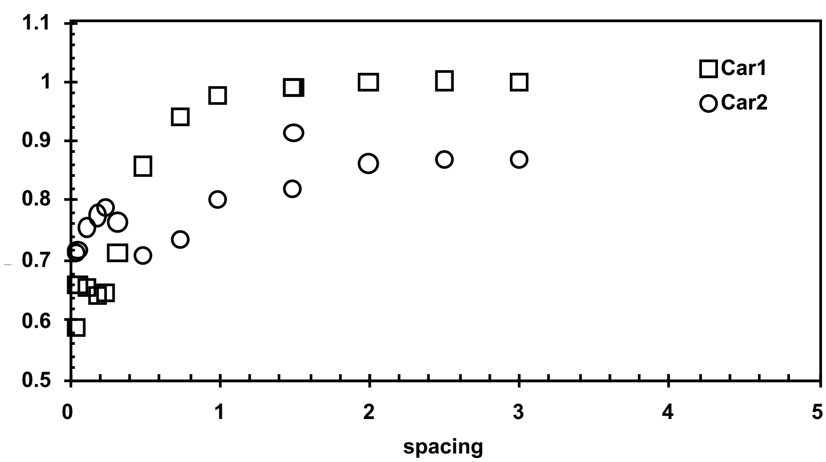
2-Car Platoon Data

Spacing	Car1	X1	D1	SF1	Y1	CDref1	CDref_inf1	CD/CDref1	Xlocal1	Cplocal1	CDloc1	CDloc_inf1	CD/CDloc1
0.046	green	181.61	3.120	1.066	0.558	0.219	0.373	0.586	208.08	-0.0943	0.200	0.343	0.582
0.062	green	181.61	3.504	-0.556	-0.207	0.245	0.373	0.657	208.08	-0.0949	0.224	0.343	0.653
0.125	green	181.61	3.488	-0.389	-0.173	0.244	0.373	0.655	208.08	-0.0934	0.223	0.343	0.651
0.188	green	181.61	3.410	0.209	-0.096	0.239	0.373	0.640	208.08	-0.0930	0.218	0.343	0.637
0.250	blue	181.61	4.943	-0.042	-0.016	0.344	0.358	0.961	208.08	-0.0857	0.317	0.329	0.964
0.250	green	181.61	3.432	0.392	-0.075	0.241	0.373	0.645	208.08	-0.0897	0.221	0.343	0.643
0.330	green	181.61	3.812	0.354	-0.073	0.266	0.373	0.714	208.08	-0.0894	0.244	0.343	0.713
0.500	blue	181.61	4.392	-0.107	-0.020	0.306	0.358	0.854	208.08	-0.0878	0.281	0.329	0.855
0.750	blue	181.61	4.811	-0.057	-0.018	0.336	0.358	0.937	208.08	-0.0857	0.309	0.329	0.939
1.000	blue	181.61	4.994	-0.038	-0.012	0.348	0.358	0.973	208.08	-0.0844	0.321	0.329	0.976
1.499	blue	181.61	5.045	-0.036	-0.015	0.354	0.358	0.989	208.08	-0.0853	0.326	0.329	0.992
1.501	blue	181.61	5.098	-0.047	-0.017	0.354	0.358	0.989	208.08	-0.0837	0.327	0.329	0.993
2.001	green	127.00	5.079	0.323	-0.057	0.356	0.357	0.997	162.48	-0.0530	0.338	0.338	1.000
2.501	green	127.00	5.082	0.348	-0.056	0.357	0.357	0.999	162.48	-0.0538	0.338	0.338	1.001
3.001	green	114.30	5.068	0.272	-0.060	0.355	0.355	0.998	147.28	-0.0380	0.342	0.342	0.999

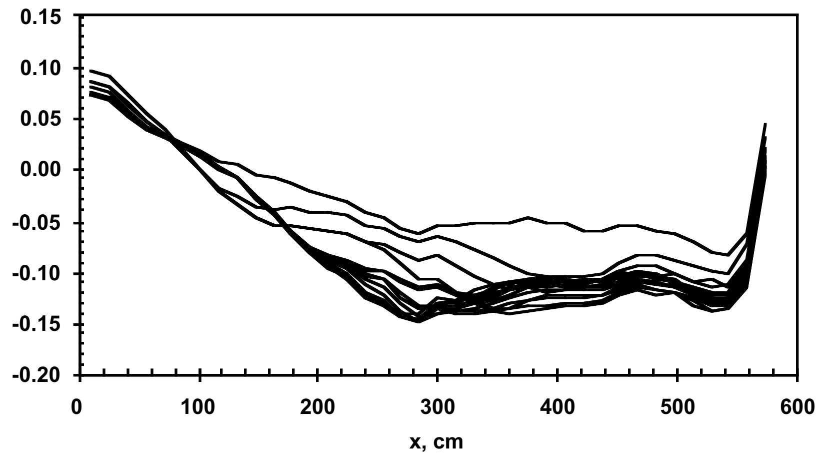
Spacing	Car2	X2	D2	SF2	Y2	CDref2	CDref_inf2	CD/CDref2	Xloc2	Cploc2	CDloc2	CDloc_inf2	CD/CDloc2
0.046	red	246.38	3.849	0.533	-0.055	0.270	0.378	0.714	268.91	-0.1414	0.236	0.337	0.701
0.062	yellow	247.36	3.783	0.285	-0.060	0.265	0.370	0.715	268.91	-0.1420	0.232	0.329	0.704
0.125	yellow	251.26	3.962	0.191	-0.040	0.278	0.368	0.754	268.91	-0.1435	0.243	0.327	0.742
0.188	yellow	255.16	4.042	-0.096	0.001	0.283	0.366	0.773	268.91	-0.1426	0.248	0.326	0.760
0.250	red	258.98	4.001	-0.134	-0.012	0.279	0.365	0.763	329.72	-0.1405	0.244	0.329	0.742
0.250	yellow	259.00	4.096	-0.189	0.012	0.287	0.366	0.784	268.91	-0.1432	0.251	0.327	0.768
0.330	yellow	263.95	3.985	-0.160	0.012	0.278	0.365	0.763	284.11	-0.1490	0.242	0.326	0.743
0.500	green	274.48	3.611	1.796	-0.740	0.251	0.355	0.708	299.31	-0.1404	0.220	0.32	0.689
0.750	green	289.92	3.612	0.008	-0.037	0.252	0.342	0.737	299.31	-0.1393	0.221	0.309	0.716
1.000	green	305.44	4.168	-0.065	0.108	0.291	0.364	0.799	329.72	-0.1374	0.256	0.329	0.777
1.499	red	336.30	4.150	-0.242	0.002	0.291	0.356	0.818	375.32	-0.1375	0.256	0.322	0.795
1.501	green	336.40	4.310	-0.236	0.035	0.299	0.329	0.910	375.32	-0.1334	0.264	0.329	0.803
2.001	red	312.74	4.463	-0.404	-0.013	0.313	0.364	0.859	344.92	-0.1207	0.279	0.33	0.846
2.501	red	343.70	4.430	-0.405	-0.002	0.311	0.359	0.866	390.53	-0.1194	0.278	0.326	0.852
3.001	red	361.95	4.458	-0.403	-0.009	0.312	0.360	0.867	390.53	-0.1032	0.283	0.327	0.865

* Note: Shaded items are not plotted below

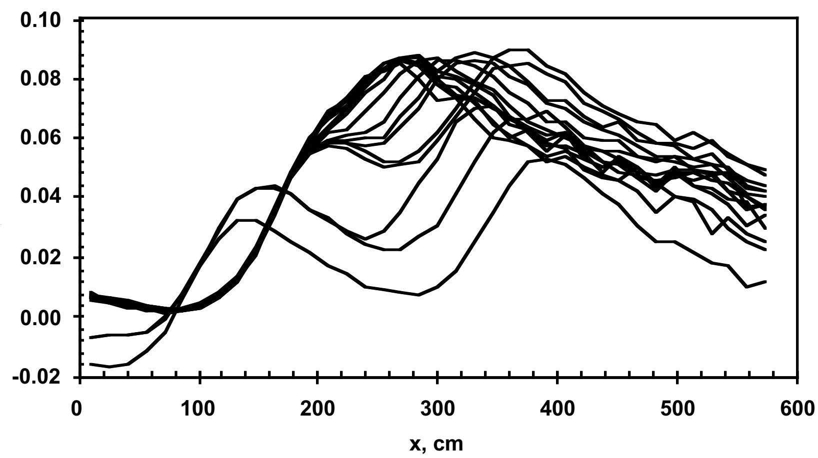
Uncorrected C_D ratios



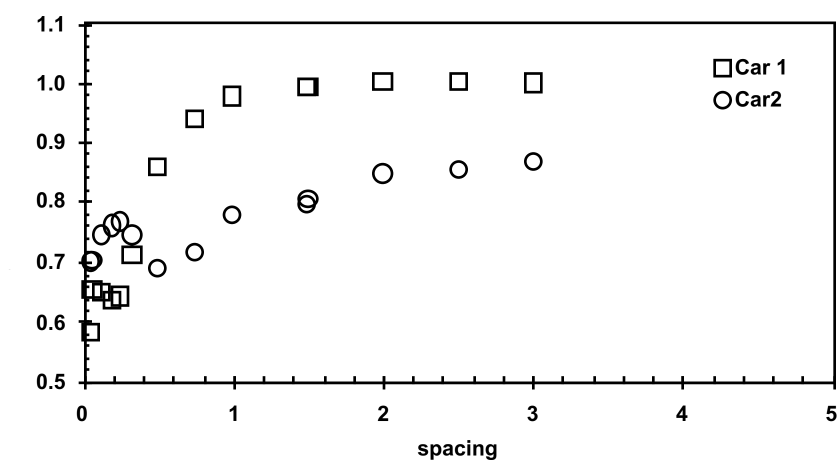
C_P distribution



ΔC_P distribution



Corrected C_D ratios



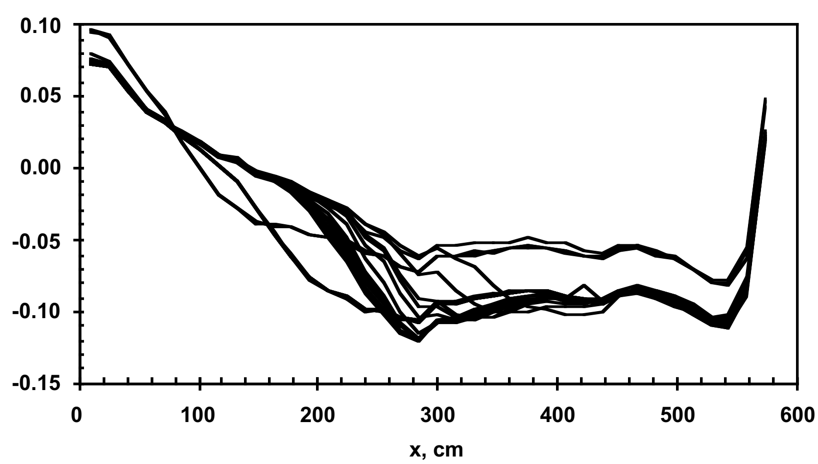
2-Car Platoon Subset B

Single Car Data

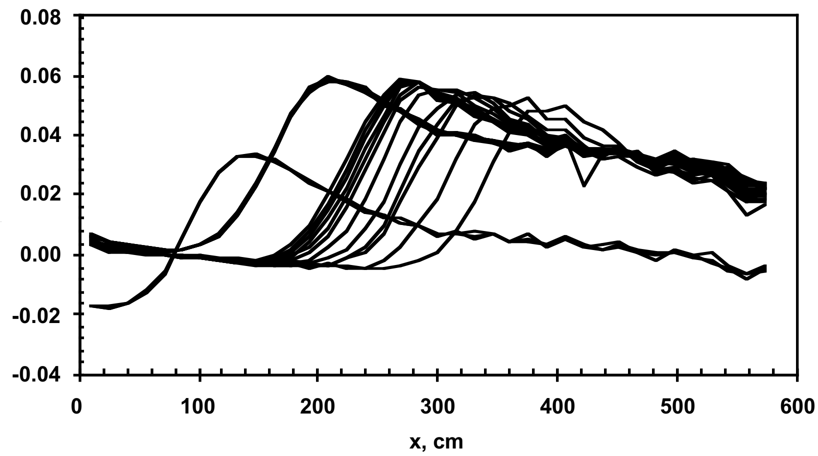
Car#	X 1	D1	SF1	Y1	CDref1	Xlocal	Cplocal	CDlocal
blue	114.30	5.082	0.283	-0.064	0.355	147.28	-0.0388	0.342
blue	114.30	5.075	0.293	-0.065	0.355	147.28	-0.0392	0.341
blue	114.30	5.069	0.268	-0.062	0.355	147.28	-0.0387	0.341
blue	181.61	5.340	0.384	-0.072	0.374	208.08	-0.0857	0.344
blue	181.61	5.328	0.406	-0.075	0.374	208.08	-0.0851	0.345
blue	181.61	4.839	2.717	0.995	0.340	208.08	-0.0846	0.313
blue	181.61	5.343	0.394	-0.073	0.374	208.08	-0.0853	0.344
blue	181.61	5.323	0.390	-0.075	0.373	208.08	-0.0846	0.344
blue	181.61	5.325	0.386	-0.072	0.373	208.08	-0.0848	0.344
blue	181.61	5.337	0.403	-0.074	0.373	208.08	-0.0843	0.344
blue	181.61	5.318	0.387	-0.073	0.373	208.08	-0.0845	0.343
blue	181.61	5.348	0.381	-0.073	0.373	208.08	-0.0850	0.344
blue	181.61	5.341	0.398	-0.075	0.375	208.08	-0.0850	0.345
green	246.38	5.286	-0.199	0.017	0.371	268.88	-0.1151	0.333
green	247.36	5.260	-0.196	0.023	0.369	268.88	-0.1145	0.331
green	251.26	5.270	-0.260	0.010	0.369	284.08	-0.1190	0.330
green	255.16	5.257	-0.253	0.004	0.367	284.08	-0.1194	0.328
green	259.00	5.234	-0.282	-0.005	0.368	284.08	-0.1193	0.329
green	263.95	5.242	-0.342	-0.020	0.366	284.08	-0.1180	0.328
green	274.48	5.211	-0.209	-0.031	0.365	314.48	-0.1080	0.330
green	289.96	5.116	-0.394	-0.027	0.358	329.68	-0.1059	0.323
green	300.04	5.202	-0.281	-0.003	0.364	344.88	-0.1032	0.330
green	305.44	5.204	-0.308	-0.011	0.365	329.68	-0.1046	0.330
green	331.00	5.167	-0.255	0.002	0.363	375.28	-0.1006	0.329
green	336.39	5.176	-0.193	-0.003	0.360	344.88	-0.1006	0.327
green	361.95	5.085	-0.368	-0.025	0.358	405.68	-0.1016	0.325

*Note: Shaded items are not plotted below.

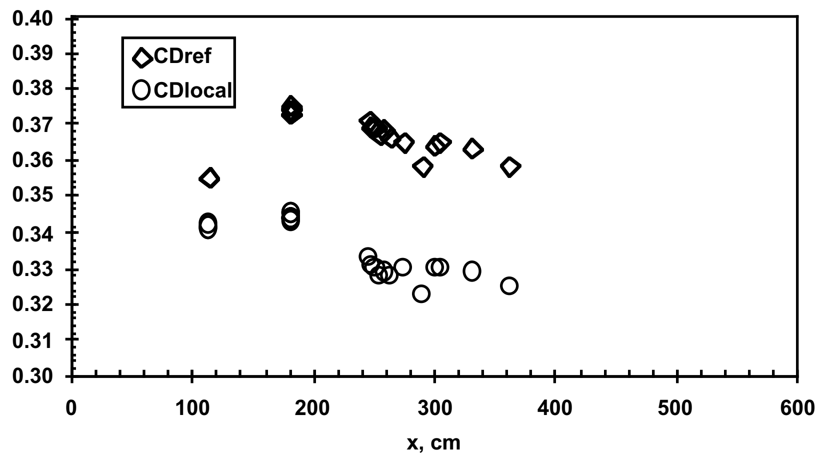
C_P distribution



ΔC_P distribution



C_D scatter



	Uncorrected	Corrected
Avg	0.366	0.335
StD	0.0084	0.0088

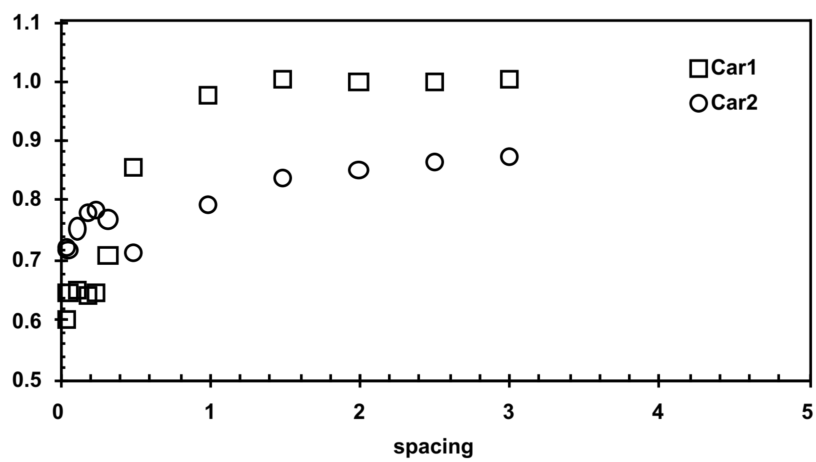
2-Car Platoon Data

Spacing	Car1	X 1	D1	SF1	Y1	CDref1	CD/CDref1	Xlocal1	Cplocal1	CDloc1	CDloc_inf1	CD/CDloc1
0.05	blue	181.61	3.174	1.084	0.017	0.223	0.601	208.08	-0.0937	0.203	0.344	0.591
0.06	blue	181.61	3.399	-0.448	-0.189	0.238	0.644	208.08	-0.0932	0.218	0.344	0.634
0.13	blue	181.61	3.422	-0.239	-0.161	0.240	0.650	208.08	-0.0934	0.220	0.344	0.639
0.19	blue	181.61	3.392	0.315	-0.086	0.237	0.642	208.08	-0.0907	0.218	0.344	0.633
0.25	blue	181.61	3.409	0.378	-0.076	0.239	0.645	208.08	-0.0911	0.219	0.344	0.636
0.33	blue	181.61	3.747	0.406	-0.075	0.262	0.709	208.08	-0.0889	0.241	0.344	0.701
0.50	blue	181.61	4.493	0.387	-0.076	0.316	0.853	208.08	-0.0863	0.291	0.344	0.845
0.75	blue	181.61	4.510	2.551	0.919	0.315	0.850	208.08	-0.0852	0.290	0.344	0.842
1.00	blue	181.61	5.149	0.413	-0.073	0.361	0.975	208.08	-0.0823	0.333	0.344	0.969
1.50	blue	181.61	5.292	0.363	-0.071	0.371	1.001	208.08	-0.0822	0.342	0.344	0.995
2.00	blue	114.30	5.039	0.261	-0.062	0.354	0.996	147.28	-0.0370	0.341	0.341	1.000
2.50	blue	114.30	5.059	0.284	-0.064	0.354	0.997	147.28	-0.0371	0.341	0.341	1.001
3.00	blue	114.30	5.102	0.275	-0.064	0.355	1.000	147.28	-0.0384	0.342	0.341	1.003

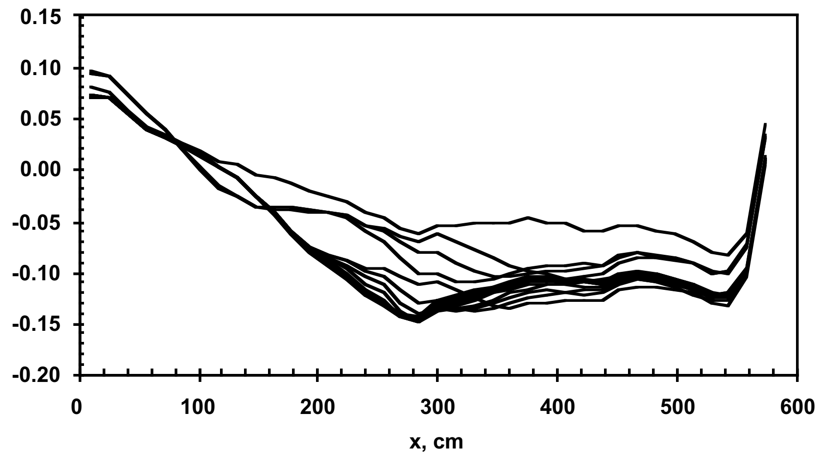
Spacing	Car2	X2	D2	SF2	Y2	CDref2	CD/CDref2	Xlocal2	Cplocal2	CDloc2	CDloc_inf2	CD/CDloc2
0.05	green	246.38	3.825	-0.661	0.081	0.268	0.722	268.88	-0.1401	0.235	0.333	0.706
0.06	green	247.36	3.786	0.280	-0.043	0.266	0.719	268.88	-0.1425	0.232	0.331	0.702
0.13	green	251.26	3.949	0.175	-0.020	0.277	0.751	268.88	-0.1425	0.243	0.330	0.736
0.19	green	255.16	4.072	-0.102	0.014	0.285	0.777	268.88	-0.1425	0.249	0.328	0.761
0.25	green	259.00	4.095	-0.146	0.017	0.287	0.779	284.08	-0.1488	0.250	0.329	0.759
0.33	green	263.95	4.010	-0.144	0.019	0.281	0.767	284.08	-0.1483	0.245	0.328	0.746
0.50	green	274.48	3.710	-0.097	0.012	0.261	0.714	284.08	-0.1476	0.227	0.330	0.688
0.75	green	289.96	3.859	-0.295	0.008	0.269	0.753	314.48	-0.1385	0.236	0.323	0.732
1.00	green	305.44	4.108	-0.317	0.002	0.288	0.789	329.68	-0.1371	0.253	0.330	0.767
1.50	green	336.39	4.297	-0.327	0.006	0.301	0.835	360.08	-0.1339	0.265	0.327	0.811
2.00	green	300.04	4.403	-0.366	-0.009	0.309	0.848	329.68	-0.1080	0.279	0.330	0.845
2.50	green	331.00	4.467	-0.374	0.004	0.313	0.862	360.08	-0.1048	0.283	0.329	0.860
3.00	green	361.95	4.470	-0.412	-0.006	0.311	0.869	405.68	-0.1049	0.282	0.325	0.866

* Note: Shaded items are not plotted below

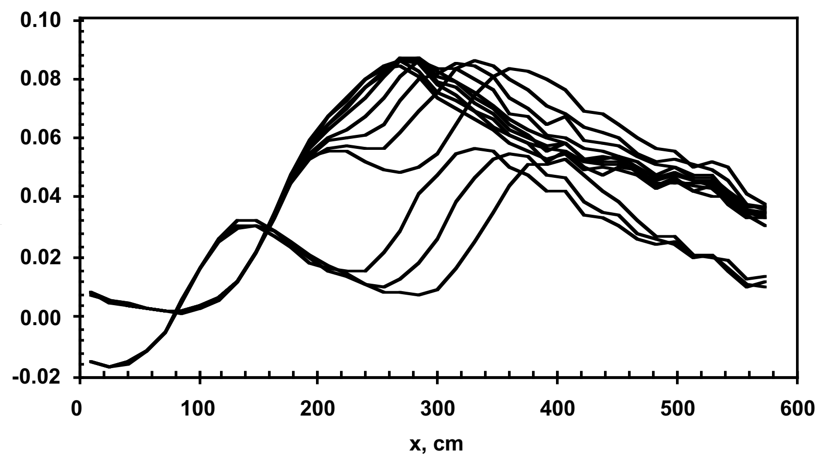
Uncorrected C_D ratios



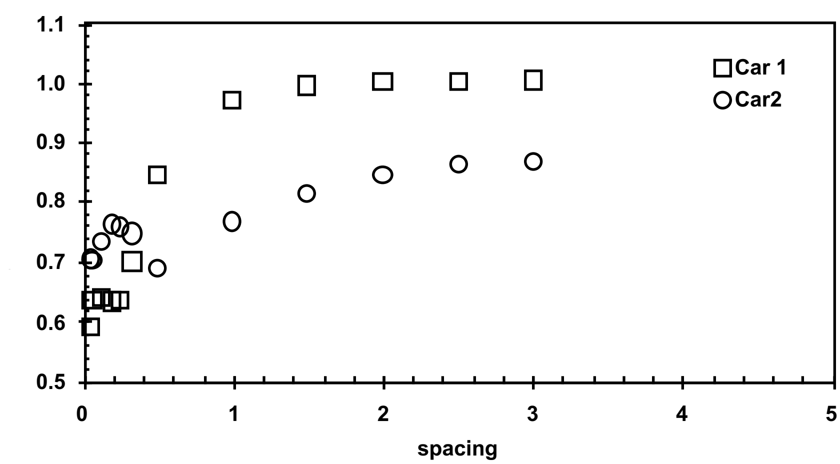
C_P distribution



ΔC_P distribution



Corrected C_D ratios

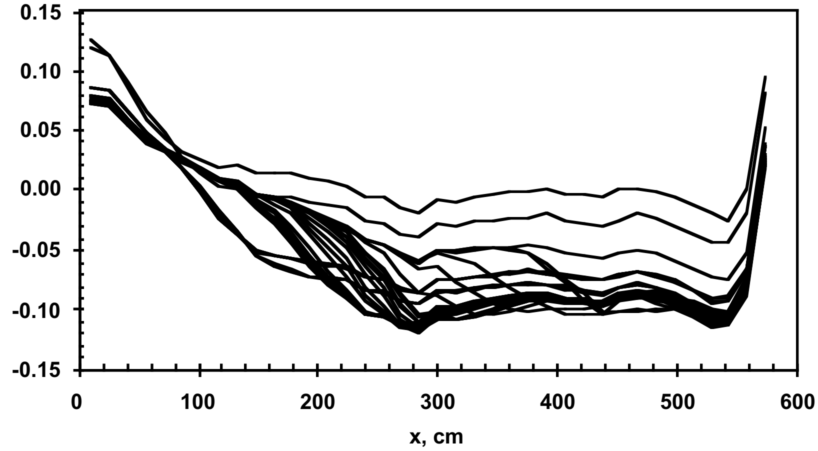


3-Car Platoon Subset A

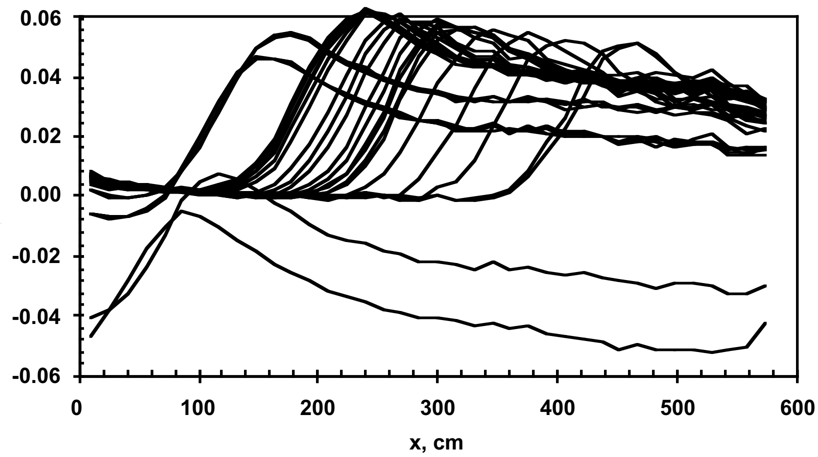
Single Car Data

Car#	X 1	D1	SF1	Y1	CDref1	Xlocal	Cplocal	CDlocal
blue	63.50	4.747	0.255	-0.068	0.332	86.48	0.0316	0.343
blue	88.90	5.272	0.320	-0.063	0.344	116.88	0.0021	0.344
blue	127.00	5.128	0.275	-0.062	0.358	162.48	-0.0545	0.340
blue	127.00	5.138	0.345	-0.067	0.359	162.48	-0.0544	0.340
blue	127.00	5.141	0.307	-0.063	0.360	162.48	-0.0546	0.341
blue	127.00	5.158	0.337	-0.064	0.360	147.28	-0.0508	0.342
blue	127.00	5.161	0.308	-0.064	0.360	147.28	-0.0501	0.343
blue	140.97	5.204	0.251	-0.075	0.364	177.68	-0.0664	0.341
blue	140.97	5.194	0.270	-0.077	0.363	177.68	-0.0664	0.341
blue	140.97	5.198	0.265	-0.078	0.364	177.68	-0.0658	0.341
blue	140.97	5.186	0.290	-0.076	0.363	177.68	-0.0657	0.341
green	202.88	5.275	-0.454	-0.029	0.369	238.48	-0.1031	0.335
green	204.39	5.275	-0.439	-0.020	0.369	238.48	-0.1027	0.335
green	206.75	5.271	-0.477	-0.026	0.369	238.48	-0.1029	0.335
green	209.34	5.323	-0.423	-0.023	0.373	238.48	-0.1032	0.338
green	210.62	5.335	-0.444	-0.022	0.374	238.48	-0.1029	0.339
green	214.52	5.356	-0.502	-0.026	0.373	238.48	-0.1030	0.338
green	219.87	5.302	-0.536	-0.020	0.371	253.68	-0.1064	0.335
green	235.35	5.311	-0.357	0.015	0.372	268.88	-0.1152	0.334
green	243.68	5.361	-0.284	0.015	0.375	268.88	-0.1135	0.337
green	249.24	5.323	-0.297	0.009	0.372	572.88	-0.1187	0.332
green	250.83	5.287	-0.278	0.009	0.370	284.08	-0.1185	0.331
orange	264.80	5.284	-0.614	-0.005	0.369	299.28	-0.1077	0.333
orange	272.53	5.262	-0.557	-0.020	0.368	299.28	-0.1081	0.332
orange	280.27	5.202	-0.585	-0.010	0.364	299.28	-0.1068	0.329
orange	281.78	5.238	-0.550	-0.014	0.368	299.28	-0.1058	0.333
orange	288.07	5.224	-0.691	0.001	0.365	314.48	-0.1073	0.330
orange	291.69	5.208	-0.683	-0.009	0.365	329.68	-0.1062	0.330
orange	313.06	5.206	-0.734	-0.010	0.364	344.88	-0.1031	0.330
orange	343.70	5.137	-0.651	0.006	0.361	375.28	-0.1002	0.328
orange	374.65	5.166	-0.680	-0.020	0.363	405.68	-0.1034	0.329
orange	398.46	5.216	-0.602	-0.018	0.363	466.48	-0.1003	0.330
orange	434.98	5.215	-0.646	-0.025	0.364	466.48	-0.1000	0.331

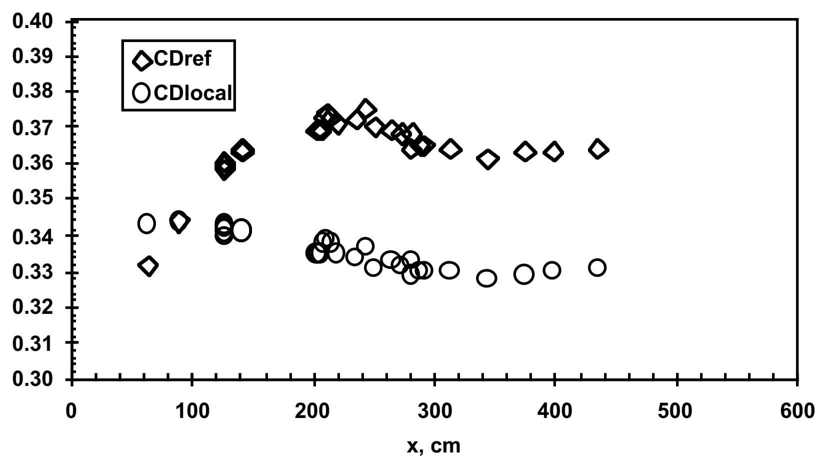
C_P distribution



ΔC_P distribution



C_D scatter



	Uncorrected	Corrected
Average CD	0.364	0.336
St. Dev.	0.0085	0.0050

Note: Improvement in local C_D scatter

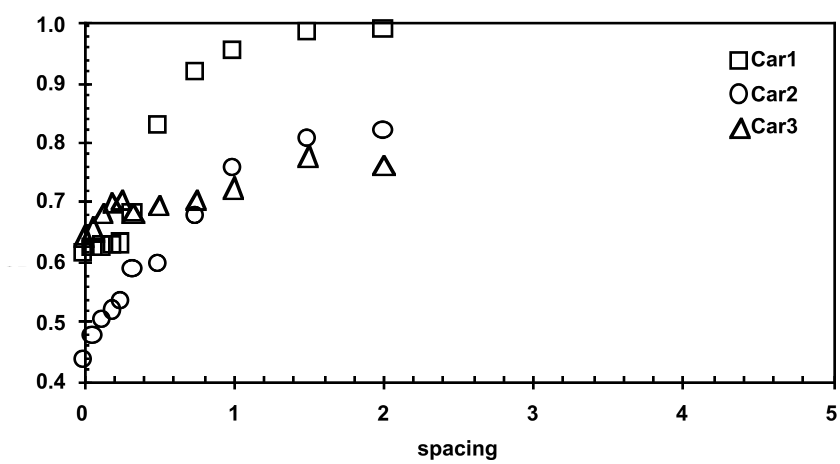
3-Car Platoon Data

Spacing	Car1	X 1	D1	SF1	Y1	CDref1	CDref_inf1	CD/CDref1	Xloc1	Cploc1	CDloc1	CDloc_inf1	CD/CDloc1
0.00	blue	140.97	3.204	-0.707	-0.225	0.225	0.364	0.617	177.68	-0.0800	0.208	0.341	0.610
0.06	blue	140.97	3.245	-0.494	-0.192	0.227	0.363	0.625	177.68	-0.0783	0.211	0.341	0.618
0.13	blue	140.97	3.258	-0.341	-0.166	0.228	0.364	0.628	177.68	-0.0776	0.212	0.341	0.621
0.19	blue	140.97	3.272	-0.125	-0.135	0.229	0.363	0.629	177.68	-0.0755	0.212	0.341	0.623
0.25	blue	127.00	3.227	0.191	-0.085	0.227	0.358	0.633	162.48	-0.0634	0.213	0.341	0.626
0.33	blue	127.00	3.488	0.348	-0.069	0.245	0.359	0.681	162.48	-0.0615	0.230	0.341	0.676
0.50	blue	127.00	4.262	0.285	-0.070	0.298	0.360	0.830	162.48	-0.0579	0.282	0.341	0.827
0.75	blue	127.00	4.712	0.351	-0.066	0.330	0.360	0.918	147.28	-0.0494	0.315	0.341	0.922
1.00	blue	127.00	4.921	0.279	-0.063	0.344	0.360	0.956	147.28	-0.0485	0.328	0.341	0.963
1.50	blue	88.90	5.067	2.280	0.753	0.339	0.344	0.986	116.88	0.0043	0.340	0.344	0.989
2.00	blue	63.50	4.715	0.240	-0.069	0.329	0.332	0.992	86.48	0.0253	0.338	0.343	0.986

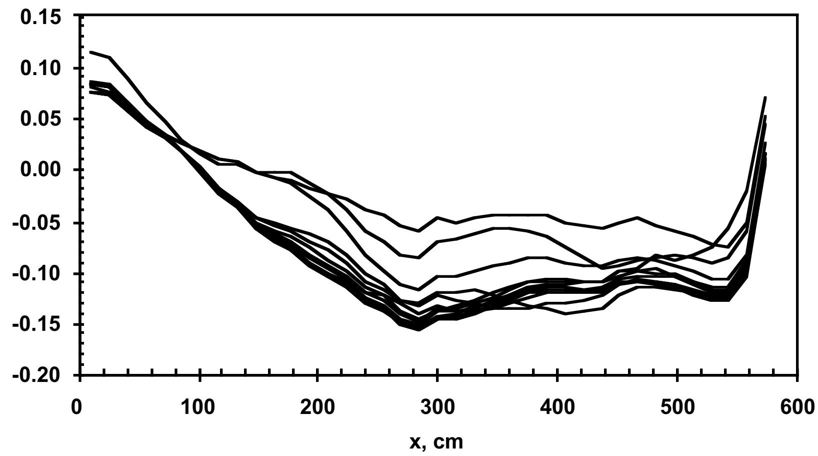
Spacing	Car2	X2	D2	SF2	Y2	CDref2	CDref_inf2	CD/CDref2	Xloc 2	Cploc2	CDloc2	CDloc_inf2	CD/CDloc2
0.00	green	202.88	2.291	1.043	-0.002	0.161	0.369	0.435	238.48	-0.1295	0.142	0.335	0.424
0.06	green	206.75	2.510	-0.095	-0.095	0.176	0.369	0.476	238.48	-0.1287	0.156	0.335	0.465
0.13	green	210.62	2.694	0.321	-0.012	0.189	0.374	0.505	238.48	-0.1284	0.167	0.339	0.494
0.19	green	214.52	2.777	0.062	-0.020	0.194	0.373	0.520	238.48	-0.1270	0.172	0.338	0.509
0.25	green	204.39	2.802	-0.107	-0.004	0.197	0.369	0.534	238.48	-0.1195	0.176	0.335	0.526
0.33	green	209.34	3.147	-0.163	0.009	0.221	0.373	0.591	238.48	-0.1185	0.197	0.338	0.584
0.50	green	219.87	3.169	-0.184	0.004	0.222	0.371	0.598	253.68	-0.1211	0.198	0.335	0.591
0.75	green	235.35	3.594	-0.122	0.025	0.252	0.372	0.676	268.88	-0.1279	0.223	0.334	0.668
1.00	green	250.83	3.996	-0.280	-0.001	0.280	0.370	0.755	284.08	-0.1312	0.247	0.331	0.747
1.50	green	243.68	4.702	-0.294	0.009	0.302	0.375	0.805	268.88	-0.0818	0.279	0.337	0.828
2.00	green	249.24	4.433	-0.360	-0.005	0.305	0.372	0.819	299.28	-0.1041	0.276	0.332	0.831

Spacing	Car3	X3	D3	SF3	Y3	CDref3	CDref_inf3	CD/CDref3	Xloc3	Cploc3	CDloc3	CDloc_inf3	CD/CDloc3
0.00	orange	264.80	3.397	-0.583	0.065	0.238	0.369	0.645	268.88	-0.1490	0.207	0.333	0.622
0.06	orange	272.53	3.436	-0.069	-0.030	0.241	0.368	0.655	284.08	-0.1548	0.208	0.332	0.628
0.13	orange	280.27	3.538	-0.263	0.008	0.248	0.364	0.681	284.08	-0.1571	0.214	0.329	0.651
0.19	orange	288.07	3.643	-0.232	0.005	0.254	0.365	0.697	299.28	-0.1451	0.222	0.330	0.673
0.25	orange	281.78	3.677	-0.216	0.014	0.259	0.368	0.703	284.08	-0.1480	0.225	0.333	0.676
0.33	orange	291.69	3.536	-0.301	0.022	0.248	0.365	0.680	299.28	-0.1366	0.218	0.330	0.661
0.50	orange	313.06	3.607	-0.355	0.023	0.253	0.364	0.694	329.68	-0.1382	0.222	0.330	0.672
0.75	orange	343.70	3.614	-0.403	0.025	0.253	0.361	0.702	375.28	-0.1348	0.223	0.328	0.680
1.00	orange	374.65	3.749	-0.444	0.014	0.262	0.363	0.723	390.48	-0.1358	0.231	0.329	0.702
1.50	orange	398.46	4.396	-0.612	-0.008	0.282	0.363	0.777	451.28	-0.0926	0.258	0.330	0.783
2.00	orange	434.98	3.973	-0.543	-0.012	0.278	0.364	0.762	268.88	-0.1127	0.249	0.331	0.753

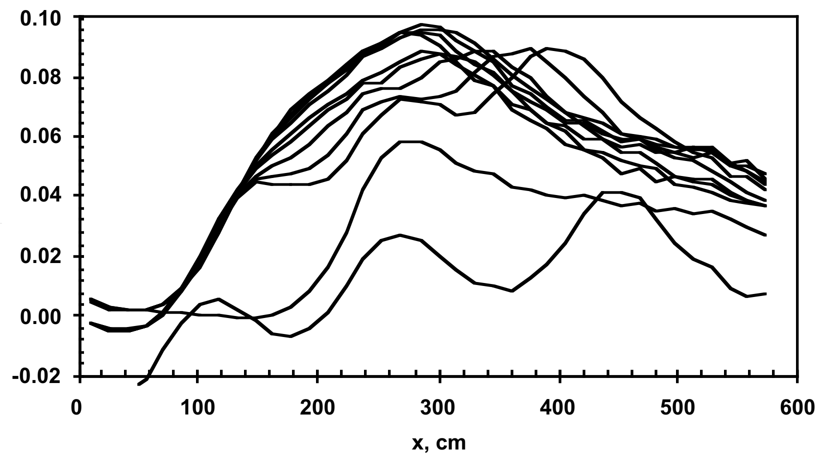
Uncorrected C_D ratios



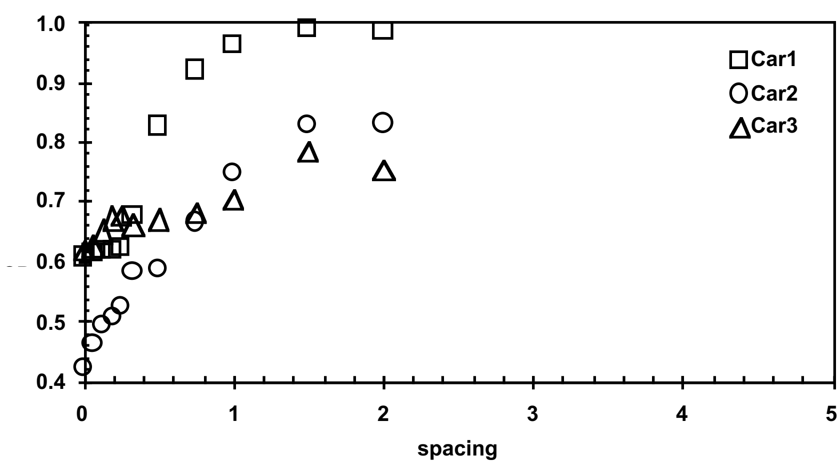
C_P distribution



ΔC_P distribution



Corrected C_D ratios

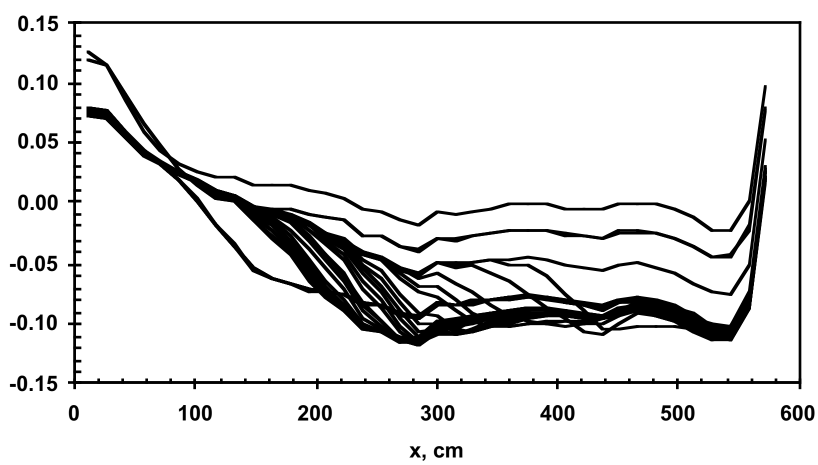


3-Car Platoon Subset B

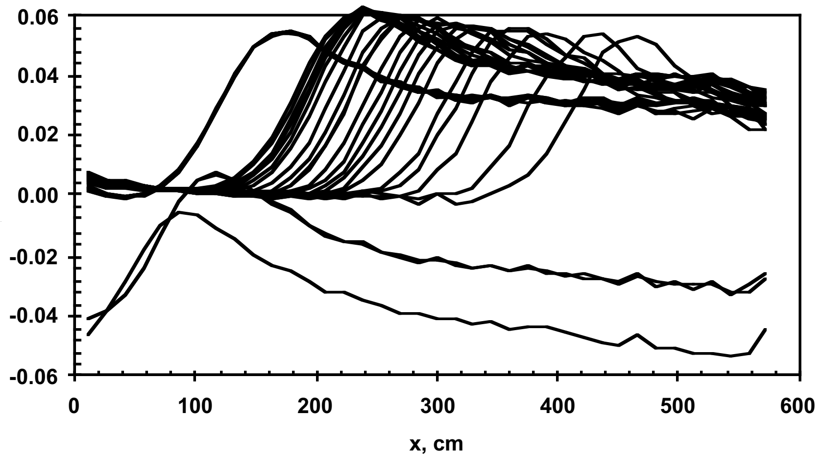
Single Car Data

Car#	X 1	D1	SF1	Y1	CDref1	Xlocal	Cplocal	CDlocal
blue	63.50	4.696	0.275	-0.061	0.329	86.48	0.0319	0.339
blue	88.90	4.877	0.319	-0.059	0.343	116.88	0.0022	0.343
blue	88.90	4.901	0.340	-0.062	0.343	116.88	0.0027	0.344
blue	140.97	5.173	0.322	-0.075	0.363	177.68	-0.0662	0.340
blue	140.97	5.210	0.318	-0.077	0.362	177.68	-0.0659	0.340
blue	140.97	5.203	0.307	-0.077	0.363	177.68	-0.0660	0.340
blue	140.97	5.191	0.315	-0.076	0.363	177.68	-0.0660	0.340
blue	140.97	5.208	0.306	-0.076	0.364	177.68	-0.0661	0.341
blue	140.97	5.215	0.306	-0.073	0.363	177.68	-0.0659	0.341
blue	140.97	5.190	0.307	-0.077	0.363	177.68	-0.0656	0.341
blue	140.97	5.206	0.304	-0.077	0.363	177.68	-0.0665	0.341
green	202.88	5.260	-0.446	-0.029	0.368	238.48	-0.1027	0.333
green	206.75	5.257	-0.490	-0.027	0.368	238.48	-0.1036	0.334
green	210.62	5.296	-0.482	-0.028	0.369	238.48	-0.1036	0.335
green	212.73	5.262	-0.517	-0.027	0.370	238.48	-0.1035	0.335
green	214.52	5.294	-0.544	-0.033	0.370	238.48	-0.1028	0.335
green	218.36	5.315	-0.514	-0.027	0.371	238.48	-0.1019	0.336
green	223.31	5.364	-0.591	-0.019	0.374	253.68	-0.1067	0.338
green	233.84	5.339	-0.414	0.009	0.375	268.88	-0.1139	0.336
green	243.68	5.381	-0.243	0.017	0.375	268.88	-0.1140	0.336
green	249.24	5.329	-0.306	0.007	0.372	268.88	-0.1134	0.334
green	249.32	5.323	-0.257	0.014	0.372	268.88	-0.1135	0.334
orange	264.80	5.338	-0.616	0.000	0.373	284.08	-0.1183	0.333
orange	272.53	5.285	-0.555	-0.022	0.370	299.28	-0.1081	0.334
orange	280.27	5.227	-0.540	-0.015	0.365	314.48	-0.1092	0.329
orange	288.07	5.176	-0.681	-0.016	0.362	329.68	-0.1058	0.327
orange	295.75	5.191	-0.710	-0.019	0.362	329.68	-0.1060	0.328
orange	305.66	5.248	-0.670	-0.004	0.367	329.68	-0.1054	0.332
orange	326.71	5.220	-0.623	0.004	0.366	375.28	-0.1000	0.332
orange	336.55	5.205	-0.542	0.001	0.364	375.28	-0.1006	0.331
orange	357.67	5.201	-0.560	-0.015	0.362	390.48	-0.0999	0.329
orange	398.46	5.261	-0.499	-0.022	0.369	436.08	-0.1090	0.332
orange	434.98	5.219	-0.646	-0.031	0.364	466.48	-0.1014	0.331

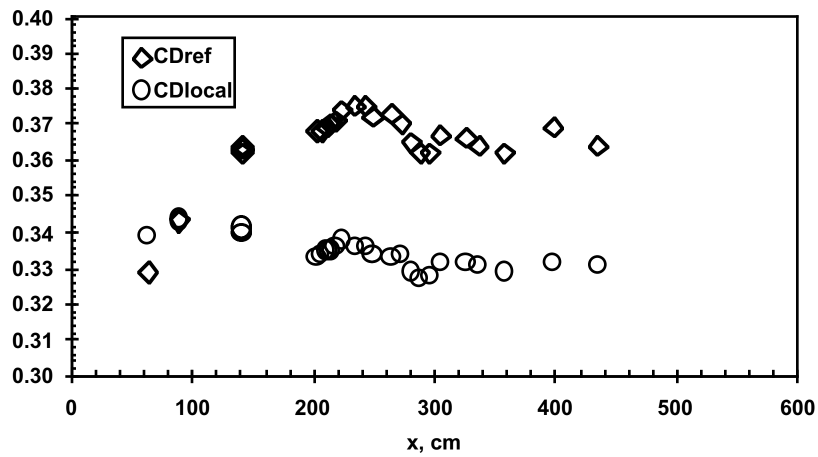
C_P distribution



ΔC_P distribution



C_D scatter



	Uncorrected	Corrected
Average CD	0.364	0.336
St. Dev.	0.0096	0.0045

Note: Improvement in local C_D scatter

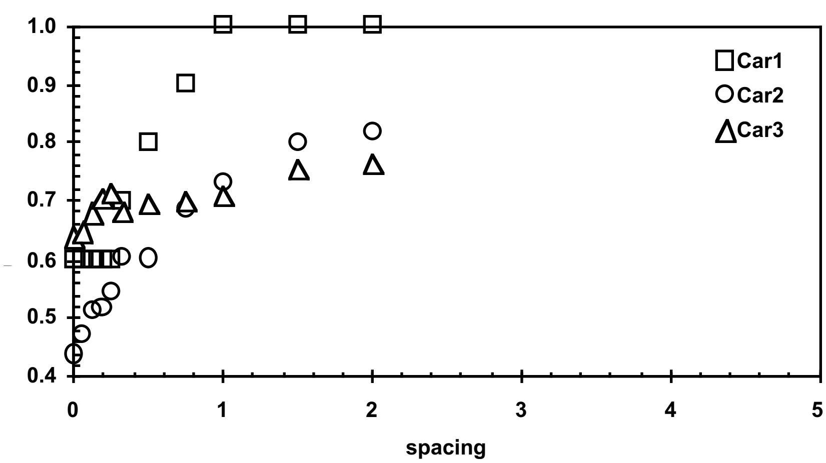
3-Car Platoon Data

Spacing	Car1	X 1	D1	SF1	Y1	CDref1	CDref_inf1	CD/CDref1	Xlocal1	Cplocal1	CDlocal1	CDlocal_ref1	CD/CDloc1
0.00	blue	140.97	3.204	-0.702	-0.224	0.224	0.363	0.618	177.68	-0.0798	0.208	0.341	0.610
0.06	blue	140.97	3.249	-0.467	-0.189	0.227	0.363	0.627	177.68	-0.0784	0.211	0.341	0.619
0.13	blue	140.97	3.276	-0.325	-0.169	0.229	0.363	0.632	177.68	-0.0779	0.213	0.341	0.624
0.19	blue	140.97	3.240	0.055	-0.116	0.227	0.363	0.625	177.68	-0.0762	0.211	0.341	0.618
0.25	blue	140.97	3.239	0.265	-0.084	0.227	0.363	0.625	177.68	-0.0749	0.211	0.341	0.619
0.33	blue	140.97	3.549	0.342	-0.075	0.248	0.363	0.685	177.68	-0.0734	0.231	0.341	0.679
0.50	blue	140.97	4.301	0.326	-0.077	0.302	0.363	0.831	177.68	-0.0695	0.282	0.341	0.828
0.75	blue	140.97	4.769	0.339	-0.074	0.334	0.363	0.922	177.68	-0.0659	0.314	0.341	0.921
1.00	blue	88.90	4.705	0.335	-0.061	0.328	0.343	0.957	116.88	0.0039	0.329	0.343	0.958
1.50	blue	88.90	4.861	0.343	-0.064	0.339	0.343	0.989	116.88	0.0047	0.341	0.343	0.992
2.00	blue	63.50	4.686	0.266	-0.064	0.328	0.329	0.997	86.48	0.0315	0.338	0.339	0.997

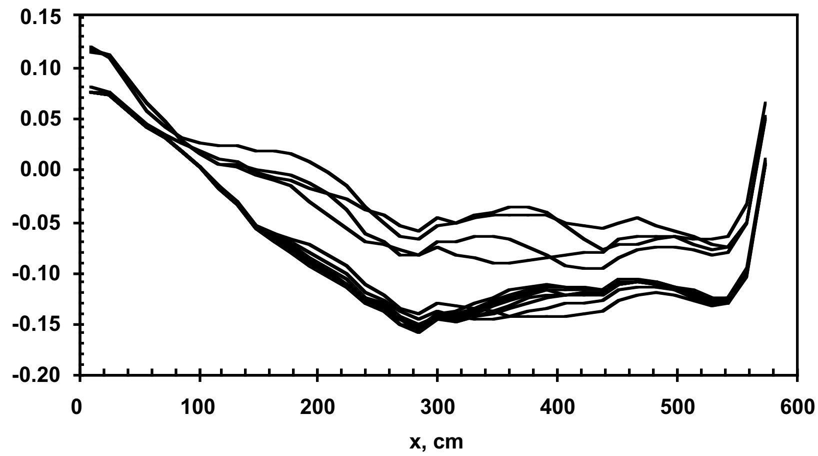
Spacing	Car2	X2	D2	SF2	Y2	CDref2	CDref_inf2	CD/CDref2	Xlocal 2	Cplocal2	CDlocal2	CDlocal_ref2	CD/CDloc2
0.00	green	202.88	2.308	1.056	-0.001	0.162	0.368	0.439	238.48	-0.1301	0.143	0.333	0.429
0.06	green	206.75	2.478	0.581	-0.013	0.173	0.368	0.471	238.48	-0.1289	0.154	0.334	0.460
0.13	green	210.62	2.712	0.299	-0.018	0.190	0.369	0.514	238.48	-0.1293	0.168	0.335	0.502
0.19	green	214.52	2.738	-0.004	-0.006	0.192	0.370	0.518	238.48	-0.1262	0.170	0.335	0.507
0.25	green	218.36	2.883	-0.147	0.003	0.202	0.371	0.544	238.48	-0.1260	0.179	0.336	0.533
0.33	green	223.31	3.246	-0.196	0.010	0.227	0.374	0.607	253.68	-0.1310	0.201	0.338	0.594
0.50	green	233.84	3.226	-0.135	0.014	0.226	0.375	0.603	268.88	-0.1390	0.199	0.336	0.590
0.75	green	249.32	3.619	-0.154	0.016	0.254	0.372	0.682	268.88	-0.1362	0.223	0.334	0.669
1.00	green	212.73	3.869	-0.355	-0.012	0.270	0.370	0.729	238.48	-0.0689	0.252	0.335	0.753
1.50	green	243.68	4.304	-0.340	-0.001	0.300	0.375	0.801	268.88	-0.0820	0.277	0.336	0.824
2.00	green	249.24	4.341	-0.389	-0.002	0.304	0.372	0.816	268.88	-0.0641	0.285	0.334	0.854

Spacing	Car3	X3	D3	SF3	Y3	CDref3	CDref_inf3	CD/CDref3	Xlocal3	Cplocal3	CDlocal3	CDlocal_ref3	CD/CDloc3
0.00	orange	264.80	3.400	-0.592	0.067	0.238	0.373	0.638	268.88	-0.1502	0.207	0.333	0.620
0.06	orange	272.53	3.423	-0.317	0.023	0.240	0.370	0.648	284.08	-0.1563	0.207	0.334	0.621
0.13	orange	280.27	3.537	-0.225	0.007	0.247	0.365	0.678	284.08	-0.1581	0.214	0.329	0.650
0.19	orange	288.07	3.634	-0.242	0.011	0.254	0.362	0.702	284.08	-0.1555	0.220	0.327	0.672
0.25	orange	295.75	3.684	-0.240	0.017	0.258	0.362	0.711	299.28	-0.1447	0.225	0.328	0.687
0.33	orange	305.66	3.566	-0.272	0.024	0.249	0.367	0.679	314.48	-0.1477	0.217	0.332	0.654
0.50	orange	326.71	3.610	-0.308	0.032	0.253	0.366	0.692	344.88	-0.1450	0.221	0.332	0.665
0.75	orange	357.67	3.618	-0.361	0.028	0.254	0.362	0.700	375.28	-0.1440	0.222	0.329	0.673
1.00	orange	336.55	3.694	-0.383	0.011	0.257	0.364	0.706	360.08	-0.0908	0.236	0.331	0.712
1.50	orange	398.46	3.985	-0.436	-0.008	0.278	0.369	0.753	420.88	-0.0967	0.253	0.332	0.762
2.00	orange	434.98	3.964	-0.532	-0.014	0.277	0.364	0.761	466.48	-0.0708	0.259	0.331	0.782

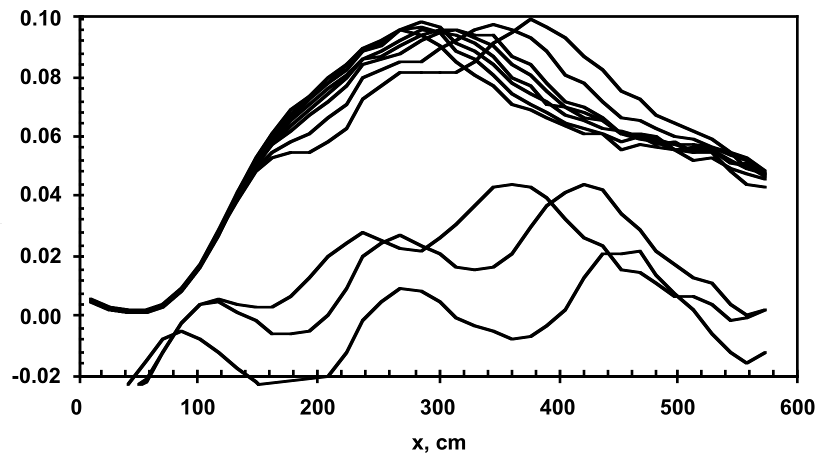
Uncorrected C_D ratios



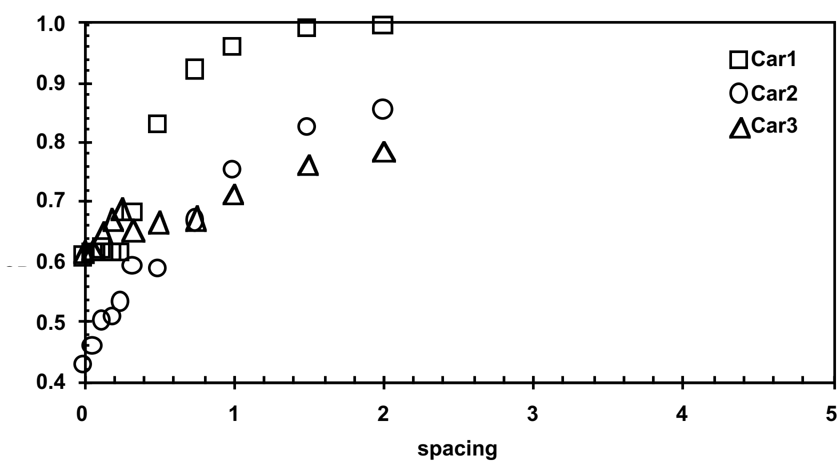
C_P distribution



ΔC_P distribution



Corrected C_D ratios

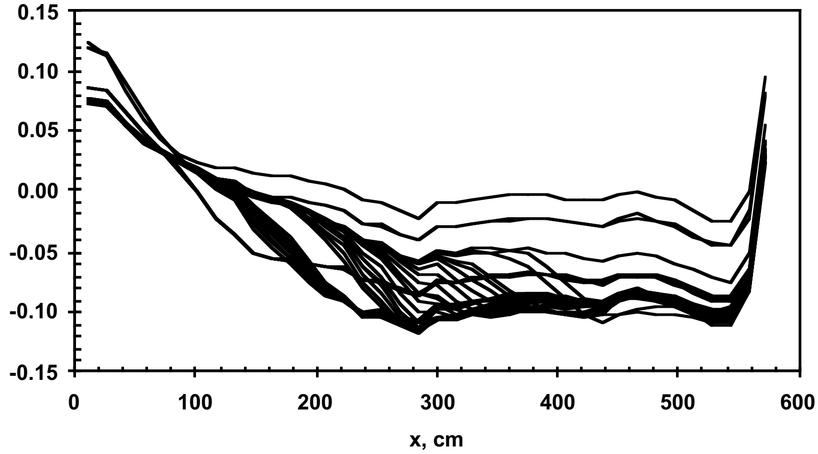


4-Car Platoon Subset A

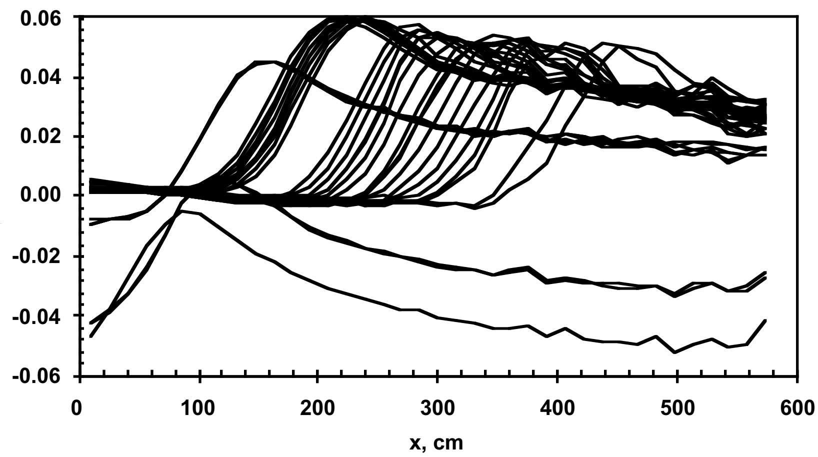
Single Car Data

Car#	X 1	D1	SF1	Y1	CDref1	Xlocal	Cplocal	CDlocal
blue	127.00	5.039	-0.120	-0.008	0.353	162.48	-0.0541	0.335
blue	127.00	5.085	-0.128	-0.012	0.355	147.28	-0.0504	0.337
blue	127.00	5.047	-0.123	-0.009	0.352	147.28	-0.0504	0.335
blue	127.00	5.033	-0.097	-0.012	0.352	162.48	-0.0545	0.334
blue	127.00	5.046	-0.079	-0.012	0.352	162.48	-0.0542	0.334
blue	127.00	5.047	-0.096	-0.014	0.353	162.48	-0.0545	0.334
blue	88.90	4.827	-0.142	-0.003	0.337	116.88	0.0025	0.338
blue	88.90	4.831	-0.112	-0.005	0.337	116.88	0.0021	0.337
blue	63.50	4.662	-0.170	-0.014	0.327	86.48	0.0308	0.337
red	188.91	5.219	-0.437	-0.021	0.366	223.28	-0.0907	0.335
red	192.78	5.231	-0.476	-0.021	0.366	223.28	-0.0902	0.336
red	196.65	5.248	-0.503	-0.025	0.368	238.48	-0.1021	0.334
red	200.55	5.307	-0.468	-0.030	0.371	238.48	-0.1021	0.336
red	204.39	5.262	-0.436	-0.030	0.369	238.48	-0.1032	0.334
red	209.34	5.322	-0.482	-0.036	0.372	238.48	-0.1022	0.338
red	181.77	5.218	-0.282	-0.008	0.365	208.08	-0.0857	0.336
red	197.25	5.287	-0.498	-0.040	0.369	223.28	-0.0903	0.338
red	187.33	5.270	-0.403	-0.024	0.368	223.28	-0.0910	0.337
green	250.83	5.278	-0.009	-0.064	0.369	284.08	-0.1172	0.330
green	258.56	5.294	-0.018	-0.075	0.370	284.08	-0.1161	0.332
green	266.30	5.293	-0.018	-0.095	0.371	284.08	-0.1160	0.332
green	274.10	5.315	0.019	-0.097	0.369	299.28	-0.1067	0.334
green	281.78	5.236	-0.031	-0.099	0.366	314.48	-0.1058	0.331
green	291.69	5.198	-0.093	-0.101	0.364	314.48	-0.1049	0.329
green	274.64	5.295	0.049	-0.100	0.369	314.48	-0.1058	0.333
green	305.60	5.308	-0.046	-0.091	0.370	344.88	-0.1015	0.336
green	311.15	5.226	-0.052	-0.089	0.366	360.08	-0.0986	0.333
orange	312.74	5.082	-0.637	-0.009	0.354	344.88	-0.1040	0.320
orange	324.35	5.088	-0.594	-0.004	0.355	360.08	-0.1002	0.323
orange	335.96	5.114	-0.488	0.013	0.356	375.28	-0.0991	0.324
orange	347.66	5.097	-0.494	0.008	0.355	375.28	-0.0987	0.323
orange	359.17	5.056	-0.529	-0.018	0.354	375.28	-0.0976	0.323
orange	367.51	5.106	-0.567	-0.016	0.356	405.68	-0.1012	0.323
orange	374.03	5.135	-0.599	-0.016	0.358	405.68	-0.1030	0.324
orange	413.94	5.165	-0.552	-0.004	0.360	436.08	-0.1088	0.324
orange	434.98	5.119	-0.658	-0.019	0.358	451.28	-0.1027	0.324

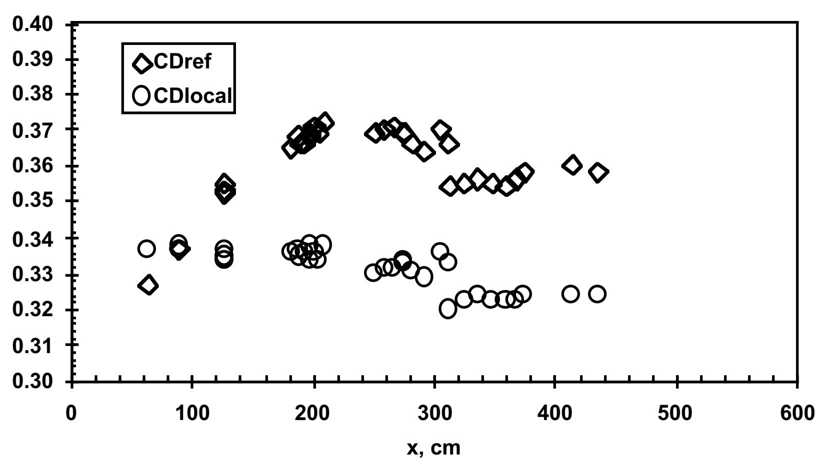
C_P distribution



ΔC_P distribution



C_D scatter



	Uncorrected	Corrected
Average CD	0.360	0.333
St. Dev.	0.0106	0.0055

Note: Improvement in local C_D scatter

4-Car Platoon Data

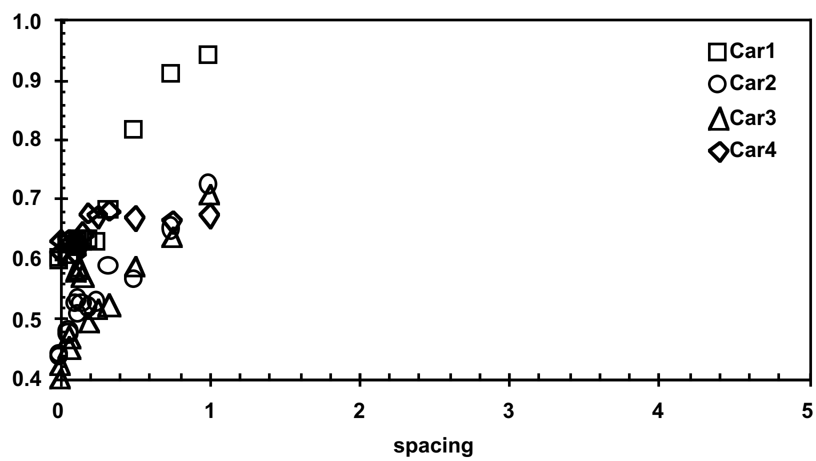
Spacing	Car1	X 1	D1	SF1	Y1	CDref1	CDref_inf1	CD/CDref1	Xlocal1	Cplocal1	CDlocal1	CDloc_inf1	CD/CDloc1
0.00	blue	127.00	3.024	-0.983	-0.133	0.212	0.353	0.600	162.48	-0.0672	0.198	0.335	0.592
0.06	blue	127.00	3.089	-0.759	-0.104	0.216	0.355	0.609	147.28	-0.0560	0.205	0.337	0.606
0.13	blue	127.00	3.134	-0.704	-0.090	0.219	0.352	0.623	147.28	-0.0558	0.208	0.335	0.620
0.19	blue	127.00	3.193	-0.596	-0.067	0.223	0.352	0.634	162.48	-0.0638	0.210	0.334	0.628
0.25	blue	127.00	3.169	-0.290	-0.030	0.222	0.352	0.630	162.48	-0.0623	0.209	0.334	0.625
0.33	blue	127.00	3.434	-0.180	-0.012	0.240	0.353	0.680	162.48	-0.0604	0.226	0.334	0.676
0.50	blue	88.90	3.913	-0.132	-0.005	0.275	0.337	0.814	116.88	0.0000	0.275	0.338	0.812
0.75	blue	88.90	4.386	-0.129	0.000	0.306	0.337	0.909	116.88	0.0026	0.307	0.337	0.909
1.00	blue	63.50	4.420	-0.186	-0.013	0.308	0.327	0.942	86.48	0.0299	0.318	0.337	0.942

Spacing	Car2	X2	D2	SF2	Y2	CDref2	CDref_inf2	CD/CDref2	Xlocal 2	Cplocal2	CDlocal2	CDloc_inf2	CD/CDloc2
0.00	red	188.91	2.274	1.146	-0.015	0.159	0.366	0.435	223.28	-0.1063	0.144	0.335	0.429
0.06	red	192.78	2.488	0.449	-0.065	0.174	0.366	0.475	223.28	-0.1066	0.157	0.336	0.468
0.13	red	196.65	2.674	0.331	-0.064	0.187	0.368	0.508	238.48	-0.1222	0.167	0.334	0.499
0.19	red	200.55	2.760	0.237	-0.062	0.193	0.371	0.520	238.48	-0.1193	0.172	0.336	0.512
0.25	red	204.39	2.787	0.034	-0.037	0.195	0.369	0.529	238.48	-0.1175	0.175	0.334	0.522
0.33	red	209.34	3.150	-0.033	-0.026	0.220	0.372	0.591	238.48	-0.1161	0.197	0.338	0.584
0.50	red	181.77	2.941	-0.010	-0.023	0.206	0.365	0.566	208.08	-0.0536	0.196	0.336	0.583
0.75	red	197.25	3.441	-0.142	-0.043	0.240	0.369	0.651	223.28	-0.0577	0.227	0.338	0.671
1.00	red	187.33	3.820	-0.037	-0.031	0.266	0.368	0.723	223.28	-0.0419	0.255	0.337	0.757

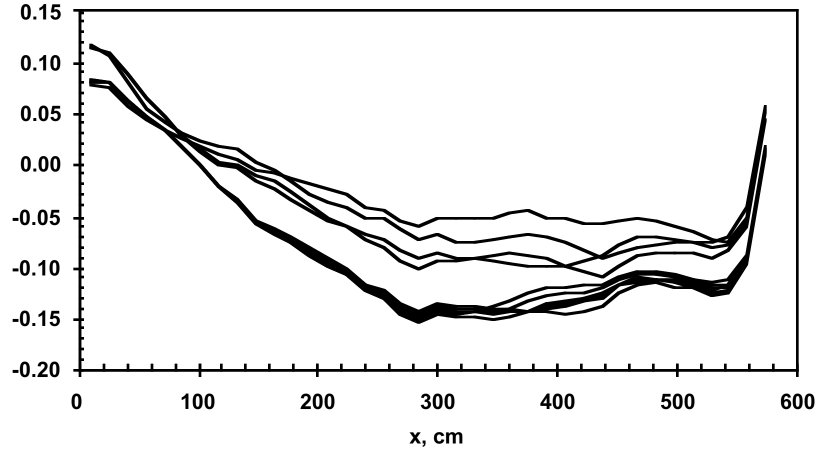
Spacing	Car3	X3	D3	SF3	Y3	CDref3	CDref_inf3	CD/CDref3	Xlocal3	Cplocal3	CDlocal3	CDloc_inf3	CD/CDloc3
0.00	green	250.83	2.119	-1.009	-0.077	0.148	0.369	0.402	284.08	-0.1498	0.129	0.330	0.391
0.06	green	258.56	2.391	-0.729	-0.141	0.167	0.370	0.452	284.08	-0.1505	0.145	0.332	0.438
0.13	green	266.30	3.112	-0.068	-0.073	0.218	0.371	0.587	284.08	-0.1529	0.189	0.332	0.568
0.19	green	274.10	2.610	0.016	-0.070	0.182	0.369	0.494	299.28	-0.1391	0.160	0.334	0.480
0.27	green	280.51	2.712	0.009	-0.049	0.190	0.366	0.519	314.48	-0.1402	0.167	0.331	0.504
0.33	green	291.69	2.734	-0.004	-0.053	0.191	0.364	0.525	314.48	-0.1383	0.168	0.329	0.509
0.50	green	274.96	3.101	-0.094	-0.043	0.218	0.369	0.590	314.48	-0.0936	0.199	0.333	0.597
0.75	green	305.60	3.386	-0.135	-0.059	0.236	0.370	0.638	344.88	-0.0879	0.217	0.336	0.646
1.00	green	311.15	3.714	-0.250	-0.074	0.259	0.366	0.707	360.08	-0.0694	0.242	0.333	0.726

Spacing	Car4	X4	D4	SF4	Y4	CDref4	CDref_inf4	CD/CDref4	Xlocal4	Cplocal4	Cdlocal4	CDloc_inf4	CD/CDloc4
0.00	orange	312.74	3.202	0.202	-0.070	0.224	0.354	0.634	314.48	-0.1445	0.196	0.320	0.611
0.06	orange	324.35	3.233	0.139	-0.052	0.226	0.355	0.637	344.88	-0.1433	0.198	0.323	0.613
0.13	orange	335.96	3.178	-0.111	-0.005	0.222	0.356	0.624	360.08	-0.1479	0.194	0.324	0.598
0.19	orange	347.66	3.434	-0.194	0.009	0.240	0.355	0.675	360.08	-0.1441	0.210	0.323	0.648
0.27	orange	359.17	3.400	-0.242	0.020	0.238	0.354	0.672	375.28	-0.1428	0.208	0.323	0.645
0.33	orange	374.03	3.464	-0.241	0.022	0.242	0.356	0.679	375.28	-0.1424	0.212	0.323	0.655
0.50	orange	367.51	3.412	-0.278	0.028	0.239	0.358	0.669	375.28	-0.0983	0.218	0.324	0.672
0.75	orange	413.94	3.418	-0.273	0.014	0.238	0.360	0.663	436.08	-0.1089	0.215	0.324	0.663
1.00	orange	434.98	3.460	-0.406	0.002	0.241	0.358	0.674	436.08	-0.0897	0.221	0.324	0.682

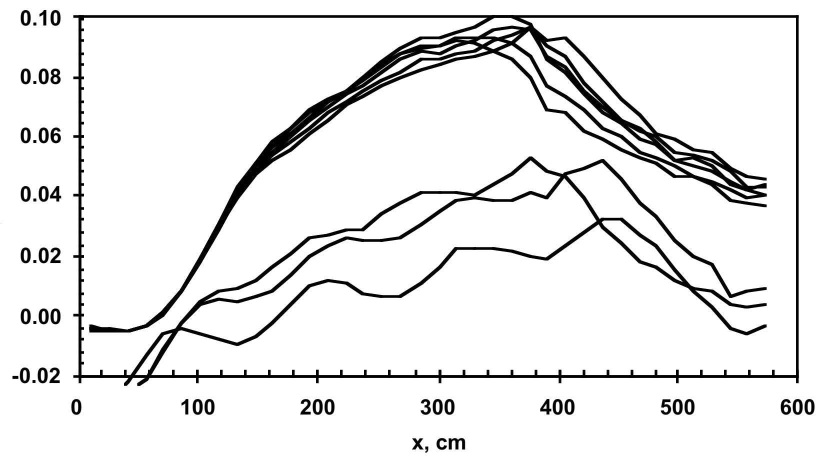
Uncorrected C_D ratios



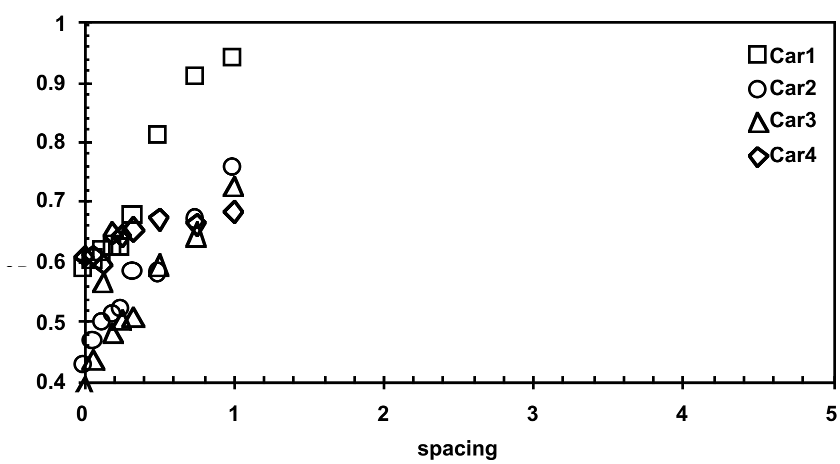
C_P distribution



ΔC_P distribution



Corrected C_D ratios



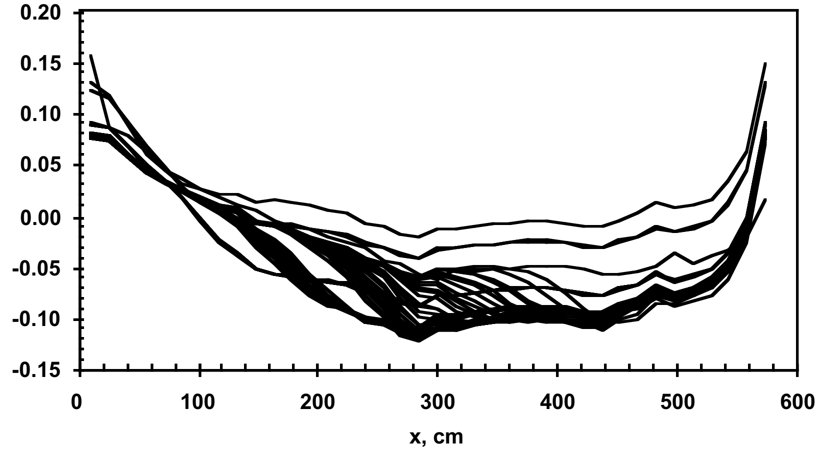
2, 3 & 4-Car Platoon Series (2nd Set)

Nick's data taken 5/17/94 - 5/22/94. Single car reference values are measured at each location.

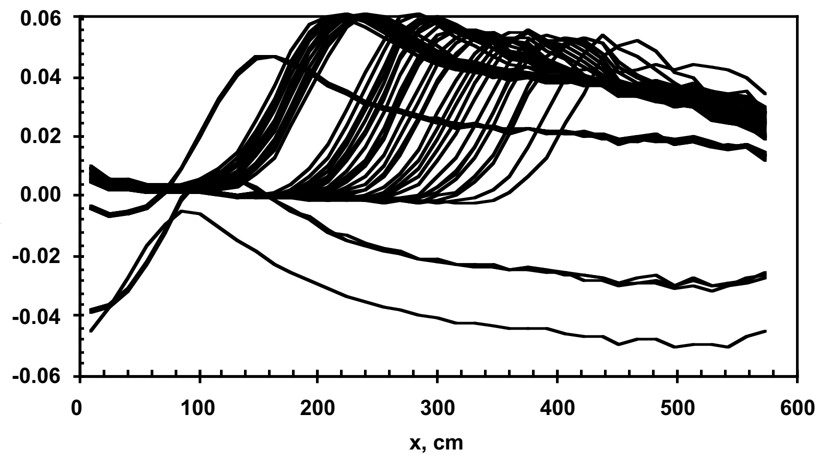
Single Car Data

Car#	Location	Drag1	SideF1	Yaw1	CDref1	Xlocal	Cplocal	CDlocal
blue	63.50	4.533	-0.064	-0.010	0.319	86.48	0.0318	0.329
blue	88.90	4.702	-0.038	0.005	0.330	116.88	0.0018	0.331
blue	88.90	4.684	-0.040	0.001	0.329	116.88	0.0012	0.330
blue	88.90	4.701	-0.041	0.001	0.328	116.88	0.0014	0.328
blue	127.00	4.922	-0.031	0.001	0.345	162.48	-0.0556	0.327
blue	127.00	4.901	-0.046	-0.001	0.344	162.48	-0.0558	0.326
blue	127.00	4.884	-0.064	-0.002	0.343	162.48	-0.0555	0.324
blue	127.00	4.858	-0.064	0.001	0.342	147.28	-0.0516	0.325
blue	127.00	4.885	-0.077	0.000	0.343	162.48	-0.0554	0.325
blue	127.00	4.894	-0.062	0.002	0.342	162.48	-0.0556	0.324
blue	127.00	4.909	-0.047	0.003	0.344	162.48	-0.0558	0.326
blue	127.00	4.911	-0.044	-0.003	0.346	147.28	-0.052	0.328
blue	127.00	4.973	-0.051	0.005	0.349	162.48	-0.056	0.330
blue	127.00	4.991	-0.057	0.006	0.350	147.28	-0.052	0.333
green	187.33	5.380	0.149	-0.054	0.377	223.28	-0.0923	0.345
green	197.25	5.380	0.032	-0.074	0.379	223.28	-0.0911	0.347
green	189.51	5.356	0.105	-0.064	0.379	223.28	-0.0929	0.346
green	181.77	5.363	0.141	-0.048	0.378	208.08	-0.0865	0.348
green	213.68	5.485	-0.053	-0.076	0.386	238.48	-0.1033	0.350
green	209.34	5.439	0.044	-0.073	0.382	238.48	-0.1031	0.346
green	207.49	5.462	0.037	-0.075	0.383	238.48	-0.103	0.347
green	204.39	5.391	0.077	-0.076	0.378	238.48	-0.1035	0.343
green	200.55	5.414	0.022	-0.081	0.382	238.48	-0.1031	0.346
green	198.20	5.411	0.039	-0.078	0.381	238.48	-0.1023	0.345
green	196.65	5.367	0.043	-0.065	0.377	238.48	-0.1026	0.342
green	195.11	5.351	0.045	-0.067	0.377	223.28	-0.0919	0.345
green	192.78	5.318	0.091	-0.055	0.374	223.28	-0.0913	0.343
green	188.91	5.321	0.093	-0.046	0.373	223.28	-0.0913	0.342
red	311.15	5.128	-0.419	0.016	0.361	344.88	-0.1049	0.327
red	305.60	5.164	-0.350	0.026	0.364	329.68	-0.1063	0.329
red	290.12	5.141	-0.437	0.010	0.360	329.68	-0.1072	0.325
red	274.64	5.148	-0.239	0.001	0.361	299.28	-0.111	0.325
red	300.36	5.153	-0.382	0.016	0.363	329.68	-0.1069	0.328
red	291.69	5.101	-0.444	0.004	0.360	329.68	-0.1069	0.325
red	287.97	5.150	-0.381	0.004	0.360	314.48	-0.1093	0.325
red	281.78	5.178	-0.293	0.000	0.362	314.48	-0.1104	0.326
red	274.10	5.260	-0.217	-0.020	0.369	299.28	-0.1122	0.332
red	270.84	5.256	-0.273	-0.020	0.369	299.28	-0.1124	0.331
red	266.30	5.245	-0.321	-0.015	0.370	299.28	-0.1116	0.333
red	263.21	5.191	-0.320	-0.003	0.365	284.08	-0.1204	0.326
red	258.56	5.293	-0.244	0.003	0.371	284.08	-0.1215	0.331
red	250.83	5.295	-0.203	0.027	0.371	284.08	-0.1216	0.331
orange	434.98	4.949	-0.433	-0.041	0.348	466.48	-0.1003	0.316
orange	413.94	5.007	-0.383	-0.025	0.353	436.08	-0.1111	0.317
orange	390.72	4.961	-0.483	-0.029	0.348	420.88	-0.109	0.314
orange	367.51	4.931	-0.366	-0.028	0.345	405.68	-0.103	0.313
orange	387.03	4.928	-0.416	-0.033	0.347	420.88	-0.1089	0.313
orange	374.03	4.945	-0.402	-0.028	0.348	405.68	-0.1037	0.315
orange	368.46	4.888	-0.407	-0.031	0.344	405.68	-0.1036	0.312
orange	359.17	4.909	-0.386	-0.029	0.344	390.48	-0.1029	0.311
orange	347.66	4.909	-0.438	-0.012	0.345	375.28	-0.1021	0.313
orange	340.60	4.929	-0.494	-0.015	0.344	375.28	-0.1029	0.312
orange	335.96	4.977	-0.412	-0.011	0.349	375.28	-0.102	0.317
orange	331.31	4.932	-0.504	-0.009	0.347	360.08	-0.1041	0.314
orange	324.35	5.017	-0.590	0.042	0.352	344.88	-0.1035	0.319
orange	312.74	5.024	-0.661	0.047	0.354	344.88	-0.1042	0.320

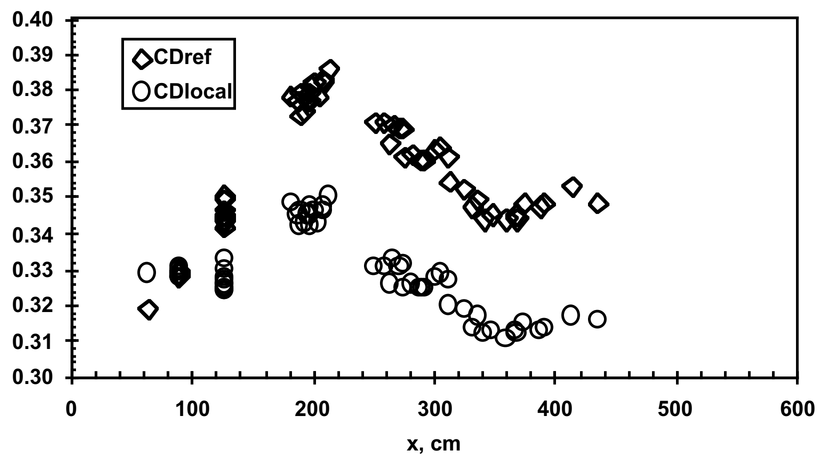
C_P distribution



ΔC_P distribution



C_D scatter



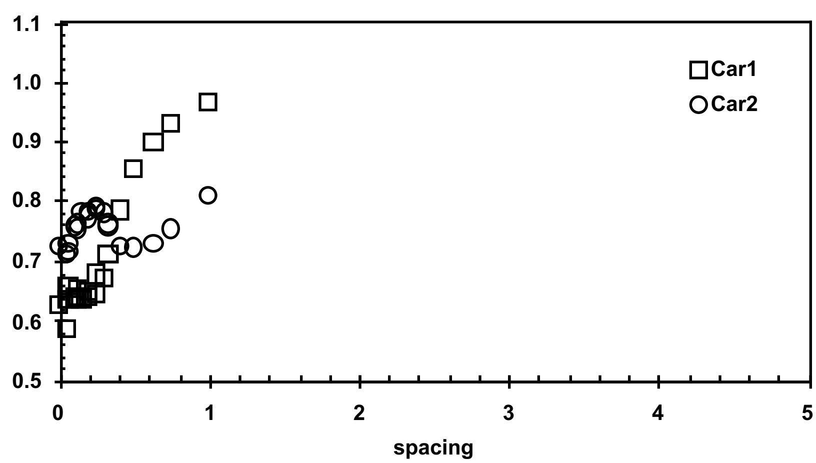
	Uncorrected	Corrected
Average CD	0.358	0.329
St. Dev.	0.016	0.011

2-Car Platoon Data

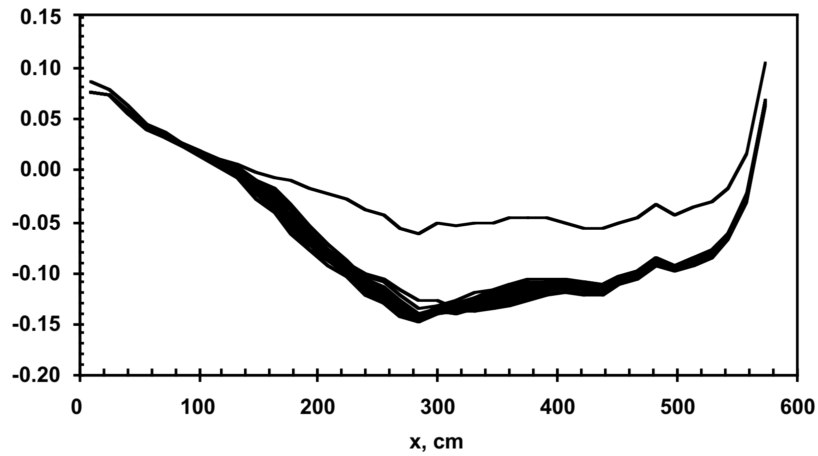
Spacing	Car1	Location1	Drag1	SideF1	Yaw1	CDref1	CD/CDref1	Xlocal1	Cplocal1	CDloc1	CD/CDloc1
1.00	green	187.33	5.168	0.142	-0.053	0.364	0.966	223.28	-0.0909	0.334	0.967
0.75	green	197.25	4.996	0.060	-0.069	0.352	0.930	223.28	-0.0904	0.323	0.930
0.63	green	189.51	4.828	0.149	-0.057	0.340	0.897	223.28	-0.0947	0.310	0.896
0.50	green	181.77	4.577	0.186	-0.042	0.321	0.851	208.08	-0.0883	0.295	0.849
0.40	green	213.68	4.284	0.027	-0.066	0.302	0.782	238.48	-0.1053	0.273	0.780
0.33	green	209.34	3.869	0.047	-0.075	0.273	0.714	238.48	-0.1081	0.246	0.711
0.30	green	207.94	3.663	0.150	-0.063	0.258	0.673	238.48	-0.1096	0.232	0.669
0.25	green	204.39	3.678	-0.155	-0.114	0.257	0.679	238.48	-0.112	0.231	0.673
0.19	green	200.55	3.532	-0.331	-0.130	0.248	0.651	238.48	-0.1142	0.223	0.644
0.15	green	198.20	3.464	-0.337	-0.131	0.243	0.637	238.48	-0.1157	0.218	0.630
0.13	green	196.65	3.403	-0.421	-0.130	0.240	0.636	238.48	-0.1172	0.215	0.628
0.10	green	195.11	3.426	-0.477	-0.145	0.242	0.641	223.28	-0.1006	0.219	0.636
0.06	green	192.78	3.382	-0.515	-0.145	0.237	0.634	223.28	-0.1015	0.216	0.628
0.00	green	188.91	3.329	-0.845	-0.173	0.234	0.627	223.28	-0.1037	0.212	0.620

Spacing	Car2	Location2	Drag2	SideF2	Yaw2	CDref2	CD/CDref2	Xlocal2	Cplocal2	CDloc2	CD/Cdloc2
1.00	red	311.15	4.126	-0.352	0.005	0.291	0.806	344.88	-0.1351	0.256	0.785
0.75	red	305.60	3.885	-0.279	-0.001	0.274	0.752	329.68	-0.1370	0.241	0.732
0.63	red	290.12	3.736	-0.251	0.010	0.263	0.730	314.48	-0.1399	0.231	0.709
0.50	red	274.64	3.723	-0.120	0.009	0.261	0.724	299.28	-0.1400	0.229	0.706
0.40	red	300.36	3.733	-0.095	0.012	0.263	0.725	329.68	-0.1369	0.231	0.705
0.33	red	291.69	3.865	-0.101	0.009	0.273	0.758	314.48	-0.1392	0.239	0.736
0.30	red	287.97	3.981	-0.117	0.016	0.280	0.778	299.28	-0.1381	0.246	0.758
0.25	red	281.78	4.092	0.021	-0.007	0.286	0.789	299.28	-0.1392	0.251	0.769
0.19	red	274.10	4.098	0.082	-0.024	0.288	0.781	284.08	-0.1485	0.251	0.756
0.15	red	270.84	4.108	0.108	-0.020	0.288	0.781	284.08	-0.1480	0.251	0.757
0.13	red	266.30	4.007	0.121	-0.029	0.283	0.764	284.08	-0.1480	0.246	0.740
0.10	red	263.21	3.924	0.138	-0.042	0.277	0.758	284.08	-0.1479	0.241	0.740
0.06	red	258.56	3.853	0.268	-0.038	0.271	0.729	268.88	-0.1425	0.237	0.715
0.00	red	250.83	3.832	0.582	-0.058	0.269	0.726	268.88	-0.1423	0.236	0.713

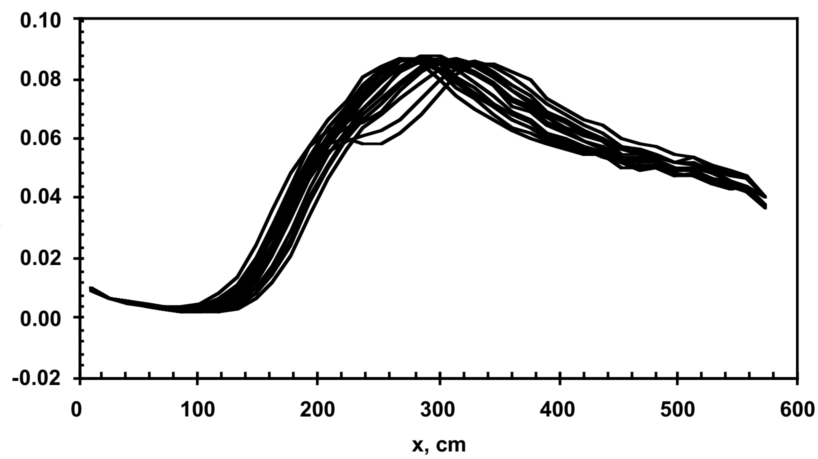
Uncorrected C_D ratios



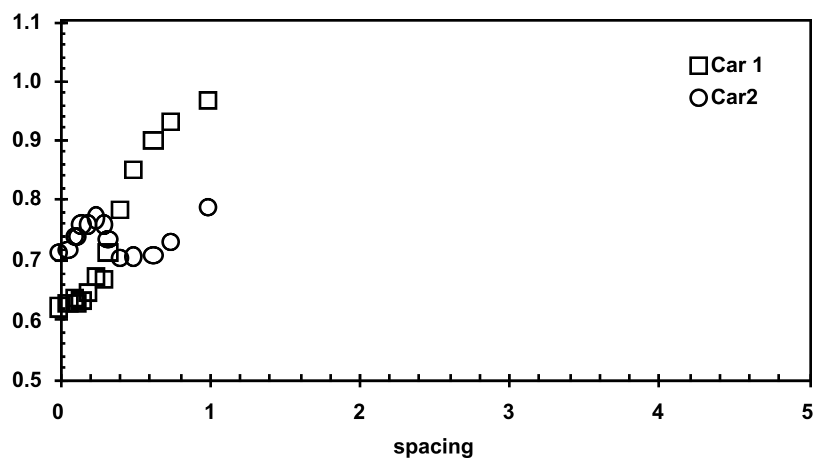
C_P distribution



ΔC_P distribution



Corrected C_D ratios



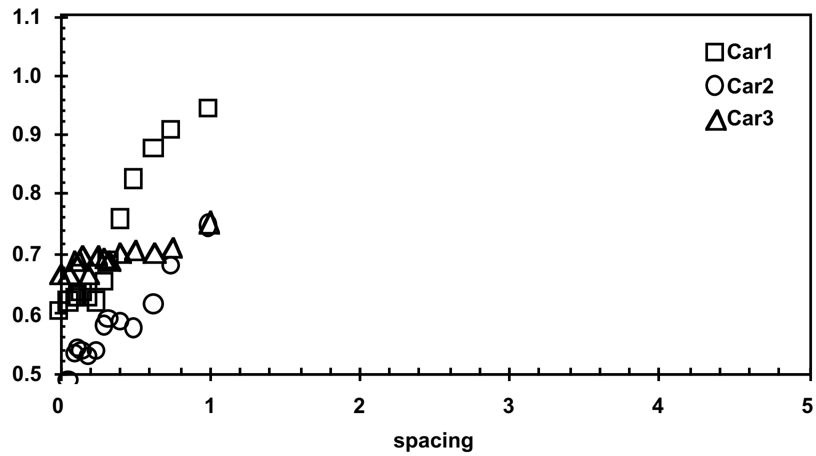
3-Car Platoon Data

Spacing	Car#	Location	Drag1	SideF1	Yaw1	CDref1	CD/CDref1	Xlocal1	Cplocal1	CDloc1	CDloc_inf1	CD/CDloc1
1.00	blue	63.50	4.283	-0.079	-0.016	0.301	0.944	86.48	0.0293	0.310	0.329	0.941
0.75	blue	88.90	4.277	-0.036	-0.005	0.300	0.907	116.88	0.0028	0.300	0.331	0.908
0.63	blue	88.90	4.103	-0.048	-0.010	0.288	0.876	116.88	0.0008	0.289	0.330	0.875
0.50	blue	88.90	3.867	-0.061	-0.006	0.270	0.823	116.88	-0.0007	0.270	0.328	0.822
0.40	blue	127.00	3.716	-0.077	-0.010	0.261	0.757	162.48	-0.0605	0.246	0.327	0.753
0.33	blue	127.00	3.359	-0.100	-0.017	0.237	0.689	162.48	-0.0623	0.223	0.326	0.684
0.30	blue	127.00	3.193	-0.167	-0.021	0.224	0.655	162.48	-0.0632	0.211	0.324	0.650
0.25	blue	127.00	3.025	-0.071	-0.008	0.212	0.620	147.28	-0.0549	0.201	0.325	0.618
0.19	blue	127.00	3.053	-0.433	-0.055	0.215	0.626	162.48	-0.0654	0.202	0.325	0.620
0.15	blue	127.00	3.119	-0.656	-0.086	0.217	0.635	162.48	-0.0660	0.204	0.324	0.629
0.13	blue	127.00	3.086	-0.685	-0.090	0.217	0.629	162.48	-0.0671	0.203	0.326	0.623
0.10	blue	127.00	3.080	-0.735	-0.101	0.217	0.627	147.28	-0.0570	0.205	0.328	0.624
0.06	blue	127.00	3.092	-0.846	-0.118	0.217	0.621	162.48	-0.0676	0.203	0.330	0.615
0.00	blue	127.00	3.035	-1.002	-0.132	0.212	0.605	147.28	-0.0586	0.200	0.333	0.601

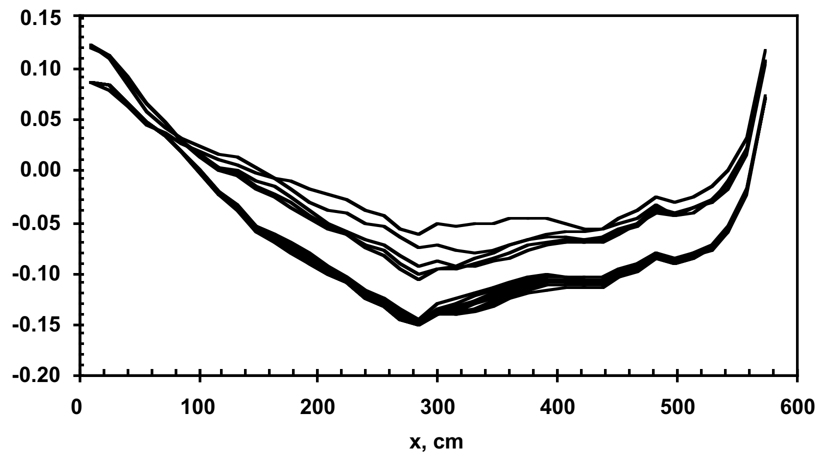
Spacing	Car#	Location	Drag2	SideF2	Yaw2	CDref2	CD/CDref2	Xlocal2	Cplocal2	CDloc2	CDloc_inf2	CD/CDloc2
1.00	green	187.33	4.014	0.014	-0.091	0.282	0.747	223.28	-0.0436	0.270	0.345	0.782
0.75	green	197.25	3.681	-0.088	-0.103	0.258	0.681	223.28	-0.0583	0.244	0.347	0.702
0.63	green	189.51	3.319	0.045	-0.079	0.233	0.616	223.28	-0.0612	0.220	0.346	0.635
0.50	green	181.77	3.107	0.106	-0.065	0.217	0.575	208.08	-0.0561	0.205	0.348	0.591
0.40	green	213.68	3.209	0.035	-0.067	0.226	0.585	238.48	-0.1165	0.202	0.350	0.578
0.33	green	209.34	3.202	0.058	-0.066	0.226	0.591	238.48	-0.1185	0.202	0.346	0.583
0.30	green	207.94	3.158	0.080	-0.068	0.222	0.579	238.48	-0.1196	0.198	0.347	0.571
0.25	green	204.39	2.909	0.090	-0.065	0.204	0.539	238.48	-0.1203	0.182	0.343	0.531
0.19	green	200.55	2.861	0.111	-0.105	0.201	0.528	238.48	-0.1220	0.179	0.346	0.519
0.15	green	198.20	2.923	0.004	-0.148	0.204	0.535	238.48	-0.1238	0.181	0.345	0.525
0.13	green	196.65	2.912	-0.221	-0.177	0.204	0.542	238.48	-0.1245	0.182	0.342	0.532
0.10	green	195.11	2.855	-0.341	-0.205	0.201	0.533	223.28	-0.1101	0.181	0.345	0.524
0.06	green	192.78	2.610	-0.283	-0.218	0.183	0.489	223.28	-0.1100	0.165	0.343	0.480
0.00	green	188.91	2.380	-0.231	-0.231	0.166	0.445	223.28	-0.1100	0.150	0.342	0.437

Spacing	Car#	Location	Drag3	SideF3	Yaw3	CDref3	CD/CDref3	Xlocal3	Cplocal3	CDloc3	CDloc_inf3	CD/CDloc3
1.00	red	311.15	3.870	-0.328	0.001	0.272	0.753	329.68	-0.0790	0.252	0.327	0.771
0.75	red	305.60	3.707	-0.215	0.003	0.260	0.713	329.68	-0.0919	0.238	0.329	0.722
0.63	red	290.12	3.610	-0.208	0.020	0.254	0.704	299.28	-0.0945	0.232	0.325	0.712
0.50	red	274.64	3.662	-0.160	0.014	0.256	0.709	284.08	-0.1050	0.231	0.325	0.713
0.40	red	300.36	3.621	-0.130	0.024	0.255	0.702	314.48	-0.1401	0.223	0.328	0.682
0.33	red	291.69	3.531	-0.131	0.019	0.249	0.692	299.28	-0.1399	0.218	0.325	0.672
0.30	red	287.97	3.561	-0.100	0.014	0.250	0.695	299.28	-0.1406	0.219	0.325	0.676
0.25	red	281.78	3.614	-0.089	0.018	0.253	0.699	284.08	-0.1489	0.220	0.326	0.675
0.19	red	274.10	3.506	-0.140	-0.014	0.247	0.668	284.08	-0.1499	0.215	0.332	0.646
0.15	red	270.84	3.697	0.146	-0.032	0.258	0.699	284.08	-0.1517	0.224	0.331	0.675
0.13	red	266.30	3.640	0.251	-0.049	0.255	0.691	268.88	-0.1456	0.223	0.333	0.670
0.10	red	263.21	3.591	0.334	-0.060	0.253	0.692	268.88	-0.1458	0.221	0.326	0.677
0.06	red	258.56	3.531	0.350	-0.066	0.247	0.666	268.88	-0.1446	0.216	0.331	0.653
0.00	red	250.83	3.547	0.459	-0.078	0.247	0.667	268.88	-0.1432	0.216	0.331	0.654

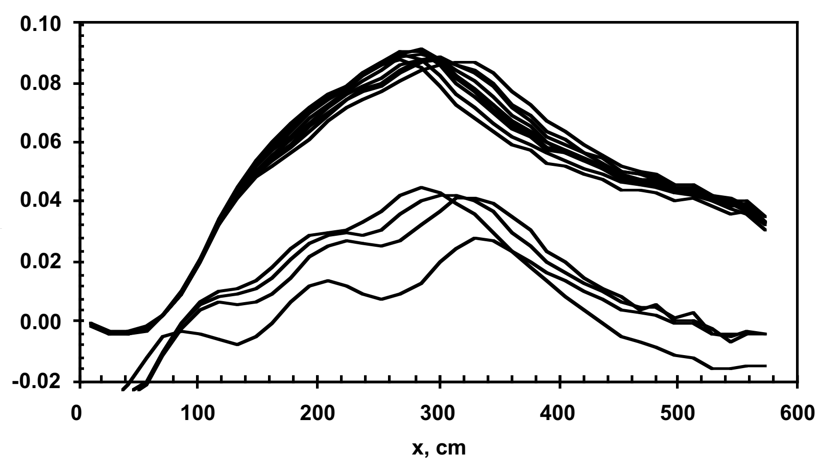
Uncorrected C_D ratios



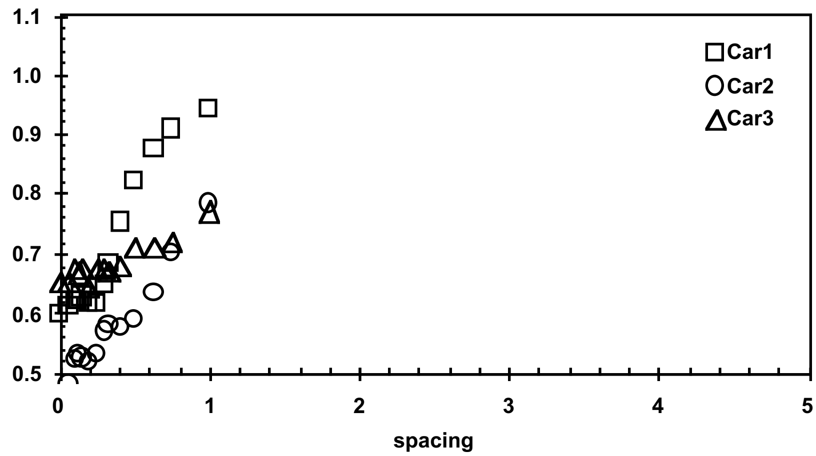
C_P distribution



ΔC_P distribution



Corrected C_D ratios



4-Car Platoon Data

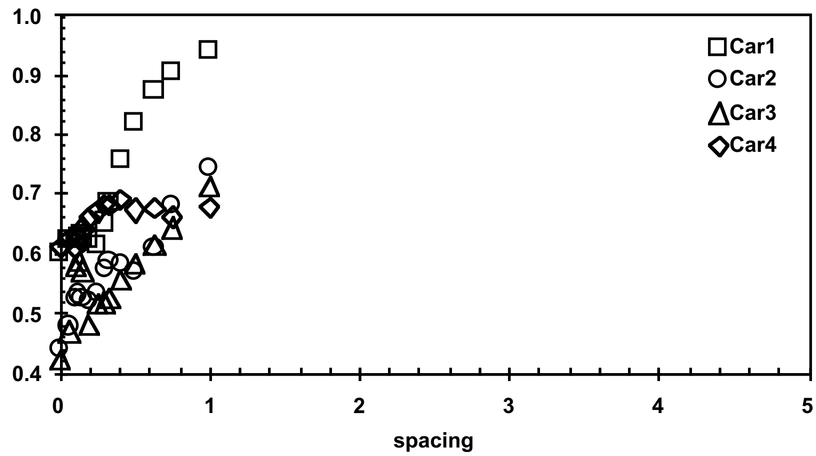
Spacing	Car#	Location	Drag1	SideF1	Yaw1	CDref1	CDref_inf1	CD/CDref1	Xlocal1	Cplocal1	CDloc1	CDloc_inf1	CD/CDloc1
1.00	blue	63.50	4.265	-0.075	-0.012	0.300	0.319	0.942	86.48	0.0305	0.309	0.329	0.940
0.75	blue	88.90	4.243	-0.043	0.004	0.299	0.330	0.906	116.88	0.0025	0.300	0.331	0.907
0.63	blue	88.90	4.119	-0.036	-0.006	0.288	0.329	0.875	116.88	0.0016	0.289	0.330	0.876
0.50	blue	88.90	3.851	-0.055	-0.003	0.269	0.328	0.821	116.88	0.0005	0.270	0.328	0.821
0.40	blue	127.00	3.708	-0.072	-0.006	0.261	0.345	0.756	162.48	-0.0594	0.246	0.327	0.753
0.33	blue	127.00	3.342	-0.101	-0.011	0.235	0.344	0.684	162.48	-0.0614	0.222	0.326	0.680
0.30	blue	127.00	3.185	-0.169	-0.017	0.224	0.343	0.654	162.48	-0.0614	0.211	0.324	0.651
0.25	blue	127.00	3.016	-0.075	-0.004	0.212	0.342	0.619	147.28	-0.0538	0.201	0.325	0.618
0.19	blue	127.00	3.067	-0.440	-0.048	0.215	0.343	0.628	162.48	-0.0641	0.202	0.325	0.623
0.15	blue	127.00	3.083	-0.666	-0.076	0.217	0.342	0.633	162.48	-0.0655	0.203	0.324	0.628
0.13	blue	127.00	3.077	-0.696	-0.083	0.216	0.344	0.629	162.48	-0.0655	0.203	0.326	0.623
0.10	blue	127.00	3.063	-0.737	-0.095	0.216	0.346	0.626	147.28	-0.0562	0.205	0.328	0.624
0.06	blue	127.00	3.101	-0.849	-0.104	0.218	0.349	0.626	162.48	-0.0662	0.205	0.330	0.620
0.00	blue	127.00	3.018	-1.013	-0.124	0.211	0.350	0.604	147.28	-0.0568	0.200	0.333	0.601

Spacing	Car#	Location	Drag2	SideF2	Yaw2	CDref2	CDref_inf2	CD/CDref2	Xlocal2	Cplocal2	CDloc2	CDloc_inf2	CD/CDloc2
1.00	green	187.33	3.990	0.000	-0.090	0.281	0.377	0.744	223.28	-0.0424	0.269	0.345	0.780
0.75	green	197.25	3.649	-0.083	-0.102	0.257	0.379	0.679	223.28	-0.0578	0.243	0.347	0.701
0.63	green	189.51	3.318	0.045	-0.076	0.232	0.379	0.613	223.28	-0.0593	0.219	0.346	0.633
0.50	green	181.77	3.086	0.095	-0.068	0.216	0.378	0.572	208.08	-0.0537	0.205	0.348	0.590
0.40	green	213.68	3.206	0.034	-0.067	0.226	0.386	0.585	238.48	-0.1148	0.202	0.350	0.579
0.33	green	209.34	3.196	0.056	-0.066	0.225	0.382	0.589	238.48	-0.1158	0.202	0.346	0.582
0.30	green	207.49	3.142	0.080	-0.067	0.221	0.383	0.577	238.48	-0.1164	0.198	0.347	0.570
0.25	green	204.39	2.884	0.094	-0.064	0.202	0.378	0.535	238.48	-0.1176	0.181	0.343	0.528
0.19	green	200.55	2.850	0.099	-0.105	0.200	0.382	0.524	238.48	-0.1192	0.179	0.346	0.517
0.15	green	198.20	2.861	0.028	-0.144	0.201	0.381	0.528	238.48	-0.1220	0.179	0.345	0.519
0.13	green	196.65	2.860	-0.209	-0.175	0.201	0.377	0.533	238.48	-0.1231	0.179	0.342	0.523
0.10	green	195.11	2.816	-0.374	-0.206	0.199	0.377	0.528	223.28	-0.1083	0.179	0.345	0.520
0.06	green	192.78	2.550	-0.326	-0.206	0.179	0.374	0.479	223.28	-0.1081	0.162	0.343	0.472
0.00	green	188.91	2.345	-0.251	-0.230	0.164	0.373	0.440	223.28	-0.1085	0.148	0.342	0.433

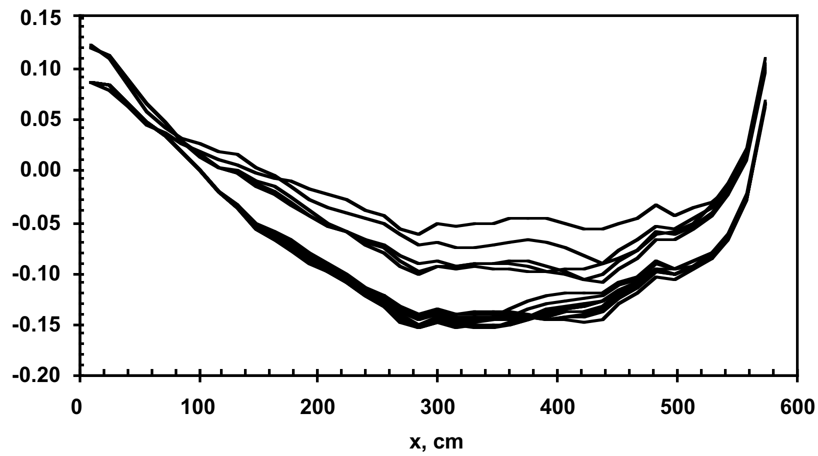
Spacing	Car#	Location	Drag3	SideF3	Yaw3	CDref3	CDref_inf3	CD/CDref3	Xlocal3	Cplocal3	CDloc3	CDloc_inf3	CD/CDloc3
1.00	red	311.15	3.653	-0.330	0.002	0.257	0.361	0.712	344.88	-0.0734	0.239	0.327	0.733
0.75	red	305.60	3.325	-0.170	0.009	0.234	0.364	0.644	329.68	-0.0912	0.215	0.329	0.653
0.63	red	290.12	3.171	-0.179	0.022	0.222	0.360	0.616	329.68	-0.0912	0.203	0.325	0.625
0.50	red	274.64	3.027	-0.147	0.020	0.212	0.361	0.587	299.28	-0.0939	0.194	0.325	0.596
0.40	red	300.36	2.875	-0.148	0.022	0.202	0.363	0.558	329.68	-0.1385	0.178	0.328	0.543
0.33	red	291.69	2.700	-0.149	0.014	0.190	0.360	0.528	329.68	-0.1393	0.167	0.325	0.513
0.30	red	287.97	2.666	-0.112	0.010	0.188	0.360	0.521	314.48	-0.1408	0.164	0.325	0.507
0.25	red	281.78	2.681	-0.109	0.013	0.188	0.362	0.519	314.48	-0.1417	0.165	0.326	0.505
0.19	red	274.10	2.529	-0.086	-0.017	0.178	0.369	0.481	299.28	-0.1429	0.155	0.332	0.468
0.15	red	270.84	3.007	-0.046	-0.047	0.211	0.369	0.574	299.28	-0.1480	0.184	0.331	0.556
0.13	red	266.30	3.091	0.030	-0.064	0.217	0.370	0.588	299.28	-0.1482	0.189	0.333	0.569
0.10	red	263.21	3.009	0.126	-0.073	0.213	0.365	0.582	284.08	-0.1548	0.184	0.326	0.565
0.06	red	258.56	2.486	-0.311	-0.157	0.175	0.371	0.471	284.08	-0.1521	0.152	0.331	0.458
0.00	red	250.83	2.242	-0.275	-0.177	0.157	0.371	0.423	284.08	-0.1522	0.136	0.331	0.412

Spacing	Car#	Location	Drag4	SideF4	Yaw4	CDref4	CDref_inf4	CD/CDref4	Xlocal4	Cplocal4	CDloc4	CDloc_inf4	CD/CDloc4
1.00	orange	434.98	3.349	-0.169	-0.016	0.236	0.348	0.677	436.08	-0.0910	0.216	0.316	0.683
0.75	orange	413.94	3.309	-0.099	-0.006	0.233	0.353	0.662	420.88	-0.1072	0.211	0.317	0.664
0.63	orange	390.72	3.357	-0.120	0.007	0.235	0.348	0.675	405.68	-0.1019	0.213	0.314	0.679
0.50	orange	367.51	3.321	-0.133	0.015	0.232	0.345	0.673	375.28	-0.0988	0.211	0.313	0.675
0.40	orange	387.03	3.401	-0.090	0.009	0.239	0.347	0.690	405.68	-0.1469	0.209	0.313	0.667
0.33	orange	374.03	3.360	-0.076	0.008	0.236	0.348	0.680	375.28	-0.1437	0.207	0.315	0.656
0.30	orange	368.46	3.330	-0.071	0.005	0.234	0.344	0.681	375.28	-0.1440	0.205	0.312	0.657
0.25	orange	359.17	3.291	-0.094	0.011	0.231	0.344	0.672	375.28	-0.1442	0.202	0.311	0.648
0.19	orange	347.66	3.242	-0.022	-0.013	0.228	0.345	0.659	360.08	-0.1468	0.198	0.313	0.633
0.15	orange	340.60	3.143	0.072	-0.031	0.221	0.344	0.642	360.08	-0.1505	0.192	0.312	0.616
0.13	orange	335.96	3.117	0.155	-0.044	0.219	0.349	0.628	344.88	-0.1524	0.190	0.317	0.600
0.10	orange	331.31	3.004	0.179	-0.052	0.212	0.347	0.612	344.88	-0.1525	0.184	0.314	0.586
0.06	orange	324.35	3.131	0.267	0.097	0.220	0.352	0.626	329.68	-0.1479	0.192	0.319	0.602
0.00	orange	312.74	3.099	0.244	0.115	0.217	0.354	0.614	329.68	-0.1444	0.190	0.320	0.592

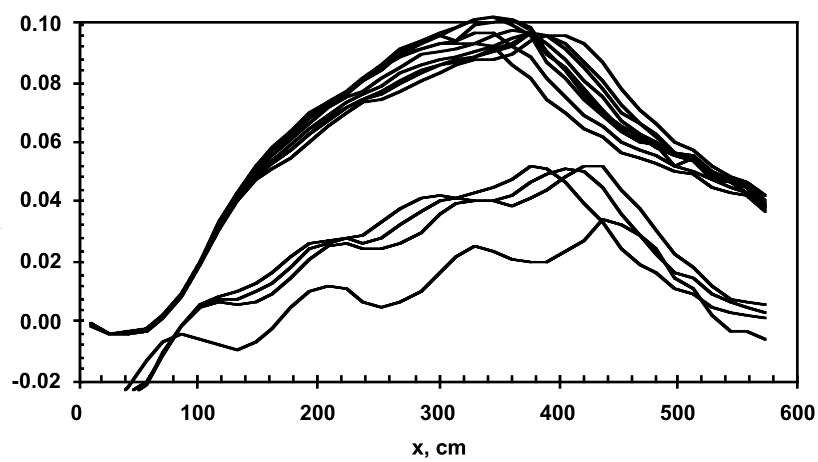
Uncorrected C_D ratios



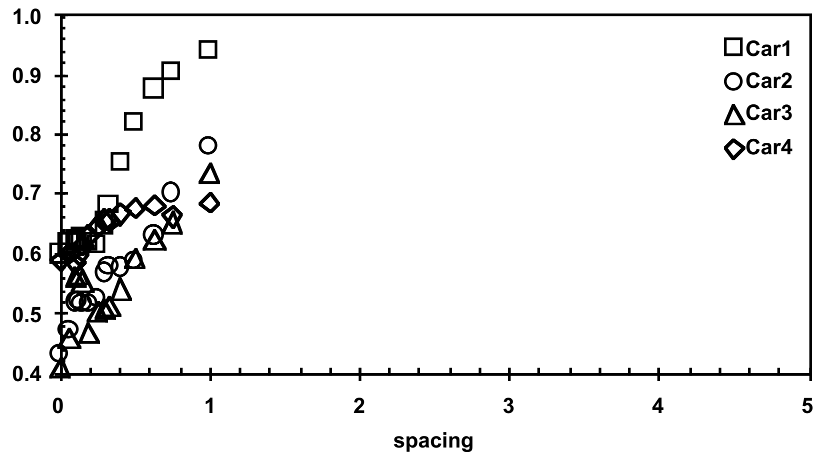
C_P distribution



ΔC_P distribution



Corrected C_D ratios



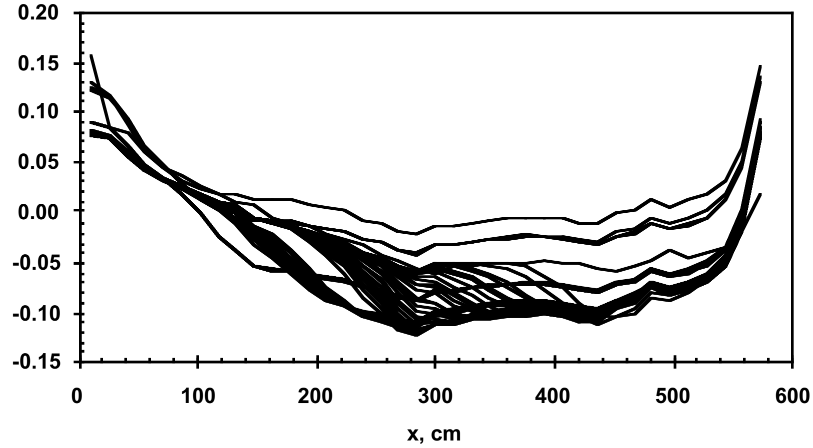
2, 3 & 4-Car Platoon Series (Tripped Set)

Nick's data taken 5/17/94 - 5/22/94. In this series, the models' boundary layers were tripped using a serrated rubber strip. Single car reference values are measured at each location.

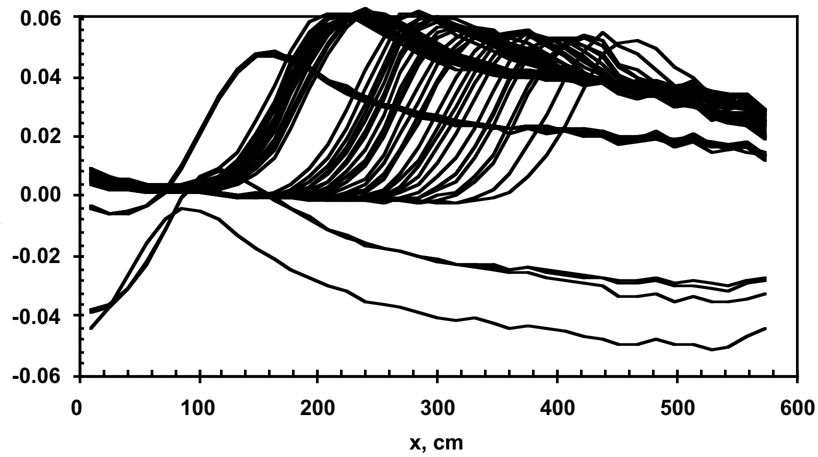
Single Car Data

Car#	Location	Drag1	SideF1	Yaw1	CDref1	Xlocal	Cplocal	CDlocal
blue	63.50	4.538	-0.155	0.003	0.319	86.48	0.0305	0.329
blue	88.90	4.746	-0.104	0.017	0.333	116.88	0.0006	0.333
blue	88.90	4.710	-0.037	0.002	0.330	116.88	0.0011	0.330
blue	88.90	4.698	-0.069	0.006	0.329	116.88	0.0013	0.329
blue	127.00	4.985	-0.114	0.008	0.350	162.48	-0.057	0.331
blue	127.00	4.912	-0.163	0.013	0.346	162.48	-0.0569	0.327
blue	127.00	4.881	-0.050	-0.002	0.343	162.48	-0.056	0.325
blue	127.00	4.867	-0.071	0.004	0.342	162.48	-0.0564	0.324
blue	127.00	4.929	-0.081	0.006	0.346	162.48	-0.0568	0.327
blue	127.00	4.951	-0.037	-0.009	0.345	162.48	-0.0567	0.326
blue	127.00	4.943	-0.057	0.007	0.349	162.48	-0.0569	0.330
blue	127.00	5.010	-0.106	0.007	0.349	162.48	-0.057	0.330
blue	127.00	4.958	-0.049	0.009	0.348	147.28	-0.0369	0.335
blue	127.00	5.031	-0.136	0.021	0.354	162.48	-0.057	0.335
green	187.33	5.378	-0.012	-0.039	0.376	223.28	-0.0856	0.347
green	197.25	5.356	-0.010	-0.053	0.378	238.48	-0.1021	0.343
green	189.51	5.353	-0.096	-0.038	0.377	223.28	-0.0859	0.348
green	181.77	5.412	-0.012	-0.023	0.380	208.08	-0.0781	0.352
green	213.68	5.519	-0.232	-0.050	0.388	238.48	-0.1042	0.351
green	209.34	5.414	-0.252	-0.044	0.381	238.48	-0.1041	0.345
green	207.94	5.433	-0.069	-0.044	0.382	238.48	-0.1037	0.346
green	204.39	5.418	-0.112	-0.050	0.380	238.48	-0.1046	0.344
green	200.55	5.402	-0.139	-0.052	0.380	238.48	-0.1034	0.345
green	198.20	5.403	-0.029	-0.049	0.379	238.48	-0.103	0.344
green	196.65	5.363	-0.021	-0.045	0.378	238.48	-0.1024	0.343
green	195.11	5.370	-0.060	-0.041	0.378	238.48	-0.103	0.342
green	192.78	5.348	-0.009	-0.041	0.375	223.28	-0.0853	0.346
green	188.91	5.357	-0.111	-0.009	0.376	223.28	-0.0864	0.346
red	311.15	5.164	-0.233	0.001	0.363	344.88	-0.1048	0.329
red	305.60	5.224	-0.315	0.024	0.368	329.68	-0.1069	0.333
red	290.12	5.169	-0.451	0.023	0.361	329.68	-0.1074	0.326
red	274.64	5.192	-0.022	0.004	0.364	299.28	-0.1109	0.327
red	300.36	5.144	-0.528	0.025	0.363	329.68	-0.1077	0.327
red	291.69	5.231	-0.404	0.002	0.368	329.68	-0.1077	0.332
red	287.97	5.171	-0.343	0.015	0.363	314.48	-0.1102	0.327
red	281.78	5.174	-0.148	0.002	0.365	314.48	-0.1106	0.328
red	274.10	5.355	-0.132	-0.039	0.376	299.28	-0.1124	0.338
red	270.84	5.305	-0.159	0.001	0.371	299.28	-0.1124	0.333
red	266.30	5.359	-0.276	-0.020	0.378	299.28	-0.1128	0.340
red	263.21	5.223	-0.352	0.013	0.367	284.08	-0.1205	0.327
red	258.56	5.392	-0.250	-0.001	0.378	284.08	-0.1226	0.337
red	250.83	5.391	0.105	0.050	0.379	284.08	-0.1223	0.338
orange	434.98	4.898	-0.448	-0.002	0.344	466.48	-0.1005	0.313
orange	413.94	5.000	-0.177	-0.038	0.352	436.08	-0.112	0.317
orange	390.72	5.011	-0.343	-0.038	0.351	420.88	-0.1088	0.316
orange	367.51	4.942	-0.375	-0.019	0.347	390.48	-0.1014	0.315
orange	387.03	4.991	-0.393	-0.041	0.352	420.88	-0.1101	0.317
orange	374.03	5.001	-0.354	-0.039	0.351	405.68	-0.1043	0.318
orange	368.46	4.924	-0.408	-0.022	0.345	390.48	-0.102	0.313
orange	359.17	4.888	-0.401	0.004	0.342	390.48	-0.1018	0.311
orange	347.66	4.976	-0.408	-0.022	0.350	375.28	-0.1021	0.318
orange	340.60	4.908	-0.498	0.001	0.343	375.28	-0.102	0.311
orange	335.96	5.023	-0.343	-0.023	0.353	375.28	-0.1027	0.320
orange	331.31	4.981	-0.448	0.000	0.347	375.28	-0.1029	0.315
orange	324.35	5.060	-0.539	0.054	0.355	360.08	-0.1038	0.322
orange	312.74	5.080	-0.517	0.055	0.357	344.88	-0.1051	0.323

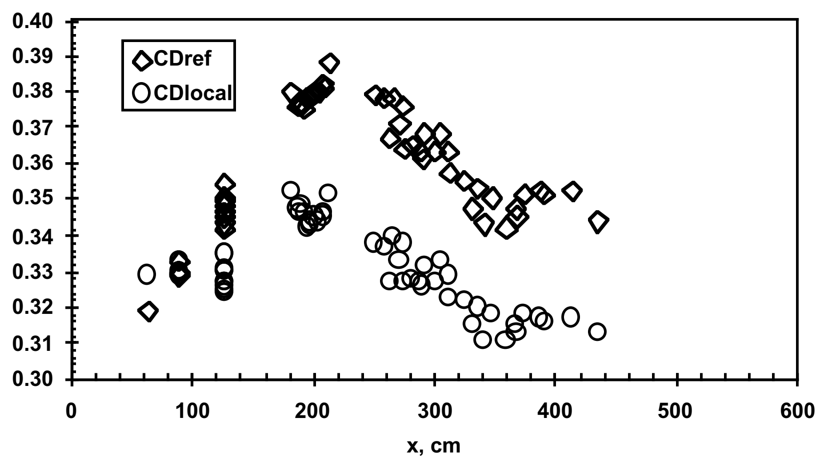
C_P distribution



ΔC_P distribution



C_D scatter



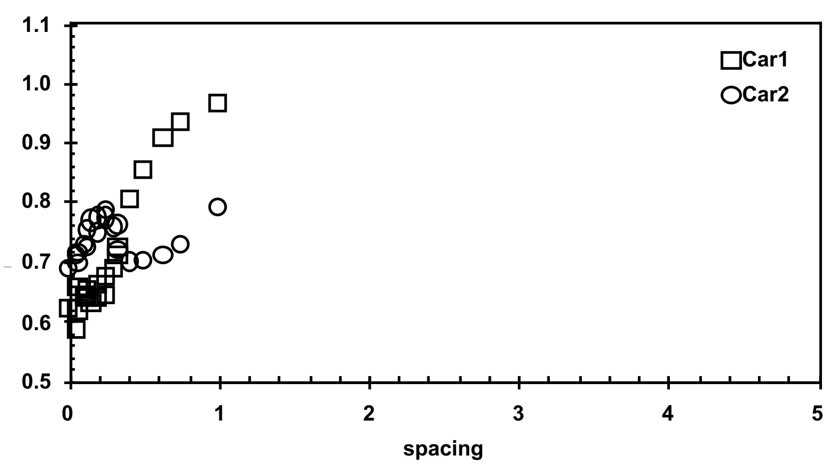
	Uncorrected	Corrected
Average CD	0.360	0.331
St. Dev.	0.016	0.011

2-Car Platoon Data

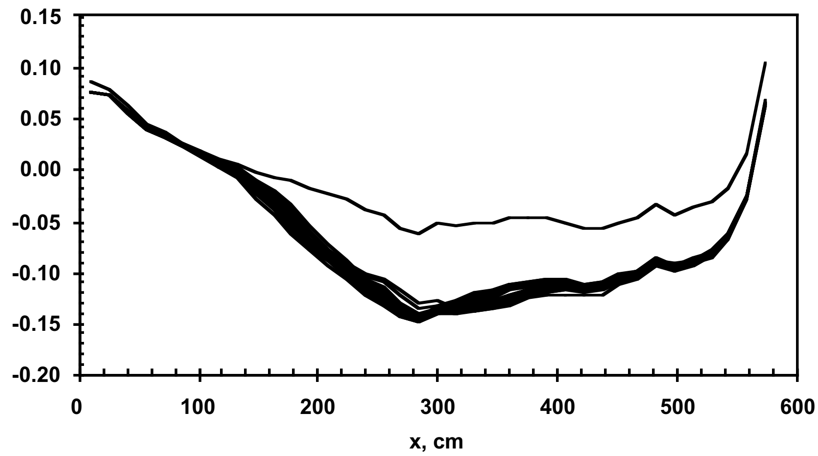
Spacing	Car1	Location1	Drag1	SideF1	Yaw1	CDref1	CD/CDref1	Xlocal1	Cplocal1	CDloc1	CDloc_inf1	CD/CDloc1
1.00	green	187.33	5.181	0.007	-0.036	0.363	0.966	223.28	-0.0909	0.333	0.347	0.961
0.75	green	197.25	5.005	0.016	-0.051	0.352	0.934	238.48	-0.1036	0.319	0.343	0.932
0.63	green	189.51	4.842	-0.115	-0.041	0.342	0.905	223.28	-0.0954	0.312	0.348	0.898
0.50	green	181.77	4.625	-0.031	-0.025	0.324	0.852	208.08	-0.0887	0.297	0.352	0.844
0.40	green	213.68	4.436	-0.133	-0.037	0.312	0.804	238.48	-0.1061	0.282	0.351	0.802
0.33	green	209.34	3.926	-0.134	-0.026	0.277	0.726	238.48	-0.1089	0.249	0.345	0.723
0.30	green	207.49	3.748	0.030	-0.031	0.263	0.689	238.48	-0.1103	0.237	0.346	0.684
0.25	green	204.39	3.656	-0.022	-0.072	0.257	0.676	238.48	-0.1126	0.231	0.344	0.671
0.19	green	200.55	3.603	-0.337	-0.078	0.253	0.665	238.48	-0.1144	0.227	0.345	0.658
0.15	green	198.20	3.423	0.056	-0.031	0.240	0.632	238.48	-0.1161	0.215	0.344	0.625
0.13	green	196.65	3.442	-0.187	-0.065	0.242	0.639	238.48	-0.1178	0.216	0.343	0.631
0.10	green	195.11	3.463	-0.368	-0.083	0.244	0.646	238.48	-0.1186	0.218	0.342	0.637
0.06	green	192.78	3.304	-0.375	-0.093	0.233	0.620	223.28	-0.1027	0.211	0.346	0.610
0.00	green	188.91	3.349	-0.638	-0.086	0.234	0.623	223.28	-0.1061	0.212	0.346	0.612

Spacing	Car2	Location2	Drag2	SideF2	Yaw2	CDref2	CD/CDref2	Xlocal2	Cplocal2	CDloc2	CDloc_inf2	CD/Cdloc2
1.00	red	311.15	4.082	-0.221	-0.017	0.286	0.788	329.68	-0.1367	0.252	0.329	0.766
0.75	red	305.60	3.814	-0.174	-0.013	0.269	0.729	329.68	-0.1367	0.236	0.333	0.710
0.63	red	290.12	3.654	-0.176	0.002	0.258	0.714	314.48	-0.1399	0.226	0.326	0.693
0.50	red	274.64	3.666	-0.117	0.004	0.256	0.705	299.28	-0.1407	0.225	0.327	0.686
0.40	red	300.36	3.615	-0.050	0.003	0.254	0.701	329.68	-0.1373	0.223	0.327	0.682
0.33	red	291.69	3.779	-0.068	0.003	0.266	0.723	299.28	-0.1386	0.234	0.332	0.704
0.30	red	287.97	3.912	-0.275	0.032	0.275	0.758	299.28	-0.1390	0.241	0.327	0.739
0.25	red	281.78	4.011	-0.108	0.001	0.282	0.773	284.08	-0.1482	0.245	0.328	0.748
0.19	red	274.10	4.012	0.071	-0.012	0.282	0.749	284.08	-0.1481	0.245	0.338	0.726
0.15	red	270.84	4.068	-0.201	0.003	0.285	0.769	284.08	-0.1478	0.248	0.333	0.746
0.13	red	266.30	3.907	-0.009	-0.005	0.274	0.725	284.08	-0.1487	0.239	0.340	0.702
0.10	red	263.21	3.792	0.068	-0.023	0.267	0.729	268.88	-0.1429	0.234	0.327	0.715
0.06	red	258.56	3.751	0.108	-0.020	0.264	0.699	268.88	-0.1428	0.231	0.337	0.687
0.00	red	250.83	3.737	0.371	-0.043	0.261	0.689	268.88	-0.1428	0.229	0.338	0.677

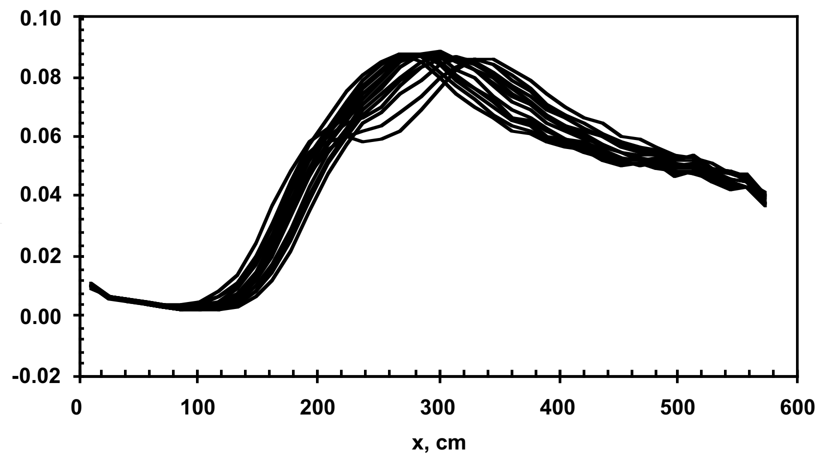
Uncorrected C_D ratios



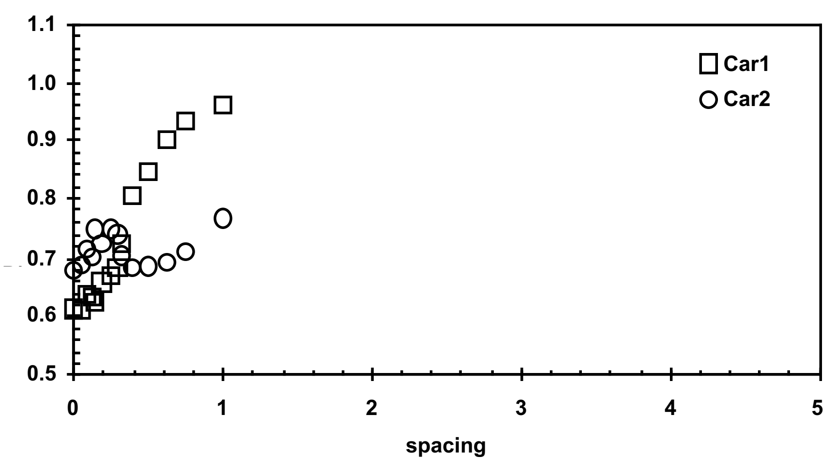
C_P distribution



ΔC_P distribution



Corrected C_D ratios



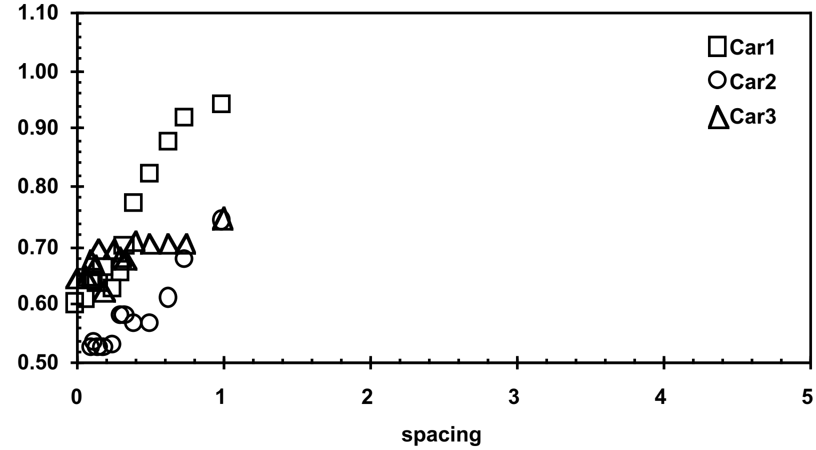
3-Car Platoon Data

Spacing	Car#	Location	Drag1	SideF1	Yaw1	CDref1	CD/CDref1	Xlocal1	Cplocal1	CDloc1	CDloc_inf1	CD/CDloc1
1.00	blue	63.50	4.273	-0.014	-0.019	0.301	0.943	86.48	0.0294	0.310	0.329	0.942
0.75	blue	88.90	4.333	-0.096	0.016	0.305	0.916	116.88	0.0017	0.306	0.333	0.917
0.63	blue	88.90	4.117	-0.046	-0.002	0.289	0.877	116.88	0.0003	0.289	0.330	0.877
0.50	blue	88.90	3.854	-0.058	0.000	0.270	0.822	116.88	-0.001	0.270	0.329	0.820
0.40	blue	127.00	3.835	-0.040	-0.010	0.270	0.772	162.48	-0.0616	0.255	0.331	0.769
0.33	blue	127.00	3.433	-0.133	-0.004	0.242	0.701	162.48	-0.0635	0.228	0.327	0.696
0.30	blue	127.00	3.208	-0.089	-0.019	0.226	0.658	162.48	-0.0635	0.212	0.325	0.653
0.25	blue	127.00	3.075	-0.006	-0.001	0.215	0.628	162.48	-0.0643	0.202	0.324	0.623
0.19	blue	127.00	3.256	-0.520	-0.044	0.229	0.663	162.48	-0.0661	0.215	0.327	0.657
0.15	blue	127.00	3.129	-0.636	-0.072	0.219	0.635	162.48	-0.0668	0.205	0.326	0.629
0.13	blue	127.00	3.202	-0.595	-0.074	0.225	0.646	162.48	-0.0678	0.211	0.330	0.640
0.10	blue	127.00	3.187	-0.618	-0.086	0.224	0.642	162.48	-0.068	0.210	0.330	0.636
0.06	blue	127.00	3.019	-0.659	-0.087	0.213	0.612	147.28	-0.0586	0.201	0.335	0.599
0.00	blue	127.00	3.038	-0.751	-0.080	0.213	0.602	162.48	-0.0688	0.199	0.335	0.595

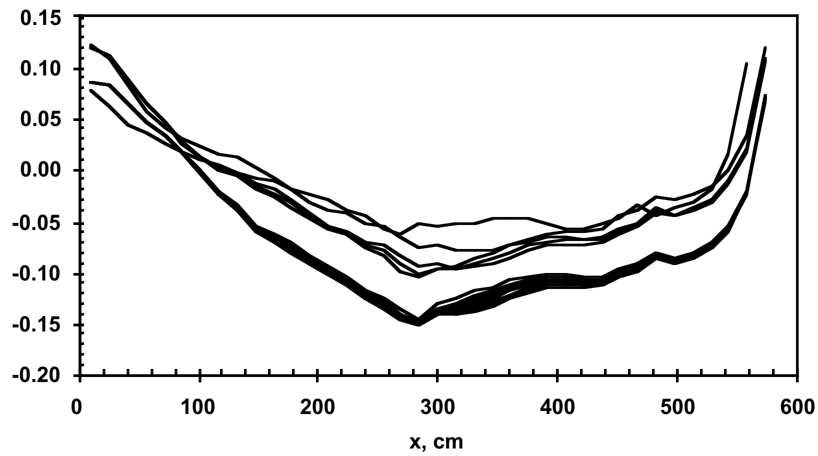
Spacing	Car#	Location	Drag2	SideF2	Yaw2	CDref2	CD/CDref2	Xlocal2	Cplocal2	CDloc2	CDloc_inf2	CD/CDloc2
1.00	green	187.33	3.982	0.005	-0.086	0.280	0.744	223.28	-0.0437	0.268	0.347	0.774
0.75	green	197.25	3.634	-0.004	-0.108	0.256	0.678	238.48	-0.0688	0.239	0.343	0.699
0.63	green	189.51	3.286	-0.034	-0.066	0.231	0.612	223.28	-0.0616	0.217	0.348	0.626
0.50	green	181.77	3.081	0.105	-0.063	0.216	0.569	208.08	-0.0564	0.204	0.352	0.580
0.40	green	213.68	3.127	0.029	-0.062	0.221	0.568	238.48	-0.1176	0.197	0.351	0.562
0.33	green	209.34	3.136	0.041	-0.058	0.221	0.581	238.48	-0.1193	0.198	0.345	0.573
0.30	green	207.94	3.161	0.058	-0.057	0.222	0.581	238.48	-0.1194	0.198	0.346	0.573
0.25	green	204.39	2.878	0.066	-0.057	0.201	0.530	238.48	-0.1204	0.180	0.344	0.522
0.19	green	200.55	2.843	0.029	-0.110	0.200	0.526	238.48	-0.1231	0.178	0.345	0.517
0.15	green	198.20	2.845	-0.033	-0.151	0.199	0.525	238.48	-0.1245	0.177	0.344	0.515
0.13	green	196.65	2.869	-0.327	-0.166	0.202	0.534	238.48	-0.125	0.180	0.343	0.524
0.10	green	195.11	2.823	-0.491	-0.195	0.199	0.526	238.48	-0.1254	0.176	0.342	0.515
0.06	green	192.78	2.341	1.061	0.406	0.165	0.439	223.28	-0.111	0.148	0.346	0.429
0.00	green	188.91	2.347	-0.480	-0.213	0.165	0.438	223.28	-0.1109	0.148	0.346	0.429

Spacing	Car#	Location	Drag3	SideF3	Yaw3	CDref3	CD/CDref3	Xlocal3	Cplocal3	CDloc3	CDloc_inf3	CD/CDloc3
1.00	red	311.15	3.848	-0.336	0.003	0.271	0.745	329.68	-0.0783	0.251	0.329	0.763
0.75	red	305.60	3.701	-0.233	0.006	0.261	0.708	329.68	-0.0931	0.238	0.333	0.717
0.63	red	290.12	3.626	-0.212	0.018	0.255	0.705	299.28	-0.0951	0.233	0.326	0.713
0.50	red	274.64	3.668	-0.171	0.013	0.257	0.706	284.08	-0.1046	0.233	0.327	0.710
0.40	red	300.36	3.649	-0.143	0.027	0.257	0.709	314.48	-0.1410	0.226	0.327	0.689
0.33	red	291.69	3.550	-0.126	0.019	0.250	0.680	299.28	-0.1405	0.220	0.332	0.661
0.30	red	287.97	3.525	-0.095	0.015	0.248	0.683	299.28	-0.1404	0.217	0.327	0.665
0.25	red	281.78	3.628	-0.107	0.021	0.254	0.696	284.08	-0.1492	0.221	0.328	0.673
0.19	red	274.10	3.327	-0.090	-0.017	0.234	0.623	284.08	-0.1508	0.204	0.338	0.603
0.15	red	270.84	3.696	0.153	-0.034	0.259	0.698	284.08	-0.1510	0.225	0.333	0.674
0.13	red	266.30	3.600	0.260	-0.050	0.253	0.670	268.88	-0.1464	0.221	0.340	0.650
0.10	red	263.21	3.543	0.338	-0.063	0.249	0.680	268.88	-0.1461	0.217	0.327	0.665
0.06	red	258.56	3.490	0.346	-0.067	0.246	0.650	268.88	-0.1444	0.215	0.337	0.637
0.00	red	250.83	3.486	0.506	-0.090	0.244	0.645	268.88	-0.1429	0.214	0.338	0.633

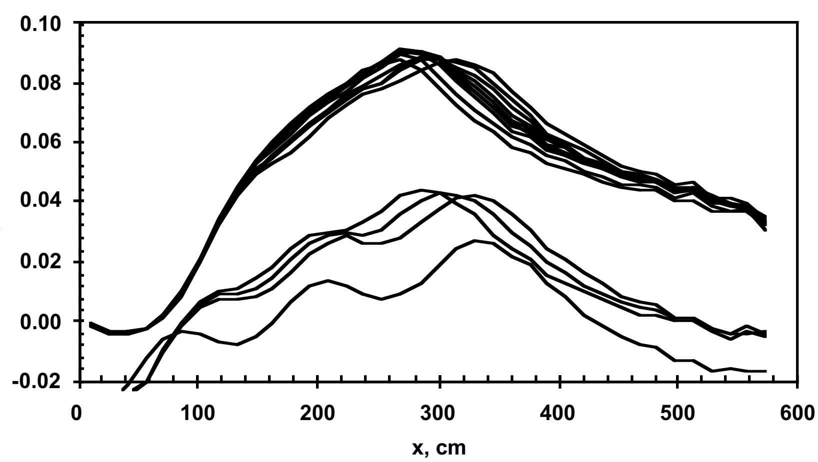
Uncorrected C_D ratios



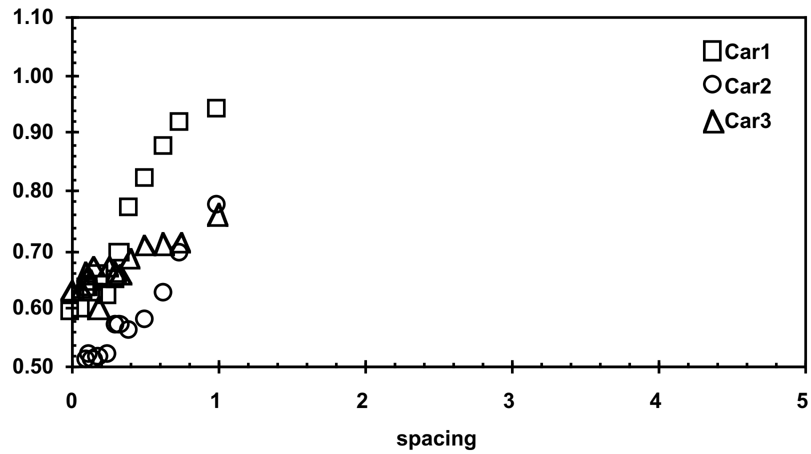
C_P distribution



ΔC_P distribution



Corrected C_D ratios



4-Car Platoon Data

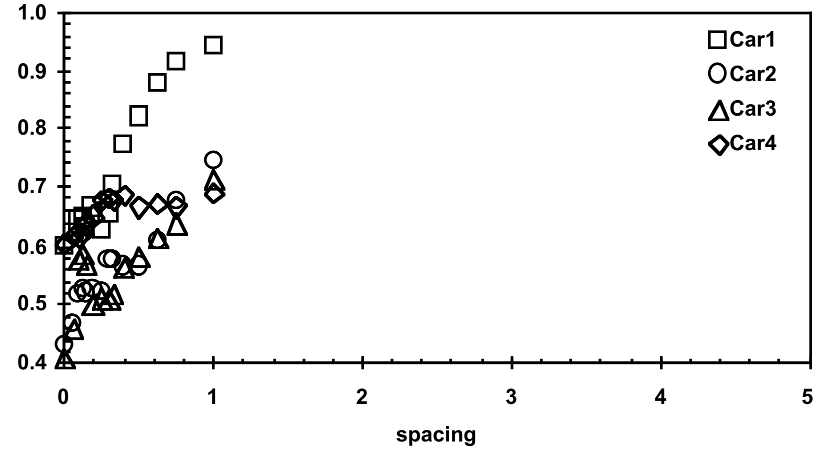
Spacing	Car#	Location	Drag1	SideF1	Yaw1	CDref1	CDref_inf1	CD/CDref1	Xlocal1	Cplocal1	CDloc1	CDloc_inf1	CD/CDloc1
1.00	blue	63.50	4.2636	-0.0142	-0.0186	0.3002	0.319	0.943	86.48	0.0307	0.310	0.329	0.943
0.75	blue	88.90	4.3245	-0.099	0.0184	0.3048	0.333	0.915	116.88	0.002	0.305	0.333	0.916
0.63	blue	88.90	4.1429	-0.0447	-0.0013	0.2889	0.330	0.877	116.88	0.0013	0.289	0.330	0.877
0.50	blue	88.90	3.848	-0.0669	0.0001	0.2698	0.329	0.821	116.88	0.0002	0.270	0.329	0.820
0.40	blue	127.00	3.8415	-0.0412	-0.0091	0.27	0.350	0.771	162.48	-0.0602	0.255	0.331	0.769
0.33	blue	127.00	3.447	-0.1309	-0.002	0.2422	0.346	0.701	162.48	-0.062	0.228	0.327	0.697
0.30	blue	127.00	3.21	-0.105	-0.0199	0.2254	0.343	0.657	162.48	-0.0623	0.212	0.325	0.653
0.25	blue	127.00	3.0708	0.0316	0.018	0.2154	0.342	0.629	162.48	-0.063	0.203	0.324	0.625
0.19	blue	127.00	3.2742	-0.5478	-0.0464	0.2296	0.346	0.664	162.48	-0.0652	0.216	0.327	0.658
0.15	blue	127.00	3.1003	-0.64	-0.0738	0.2183	0.345	0.633	162.48	-0.0656	0.205	0.326	0.628
0.13	blue	127.00	3.2158	-0.6228	-0.0763	0.2256	0.349	0.647	162.48	-0.0667	0.211	0.330	0.641
0.10	blue	127.00	3.1805	-0.6203	-0.0853	0.2238	0.349	0.641	162.48	-0.0669	0.210	0.330	0.635
0.06	blue	127.00	3.101	-0.717	-0.0684	0.2177	0.348	0.626	147.28	-0.0566	0.206	0.335	0.615
0.00	blue	127.00	3.0366	-0.7643	-0.0815	0.2131	0.354	0.602	162.48	-0.0672	0.200	0.335	0.596

Spacing	Car#	Location	Drag2	SideF2	Yaw2	CDref2	CDref_inf2	CD/CDref2	Xlocal2	Cplocal2	CDloc2	CDloc_inf2	CD/CDloc2
1.00	green	187.33	3.9747	-0.0133	-0.0881	0.2798	0.376	0.744	223.28	-0.0416	0.269	0.347	0.775
0.75	green	197.25	3.6128	-0.0007	-0.1071	0.2546	0.378	0.674	238.48	-0.0671	0.239	0.343	0.697
0.63	green	189.51	3.2991	-0.0339	-0.0664	0.2301	0.377	0.610	223.28	-0.0591	0.217	0.348	0.625
0.50	green	181.77	3.0651	0.0966	-0.0645	0.2149	0.380	0.566	208.08	-0.0542	0.204	0.352	0.579
0.40	green	213.68	3.1288	0.0277	-0.0633	0.2199	0.388	0.567	238.48	-0.1151	0.197	0.351	0.561
0.33	green	209.34	3.1356	0.0438	-0.0576	0.2203	0.381	0.579	238.48	-0.117	0.197	0.345	0.572
0.30	green	207.49	3.157	0.0627	-0.0583	0.2217	0.382	0.580	238.48	-0.1169	0.198	0.346	0.573
0.25	green	204.39	2.8396	0.0334	-0.0532	0.1992	0.380	0.524	238.48	-0.1182	0.178	0.344	0.518
0.19	green	200.55	2.8531	0.0093	-0.1143	0.2001	0.380	0.526	238.48	-0.1206	0.179	0.345	0.518
0.15	green	198.20	2.8017	-0.0352	-0.1504	0.1973	0.379	0.520	238.48	-0.1214	0.176	0.344	0.512
0.13	green	196.65	2.8357	-0.3225	-0.1663	0.199	0.378	0.526	238.48	-0.1238	0.177	0.343	0.516
0.10	green	195.11	2.7844	-0.4916	-0.1933	0.196	0.378	0.519	238.48	-0.1246	0.174	0.342	0.509
0.06	green	192.78	2.4994	-0.4422	-0.1881	0.1755	0.375	0.468	223.28	-0.1078	0.158	0.346	0.458
0.00	green	188.91	2.3167	-0.4876	-0.2138	0.1626	0.376	0.433	223.28	-0.1085	0.147	0.346	0.424

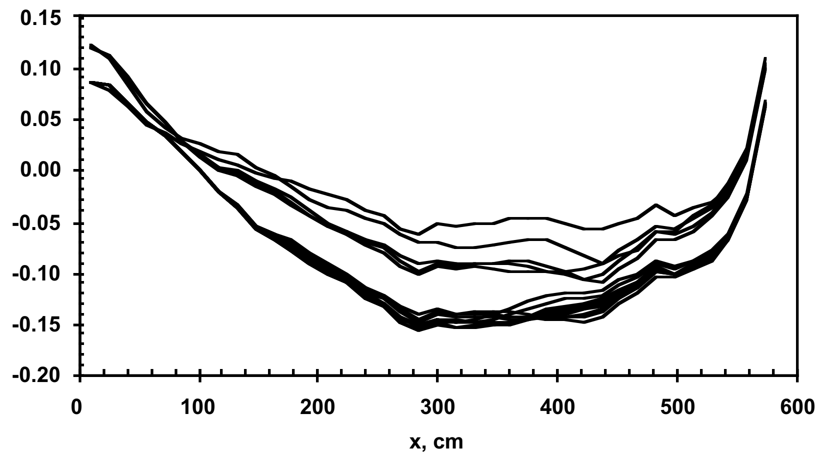
Spacing	Car#	Location	Drag3	SideF3	Yaw3	CDref3	CDref_inf3	CD/CDref3	Xlocal3	Cplocal3	CDloc3	CDloc_inf3	CD/CDloc3
1.00	red	311.15	3.6671	-0.3338	0.0017	0.2582	0.363	0.711	344.88	-0.0733	0.241	0.329	0.731
0.75	red	305.60	3.3331	-0.1851	0.0124	0.2349	0.368	0.638	329.68	-0.0911	0.215	0.333	0.647
0.63	red	290.12	3.1811	-0.1878	0.0201	0.2218	0.361	0.614	329.68	-0.0917	0.203	0.326	0.623
0.50	red	274.64	3.0242	-0.1457	0.0186	0.212	0.364	0.583	299.28	-0.0936	0.194	0.327	0.592
0.40	red	300.36	2.9091	-0.1522	0.0245	0.2045	0.363	0.564	329.68	-0.1376	0.180	0.327	0.549
0.33	red	291.69	2.7108	-0.1479	0.0149	0.1904	0.368	0.517	329.68	-0.1395	0.167	0.332	0.503
0.30	red	287.97	2.6285	-0.0928	0.0102	0.1846	0.363	0.509	314.48	-0.1414	0.162	0.327	0.495
0.25	red	281.78	2.6605	-0.1235	0.0162	0.1866	0.365	0.512	314.48	-0.1423	0.163	0.328	0.498
0.19	red	274.10	2.6735	-0.1028	-0.0299	0.1875	0.376	0.499	299.28	-0.1452	0.164	0.338	0.485
0.15	red	270.84	2.9942	-0.0503	-0.0513	0.2108	0.371	0.569	299.28	-0.1474	0.184	0.333	0.551
0.13	red	266.30	3.1785	-0.0038	-0.0692	0.223	0.378	0.589	299.28	-0.1494	0.194	0.340	0.571
0.10	red	263.21	3.0183	0.0711	-0.0791	0.2124	0.367	0.580	284.08	-0.1565	0.184	0.327	0.561
0.06	red	258.56	2.4787	-0.3373	-0.1581	0.174	0.378	0.460	284.08	-0.152	0.151	0.337	0.449
0.00	red	250.83	2.2017	-0.2237	-0.1867	0.1545	0.379	0.408	284.08	-0.152	0.134	0.338	0.397

Spacing	Car#	Location	Drag4	SideF4	Yaw4	CDref4	CDref_inf4	CD/CDref4	Xlocal4	Cplocal4	CDloc4	CDloc_inf4	CD/CDloc4
1.00	orange	434.98	3.3655	-0.0486	0.1161	0.2369	0.344	0.688	436.08	-0.0898	0.217	0.313	0.695
0.75	orange	413.94	3.3364	-0.1354	0.0016	0.2351	0.352	0.667	436.08	-0.1088	0.212	0.317	0.669
0.63	orange	390.72	3.3637	-0.1111	0.0066	0.2346	0.351	0.669	405.68	-0.1021	0.213	0.316	0.673
0.50	orange	367.51	3.3003	-0.1186	0.0085	0.2314	0.347	0.667	375.28	-0.0988	0.211	0.315	0.669
0.40	orange	387.03	3.4236	-0.1033	0.0124	0.2406	0.352	0.684	390.48	-0.1446	0.210	0.317	0.664
0.33	orange	374.03	3.3805	-0.098	0.0114	0.2375	0.351	0.676	375.28	-0.1436	0.208	0.318	0.653
0.30	orange	368.46	3.3406	-0.0935	0.0122	0.2346	0.345	0.681	375.28	-0.1439	0.205	0.313	0.656
0.25	orange	359.17	3.2937	-0.0931	0.0098	0.231	0.342	0.675	375.28	-0.1445	0.202	0.311	0.650
0.19	orange	347.66	3.2493	0.0252	-0.0223	0.2278	0.350	0.651	344.88	-0.1490	0.198	0.318	0.624
0.15	orange	340.60	3.1239	0.0879	-0.0433	0.22	0.343	0.641	344.88	-0.1501	0.191	0.311	0.614
0.13	orange	335.96	3.1348	0.1852	-0.0463	0.2199	0.353	0.623	344.88	-0.1521	0.191	0.320	0.596
0.10	orange	331.31	3.04	0.2004	-0.0533	0.214	0.347	0.616	344.88	-0.1521	0.186	0.315	0.590
0.06	orange	324.35	3.1312	0.2692	0.0971	0.2198	0.355	0.619	329.68	-0.1475	0.192	0.322	0.595
0.00	orange	312.74	3.0776	0.2484	0.1135	0.2159	0.357	0.605	314.48	-0.1470	0.188	0.323	0.583

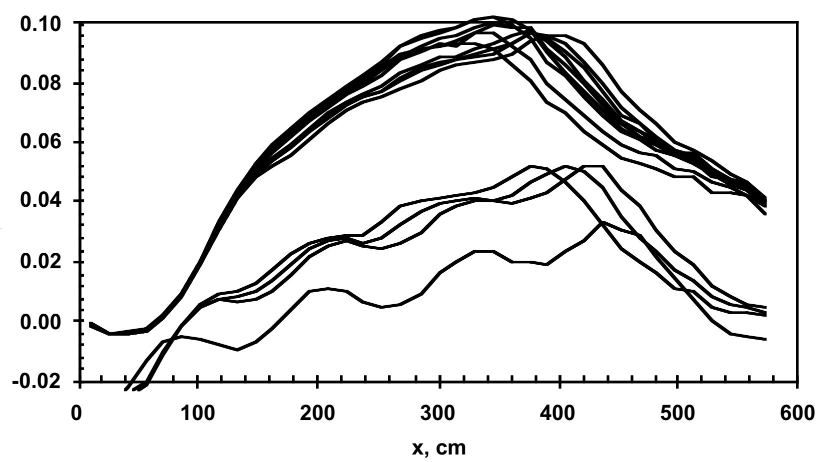
Uncorrected C_D ratios



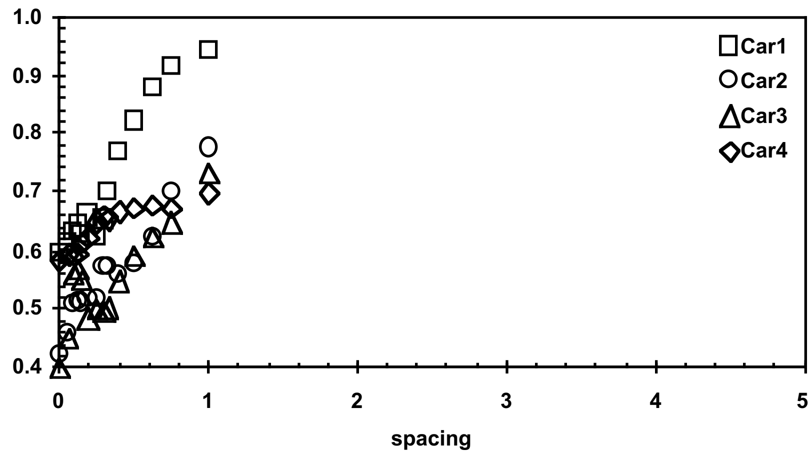
C_P distribution



ΔC_P distribution



Corrected C_D ratios



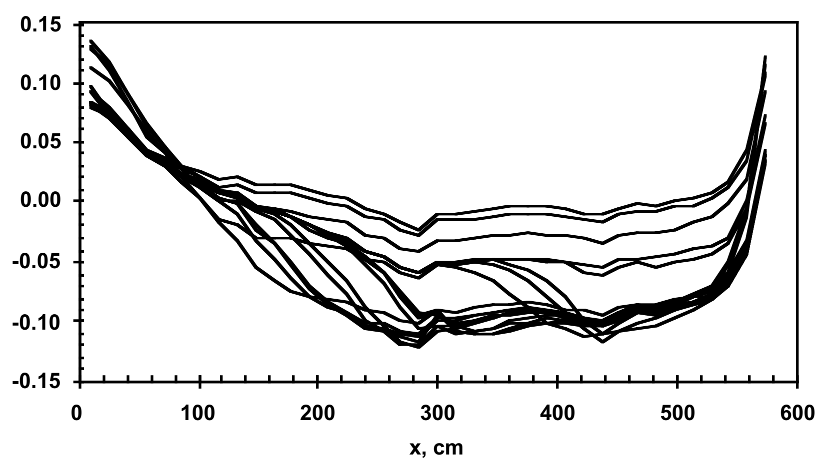
2 ,3 & 4-Car Platoon Series (Set 3)

MZ's data. In this series, the CD of each model alone at each position was recorded just before platoon measurements were taken.

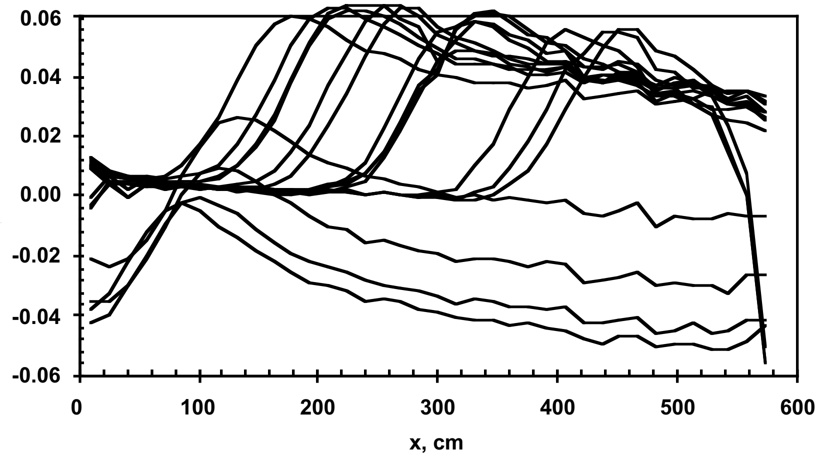
Single Car Data

Car#	Position	Drag	Side F	Yaw	CDref	Xlocal	Cplocal	CDlocal
blue	150.65	5.872	-0.370	0.004	0.350	177.78	-0.0731	0.326
blue	104.22	5.666	-0.369	0.003	0.337	132.18	-0.0192	0.331
blue	88.75	5.523	-0.256	0.012	0.327	116.98	-0.0001	0.327
blue	73.25	5.462	-0.380	0.012	0.323	101.78	0.0204	0.330
blue	57.79	5.207	-0.317	0.006	0.309	86.58	0.0293	0.318
green	243.52	6.216	0.280	-0.044	0.372	284.18	-0.1223	0.331
green	228.04	6.284	-0.044	-0.066	0.373	268.98	-0.1182	0.334
green	197.08	6.235	0.156	-0.078	0.371	238.58	-0.1061	0.335
green	197.08	6.218	0.172	-0.076	0.368	238.58	-0.1035	0.333
green	181.61	6.110	0.346	-0.046	0.365	208.18	-0.0880	0.335
red	305.44	5.888	-0.637	0.024	0.351	344.98	-0.1101	0.316
red	305.44	5.871	-0.638	0.025	0.353	344.98	-0.1096	0.318
red	305.44	5.901	-0.612	0.001	0.350	329.78	-0.1078	0.316
red	289.94	5.864	-0.718	-0.002	0.348	329.78	-0.1077	0.314
yellow	429.26	6.195	-0.663	-0.028	0.365	466.58	-0.1054	0.330
yellow	413.79	6.190	-0.646	-0.006	0.368	436.18	-0.1159	0.330
yellow	382.83	6.088	-0.740	-0.011	0.361	405.78	-0.1062	0.326

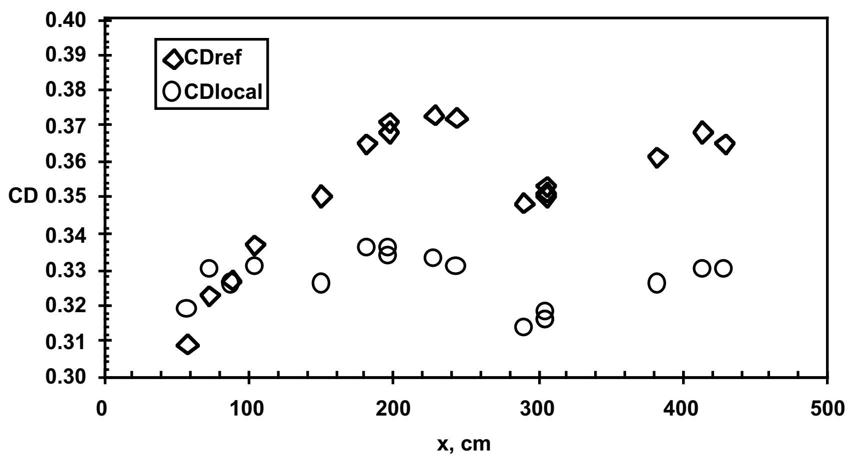
C_P distribution



ΔC_P distribution



C_D scatter



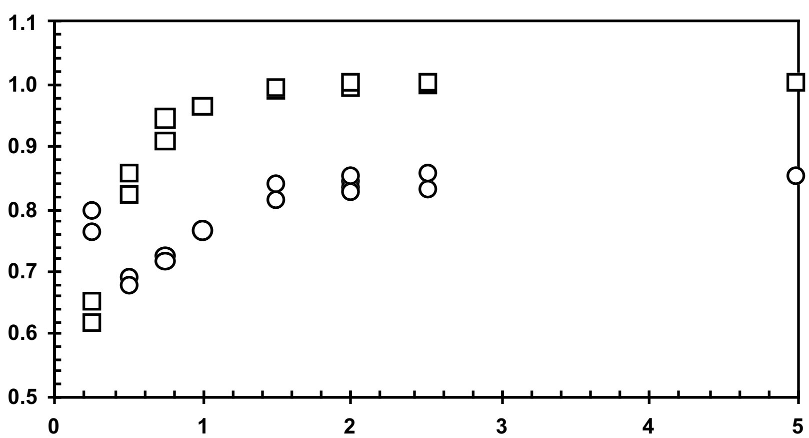
	CDref	CDlocal
Average	0.352	0.327
Std. Dev.	0.019	0.007

2-Car Platoon Data

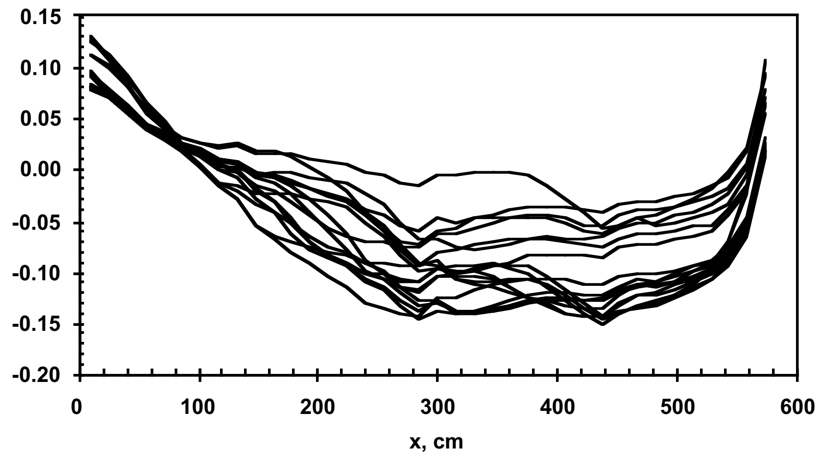
Spacing	Car#	Position1	Drag1	Side F1	Yaw1	CDref1	CDref_inf1	CD/CDref1	Xlocal1	Cplocal1	CDlocal1	CDloc_inf1	CD/CDloc1
0.25	blue	150.65	3.628	-0.401	-0.013	0.216	0.350	0.617	177.78	-0.0789	0.200	0.326	0.614
0.25	red	305.44	3.870	-0.555	0.007	0.230	0.353	0.652	344.98	-0.1141	0.206	0.316	0.653
0.50	blue	104.22	4.663	-0.298	0.006	0.277	0.337	0.822	132.18	-0.0219	0.271	0.331	0.820
0.50	green	197.08	5.300	0.208	-0.073	0.315	0.368	0.856	238.58	-0.1090	0.284	0.335	0.847
0.75	blue	88.75	5.022	-0.230	0.009	0.297	0.327	0.908	116.98	-0.0003	0.297	0.327	0.908
0.75	green	197.08	5.759	0.220	-0.072	0.347	0.368	0.943	238.58	-0.1069	0.313	0.335	0.935
1.00	green	181.61	5.912	0.360	-0.046	0.352	0.365	0.964	208.18	-0.1007	0.320	0.335	0.953
1.00	red	305.44	5.713	-0.644	0.023	0.340	0.353	0.963	344.98	-0.1094	0.306	0.316	0.969
1.50	blue	150.65	5.862	-0.369	0.004	0.347	0.350	0.991	177.78	-0.0703	0.324	0.326	0.994
1.50	green	228.04	6.227	-0.022	-0.063	0.370	0.373	0.992	268.98	-0.1141	0.332	0.334	0.996
2.00	blue	104.22	5.677	-0.371	0.001	0.335	0.337	0.994	132.18	-0.0171	0.329	0.331	0.996
2.00	blue	57.79	5.150	-0.323	0.004	0.307	0.309	0.994	86.58	0.0298	0.316	0.318	0.994
2.00	green	243.52	6.240	0.266	-0.047	0.370	0.372	0.995	284.18	-0.1183	0.331	0.331	0.998
2.00	green	197.08	6.227	0.155	-0.078	0.368	0.368	1.000	238.58	-0.1009	0.334	0.335	0.997
2.50	blue	88.75	5.479	-0.244	0.014	0.326	0.327	0.997	116.98	0.0019	0.327	0.327	0.999
2.50	green	197.08	6.204	0.189	-0.076	0.368	0.368	1.000	238.58	-0.1009	0.334	0.335	0.997
5.00	blue	57.79	5.199	-0.327	0.004	0.309	0.309	1.000	86.58	0.0298	0.318	0.318	1.001

Spacing	Car#	Position2	Drag2	Side F2	Yaw2	CDref2	CDref_inf2	CD/Cdref2	Xlocal2	Cplocal2	CDlocal2	Cdloc_inf2	CD/CDloc2
0.25	green	228.04	4.983	0.091	-0.050	0.297	0.373	0.796	253.71	-0.1346	0.262	0.334	0.785
0.25	yellow	382.83	4.636	-0.118	-0.007	0.275	0.361	0.762	405.73	-0.1321	0.243	0.326	0.744
0.50	green	197.08	4.302	0.072	-0.065	0.256	0.371	0.690	223.30	-0.0810	0.237	0.335	0.706
0.50	red	289.94	3.974	-0.249	0.030	0.236	0.348	0.678	329.72	-0.1374	0.207	0.314	0.660
0.75	green	197.08	4.541	-0.030	-0.068	0.269	0.371	0.725	223.30	-0.0631	0.253	0.335	0.754
0.75	red	305.44	4.158	-0.462	0.014	0.251	0.351	0.715	329.72	-0.1416	0.220	0.316	0.695
1.00	red	305.44	4.499	-0.554	0.022	0.268	0.351	0.764	344.92	-0.1376	0.236	0.316	0.745
1.00	yellow	429.26	4.684	-0.225	-0.023	0.279	0.365	0.764	451.33	-0.1407	0.245	0.330	0.741
1.50	red	305.44	4.974	-0.372	-0.014	0.294	0.351	0.838	329.72	-0.1371	0.259	0.316	0.818
1.50	yellow	382.83	4.959	-0.489	0.012	0.294	0.361	0.814	405.73	-0.1396	0.258	0.326	0.791
2.00	red	289.94	4.967	-0.547	-0.010	0.293	0.348	0.842	329.72	-0.0972	0.267	0.314	0.850
2.00	green	243.52	5.211	0.029	-0.056	0.310	0.372	0.833	268.91	-0.0687	0.290	0.331	0.875
2.00	yellow	429.26	5.094	-0.505	0.014	0.302	0.365	0.827	466.54	-0.1351	0.266	0.330	0.806
2.00	yellow	382.83	5.188	-0.561	0.011	0.307	0.361	0.850	405.73	-0.1402	0.269	0.326	0.825
2.50	red	305.44	4.935	-0.573	-0.001	0.293	0.353	0.830	329.72	-0.0764	0.272	0.316	0.861
2.50	yellow	413.79	5.319	-0.556	0.014	0.315	0.368	0.856	436.13	-0.1500	0.274	0.330	0.831
5.00	yellow	429.26	5.232	-0.567	-0.017	0.311	0.365	0.852	451.33	-0.0537	0.295	0.330	0.894

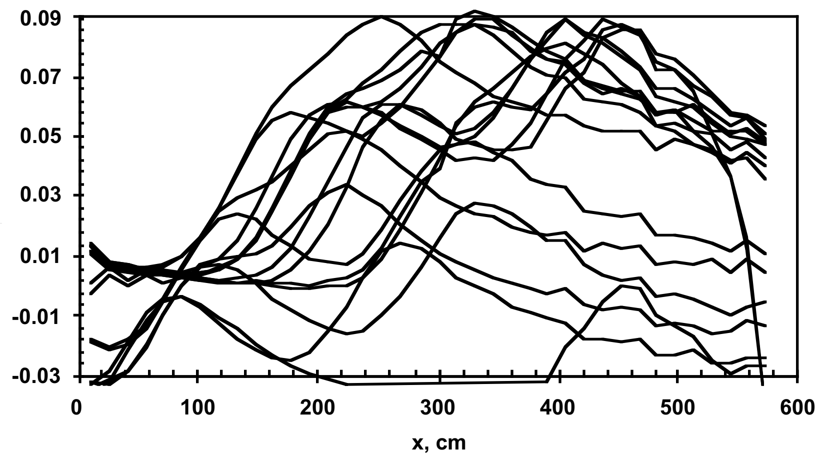
Uncorrected C_D ratios



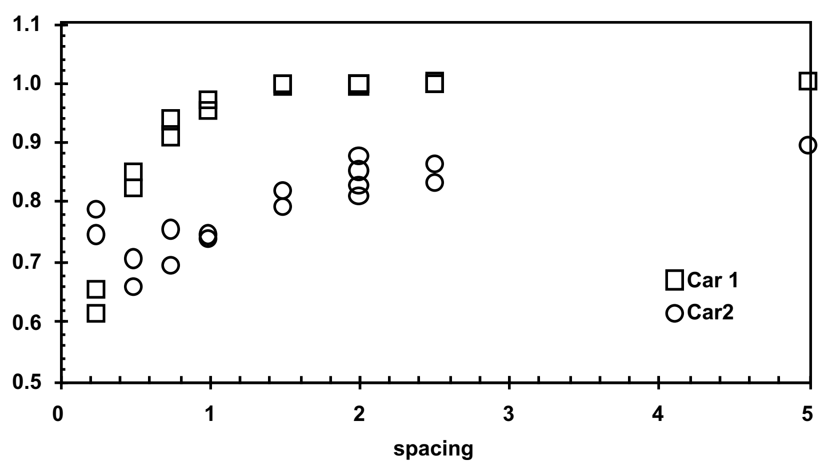
C_P distribution



ΔC_P distribution



Corrected C_D ratios



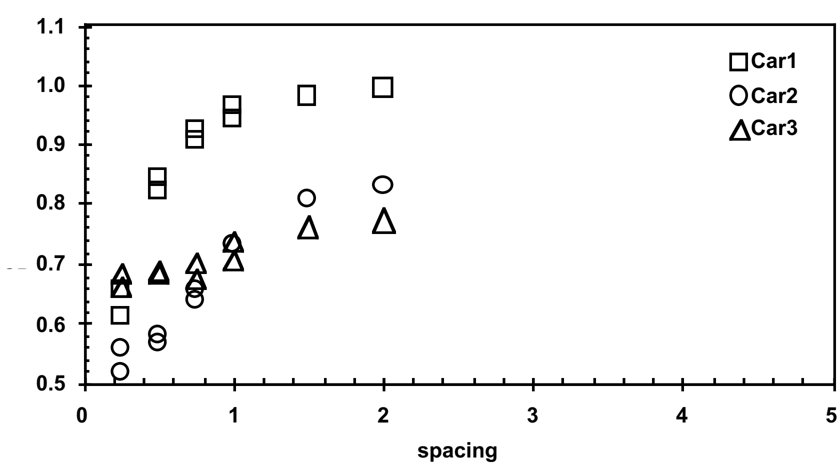
3-Car Platoon Data

Spacing	Position1	Drag1	Side F1	Yaw1	CDref1	CDref_inf1	CD/CDref1	Xlocal1	Cplocal1	CDlocal1	Cdloc_inf3	CD/CDloc1
0.25	150.65	3.621	-0.408	-0.010	0.215	0.350	0.614	177.78	-0.0772	0.200	0.326	0.612
0.25	228.04	4.130	-0.143	-0.083	0.245	0.373	0.657	268.98	-0.1258	0.218	0.334	0.652
0.50	104.22	4.651	-0.301	0.005	0.276	0.337	0.819	132.18	-0.0211	0.270	0.331	0.817
0.50	197.08	5.297	0.233	-0.069	0.313	0.371	0.844	238.58	-0.1073	0.283	0.335	0.843
0.75	88.75	5.000	-0.233	0.011	0.296	0.327	0.905	116.98	0.0005	0.296	0.327	0.906
0.75	197.08	5.786	0.241	-0.071	0.343	0.371	0.925	238.58	-0.1022	0.311	0.335	0.928
1.00	57.79	4.868	-0.312	0.001	0.291	0.309	0.942	86.58	0.0283	0.299	0.318	0.941
1.00	181.61	5.884	0.340	-0.049	0.352	0.365	0.964	208.18	-0.0878	0.324	0.335	0.965
1.50	73.25	5.332	-0.365	0.011	0.317	0.323	0.981	101.78	0.0219	0.324	0.330	0.983
2.00	57.79	5.155	-0.329	0.003	0.307	0.309	0.994	86.58	0.0305	0.317	0.318	0.995

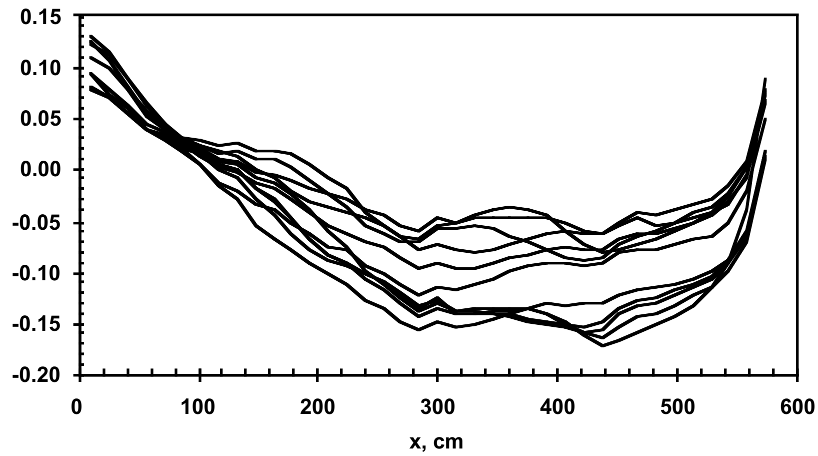
Spacing	Position2	Drag2	Side F2	Yaw2	CDref2	CDref_inf2	CD/CDref2	Xlocal2	Cplocal2	CDlocal2	CDloc_inf3	CD/CDloc2
0.25	228.04	3.502	0.141	-0.054	0.208	0.373	0.558	268.98	-0.1488	0.181	0.334	0.543
0.25	305.44	3.075	0.037	0.004	0.182	0.351	0.519	344.98	-0.1393	0.160	0.316	0.505
0.50	197.08	3.646	0.149	-0.055	0.216	0.371	0.582	238.58	-0.0929	0.198	0.335	0.589
0.50	289.94	3.349	-0.170	0.030	0.198	0.348	0.569	329.78	-0.1108	0.178	0.314	0.567
0.75	197.08	4.124	-0.014	-0.071	0.244	0.371	0.658	238.58	-0.0699	0.228	0.335	0.680
0.75	305.44	3.795	-0.386	0.020	0.225	0.351	0.641	344.98	-0.1353	0.198	0.316	0.627
1.00	181.61	4.497	0.385	-0.024	0.268	0.365	0.734	208.18	-0.0392	0.258	0.335	0.769
1.00	305.44	4.304	-0.573	0.020	0.258	0.351	0.735	344.98	-0.1380	0.227	0.316	0.717
1.50	228.04	5.065	-0.137	-0.073	0.301	0.373	0.807	268.98	-0.0693	0.281	0.334	0.844
2.00	243.52	5.199	0.024	-0.058	0.309	0.372	0.831	284.18	-0.0681	0.289	0.331	0.873

Spacing	Position3	Drag3	Side F3	Yaw3	CDref3	CDref_inf3	CD/CDref3	Xlocal3	Cplocal3	CDlocal3	CDloc_inf3	Cd/CDloc3
0.25	305.44	4.037	-0.015	0.007	0.240	0.351	0.684	314.52	-0.1541	0.208	0.316	0.658
0.25	382.83	4.029	-0.203	0.015	0.239	0.361	0.662	405.3	-0.1513	0.208	0.326	0.636
0.50	289.94	4.016	-0.187	0.014	0.238	0.348	0.684	299.31	-0.1137	0.214	0.314	0.680
0.50	382.83	4.210	-0.378	0.041	0.249	0.361	0.690	405.73	-0.1548	0.216	0.326	0.661
0.75	305.44	4.009	-0.341	0.013	0.238	0.351	0.678	329.72	-0.0950	0.217	0.316	0.687
0.75	413.79	4.363	-0.330	0.020	0.259	0.368	0.704	436.13	-0.1641	0.222	0.330	0.675
1.00	305.44	4.172	-0.495	0.020	0.249	0.351	0.709	329.72	-0.0791	0.231	0.316	0.730
1.00	429.26	4.508	-0.356	0.008	0.270	0.365	0.740	451.33	-0.1677	0.231	0.330	0.700
1.50	382.83	4.618	-0.443	0.005	0.275	0.361	0.762	405.73	-0.0840	0.254	0.326	0.777
2.00	429.26	4.748	-0.447	0.011	0.282	0.365	0.773	451.33	-0.0772	0.262	0.330	0.793

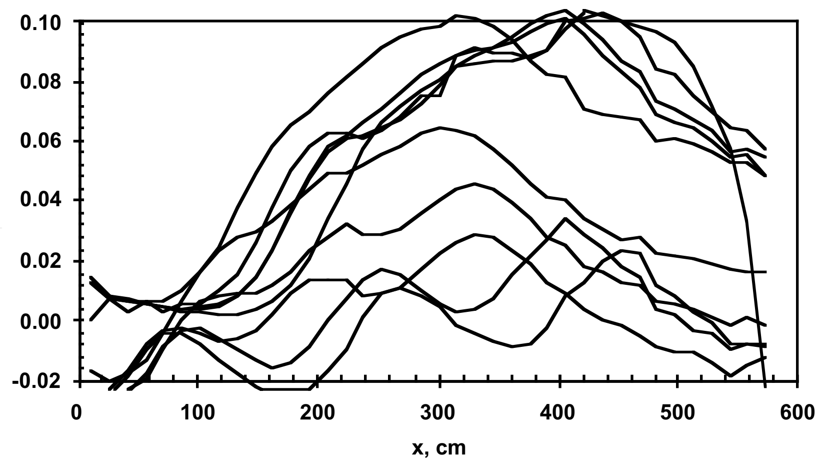
Uncorrected C_D ratios



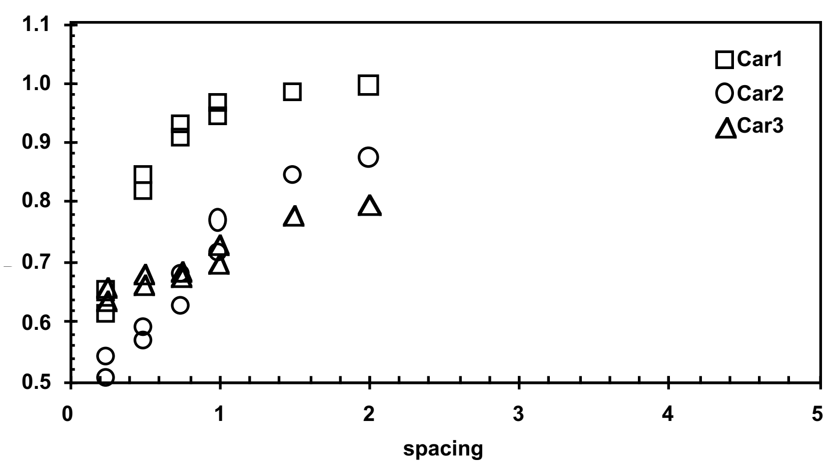
C_P distribution



ΔC_P distribution



Corrected C_D ratios



4-Car Platoon Data

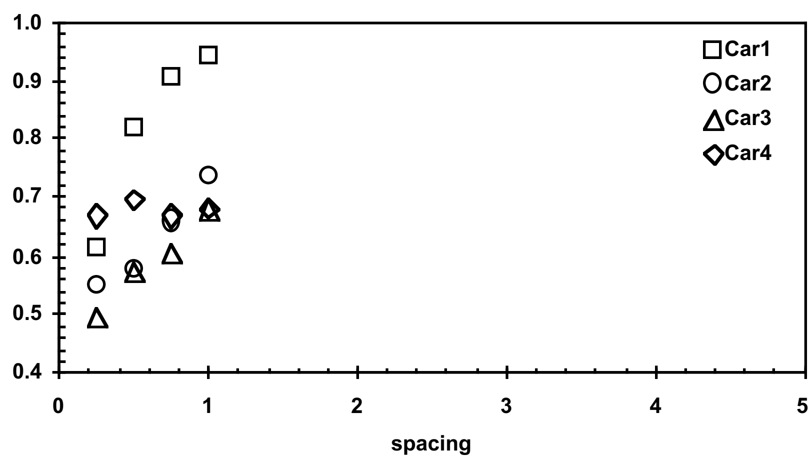
Spacing	Position1	Drag1	Side F1	Yaw1	CDref1	CDref_inf1	CD/CDref1	Xlocal1	Cplocal1	CDlocal1	CDloc_inf1	CD/CDloc1
0.25	150.65	3.627	-0.435	-0.013	0.215	0.350	0.614	177.78	-0.0762	0.200	0.326	0.613
0.50	104.22	4.654	-0.311	0.004	0.276	0.337	0.819	132.18	-0.0200	0.271	0.331	0.818
0.75	88.75	4.970	-0.238	0.011	0.296	0.327	0.905	116.98	0.0007	0.296	0.327	0.906
1.00	57.79	4.873	-0.315	0.001	0.291	0.309	0.942	86.58	0.0288	0.300	0.318	0.941

Spacing	Position2	Drag2	Side F2	Yaw2	CDref2	CDref_inf2	CD/CDref2	Xlocal2	Cplocal2	CDlocal2	CDloc_inf2	CD/CDloc2
0.25	228.04	3.472	0.147	-0.053	0.206	0.373	0.552	268.98	-0.1457	0.180	0.334	0.539
0.50	197.08	3.634	0.141	-0.057	0.215	0.371	0.580	238.58	-0.0900	0.197	0.335	0.588
0.75	197.08	4.093	-0.013	-0.069	0.244	0.371	0.658	238.58	-0.0684	0.228	0.333	0.685
1.00	181.61	4.488	0.437	-0.019	0.268	0.365	0.734	208.18	-0.0387	0.258	0.335	0.769

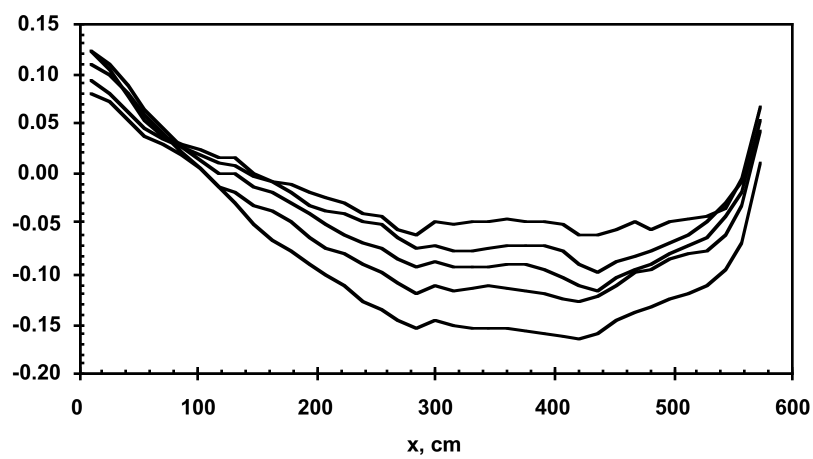
Spacing	Position3	Drag3	Side F3	Yaw3	CDref3	CDref_inf3	CD/CDref3	Xlocal3	Cplocal3	CDlocal3	CDloc_inf3	CD/CDloc3
0.25	305.44	2.932	-0.044	0.004	0.174	0.351	0.496	344.98	-0.1533	0.151	0.316	0.477
0.50	289.94	3.353	-0.168	0.022	0.199	0.348	0.572	329.78	-0.1126	0.179	0.314	0.569
0.75	305.44	3.585	-0.230	0.026	0.213	0.351	0.607	344.98	-0.0909	0.195	0.316	0.618
1.00	305.44	3.980	-0.464	0.028	0.238	0.351	0.678	344.98	-0.0734	0.222	0.316	0.701

Spacing	Position4	Drag4	Side F4	Yaw4	CDref4	CDref_inf4	CD/CDref4	Xlocal4	Cplocal4	Cdlocal4	CDloc_inf4	CD/CDloc4
0.25	382.83	4.068	-0.262	0.018	0.241	0.361	0.668	405.73	-0.1619	0.207	0.326	0.636
0.50	382.83	4.219	-0.301	0.027	0.250	0.361	0.693	405.73	-0.1239	0.222	0.326	0.682
0.75	413.79	4.124	-0.237	0.013	0.246	0.368	0.668	436.13	-0.1150	0.221	0.330	0.669
1.00	429.26	4.156	-0.353	0.022	0.248	0.365	0.679	436.13	-0.0962	0.226	0.330	0.685

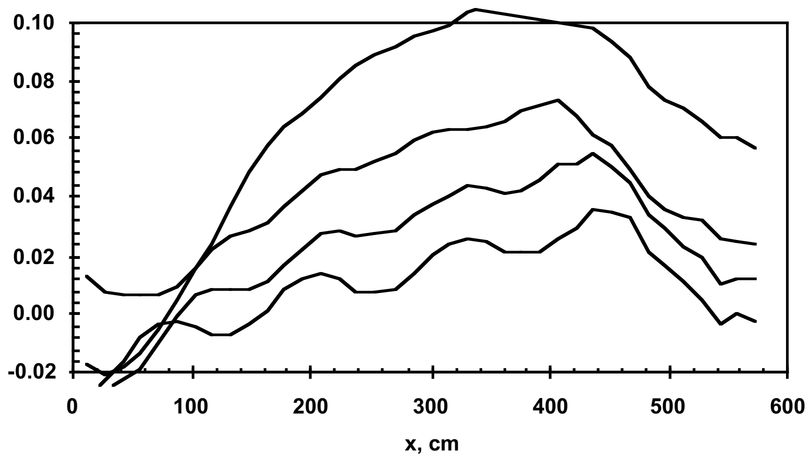
Uncorrected C_D ratios



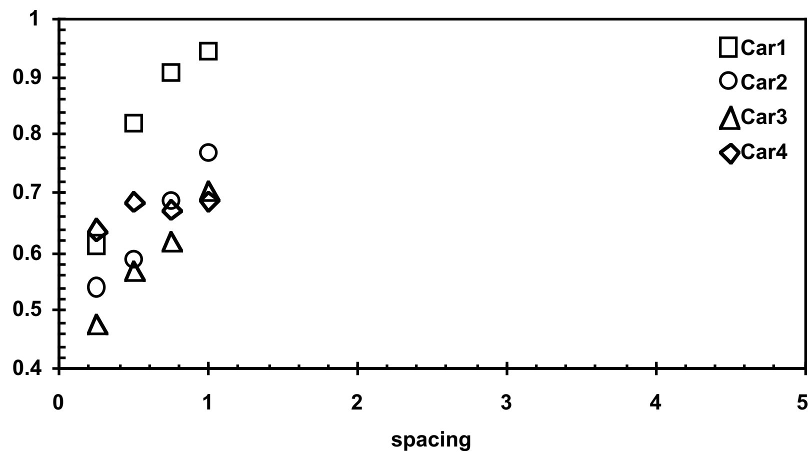
C_P distribution



ΔC_P distribution



Corrected C_D ratios



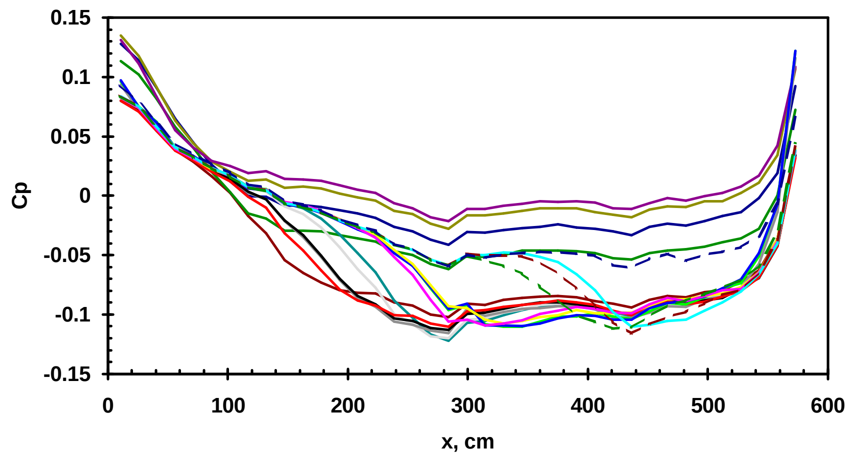
2 ,3 & 4-Car Platoon Series (Set 4)

In this series, the CD of each model alone at each position was recorded just before platoon measurements were taken.

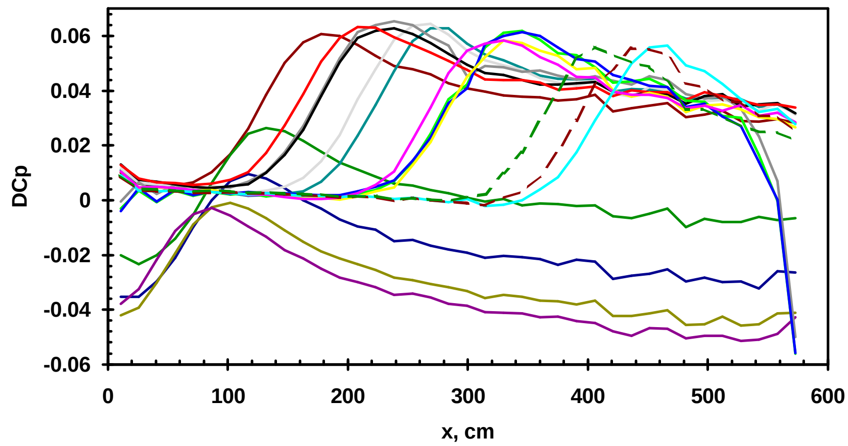
Single Car Data

Car1#	Position	Drag	Side F	Yaw	C_{Dref}	Cp_{local}	C_{Dlocal}
blue	150.65	5.872	-0.370	0.004	0.350	-0.0731	0.326
blue	104.22	5.666	-0.369	0.003	0.337	-0.0192	0.331
blue	88.75	5.523	-0.256	0.012	0.327	-0.0001	0.326
blue	73.25	5.462	-0.380	0.012	0.323	0.0204	0.330
blue	57.79	5.207	-0.317	0.006	0.309	0.0293	0.319
green	243.52	6.216	0.280	-0.044	0.372	-0.1223	0.331
green	228.04	6.284	-0.044	-0.066	0.373	-0.1182	0.333
green	197.08	6.235	0.156	-0.078	0.371	-0.1061	0.336
green	197.08	6.218	0.172	-0.076	0.368	-0.1035	0.334
green	181.61	6.110	0.346	-0.046	0.365	-0.088	0.336
red	305.44	5.888	-0.637	0.024	0.351	-0.1101	0.316
red	305.44	5.871	-0.638	0.025	0.353	-0.1096	0.318
red	305.44	5.901	-0.612	0.001	0.350	-0.1078	0.316
red	289.94	5.864	-0.718	-0.002	0.348	-0.1077	0.314
yellow	429.26	6.195	-0.663	-0.028	0.365	-0.1054	0.330
yellow	413.79	6.190	-0.646	-0.006	0.368	-0.1159	0.330
yellow	382.83	6.088	-0.740	-0.011	0.361	-0.1062	0.326

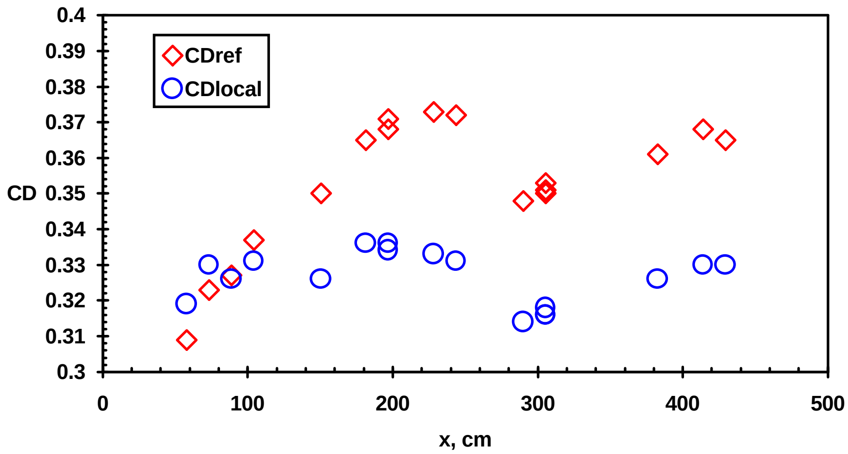
Cp distribution



ΔCp distribution



C_D scatter



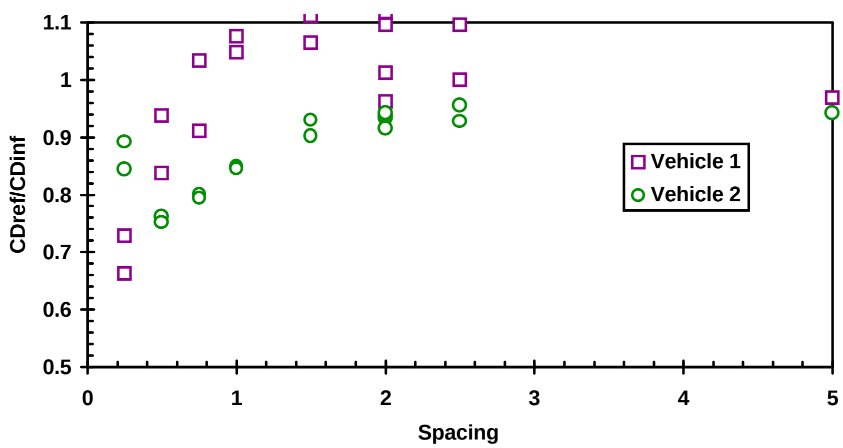
	CDref	CDlocal
Average	0.352	0.327
Std. Dev.	0.019	0.007

2-Car Platoon Data

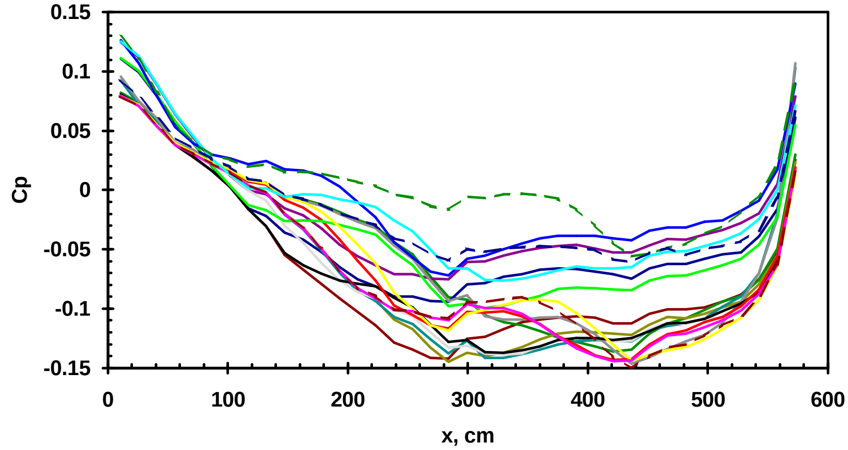
U_{ref} = 25 m/s

Spacing	$Position_1$	$Drag_1$	Side F_1	Yaw_1	$Position_2$	$Drag_2$	Side F_2	Yaw_2	C_{Dref1}	C_{Dref2}	$\frac{C_{Dref}}{C_{D1}}$	$\frac{C_{Dref}}{C_{D2}}$
0.25	150.65	3.628	-0.401	-0.013	228.04	4.983	0.091	-0.050	0.216	0.297	0.663	0.892
0.25	305.44	3.870	-0.555	0.007	382.83	4.636	-0.118	-0.007	0.230	0.275	0.728	0.844
0.50	104.22	4.663	-0.298	0.006	197.08	4.302	0.072	-0.065	0.277	0.256	0.837	0.762
0.50	197.08	5.300	0.208	-0.073	289.94	3.974	-0.249	0.030	0.315	0.236	0.938	0.752
0.75	88.75	5.022	-0.230	0.009	197.08	4.541	-0.030	-0.068	0.297	0.269	0.911	0.801
0.75	197.08	5.759	0.220	-0.072	305.44	4.158	-0.462	0.014	0.347	0.251	1.033	0.794
1.00	181.61	5.912	0.360	-0.046	305.44	4.499	-0.554	0.022	0.352	0.268	1.048	0.848
1.00	305.44	5.713	-0.644	0.023	429.26	4.684	-0.225	-0.023	0.340	0.279	1.076	0.845
1.50	150.65	5.862	-0.369	0.004	305.44	4.974	-0.372	-0.014	0.347	0.294	1.064	0.930
1.50	228.04	6.227	-0.022	-0.063	382.83	4.959	-0.489	0.012	0.370	0.294	1.111	0.902
2.00	104.22	5.677	-0.371	0.001	289.94	4.967	-0.547	-0.010	0.335	0.293	1.012	0.933
2.00	57.79	5.150	-0.323	0.004	243.52	5.211	0.029	-0.056	0.307	0.310	0.962	0.937
2.00	243.52	6.240	0.266	-0.047	429.26	5.094	-0.505	0.014	0.370	0.302	1.118	0.915
2.00	197.08	6.227	0.155	-0.078	382.83	5.188	-0.561	0.011	0.368	0.307	1.095	0.942
2.50	88.75	5.479	-0.244	0.014	305.44	4.935	-0.573	-0.001	0.326	0.293	1.000	0.927
2.50	197.08	6.204	0.189	-0.076	413.79	5.319	-0.556	0.014	0.368	0.315	1.095	0.955
5.00	57.79	5.199	-0.327	0.004	429.26	5.232	-0.567	-0.017	0.309	0.311	0.969	0.942

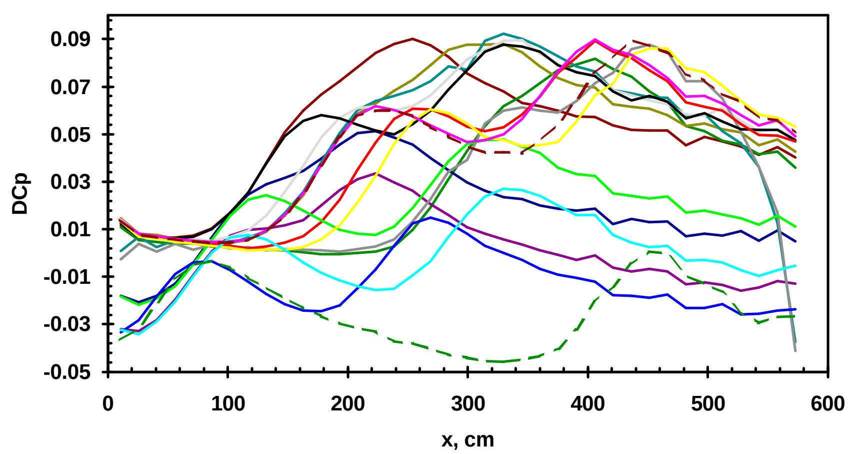
Uncorrected C_D ratios



Cp distribution

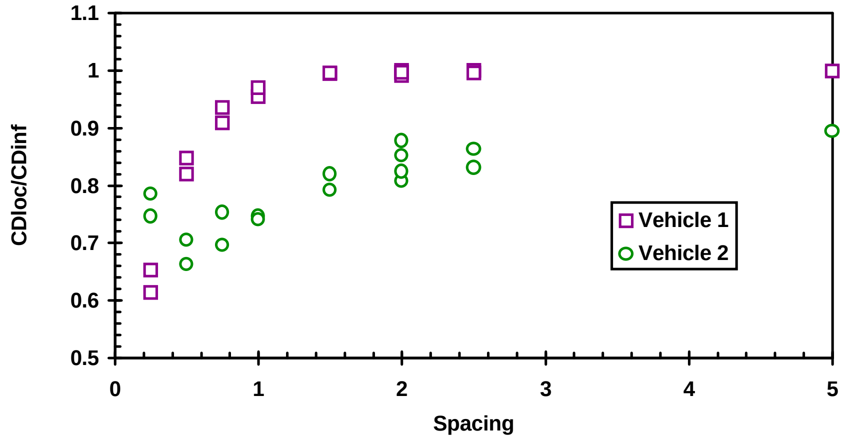


ΔCp distribution



Spacing	DCp_{max}	$X_{DCp_{max}}$	Cp_{local1}	Cp_{local2}	$C_{Dlocal1}$	$C_{Dlocal2}$	$\frac{C_{Dloc1}}{C_{D\infty 1}}$	$\frac{C_{Dloc2}}{C_{D\infty 2}}$
0.25	0.0901	253.71	-0.0789	-0.1346	0.200	0.262	0.614	0.785
0.25	0.0818	405.73	-0.1141	-0.1321	0.206	0.243	0.653	0.746
0.50	0.0514	223.30	-0.0219	-0.081	0.271	0.237	0.820	0.705
0.50	0.088	329.72	-0.109	-0.1374	0.284	0.208	0.847	0.662
0.75	0.0335	223.30	-0.0003	-0.0631	0.297	0.253	0.909	0.753
0.75	0.0922	329.72	-0.1069	-0.1416	0.314	0.220	0.935	0.696
1.00	0.0895	344.92	-0.1007	-0.1376	0.320	0.236	0.954	0.746
1.00	0.0877	451.33	-0.1094	-0.1407	0.306	0.244	0.970	0.741
1.50	0.0877	329.72	-0.0703	-0.1371	0.324	0.259	0.994	0.820
1.50	0.0893	405.73	-0.1141	-0.1396	0.332	0.258	0.995	0.792
2.00	0.0478	329.72	-0.0171	-0.0972	0.330	0.267	0.996	0.852
2.00	0.0149	268.91	0.0298	-0.0687	0.316	0.290	0.991	0.877
2.00	0.0861	466.54	-0.1183	-0.1351	0.331	0.266	1.000	0.807
2.00	0.0899	405.73	-0.1009	-0.1402	0.334	0.269	0.996	0.824
2.50	0.027	329.72	0.0019	-0.0764	0.326	0.273	1.000	0.863
2.50	0.0895	436.13	-0.1009	-0.15	0.334	0.274	0.995	0.831
5.00	0.0007	451.33	0.0298	-0.0537	0.318	0.295	0.999	0.894

Corrected C_D ratios



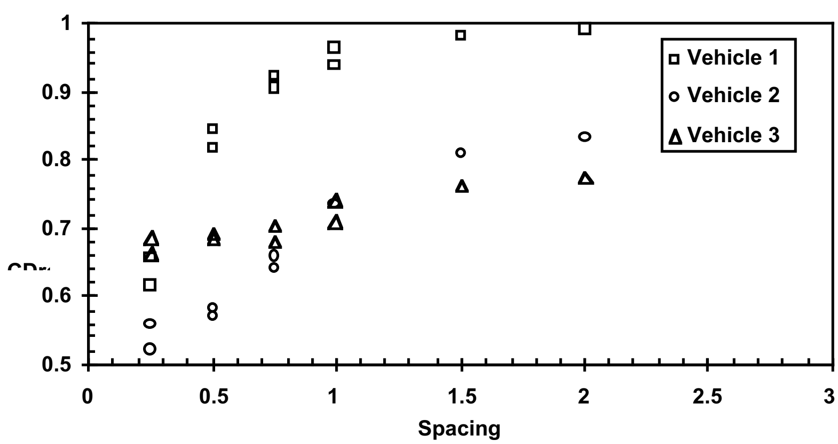
3-Car Platoon Data

U_{ref} = 25 m/s

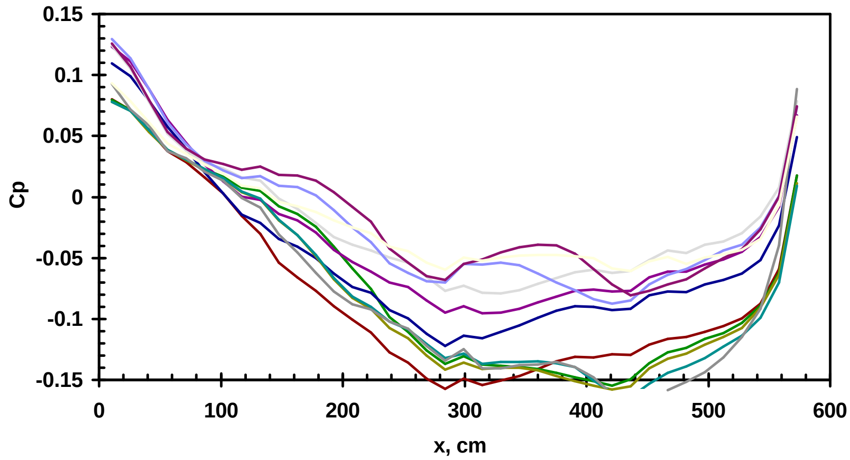
Spacing	Position$_1$	Drag$_1$	Side F$_1$	Yaw$_1$	Position$_2$	Drag$_2$	Side F$_2$	Yaw$_2$	Position$_3$	Drag$_3$	Side F$_3$	Yaw$_3$
0.25	150.65	3.621	-0.408	-0.010	228.04	3.502	0.141	-0.054	305.44	4.037	-0.015	0.007
0.25	228.04	4.130	-0.143	-0.083	305.44	3.075	0.037	0.004	382.83	4.029	-0.203	0.015
0.50	104.22	4.651	-0.301	0.005	197.08	3.646	0.149	-0.055	289.94	4.016	-0.187	0.014
0.50	197.08	5.297	0.233	-0.069	289.94	3.349	-0.170	0.030	382.83	4.210	-0.378	0.041
0.75	88.75	5.000	-0.233	0.011	197.08	4.124	-0.014	-0.071	305.44	4.009	-0.341	0.013
0.75	197.08	5.786	0.241	-0.071	305.44	3.795	-0.386	0.020	413.79	4.363	-0.330	0.020
1.00	57.79	4.868	-0.312	0.001	181.61	4.497	0.385	-0.024	305.44	4.172	-0.495	0.020
1.00	181.61	5.884	0.340	-0.049	305.44	4.304	-0.573	0.020	429.26	4.508	-0.356	0.008
1.50	73.25	5.332	-0.365	0.011	228.04	5.065	-0.137	-0.073	382.83	4.618	-0.443	0.005
2.00	57.79	5.155	-0.329	0.003	243.52	5.199	0.024	-0.058	429.26	4.748	-0.447	0.011

Spacing	C_{Dref1}	C_{Dref2}	C_{Dref3}	$\frac{C_{Dref}}{C_{D1}}$	$\frac{C_{Dref}}{C_{D2}}$	$\frac{C_{Dref}}{C_{D3}}$
0.25	0.215	0.208	0.240	0.614	0.558	0.684
0.25	0.245	0.182	0.239	0.657	0.520	0.663
0.50	0.276	0.216	0.238	0.819	0.583	0.686
0.50	0.313	0.198	0.249	0.844	0.570	0.690
0.75	0.296	0.244	0.238	0.907	0.658	0.678
0.75	0.343	0.225	0.259	0.924	0.642	0.703
1.00	0.291	0.268	0.249	0.939	0.735	0.710
1.00	0.352	0.258	0.270	0.965	0.735	0.740
1.50	0.317	0.301	0.275	0.982	0.808	0.761
2.00	0.307	0.309	0.282	0.991	0.832	0.774

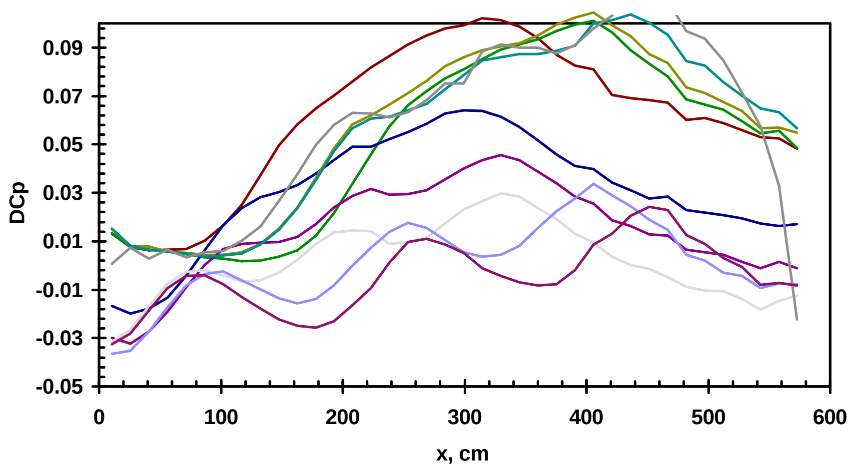
Uncorrected C_D ratio



Cp distribution

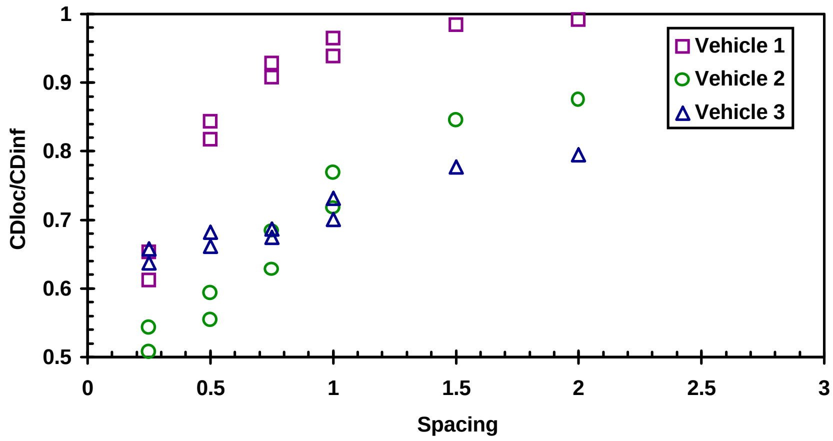


ΔCp distribution



Spacing	DCp_{max}	X_{DCpmax}	Cp_{local1}	Cp_{local2}	Cp_{local3}	$C_{Dlocal1}$	$C_{Dlocal2}$	$C_{Dlocal3}$	$\frac{C_{Dloc1}}{C_{D\infty1}}$	$\frac{C_{Dloc2}}{C_{D\infty2}}$	$\frac{C_{Dloc3}}{C_{D\infty3}}$
0.25	0.102	314.52	-0.0772	-0.1488	-0.1541	0.199	0.181	0.208	0.612	0.543	0.658
0.25	0.101	405.3	-0.1258	-0.1393	-0.1513	0.218	0.160	0.208	0.653	0.507	0.637
0.50	0.064	299.31	-0.0211	-0.0929	-0.1137	0.270	0.198	0.214	0.817	0.593	0.682
0.50	0.1045	405.73	-0.1073	-0.1399	-0.1548	0.283	0.174	0.216	0.843	0.554	0.661
0.75	0.0456	329.72	0.0005	-0.0699	-0.095	0.296	0.228	0.217	0.908	0.684	0.687
0.75	0.1036	436.13	-0.1022	-0.1353	-0.1641	0.311	0.198	0.222	0.928	0.628	0.674
1.00	0.0297	329.72	0.0283	-0.0392	-0.0791	0.299	0.258	0.231	0.938	0.769	0.731
1.00	0.1147	451.33	-0.0878	-0.138	-0.1677	0.324	0.226	0.231	0.965	0.717	0.701
1.50	0.0337	405.73	0.0219	-0.0693	-0.084	0.324	0.282	0.253	0.984	0.845	0.777
2.00	0.0242	451.33	0.0305	-0.0681	-0.0772	0.316	0.289	0.262	0.992	0.875	0.795

Corrected C_D ratio



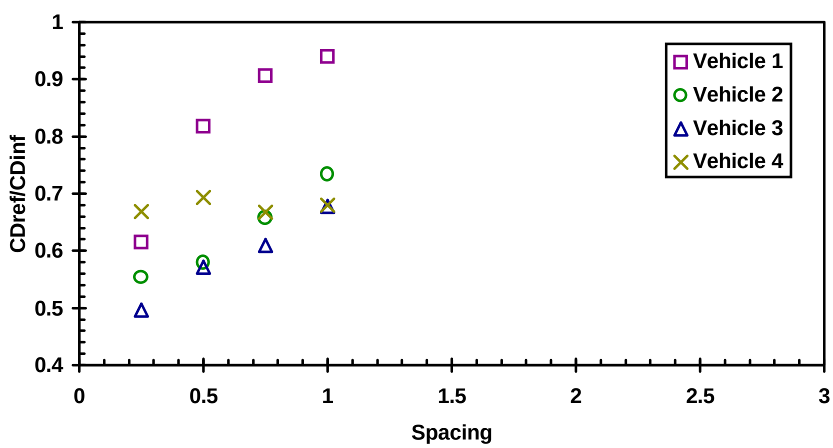
4-Car Platoon Data

U_{ref} = 25 m/s

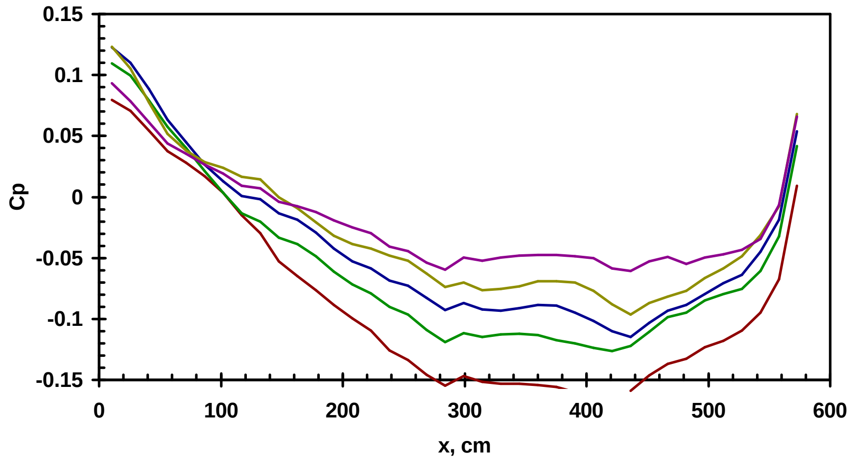
Spacing	$Position_1$	$Drag_1$	Side F_1	Yaw_1	$Position_2$	$Drag_2$	Side F_2	Yaw_2	$Position_3$	$Drag_3$	Side F_3	Yaw_3
0.25	150.65	3.627	-0.435	-0.013	228.04	3.472	0.147	-0.053	305.44	2.932	-0.044	0.004
0.5	104.22	4.654	-0.311	0.004	197.08	3.634	0.141	-0.057	289.94	3.353	-0.168	0.022
0.75	88.75	4.970	-0.238	0.011	197.08	4.093	-0.013	-0.069	305.44	3.585	-0.230	0.026
1	57.79	4.873	-0.315	0.001	181.61	4.488	0.437	-0.019	305.44	3.980	-0.464	0.028

Spacing	$Position_4$	$Drag_4$	Side F_4	Yaw_4	C_{Dref1}	C_{Dref2}	C_{Dref3}	C_{Dref4}	$\frac{C_{Dref}}{C_{D1}}$	$\frac{C_{Dref}}{C_{D2}}$	$\frac{C_{Dref}}{C_{D3}}$	$\frac{C_{Dref}}{C_{D4}}$
0.25	382.83	4.068	-0.262	0.018	0.215	0.206	0.174	0.241	0.615	0.553	0.496	0.669
0.5	382.83	4.219	-0.301	0.027	0.276	0.215	0.199	0.250	0.817	0.579	0.571	0.693
0.75	413.79	4.124	-0.237	0.013	0.296	0.244	0.213	0.246	0.906	0.657	0.609	0.667
1	429.26	4.156	-0.353	0.022	0.291	0.268	0.238	0.248	0.940	0.734	0.678	0.680

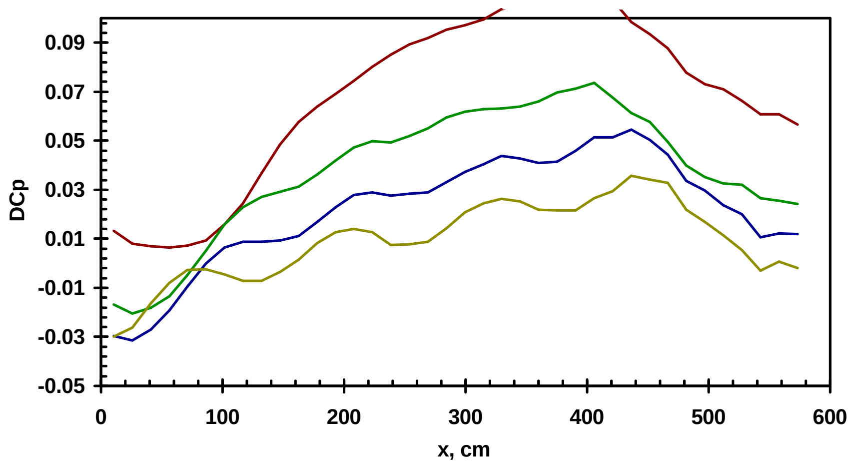
Uncorrected C_D ratio



Cp distribution



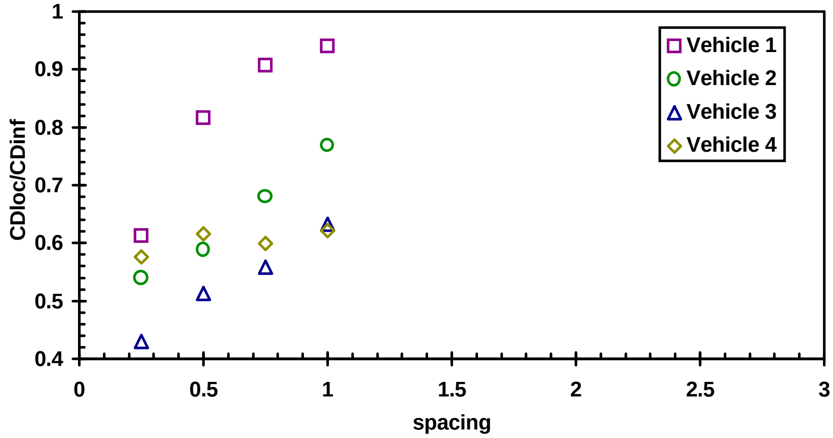
ΔCp distribution



Spacing	DCp_{max}	$X_{DCp_{max}}$	Cplocal1	Cplocal2	Cplocal3	Cplocal4	$C_{Dlocal1}$	$C_{Dlocal2}$	$C_{Dlocal3}$	$C_{Dlocal4}$
0.25	0.1116	405.73	-0.0762	-0.1457	-0.1533	-0.1619	0.200	0.180	0.151	0.208
0.5	0.0736	405.73	-0.0200	-0.0900	-0.1126	-0.1239	0.270	0.197	0.178	0.222
0.75	0.0545	436.13	0.0007	-0.0684	-0.0909	-0.1150	0.296	0.228	0.196	0.220
1	0.0357	436.13	0.0288	-0.0387	-0.0734	-0.0962	0.300	0.258	0.221	0.226

Spacing	$\frac{C_{Dloc1}}{C_{D\infty1}}$	$\frac{C_{Dloc2}}{C_{D\infty2}}$	$\frac{C_{Dloc3}}{C_{D\infty3}}$	$\frac{C_{Dloc4}}{C_{D\infty4}}$
0.25	0.613	0.539	0.430	0.576
0.5	0.816	0.588	0.513	0.616
0.75	0.907	0.680	0.558	0.599
1	0.940	0.769	0.632	0.621

Corrected C_D ratio



Appendix 2:

2-Vehicle Platoon Data with Varying Geometries

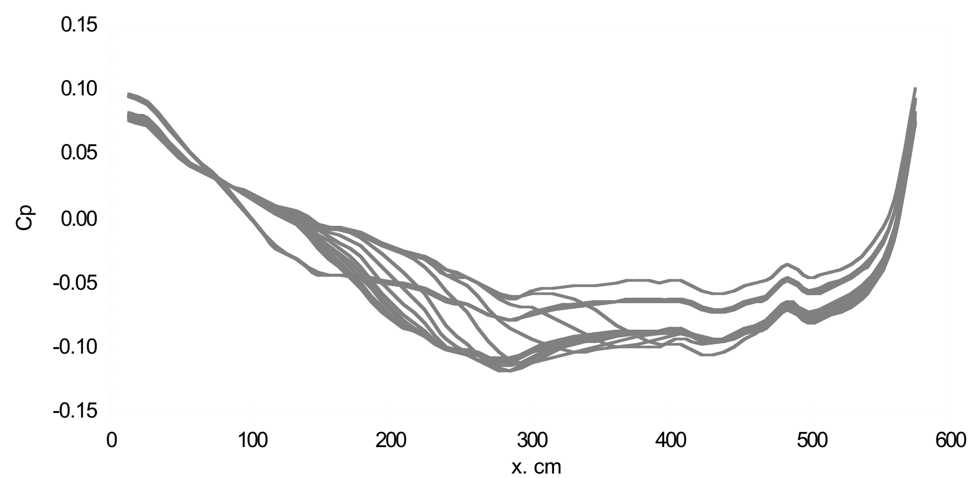
Geometry Variation Series (porous plate with suction)

Front-to-Front Platoon Set A

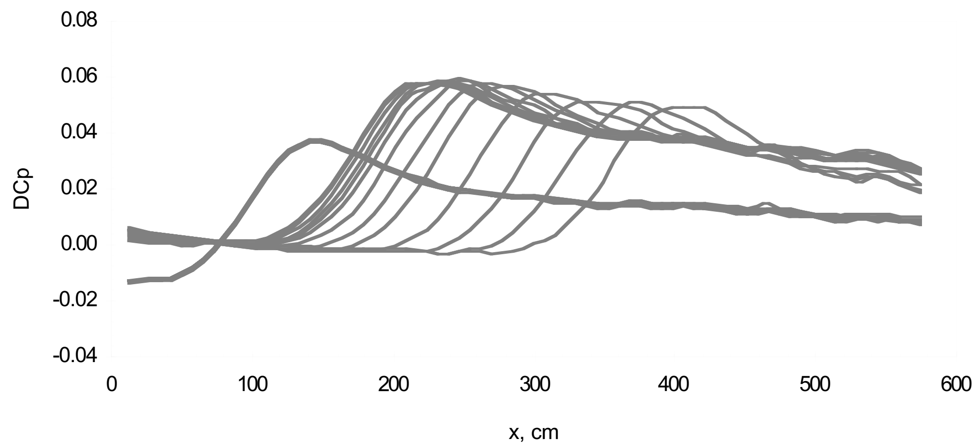
Single Car Data

Car#	Location	Drag1	SideF1	Yaw1	CDref1	Cp_max_d(	Xlocal1	CDloc1
green	127.00	5.306	-0.153	-0.009	0.374	-0.042	147.28	0.359
green	127.00	5.311	-0.154	-0.010	0.373	-0.042	147.28	0.358
green	127.00	5.321	-0.163	-0.003	0.373	-0.042	147.28	0.358
green	127.00	5.319	-0.159	-0.004	0.373	-0.041	147.28	0.359
green	127.00	5.276	-0.160	-0.005	0.373	-0.042	147.28	0.358
green	127.00	5.291	-0.156	-0.009	0.372	-0.042	147.28	0.357
green	127.00	5.287	-0.163	-0.005	0.372	-0.041	147.28	0.357
green	127.00	5.309	-0.156	-0.008	0.373	-0.041	147.28	0.358
green	127.00	5.302	-0.148	-0.009	0.372	-0.042	147.28	0.357
green	127.00	5.299	-0.153	-0.011	0.372	-0.042	147.28	0.358
green	127.00	5.303	-0.164	-0.006	0.372	-0.042	147.28	0.357
green	127.00	5.299	-0.157	-0.009	0.372	-0.042	147.28	0.357
green	127.00	5.293	-0.164	-0.005	0.372	-0.042	147.28	0.357
blue	374.65	5.221	-0.300	-0.034	0.366	-0.097	405.68	0.333
blue	343.70	5.175	-0.360	-0.018	0.364	-0.099	375.28	0.331
blue	312.74	5.210	-0.439	-0.014	0.367	-0.102	329.68	0.333
blue	281.78	5.263	-0.361	-0.022	0.369	-0.110	299.28	0.333
blue	250.83	5.309	-0.219	0.004	0.374	-0.117	284.08	0.334
blue	235.35	5.370	-0.334	0.002	0.378	-0.113	268.88	0.339
blue	219.87	5.370	-0.493	-0.029	0.378	-0.105	253.68	0.342
blue	209.34	5.386	-0.404	-0.026	0.379	-0.101	238.48	0.344
blue	204.39	5.361	-0.410	-0.033	0.377	-0.101	238.48	0.342
blue	200.55	5.332	-0.409	-0.033	0.375	-0.100	238.48	0.340
blue	196.65	5.317	-0.415	-0.023	0.373	-0.100	238.48	0.339
blue	192.78	5.278	-0.392	-0.023	0.372	-0.089	223.28	0.341
blue	188.91	5.299	-0.389	-0.020	0.374	-0.083	208.08	0.345

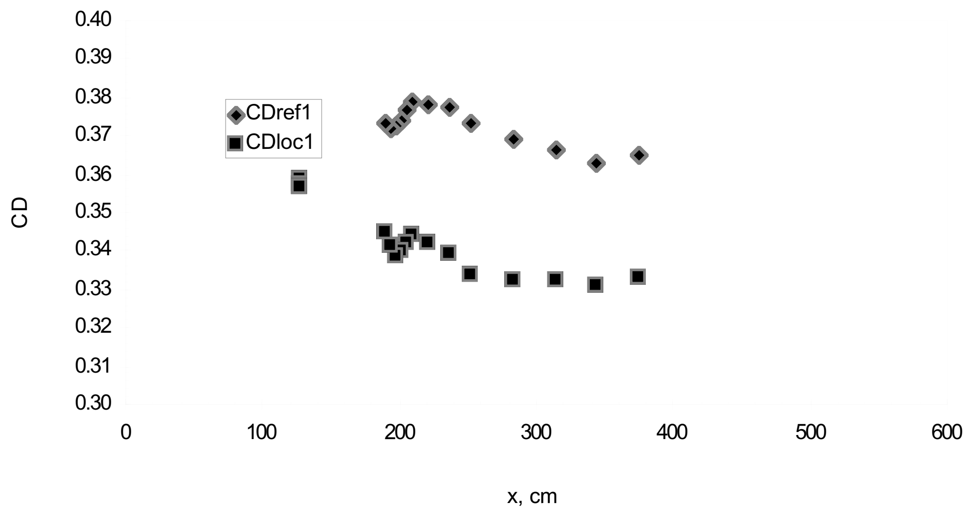
Cp distribution



ΔC_P distribution



C_D scatter



Note: Front vehicle is rear facing.

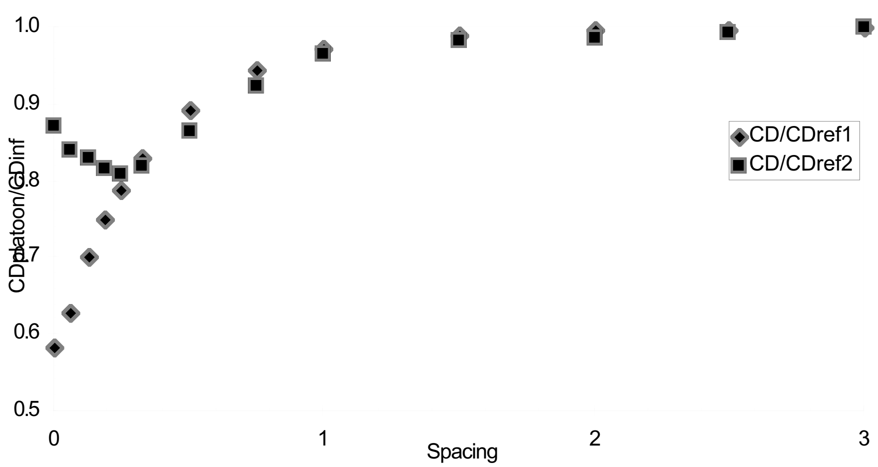
	Front Vehicle		Rear Vehicle	
	Uncorr	Corr	Uncorr	Corr
Average	0.358	0.373	0.338	0.373
Std. Dev.	0.001	0.001	0.005	0.005

2-Car Platoon Data

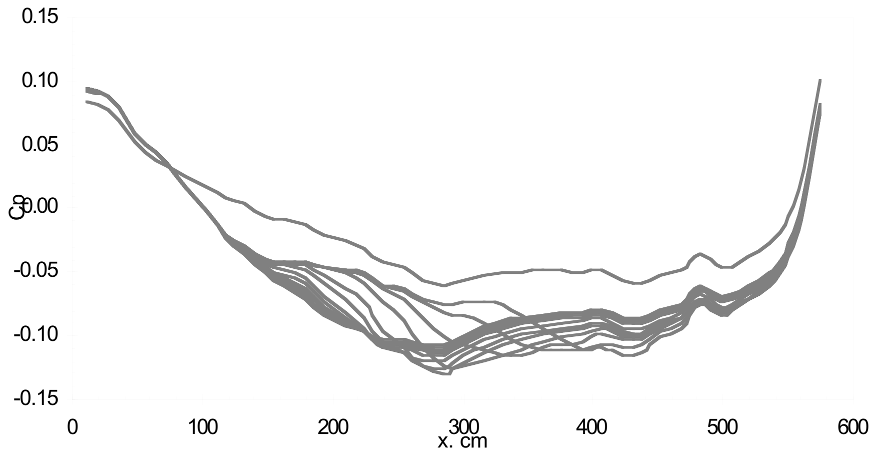
Spacing	Car#1	x1	Drag1	Side1	Yaw1	CDref1	CDinf1	CD/CDi	Cploc1	Xloc1	CDloc1	CDinf1	CD/CDI
3.00	green	127.0	5.320	-0.148	-0.008	0.373	0.374	0.998	-0.04	147.3	0.358	0.359	0.999
2.50	green	127.0	5.294	-0.154	-0.009	0.372	0.373	0.998	-0.04	147.3	0.357	0.358	0.999
2.00	green	127.0	5.277	-0.159	-0.003	0.372	0.373	0.997	-0.04	147.3	0.357	0.358	0.998
1.50	green	127.0	5.279	-0.158	-0.004	0.370	0.373	0.991	-0.04	147.3	0.356	0.359	0.993
1.00	green	127.0	5.140	-0.159	-0.005	0.362	0.373	0.971	-0.04	147.3	0.348	0.358	0.973
0.75	green	127.0	5.005	-0.155	-0.009	0.352	0.372	0.945	-0.04	147.3	0.338	0.357	0.947
0.50	green	127.0	4.723	-0.161	-0.006	0.332	0.372	0.894	-0.04	147.3	0.319	0.357	0.893
0.33	green	127.0	4.409	-0.141	-0.008	0.309	0.373	0.830	-0.04	147.3	0.296	0.358	0.827
0.25	green	127.0	4.177	-0.121	-0.008	0.293	0.372	0.787	-0.05	147.3	0.28	0.357	0.784
0.19	green	127.0	3.959	-0.112	-0.006	0.279	0.372	0.748	-0.05	147.3	0.266	0.358	0.744
0.12	green	127.0	3.705	-0.090	0.002	0.261	0.372	0.702	-0.05	147.3	0.249	0.357	0.698
0.06	green	127.0	3.307	-0.032	0.006	0.233	0.372	0.627	-0.05	147.3	0.222	0.357	0.622
0.00	green	127.0	3.087	-0.004	0.001	0.217	0.372	0.582	-0.05	147.3	0.206	0.357	0.578

Spacing	Car#2	x2	Drag2	Side2	Yaw2	CDref2	CDinf2	CD/CDi	Cploc2	Xloc2	CDloc2	CDinf2	CD/CDI
3.00	blue	374.7	4.747	-0.502	-0.050	0.333	0.366	0.999	-0.11	390.5	0.300	0.333	0.901
2.50	blue	343.7	4.683	-0.582	-0.037	0.329	0.364	0.994	-0.11	375.3	0.296	0.331	0.895
2.00	blue	312.7	4.654	-0.602	-0.032	0.328	0.367	0.985	-0.11	329.7	0.294	0.333	0.884
1.50	blue	281.8	4.661	-0.533	-0.042	0.327	0.369	0.982	-0.12	314.5	0.292	0.333	0.878
1.00	blue	250.8	4.587	-0.389	-0.035	0.323	0.374	0.966	-0.13	284.1	0.286	0.334	0.856
0.75	blue	235.3	4.460	-0.420	-0.035	0.314	0.378	0.924	-0.11	253.7	0.282	0.339	0.830
0.50	blue	219.9	4.214	-0.429	-0.051	0.297	0.378	0.866	-0.11	238.5	0.268	0.342	0.782
0.33	blue	209.3	4.017	-0.359	-0.052	0.282	0.379	0.818	-0.11	238.5	0.254	0.344	0.739
0.25	blue	204.4	3.944	-0.337	-0.050	0.277	0.377	0.808	-0.1	223.3	0.253	0.342	0.738
0.19	blue	200.6	3.938	-0.311	-0.048	0.277	0.375	0.815	-0.09	208.1	0.255	0.340	0.748
0.12	blue	196.7	3.993	-0.207	-0.035	0.282	0.373	0.830	-0.09	208.1	0.258	0.339	0.762
0.06	blue	192.8	4.075	-0.105	-0.027	0.288	0.372	0.842	-0.09	208.1	0.264	0.341	0.772
0.00	blue	188.9	4.284	-0.116	-0.024	0.301	0.374	0.872	-0.09	208.1	0.276	0.345	0.799

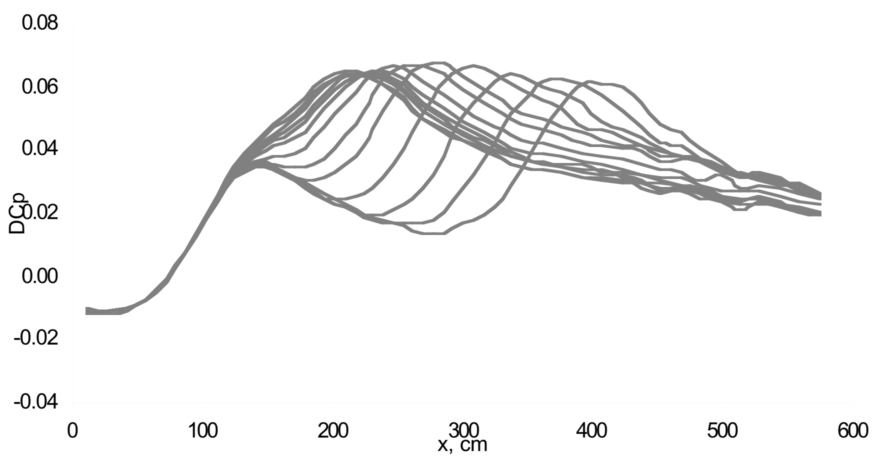
Uncorrected C_D Ratios



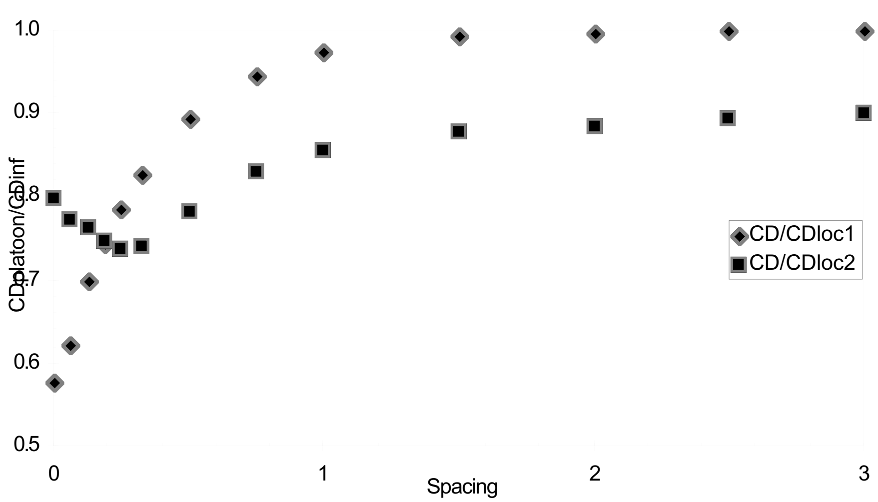
Cp distribution



ΔC_P distribution



Corrected C_D Ratios

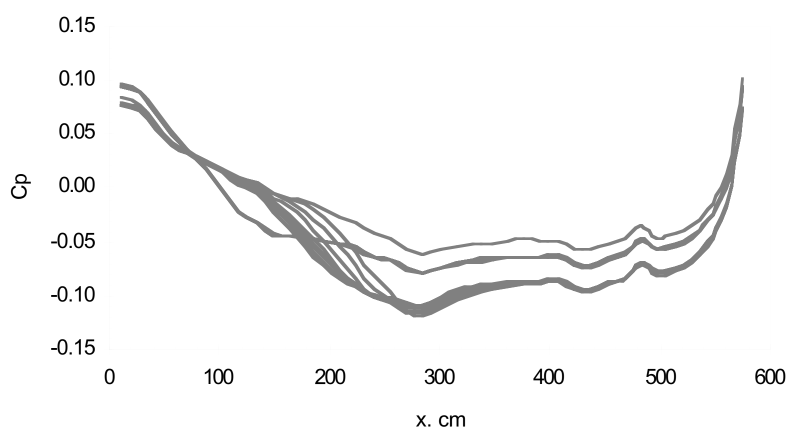


Front-to-Front Platoon Set B

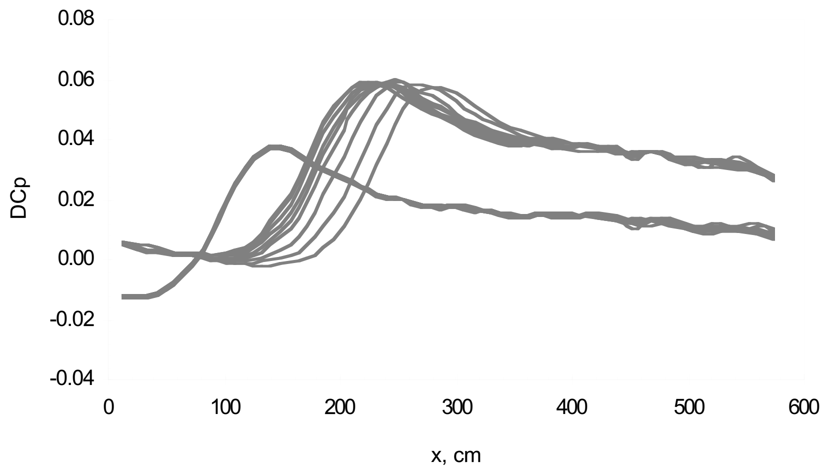
Single Car Data

Car#	Location	Drag1	SideF1	Yaw1	CDref1	Cp_ma	Xlocal1	CDloc1
green	127.00	5.336	-0.163	-0.008	0.374	-0.042	147.3	0.359
green	127.00	5.341	-0.159	-0.012	0.374	-0.042	147.3	0.359
green	127.00	5.307	-0.165	-0.009	0.374	-0.042	147.3	0.358
green	127.00	5.311	-0.164	-0.009	0.373	-0.042	147.3	0.358
green	127.00	5.303	-0.173	-0.007	0.374	-0.042	147.3	0.359
green	127.00	5.318	-0.179	-0.004	0.373	-0.042	147.3	0.358
green	127.00	5.340	-0.166	-0.008	0.372	-0.042	147.3	0.357
green	127.00	5.311	-0.175	-0.008	0.374	-0.042	147.3	0.359
green	127.00	5.320	-0.168	-0.007	0.374	-0.042	147.3	0.359
blue	188.91	5.326	-0.328	-0.024	0.374	-0.090	223.3	0.343
blue	192.78	5.304	-0.381	-0.024	0.373	-0.090	223.3	0.342
blue	196.65	5.311	-0.381	-0.027	0.374	-0.090	223.3	0.343
blue	200.55	5.326	-0.388	-0.033	0.375	-0.100	238.5	0.341
blue	204.39	5.381	-0.382	-0.035	0.379	-0.101	238.5	0.344
blue	209.34	5.429	-0.362	-0.026	0.381	-0.185	390.5	0.322
blue	219.87	5.377	-0.427	-0.029	0.378	-0.105	253.7	0.342
blue	235.35	5.410	-0.301	0.001	0.381	-0.114	268.9	0.342
blue	250.83	5.320	-0.214	-0.004	0.374	-0.118	284.1	0.334

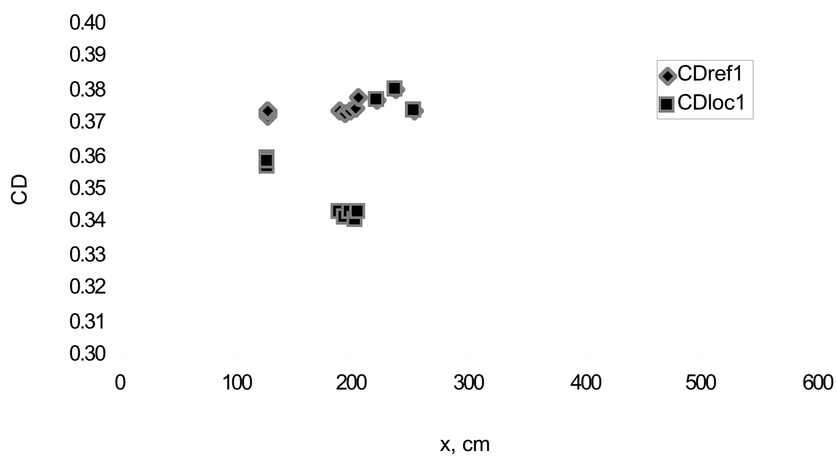
Cp distribution



ΔC_P distribution



C_D scatter



Note: Front vehicle is rear facing

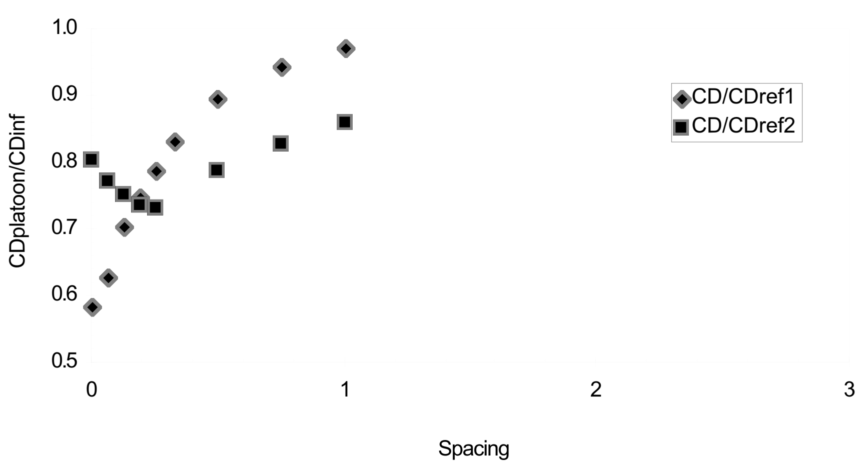
	Front Vehicle		Rear Vehicle	
	Uncorr	Corr	Uncorr	Corr
Average	0.374	0.359	0.376	0.376
Std. Dev.	0.001	0.001	0.003	0.003

2-Car Platoon Data

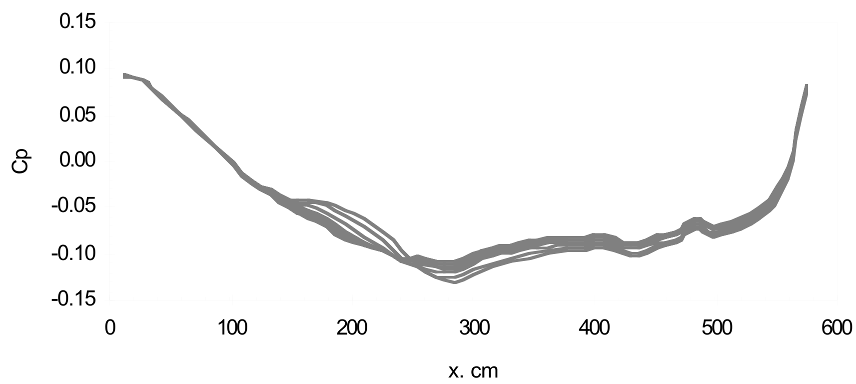
Spacin	Car#1	x1	Drag1	Side1	Yaw1	CDref1	CDinf1_	CD/CD	Cploc1	Xloc1	CDloc1	CDinf1_I	CD/CDI
0.00	green	127.00	3.129	-0.004	-0.003	0.218	0.374	0.583	-0.050	147.28	0.208	0.359	0.5781
0.06	green	127.00	3.344	-0.027	-0.004	0.235	0.374	0.629	-0.050	147.28	0.224	0.359	0.6242
0.13	green	127.00	3.729	-0.082	-0.001	0.263	0.374	0.703	-0.049	147.28	0.250	0.358	0.6983
0.19	green	127.00	3.979	-0.116	-0.004	0.279	0.373	0.748	-0.047	147.28	0.267	0.358	0.744
0.25	green	127.00	4.184	-0.144	-0.006	0.295	0.374	0.788	-0.046	147.28	0.282	0.359	0.7854
0.33	green	127.00	4.416	-0.164	-0.005	0.311	0.373	0.833	-0.045	147.28	0.298	0.358	0.8308
0.50	green	127.00	4.758	-0.153	-0.009	0.333	0.372	0.894	-0.042	147.28	0.319	0.357	0.8935
0.75	green	127.00	5.034	-0.175	-0.008	0.354	0.374	0.945	-0.040	147.28	0.340	0.359	0.9469
1.00	green	127.00	5.165	-0.166	-0.007	0.363	0.374	0.971	-0.040	147.28	0.349	0.359	0.9737

Spacin	Car#2	x2	Drag2	Side2	Yaw2	CDref2	CDinf2_	CD/CD	Cploc2	Xloc2	CDloc2	CDinf2_I	CD/CDI
0.00	blue	188.91	4.310	-0.096	-0.029	0.300	0.374	0.803	-0.091	208.08	0.275	0.343	0.8026
0.06	blue	192.78	4.093	-0.050	-0.023	0.288	0.373	0.771	-0.090	208.08	0.264	0.342	0.7712
0.13	blue	196.65	3.998	-0.170	-0.035	0.282	0.374	0.752	-0.096	223.28	0.257	0.343	0.7479
0.19	blue	200.55	3.943	-0.260	-0.048	0.277	0.375	0.737	-0.096	223.28	0.253	0.341	0.7403
0.25	blue	204.39	3.937	-0.288	-0.055	0.277	0.379	0.733	-0.106	238.48	0.251	0.344	0.7291
0.33	blue	209.34	4.024	-0.299	-0.057	0.283	0.381	0.743	-0.107	238.48	0.256	0.322	0.7948
0.50	blue	219.87	4.255	-0.406	-0.055	0.298	0.378	0.788	-0.112	253.68	0.268	0.342	0.7826
0.75	blue	235.35	4.478	-0.377	-0.042	0.315	0.381	0.827	-0.114	253.68	0.283	0.342	0.8271
1.00	blue	250.83	4.580	-0.383	-0.046	0.322	0.374	0.861	-0.129	284.08	0.285	0.334	0.8532

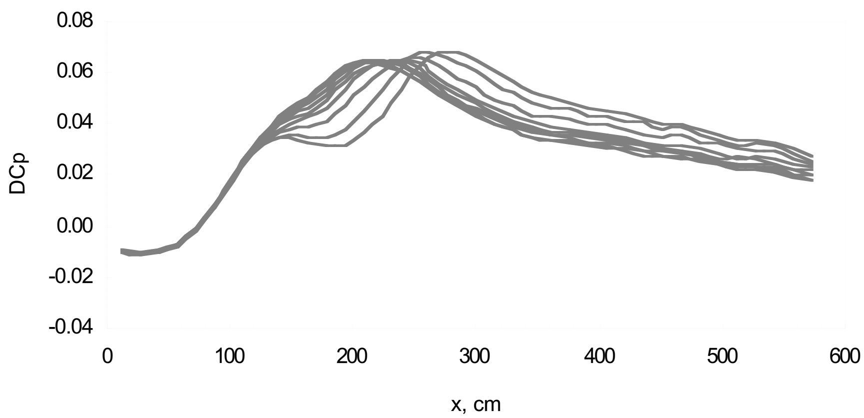
Uncorrected C_D Ratios



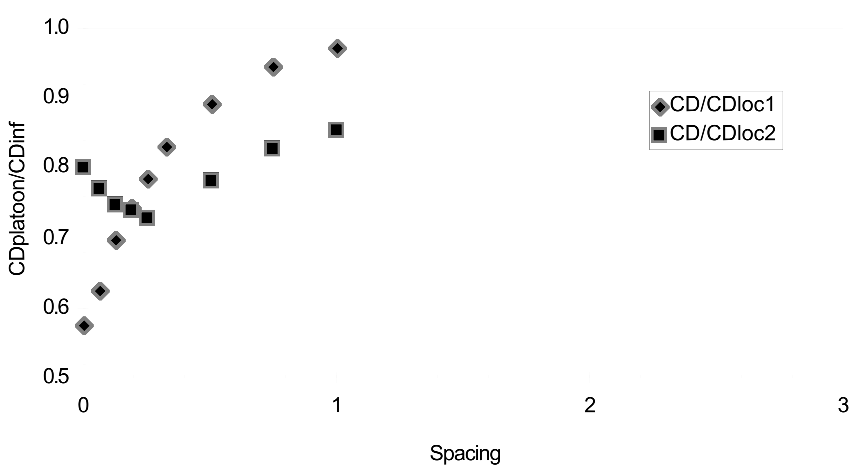
Cp distribution



ΔCp distribution



Corrected C_D Ratios

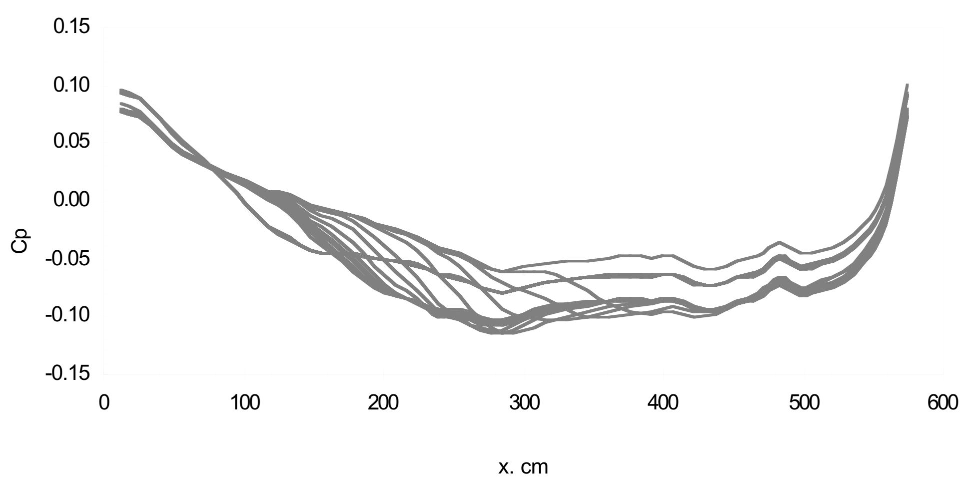


Reversed Platoon Set A

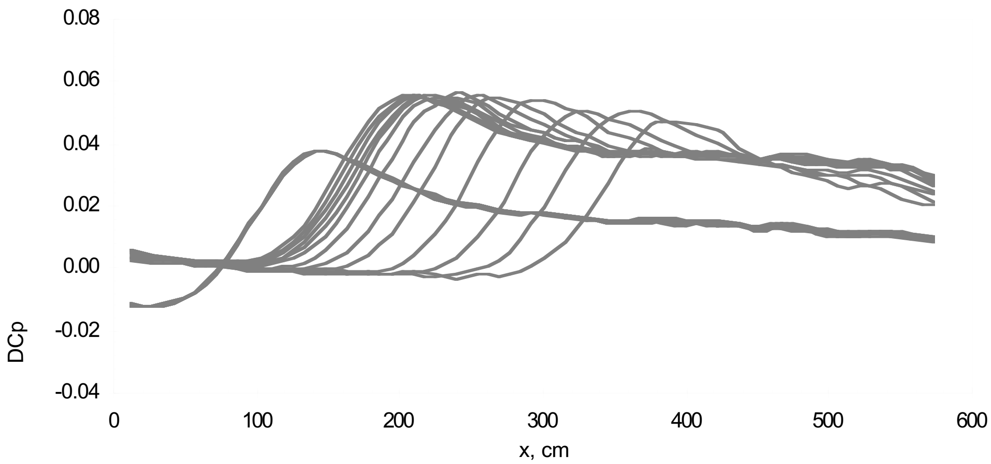
Single Car Data

Car#	Location	Drag1	SideF1	Yaw1	CDref1	Cp_max_	Xlocal1	CDloc1
Green	127.0	5.333	-0.164	-0.006	0.375	-0.0421	147.28	0.360
Green	127.0	5.353	-0.141	0.014	0.376	-0.0424	147.28	0.361
Green	127.0	5.366	-0.133	0.014	0.376	-0.0421	147.28	0.361
Green	127.0	5.342	-0.139	0.015	0.376	-0.0424	147.28	0.360
Green	127.0	5.349	-0.137	0.016	0.375	-0.0426	147.28	0.359
Green	127.0	5.332	-0.136	0.015	0.375	-0.0422	147.28	0.360
Green	127.0	5.338	-0.137	0.015	0.375	-0.0421	147.28	0.360
Green	127.0	5.337	-0.141	0.015	0.376	-0.0421	147.28	0.360
Green	127.0	5.342	-0.148	0.012	0.375	-0.0421	147.28	0.359
Green	127.0	5.324	-0.148	0.010	0.374	-0.0421	147.28	0.359
Green	127.0	5.321	-0.143	0.015	0.375	-0.0422	147.28	0.360
Green	127.0	5.348	-0.145	0.011	0.375	-0.0421	147.28	0.360
Green	127.0	5.365	-0.145	0.012	0.376	-0.0423	147.28	0.360
Blue	188.9	5.601	-0.129	0.028	0.393	-0.0814	208.08	0.364
Blue	192.8	5.600	-0.180	0.035	0.393	-0.0809	208.08	0.363
Blue	196.7	5.604	-0.160	0.030	0.395	-0.0808	208.08	0.365
Blue	200.6	5.630	-0.088	0.031	0.395	-0.0799	208.08	0.366
Blue	204.4	5.656	-0.094	0.030	0.396	-0.0869	223.28	0.364
Blue	209.3	5.702	-0.081	0.019	0.402	-0.0965	238.48	0.366
Blue	219.9	5.659	-0.147	0.051	0.398	-0.0981	238.48	0.362
Blue	235.3	5.648	-0.006	0.071	0.398	-0.1012	253.68	0.362
Blue	250.8	5.716	0.040	0.051	0.401	-0.1107	268.88	0.361
Blue	281.8	5.808	0.185	0.047	0.408	-0.1101	299.28	0.367
Blue	312.7	5.586	0.098	0.058	0.393	-0.1013	329.68	0.357
Blue	343.7	5.895	0.137	0.055	0.414	-0.0989	360.08	0.377
Blue	374.7	5.473	0.210	0.036	0.386	-0.0958	390.48	0.353

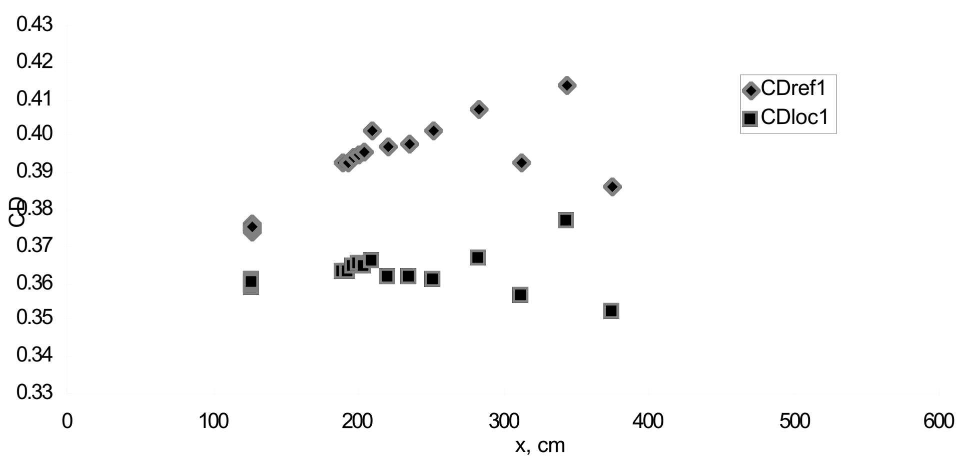
Cp distribution



ΔCp distribution



C_D scatter



Note: Both vehicles are rear facing

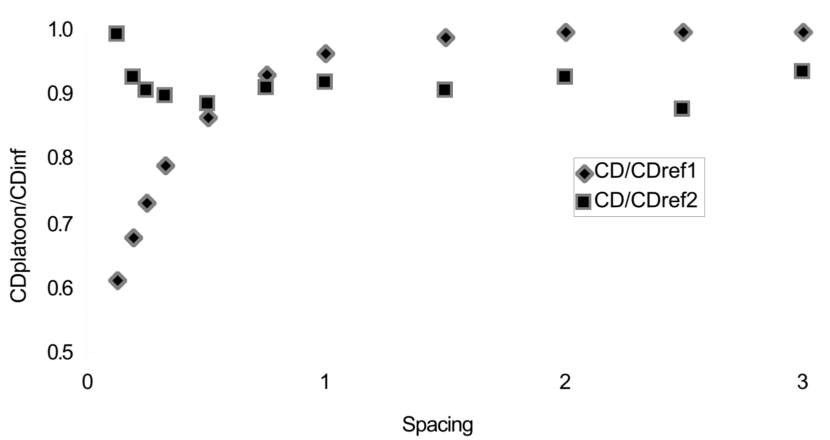
	Front Vehicle		Rear Vehicle	
	Uncorr	Corr	Uncorr	Corr
Average	0.375	0.360	0.398	0.364
Std. Dev.	0.001	0.001	0.007	0.006

2-Car Platoon Data

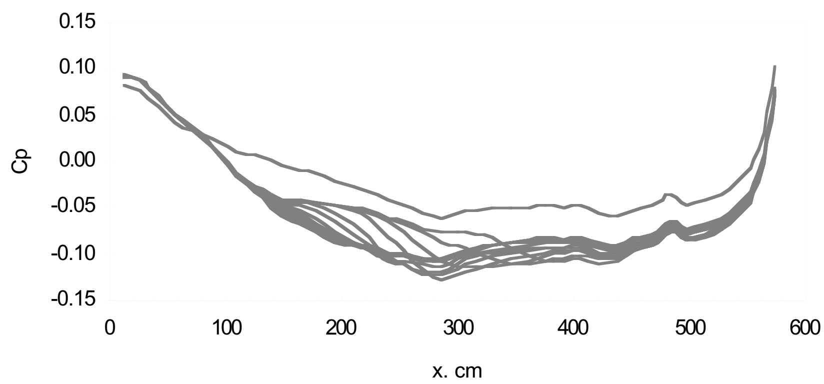
Spacing	Car#1	x1	Drag1	Side1	Yaw1	CDref1	CDinf1_re	CD/CDre	Cploc1	Xloc1	CDloc1	CDinf1_lo	CD/CDlo
0.00	Green	127.0	2.204	0.084	0.002	0.155	0.375	0.415	-0.0565	147.28	0.147	0.360	0.409
0.13	Green	127.0	3.290	-0.018	-0.002	0.232	0.376	0.617	-0.0528	147.28	0.221	0.361	0.611
0.19	Green	127.0	3.660	-0.070	0.001	0.257	0.376	0.683	-0.0512	147.28	0.244	0.361	0.677
0.25	Green	127.0	3.923	-0.099	0.009	0.276	0.376	0.733	-0.0497	147.28	0.262	0.360	0.728
0.33	Green	127.0	4.220	-0.108	0.012	0.297	0.375	0.792	-0.0482	147.28	0.283	0.359	0.787
0.50	Green	127.0	4.645	-0.131	0.016	0.326	0.375	0.869	-0.0452	147.28	0.312	0.360	0.866
0.75	Green	127.0	4.979	-0.136	0.016	0.350	0.375	0.934	-0.0421	147.28	0.336	0.360	0.934
0.88	Green	127.0	2.869	0.023	-0.008	0.201	0.376	0.535	-0.0540	147.28	0.191	0.360	0.529
1.00	Green	127.0	5.136	-0.135	0.016	0.362	0.375	0.967	-0.0407	147.28	0.348	0.359	0.968
1.50	Green	127.0	5.287	-0.136	0.014	0.372	0.374	0.993	-0.0400	147.28	0.358	0.359	0.995
2.00	Green	127.0	5.308	-0.132	0.013	0.374	0.375	0.999	-0.0405	147.28	0.360	0.360	1.000
2.50	Green	127.0	5.326	-0.135	0.013	0.376	0.375	1.002	-0.0411	147.28	0.361	0.360	1.003
3.00	Green	127.0	5.349	-0.136	0.014	0.376	0.376	1.001	-0.0412	147.28	0.361	0.360	1.002

Spacing	Car#2	x2	Drag2	Side2	Yaw2	CDref2	CDinf2_re	CD/CDre	Cploc2	Xloc2	CDloc2	CDinf2_lo	CD/CDlo
0.00	Blue	188.9	6.133	-0.160	0.032	0.432	0.393	1.099	-0.0862	192.88	0.398	0.364	1.094
0.13	Blue	196.7	5.533	-0.154	0.008	0.391	0.393	0.995	-0.0896	208.08	0.359	0.363	0.987
0.19	Blue	200.6	5.234	-0.091	0.006	0.367	0.395	0.931	-0.0884	208.08	0.337	0.365	0.924
0.25	Blue	204.4	5.108	-0.066	0.004	0.359	0.395	0.908	-0.0881	208.08	0.330	0.366	0.901
0.33	Blue	209.3	5.068	-0.080	0.008	0.356	0.396	0.900	-0.0877	208.08	0.328	0.364	0.899
0.50	Blue	219.9	5.098	-0.107	0.023	0.358	0.402	0.890	-0.0944	223.28	0.327	0.366	0.891
0.75	Blue	235.3	5.166	-0.041	0.043	0.363	0.398	0.914	-0.1108	253.68	0.327	0.362	0.904
0.88	Blue	243.6	5.665	-0.186	0.015	0.397	0.398	0.996	-0.0838	192.88	0.366	0.362	1.012
1.00	Blue	250.8	5.255	-0.001	0.035	0.371	0.401	0.923	-0.1110	253.68	0.333	0.361	0.923
1.50	Blue	281.8	5.258	0.021	0.041	0.370	0.408	0.907	-0.1212	299.28	0.330	0.367	0.898
2.00	Blue	312.7	5.187	-0.027	0.056	0.366	0.393	0.931	-0.1135	329.68	0.329	0.357	0.920
2.50	Blue	343.7	5.161	0.025	0.052	0.364	0.414	0.879	-0.1103	360.08	0.328	0.377	0.870
3.00	Blue	374.7	5.156	0.097	0.037	0.362	0.386	0.938	-0.1078	390.48	0.327	0.353	0.928

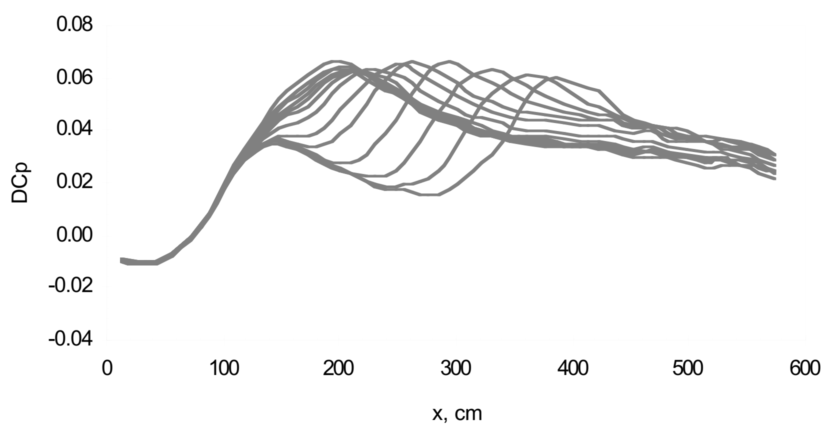
Uncorrected C_D Ratios



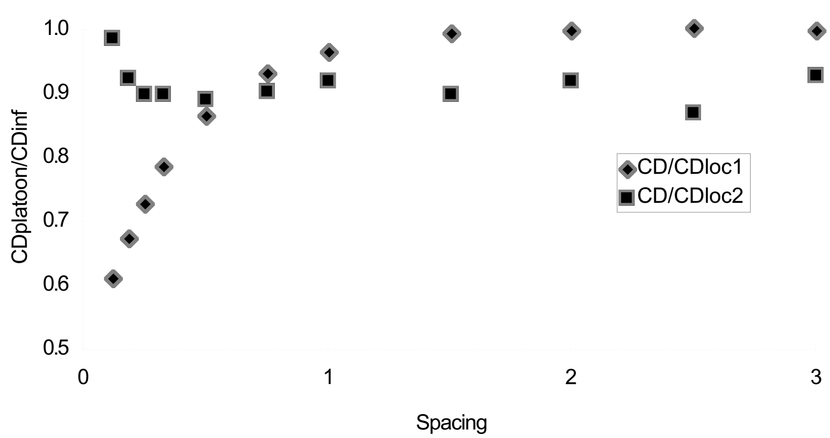
Cp distribution



ΔCp distribution



Corrected C_D Ratios

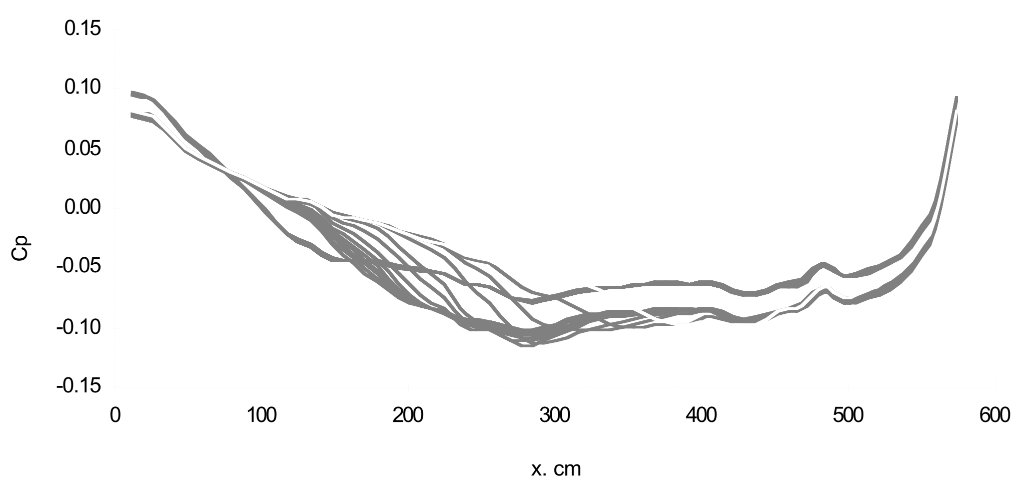


Reversed Platoon Set B

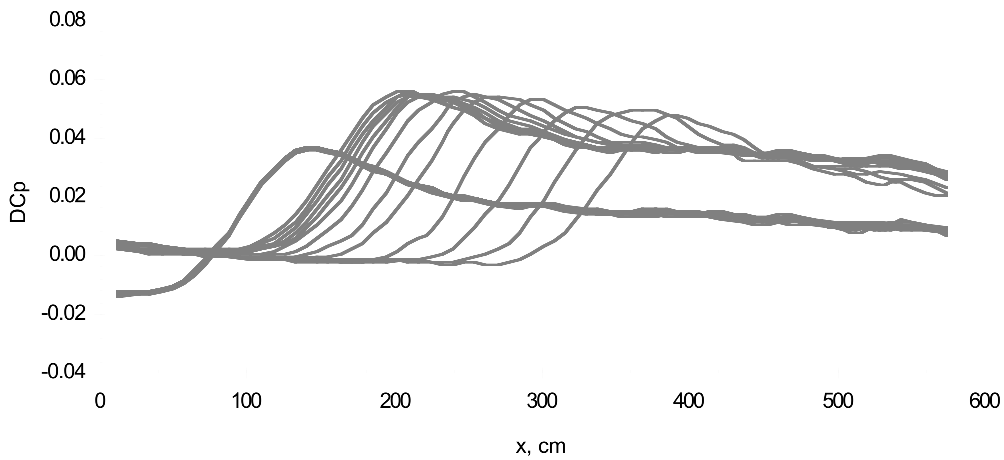
Single Car Data

Car#	Locati	Drag1	SideF1	Yaw1	CDref1	Cp_max_	Xlocal	CDloc1
green	127.0	5.360	-0.147	0.010	0.377	-0.0418	147	0.362
green	127.0	5.350	-0.147	0.011	0.375	-0.0417	147	0.360
green	127.0	5.353	-0.144	0.012	0.375	-0.0414	147	0.360
green	127.0	5.336	-0.138	0.013	0.374	-0.0417	147	0.359
green	127.0	5.331	-0.145	0.009	0.374	-0.0416	147	0.359
green	127.0	5.315	-0.140	0.014	0.375	-0.0419	147	0.360
green	127.0	5.344	-0.140	0.012	0.375	-0.0418	147	0.360
green	127.0	5.333	-0.140	0.011	0.375	-0.0419	147	0.360
green	127.0	5.330	-0.141	0.010	0.375	-0.0405	147	0.360
green	127.0	5.349	-0.150	0.010	0.375	-0.0415	147	0.360
green	127.0	5.350	-0.150	0.010	0.376	-0.0414	147	0.361
green	127.0	5.342	-0.136	0.013	0.375	-0.0416	147	0.360
green	127.0	5.340	-0.150	0.014	0.375	-0.0415	147	0.360
blue	188.9	5.594	-0.117	0.028	0.394	-0.0812	208	0.364
blue	192.8	5.619	-0.155	0.035	0.394	-0.0807	208	0.365
blue	196.7	5.602	-0.151	0.030	0.396	-0.0810	208	0.366
blue	200.6	5.617	-0.090	0.031	0.396	-0.0797	208	0.367
blue	204.4	5.666	-0.072	0.032	0.399	-0.0862	223	0.367
blue	209.3	5.675	-0.053	0.035	0.399	-0.0963	238	0.364
blue	219.9	5.658	-0.124	0.050	0.399	-0.0975	238	0.363
blue	235.3	5.702	-0.007	0.065	0.400	-0.1010	254	0.364
blue	250.8	5.728	0.050	0.049	0.402	-0.1101	269	0.362
blue	281.8	5.591	0.185	0.037	0.393	-0.1090	299	0.355
blue	312.7	5.579	0.102	0.060	0.392	-0.1013	330	0.356
blue	343.7	5.908	0.135	0.058	0.415	-0.0985	360	0.377
blue	374.7	5.515	0.206	0.039	0.388	-0.0962	390	0.354

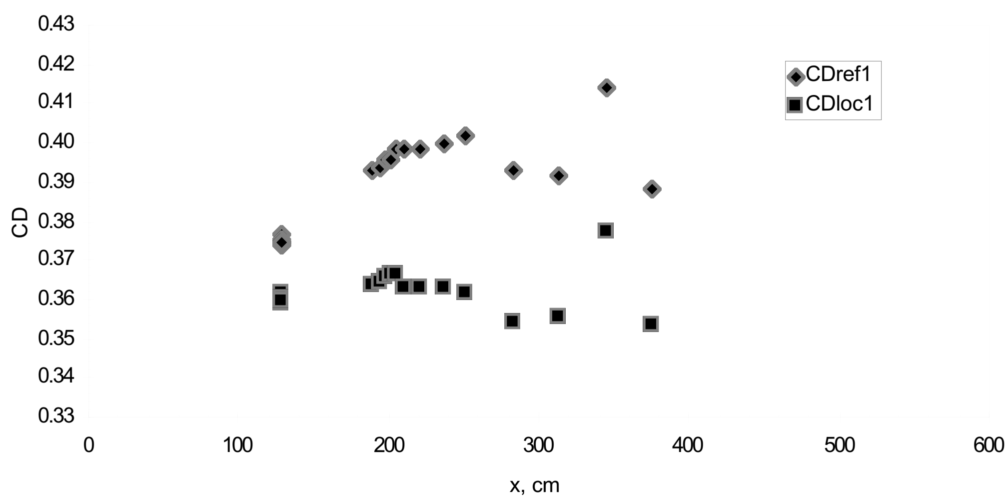
Cp distribution



ΔCp distribution



C_D scatter



Note: Both vehicles are rear facing

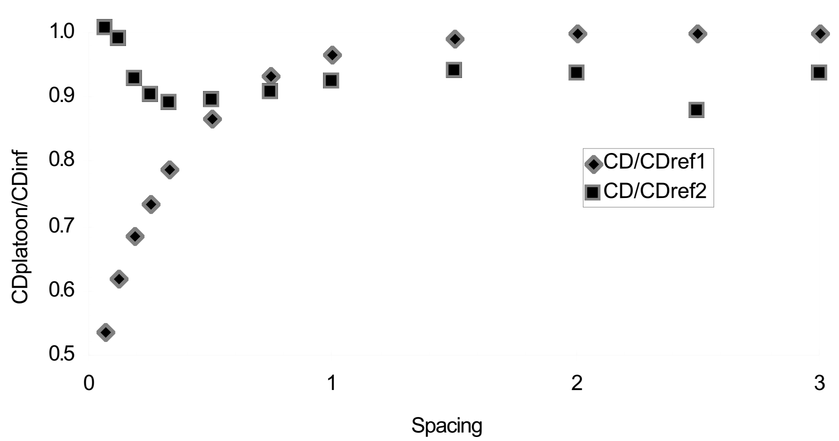
	Front Vehicle		Rear Vehicle	
	Uncorr	Corr	Uncorr	Corr
Average	0.373	0.360	0.397	0.363
Std. Dev.	0.001	0.001	0.006	0.006

2-Car Platoon Data

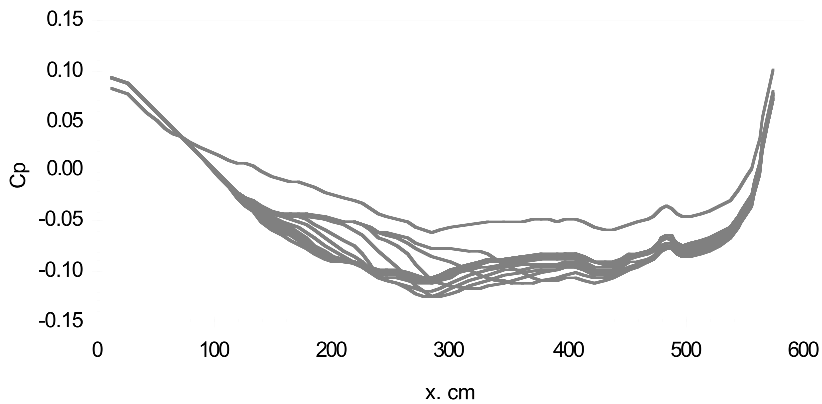
Spacing	Car#1	x1	Drag1	Side1	Yaw1	CDref1	CDinf1_re	CD/CDref1	Cploc1	Xloc1	CDloc1	CDinf1_lo	CD/CDloc1
0.00	green	127.0	2.213	0.087	0.002	0.156	0.377	0.414	-0.0562	147.3	0.148	0.362	0.408
0.06	green	127.0	2.861	0.025	-0.008	0.201	0.375	0.535	-0.0539	147.3	0.191	0.360	0.529
0.13	green	127.0	3.316	-0.018	-0.004	0.233	0.375	0.620	-0.0521	147.3	0.221	0.360	0.614
0.19	green	127.0	3.660	-0.065	0.004	0.257	0.374	0.686	-0.0508	147.3	0.244	0.359	0.680
0.25	green	127.0	3.914	-0.097	0.005	0.275	0.374	0.735	-0.0499	147.3	0.262	0.359	0.729
0.33	green	127.0	4.205	-0.117	0.013	0.296	0.375	0.789	-0.0476	147.3	0.283	0.360	0.785
0.50	green	127.0	4.631	-0.133	0.012	0.326	0.375	0.869	-0.0447	147.3	0.312	0.360	0.867
0.75	green	127.0	4.973	-0.138	0.012	0.350	0.375	0.934	-0.0420	147.3	0.336	0.360	0.933
1.00	green	127.0	5.145	-0.144	0.011	0.362	0.375	0.967	-0.0405	147.3	0.348	0.360	0.967
1.50	green	127.0	5.301	-0.146	0.010	0.371	0.375	0.990	-0.0394	147.3	0.357	0.360	0.992
2.00	green	127.0	5.338	-0.146	0.010	0.375	0.376	0.998	-0.0400	147.3	0.360	0.361	0.999
2.50	green	127.0	5.316	-0.137	0.012	0.374	0.375	0.999	-0.0406	147.3	0.360	0.360	1.000
3.00	green	127.0	5.315	-0.152	0.014	0.375	0.375	0.999	-0.0409	147.3	0.360	0.360	1.000

Spacing	Car#2	x2	Drag2	Side2	Yaw2	CDref2	CDinf2_re	CD/CDref2	Cploc2	Xloc2	CDloc2	CDinf2_lo	CD/CDloc2
0.00	blue	188.9	6.132	-0.154	0.031	0.432	0.394	1.098	-0.0859	192.9	0.398	0.364	1.093
0.06	blue	192.8	5.671	-0.181	0.015	0.398	0.394	1.010	-0.0836	192.9	0.367	0.365	1.007
0.13	blue	196.7	5.588	-0.157	0.009	0.392	0.396	0.990	-0.0890	208.1	0.360	0.366	0.983
0.19	blue	200.6	5.234	-0.103	0.005	0.367	0.396	0.928	-0.0885	208.1	0.337	0.367	0.920
0.25	blue	204.4	5.124	-0.070	0.007	0.360	0.399	0.904	-0.0885	208.1	0.331	0.367	0.902
0.33	blue	209.3	5.064	-0.083	0.015	0.356	0.399	0.894	-0.0875	208.1	0.328	0.364	0.901
0.50	blue	219.9	5.088	-0.113	0.027	0.358	0.399	0.897	-0.0941	223.3	0.327	0.363	0.900
0.75	blue	235.3	5.184	-0.049	0.043	0.365	0.400	0.911	-0.1105	253.7	0.328	0.364	0.903
1.00	blue	250.8	5.269	0.008	0.033	0.371	0.402	0.924	-0.1211	268.9	0.331	0.362	0.915
1.50	blue	281.8	5.293	0.032	0.031	0.371	0.393	0.942	-0.1204	299.3	0.331	0.355	0.933
2.00	blue	312.7	5.231	-0.035	0.058	0.367	0.392	0.938	-0.1135	329.7	0.330	0.356	0.927
2.50	blue	343.7	5.185	0.022	0.054	0.365	0.415	0.881	-0.1093	360.1	0.329	0.377	0.872
3.00	blue	374.7	5.169	0.090	0.036	0.365	0.388	0.939	-0.1076	390.5	0.329	0.354	0.930

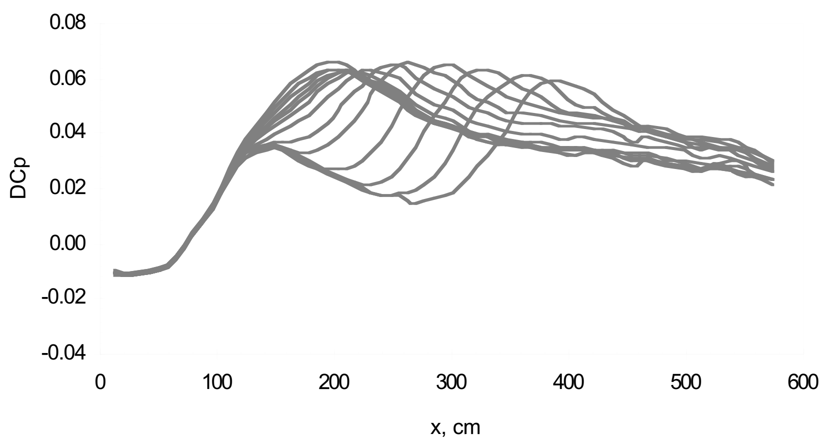
Uncorrected C_D Ratios



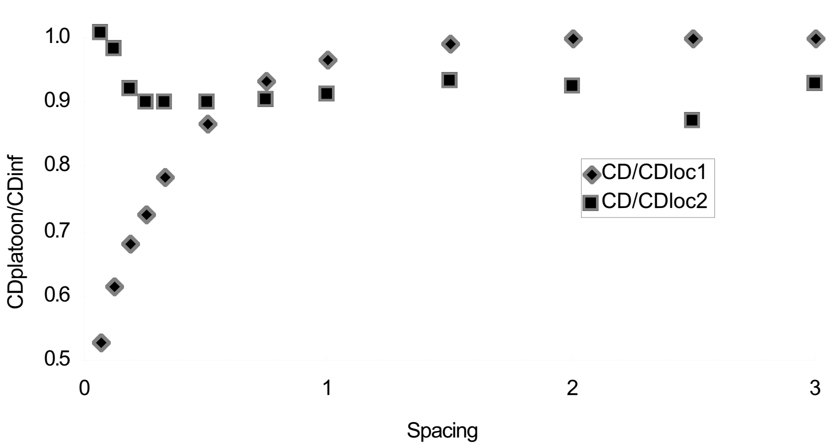
Cp distribution



ΔCp distribution



Corrected C_D Ratios

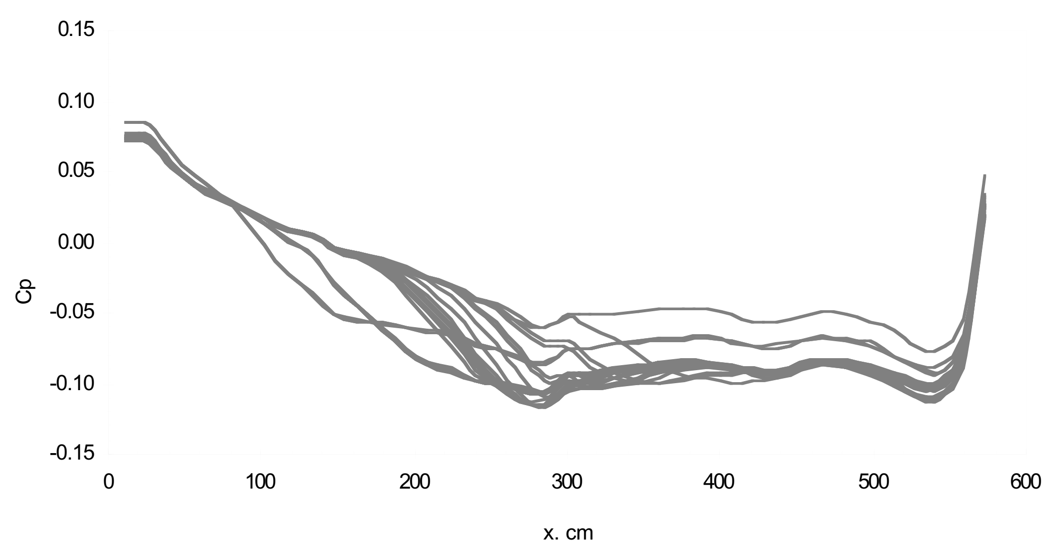


Back-to-Back Platoon Set A

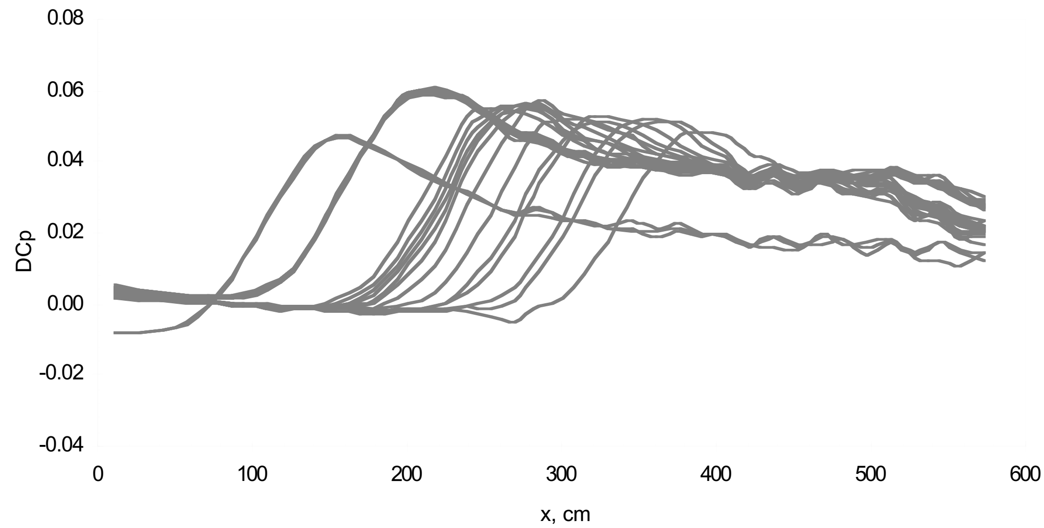
Single Car Data

Car#	Location	Drag1	SideF1	Yaw1	CDref1	Cp_max	Xlocal1	CDloc1
green	127.0	4.995	-0.038	0.016	0.348	-0.055	162.5	0.330
green	127.0	4.996	0.042	0.029	0.350	-0.055	162.5	0.332
green	127.0	5.000	0.037	0.030	0.350	-0.055	162.5	0.332
green	181.6	5.189	-0.245	0.011	0.364	-0.085	208.1	0.335
green	181.6	5.188	-0.276	0.008	0.363	-0.085	208.1	0.335
green	181.6	5.177	-0.256	0.011	0.363	-0.085	208.1	0.335
green	181.6	5.166	-0.267	0.012	0.363	-0.085	208.1	0.335
green	181.6	5.168	-0.269	0.009	0.361	-0.085	208.1	0.333
green	181.6	5.173	-0.290	0.006	0.362	-0.085	208.1	0.333
green	181.6	5.132	-0.211	0.023	0.361	-0.084	208.1	0.332
green	181.6	5.145	-0.265	0.009	0.361	-0.085	208.1	0.333
green	181.6	5.138	-0.279	0.007	0.361	-0.084	208.1	0.333
green	181.6	5.153	-0.284	0.007	0.361	-0.085	208.1	0.332
yellow	374.7	5.973	0.051	0.038	0.417	-0.095	390.5	0.381
yellow	343.7	5.983	-0.113	0.058	0.419	-0.097	375.3	0.382
yellow	312.7	6.010	-0.099	0.058	0.422	-0.102	329.7	0.383
yellow	336.4	5.973	-0.062	0.056	0.419	-0.099	360.1	0.381
yellow	305.4	6.019	-0.092	0.049	0.422	-0.101	329.7	0.384
yellow	290.0	5.979	-0.121	0.051	0.420	-0.102	299.3	0.381
yellow	274.5	6.060	0.001	0.022	0.425	-0.116	284.1	0.380
yellow	264.0	6.119	-0.156	0.044	0.429	-0.115	284.1	0.385
yellow	259.0	6.143	-0.217	0.052	0.429	-0.115	284.1	0.385
yellow	255.2	6.113	-0.261	0.059	0.429	-0.110	268.9	0.386
yellow	251.3	6.138	-0.280	0.065	0.430	-0.112	268.9	0.387
yellow	247.4	6.127	-0.262	0.075	0.429	-0.111	268.9	0.386
yellow	243.5	6.113	-0.264	0.084	0.429	-0.102	253.7	0.389

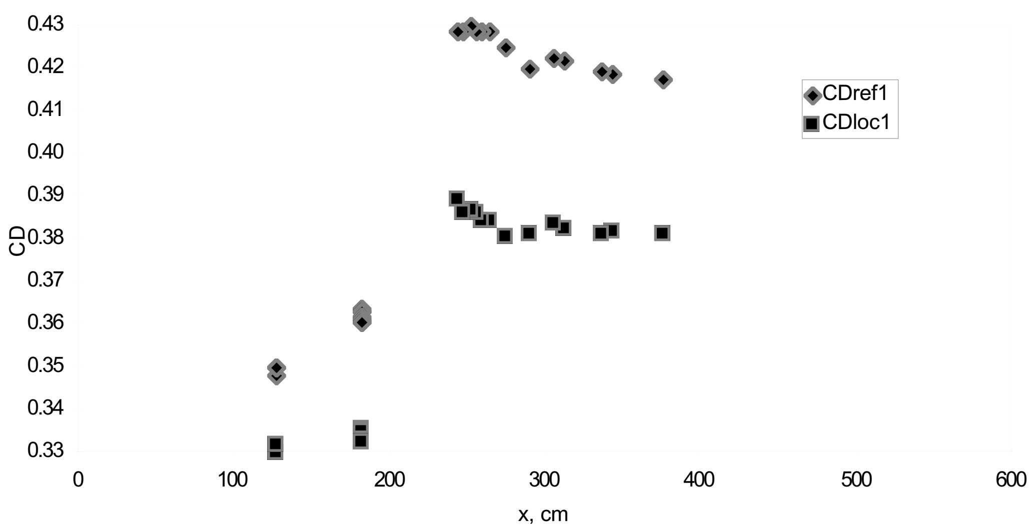
Cp distribution



ΔCp distribution



C_D scatter



Note: Rear vehicle is rear facing

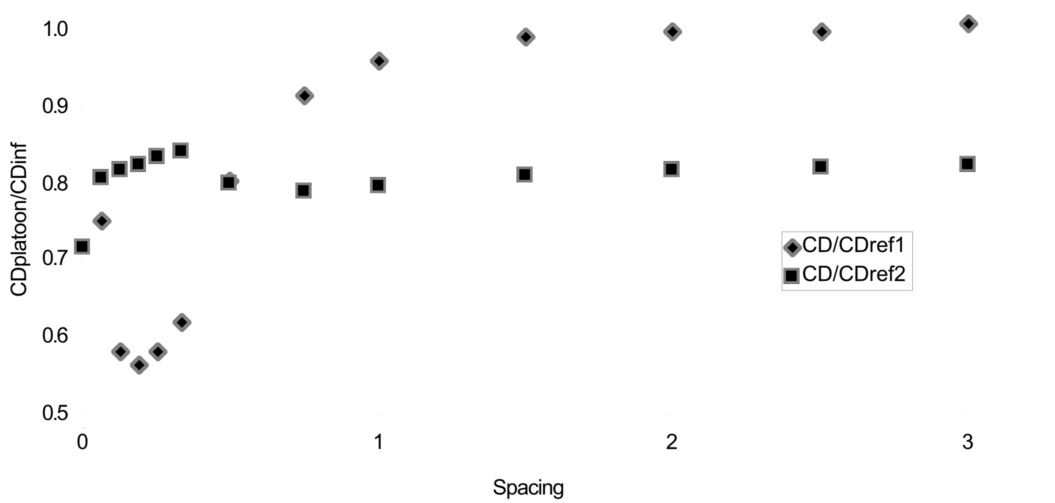
	Front Vehicle		Rear Vehicle	
	Uncorr	Corr	Uncorr	Corr
Average	0.359	0.333	0.424	0.384
Std. Dev.	0.006	0.002	0.005	0.003

2-Car Platoon Data

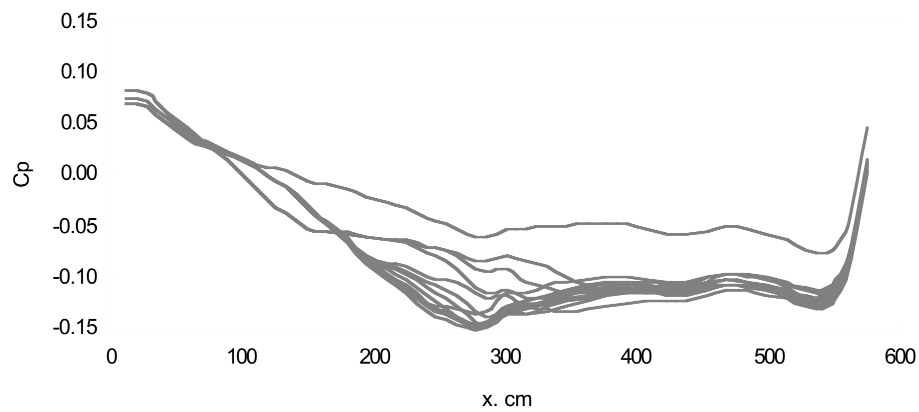
Spacing	Car#1	x1	Drag1	Side1	Yaw1	CDref1	CDinf1_ref	CD/CDref1	Cploc1	Xloc1	CDloc1	CDinf1_loc	CD/CDloc1
3.00	green	127.0	5.033	0.041	0.032	0.351	0.348	1.009	-0.0541	162.48	0.333	0.330	1.010
2.50	green	127.0	4.992	0.034	0.029	0.350	0.350	0.999	-0.0539	162.48	0.332	0.332	1.000
2.00	green	127.0	5.009	0.034	0.031	0.350	0.350	1.001	-0.0536	162.48	0.332	0.332	1.002
1.50	green	181.6	5.154	-0.248	0.010	0.362	0.364	0.993	-0.0841	208.08	0.334	0.335	0.995
1.00	green	181.6	4.977	-0.327	0.001	0.349	0.363	0.961	-0.0853	208.08	0.322	0.335	0.961
0.75	green	181.6	4.745	-0.356	-0.002	0.333	0.363	0.917	-0.0874	208.08	0.306	0.335	0.914
0.50	green	181.6	4.185	-0.343	-0.001	0.292	0.363	0.805	-0.0903	208.08	0.268	0.335	0.801
0.33	green	181.6	3.199	-0.141	0.019	0.224	0.361	0.621	-0.0946	208.08	0.205	0.333	0.616
0.25	green	181.6	3.000	-0.138	0.017	0.211	0.362	0.582	-0.0942	208.08	0.192	0.333	0.577
0.19	green	181.6	2.919	-0.103	0.027	0.205	0.361	0.567	-0.0957	208.08	0.187	0.332	0.561
0.13	green	181.6	2.997	0.106	0.044	0.210	0.361	0.583	-0.0964	208.08	0.192	0.333	0.576
0.06	green	181.6	3.868	0.172	0.049	0.272	0.361	0.755	-0.0998	208.08	0.247	0.333	0.744
0.00	green	181.6	2.424	0.611	0.120	0.170	0.361	0.472	-0.0970	208.08	0.155	0.332	0.467

Spacing	Car#2	x2	Drag2	Side2	Yaw2	CDref2	CDinf2_ref	CD/CDref2	Cploc2	Xloc2	CDloc2	CDinf2_loc	CD/CDloc2
3.00	yellow	374.7	4.936	-0.055	0.047	0.345	0.417	0.825	-0.1122	390.48	0.310	0.381	0.813
2.50	yellow	343.7	4.912	-0.145	0.060	0.344	0.419	0.822	-0.1143	344.88	0.309	0.382	0.809
2.00	yellow	312.7	4.941	-0.122	0.054	0.345	0.422	0.819	-0.1190	329.68	0.309	0.383	0.806
1.50	yellow	336.4	4.855	-0.070	0.051	0.341	0.419	0.813	-0.1329	344.88	0.301	0.381	0.788
1.00	yellow	305.4	4.809	-0.120	0.055	0.337	0.422	0.799	-0.1351	314.48	0.297	0.384	0.774
0.75	yellow	290.0	4.740	-0.169	0.061	0.332	0.420	0.791	-0.1449	284.08	0.290	0.381	0.761
0.50	yellow	274.5	4.884	-0.137	0.060	0.341	0.425	0.804	-0.1483	284.08	0.297	0.380	0.781
0.33	yellow	264.0	5.164	-0.037	0.048	0.362	0.429	0.844	-0.1444	268.88	0.316	0.385	0.823
0.25	yellow	259.0	5.124	-0.008	0.047	0.359	0.429	0.838	-0.1339	253.68	0.317	0.385	0.824
0.19	yellow	255.2	5.066	-0.036	0.047	0.355	0.429	0.828	-0.1330	253.68	0.313	0.386	0.811
0.13	yellow	251.3	5.014	-0.080	0.046	0.352	0.430	0.818	-0.1333	253.68	0.310	0.387	0.803
0.06	yellow	247.4	4.940	-0.113	0.054	0.347	0.429	0.810	-0.1386	253.68	0.305	0.386	0.790
0.00	yellow	241.3	4.398	-0.406	0.125	0.309	0.429	0.720	-0.1230	238.48	0.275	0.389	0.707

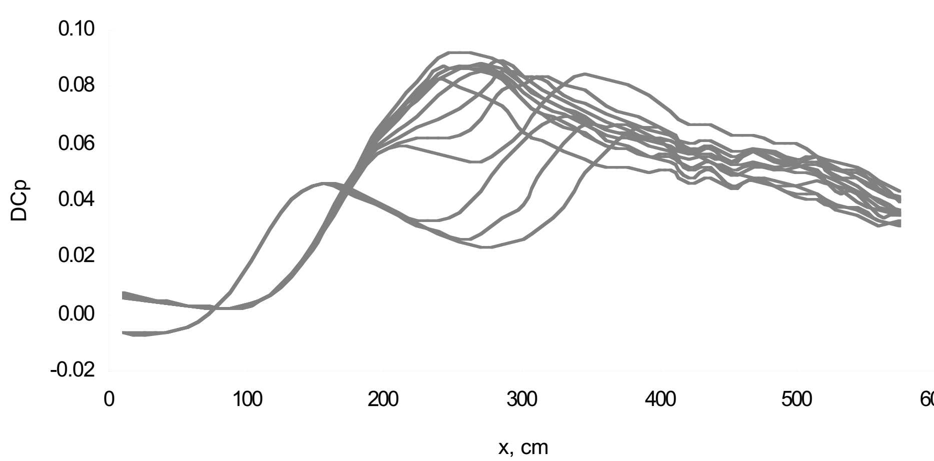
Uncorrected C_D Ratios



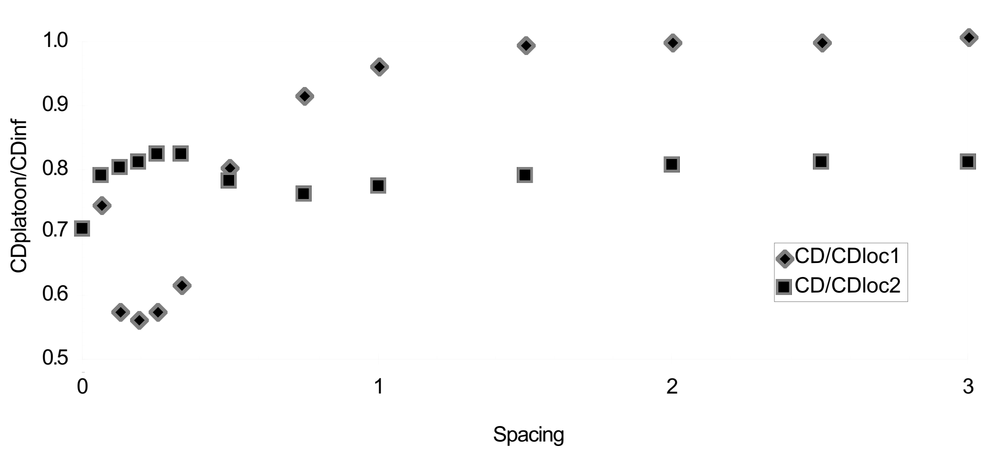
Cp distribution



ΔCp distribution



Corrected C_D Ratios

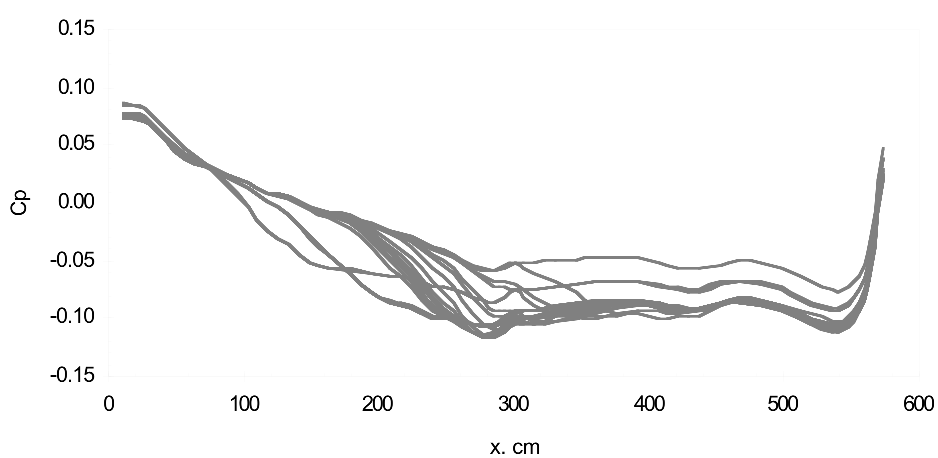


Back-to-Back Platoon Set B

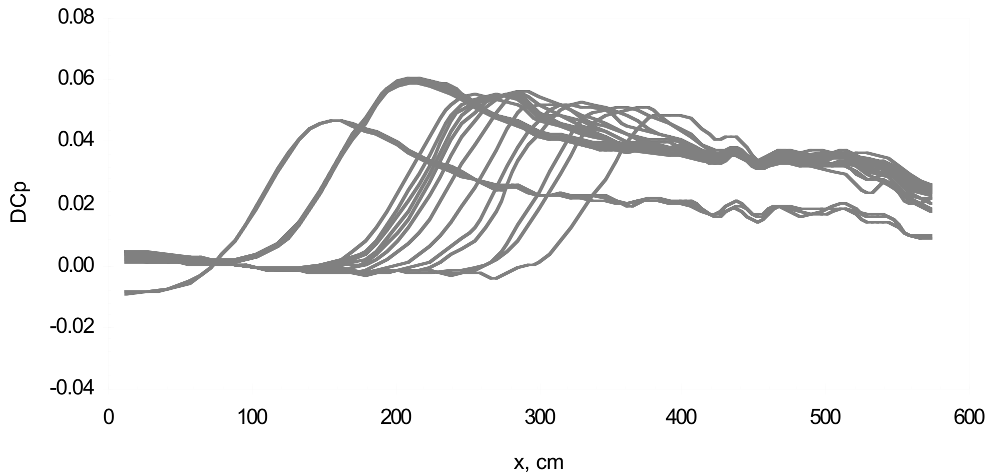
Single Car Data

Car#	Location	Drag1	SideF1	Yaw1	CDref1	Cp_max_	Xlocal1	CDloc1
Green	127.0	4.936	-0.003	0.026	0.347	-0.055	162.5	0.328
Green	127.0	4.967	0.027	0.031	0.349	-0.055	162.5	0.330
Green	127.0	4.940	0.030	0.030	0.347	-0.055	162.5	0.329
Green	181.6	5.222	-0.270	0.013	0.365	-0.085	208.1	0.337
Green	181.6	5.188	-0.299	0.008	0.363	-0.085	208.1	0.334
Green	181.6	5.168	-0.276	0.011	0.362	-0.085	208.1	0.334
Green	181.6	5.175	-0.278	0.011	0.362	-0.085	208.1	0.334
Green	181.6	5.174	-0.272	0.012	0.362	-0.085	208.1	0.333
Green	181.6	5.161	-0.276	0.011	0.362	-0.085	208.1	0.334
Green	181.6	5.184	-0.281	0.010	0.362	-0.085	208.1	0.333
Green	181.6	5.168	-0.280	0.014	0.362	-0.084	208.1	0.334
Green	181.6	5.165	-0.260	0.017	0.362	-0.085	208.1	0.334
Green	181.6	5.159	-0.274	0.014	0.362	-0.085	208.1	0.333
Yellow	374.7	5.934	0.042	0.034	0.417	-0.095	390.5	0.380
Yellow	343.7	5.989	-0.099	0.063	0.419	-0.096	375.3	0.382
Yellow	336.4	5.974	-0.059	0.059	0.418	-0.098	360.1	0.380
Yellow	312.7	5.998	-0.121	0.059	0.421	-0.102	329.7	0.382
Yellow	305.4	6.028	-0.083	0.052	0.423	-0.104	314.5	0.383
Yellow	290.0	5.959	-0.104	0.052	0.418	-0.103	314.5	0.379
Yellow	274.5	6.070	0.009	0.021	0.425	-0.115	284.1	0.381
Yellow	264.0	6.124	-0.139	0.047	0.429	-0.115	284.1	0.384
Yellow	259.0	6.132	-0.208	0.053	0.429	-0.115	284.1	0.385
Yellow	255.2	6.131	-0.268	0.061	0.429	-0.114	284.1	0.385
Yellow	251.3	6.155	-0.278	0.069	0.430	-0.111	268.9	0.388
Yellow	247.4	6.156	-0.261	0.074	0.430	-0.111	268.9	0.387
Yellow	243.5	6.142	-0.270	0.084	0.430	-0.102	253.7	0.390

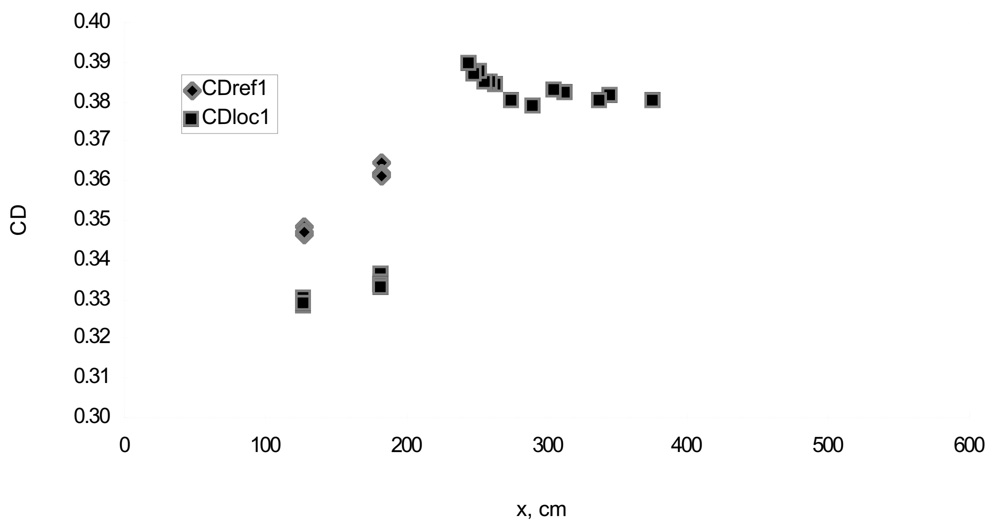
Cp distribution



ΔCp distribution



C_D scatter



Note: Rear vehicle is rear facing

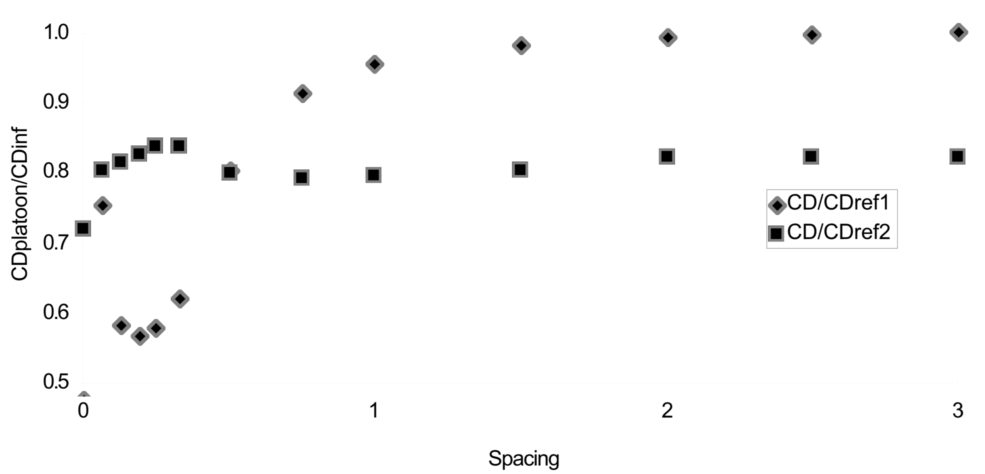
	Front Vehicle		Rear Vehicle	
	Uncorr	Corr	Uncorr	Corr
Average	0.359	0.333	0.424	0.384
Std. Dev.	0.007	0.002	0.005	0.003

2-Car Platoon Data

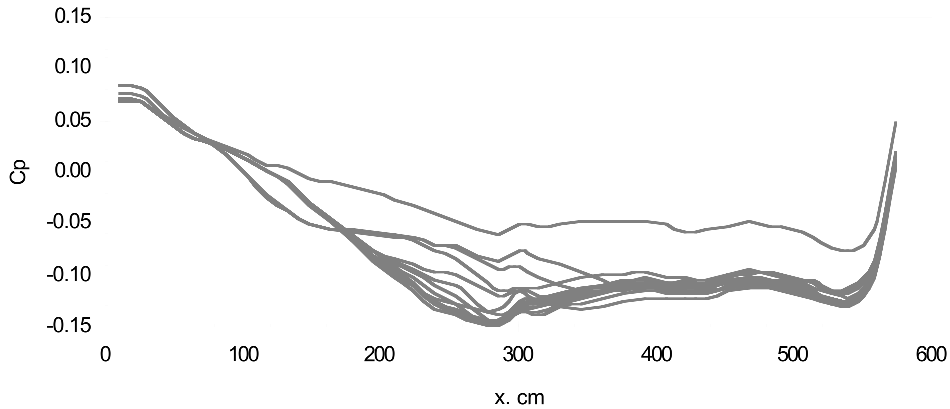
Spacing	Car#1	x1	Drag1	Side1	Yaw1	CDref1	CDinf1_ref	CD/CDref1	Cploc1	Xloc1	CDloc1	CDinf1_loc	CD/CDloc1
3.00	Green	127.0	4.940	0.025	0.030	0.347	0.347	1.002	-0.0542	162.48	0.329	0.328	1.003
2.50	Green	127.0	4.963	0.025	0.030	0.348	0.349	0.999	-0.0534	162.48	0.331	0.330	1.001
2.00	Green	127.0	4.942	-0.020	0.024	0.346	0.347	0.998	-0.0532	162.48	0.329	0.329	0.999
1.50	Green	181.6	5.115	-0.265	0.016	0.359	0.365	0.984	-0.0837	208.08	0.332	0.337	0.985
1.00	Green	181.6	4.968	-0.304	0.011	0.348	0.363	0.959	-0.0855	208.08	0.320	0.334	0.958
0.75	Green	181.6	4.744	-0.360	0.002	0.332	0.362	0.916	-0.0871	208.08	0.305	0.334	0.914
0.50	Green	181.6	4.158	-0.348	-0.002	0.292	0.362	0.805	-0.0907	208.08	0.267	0.334	0.801
0.33	Green	181.6	3.214	-0.150	0.022	0.225	0.362	0.623	-0.0941	208.08	0.206	0.333	0.618
0.25	Green	181.6	2.990	-0.157	0.017	0.210	0.362	0.580	-0.0954	208.08	0.191	0.334	0.574
0.19	Green	181.6	2.931	-0.044	0.031	0.206	0.362	0.569	-0.0961	208.08	0.188	0.333	0.563
0.13	Green	181.6	3.014	0.046	0.038	0.212	0.362	0.585	-0.0971	208.08	0.193	0.334	0.578
0.06	Green	181.6	3.892	0.170	0.050	0.273	0.362	0.754	-0.0998	208.08	0.248	0.334	0.744
0.00	Green	181.6	2.460	0.634	0.126	0.172	0.362	0.477	-0.0971	208.08	0.157	0.333	0.471

Spacing	Car#2	x2	Drag2	Side2	Yaw2	CDref2	CDinf2_ref	CD/CDref2	Cploc2	Xloc2	CDloc2	CDinf2_loc	CD/CDloc2
3.00	Yellow	374.7	4.887	-0.060	0.041	0.344	0.417	0.825	-0.1127	390.48	0.309	0.380	0.812
2.50	Yellow	343.7	4.915	-0.130	0.063	0.345	0.419	0.824	-0.1129	375.28	0.310	0.382	0.812
2.00	Yellow	312.7	4.921	-0.128	0.056	0.345	0.418	0.825	-0.1181	329.68	0.308	0.380	0.810
1.50	Yellow	336.4	4.838	-0.072	0.052	0.340	0.421	0.807	-0.1327	344.88	0.300	0.382	0.785
1.00	Yellow	305.4	4.815	-0.110	0.054	0.337	0.423	0.797	-0.1358	314.48	0.297	0.383	0.774
0.75	Yellow	290.0	4.737	-0.169	0.062	0.331	0.418	0.793	-0.1437	284.08	0.290	0.379	0.765
0.50	Yellow	274.5	4.858	-0.138	0.060	0.341	0.425	0.803	-0.1474	284.08	0.297	0.381	0.780
0.33	Yellow	264.0	5.134	-0.052	0.052	0.360	0.429	0.840	-0.1446	268.88	0.315	0.384	0.818
0.25	Yellow	259.0	5.129	-0.013	0.048	0.360	0.429	0.838	-0.1434	268.88	0.315	0.385	0.817
0.19	Yellow	255.2	5.055	-0.037	0.047	0.355	0.429	0.827	-0.1430	268.88	0.311	0.385	0.806
0.13	Yellow	251.3	5.003	-0.088	0.049	0.351	0.430	0.816	-0.1337	253.68	0.310	0.388	0.799
0.06	Yellow	247.4	4.944	-0.130	0.054	0.347	0.430	0.807	-0.1381	253.68	0.305	0.387	0.788
0.00	Yellow	243.5	4.422	-0.423	0.130	0.310	0.430	0.721	-0.1228	238.48	0.276	0.390	0.708

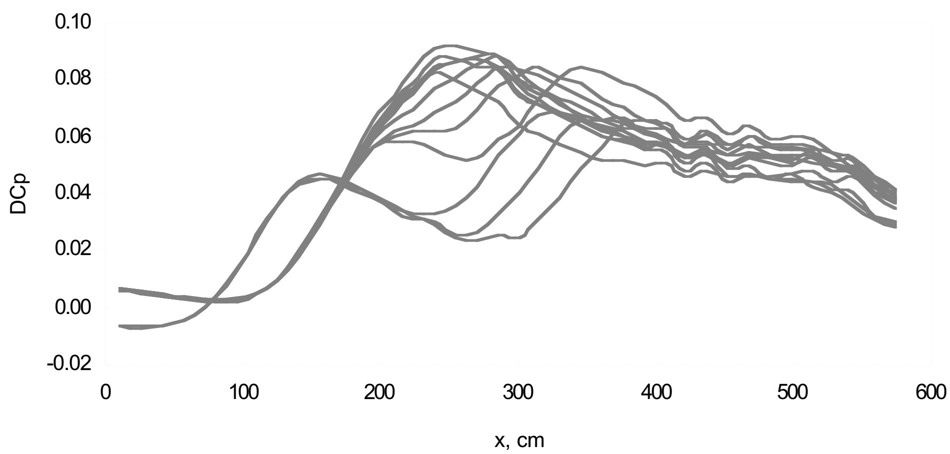
Uncorrected C_D Ratios



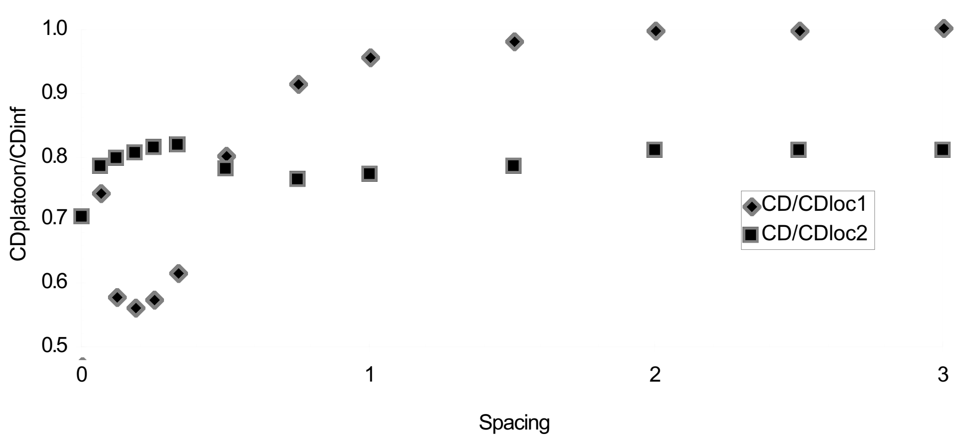
Cp distribution



ΔCp distribution



Corrected C_D Ratios



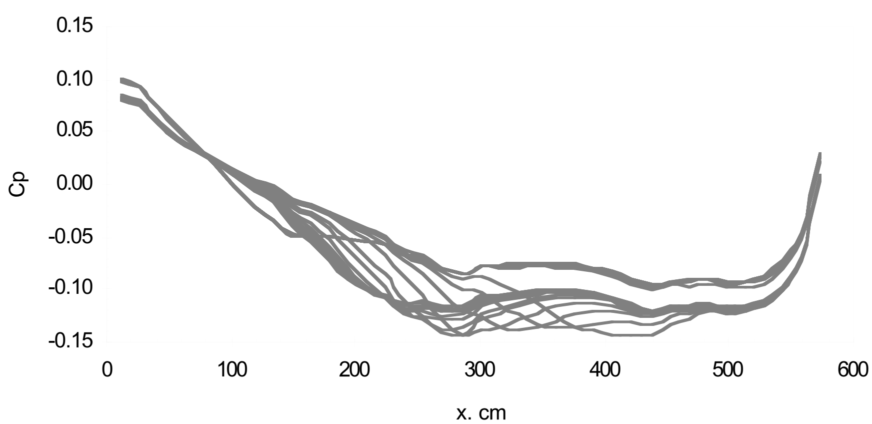
Geometry Variation Series (covered ground plane)

Forward Facing Platoon Set A

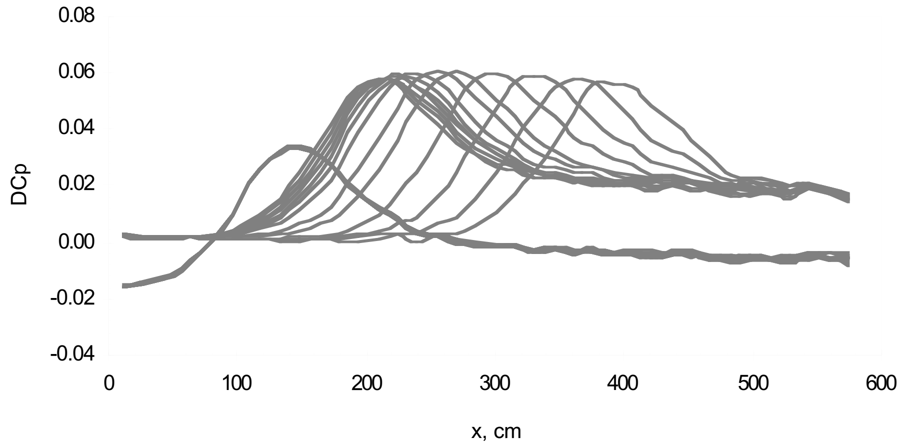
Single Car Data

Car#	Location	Drag1	SideF1	Yaw1	CDref1	Cp_max_	Xlocal1	CDloc1
blue	127.00	4.465	0.318	-0.130	0.312	-0.0471	147.3	0.298
blue	127.00	4.359	0.338	-0.092	0.305	-0.0471	147.3	0.291
blue	127.00	4.342	0.362	-0.096	0.305	-0.0468	147.3	0.291
blue	127.00	4.338	0.321	-0.100	0.304	-0.0472	147.3	0.291
blue	127.00	4.326	0.436	-0.090	0.303	-0.0466	147.3	0.290
blue	127.00	4.331	0.327	-0.098	0.304	-0.0467	147.3	0.290
blue	127.00	4.341	0.266	-0.108	0.304	-0.0469	147.3	0.291
blue	127.00	4.333	0.428	-0.088	0.303	-0.0462	147.3	0.290
blue	127.00	4.332	0.468	-0.088	0.304	-0.0468	147.3	0.290
blue	127.00	4.363	0.308	-0.103	0.305	-0.0467	147.3	0.291
blue	127.00	4.323	0.338	-0.104	0.304	-0.0466	147.3	0.290
blue	127.00	4.352	0.278	-0.104	0.304	-0.0466	147.3	0.291
blue	127.00	4.337	0.322	-0.102	0.304	-0.0472	147.3	0.290
yellow	374.65	4.511	-0.517	-0.013	0.318	-0.1346	375.3	0.280
yellow	343.70	4.441	-0.606	-0.004	0.313	-0.1360	360.1	0.275
yellow	312.74	4.533	-0.508	-0.011	0.318	-0.1367	329.7	0.280
yellow	281.78	4.626	-0.625	-0.021	0.325	-0.1369	299.3	0.285
yellow	250.83	4.701	-0.444	-0.006	0.331	-0.1394	268.9	0.290
yellow	235.35	4.727	-0.356	-0.031	0.333	-0.1281	253.7	0.295
yellow	219.87	4.768	-0.453	-0.013	0.335	-0.1216	238.5	0.299
yellow	209.34	4.753	-0.470	-0.016	0.334	-0.1198	238.5	0.298
yellow	204.39	4.715	-0.403	-0.003	0.332	-0.1077	223.3	0.300
yellow	200.55	4.739	-0.435	-0.001	0.331	-0.1071	223.3	0.299
yellow	196.65	4.712	-0.392	0.000	0.331	-0.0995	208.1	0.301
yellow	192.78	4.702	-0.415	-0.001	0.330	-0.0995	208.1	0.301
yellow	188.91	4.711	-0.368	-0.005	0.331	-0.0992	208.1	0.301

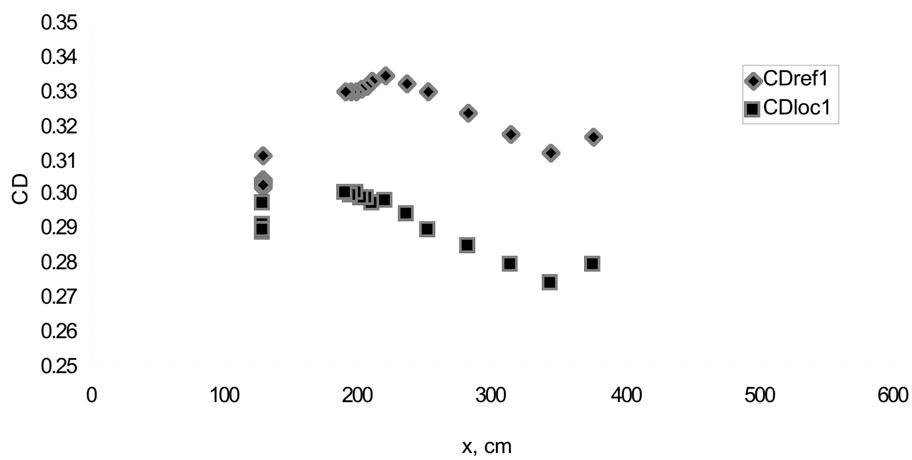
Cp distribution



ΔCp distribution



C_D scatter



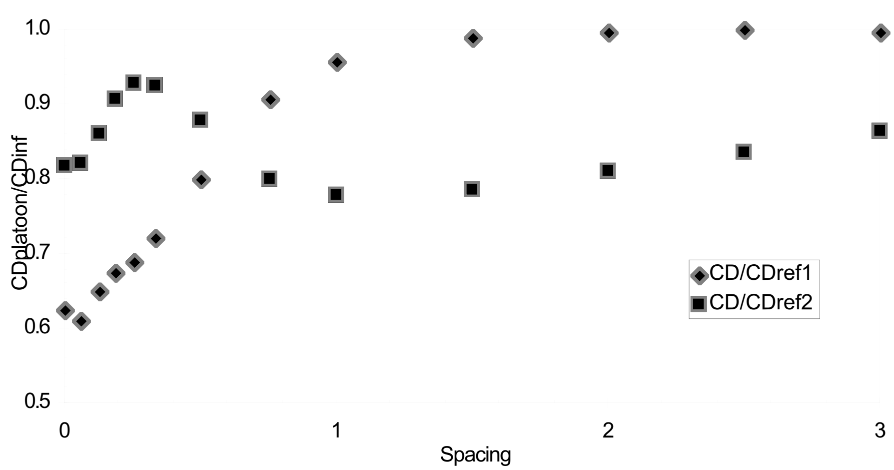
	Front Vehicle		Rear Vehicle	
	Uncorr	Corr	Uncorr	Corr
Average	0.305	0.291	0.328	0.293
Std. Dev.	0.002	0.002	0.007	0.009

2-Car Platoon Data

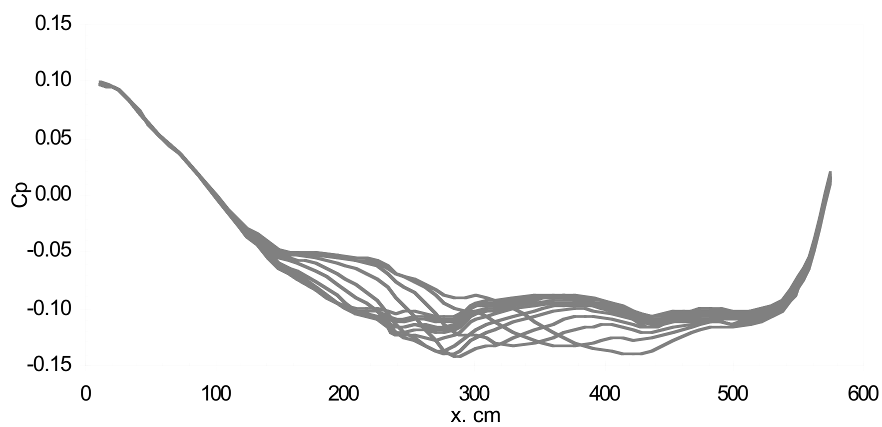
Spacing	Car#1	x1	Drag1	Side1	Yaw1	CDref1	CDinf1_	CD/CDr	Cploc1	Xloc1	CDloc1	CDinf1_	CD/CDl
3.00	blue	127.00	4.428	0.302	-0.130	0.311	0.312	0.997	-0.0473	147.28	0.297	0.298	0.997
2.50	blue	127.00	4.355	0.329	-0.093	0.305	0.305	0.999	-0.0474	147.28	0.291	0.291	0.999
2.00	blue	127.00	4.328	0.372	-0.096	0.304	0.305	0.997	-0.0476	147.28	0.290	0.291	0.996
1.50	blue	127.00	4.282	0.308	-0.102	0.301	0.304	0.989	-0.0487	147.28	0.287	0.291	0.988
1.00	blue	127.00	4.132	0.420	-0.092	0.290	0.303	0.956	-0.0505	147.28	0.276	0.290	0.953
0.75	blue	127.00	3.928	0.359	-0.095	0.276	0.304	0.908	-0.0531	147.28	0.262	0.290	0.903
0.50	blue	127.00	3.462	0.396	-0.097	0.243	0.304	0.798	-0.0576	147.28	0.230	0.291	0.790
0.33	blue	127.00	3.098	0.619	-0.073	0.218	0.303	0.720	-0.0596	147.28	0.206	0.290	0.711
0.25	blue	127.00	2.978	0.662	-0.072	0.210	0.304	0.691	-0.0607	147.28	0.198	0.290	0.682
0.19	blue	127.00	2.952	0.514	-0.085	0.206	0.305	0.676	-0.0616	147.28	0.194	0.291	0.667
0.13	blue	127.00	2.808	0.476	-0.097	0.197	0.304	0.649	-0.0622	147.28	0.186	0.290	0.640
0.06	blue	127.00	2.661	0.374	-0.102	0.186	0.304	0.612	-0.0632	147.28	0.175	0.291	0.602
0.00	blue	127.00	2.703	1.127	-0.017	0.190	0.304	0.626	-0.0631	147.28	0.179	0.290	0.617

Spacing	Car#2	x2	Drag2	Side2	Yaw2	CDref2	CDinf2_	CD/CDr	Cploc2	Xloc2	CDloc2	CDinf2_	CD/CDl
3.00	yellow	374.65	3.900	-0.511	-0.032	0.274	0.318	0.864	-0.1340	390.48	0.242	0.280	0.864
2.50	yellow	343.70	3.734	-0.586	-0.024	0.261	0.313	0.836	-0.1321	360.08	0.231	0.275	0.838
2.00	yellow	312.74	3.674	-0.511	-0.028	0.258	0.318	0.810	-0.1324	329.68	0.228	0.280	0.813
1.50	yellow	281.78	3.631	-0.573	-0.031	0.255	0.325	0.787	-0.1345	299.28	0.225	0.285	0.789
1.00	yellow	250.83	3.667	-0.413	-0.029	0.257	0.331	0.779	-0.1369	268.88	0.226	0.290	0.781
0.75	yellow	235.35	3.790	-0.377	-0.042	0.266	0.333	0.800	-0.1277	253.68	0.236	0.295	0.800
0.50	yellow	219.87	4.201	-0.471	-0.032	0.295	0.335	0.879	-0.1087	223.28	0.266	0.299	0.889
0.33	yellow	209.34	4.384	-0.454	-0.026	0.309	0.334	0.924	-0.1027	208.08	0.280	0.298	0.939
0.25	yellow	204.39	4.388	-0.406	-0.026	0.309	0.332	0.930	-0.1031	208.08	0.280	0.300	0.933
0.19	yellow	200.55	4.308	-0.397	-0.030	0.301	0.331	0.909	-0.1029	208.08	0.273	0.299	0.912
0.13	yellow	196.65	4.055	-0.415	-0.022	0.285	0.331	0.862	-0.0949	192.88	0.260	0.301	0.865
0.06	yellow	192.78	3.889	-0.394	-0.016	0.272	0.330	0.823	-0.0946	192.88	0.248	0.301	0.827
0.00	yellow	188.91	3.852	-0.887	-0.082	0.271	0.331	0.819	-0.0929	192.88	0.248	0.301	0.824

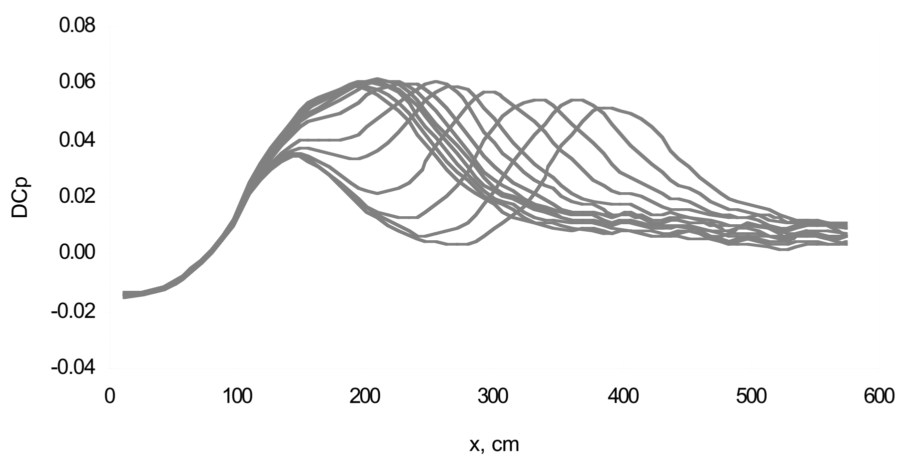
Uncorrected C_D Ratios



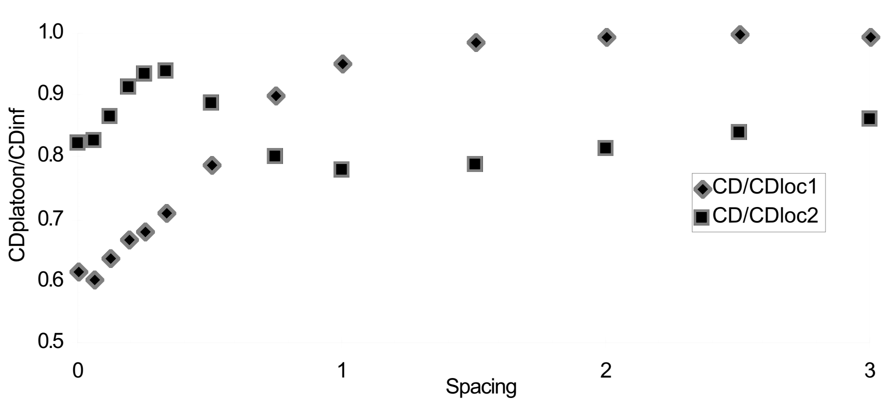
Cp distribution



ΔCp distribution



Corrected C_D Ratios

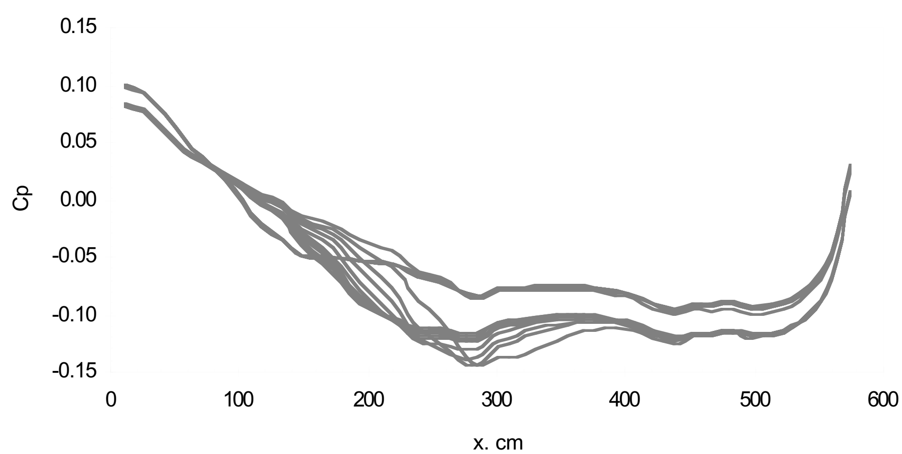


Forward Facing Platoon Set B

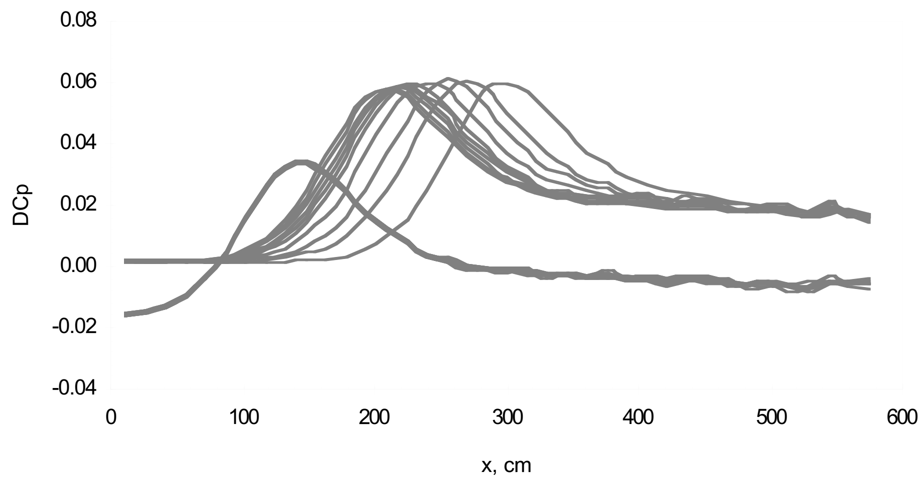
Single Car Data

Car#	Location	Drag1	SideF1	Yaw1	CDref1	Cp_max	Xlocal1	CDloc1
blue	127.0	4.378	0.200	-0.137	0.307	-0.0471	147.3	0.293
blue	127.0	4.377	0.293	-0.124	0.307	-0.0474	147.3	0.293
blue	127.0	4.386	0.318	-0.127	0.307	-0.0471	147.3	0.293
blue	127.0	4.400	0.274	-0.127	0.308	-0.0471	147.3	0.294
blue	127.0	4.405	0.314	-0.126	0.309	-0.0468	147.3	0.295
blue	127.0	4.386	0.326	-0.121	0.308	-0.0473	147.3	0.294
blue	127.0	4.417	0.343	-0.131	0.310	-0.0470	147.3	0.296
blue	127.0	4.417	0.376	-0.127	0.311	-0.0470	147.3	0.297
blue	127.0	4.447	0.264	-0.139	0.313	-0.0472	147.3	0.298
blue	127.0	4.456	0.276	-0.137	0.312	-0.0467	147.3	0.298
yellow	281.8	4.636	-0.544	0.001	0.325	-0.1369	299.3	0.286
yellow	250.8	4.720	-0.474	0.001	0.331	-0.1384	268.9	0.291
yellow	235.3	4.765	-0.418	-0.014	0.336	-0.1282	253.7	0.298
yellow	219.9	4.791	-0.461	-0.011	0.336	-0.1218	238.5	0.300
yellow	209.3	4.771	-0.447	-0.008	0.334	-0.1079	223.3	0.302
yellow	204.4	4.735	-0.401	-0.002	0.333	-0.1076	223.3	0.300
yellow	200.6	4.713	-0.431	-0.002	0.332	-0.1069	223.3	0.300
yellow	196.7	4.712	-0.410	0.002	0.331	-0.1065	223.3	0.299
yellow	192.8	4.731	-0.400	-0.034	0.332	-0.0994	208.1	0.302
yellow	188.9	4.728	-0.346	-0.016	0.331	-0.0991	208.1	0.301

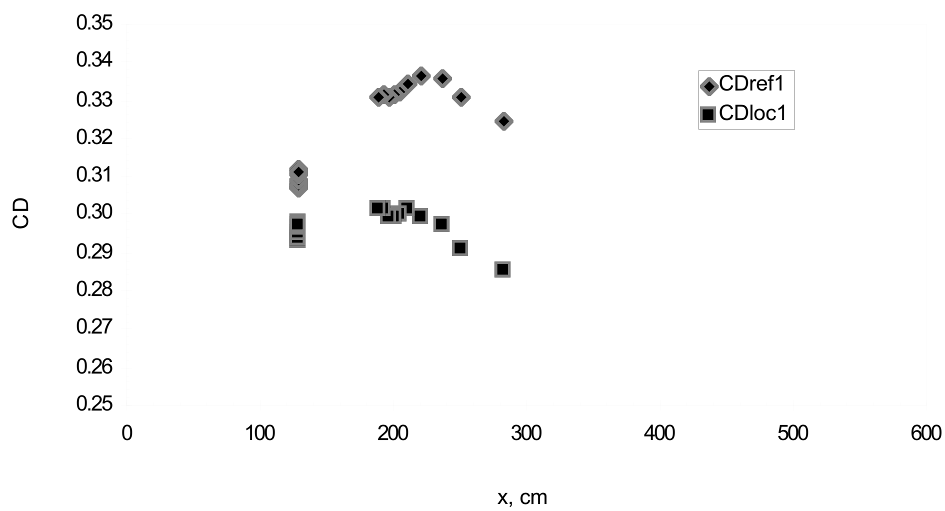
Cp distribution



ΔCp distribution



C_D scatter



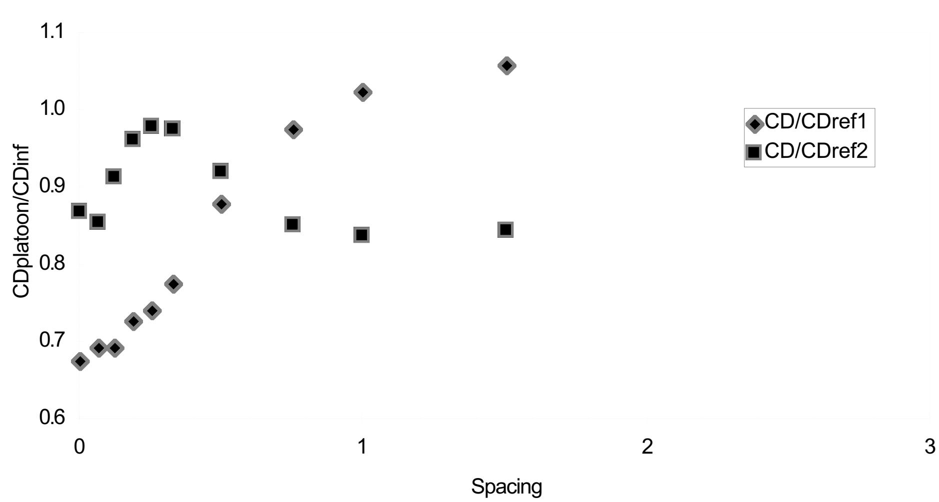
	Front Vehicle		Rear Vehicle	
	Uncorr	Corr	Uncorr	Corr
Average	0.309	0.295	0.332	0.298
Std. Dev.	0.002	0.002	0.003	0.005

2-Car Platoon Data

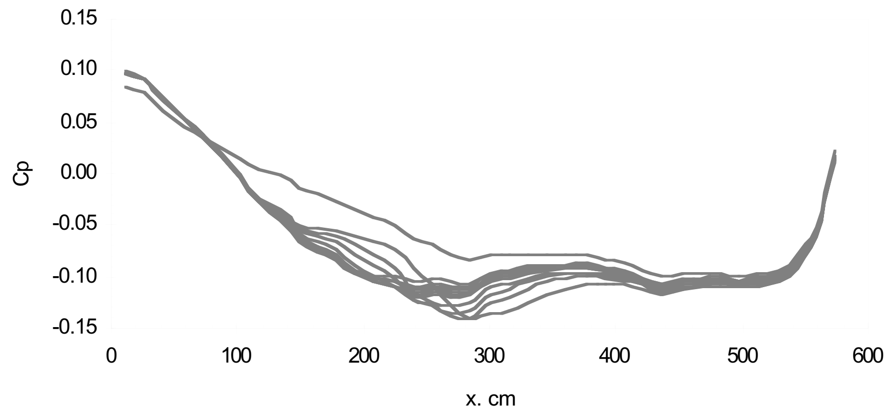
Spacing	Car#1	x1	Drag1	Side1	Yaw1	CDref1	CDinf1_r	CD/CDr	Cploc1	Xloc1	CDloc1	CDinf1_	CD/CDl
1.50	blue	127.0	4.410	0.264	-0.139	0.310	0.307	1.009	-0.0473	147.28	0.297	0.293	1.014
1.00	blue	127.0	4.241	0.282	-0.138	0.299	0.307	0.973	-0.0474	147.28	0.291	0.293	0.991
0.75	blue	127.0	4.043	0.358	-0.130	0.285	0.307	0.926	-0.0476	147.28	0.290	0.293	0.988
0.50	blue	127.0	3.624	0.440	-0.123	0.256	0.308	0.830	-0.0487	147.28	0.287	0.294	0.976
0.33	blue	127.0	3.180	0.569	-0.099	0.224	0.309	0.724	-0.0505	147.28	0.276	0.295	0.936
0.25	blue	127.0	3.043	0.503	-0.110	0.213	0.308	0.692	-0.0531	147.28	0.262	0.294	0.891
0.19	blue	127.0	2.987	0.457	-0.110	0.210	0.310	0.678	-0.0576	147.28	0.230	0.296	0.777
0.13	blue	127.0	2.854	0.500	-0.114	0.200	0.311	0.644	-0.0596	147.28	0.206	0.297	0.694
0.06	blue	127.0	2.865	-0.009	-0.174	0.201	0.313	0.644	-0.0607	147.28	0.198	0.298	0.662
0.00	blue	127.0	2.771	1.228	-0.025	0.195	0.312	0.625	-0.0616	147.28	0.194	0.298	0.653

Spacing	Car#2	x2	Drag2	Side2	Yaw2	CDref2	CDinf2_r	CD/CDr	Cploc2	Xloc2	CDloc2	CDinf2_	CD/CDl
1.50	yellow	281.8	3.677	-0.538	-0.028	0.259	0.325	0.795	-0.1340	390.48	0.242	0.286	0.846
1.00	yellow	250.8	3.709	-0.541	-0.031	0.262	0.331	0.790	-0.1321	360.08	0.231	0.291	0.793
0.75	yellow	235.3	3.829	-0.441	-0.054	0.270	0.336	0.802	-0.1324	329.68	0.228	0.298	0.764
0.50	yellow	219.9	4.150	-0.523	-0.037	0.293	0.336	0.871	-0.1345	299.28	0.225	0.300	0.751
0.33	yellow	209.3	4.397	-0.467	-0.030	0.309	0.334	0.924	-0.1369	268.88	0.226	0.302	0.750
0.25	yellow	204.4	4.405	-0.433	-0.029	0.309	0.333	0.928	-0.1277	253.68	0.236	0.300	0.786
0.19	yellow	200.6	4.300	-0.442	-0.028	0.302	0.332	0.910	-0.1087	223.28	0.266	0.300	0.887
0.13	yellow	196.7	4.080	-0.453	-0.024	0.286	0.331	0.864	-0.1027	208.08	0.280	0.299	0.934
0.06	yellow	192.8	3.805	-0.140	0.019	0.267	0.332	0.807	-0.1031	208.08	0.280	0.302	0.929
0.00	yellow	188.9	3.855	-0.952	-0.092	0.271	0.331	0.819	-0.1029	208.08	0.273	0.301	0.906

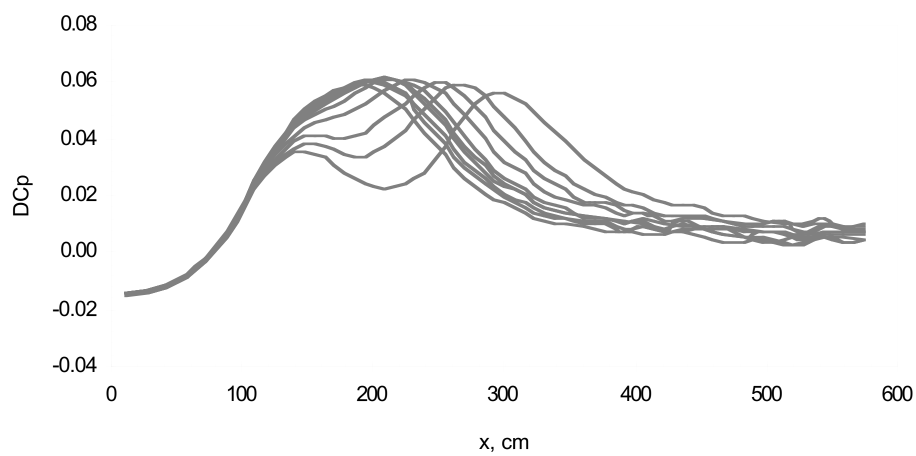
Uncorrected C_D Ratios



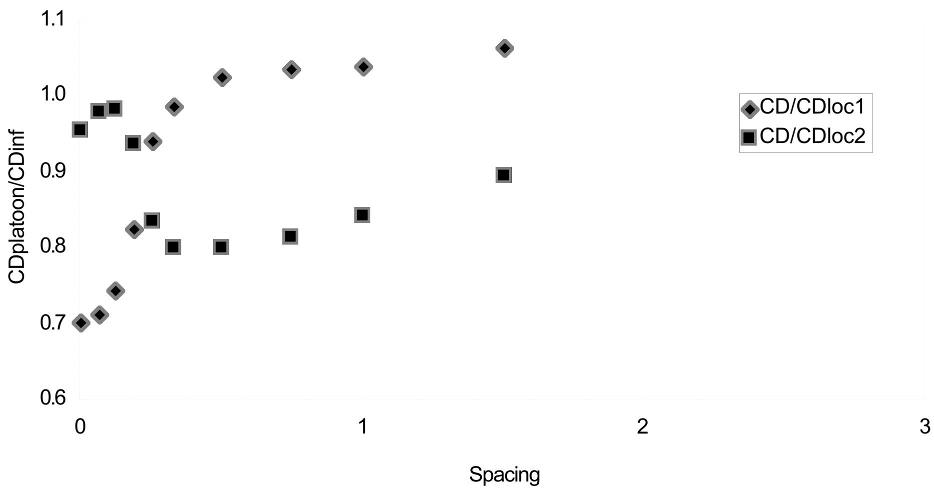
Cp distribution



ΔCp distribution



Corrected C_D Ratios

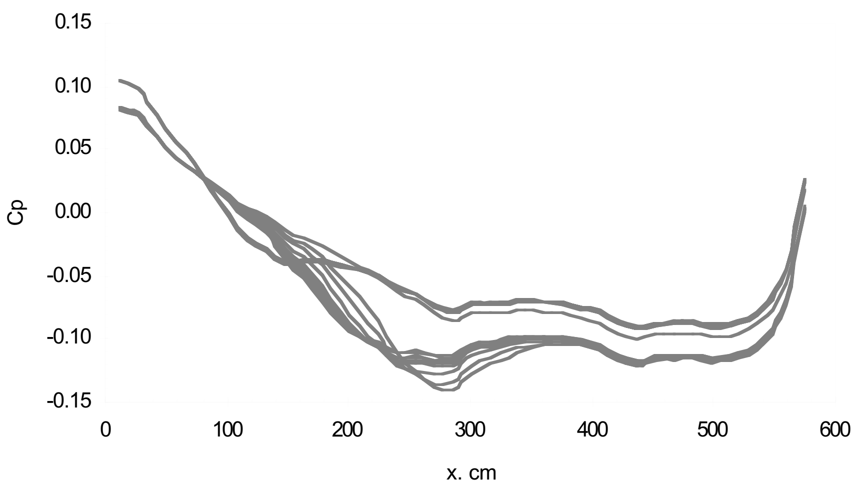

1.1
1.0
0.9
0.8
0.7
0.6
CDplatoon/CDinf
0
1
2
3
Spacing
CD/CDloc1
CD/CDloc2

Front-to-Front Platoon Set A

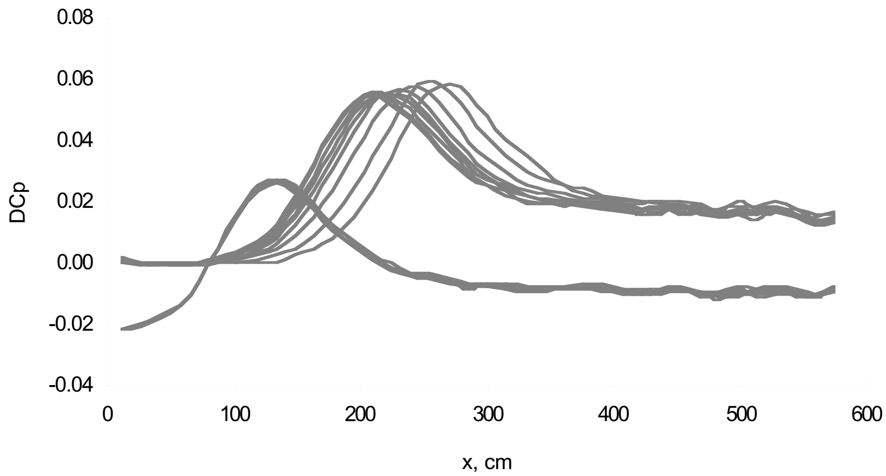
Single Car Data

Car#	Locatio	Drag1	SideF1	Yaw1	CDref1	Cp_max	Xlocal	CDloc1
yellow	127	5.187	-0.103	-0.025	0.366	-0.0280	132.1	0.356
yellow	127	5.189	-0.112	-0.03	0.365	-0.0280	132.1	0.355
yellow	127	5.185	-0.112	-0.034	0.364	-0.0280	132.1	0.354
yellow	127	5.23	-0.117	-0.023	0.364	-0.0279	132.1	0.354
yellow	127	5.217	-0.138	-0.022	0.364	-0.0282	132.1	0.354
yellow	127	5.247	-0.108	-0.022	0.366	-0.0282	132.1	0.355
yellow	127	5.243	-0.111	-0.022	0.365	-0.0280	132.1	0.355
yellow	127	5.31	-0.222	-0.02	0.372	-0.0290	132.1	0.361
yellow	127	5.318	-0.223	-0.019	0.372	-0.0294	132.1	0.361
blue	188.9	4.533	-0.325	0.004	0.318	-0.0978	208.1	0.290
blue	192.8	4.566	-0.625	-0.03	0.321	-0.0981	208.1	0.292
blue	196.7	4.543	-0.566	-0.009	0.319	-0.0981	208.1	0.290
blue	200.6	4.55	-0.579	-0.015	0.319	-0.1051	223.3	0.289
blue	204.4	4.522	-0.497	0.002	0.317	-0.1052	223.3	0.287
blue	209.3	4.546	-0.573	-0.004	0.318	-0.1060	223.3	0.287
blue	219.9	4.536	-0.618	-0.006	0.317	-0.1199	238.5	0.283
blue	235.3	4.494	-0.365	0.036	0.314	-0.1267	253.7	0.278
blue	250.8	4.552	-0.625	-0.042	0.316	-0.1370	268.9	0.278

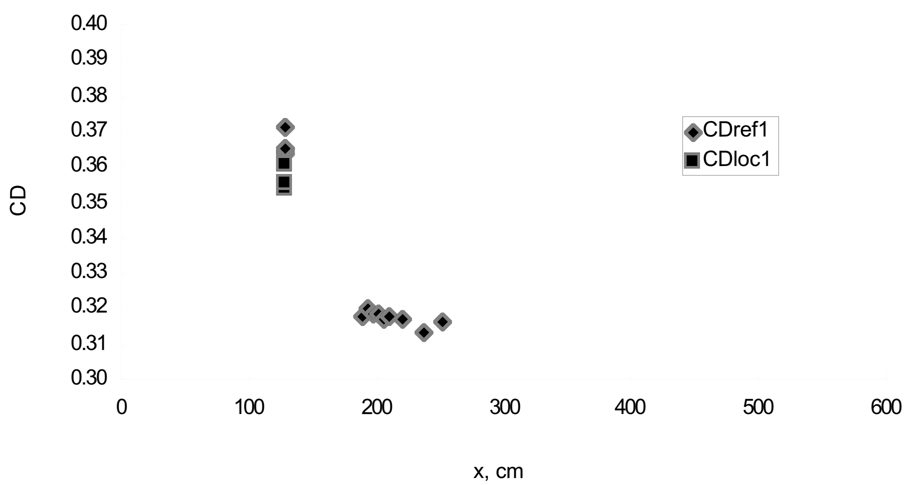
Cp distribution



ΔCp distribution



C_D scatter



Note: Front vehicle is rear facing

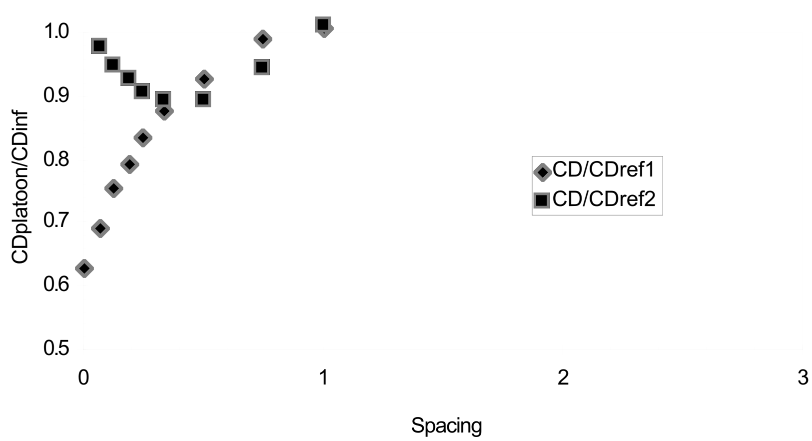
	Front Vehicle		Rear Vehicle	
	Uncorr	Corr	Uncorr	Corr
Average	0.366	0.356	0.318	0.286
Std. Dev.	0.003	0.003	0.002	0.005

2-Car Platoon Data

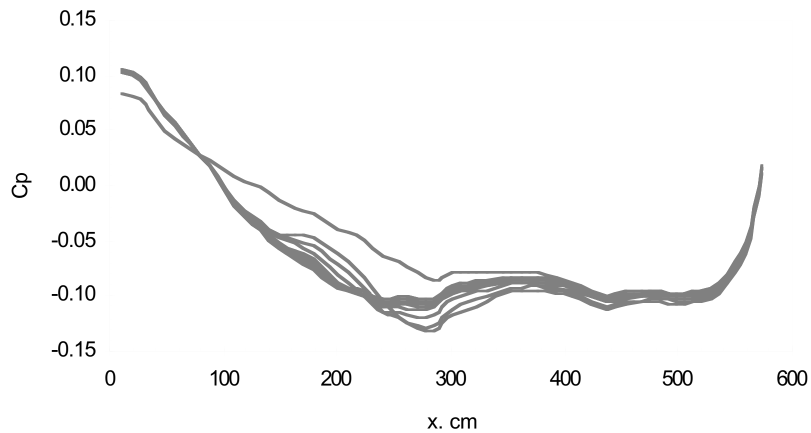
Spacing	Car#1	x1	Drag1	Side1	Yaw1	CDref1	CDinf1_	CD/CDr	Cploc1	Xloc1	CDloc1	CDinf1_	CD/CDl
0.000	yellow	127.0	3.196	-0.062	-0.022	0.224	0.356	0.631	-0.0389	132.1	0.216	0.356	0.607
0.062	yellow	127.0	3.490	-0.061	-0.023	0.246	0.355	0.692	-0.0388	132.1	0.237	0.355	0.666
0.125	yellow	127.0	3.819	-0.054	-0.024	0.268	0.354	0.756	-0.0382	132.1	0.258	0.354	0.728
0.188	yellow	127.0	4.017	-0.090	-0.015	0.281	0.354	0.794	-0.0374	132.1	0.271	0.354	0.765
0.250	yellow	127.0	4.232	-0.106	-0.014	0.296	0.354	0.837	-0.0369	132.1	0.286	0.354	0.807
0.330	yellow	127.0	4.448	-0.082	-0.017	0.312	0.355	0.878	-0.0358	132.1	0.301	0.355	0.847
0.500	yellow	127.0	4.737	-0.106	-0.014	0.331	0.355	0.931	-0.0336	132.1	0.320	0.355	0.900
0.750	yellow	127.0	5.156	-0.215	-0.017	0.358	0.361	0.991	-0.0325	132.1	0.347	0.361	0.960
1.000	yellow	127.0	5.229	-0.223	-0.018	0.364	0.361	1.008	-0.0311	132.1	0.353	0.361	0.978

Spacing	Car#2	x2	Drag2	Side2	Yaw2	CDref2	CDinf2_	CD/CDr	Cploc2	Xloc2	CDloc2	CDinf2_	CD/CDl
0.000	blue	188.9	4.321	-0.228	0.001	0.303	0.290	1.046	-0.0863	192.9	0.279	0.290	0.963
0.062	blue	192.8	4.068	-0.203	0.016	0.286	0.292	0.981	-0.0859	192.9	0.264	0.292	0.903
0.125	blue	196.7	3.926	-0.270	0.012	0.275	0.290	0.948	-0.0938	208.1	0.252	0.290	0.867
0.188	blue	200.6	3.834	-0.271	0.009	0.268	0.289	0.930	-0.0932	208.1	0.246	0.289	0.851
0.250	blue	204.4	3.726	-0.270	0.012	0.261	0.287	0.909	-0.0931	208.1	0.239	0.287	0.832
0.330	blue	209.3	3.665	-0.341	0.017	0.257	0.287	0.894	-0.1000	223.3	0.234	0.287	0.813
0.500	blue	219.9	3.629	-0.409	0.026	0.254	0.283	0.895	-0.1133	238.5	0.228	0.283	0.804
0.750	blue	235.3	3.783	-0.195	0.039	0.263	0.278	0.943	-0.1193	253.7	0.235	0.278	0.843
1.000	blue	250.8	4.041	-0.334	-0.010	0.281	0.278	1.011	-0.1293	268.9	0.249	0.278	0.895

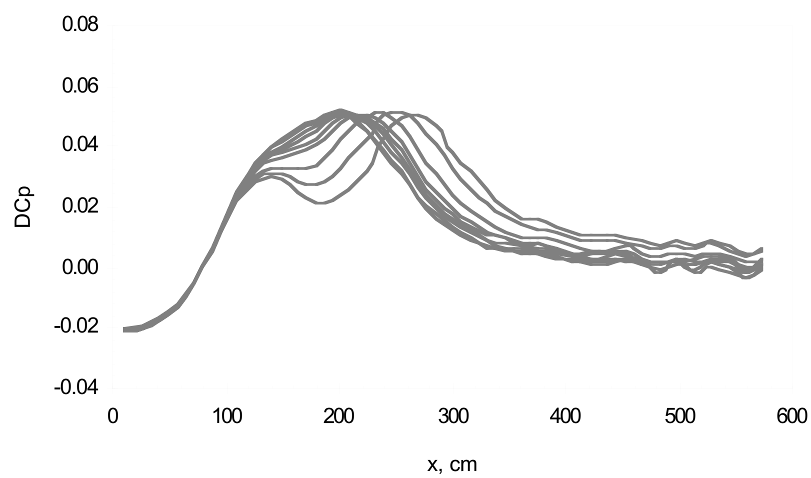
Uncorrected C_D Ratios



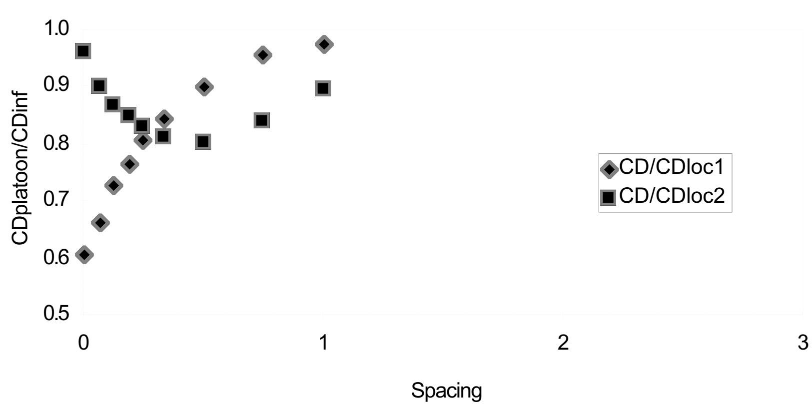
Cp distribution



ΔCp distribution



Corrected C_D Ratios

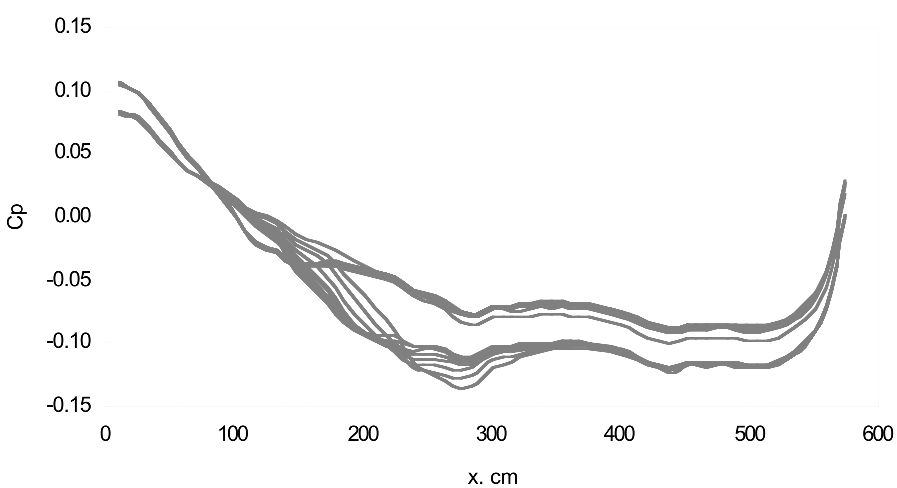


Reversed Platoon Set A

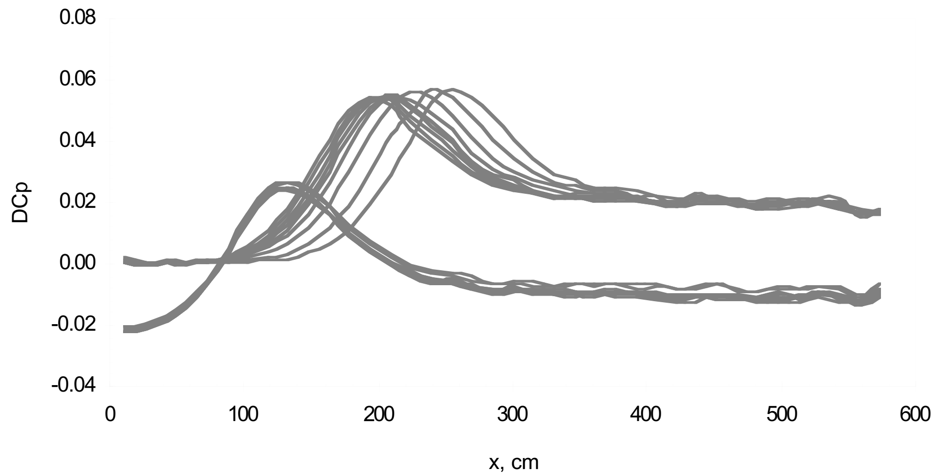
Single Car Data

Car#	Location	Drag1	SideF1	Yaw1	CDref1	Cp_max_	Xlocal1	CDloc1
blue	127.0	4.990	-0.072	0.037	0.352	-0.0284	132.1	0.342
blue	127.0	5.051	-0.129	0.049	0.356	-0.0284	132.1	0.346
blue	127.0	4.968	-0.059	0.041	0.350	-0.0265	132.1	0.341
blue	127.0	4.982	-0.059	0.041	0.350	-0.0264	132.1	0.341
blue	127.0	4.994	-0.058	0.041	0.351	-0.0264	132.1	0.342
blue	127.0	5.002	-0.052	0.045	0.351	-0.0264	132.1	0.342
blue	127.0	4.968	-0.059	0.044	0.350	-0.0262	132.1	0.341
blue	127.0	4.963	-0.044	0.042	0.350	-0.0260	132.1	0.341
blue	127.0	4.972	-0.031	0.044	0.350	-0.0259	132.1	0.341
yellow	188.9	5.434	-0.218	0.001	0.382	-0.0889	192.9	0.350
yellow	192.8	5.428	-0.198	-0.018	0.382	-0.0888	192.9	0.351
yellow	196.7	5.458	-0.186	-0.025	0.384	-0.0963	208.1	0.350
yellow	200.6	5.459	-0.181	-0.018	0.384	-0.0973	208.1	0.350
yellow	204.4	5.437	-0.191	-0.005	0.385	-0.0972	208.1	0.350
yellow	209.3	5.488	-0.173	-0.009	0.387	-0.0970	208.1	0.353
yellow	219.9	5.503	-0.145	-0.008	0.387	-0.1057	223.3	0.350
yellow	235.3	5.543	-0.169	0.003	0.390	-0.1191	238.5	0.349
yellow	250.8	5.459	-0.233	-0.018	0.385	-0.1244	253.7	0.343

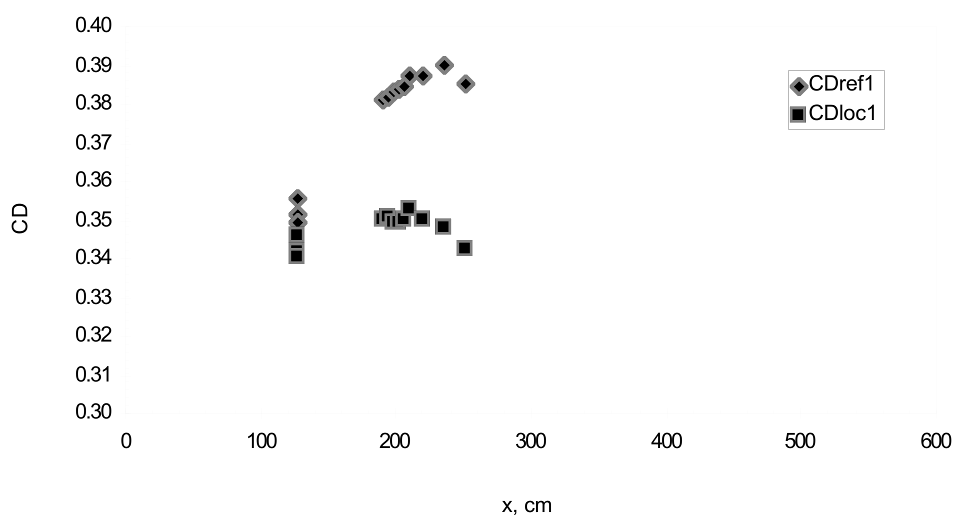
Cp distribution



ΔCp distribution



C_D scatter



Note: Both vehicles are rear facing

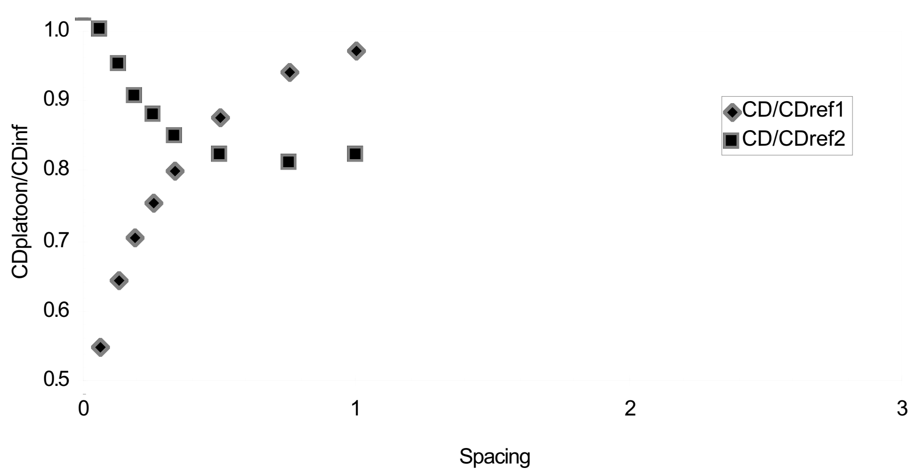
	Front Vehicle		Rear Vehicle	
	Uncorr	Corr	Uncorr	Corr
Average	0.351	0.342	0.385	0.350
Std. Dev.	0.002	0.002	0.003	0.003

2-Car Platoon Data

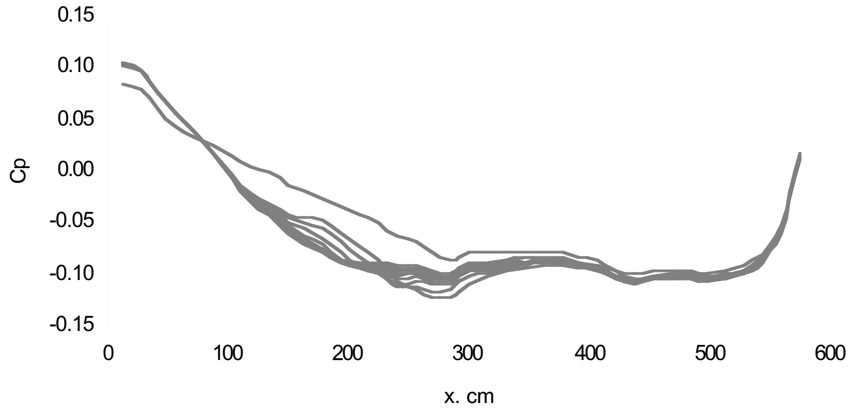
Spacing	Car#1	x1	Drag1	Side1	Yaw1	CDref1	CDinf1_r	CD/CDref	Cploc1	Xloc1	CDloc1	CDinf1_lc	CD/CDloc
0.00	blue	127.0	2.353	0.033	0.053	0.166	0.352	0.471	-0.0422	132.1	0.159	0.342	0.464
0.06	blue	127.0	2.786	-0.003	0.049	0.196	0.356	0.551	-0.0413	132.1	0.188	0.346	0.544
0.13	blue	127.0	3.212	-0.016	0.046	0.226	0.350	0.645	-0.0402	132.1	0.217	0.341	0.637
0.19	blue	127.0	3.514	-0.027	0.047	0.247	0.350	0.707	-0.0395	132.1	0.238	0.341	0.698
0.25	blue	127.0	3.759	-0.030	0.046	0.265	0.351	0.755	-0.0385	132.1	0.255	0.342	0.746
0.33	blue	127.0	4.005	-0.036	0.047	0.281	0.351	0.801	-0.0370	132.1	0.271	0.342	0.793
0.50	blue	127.0	4.364	-0.055	0.044	0.307	0.350	0.878	-0.0343	132.1	0.297	0.341	0.871
0.75	blue	127.0	4.677	-0.042	0.043	0.329	0.350	0.941	-0.0314	132.1	0.319	0.341	0.936
1.00	blue	127.0	4.813	-0.041	0.044	0.340	0.350	0.972	-0.0300	132.1	0.330	0.341	0.968

Spacing	Car#2	x2	Drag2	Side2	Yaw2	CDref2	CDinf2_r	CD/CDref	Cploc2	Xloc2	CDloc2	CDinf2_lc	CD/CDloc
0.00	yellow	188.9	5.570	-0.209	0.016	0.392	0.382	1.028	-0.0781	177.7	0.364	0.350	1.038
0.06	yellow	192.8	5.452	-0.193	0.006	0.384	0.382	1.004	-0.0870	192.9	0.353	0.351	1.006
0.13	yellow	196.7	5.201	-0.176	-0.002	0.365	0.384	0.953	-0.0866	192.9	0.336	0.350	0.961
0.19	yellow	200.6	4.957	-0.139	-0.003	0.348	0.384	0.907	-0.0869	192.9	0.320	0.350	0.916
0.25	yellow	204.4	4.801	-0.136	-0.001	0.339	0.385	0.881	-0.0857	192.9	0.312	0.350	0.891
0.33	yellow	209.3	4.701	-0.163	0.001	0.330	0.387	0.853	-0.0929	208.1	0.302	0.353	0.856
0.50	yellow	219.9	4.548	-0.202	0.017	0.320	0.387	0.825	-0.0912	208.1	0.293	0.350	0.836
0.75	yellow	235.3	4.505	-0.152	0.020	0.317	0.390	0.813	-0.1102	238.5	0.286	0.349	0.820
1.00	yellow	250.8	4.498	-0.128	-0.004	0.317	0.385	0.824	-0.1145	253.7	0.285	0.343	0.831

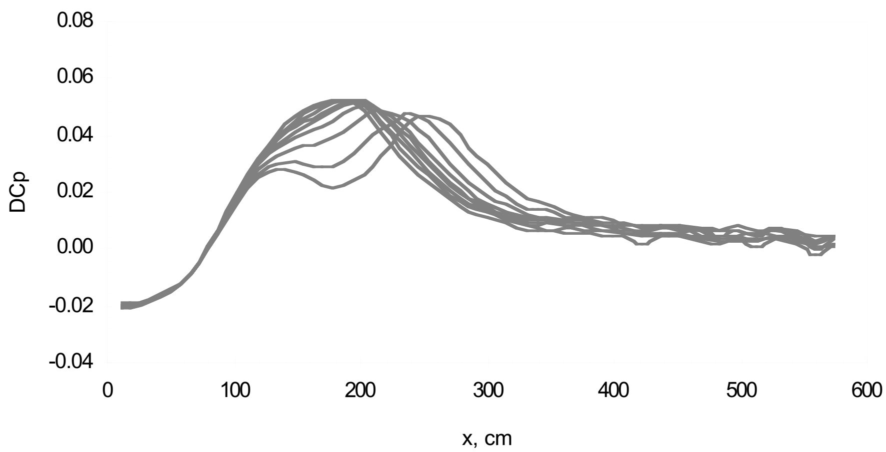
Uncorrected C_D Ratios



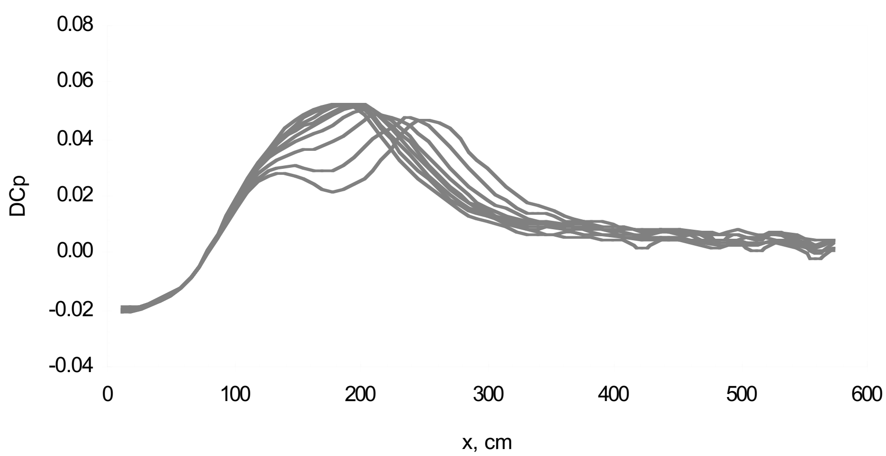
Cp distribution



ΔCp distribution



Corrected C_D Ratios

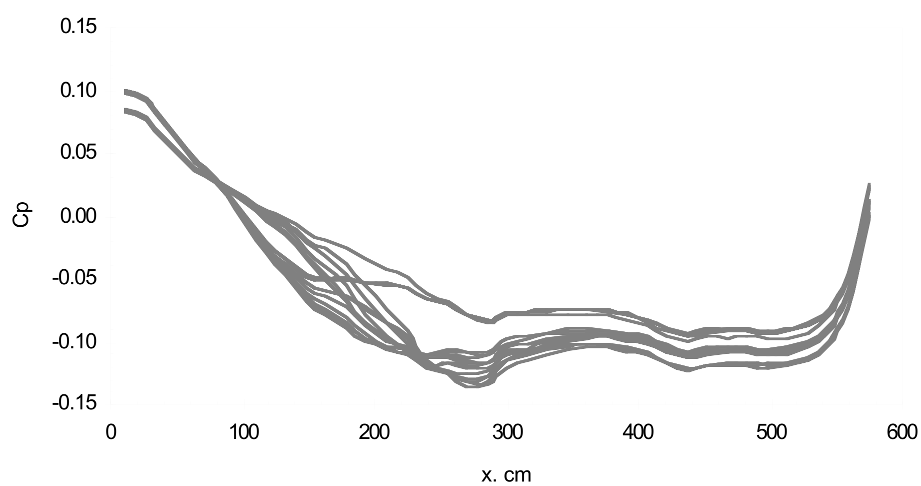


Back-to-Back Platoon Set A

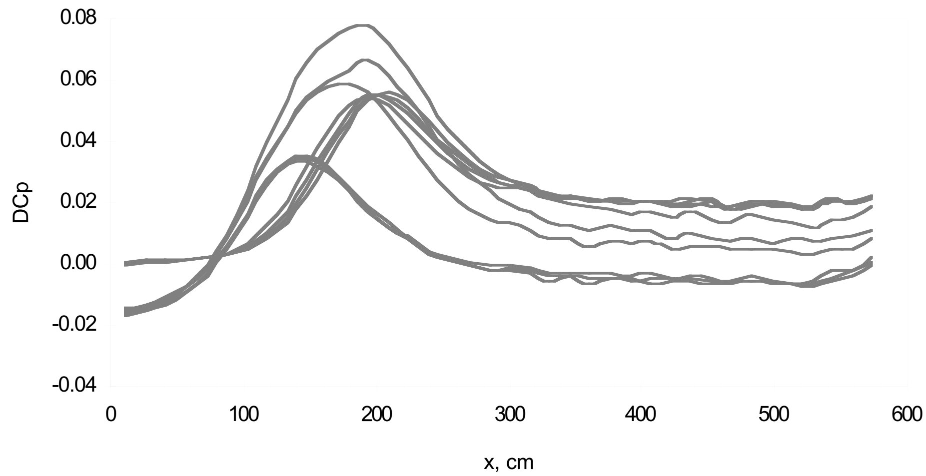
Single Car Data

Car#	Location	Drag1	SideF1	Yaw1	CDref1	Cp_max_d	Xlocal1	CDloc1
blue	127.0	4.485	-0.255	-0.005	0.310	-0.1255	253.7	0.276
blue	127.0	4.439	-0.263	-0.005	0.310	-0.1238	253.7	0.276
blue	127.0	4.343	-0.322	-0.025	0.302	-0.1217	253.7	0.269
blue	127.0	4.337	-0.318	-0.024	0.302	-0.0470	147.3	0.289
blue	127.0	4.383	-0.365	-0.035	0.304	-0.0468	147.3	0.290
blue	127.0	4.362	-0.369	-0.035	0.304	-0.1069	223.3	0.274
blue	127.0	4.360	-0.312	-0.031	0.303	-0.1191	238.5	0.271
blue	127.0	4.318	-0.312	-0.028	0.304	-0.1049	223.3	0.275
blue	127.0	4.347	-0.412	-0.043	0.305	-0.1035	208.1	0.276
yellow	188.9	5.429	-0.211	-0.013	0.382	-0.0468	147.3	0.365
yellow	192.8	5.434	-0.222	-0.004	0.381	-0.0468	147.3	0.364
yellow	196.7	5.449	-0.235	-0.006	0.381	-0.0978	192.9	0.347
yellow	200.6	5.504	-0.220	0.012	0.384	-0.0960	192.9	0.351
yellow	204.4	5.542	-0.243	0.008	0.387	-0.1057	223.3	0.350
yellow	209.3	5.529	-0.196	0.020	0.387	-0.0990	208.1	0.352
yellow	219.9	5.528	-0.204	0.008	0.385	-0.0979	192.9	0.350
yellow	235.3	5.563	-0.203	0.022	0.387	-0.0473	147.3	0.369
yellow	250.8	5.413	-0.467	0.013	0.377	-0.0470	147.3	0.360

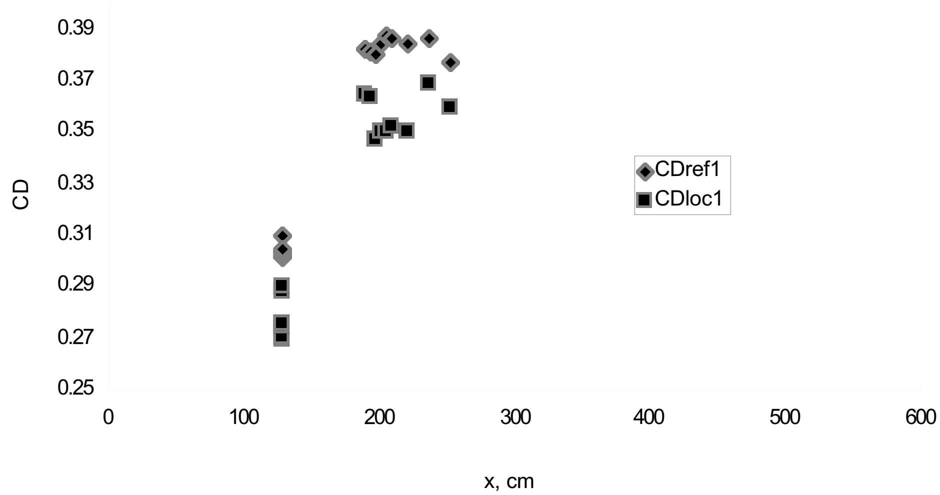
Cp distribution



ΔCp distribution



C_D scatter



Note: Rear vehicle is rear facing

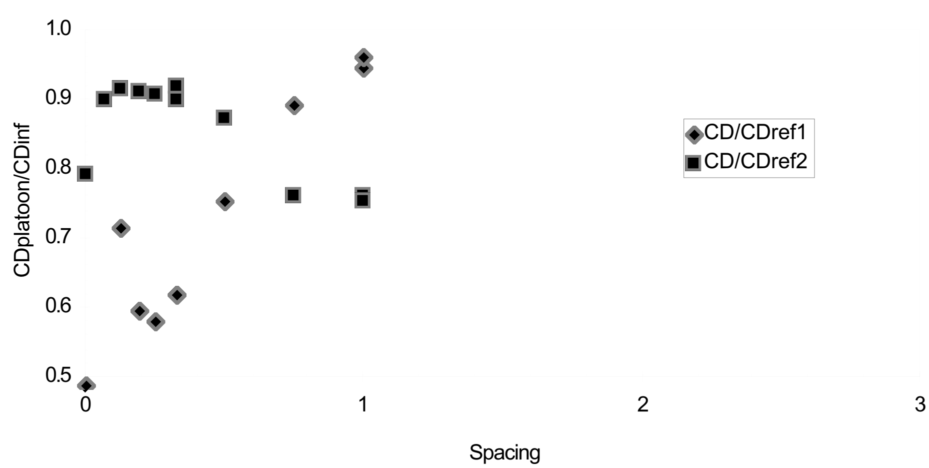
	Front Vehicle		Rear Vehicle	
	Uncorr	Corr	Uncorr	Corr
Average	0.305	0.277	0.383	0.356
Std. Dev.	0.003	0.007	0.004	0.008

2-Car Platoon Data

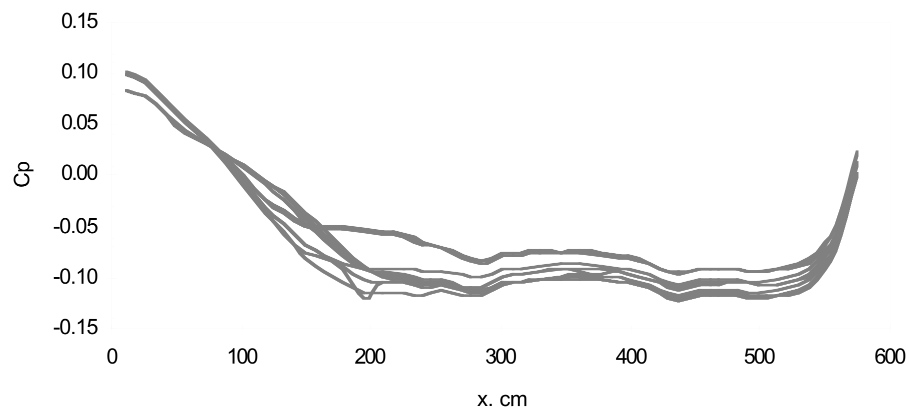
Spacing	Car#1	x1	Drag1	Side1	Yaw1	CDref1	CDinf1_	CD/CDref	Cploc1	Xloc1	CDloc1	CDinf1_	CD/CDlo
0.00	blue	127.0	2.149	-1.000	-0.114	0.151	0.310	0.487	-0.1038	253.68	0.137	0.276	0.497
0.06	blue	127.0	5.309	-0.179	-0.012	0.374	0.310	1.205	-0.1067	253.68	0.338	0.276	1.224
0.13	blue	127.0	3.104	-1.003	-0.098	0.216	0.302	0.716	-0.1050	253.68	0.196	0.269	0.727
0.19	blue	127.0	2.585	-0.567	-0.047	0.181	0.302	0.597	-0.0752	147.28	0.168	0.289	0.582
0.25	blue	127.0	2.528	-0.254	-0.016	0.176	0.304	0.580	-0.0465	147.28	0.168	0.290	0.580
0.33	blue	127.0	2.678	-0.157	0.001	0.188	0.304	0.620	-0.0570	223.28	0.178	0.274	0.649
0.33	blue	127.0	2.686	-0.199	-0.010	0.188	0.304	0.621	-0.1153	238.48	0.169	0.274	0.616
0.50	blue	127.0	3.287	-0.295	-0.018	0.229	0.303	0.754	-0.0977	223.28	0.208	0.271	0.769
0.75	blue	127.0	3.898	-0.235	0.001	0.271	0.304	0.892	-0.0538	208.08	0.257	0.275	0.936
1.00	blue	127.0	4.145	-0.318	-0.007	0.289	0.305	0.947	-0.0915	253.68	0.264	0.276	0.958
1.00	blue	127.0	4.217	-0.427	-0.026	0.293	0.305	0.962	-0.1004	253.68	0.266	0.276	0.964

Spacing	Car#2	x2	Drag2	Side2	Yaw2	CDref2	CDinf2_	CD/CDref	Cploc2	Xloc2	CDloc2	CDinf2_	CD/CDlo
0.00	yellow	188.9	4.309	0.278	-0.101	0.303	0.382	0.794	-0.1006	192.88	0.275	0.365	0.755
0.06	yellow	192.8	4.871	-0.225	0.020	0.343	0.381	0.900	-0.0977	208.08	0.312	0.364	0.858
0.13	yellow	196.7	5.003	0.016	0.000	0.348	0.381	0.915	-0.0964	208.08	0.318	0.347	0.916
0.19	yellow	200.6	5.010	-0.123	0.019	0.350	0.384	0.911	-0.1190	192.88	0.313	0.351	0.892
0.25	yellow	204.4	5.051	-0.219	0.024	0.351	0.387	0.907	-0.0465	147.28	0.336	0.350	0.958
0.33	yellow	209.3	5.057	-0.225	0.026	0.355	0.387	0.918	-0.0482	147.28	0.339	0.352	0.962
0.33	yellow	209.3	4.973	-0.245	0.029	0.349	0.387	0.902	-0.1124	192.88	0.314	0.352	0.891
0.50	yellow	219.9	4.821	-0.339	0.042	0.335	0.385	0.872	-0.0896	192.88	0.308	0.350	0.879
0.75	yellow	235.3	4.247	-0.509	0.065	0.295	0.387	0.763	-0.0471	147.28	0.282	0.369	0.763
1.00	yellow	250.8	4.116	-0.474	0.037	0.286	0.377	0.760	-0.0837	177.68	0.264	0.360	0.734
1.00	yellow	250.8	4.091	-0.439	0.035	0.284	0.377	0.754	-0.0891	192.88	0.261	0.360	0.725

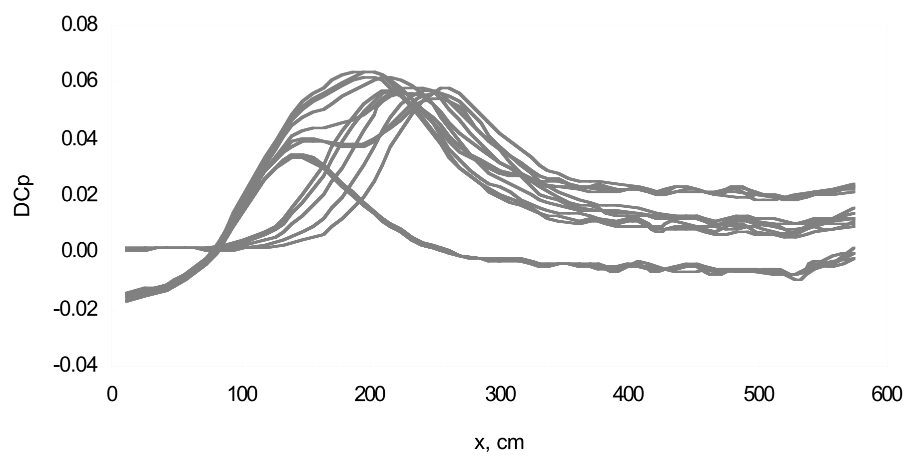
Uncorrected C_D Ratios



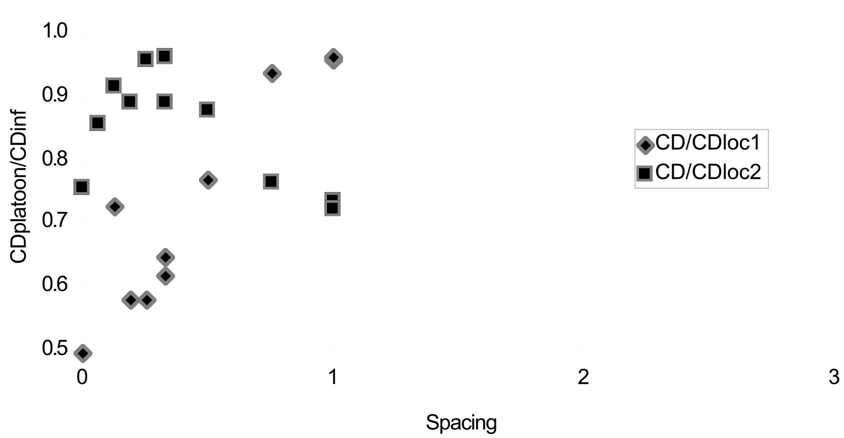
Cp distribution



ΔCp distribution



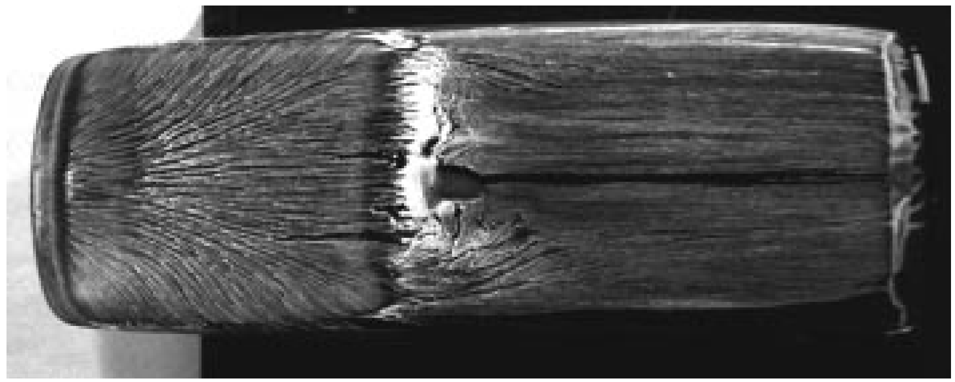
Corrected C_D Ratios



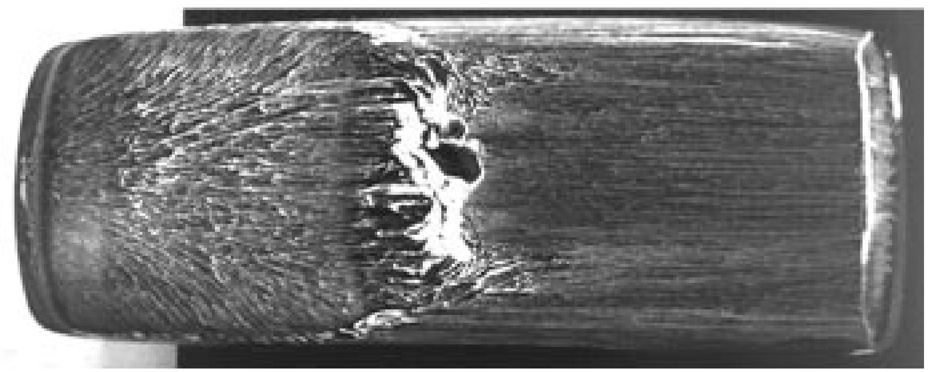
Appendix 3:

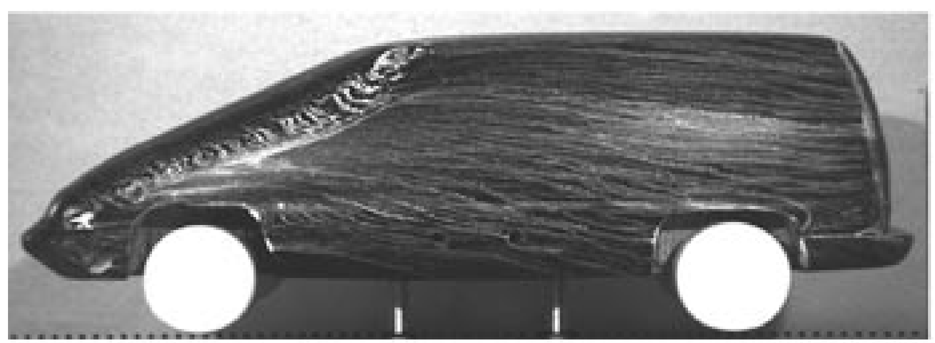
Flow Visualization

Single Car
Porous Plate

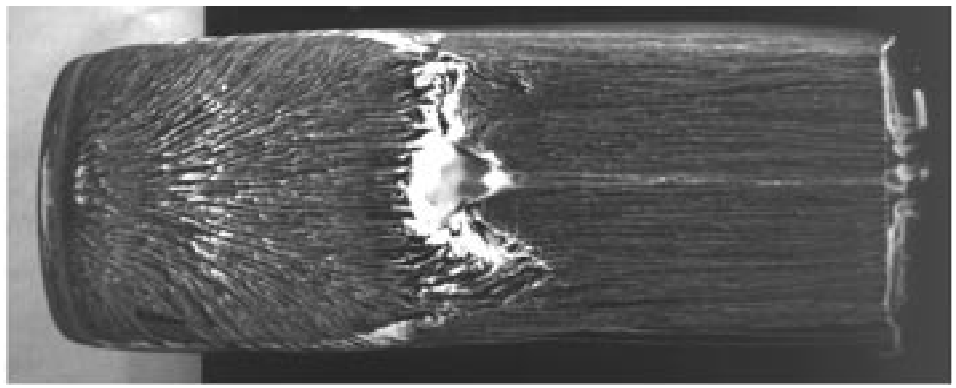


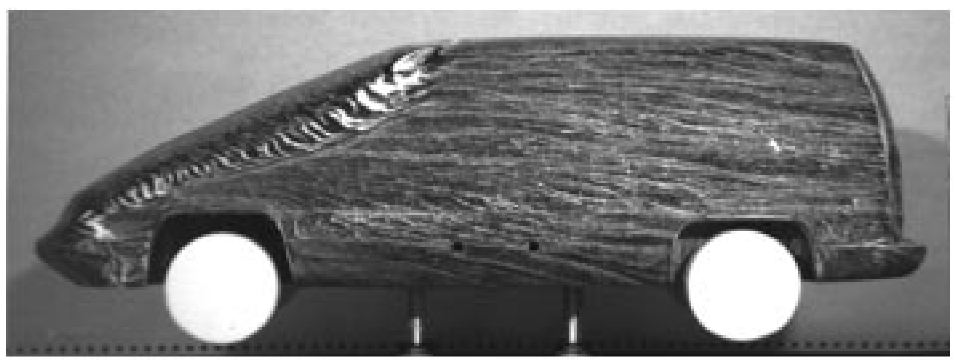
Single Car
Porous Plate



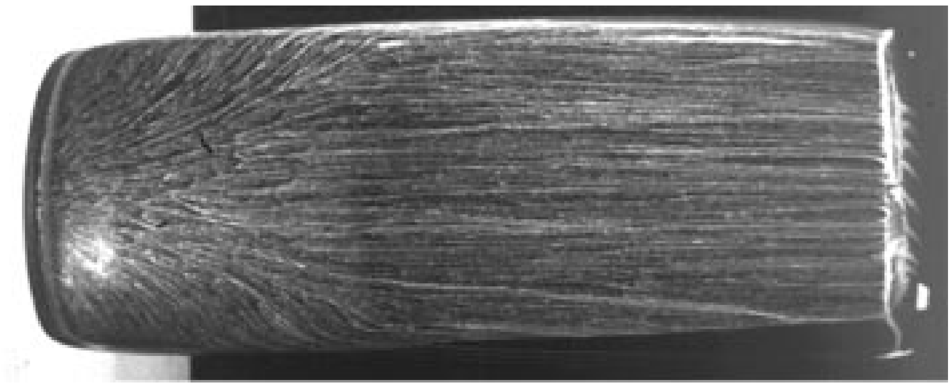


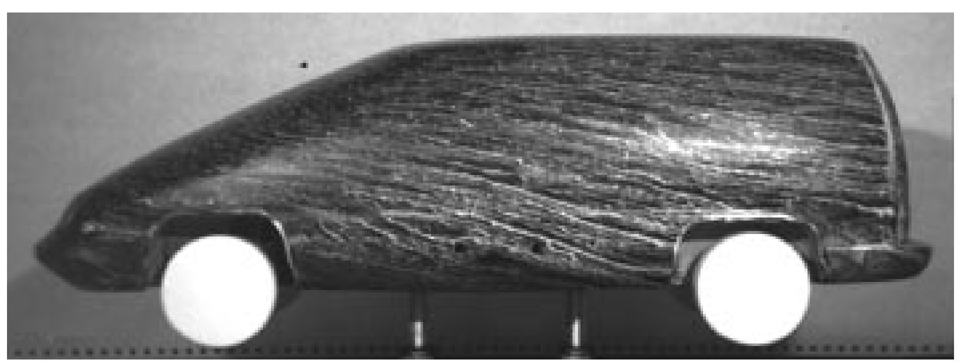
Lead Car of a 2 Car Platoon
4 Car Length Separation
Porous Plate



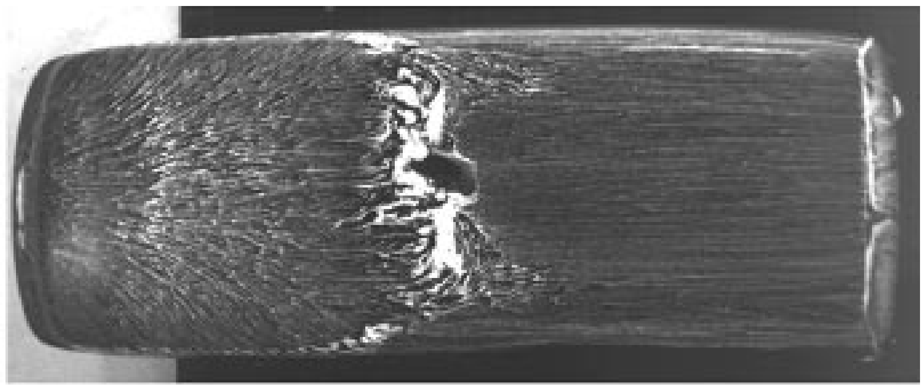


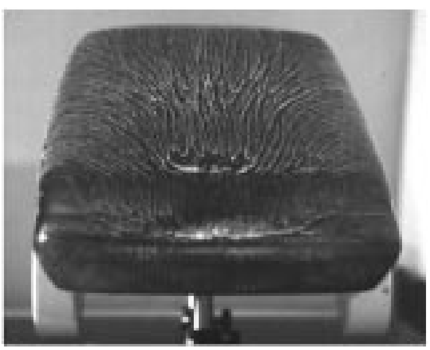
Trail Car of a 2 Car Platoon
4 Car Length Separation
Porous Plate

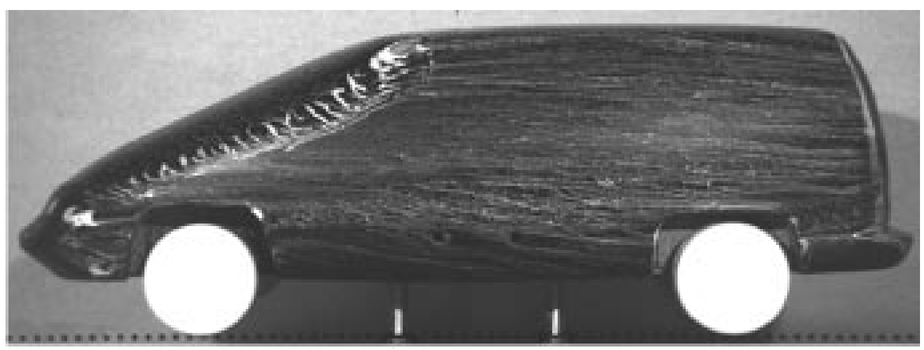




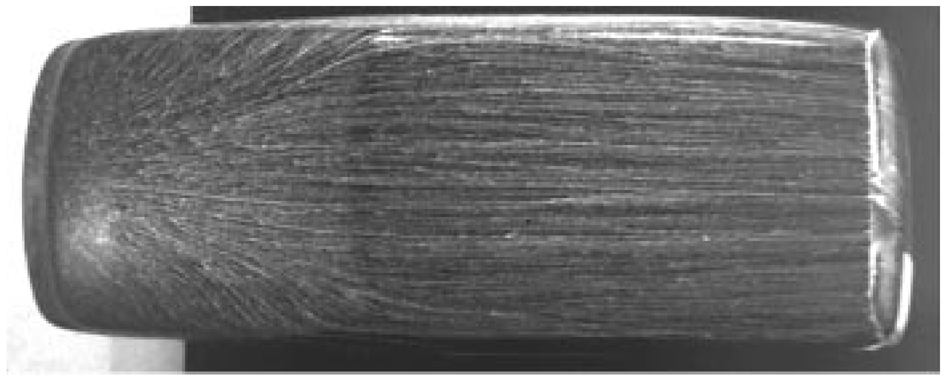
Lead Car of a 2 Car Platoon
1 Car Length Separation
Porous Plate

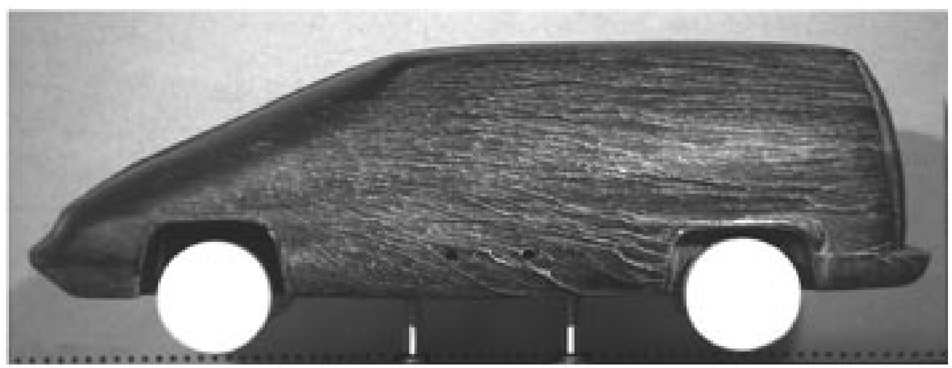




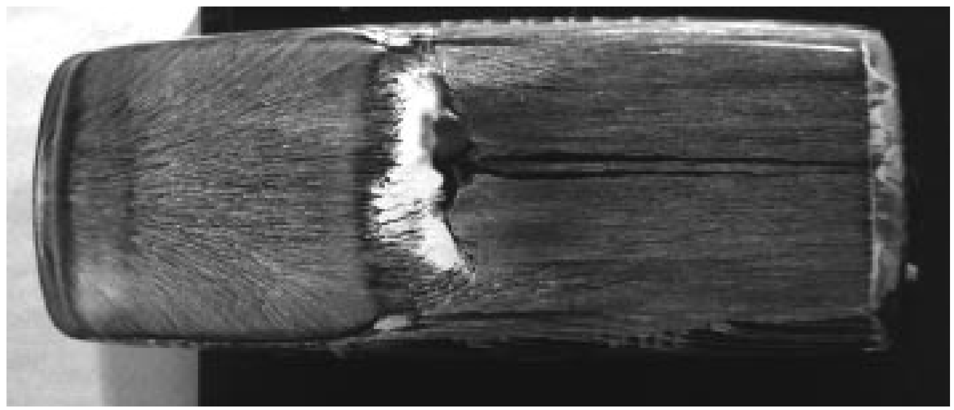


Trail Car of a 2 Car Platoon
1 Car Length Separation
Porous Plate

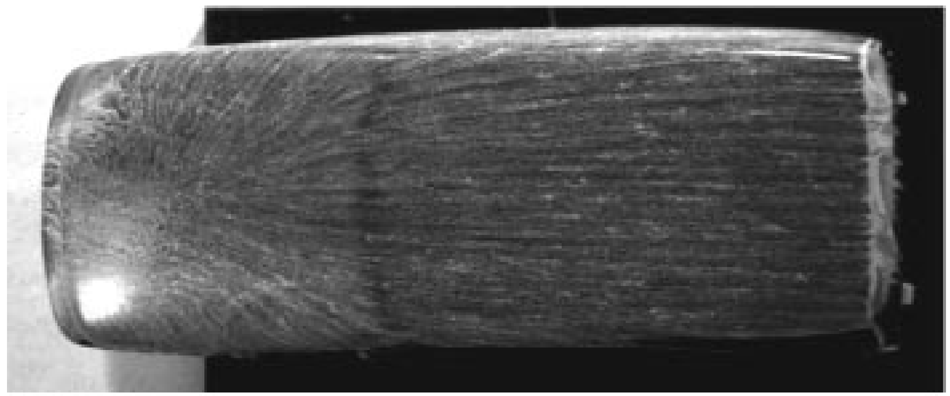


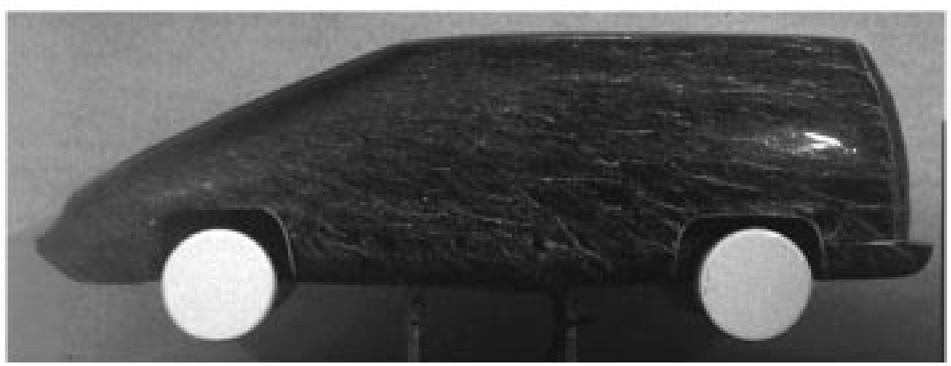


Lead Car of a 2 Car Platoon
1/4 Car Length Separation
Porous Plate

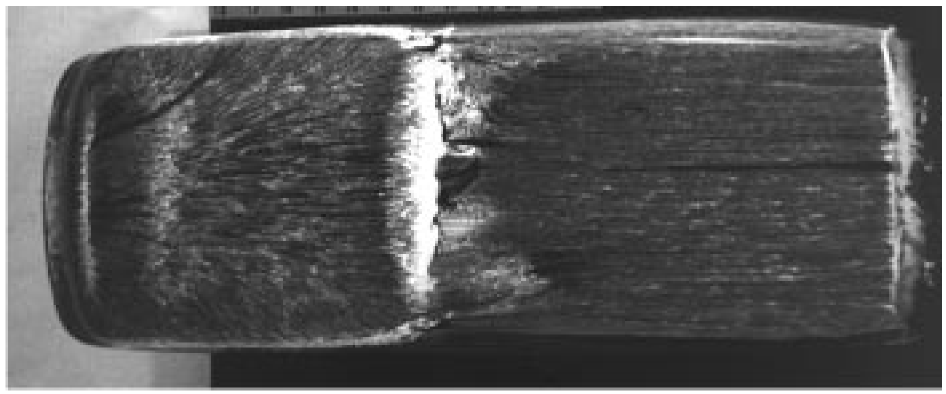


Trail Car of a 2 Car Platoon
1/4 Car Length Separation
Porous Plate

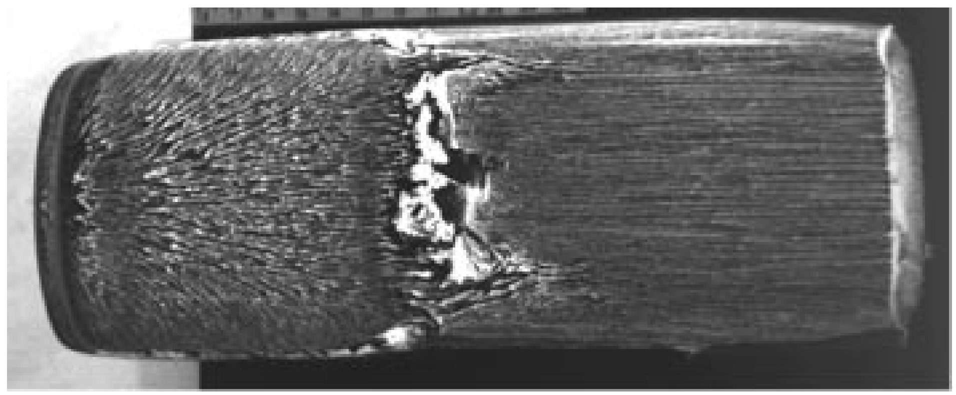


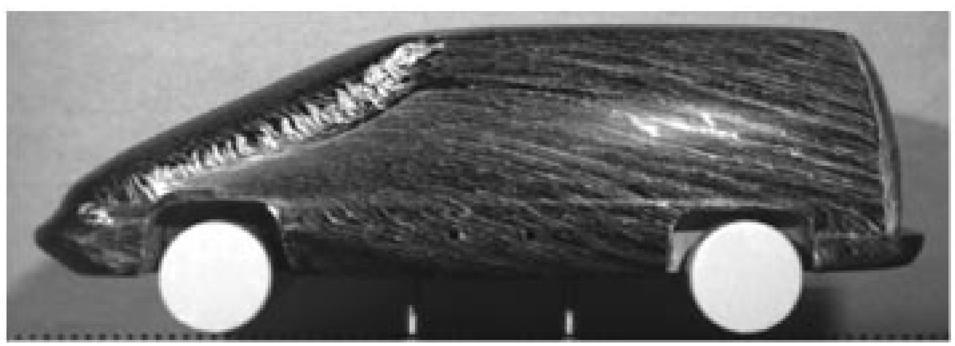


Single Car
Solid Plate

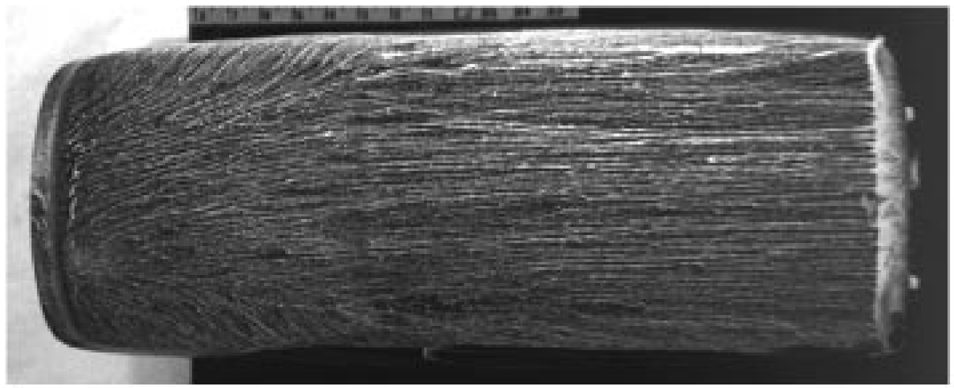


Lead Car of a 2 Car Platoon
1 Car Length Separation
Solid Plate

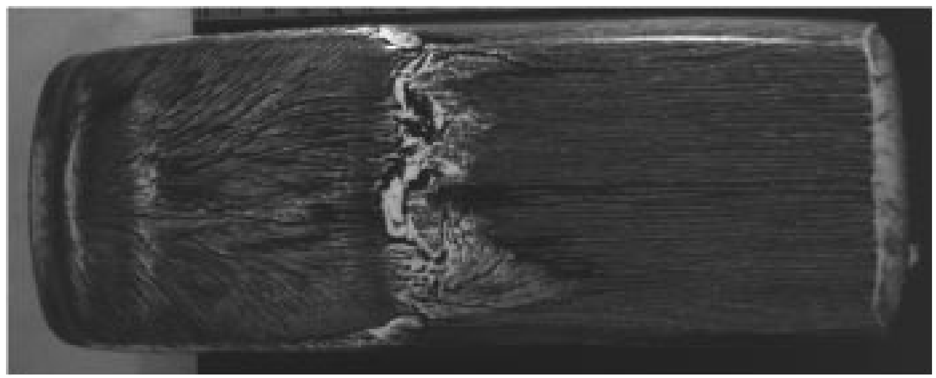


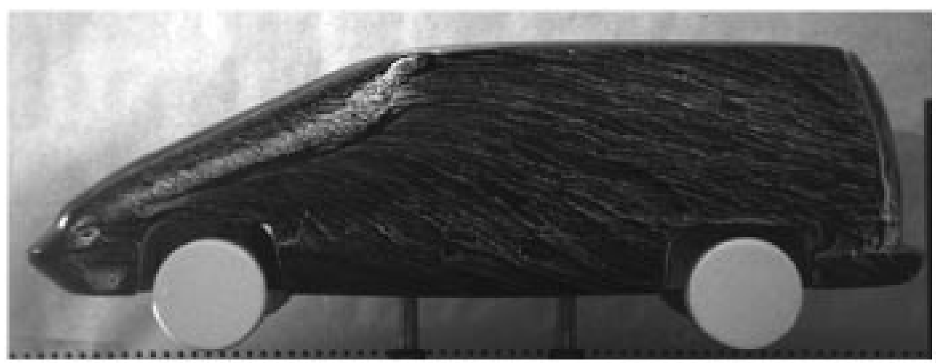


Trail Car of a 2 Car Platoon
1 Car Length Separation
Solid Plate



Lead Car of a 2 Car Platoon
1/4 Car Length Separation
Solid Plate





Trail Car of a 2 Car Platoon
1/4 Car Length Separation
Solid Plate